CNGS and North Area Operation

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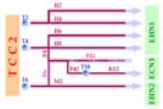
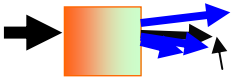
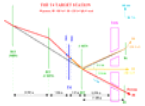
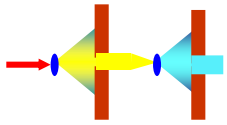
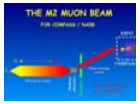
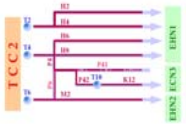
Outline

- **North Area**
  - Introduction 
  - Particle production 
  - Wobbling 
  - Secondary/tertiary beam line 
  - Access issues 
  - Operational aspects 
- **Beam lines with long-lasting Experiments**
  - M2, Compass 
  - P42, K12, NA62 
  - CNGS

The CERN Secondary Beam Line Complex

SPS North Area

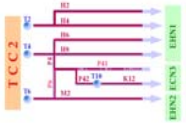
- **Three experimental halls : EHN1, EHN2, ECN3 , 3 service buildings**
- **7 beam lines ; ~1000 equipment installed ; total length 5.8 km**
- **~2000 users / year performing experiments and tests ; frequent changes of beam configuration and settings**



The CERN Secondary Beam Line Complex

PS East Area

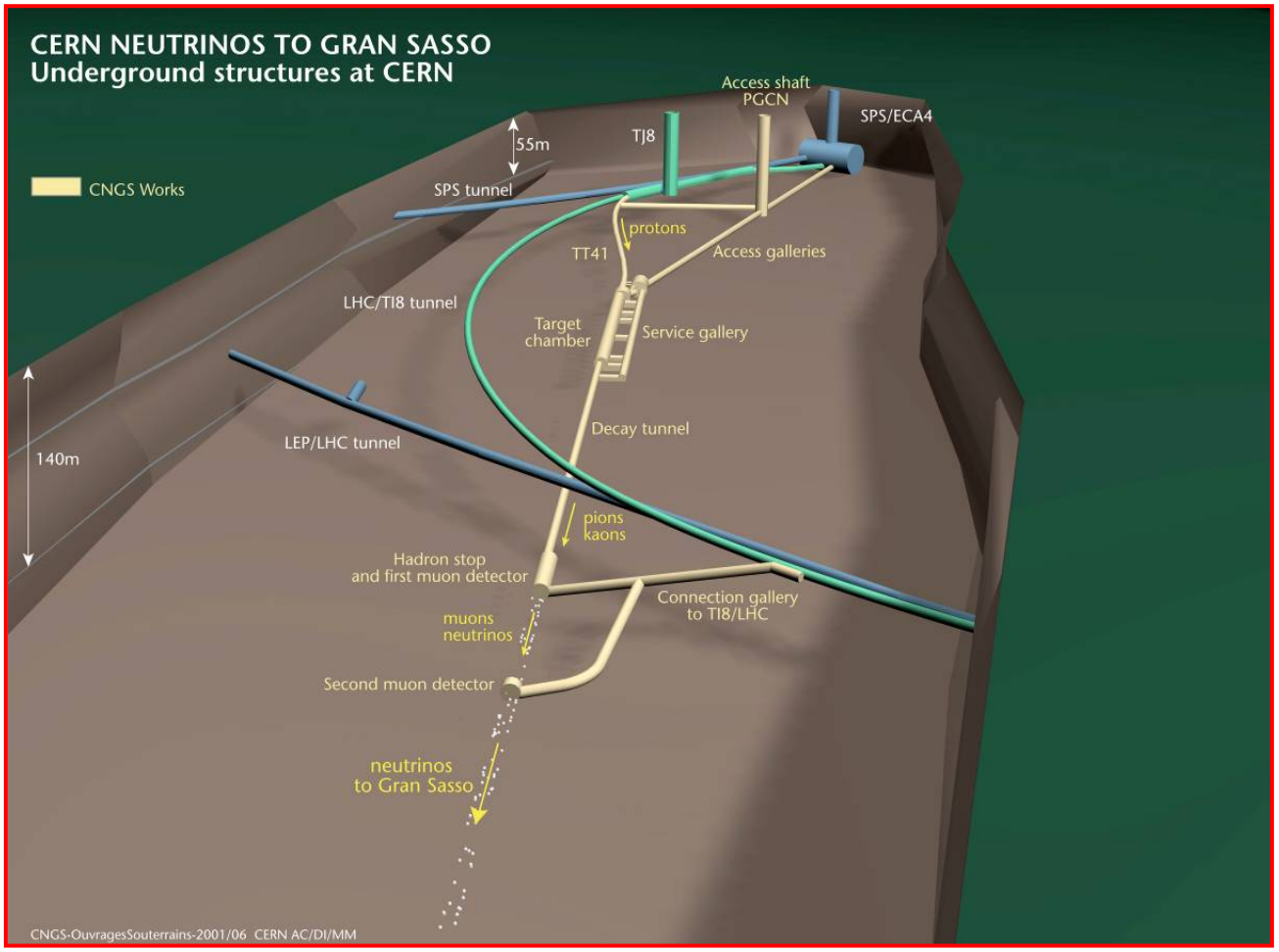
- 5 **beam lines ; ~**120 **equipment installed ; total length** 300m
- **~**300 **users / year performing experiments and tests**

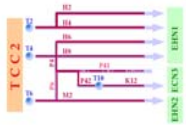


The CERN Secondary Beam Line Complex

CERN Neutrinos Gran Sasso, CNGS

- 1 **beam line ; ~**50 **equipment installed ; total length** 1 (+732) km
- **LNGS experiments: OPERA and ICARUS**





General

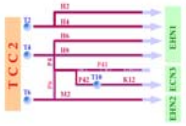
- **The SPS North Area originally designed to house long-lasting experiments**
  - **demands for high quality of beams: high intensity, high energy, high resolution**

- **In recent years most of the users are "tests"**
  - **LHC detectors with permanent or "semi-permanent" BIG installations**
  - **several shorter-term users from astro-particle experiments and linear colliders**

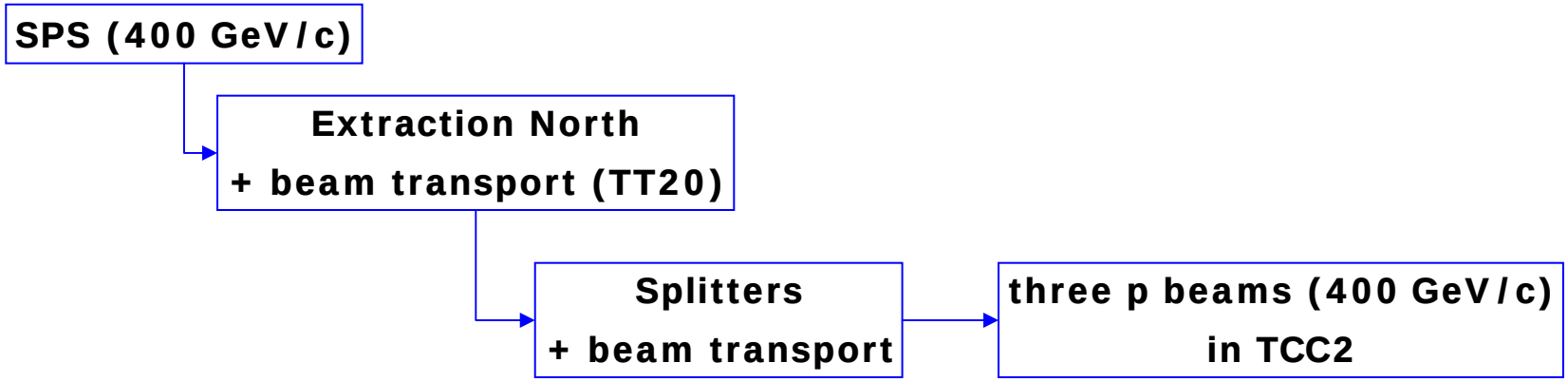
- **The test users have very different requirements:**
  - **scan full energy range ; typically [10, 300] GeV/c**
    - **with sometimes increased precision (linearity) requirements**
  - **use beams of all particle types (electrons, pions, protons, muons)**
    - **with as good as possible separation and identification**
  - **sometimes request high (or very high) rates**

all that during the few (or even one!) week(s) of their allocated time!

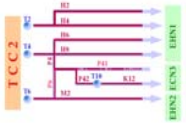
➔ **Rapidly changing environment, quite demanding on beam conditions and tunes, often inexperienced users!**



The North Experimental Areas at the SPS



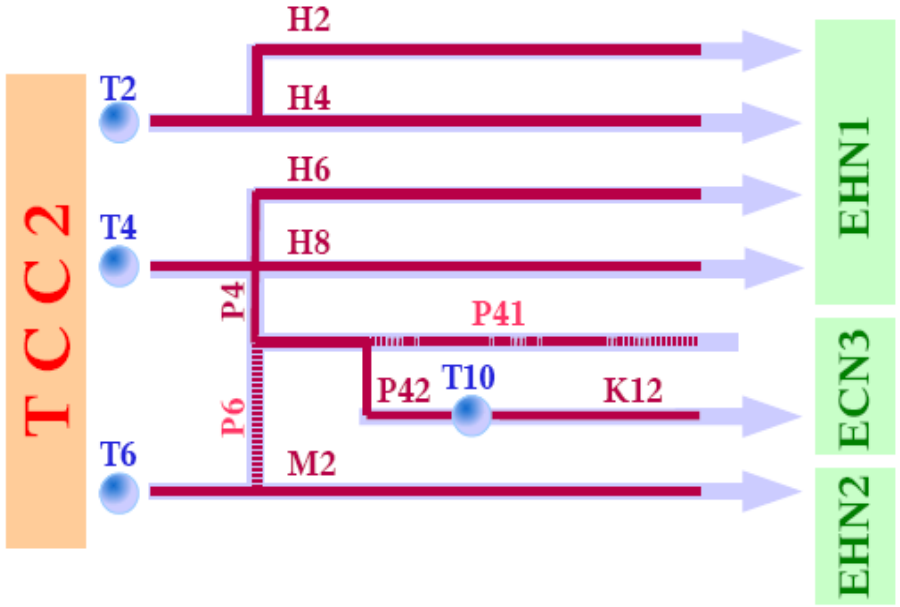
- **The proton beam (400 GeV/c) from SPS is slowly extracted to the North Area at LSS2**
- **The extracted beam is transported in the TT20 tunnel**
  - **11% slope to arrive into TCC2 – then horizontal ; ~10m underground**
- **The primary proton beam is split in three parts directed towards to the North Area primary targets: T2, T4 and T6**



North Area

The SPS North Area Beams

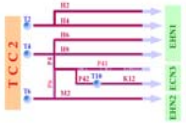
- **The three proton beams are directed onto the primary targets:**
  - **T2 →** H2 **and** H4 **beam lines**
  - **T4 →** H6, H8**, and** P0 **beam lines**
  - **T6 →** M2 **beam line**



Experimental Areas:

- **ECN3: underground experimental hall, transports the primary proton beam with high intensity to T10, from there high intensity secondary beam to the experiment in ECN3. (P42/K12)**

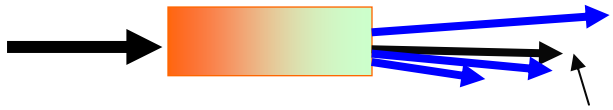
- **EHN2: surface experimental hall, receives the intense secondary beams or intense muon beam (COMPASS)**
- **EHN1: surface experimental hall, can receive secondary beams and/or attenuated primary proton beams (H4, H8)**



The EHN1 Beams

Target	Beam	Characteristics
T2	**H2**	**High-energy, high-resolution secondary beam.** **Alternatively can be used to transport: attenuated primary beam of protons, electrons from γ-conversion, polarized protons for Λ decay, enriched low-intensity beam of anti-protons, or K^+** **Main parameters: P_{max}= 400 (450) GeV/c, Acc.=1.5 μSr, $\Delta p/p_{max}$= ±2.0 %**
	H4	**High-energy, high-resolution secondary beam.** **Alternatively can be used to transport: primary protons, electrons from γ-conversion, polarized protons for Λ decay, enriched low-intensity beam of anti-protons, or K^+** **Main parameters: P_{max}= 330 (450) GeV/c, Acc.=1.5 μSr, $\Delta p/p_{max}$= ±1.4 %**
T4	**H6**	**High-energy secondary beam.** **Main parameters: P_{max}= 280 GeV/c, Acc.= 2.0 μSr, $\Delta p/p_{max}$= ±1.5 %**
	H8	**High-energy, high-resolution secondary beam.** **Alternatively can be used to transport an attenuated primary proton beam** **Main parameters: P_{max}= 400(450) GeV/c, Acc.= 2.5 μSr, $\Delta p/p_{max}$= ±1.5 %**

Targets

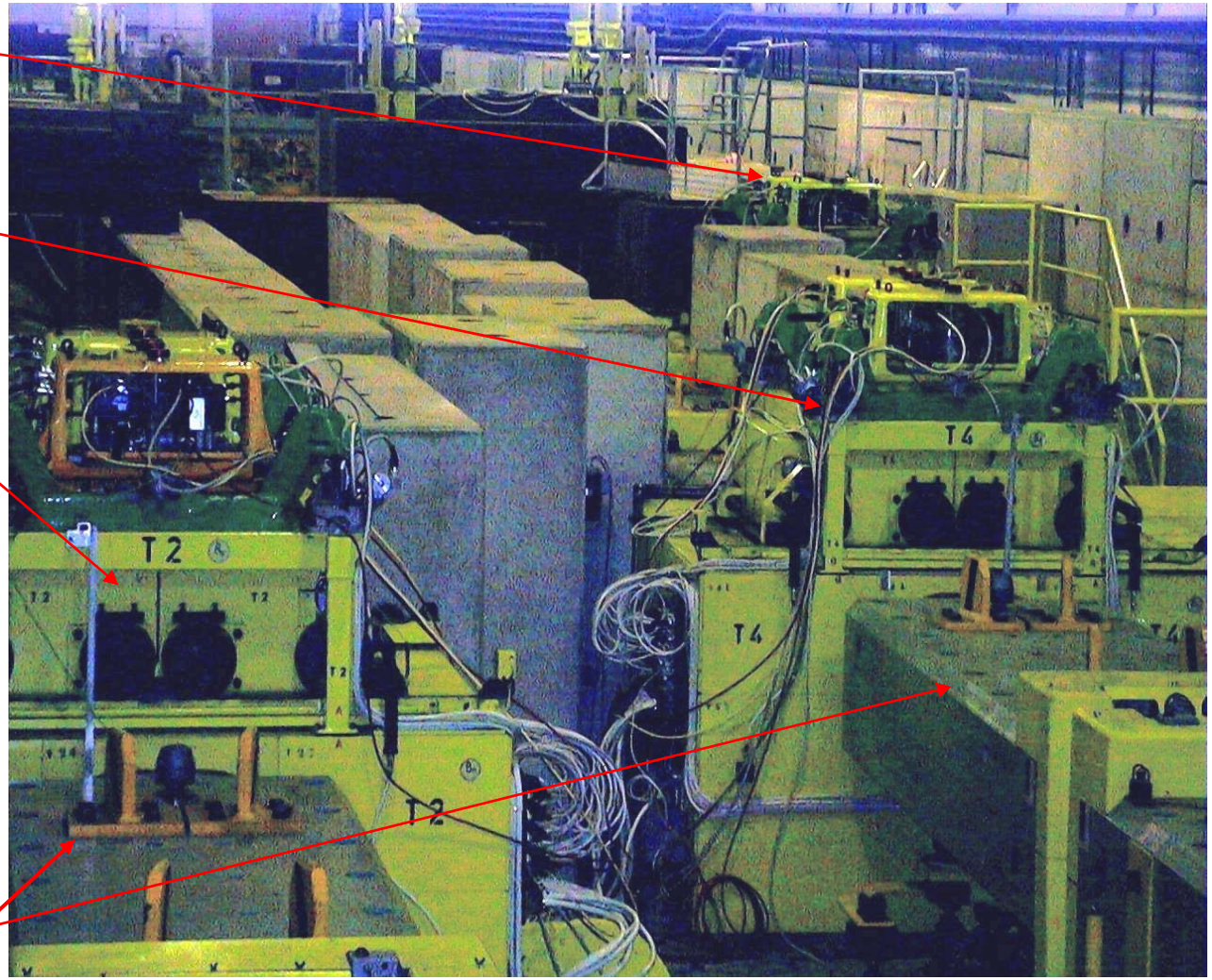


T6 target
(M2, COMPASS)

T4 target
(H6, H8, P0)

T2 target
(H2, H4)

Wobbling magnets



Targets

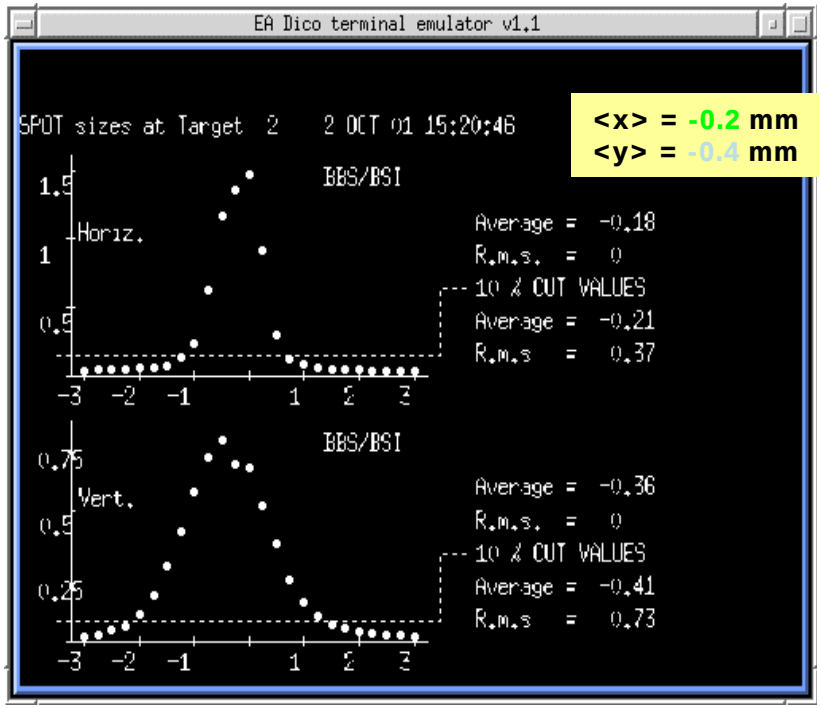
The target heads

T2 target				
Position	H (mm)	V (mm)	L (mm)	Material
0	EMPTY			
1	160	2	300	Be
2	160	2	500	Be
3	160	2	180	Be
4	160	2	100	Be
5	120	2	40	Be

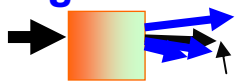
T4 target				
Position	H (mm)	V (mm)	L (mm)	Material
0	EMPTY			
1	160	2	300	Be
2	3	2	300	Be
3	160	2	200	Be
4	160	10	100	Be
5	120		40	Pb

Beam position monitors

- TBIU **(upstream)** , TBID **(downstream)**

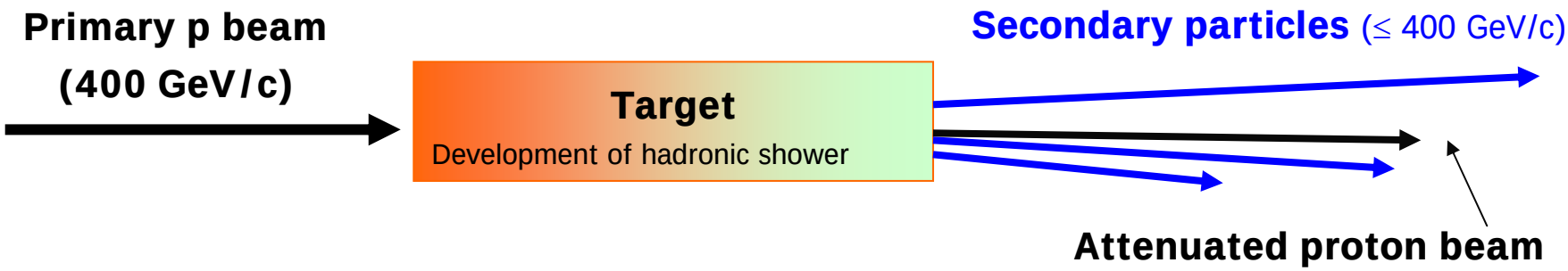


- **mounted on same girder as the target head for better alignment**
- **beam steering onto the target using BSM located ~30m upstream of the target**

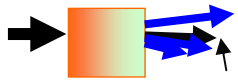


Particle Production

Particle production inside the primary target



- **Protons : remnant of the incoming primary beams**
  - **the target actually serves as attenuator**
  - **Some emittance blow-up**
  - **~40% of the initial incoming intensity of the beam**
- **Pions (hadrons) : produced in hadronic interactions**
  - **Typical scale: interaction length (λ_{int})**
- **Electrons : produced in electromagnetic processes**
  - **Typical length scale : radiation length (X_0)**
- **Muons : produced in the decay of pions**
  - **At the target and also along the beam line**



Particle Production

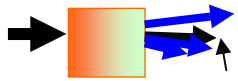
Target material and length

- **The proton intensity on each target can go up to 1.4** 10^{13} protons/pulse
  - **limited by target and TAX absorber construction (i.e. cooling, etc.)**

- **The material with largest ratio:** X_o/λ_{int} is preferred → Beryllium

- **Increasing the target length:**
  - **more production but also more re-absorption**
  - **lower the energy of the outgoing particles**

Optimal choice ~ 1 interaction length



Particle Production

Muon beam

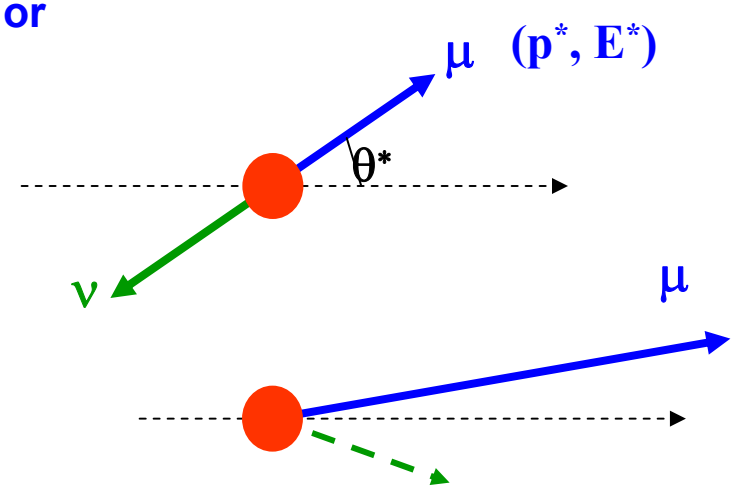
Muon beams are formed by the decay of pions (π^+, or π^-)

Decay kinematics:

- **At the pion center of mass system:**

$$p^* = \frac{m_\pi^2 - m_\mu^2}{2\,m_\pi} = 30\ MeV/c$$

$$E^* = \frac{m_\pi^2 + m_\mu^2}{2\,m_\pi} = 110\ MeV/c$$



- **At the laboratory frame – boost**

$$E_\mu = \gamma_\pi \left(E^* + \beta_\pi p^* \cos\vartheta^* \right)$$

- **Limiting cases:**

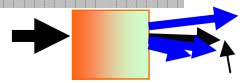
$$\cos\vartheta = +1 \rightarrow E_{\max} = 1.0 \cdot E_\pi$$

$$\cos\vartheta = -1 \rightarrow E_{\min} = 0.57 \cdot E_\pi$$

Conclusion:

- **the muon beam energy is in the interval [0.57,1.0] of the initial pion beam energy**

$$0.57 \le E_\mu / E_\pi \le 1.0$$



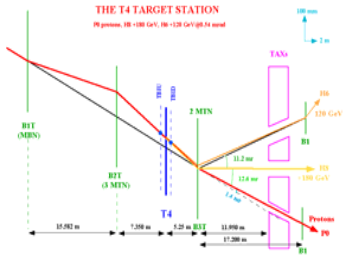
How to Increase Flexibility with a Target Station?

→ Produce "several" secondary beams from the same target

- when the primary beam hits the target:
  - "all" particles are produced in a large variety of angles and energies
- the most energetic particles are in forward direction

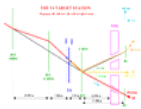
→ SOLUTION: Wobbling:

→ hit the target under variable angle



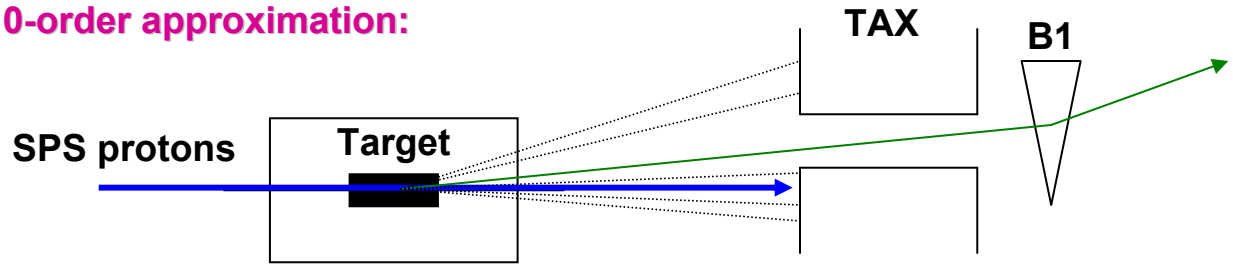
→ But be aware:

- The very intense primary proton beam has to be dumped in a controlled way
- The secondary beams of the chosen momentum:
  - into the directions foreseen by the beam geometry (i.e. inside the vacuum tube of each beam line)



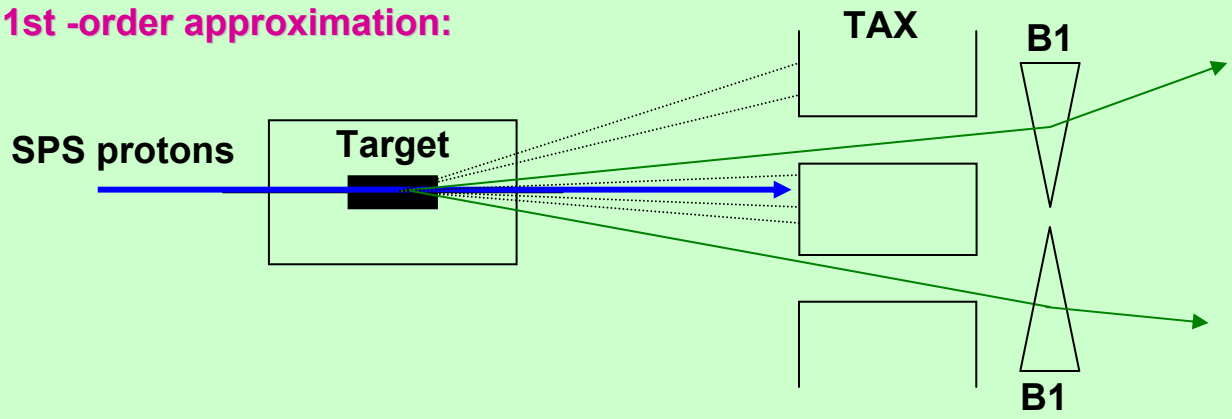
Target Station Wobbling - General

0-order approximation:



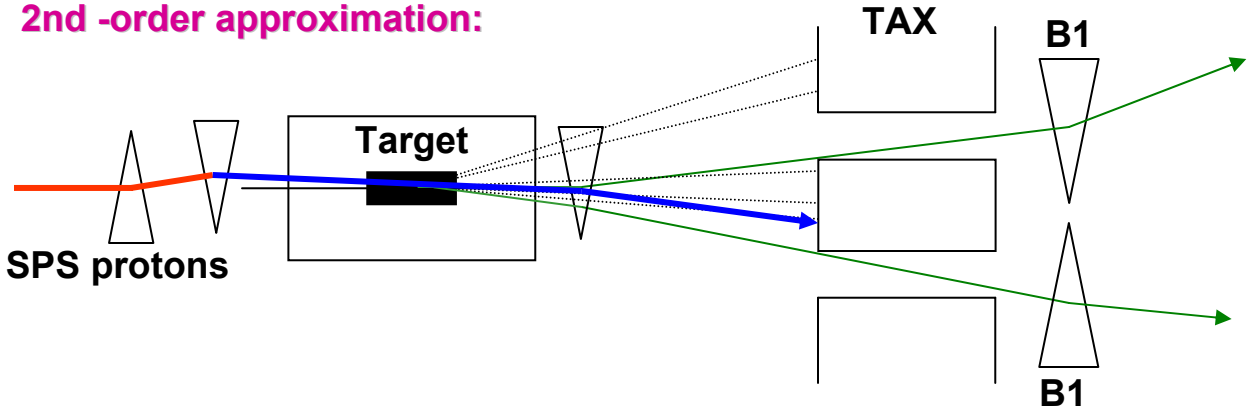
- single secondary or primary beam
- fixed production angle

1st -order approximation:



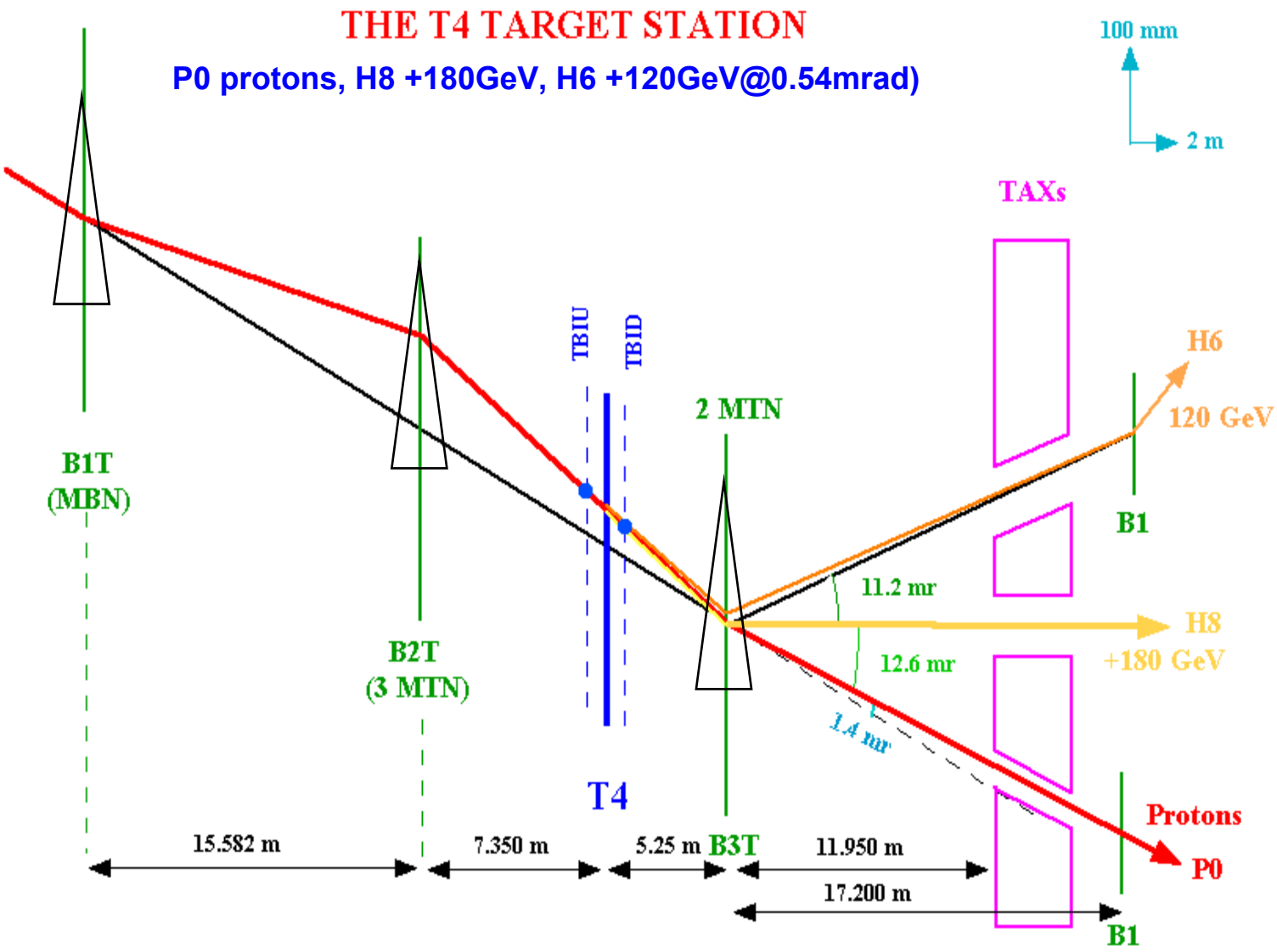
- two secondary beams
  - one could be the primary beam
- fixed production angles

2nd -order approximation:



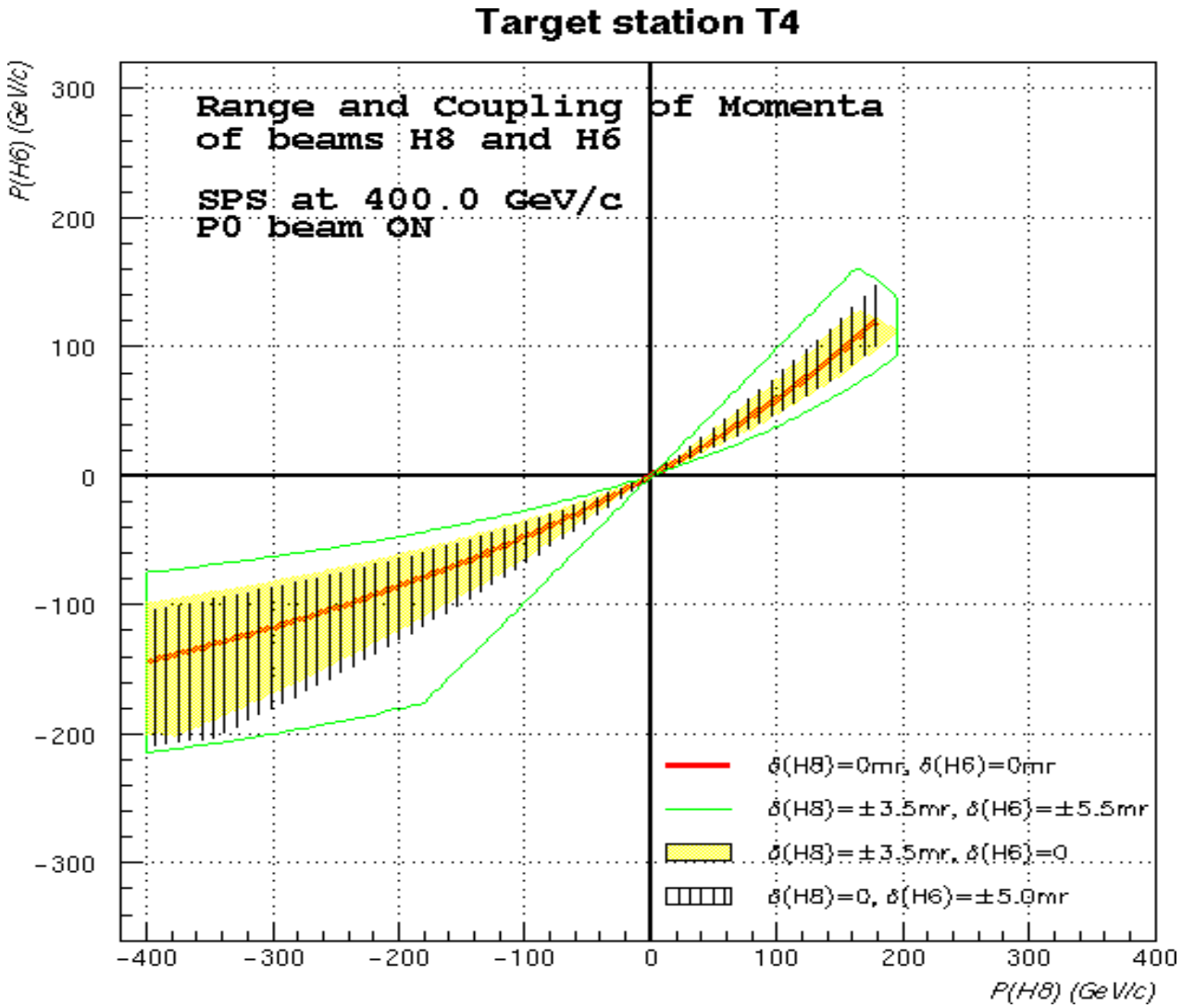
- two secondary beams
  - one could be the primary beam
- variable production angles

T4 Wobbling Example



… T4 Wobbling Example

P0 protons, H8, H6 secondary beam



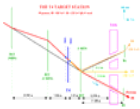
Wobbling Survey and Changes

Safety - Survey

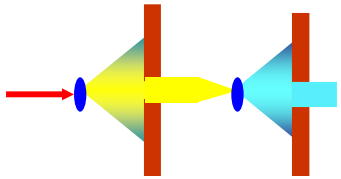
- Survey current in the "wobbling" magnets
- Survey position of the TBIU, TBID monitors
  - automatically done
  - A program called WOBSU should be running continuously
- Manual INHIBIT signal set in CCC for planned wobbling changes.

Wobbling Changes:

- Initiated by the EA physicist (upon the user requests)
- Discussed in the EATC / Monday meetings
  - documented in the minutes
- Settings file
  - prepared and communicated by the EA physicist
  - Described in EA Wikipage
- Performed by the operators on the agreed time
  - re-tuning of the the beam lines after the wobbling changes is often required



Secondary/Tertiary Beam



How to Increase Flexibility for Beam Energy and Particle Type?

Reminder:

Secondary beams:

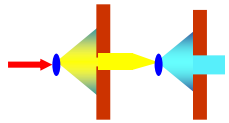
- transport particles directly produced in the primary targets
- energy and polarity depending on the wobbling setting

Target "wobbling":

- advantages:
  - several beams per target are available
  - flexibility of production angle and secondary beam energy
- drawback:
  - introduces coupling between beams: e.g. P0 + H8 + H6, H2 + H4
  - changes are difficult to agree and schedule

but the users (in particular the LHC detector calibration tests) demand a frequent change of beam energy and particle type

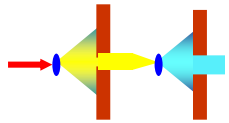
→solution: TERTIARY BEAMS



Tertiary Beams - Introduction

- **Allows more flexibility (independence) of the users in different beam lines**
  - **keep longer periods with the same wobbling setting**
  - **use mainly the filter mode optics**

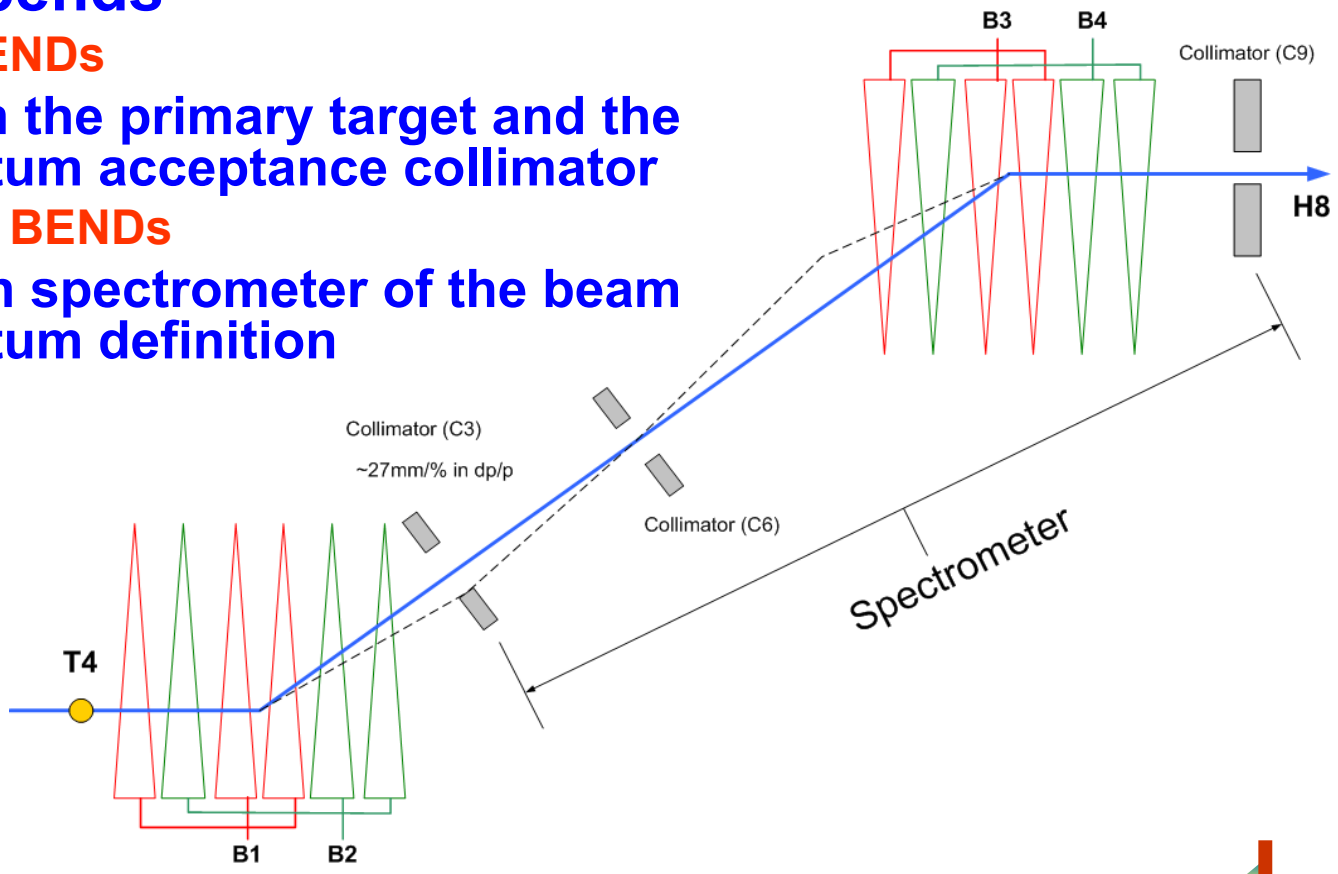
- **Produced in two distinct ways:**
  - **H2, H4, H6, H8: use a second target (filter)**
  - **H2, H4: from the conversion or decay of secondary neutral particles**



Secondary Beams - Reminder

Basic beam design

- momentum selection in the vertical plane
- two sets of bends
  - Upstream BENDs
    - between the primary target and the momentum acceptance collimator
  - Downstream BENDs
    - the main spectrometer of the beam momentum definition

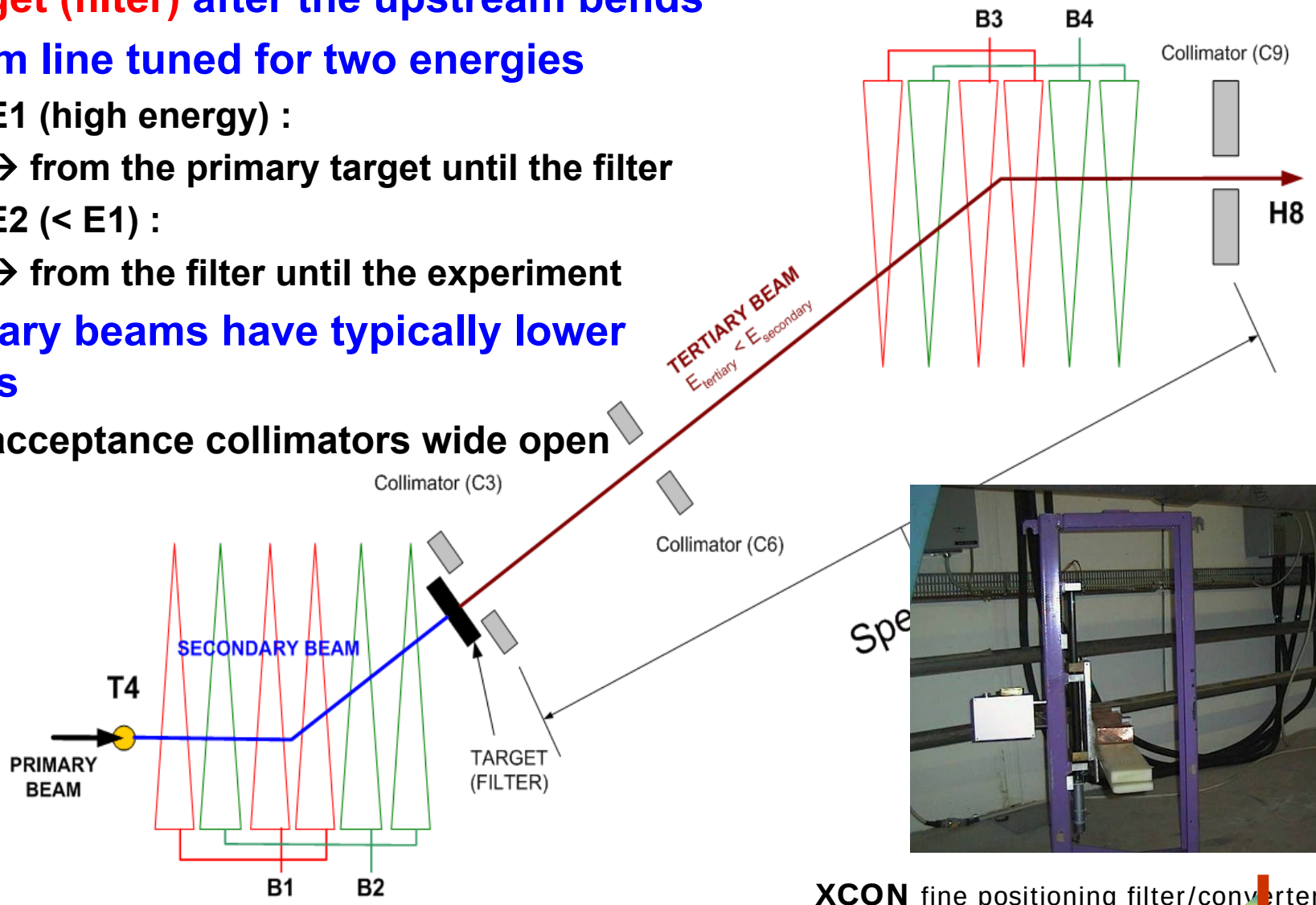


H6 & H8 Beam Lines

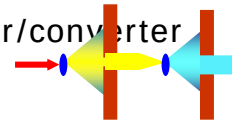
View of the H8 and H6 beam lines in TT81 tunnel.

Tertiary Beams - H6, H8

- **Target (filter) after the upstream bends**
- **beam line tuned for two energies**
  - **E1 (high energy) :**
    → from the primary target until the filter
  - **E2 (< E1) :**
    → from the filter until the experiment
- **tertiary beams have typically lower rates**
  → acceptance collimators wide open



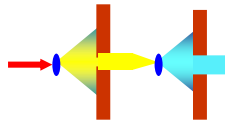
XCON fine positioning filter/converter



Tertiary Beams - H6, H8

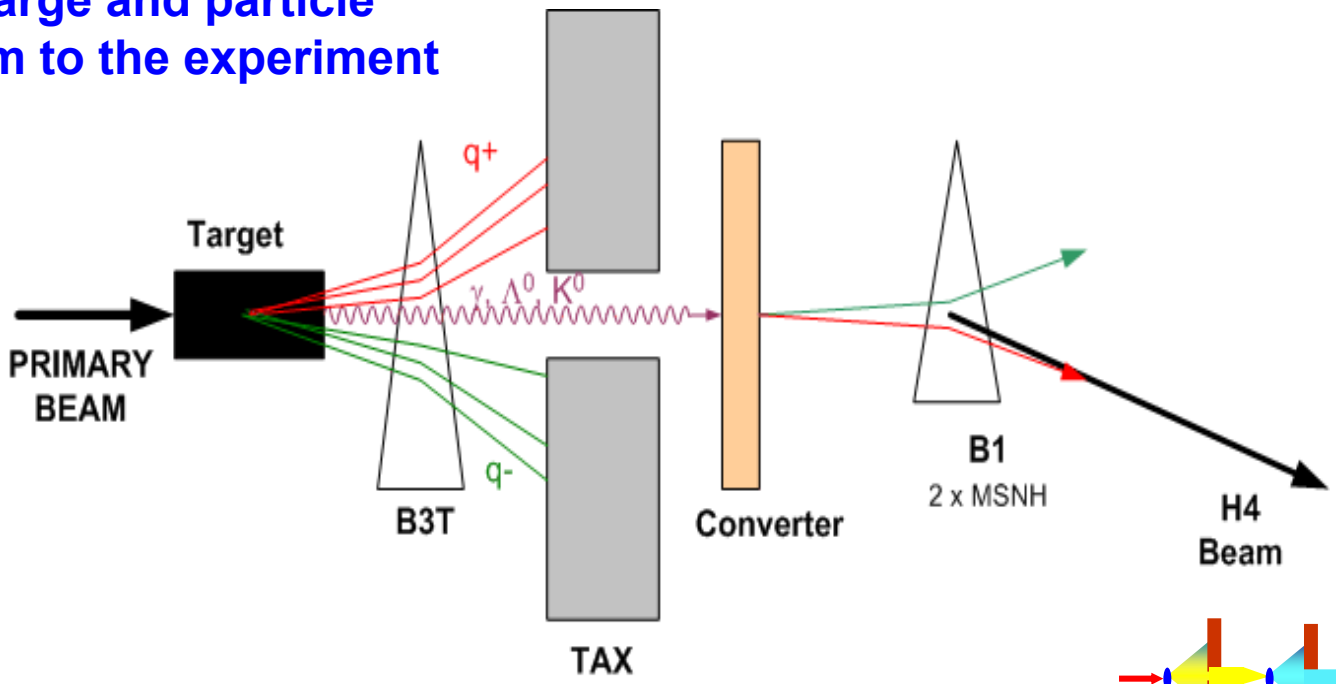
→ **choice of target material**
enhance/select different particles

Material	X_o (cm)	Λ_{int} (cm)	X_o/λ_{int}	
Beryllium	**35.3**	**40.7**	**0.87**	**Mixed beam**
Copper	**1.50**	**15.0**	**0.10**	**Hadrons**
Lead	**0.56**	**17.1**	**0.03**	**Electrons**



Tertiary Beams - H2, H4

- **Bend B3 of the wobbling as sweeping magnet**
  - **charged particles are absorbed in the TAX**
  - **neutral particles go through and hit the converter**
    - ***note:* neutral particles can have zero or non zero production angle**
- **converter**
  - **γ on Pb (Converter=lead): to produce electrons (e^+, e^-)**
  - **Converter=air (no converter) to let K^0, Λ^0 , to decay**
    - **$K^0 \rightarrow \pi^+ + \pi^-$**
    - **$\Lambda^0 \rightarrow p + \pi^-$**
- **Bend B1: select charge and particle for the tertiary beam to the experiment**



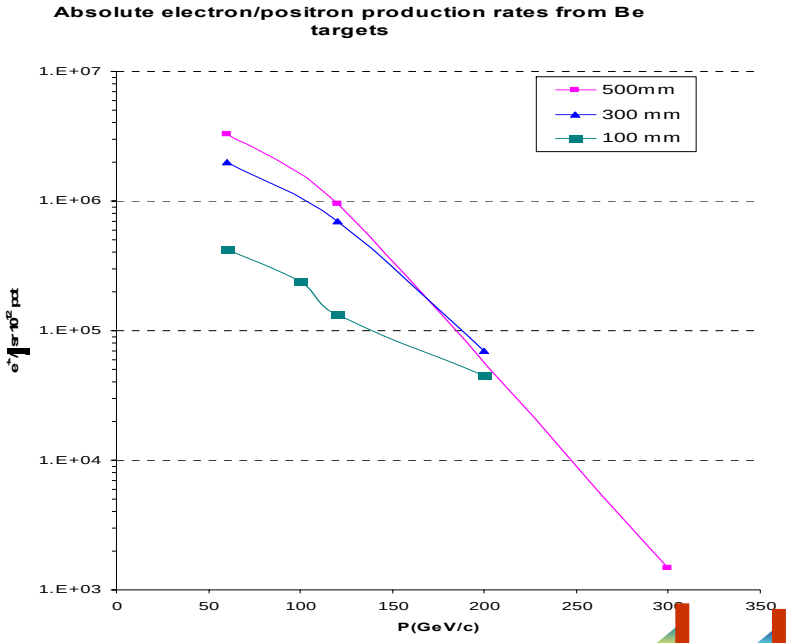
Electron Beams

Secondary beams

- Produced at the primary target
  - rate goes down with energy increase
- Electron production: more with longer (Be-) targets
  - e/pi ratio ~ proportional to target length
- With synchrotron radiation:
  - separation from hadrons at high energies (≥120 GeV/c)
- mixed beams pion (hadron) contamination for lower energies
  - user CEDAR or treshold Cherenkov counters for tagging

Tertiary beams

- H6, H8: use Pb as secondary target
  - few mm, or ~1-2 radiation lengths (X0)
  - radiation length: distance in matter where
    - electrons loose ~1/e of their energy
    - hadrons loose ~nothing
- H2, H4: electrons from photon conversion
  - high purity beams!



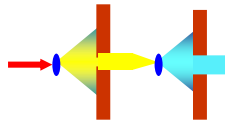
Hadron Beams

Secondary beams

- produced at the primary target
- positive sign beam
  - a good fraction of the total hadron rate is protons
- Eliminate electron contamination
  - using an absorber (~1-2 X_0 of Pb) in the beam

Tertiary beams

- H6, H8: use secondary target of Cu, $(CH)_n$
  - ~1 interaction length λ_I
  - interaction length: characterizes the average longitudinal distribution of hadronic showers
    - a high energy hadron has 1-1/e probability to interact within one λ_I
    - $\lambda_I >> X_0$ for most of materials
- H2, H4: hadrons produced in the decay of neutral mesons
  - $\Lambda^0 \rightarrow p + \pi^-$, $K^0 \rightarrow \pi^+ + \pi^-$



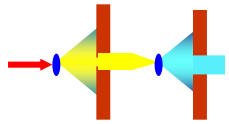
Muon Beams

Secondary beams

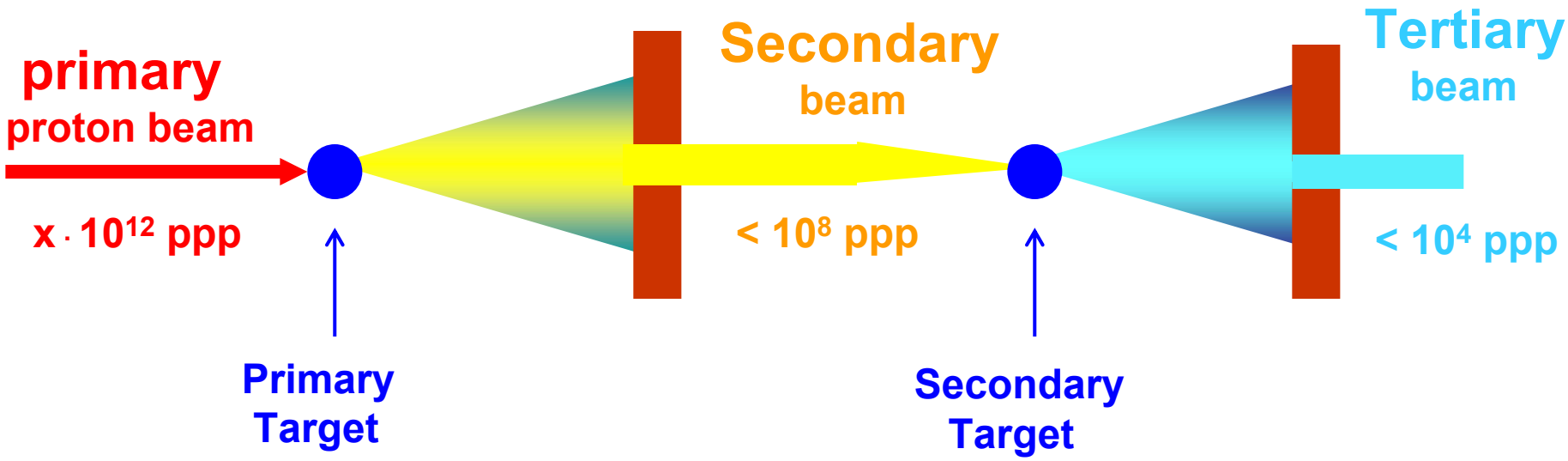
- **Muons produced by the decay of pions**
  - **muon momentum: 57-100% of the parent pion momentum**
- **For a pure muon beam for the experiment:**
  - **close the last collimators of the beam line (out of beam axis)**
- **Momentum selected muons:**
  - **closing the collimator upstream of the last bend of the line**
- **rule of thumb: muons in a 10×10cm^2 trigger represent ~1% of the hadron/pion flux**
  - **there is another ~1% in a cone about 1 × 1m^2 around the beam axis**
  - 10^6 muons / 10 × 10 cm^2 trigger → **1.3 uSv/h**

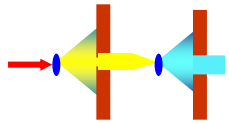
Tertiary beams

- **Muon energy range 57-100% of the secondary beam momentum**



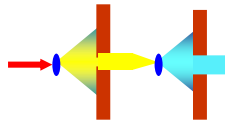
Intensities in a secondary beam





Ingredients for Transporting and Tuning Beam

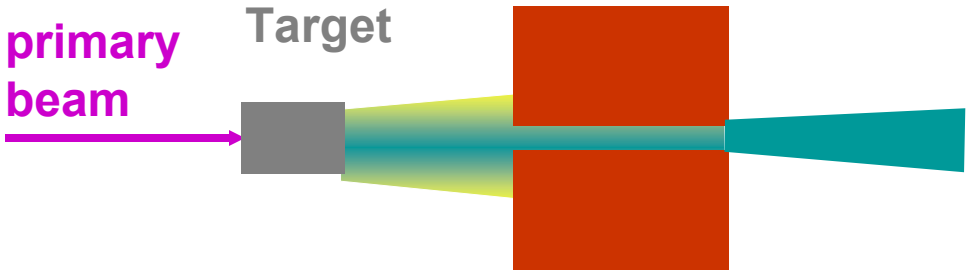
- **Type of Particles in Beam**
  - Targets
  - Absorbers
  - Converters
- **Beam Steering and Focusing of Beam**
  - Bends
  - Correction dipoles (Trims)
  - Quads
- **Clean-up of Beam**
  - Collimators (TAX, momentum, acceptance, cleaning collimators)
  - Scrapers, MIBs
- **Steering, Momentum Measurement, Particle Identification, Timing/Spill**
  - Scintillator
  - MWPC (Analog Chamber)
  - XDWC (Delay Wire Chamber)
  - FISC Counter
  - XCET
  - Cedar
  - EXPT (Experimental Scaler)
  - Ionization Chamber



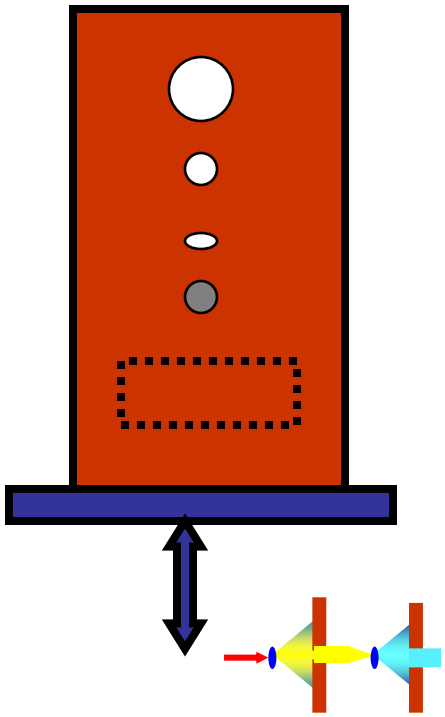
1. Dump collimators (TAX)

TAX stands for Target Attenuator eXperimental areas

→ stop the primary beam (e.g. in case of access)
→ define the beam acceptance or limit its rate (by attenuation)

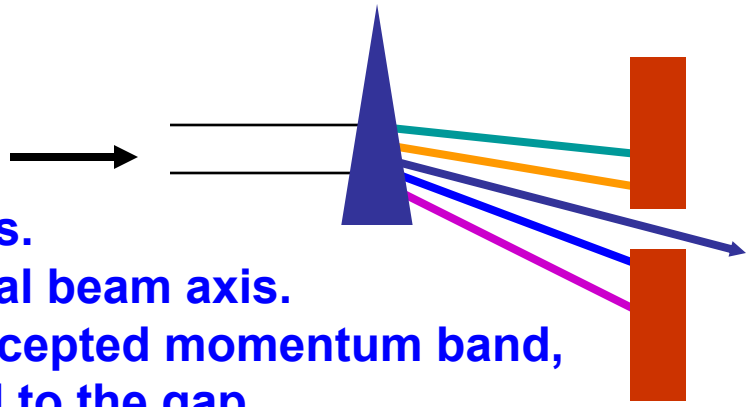


Acceptance defined by TAX



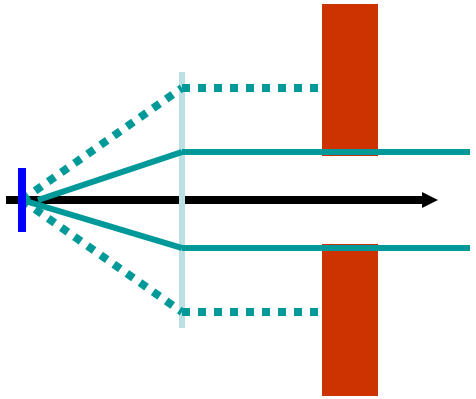
1.6 m long water-cooled table with Cu, Al and Fe blocks
→ This table is motorised in the vertical plane
→ some holes of different diameters are drilled
→ contain 40 – 120 cm of Beryllium (for attenuation)
→ One position (+ 140 mm) is fully plugged (DUMP)
→ The range of the movement is interlocked (EA safe – Chain 9)
→ TAX are also safety elements in the Access system

2. Momentum collimator



→ Normally located at a dispersive focus.
→ Center of the gap should be at nominal beam axis.
→ The aperture is proportional to the accepted momentum band,
→ The rate is normally also proportional to the gap.
However, $\Delta P/p$ cannot be smaller than the intrinsic resolution.
→ Hence the need (in general) to have a rather sharp focus.

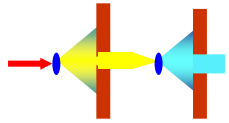
3. Acceptance collimator



→ Located where the beam is large (ideally even parallel),
→ Allows to define the angular aperture of the beam,
→ Affects therefore the rate as well, however non-linearly.

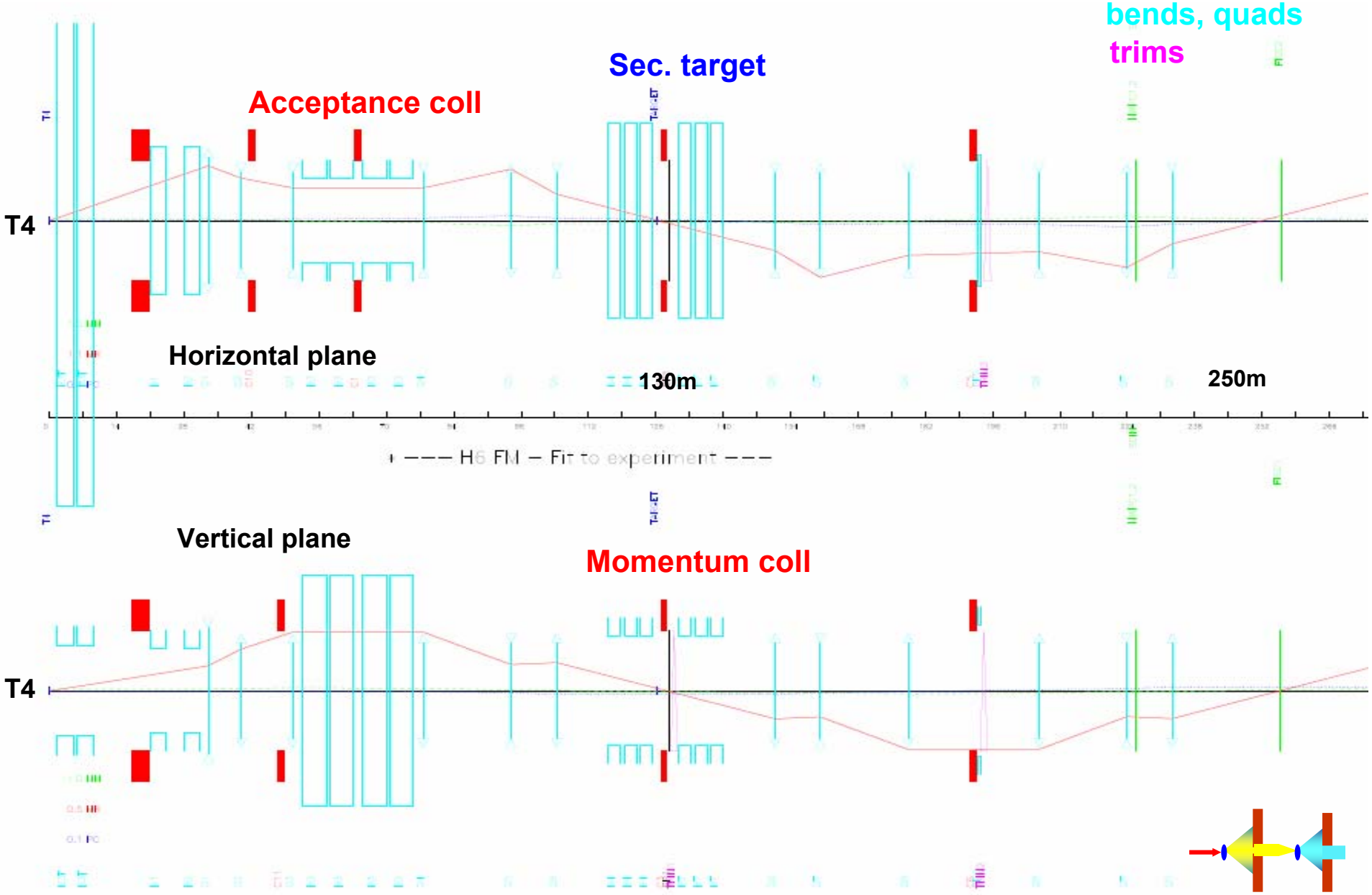
4. Cleaning collimator

A repetition of an earlier (acceptance) collimator.
→ Cleans up particles scattered on the edge of the earlier collimator



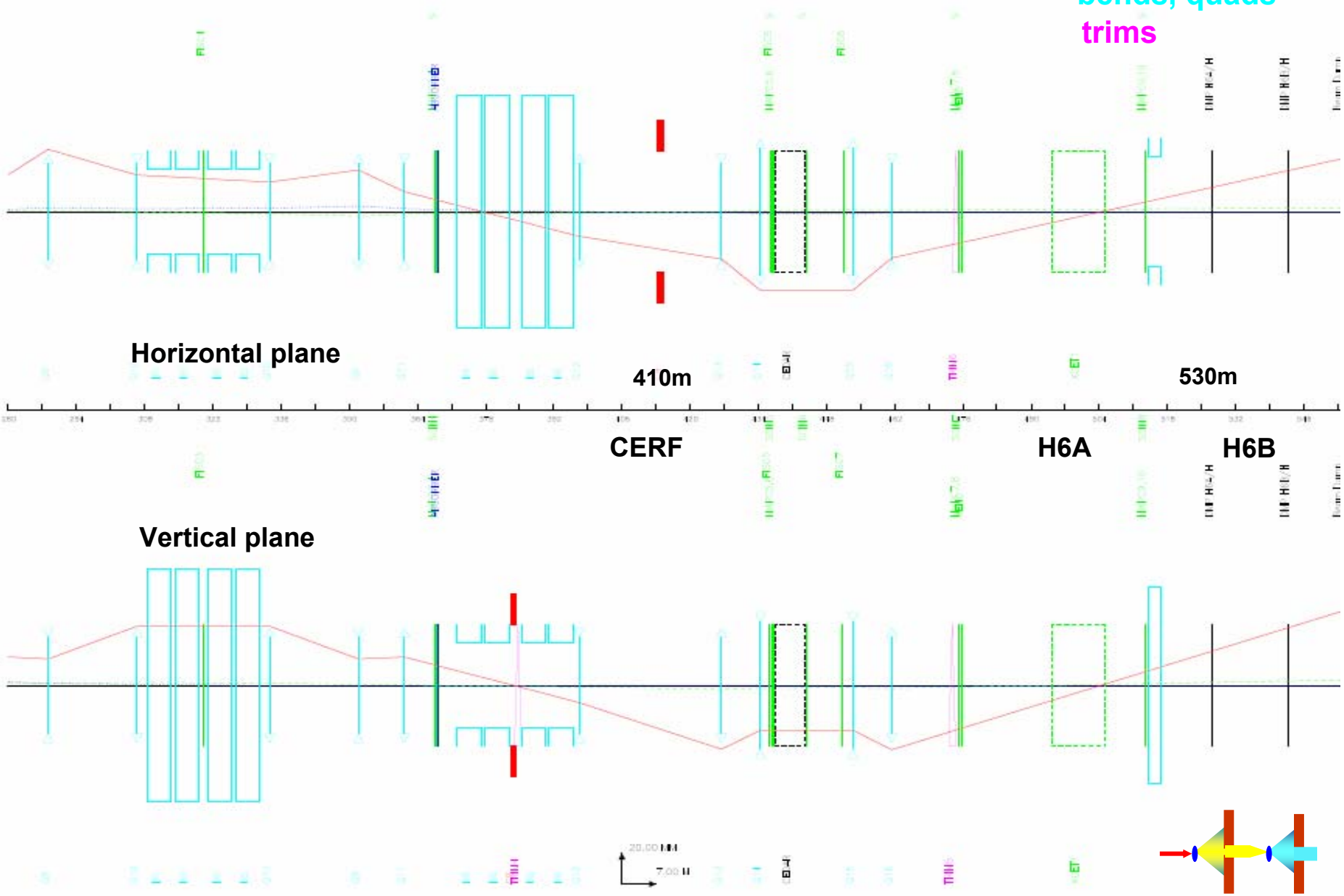
Optics File - H6 Part1

MWPC, Scint,..
collimators
bends, quads
trims

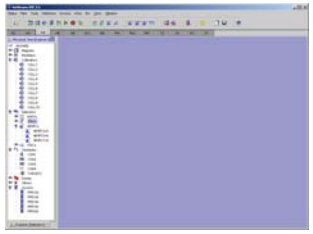


Optics File - H6 Part2

MWPC, Scint,..
collimators
bends, quads
trims



North Area Operational Aspects



Organization of EA Operations

- **EA experts:**
  - Setting up (commissioning) of secondary beam lines.

    → They provide operational setting files.

- **SPS operators**
  - handle the technical problems of the secondary beam lines.
  - change beam conditions according to schedule using operational setting files

Operational Aspects – General

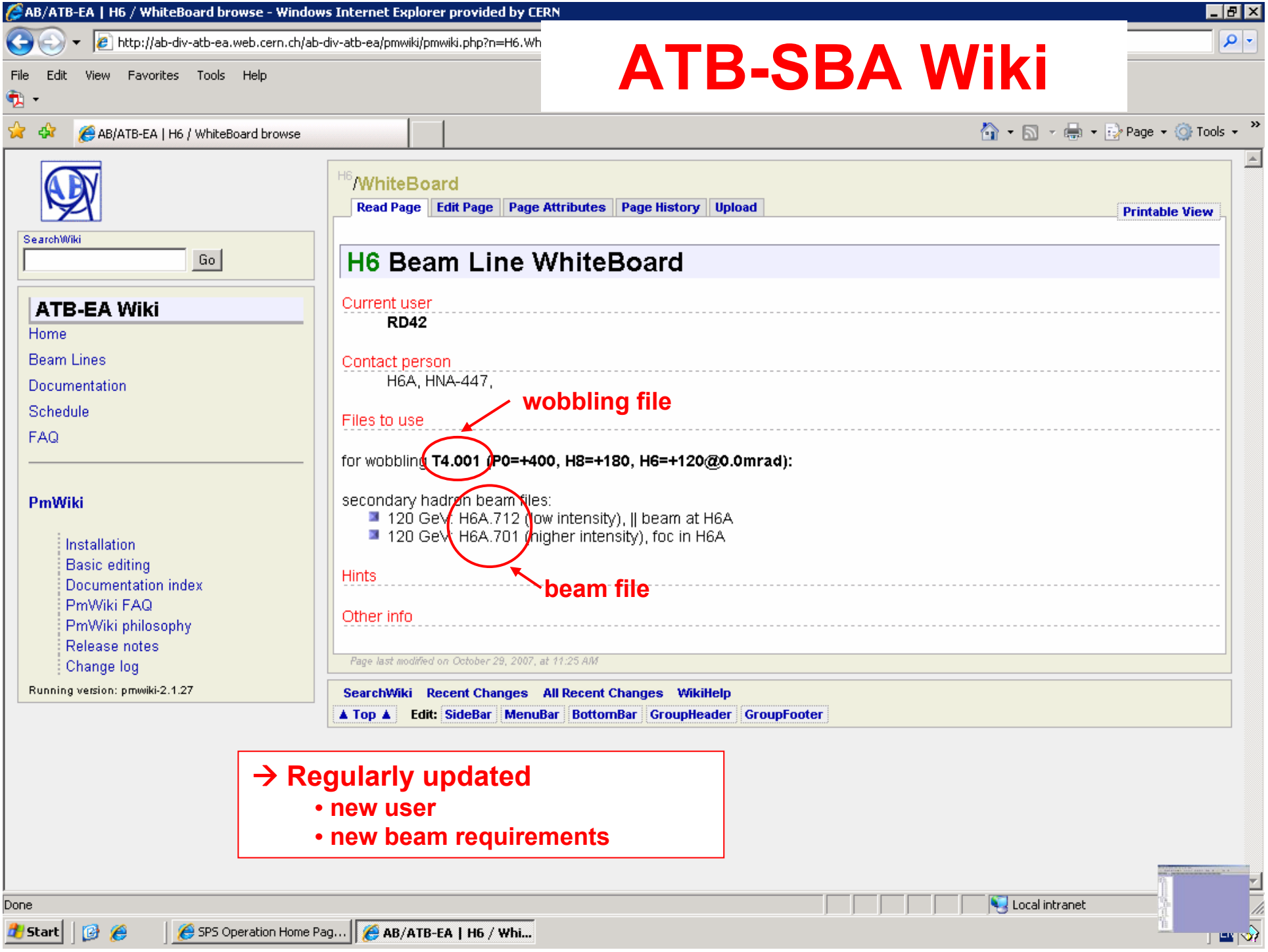
- **Goal: deliver good quality of beam to the experiment!**
  - **sufficient rate, spot size, particle purity,…**
- **Tuning the beam is required for each change**
  - **energy, wobbling, user**
- **To first order, all beam lines are quite similar**
  - **however there are some differences which need time to become familiar with**
- **Some users are quite experienced with their beam, and can do many things alone**
- **Time is important for you and the users**
  - **there is always a limit to how good a beam can be; let the users decide**

Operational Aspects – Startup

- **Beam line snapshot:**
  - status of magnets/files/wobbling settings
  - status of collimators, target, absorber
  - rates in few counters (start, middle, end of beam line)
- **Start from an already prepared beam file by the EA physicists**
  - **WIKI pages**
  - Be sure it corresponds to the present wobbling settings
  - Be sure it can fulfill the user requirements
    - typically users know “their” files, but better check it..
- **Treat each plane independently**
  - start with the vertical plane which is the most important to get the beam to the experimental hall
- **Select your observation point**
  - a scintillator counter close to the end of the beam line


AB/OP/SPS Wiki : Whiteboard - Windows Internet Explorer provided by CERN
http://controls-wiki.web.cern.ch/controls-wiki/OP/SPS/Whiteb
File Edit View Favorites Tools Help
AB/OP/SPS Wiki : Whiteboard
SPS-OP Wiki
AB/OP/SPS Wiki
SPS / Whiteboard
Edit · History
Print · Search
General (edit)
Home Page
News
SPS operation
Shift Planning
Recent News
FAQ
North Area Beam line instructions
Daily operation and short term plans
Pending problems
Access Requests
Scrubbing Run - Instructions
RF
Timing
Teletext Fixed Displays
SPS Shutdown Activities
Documentation
NORTH area layouts
SPS Machine Protection
CNGS Secondary Beam
SPS Wirescanners
Training
SPS experts & piquets
AB-OP Piquets
Piquet Service PO
Feedback to CO
Links
E-Whiteboard
CESAR Wiki
SIS Wiki
NORTH area target intensities:
T2 : aim for 32
T4 : aim for 32
T6 : aim for 140
T10 : 0
Search to be done for ECN3 on Tuesday 29/10 morning
Limit on T6 : 150 for SC length of 14.4 and 16.8 s.
Beam Line Instructions:
Direct infos on the beam lines and users:
Primary target and wobble settings
H2, H4, H6, H8
M2, P42, K12
Detailed informations and instructions can be found on the EA Wiki page!
In case of technical stop
1. We have to put in stand by all North Area power converters EXCEPT Bend 10 & 11 on M2 (Compass spectrometer).
2. If we have to switch these two bends OFF, we should first call Compass control room to inform them.
In case of supercycle change:
1. Deactivate the RF by switching all Lines to RF Drive Permitted: "NO"
In case of technical problems with one the Targets change:
Local intranet
Start
SPS Operation Home Pag...
AB/OP/SPS Wiki : Whi...

ATB-SBA Wiki



→ **Regularly updated**

- **new user**
- **new beam requirements**

Operational Aspects – Remarks

- **Switching beam files:**
  - secondary beams have high rates → acceptance collimators closed
  - tertiary beams have low rates → acceptance collimators wide open

    → therefore: switching from tertiary to secondary beam, load FIRST the collimators and then the magnets

- **Consistent particle rates when following them along the beam line**
  - use as much as possible normalized rates: rate/pot
  - monitor beam losses, be sure you are looking at the beam not at its halo

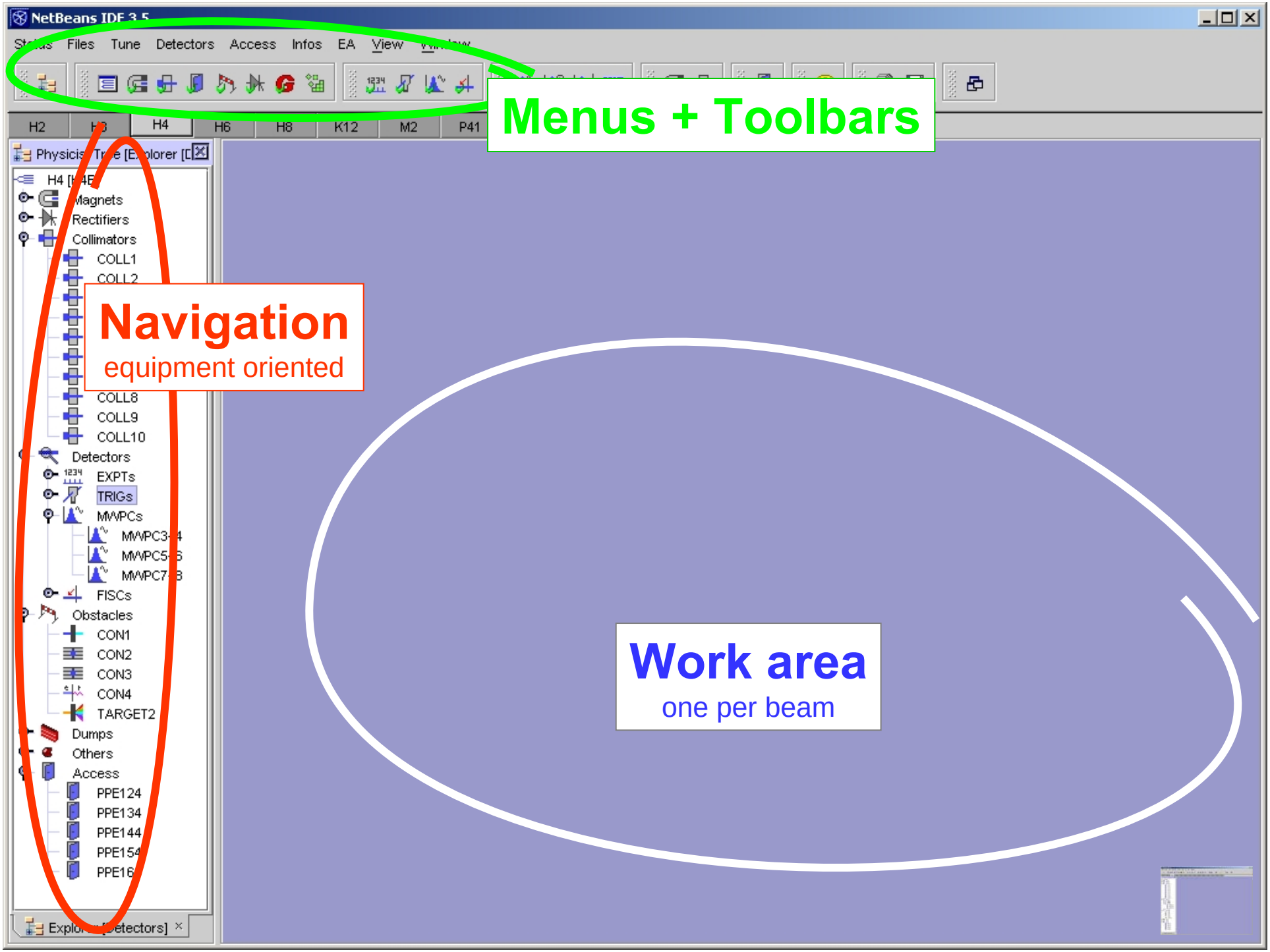
- **For electron beam: electrons hate material!**
  - remove triggers or other detectors from the beam line, otherwise you may damage the whole beam line
  - be careful when you try to measure/monitor things, you may disturb the users

CESAR - Equipment and Control

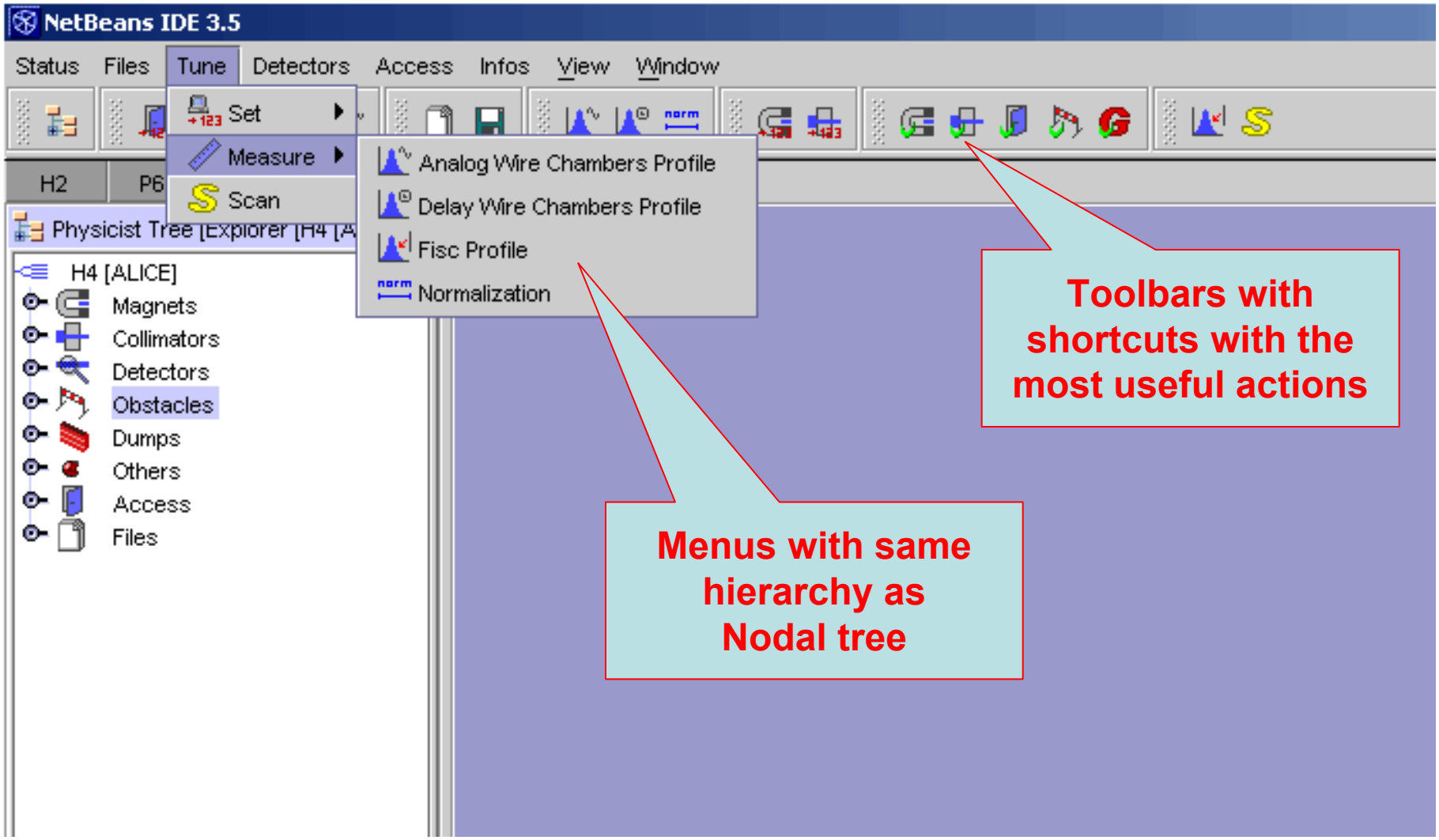
Equipments

- Magnets
- Collimators
- Scrapers
- TAXs
- TDXs, TDVs
- Obstacles (Targets, Converters, Absorbers, …)
- Pumpes (only reading)
- Scalers
- Scintillators
- Analog Wire Chambers (status+profiles)
- Delay Wire Chambers
- FISCs (status + fast & slow profiles)
- SEMs
- Doors

- Access command & diagnostic
- Files Management
- Mode analyze
- General Status
- Scan
- North Area Fix Display
- North Area Interlocks
- Login + Security

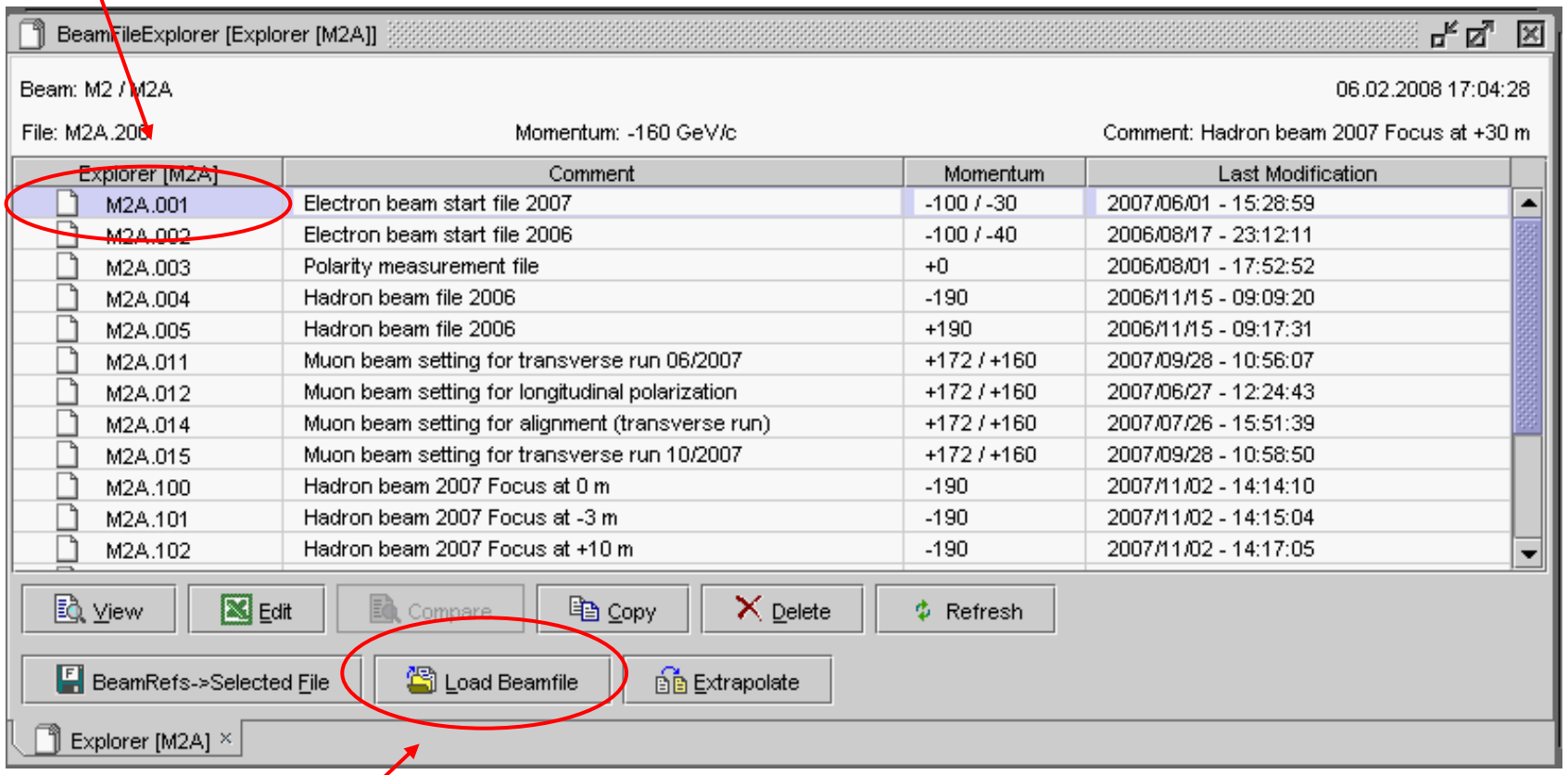

NetBeans IDE 3.5
Files
Tune
Detectors
Access
Infos
EA
View
Menus + Toolbars
H2
H4
H6
H8
K12
M2
P41
Collimators
COLL1
COLL2
COLL8
COLL9
COLL10
Detectors
EXPTs
TRIGs
MWPCs
FISCs
Obstacles
CON1
CON2
CON3
CON4
TARGET2
Dumps
Others
Access
PPE124
PPE134
PPE144
PPE154
Navigation
equipment oriented
Work area
one per beam

Menus and Toolbars



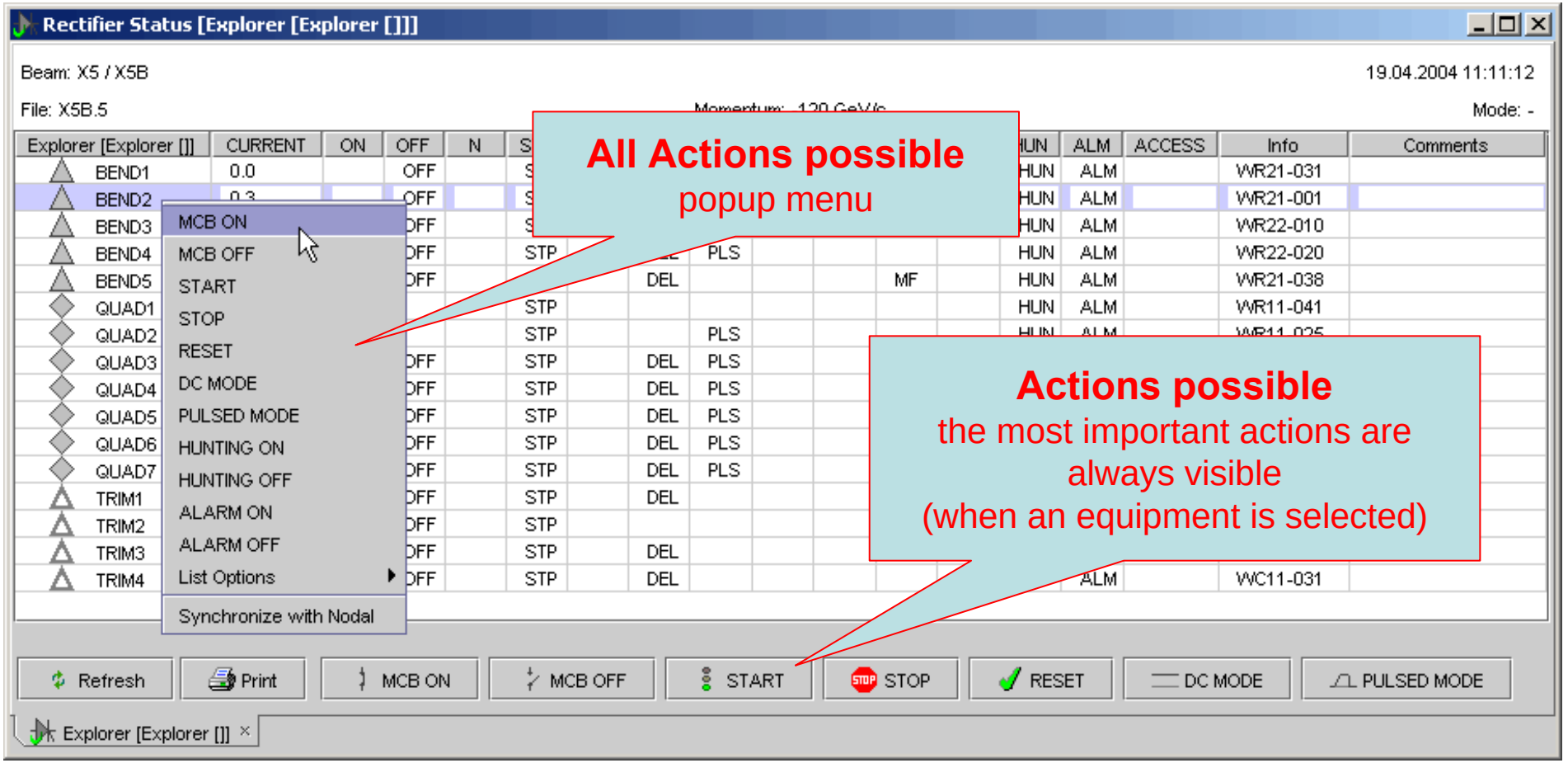
File Handling

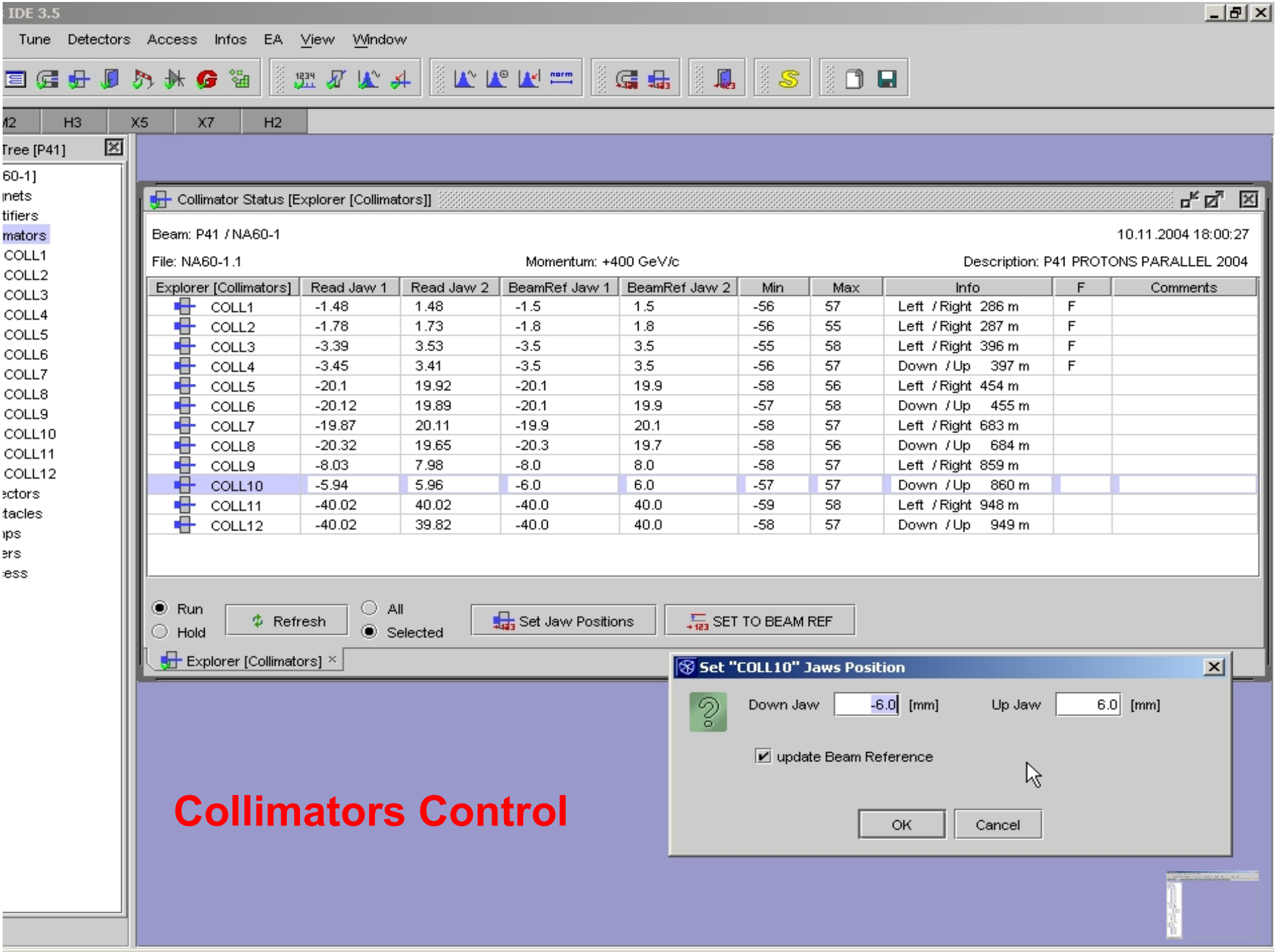
Choose a Beamfile



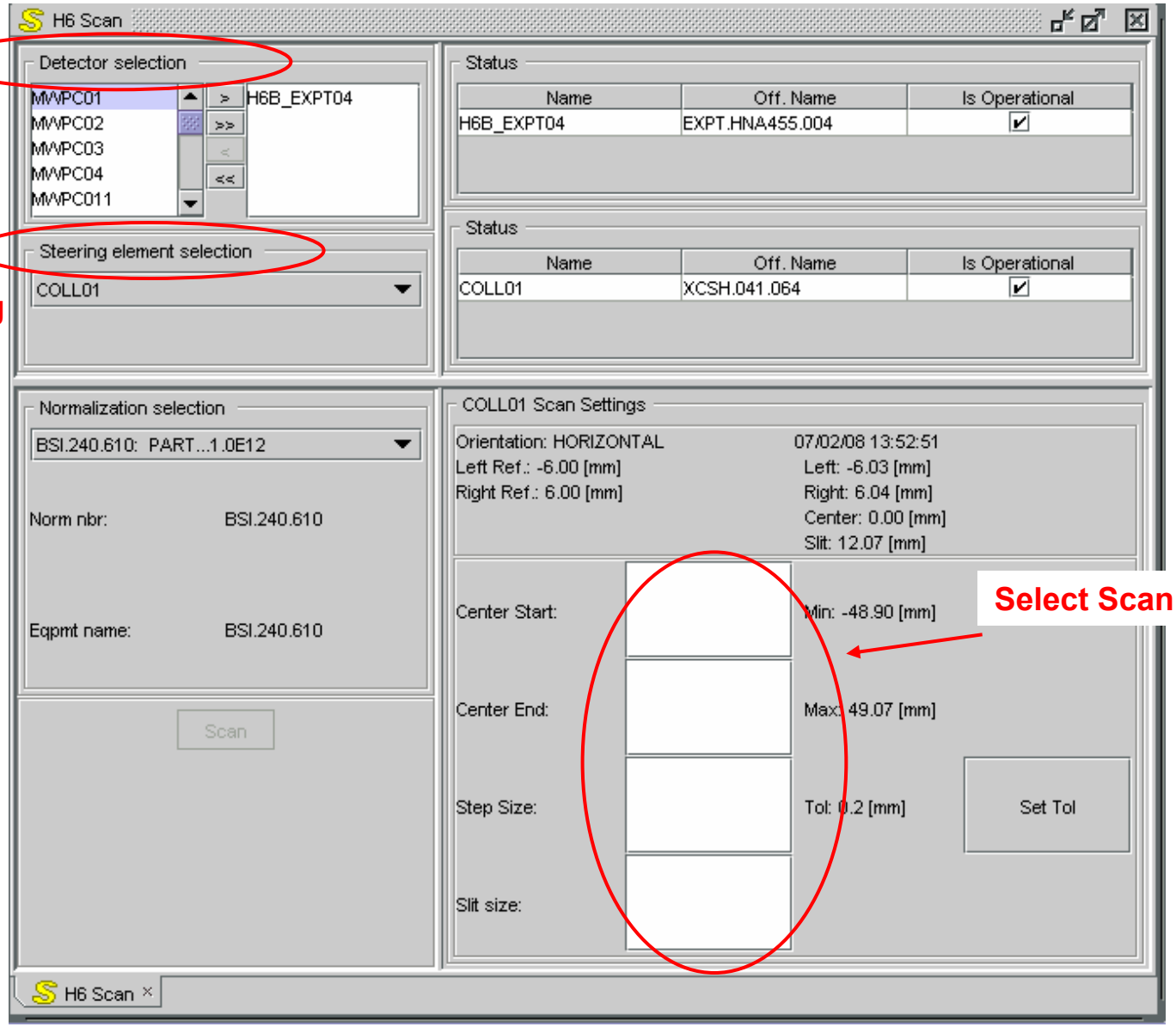
Load the Beamfile

Actions


Rectifier Status [Explorer [Explorer []]]
Beam: X5 / X5B
19.04.2004 11:11:12
File: X5B.5
Mode: -
Explorer [Explorer []]
CURRENT
ON
OFF
N
ALM
ACCESS
Info
Comments
BEND1
BEND2
BEND3
BEND4
BEND5
QUAD1
QUAD2
QUAD3
QUAD4
QUAD5
QUAD6
QUAD7
TRIM1
TRIM2
TRIM3
TRIM4
MCB ON
MCB OFF
START
STOP
RESET
DC MODE
PULSED MODE
HUNTING ON
HUNTING OFF
ALARM ON
ALARM OFF
List Options
Synchronize with Nodal
All Actions possible
popup menu
Actions possible
the most important actions are always visible
(when an equipment is selected)
Refresh
Print
MCB ON
MCB OFF
START
STOP
RESET
DC MODE
PULSED MODE
Explorer [Explorer []]


IDE 3.5
Tune Detectors Access Infos EA View Window
M2 H3 X5 X7 H2
Tree [P41]
60-1]
nets
tifiers
mators
COLL1
COLL2
COLL3
COLL4
COLL5
COLL6
COLL7
COLL8
COLL9
COLL10
COLL11
COLL12
ectors
tacles
ips
ers
ess
Collimator Status [Explorer [Collimators]]
Beam: P41 / NA60-1
10.11.2004 18:00:27
File: NA60-1.1
Momentum: +400 GeV/c
Description: P41 PROTONS PARALLEL 2004
Explorer [Collimators] | Read Jaw 1 | Read Jaw 2 | BeamRef Jaw 1 | BeamRef Jaw 2 | Min | Max | Info | F | Comments
COLL1 -1.48 1.48 -1.5 1.5 -56 57 Left / Right 286 m F
COLL2 -1.78 1.73 -1.8 1.8 -56 55 Left / Right 287 m F
COLL3 -3.39 3.53 -3.5 3.5 -55 58 Left / Right 396 m F
COLL4 -3.45 3.41 -3.5 3.5 -56 57 Down / Up 397 m F
COLL5 -20.1 19.92 -20.1 19.9 -58 56 Left / Right 454 m
COLL6 -20.12 19.89 -20.1 19.9 -57 58 Down / Up 455 m
COLL7 -19.87 20.11 -19.9 20.1 -58 57 Left / Right 683 m
COLL8 -20.32 19.65 -20.3 19.7 -58 56 Down / Up 684 m
COLL9 -8.03 7.98 -8.0 8.0 -58 57 Left / Right 859 m
COLL10 -5.94 5.96 -6.0 6.0 -57 57 Down / Up 860 m
COLL11 -40.02 40.02 -40.0 40.0 -59 58 Left / Right 948 m
COLL12 -40.02 39.82 -40.0 40.0 -58 57 Down / Up 949 m
Run
Hold
Refresh
All
Selected
Set Jaw Positions
SET TO BEAM REF
Explorer [Collimators]
Set "COLL10" Jaws Position
Down Jaw -6.0 [mm]
Up Jaw 6.0 [mm]
update Beam Reference
OK
Cancel
Collimators Control

Beam Steering - Scans

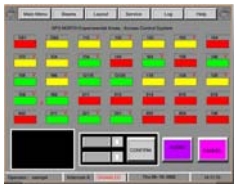


Select Detector

Select Steering Element

Select Scan Range

Access System

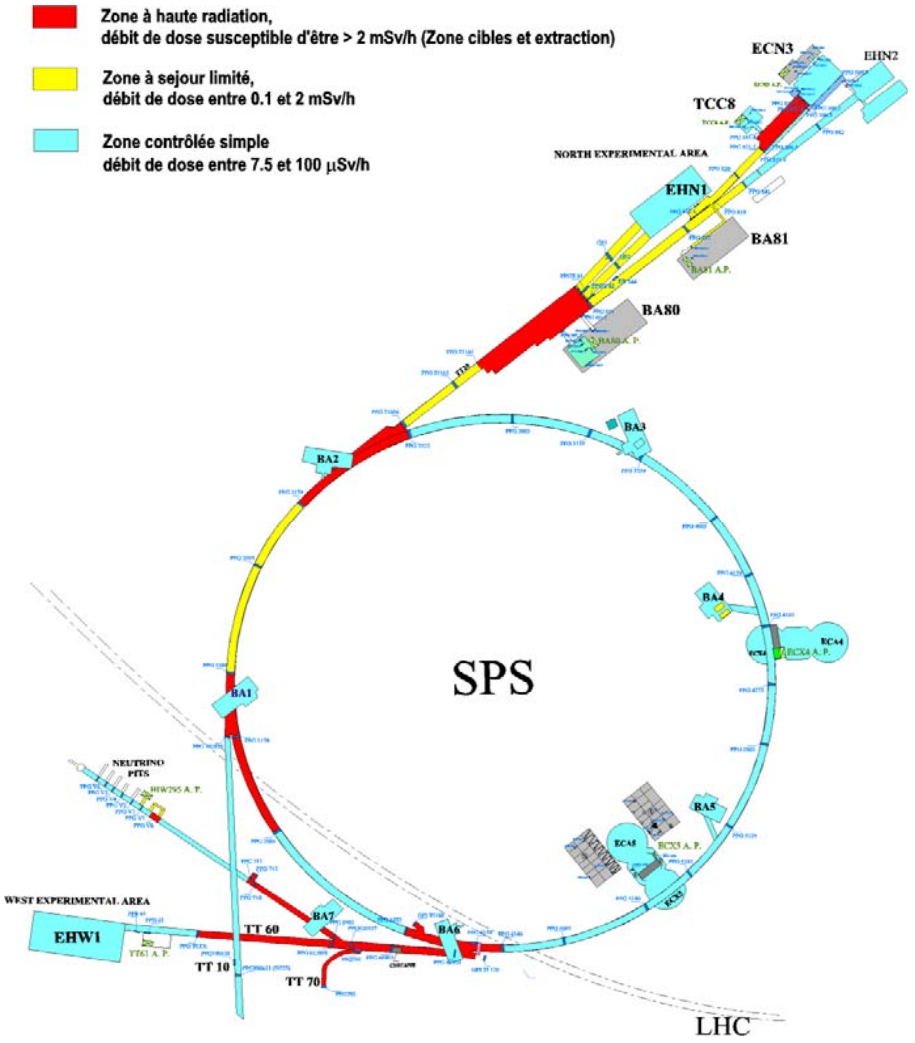


Access System – General

Beamline and Experimental Area classification

- **Secondary beam areas**
  - EHN1 (H2, H4, H6, H8)
  - EHN2 (P61/M2)
  - access granted locally
  - interlock system per beam line/area

- **Primary beam areas**
  - TCC2 (north area targets)
  - ECN3 (P0)
  - same access rules as SPS machine and target zones



- **The access system is used to prevent in-beam exposure for the personnel**
- **For EA two categories: Barracks and Experimental zones**

Access System – NA Beam Interlock

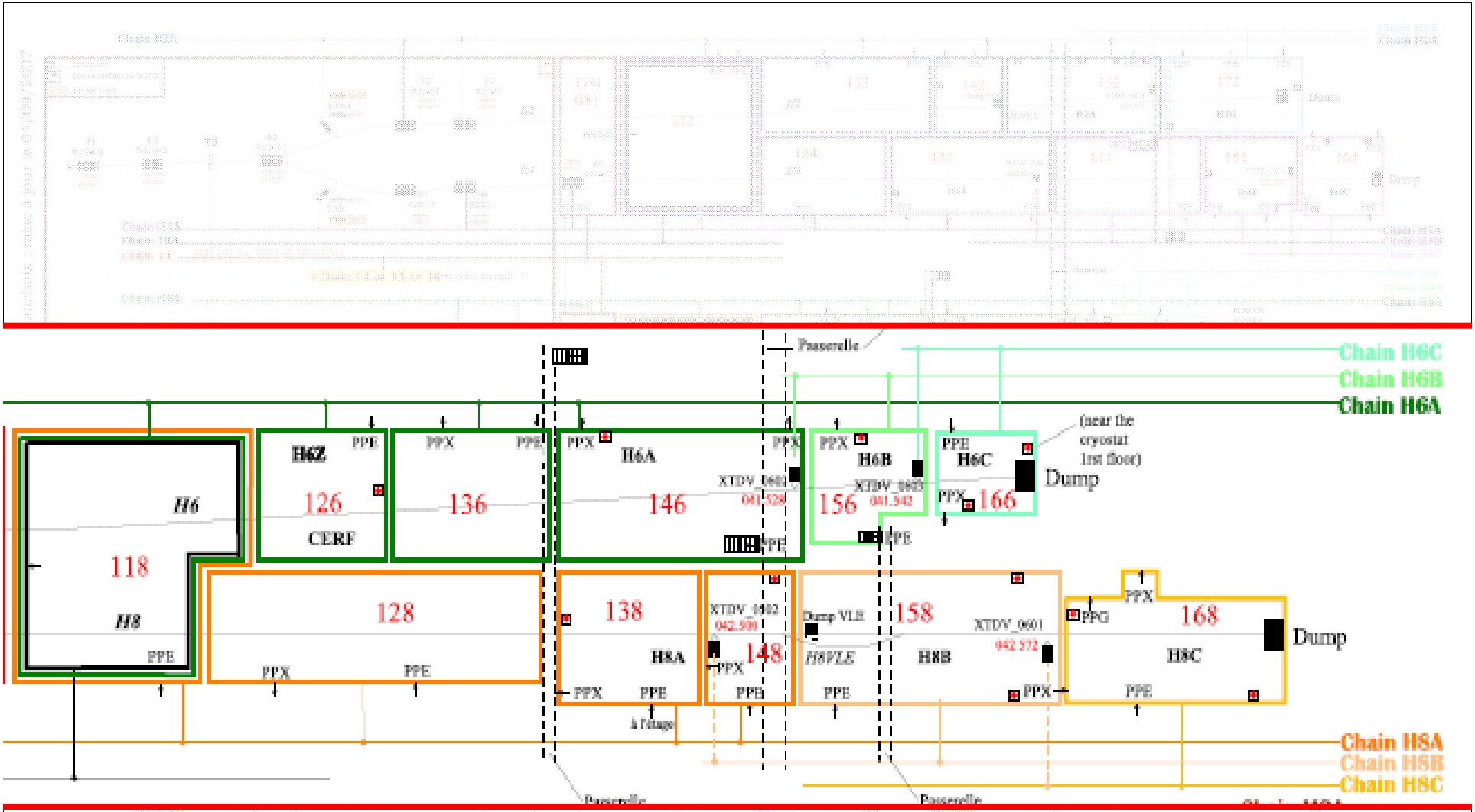
Proton extraction to the North is allowed only if the North Area is in SAFE mode

- **North Area SAFE when ALL the corresponding Beam Lines are in safe mode**

- **Beam Line SAFE if**
  - either **the nominal beam energy is limited below the energy of primary protons**
    - **ie. cannot transport primary protons**
  - or **the beam intensity is limited by beam attenuators (TAX's or combination of TAX's and other beam elements)**

Access System – Safety Elements

- **Doors: allow access to the experimental areas and underground tunnels**
  - the main one (PPE) and at least one emergency escape door (PPX, PPG)
  - if a door is left open more than 1min switches automatically to free state
  - Free, key access, closed (beam on/off)
- **Dumps: motorized dumps to separate experimental areas in the same beam line**
  - attached to the interlock chain of the downstream area
  - Before moving a dump the beam must be stopped to avoid spraying particles as the edge of the dump crosses the beam
- **TAX: motorized blocks "dumps with holes" to attenuate or dump the beam**
  - two motors (XTAXxxxyyy) per beam
  - Massive blocks of material (Al-Cu-Fe), 3.2m long\
  - Movement split in ranges: small (primary beam) , medium, large (sec. beam)
- **Magnets: stop the transport of a beam; ("champ null" detector, current limit, interlock)**
- **Equipment: has to be present and in a given configuration**
  - H8 micro-collimator
- **Special case: radiation monitors**
  - can stop the beam if above threshold, but not included in the access system
- **Status information available on the control room**

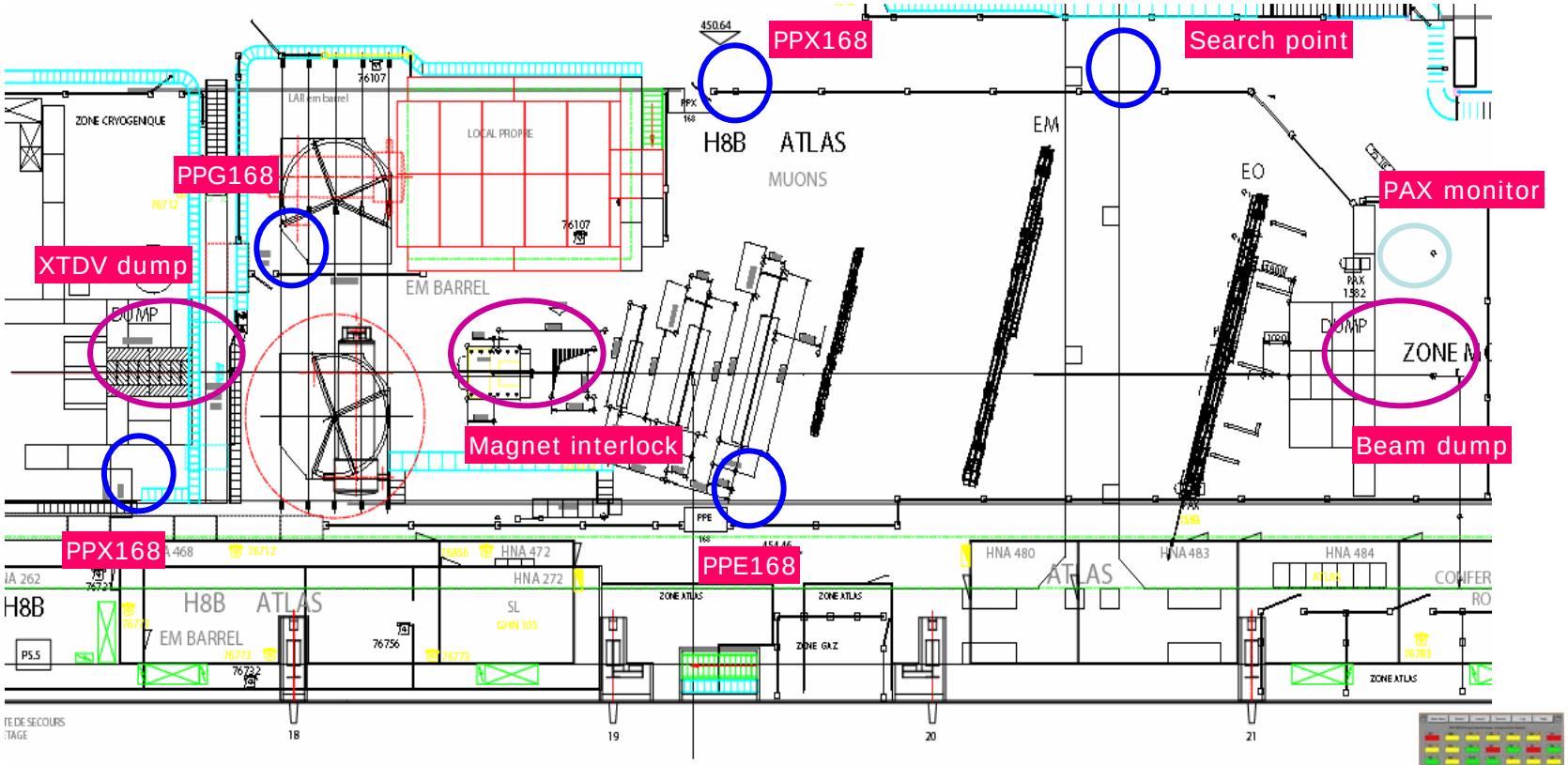


Interlock chains - North Area

Access System - Example

PPE168 – H8B

- Large area with four doors and a search point
- Big and complicated detector installations
- Radioactive sources, gas distribution (including flammable)

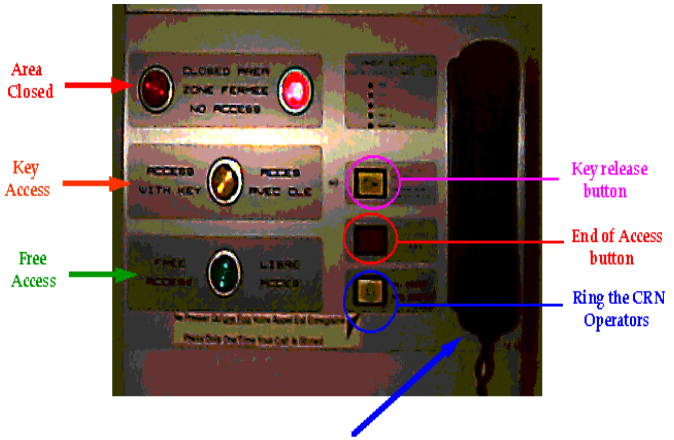


Access System - Doors

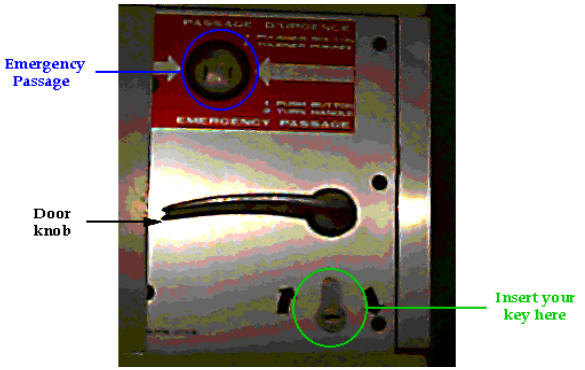
PPExxx Door

keys

door and area status and control panel



door handle



Access System – Door Status and Control Display

- **Displays the status of the PPE doors**
- **Allows monitoring and control of their state**

The doors can be in one of the following states:

FREE

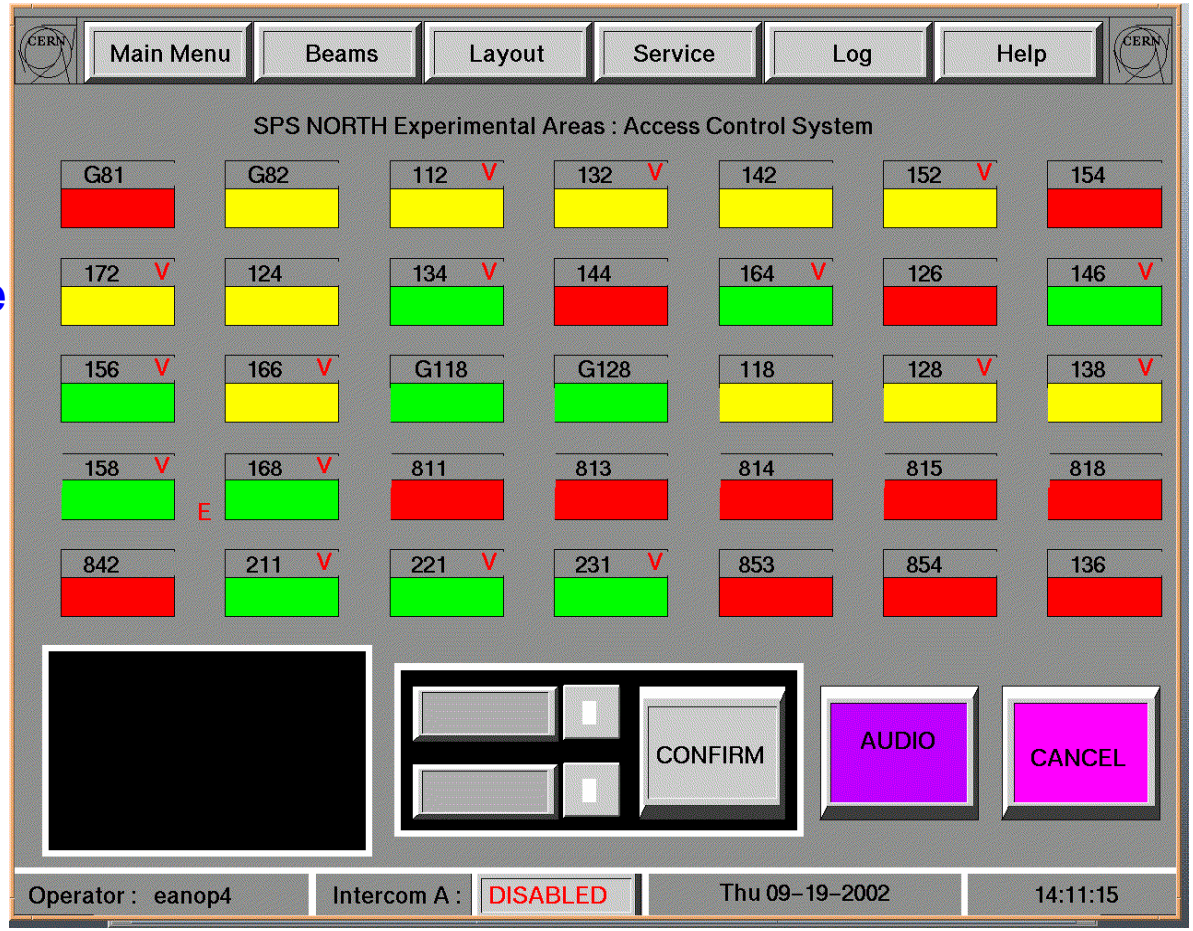
- **No access control**

KEY ACCESS

- **Access with key**
- **Limited number of people**

CLOSED

- **Beam present**



Access System – Interlock Chain Status

- Hardware system to define a status of a beam line
- Hierarchical organization
- Interlock signal based on information from at least two safety elements

The chains can be:

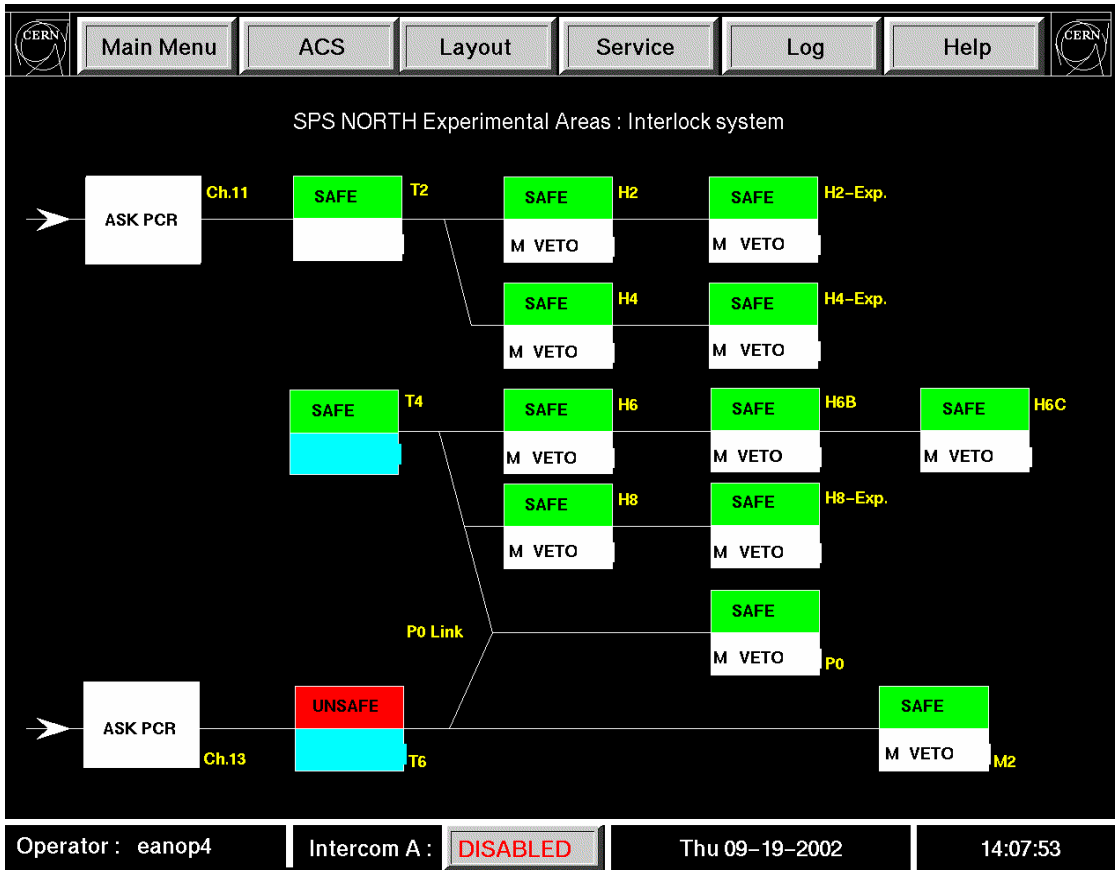
SAFE

- **If all the elements in the chain are in the SAFE state**
  - **it means we can have access to the area**

or

UNSAFE

- **If any of the elements in the chain is in UNSAFE state**
  - **we can't have access**
  - **the beam is present**



Access System – SW Chains/Matrices

… like an 'Access Sequencer'…
Hardware layout is reproduced in CESAR system

- **Should correspond to the actual hardware configuration**
  - **matrices describing the configuration of each interlock chain**
- **Used to facilitate the users/operators**
  - **avoid mistakes that can cause access alarms**
  - **fast help and monitor of the access system**

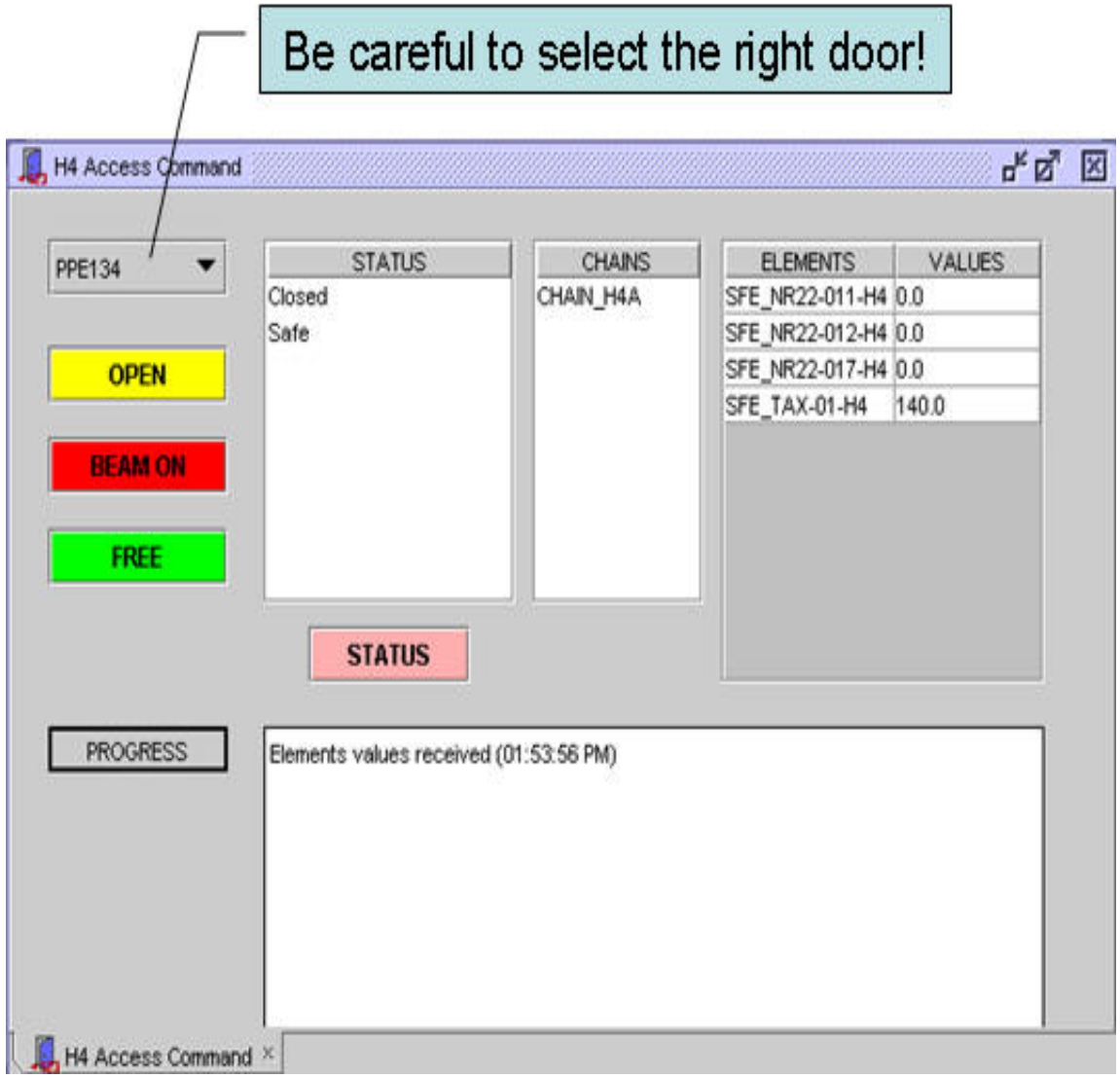
however

- **Intended for high-level commands/programs**
  - **direct calls to the hardware (ie. move a TAX or XTDV) may still be possible**
- **Software interlocks not considered as SAFE**

Note:

- **Hardware for the interlock system maintained by M.Grill (ST/MA)**
- **Annual inspection before SPS startup**

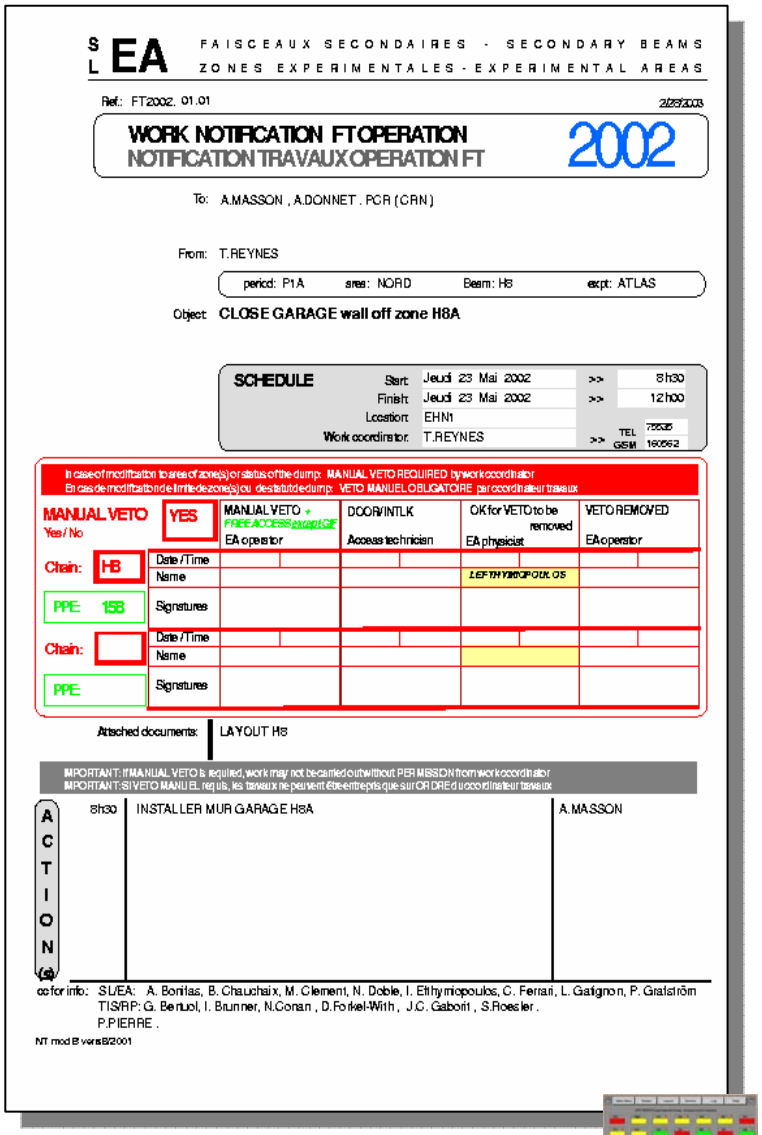
Request Access in CESAR



Access System – Manual Veto

- **To veto an interlock chain of a beam line**
  → Key
  - **blocks beam in an exp. area**
  - **regardless the status of the existing safety elements of the chain**
- **Normal status of all exp. area chains during shutdown**
- **Must be set when work foreseen that can modify the status of an exp. area**
- **Can ONLY be lifted with the agreement (signature) of the EA physicist.**
- **The EA physicist must patrol the exp. area before signing to lift the Manual Veto**
  - **verify that its perimeter is correctly closed**
  - **the safety elements (dumps, doors, magnets) are present and functional**

  i.e. must verify that the access system can function correctly



SL EA FAISCEAUX SECONDAIRES - SECONDARY BEAMS
ZONES EXPERIMENTALES - EXPERIMENTAL AREAS

Ref.: FT2002. 01.01 2/2/2002

WORK NOTIFICATION FT OPERATION
NOTIFICATION TRAVAUX OPERATION FT 2002

To: A.MASSON , A.DONNET . PCR (CRN)

From: T.REYNES

period: P1A area: NORD Beam: H8 expt: ATLAS

Object: CLOSE GARAGE wall off zone H8A

SCHEDULE
Start: Jeudi 23 Mai 2002 >> 8h30
Finish: Jeudi 23 Mai 2002 >> 12h00
Location: EHN1
Work coordinator: T.REYNES >> TEL 75535 GSM 160562

In case of modification to area of zone(s) or status of the dump: MANUAL VETO REQUIRED by work coordinator
En cas de modification de limite de zone(s) ou de statut de dump: VETO MANUEL OBLIGATOIRE par coordinateur travaux

MANUAL VETO Yes / No	YES	MANUAL VETO + FREE ACCESS except LGF EA operator	DOOR/INTLK Access technician	OK for VETO to be removed EA physicist	VETO REMOVED EA operator
Chain: H8	Date / Time				
	Name			LEFTHYMIOPOULOS	
PPE: 158	Signatures				
Chain:	Date / Time				
	Name				
PPE:	Signatures				

Attached documents: LAYOUT H8

IMPORTANT: If MANUAL VETO is required, work may not be carried out without PERMISSION from work coordinator
IMPORTANT: SI VETO MANUEL requis, les travaux ne peuvent être entrepris que sur ORDRE du coordinateur travaux

ACTION(s)		
8h30	INSTALLER MUR GARAGE H8A	A. MASSON

cc for info: SL/EA: A. Bonifas, B. Chauchaix, M. Clement, N. Doble, I. Efthymiopoulos, C. Ferrari, L. Gatignon, P. Grafström
TIS/RP: G. Benuol, I. Brunner, N.Conan , D.Forkel-With , J.C. Gaboriit , S.Roesler .
P.PIERRE .

NT mod B vers8/2001

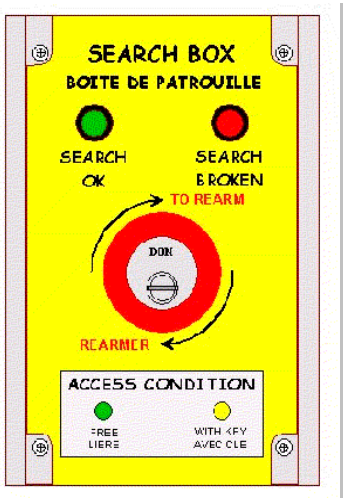
Access System – Search & Secure Procedure

- Needed in order to switch from ‘Free’ to ‘Key access’
- The search is conducted by
  - the search leader
    - normally the GLIMOS of the experiment and other authorized person(s)
- The defined procedure should be rigorously followed

Search Zone / Rearm Doors

Procedure:

1. Ask all the persons present in the area to exit and close all the doors (PPE, PPX, PPG)
2. Verify that all fences and blocks defining the perimeter of the area are in place
3. Remove all ladders or any other equipment can be used by people to climb over the fences
4. Go to the PPE door and call the PCR to switch it from “Free Access” to “Key Access”
5. Leave one person at the PPE door and start the search. All persons entering the area must take a key. Audible devices can be used during the search to warn people. Take your time and look carefully everywhere
6. If there is a “Search Box” you must re-arm it
   - although there is a time-out to do so, don’t rush!
   - it is more to force you to look into that area not just to turn the key!
7. Return all the keys to the PPE door and press the “End of Access” button

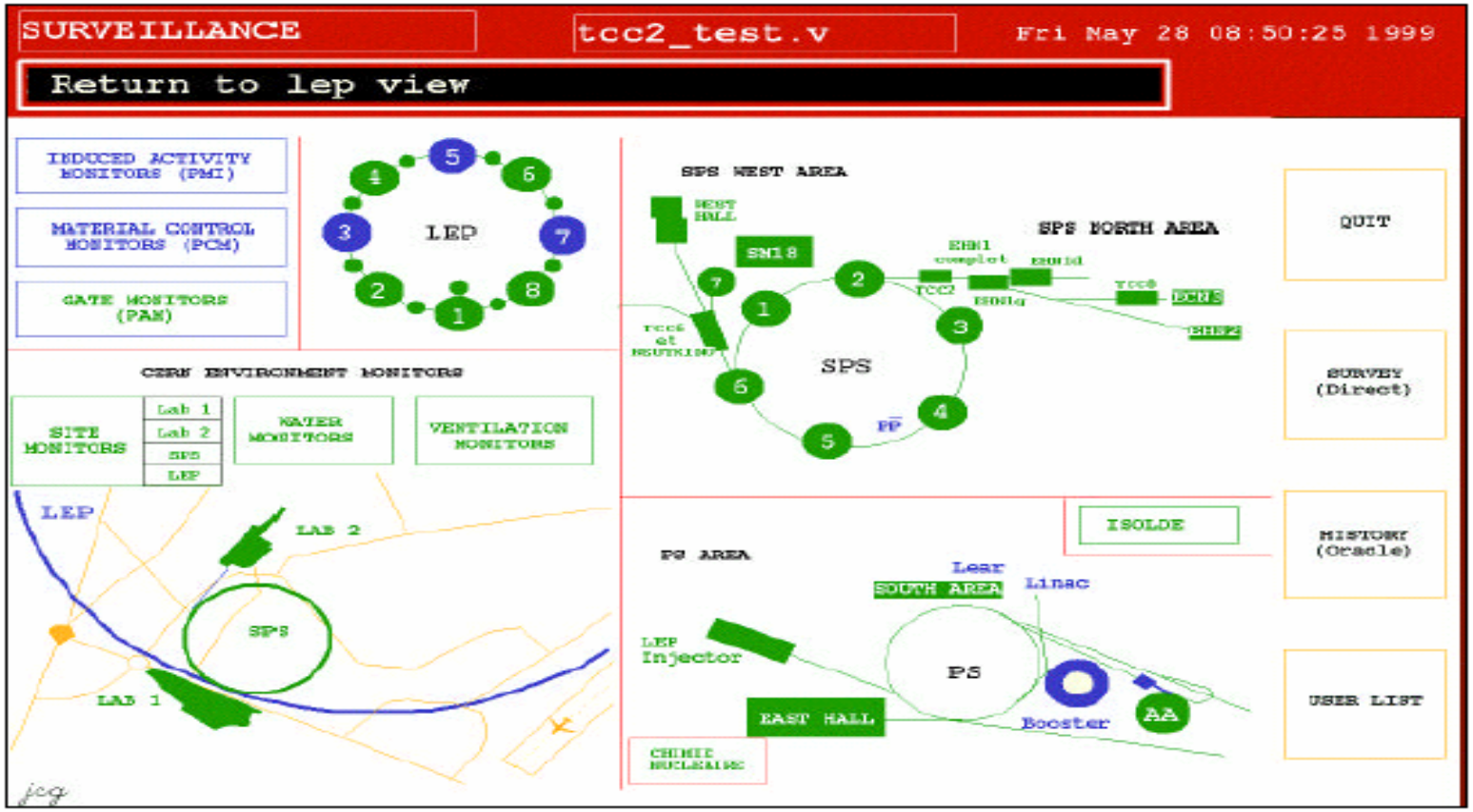


Access System – Changes to Access System

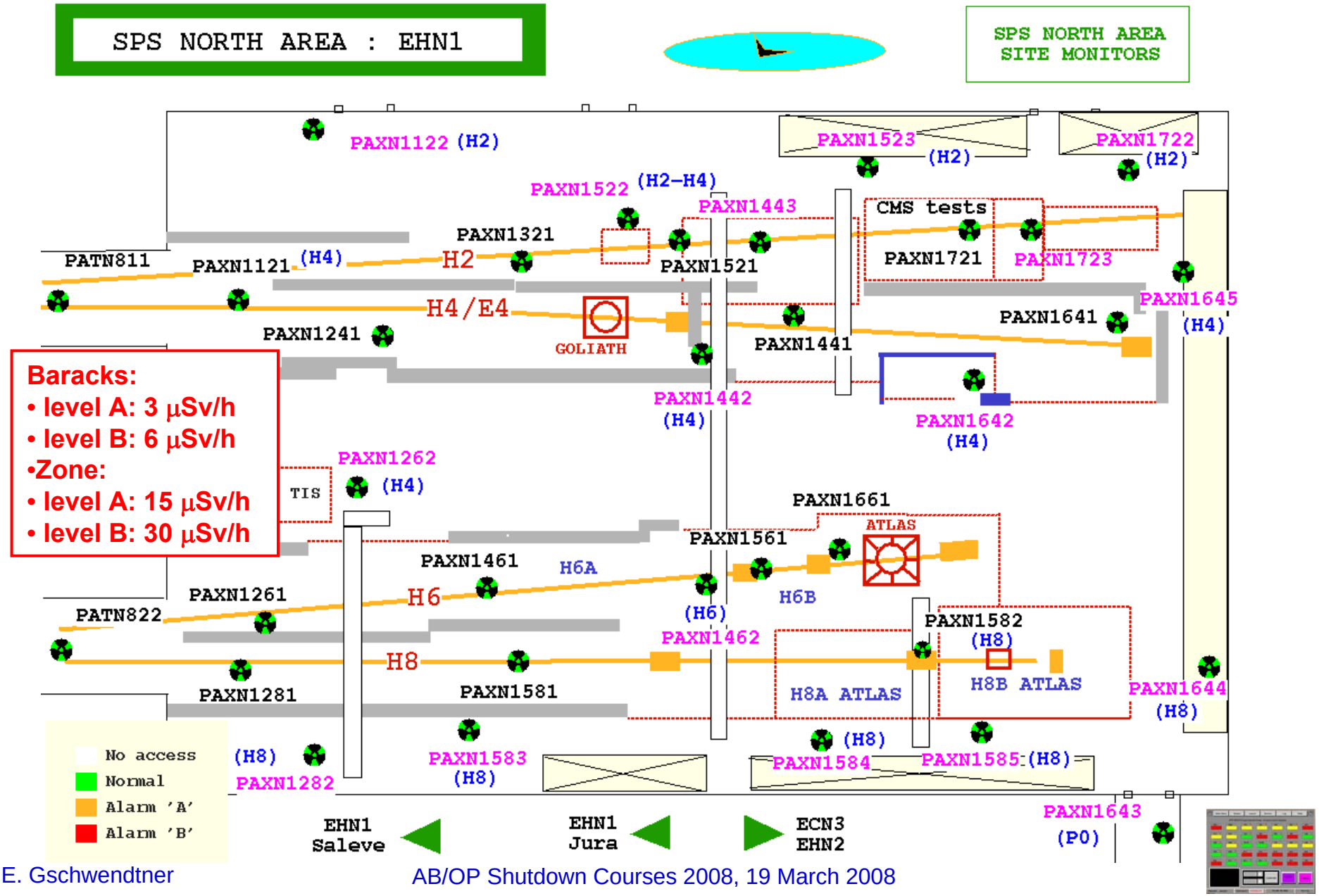
- **Initiated and under the responsibility of the EA physicist**
  - **New conditions from users, modifications in the beam line or exp. area…**
- **All the parties involved are consulted and agree → EA physicist takes care**
  - **EA and BI beam line experts**
  - **access system experts, ST/MA (M. Grill)**
  - **TIS/RP and AB/RSO**
- **All modifications:**
  - **discussed in the EATC meetings and documented in the minutes**
  - **1st meeting of the year: summary of all modifications during the shutdown**
  - **during operation, in the meeting before the SPS period concerned**

RP Central data acquisition system

- All installed radiation alarm monitors can be read remotely
- Data are stored in a database for further retrieval
- The parameters for each monitor are accessible
  - can only be set/modified by authorized persons (TIS/RP)



… RP Central data acquisition system

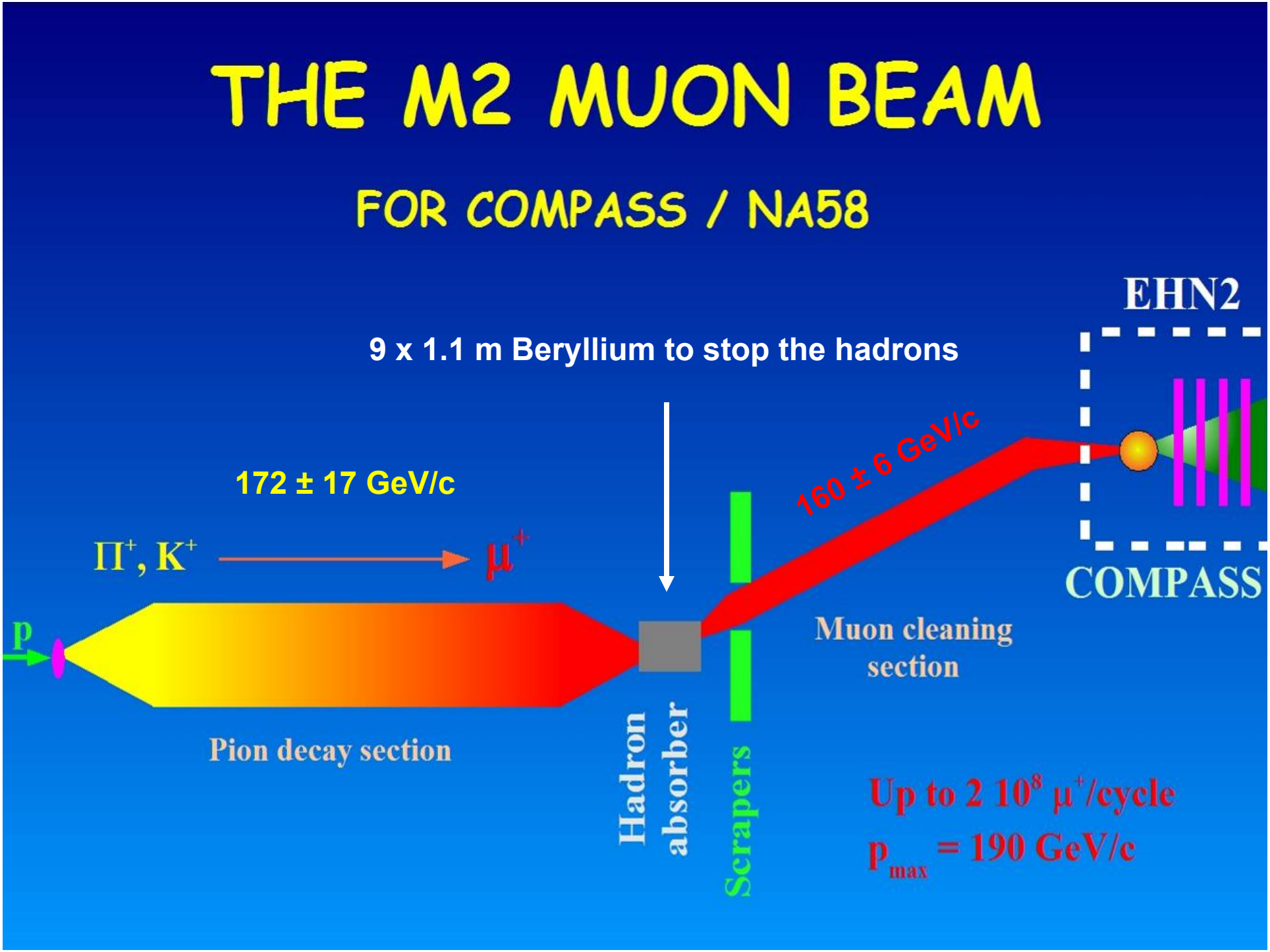


Beam Lines with Long-Lasting Experiments

M2 (COMPASS)

THE M2 MUON BEAM

FOR COMPASS / NA58



M2 Beam Line for COMPASS

1.13 km long beam line that

→ serves the COMPASS experiment (only user)

→ produced from the T6 primary target

Operated in three basic modes:

1. **High-intensity muon beam in the momentum range 60 to 190 GeV/c**

   Typically 2.3 10^8 muons per pulse from 1.4 10^{13} ppp on T6

   So far the main mode.

2. **High-intensity, high energy hadron beam, typically ±190 GeV/c**

   Typically 2 – 5 10^7 hadrons per spill, from 5 10^{12} ppp on T6 (tbc)

3. **Low-intensity low-energy low-quality tertiary electron calibration beam**

   Typically few 10^3 electrons per pulse of up to 40 GeV/c

→ In 2008 the beam will mainly be operated as a hadron beam.

Some short (~1 week) runs with electrons and muons are foreseen as well.

The Hadron Mode

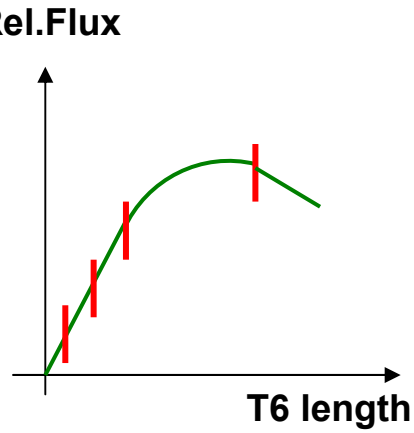
- Simple secondary hadron beam
- Never yet been fine-tuned so far
- New improved optics version is prepared
  - Will be commissioned in 2008
- Once commissioned, operation conditions should be stable

→ Documented on Wiki page, eLogbook, beamfiles

The request is for +190 GeV/c hadrons @ 5 10^7 ppp

-190 GeV/c hadrons @ 2.5 10^7 ppp

both assuming a long flat top operation



The intensity is controlled via:

COLL-1_H = COLL-3_H	also momentum slit
COLL-2_V = COLL-4_V	vertical acceptance
T6 primary target head	0, 40, 100, 200, 500 mm

All absorbers are OUT

M2 Specials

- **T6 target head: under user control**
- **BEND-6: momentum defining bend → never change its value!**
- **Bends 10 and 11: main spectrometers of COMPASS.**

  → Do not switch them off without informing / consulting COMPASS

  (except in case of emergencies or 'force majeure')
- **The SM1+SM2 interlock:**

  In case of a trip (or wrong current) in spectrometer magnets SM1&SM2 → Interlock

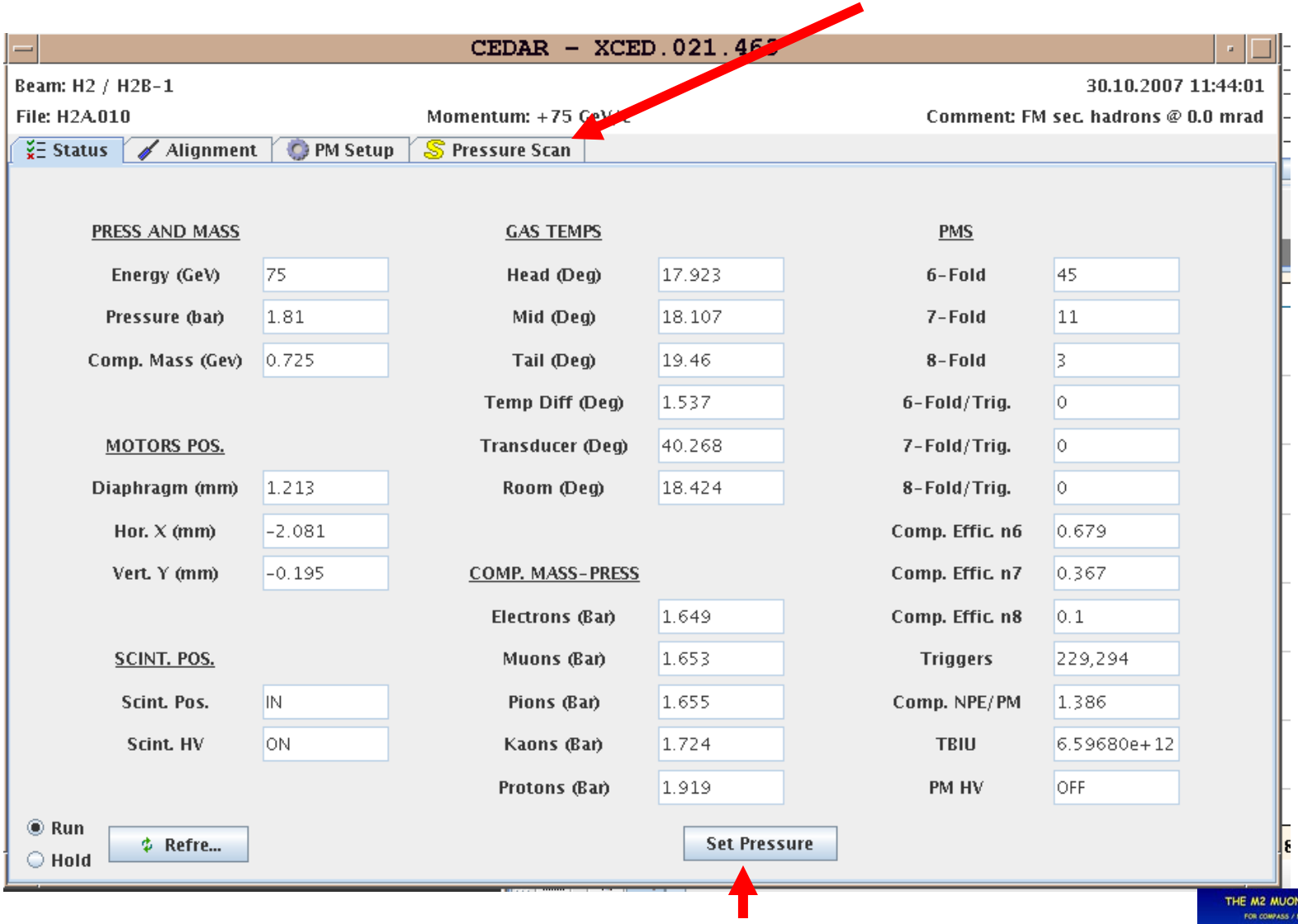
  - **puts Bends 4 on 'delestage'**
  - **Avoids that beam hits sensitive parts of detector**

  → Interlock only be disabled by the experiment!
- **SCRAPERS and MIBs are special magnets: provide ~ 0 field on axis and a toroidal field outside the beam aperture – to clean muon halo.**

  Do not touch scraper positions without good reason!

- **Two CEDAR counters will be commissioned and used.**

  Special status and Scan GUIs have been developed:



Other Modes of M2

Electron Mode

- -100GeV/c upt to Q20, -40 GeV/c or lower after Q20
- 5mm lead converter ('electron target' is IN) downgrades energy of electrons

Muon Mode

- Beam energy downstream of hadron absorber ~8% lower than upstream
- At least 7 absorber modules are IN to stop all hadrons
- Scrapers and MIBs are important in that mode

Changes between different modes:

- under ATB/SBA control
- or by instructed experts in the experiment.

→ Documented in Wiki pages

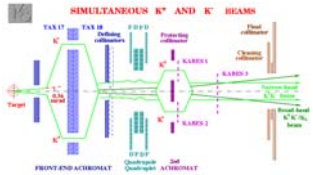
Summary of M2 Beam Modes

The settings for the different beam modes are summarized in the table below:

Beam Mode	Typical momentum	Safety guarantee	T6 target head length	Hadron absorbers	Colls 1 to 5	Secondary Target
Muons	+177/160	Absorbers	any OK	- I I I I I I I -	Open	Out
Hadrons	+200 -100	T6 head Colls 1-5	max. 100 up to 500	- - - - - - - - -	Very closed	Out
Electrons	-100/40	Colls 1-5 p_{EHN2}/p_{T6}	**Must** be 500	- - - - - - - - -	Rather closed	In

→ **See the M2 User Guide on the ATB-SBA web page for more details**

P42, K12


SIMULTANEOUS K+ AND K- BEAMS
TAX 17
TAX 18
Defining collimators
FDFD
Protecting collimator
KABES 1
KABES 3
KABES 2
Target
DFDF
Quadrupole
Quadrupole
FRONT-END ACHROMAT
2nd ACHROMAT

The P42 + K12 beam lines for NA62

- From T4 primary target to NA62 experiment in ECN3
- 2 parts
  - P42 primary proton beam from T4 to T10 Target (~840m)
  - K12 beam from T10 to the experiment (~260m)
- P42 settings:
  - Rather stable
  - Only fine steering onto the 2mm diameter T10 target
- K12 settings:
  - Frequent changes

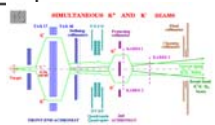
→ But: P42 and K12 only starts operation on 11th September 2008!

27-Feb-2008 **2008 SPS Fixed Target Programme** Version 1.0

Colour code: blue (dark shading) = not yet allocated ; yellow (light shading) = not allocatable or Machine Development

	P1	P2	P3	P4	P5	P6
	24 19 May 12 Jun	28 12 Jun 10 Jul	35 10 Jul 14 Aug	28 14 Aug 11 Sep	28 11 Sep 9 Oct	34 9 Oct 12 Nov
T4 -P0	EA 3	13	28	35	28	NA62 13	8	NA62 7	NA62 10	7	NA62 17

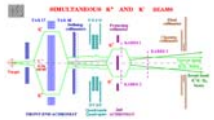
Physics Straw R&D RICH R&D



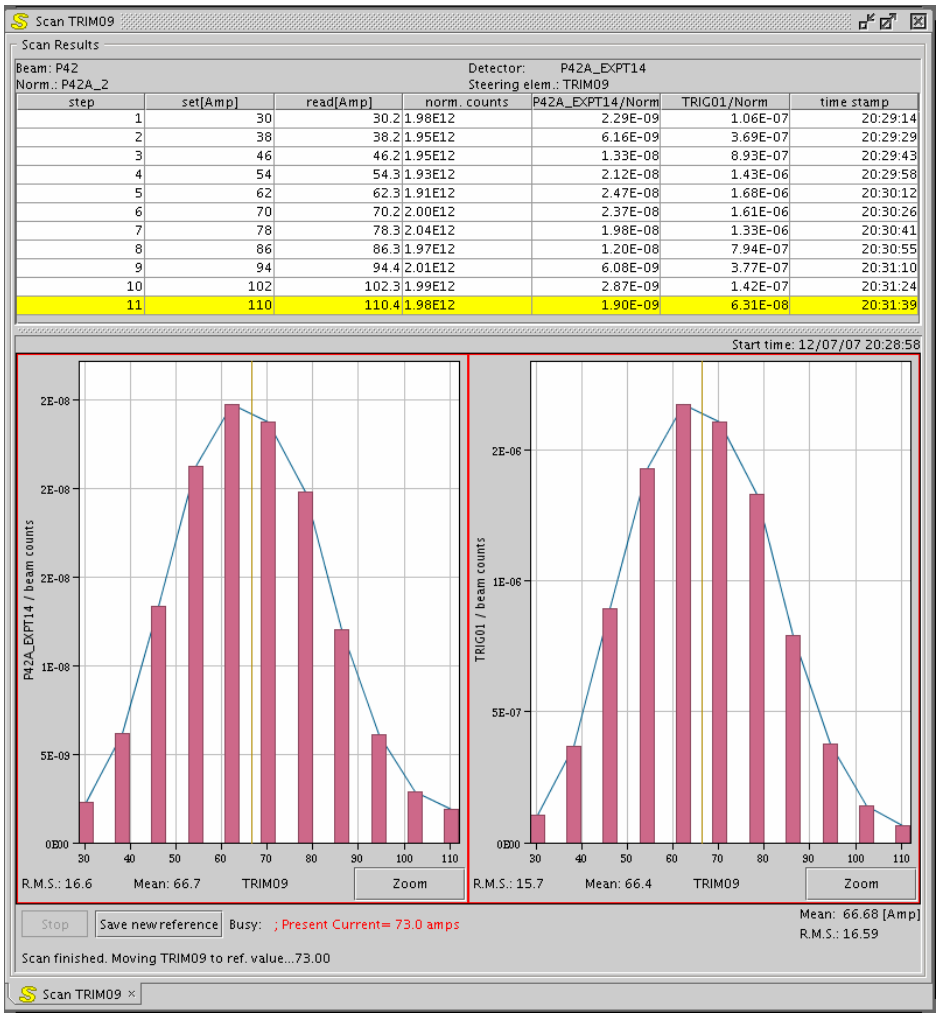
P42 Specials

- **Magnet currents: tuned and kept updated in P42 beam file**
  - **Only Trims 9 and 10 regularly tuned to steer onto T10 (wobbling!)**
- **High intensities → use of collimators forbidden!**
- **Control of T10 flux only possible by**
  - **Changing TAX hole (=position) in the P42 TAXes (only discrete changes)**
  - **Changing intensity onto T4 (any values, but tedious)**
  - **Changing T4 target head (affects H6, H8- needs EA physicists)**
- **Intensity is high (1.5 10E12 on T10 target)→ currents of main bends in P42 and some currents in K12 are monitored by P0-SURVEY**
- **Cooling of the T10 target and TAX are monitored by DUMP CONTROL**
- **Access to ECN3 and galleries requires closure of P6 TAXes**

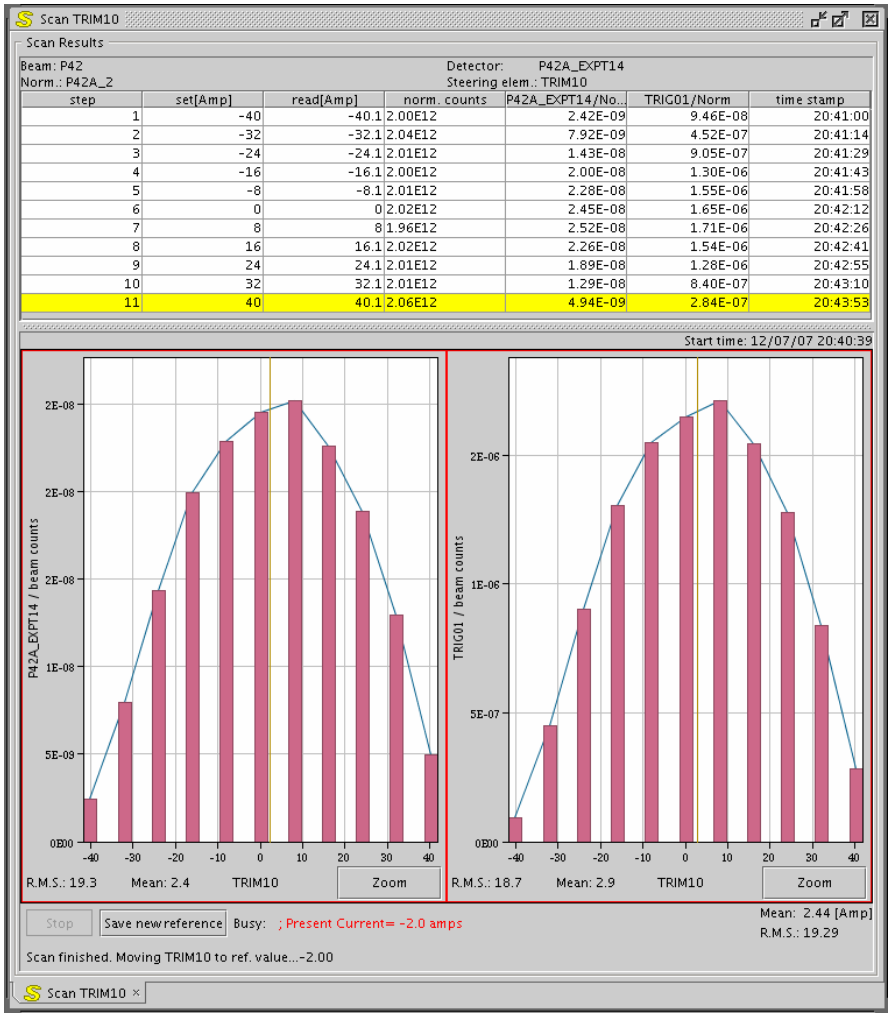
→ Never disable P0 survey or DUMP control without prior agreement of the responsible EA physicist!



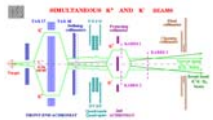
P42 Trim Scans



P42-TRIM9 scan

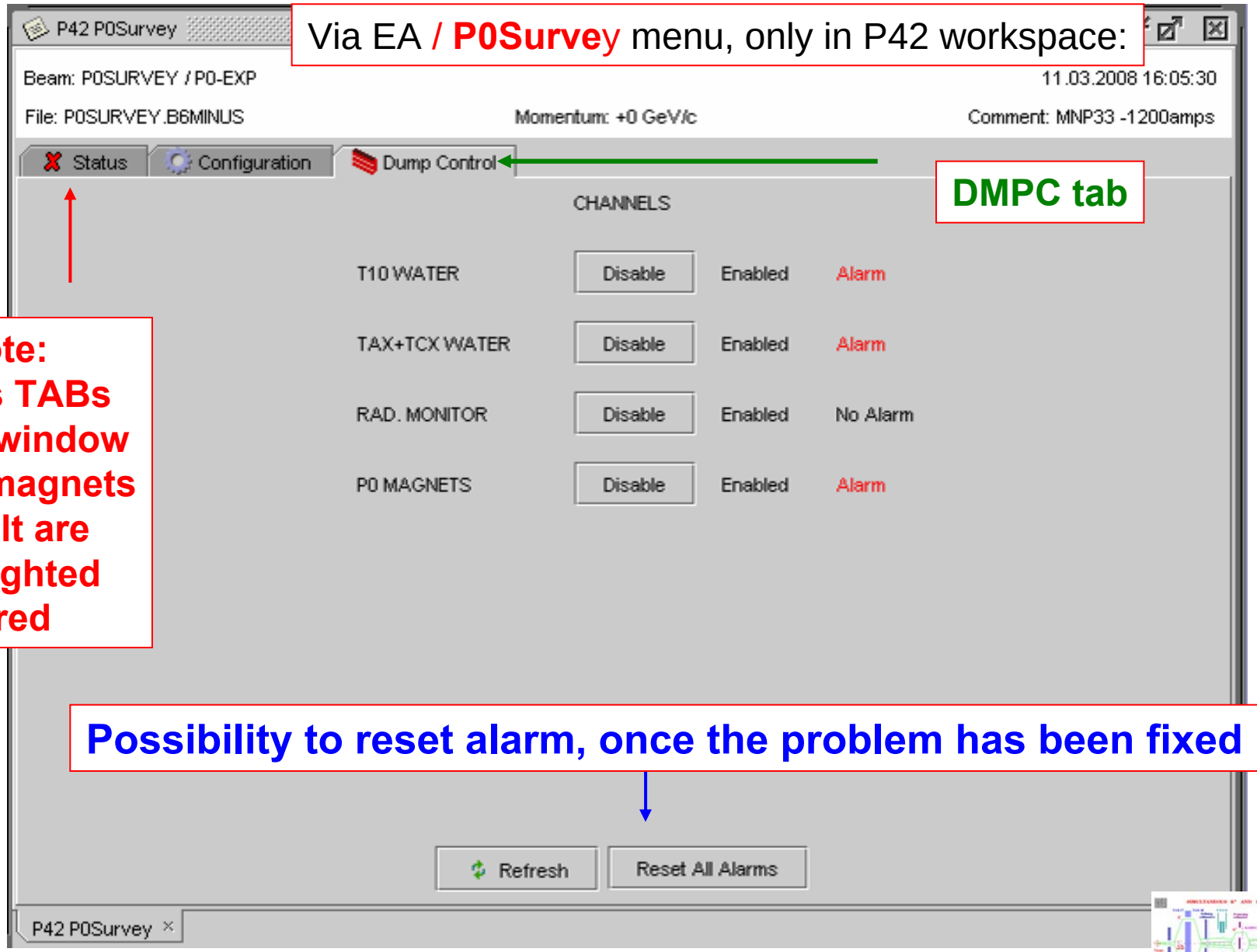


P42-TRIM10 scan



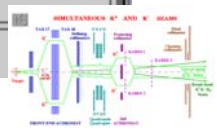
P42, K12 P0Survey

Via EA / **P0Survey** menu, only in P42 workspace:

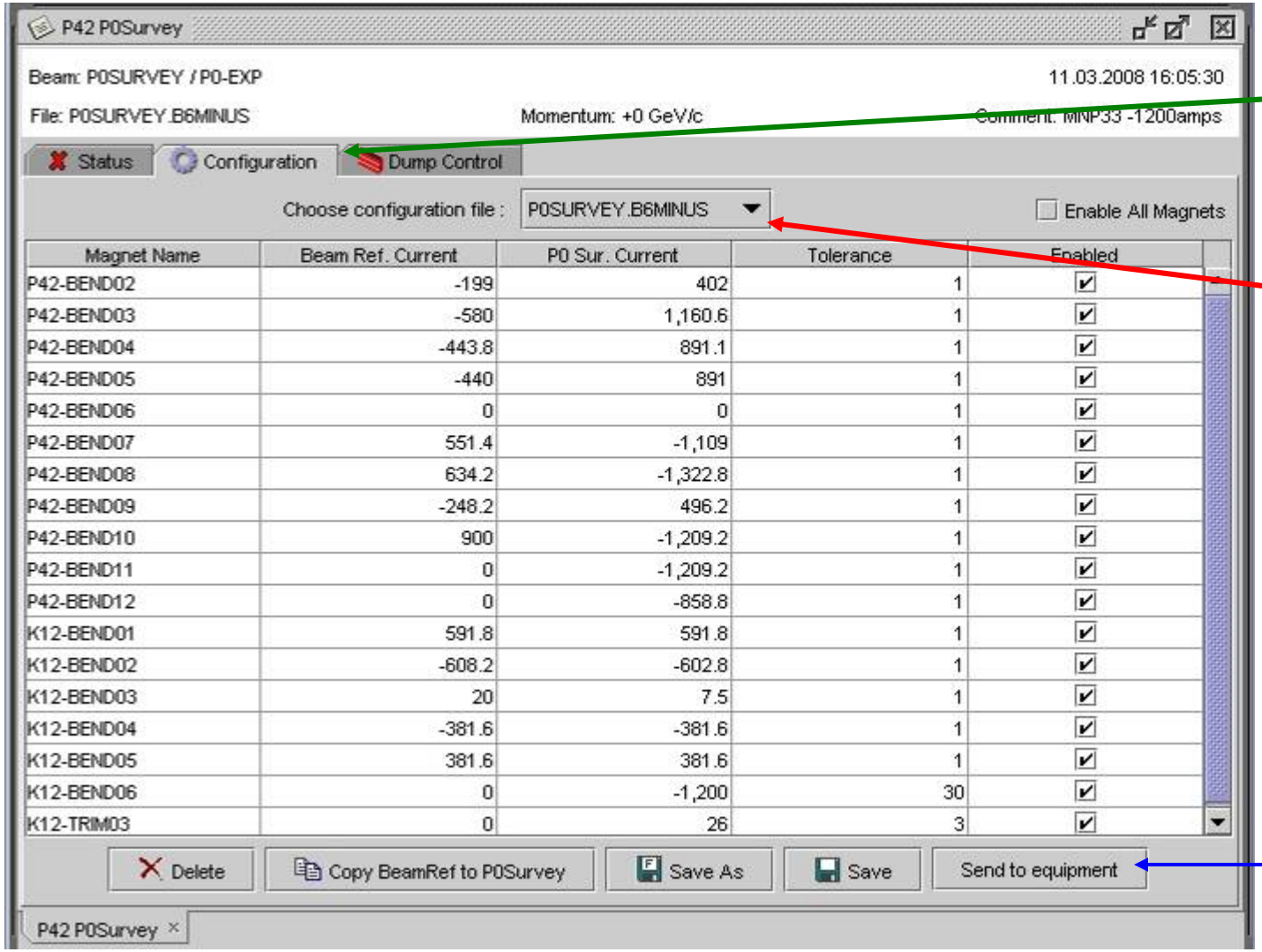


Note: Status TABs opens window where magnets in fault are highlighted in red

Possibility to reset alarm, once the problem has been fixed



P42, K12 P0Survey



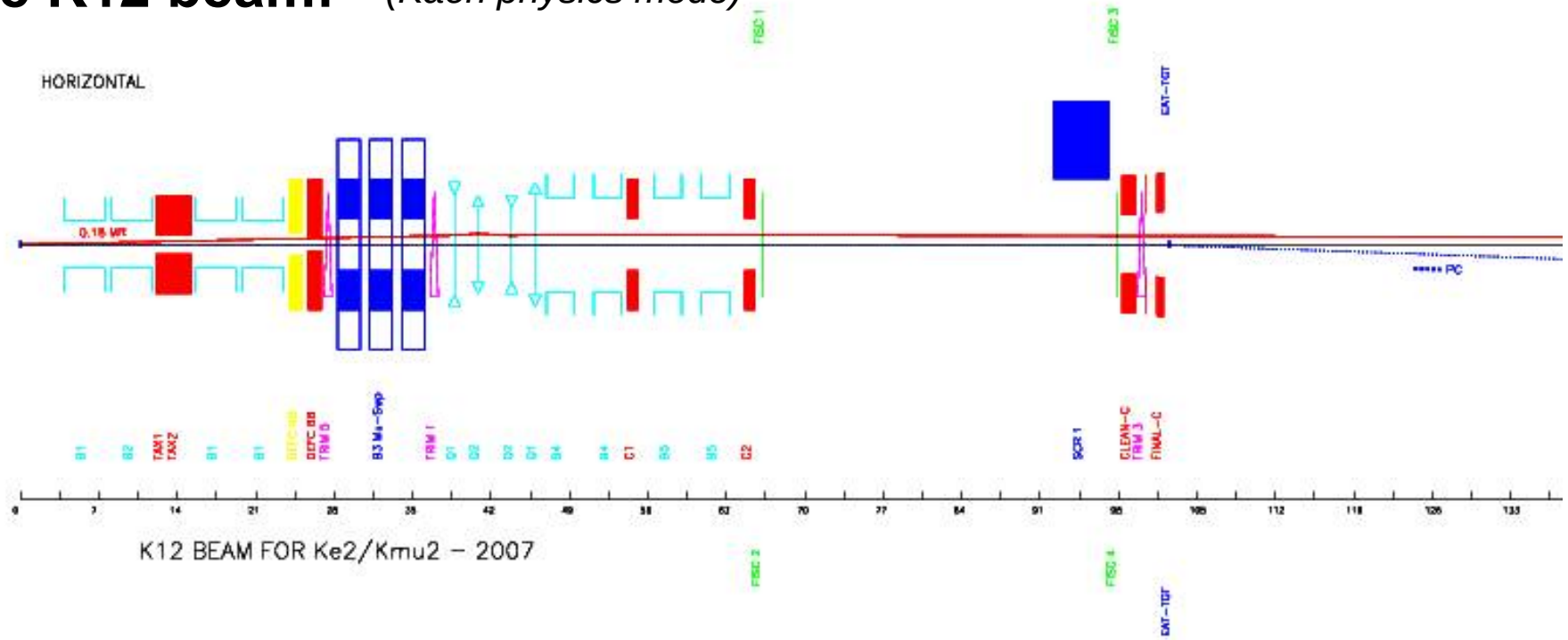
Config tab

Choose surveillance reference file corresponding to beam file in use

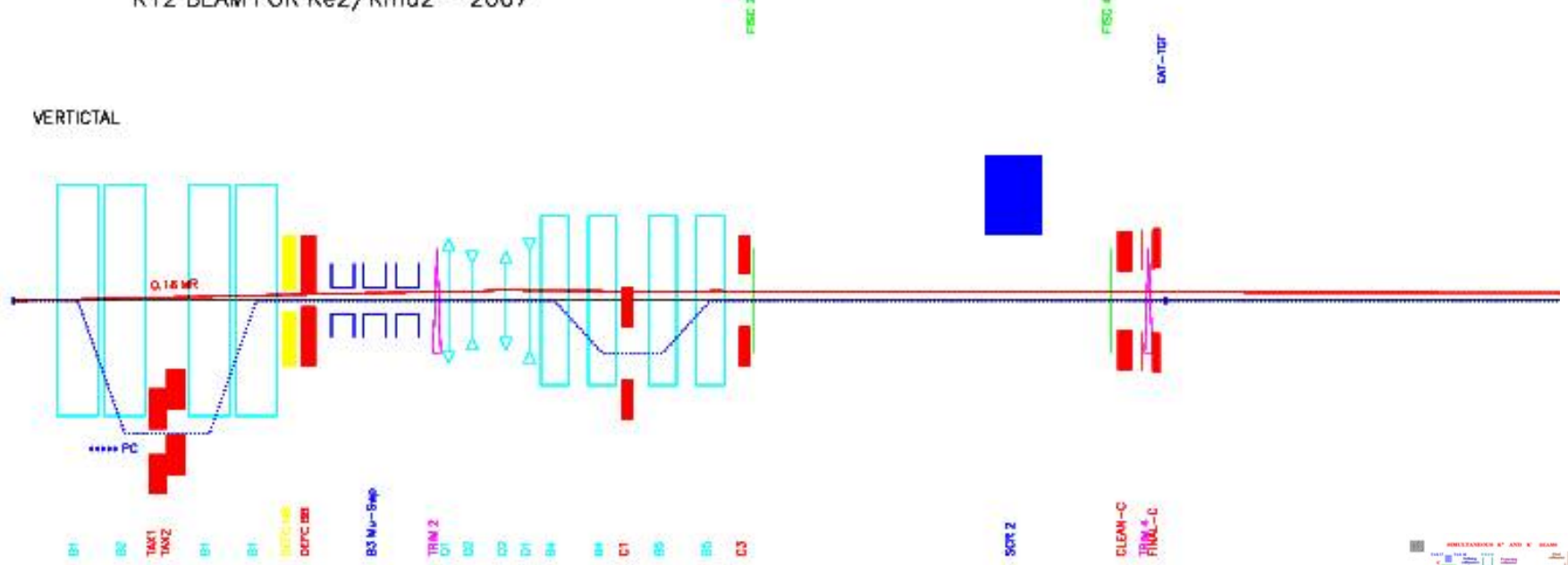
To activate new survey references

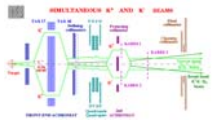
Normally only changed by EA physicists

The K12 beam: *(Kaon physics mode)*



K12 BEAM FOR Ke2/Kmu2 – 2007

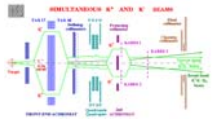




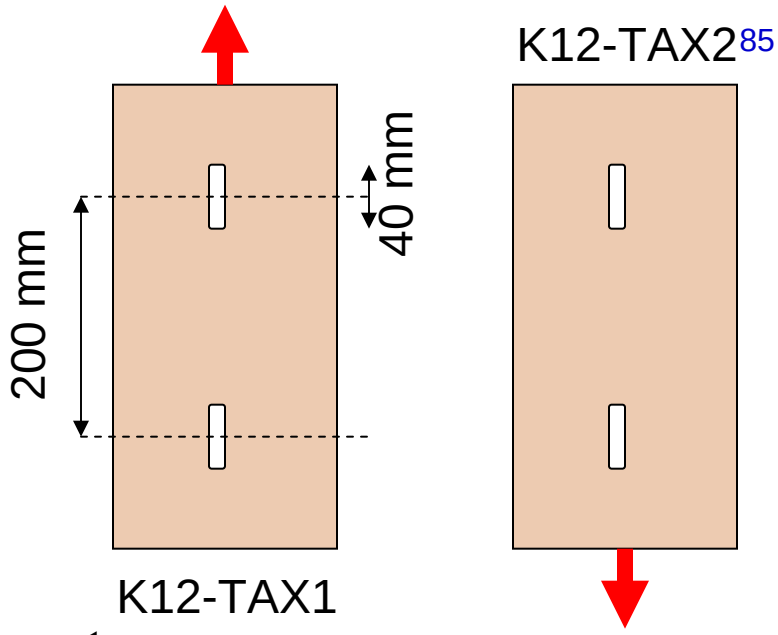
Operation Modes of K12 Beam Line:

- **K^+ or K^- or simultaneous K^+ + K^- beams (typically ±75 GeV/c)**
  - This is the typical condition for physics operation
  - Two 'achromats' with momentum selection in K12 TAX
  - Muon sweeping with Bend3 ('filled' with Iron) and scrapers
- **Muon beams**
  - Dump the beam from T10 in the K12 TAX
  - Switch muons sweepers, quadrupoles, trims and 2nd achromat off
- **Low energy secondary beams for straw detectors**
  - 40 GeV selected instead of 75 GeV,
  - deflected away from beam (by 15 cm!) axis with Trim-3 (as in 2007)
- **Low-energy secondary PARALLEL beams for RICH prototype**
  - typically around 30 GeV. Special beam optics. **NEW FOR 2008.**

Changes between these modes are done by EA physicist
They involve beam files, K12 TAX positions, P0-survey



K12 Specials:



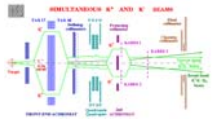
- The **K12 TAX** have two race-track slits:
  → can be offset to define one or two momentum slits
  → one hole on the central axis
- Bends 6 and 7 control the two coupled pairs of coils of the **MNP33 spectrometer**.
  → operated only via a special program EA → MNP33 in the K12 beam
- Three special **XCLD collimators**
  → allow to define the angular acceptance of the beam line.
  → solid blocks with a fixed dimension hole.
  → can be moved IN and OUT of the beam.
  → When IN, they can be positioned finely in both planes (range ±4 mm)

Please do not move without consulting the EA physicist!

Access to K12

- **Access to ECN3 cuts 4 TAX and 3 rectifiers.**
  - → reset of P0-survey necessary after end of access.
  - → Normally done automatically by the access program
- **The technical gallery G300 access requires ‘ small range’ on P42-TAX2**
  - → Monitored by a EA-SIS program.
  - → If the position or range changes during access, P42-TAX2 is closed !
- **If P42-TAX2 does not open beyond +44 mm, the range is blocked**
  - → most likely due to the user not having pushed “ End of Access” button after an access to G300
  - → Change TAX to medium or large range once the G300 access ended

More details under K12 from the ATB-SBA home page and in the Wiki pages.



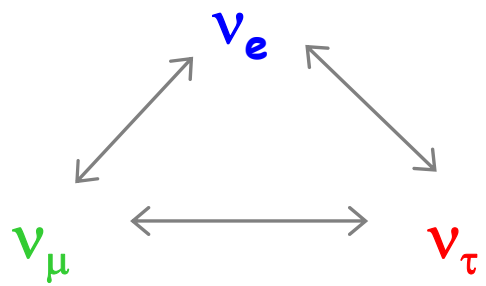
CNGS

CNGS Project

CNGS (CERN Neutrino Gran Sasso)

- A long base-line neutrino beam facility (732km)
- send ν_μ beam produced at CERN
- detect ν_τ appearance in OPERA experiment at Gran Sasso

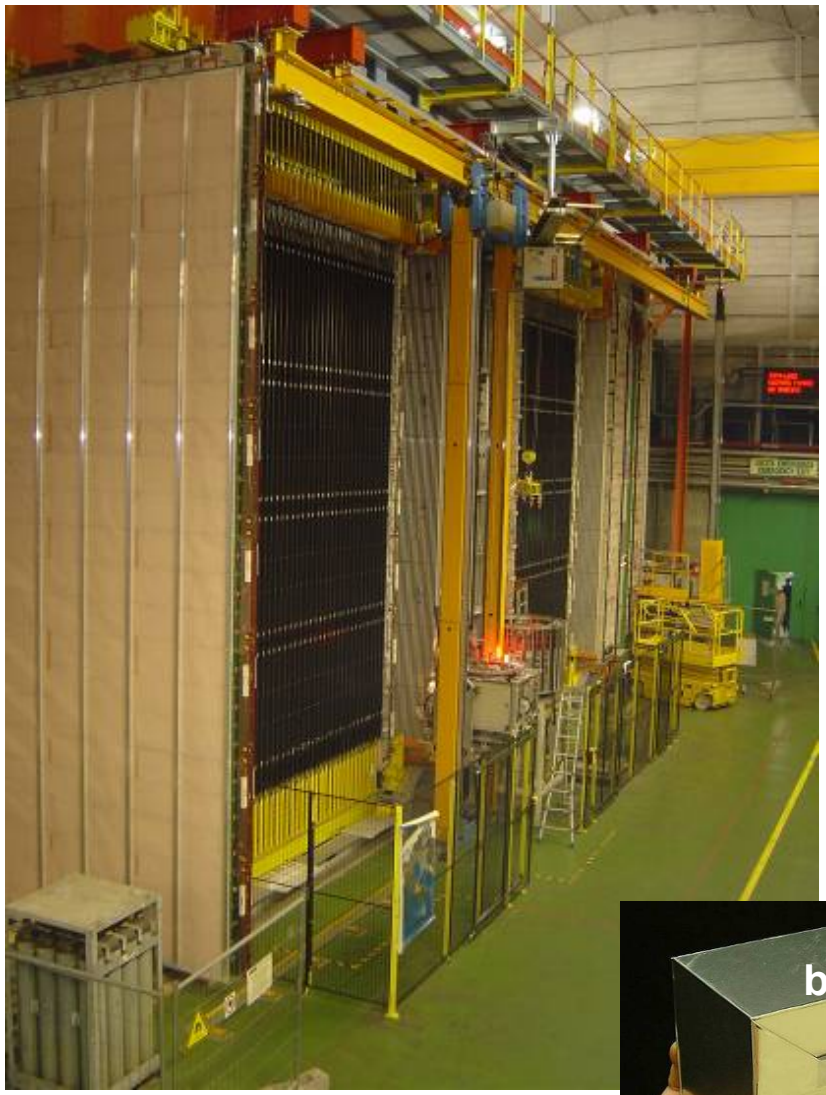
If neutrinos have mass...



➔ 'neutrino oscillation'

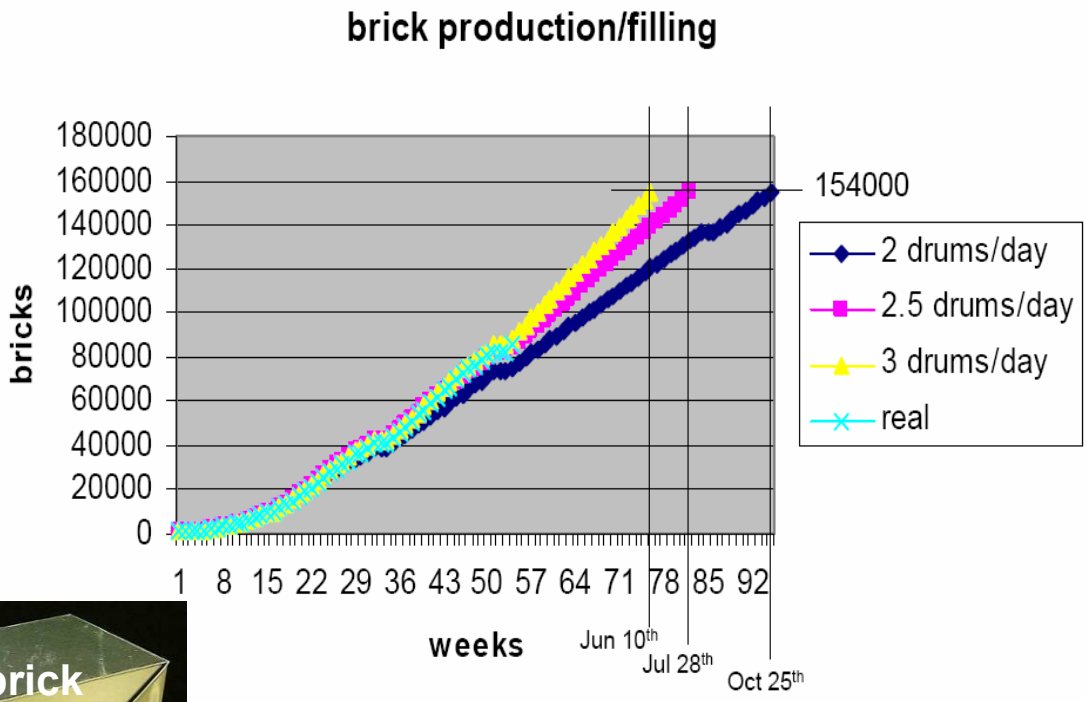
➔ direct proof of ν_μ - ν_τ oscillation (appearance experiment)

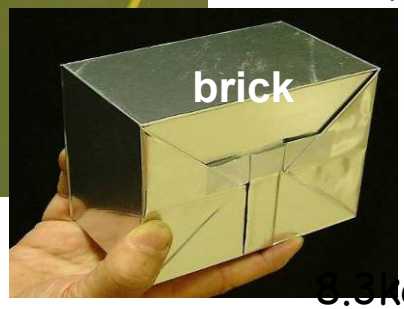
OPERA



11th January 2008:

- **85202 bricks (out of 154000) are produced**
- **Production is stabilized at a rate of 3 drums/day (700 bricks).**
  → Finished by 10th June 2008.

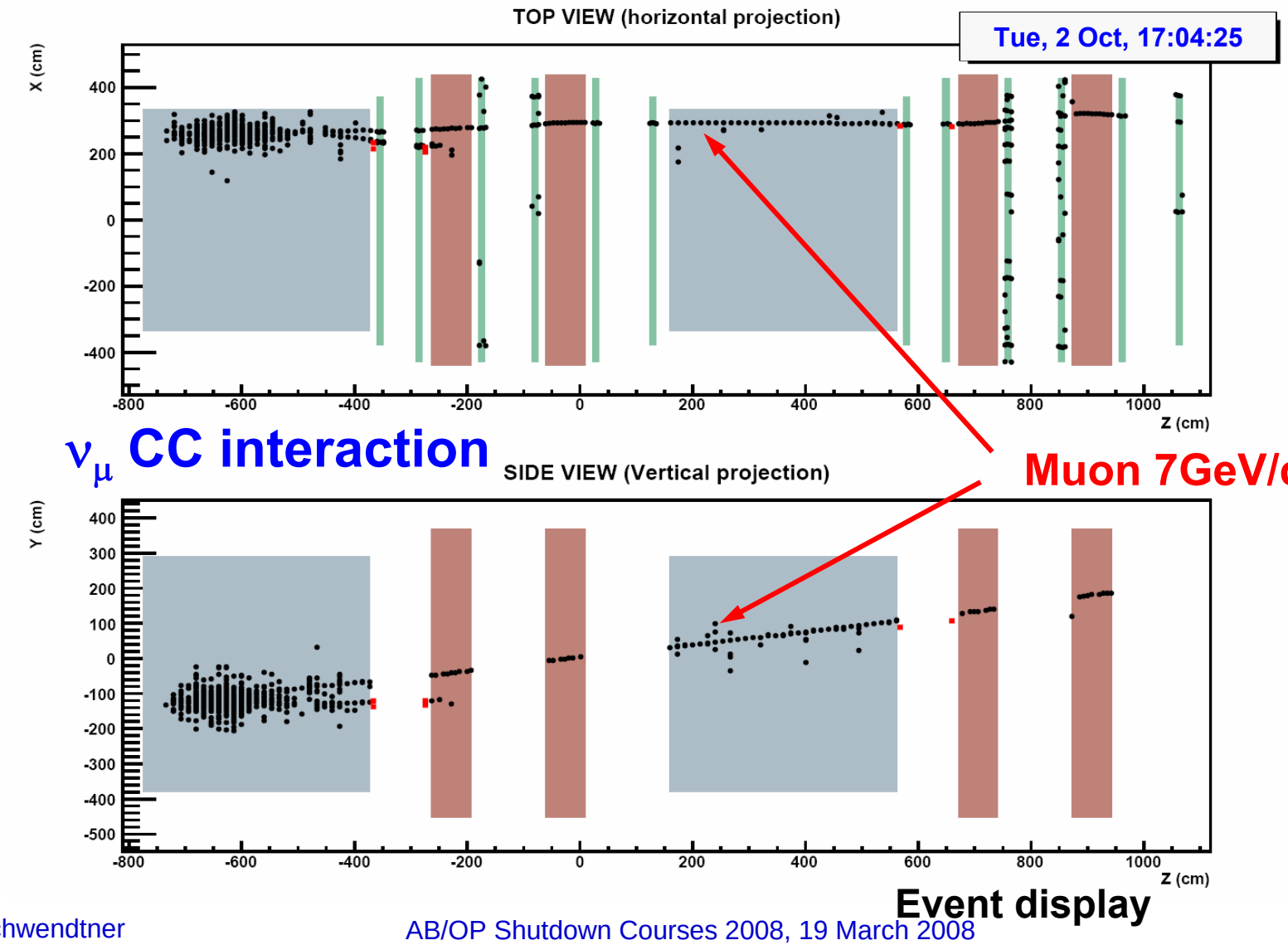




OPERA

Brick Manipulator System, BMS

First CNGS Neutrino Interaction inside an OPERA Brick, 2nd October 2007



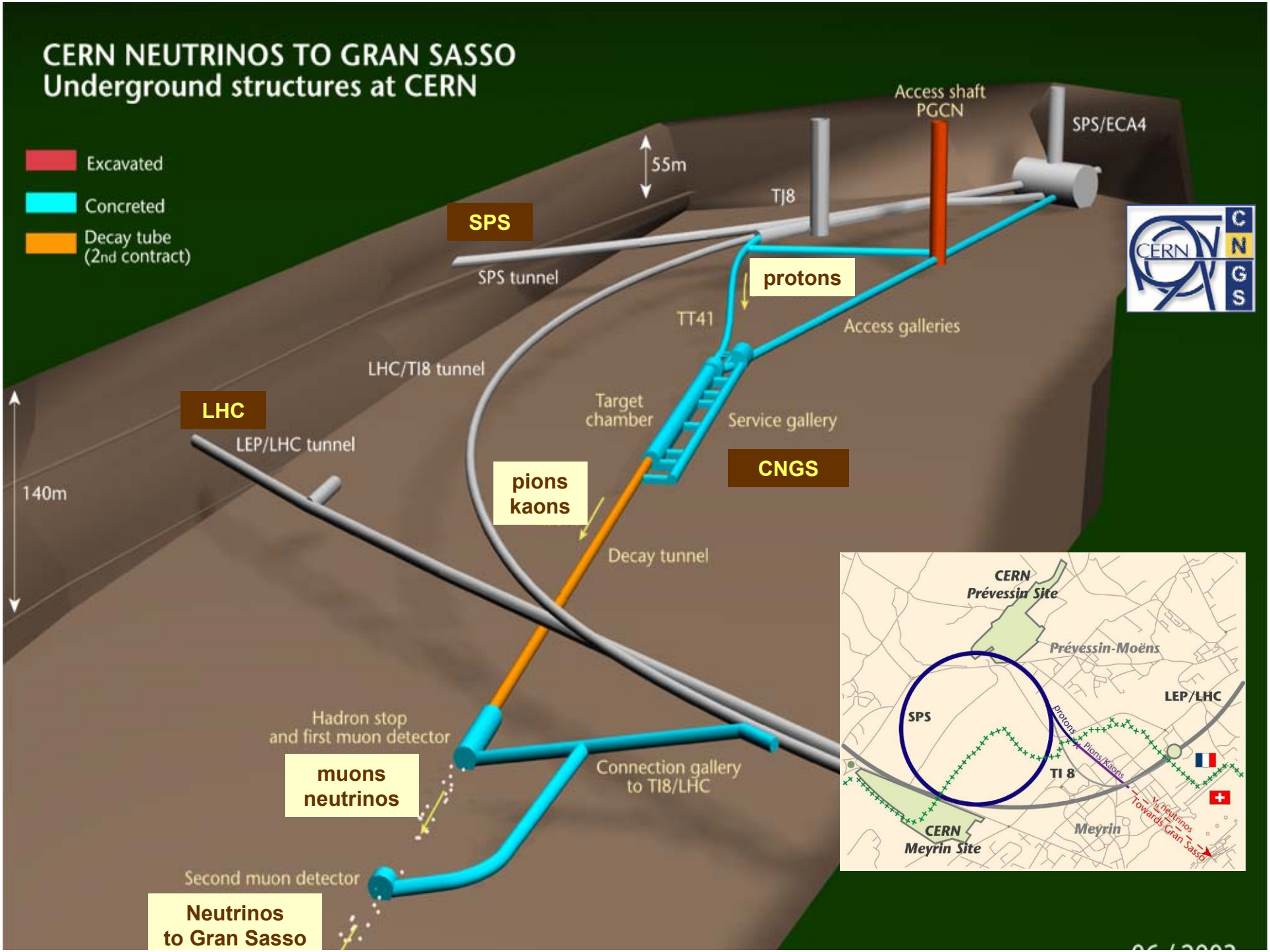
CNGS Challenges

- **High Intensity, High Energy Proton Beam (2 x 2.4 10^{13} p/cycle)**
  - Proton Beam: Tune!!!
  - Induced radioactivity
    - In components, shielding, fluids, etc…
  - Intervention on equipment 'impossible'
    - Remote handling by overhead crane
    - Replace broken equipment, no repair
    - Human intervention only after long 'cooling time'
  - Design of equipment: compromise
    - E.g. horn inner conductor: for neutrino yield: thin tube, for reliability: thick tube

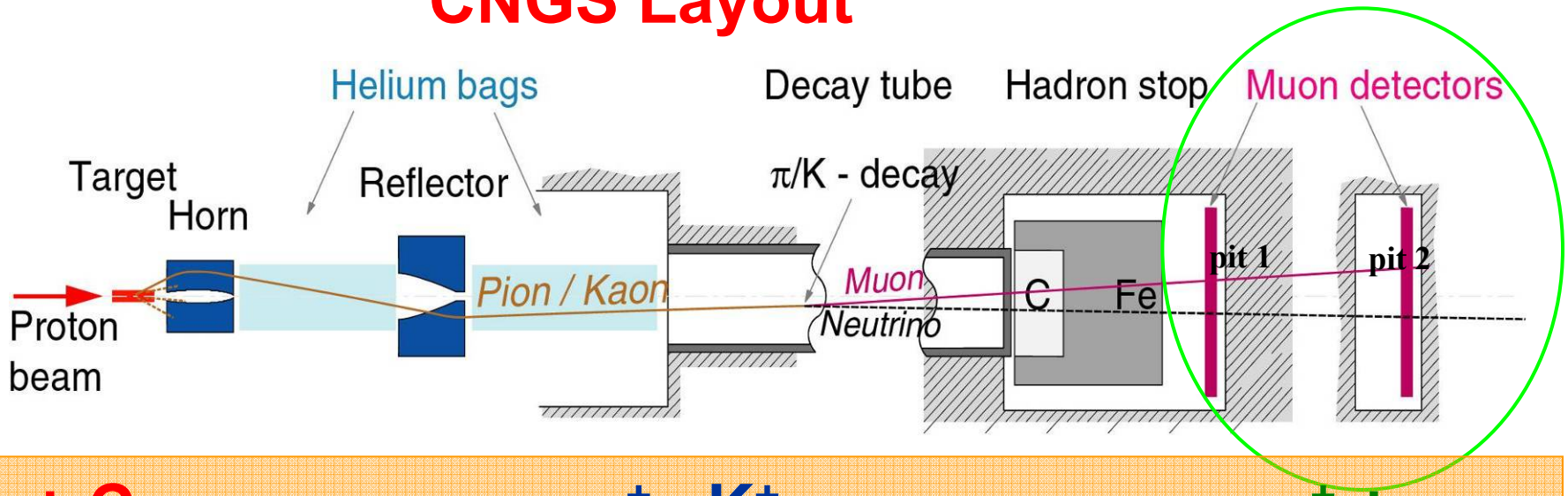
Beam parameters	Nominal CNGS beam
Nominal energy [GeV]	400
# extractions per cycle	2 separated by 50 ms
Batch length[μs]	10.5
# of bunches per pulse	2100
Intensity per extraction [10^{13}p]	2.4
Beam sizes at 400 GeV [mm]	0.5 mm

- **Intense Short Beam Pulses, Small Beam Spot (within ±0.5mm of target)**
  - Proton Beam: Interlock!!!
  - Thermo mechanical shocks by energy deposition (designing target rods, thin windows, etc…)

→ **most challenging zone: Target Chamber** (target–horn–reflector)


CERN NEUTRINOS TO GRAN SASSO
Underground structures at CERN
Excavated
Concreted
Decay tube
(2nd contract)
Access shaft
PGCN
SPS/ECA4
55m
TI8
SPS
SPS tunnel
protons
TT41
Access galleries
LHC/TI8 tunnel
LHC
Target
chamber
Service gallery
CNGS
LEP/LHC tunnel
140m
pions
kaons
Decay tunnel
Hadron stop
and first muon detector
muons
neutrinos
Connection gallery
to TI8/LHC
Second muon detector
Neutrinos
to Gran Sasso
CERN
Prévessin Site
Prévessin-Moëns
LEP/LHC
SPS
protons
Pions/Kaons
TI 8
ν neutrinos
Towards Gran Sasso
CERN
Meyrin Site
Meyrin

CNGS Layout



$p + C \rightarrow$ (interactions) $\rightarrow \pi^+, K^+ \rightarrow$ (decay in flight) $\rightarrow \mu^+ + \nu_\mu$

Muon detectors are monitoring:

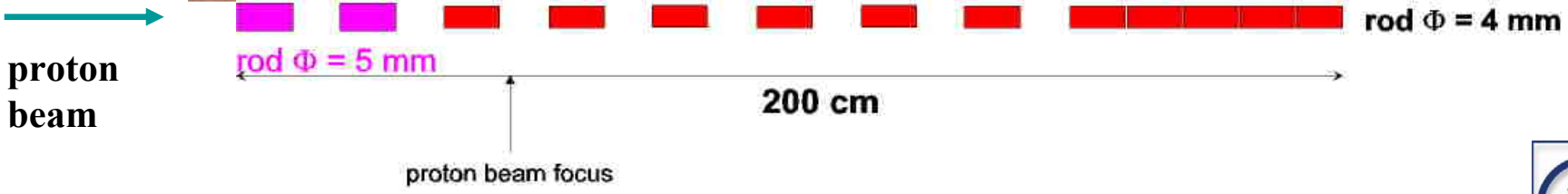
- **muon intensity**
- **muon beam profile shape & centre**

Muon energy filter due to 67m rock in between pit 1 and pit 2.

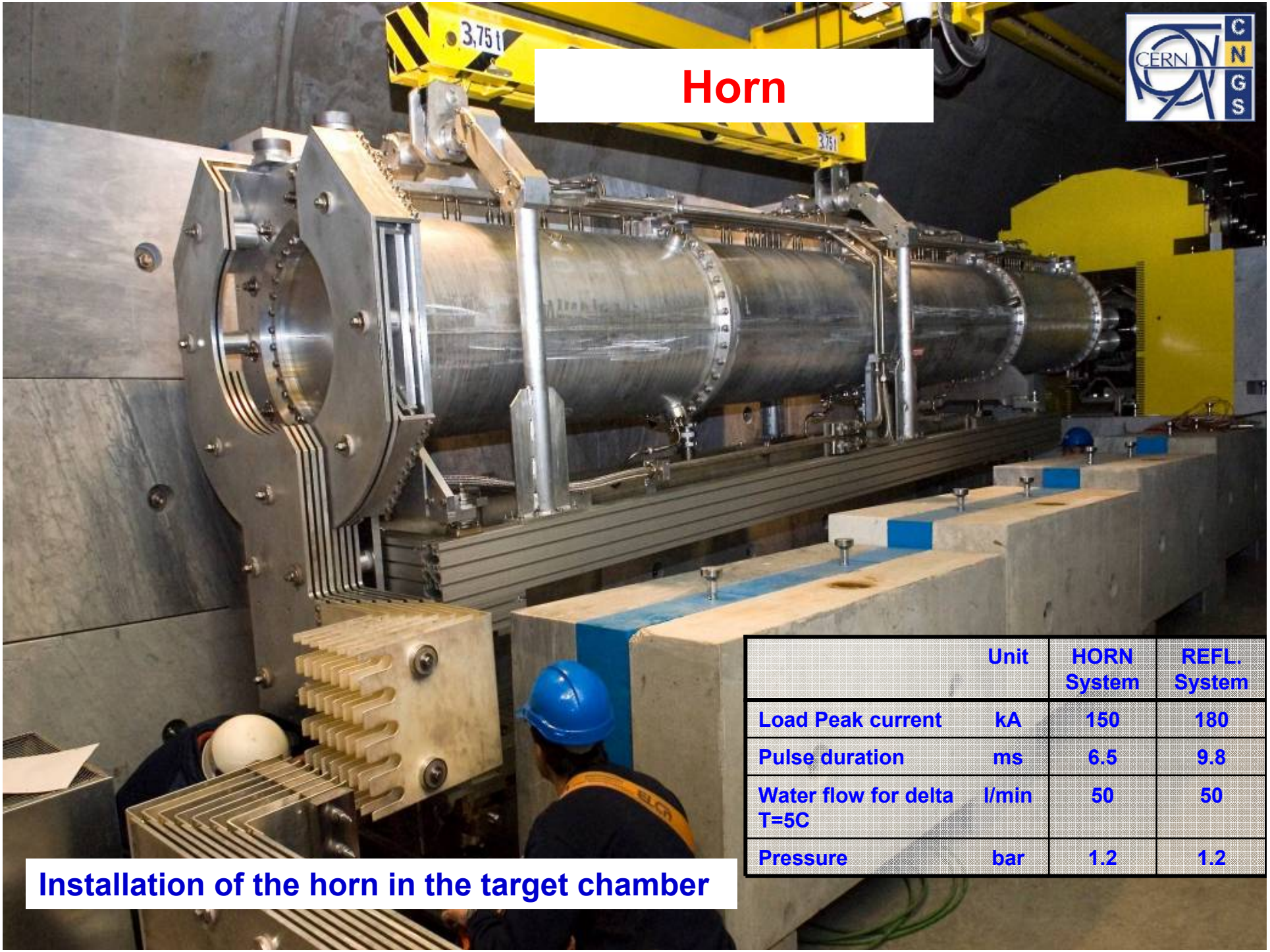
Muon intensity:

Up to ~8x10^7 per cm^2 and 10.5μs

Target Magazine



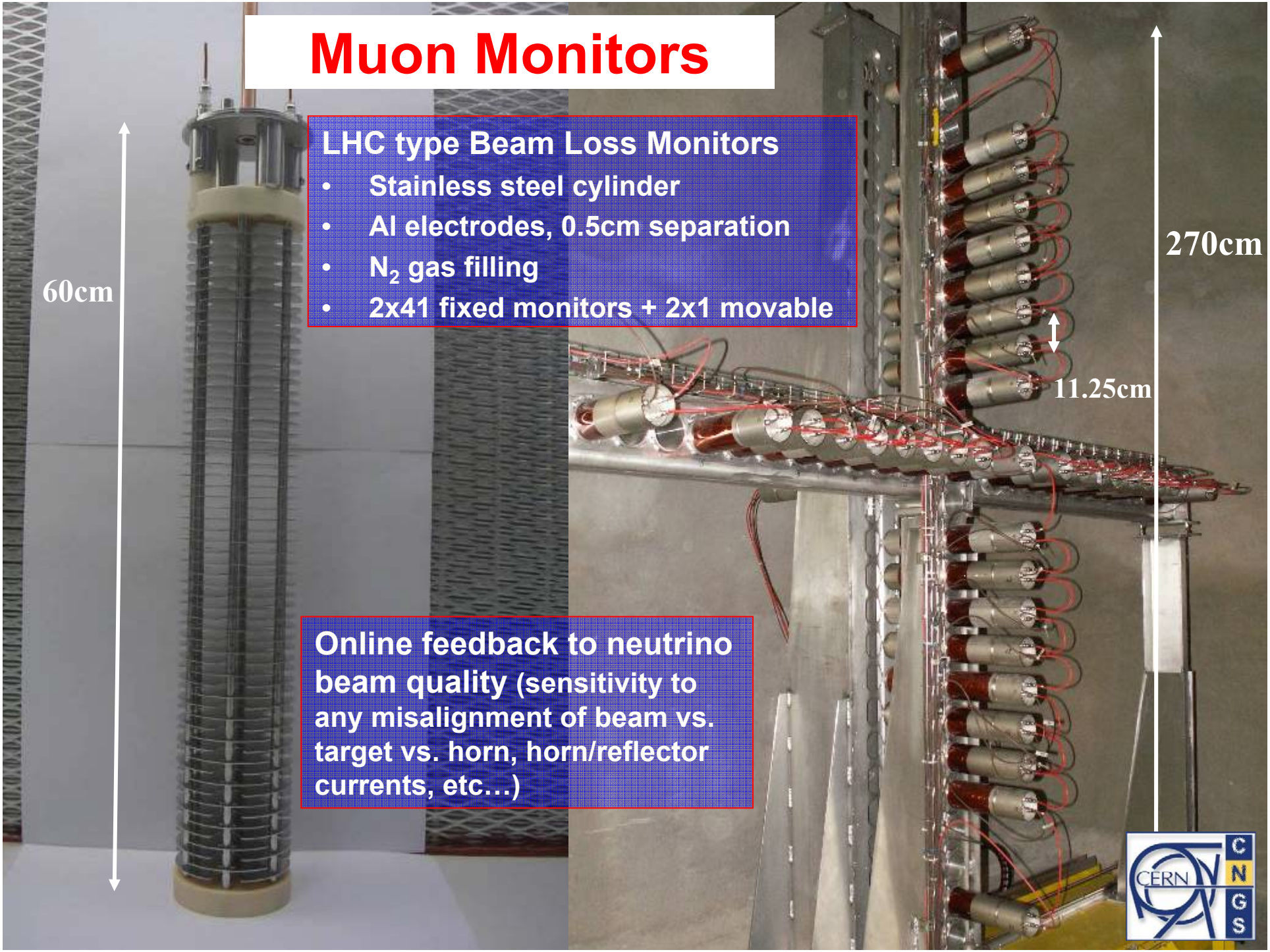
Horn



	Unit	HORN System	REFL. System
Load Peak current	kA	150	180
Pulse duration	ms	6.5	9.8
Water flow for delta T=5C	l/min	50	50
Pressure	bar	1.2	1.2

Installation of the horn in the target chamber

Muon Monitors

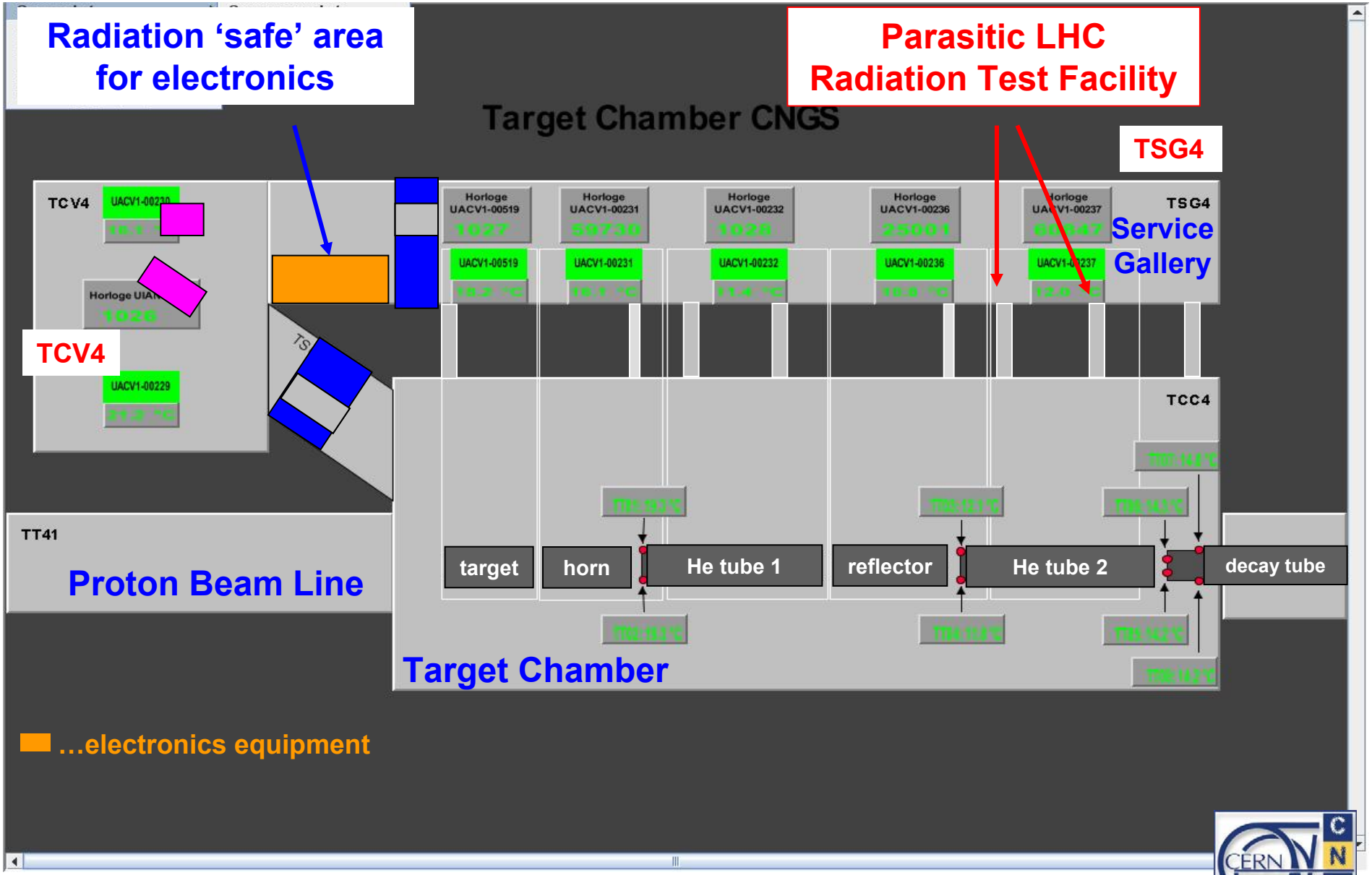


LHC type Beam Loss Monitors

- Stainless steel cylinder
- Al electrodes, 0.5cm separation
- N_2 gas filling
- 2x41 fixed monitors + 2x1 movable

Online feedback to neutrino beam quality (sensitivity to any misalignment of beam vs. target vs. horn, horn/reflector currents, etc…)

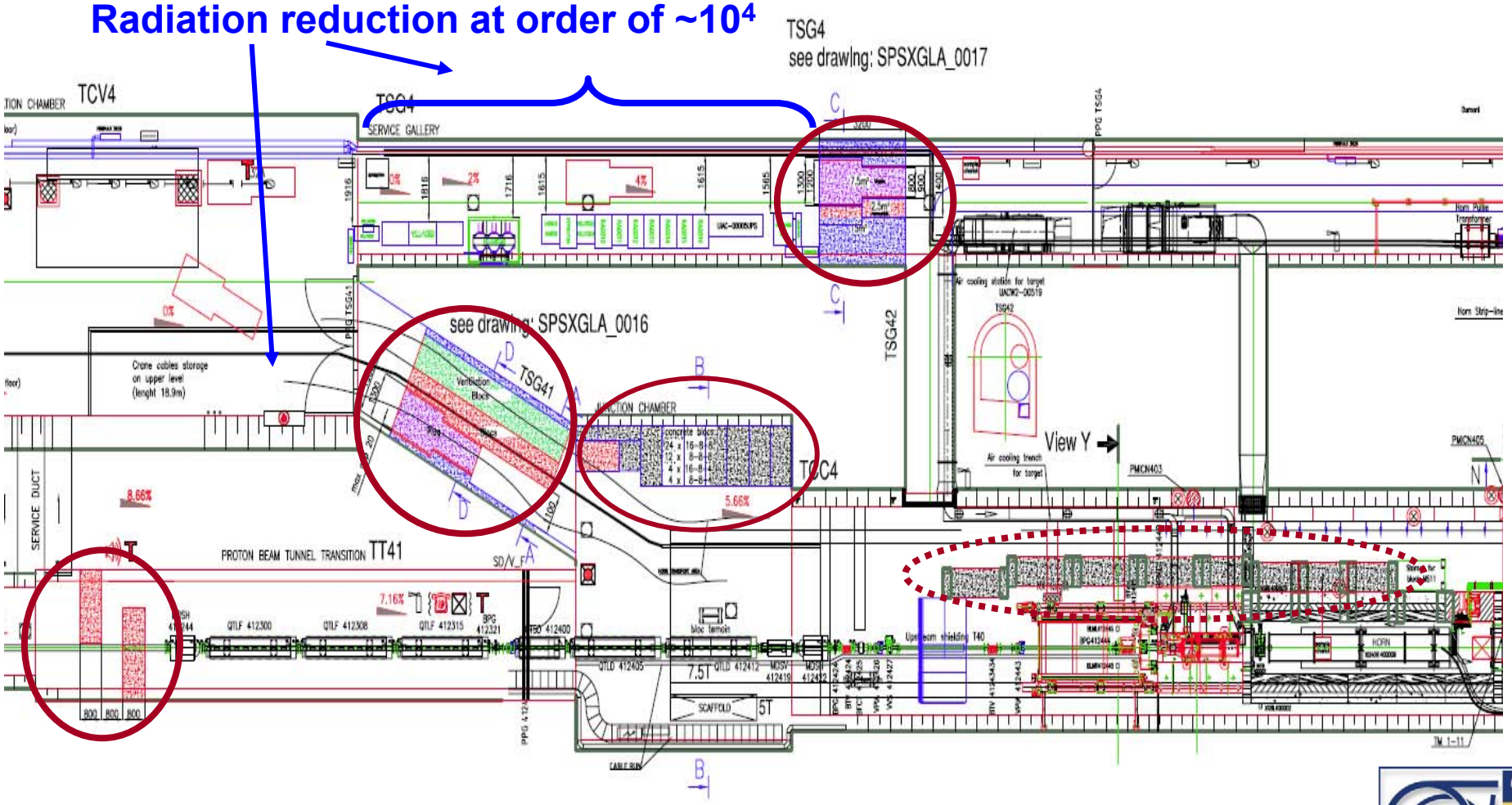
CNGS Layout 2008



New Shielding Layout

Radiation safe area

Radiation reduction at order of ~10^4



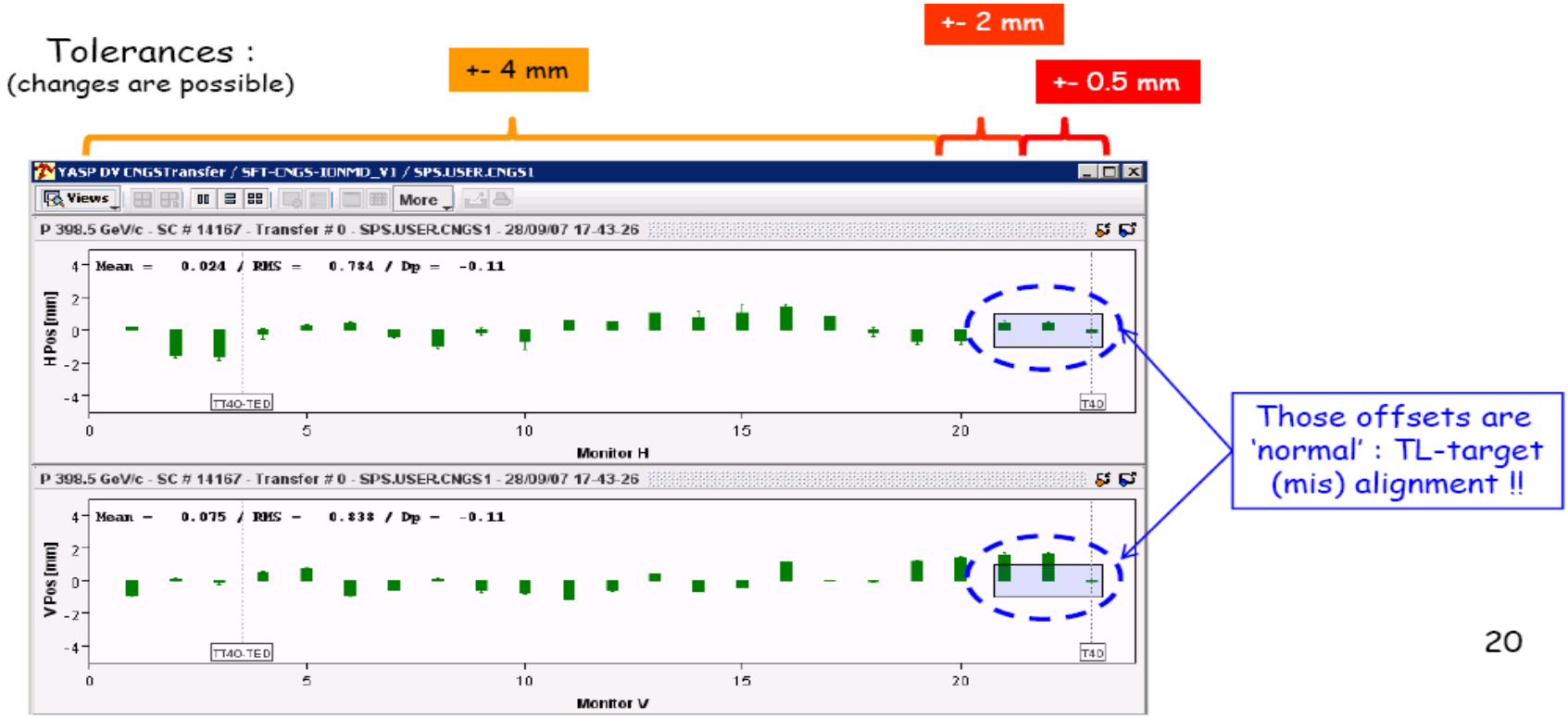
CNGS Operational Aspects

CNGS – Operational Aspects

- **Static operation : shoot the beam in the middle of the target.**
  - **the beam must hit the target very accurately!!**
    target resistance and to protect other equipment!
- **Steering is very reliable**
- **Simple but dangerous (lot of interlocks)**
- **Main operator's effort is on keeping the beam quality in the ring. Especially with frequent SC-changes.**
- **Need of EA specialist for beam-monitors-target-horn alignment.**
- **Heavy involvement of RP in access procedures.**

Primary Beam Line

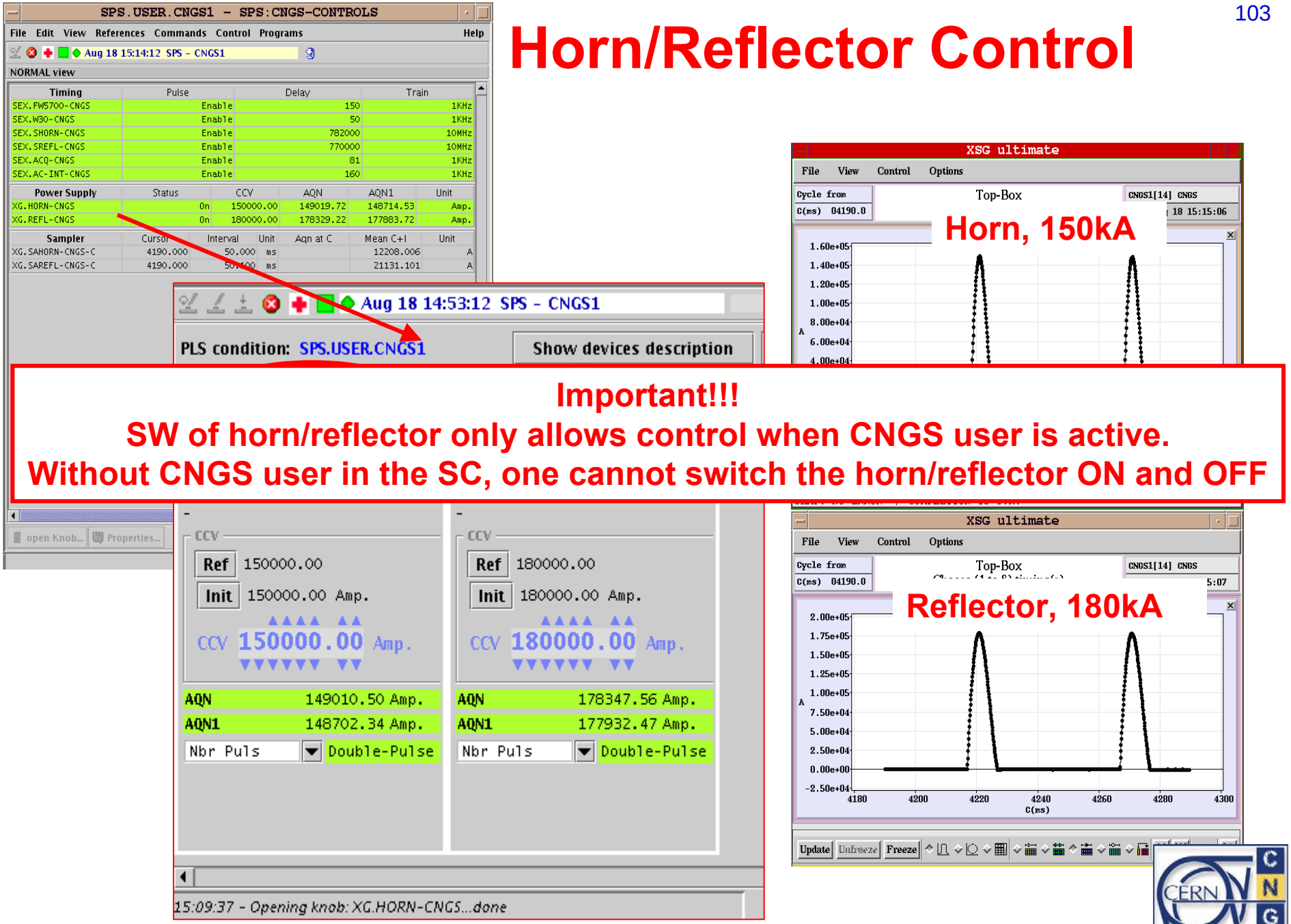
- **Beam losses in TT40 and in TT41. Losses above threshold trigger beam interlock.**
  - **In TT40 > 20 mGray (BLM behind the TED >100 mGray).**
  - **In TT41 > 5 mGray on all monitors (except first one- sees losses from TED).**
- **Horizontal and vertical beam trajectory.**
  - **Positions are interlocked. Always steer to the reference trajectory.**



20

→More details on Primary Beam Operation: see SPS/OP Wikipage!! J. Wenningers talk

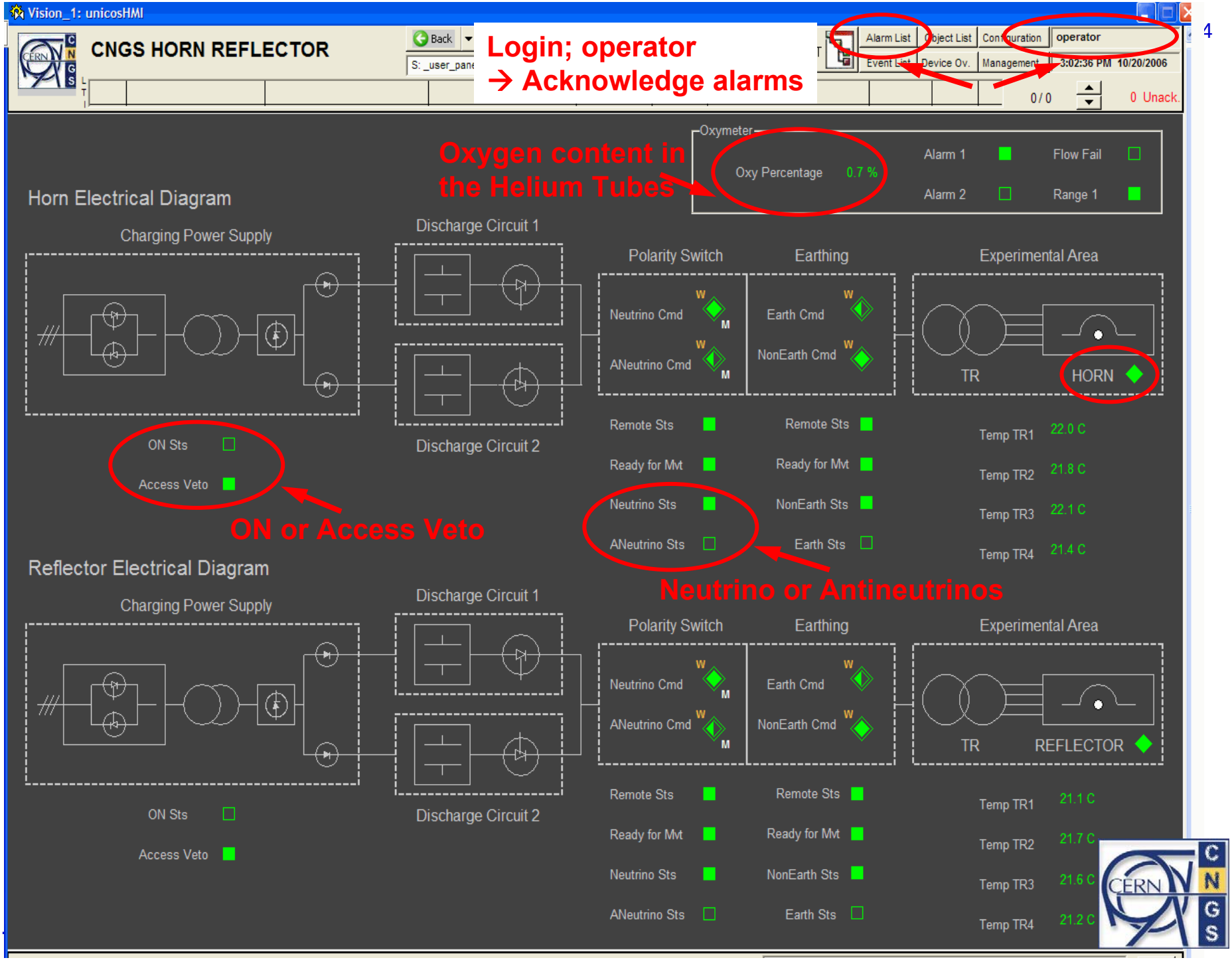
Horn/Reflector Control

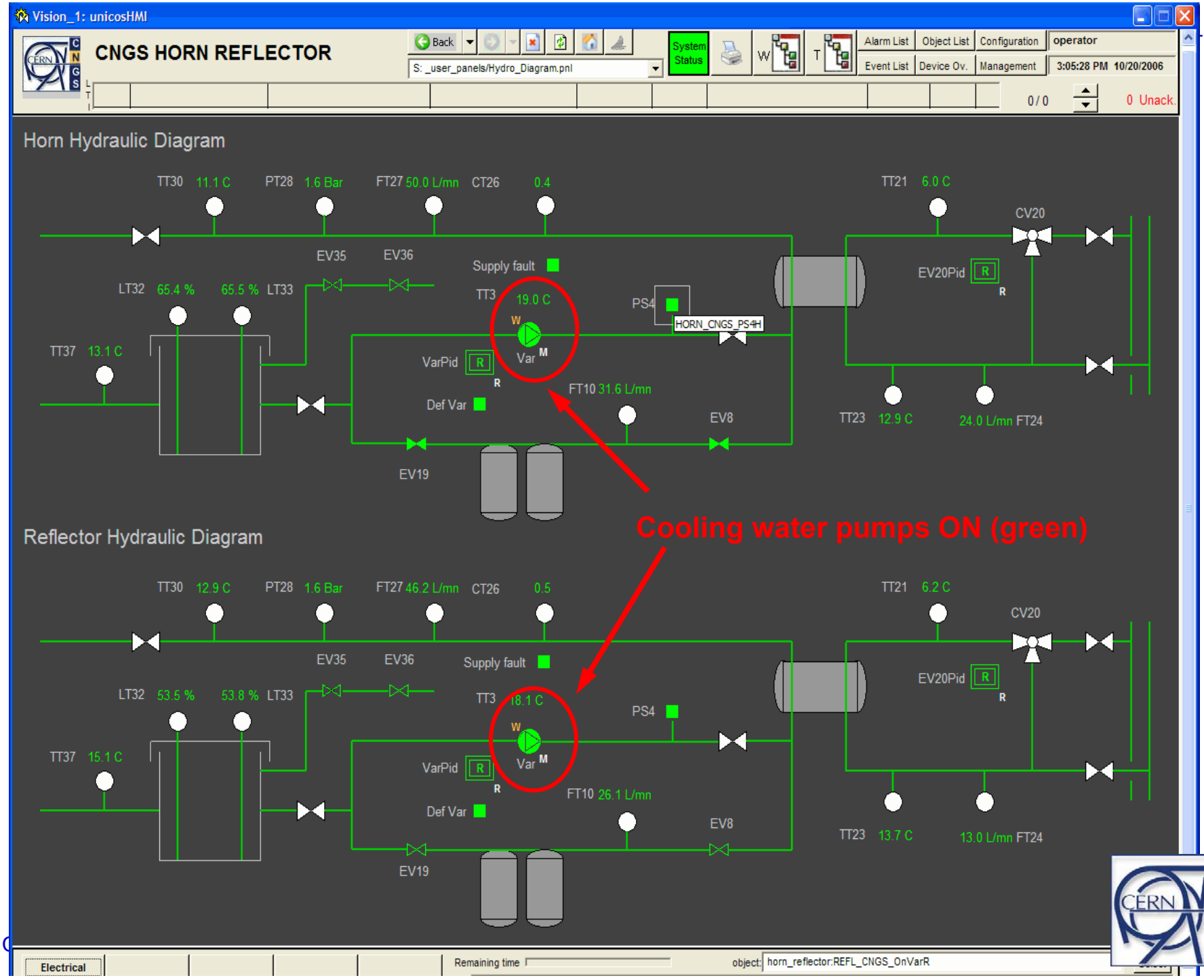


Important!!!

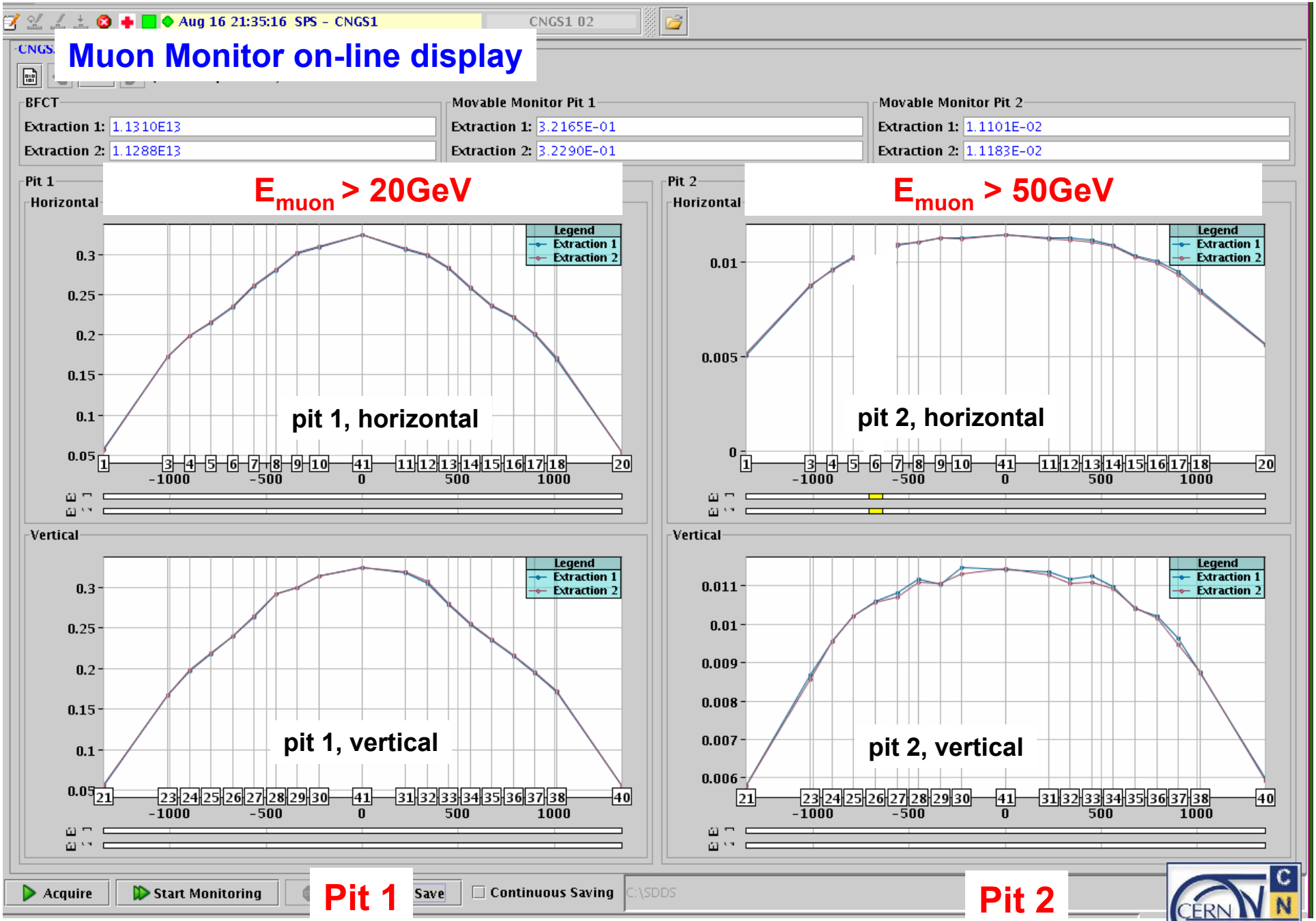
SW of horn/reflector only allows control when CNGS user is active.

Without CNGS user in the SC, one cannot switch the horn/reflector ON and OFF


Vision_1: unicosHMI
CNGS HORN REFLECTOR
Back
Login; operator
→ Acknowledge alarms
Alarm List
Object List
Configuration
operator
Event List
Device Ov.
Management
3:02:36 PM 10/20/2006
0 / 0
0 Unack.
Oxymeter
Oxy Percentage 0.7 %
Alarm 1
Alarm 2
Flow Fail
Range 1
Oxygen content in the Helium Tubes
Horn Electrical Diagram
Charging Power Supply
Discharge Circuit 1
Discharge Circuit 2
Polarity Switch
Earthing
Experimental Area
Neutrino Cmd
ANeutrino Cmd
Earth Cmd
NonEarth Cmd
TR
HORN
ON Sts
Access Veto
Remote Sts
Ready for Mvt
Neutrino Sts
ANeutrino Sts
NonEarth Sts
Earth Sts
Temp TR1 22.0 C
Temp TR2 21.8 C
Temp TR3 22.1 C
Temp TR4 21.4 C
ON or Access Veto
Neutrino or Antineutrinos
Reflector Electrical Diagram
REFLECTOR
Temp TR1 21.1 C
Temp TR2 21.7 C
Temp TR3 21.6 C
Temp TR4 21.2 C


Vision_1: unicosHMI
CNGS HORN REFLECTOR
Back
S: _user_panels/Hydro_Diagram.pnl
System Status
Alarm List
Object List
Configuration
operator
Event List
Device Ov.
Management
3:05:28 PM 10/20/2006
0 / 0
0 Unack.
Horn Hydraulic Diagram
TT30 11.1 C
PT28 1.6 Bar
FT27 50.0 L/mn
CT26 0.4
TT21 6.0 C
CV20
EV35
EV36
Supply fault
EV20Pid
LT32 65.4 %
65.5 % LT33
TT3 19.0 C
PS4
HORN_CNGS_PS4H
TT37 13.1 C
VarPid
Var
FT10 31.6 L/mn
Def Var
EV8
TT23 12.9 C
24.0 L/mn FT24
EV19
Cooling water pumps ON (green)
Reflector Hydraulic Diagram
TT30 12.9 C
PT28 1.6 Bar
FT27 46.2 L/mn
CT26 0.5
TT21 6.2 C
CV20
EV35
EV36
Supply fault
EV20Pid
LT32 53.5 %
53.8 % LT33
TT3 18.1 C
PS4
TT37 15.1 C
VarPid
Var
FT10 26.1 L/mn
Def Var
EV8
TT23 13.7 C
13.0 L/mn FT24
EV19
Electrical
Remaining time
object:
horn_reflector:REFL_CNGS_OnVarR

Muon Monitor on-line display



E_{muon} > 20GeV

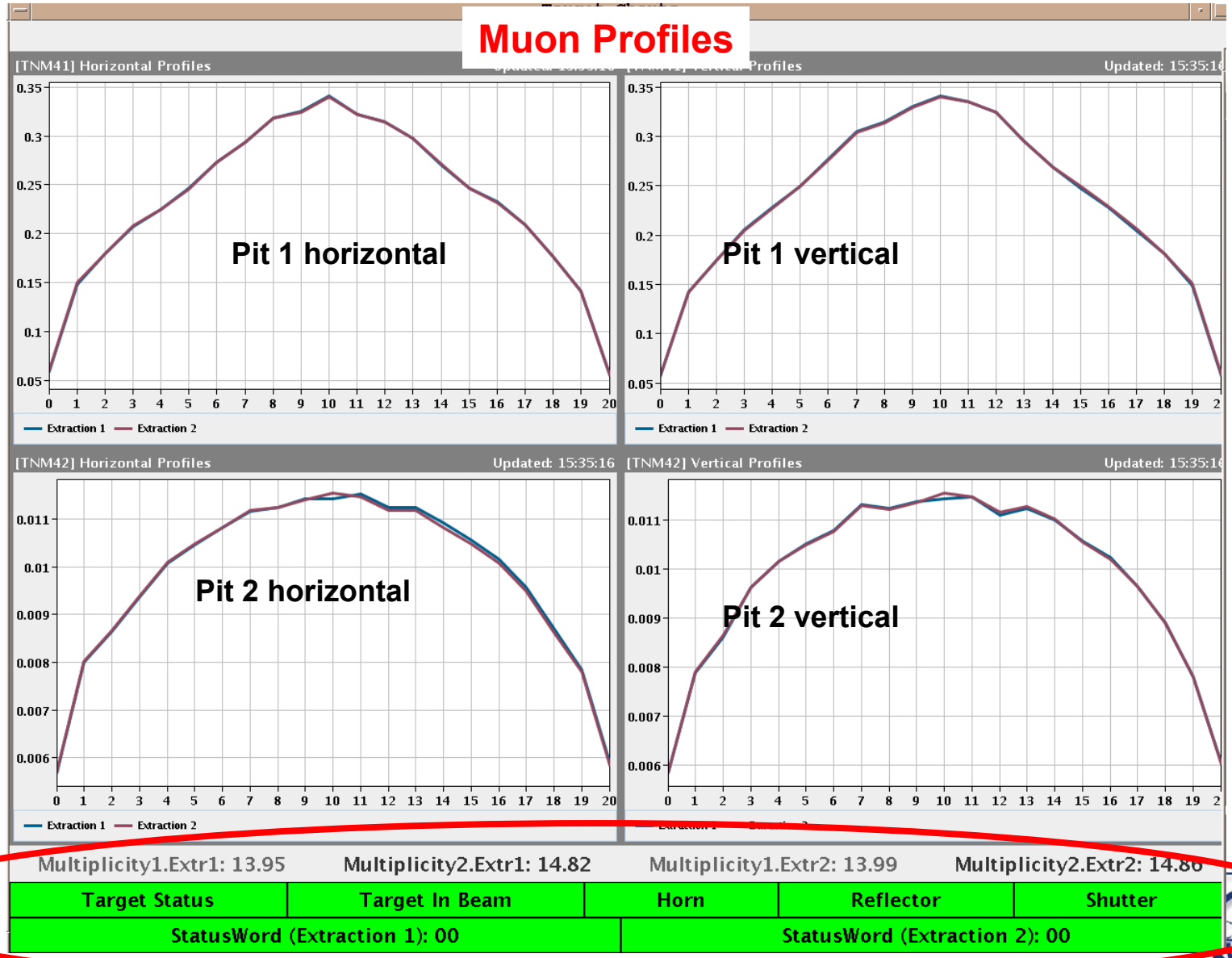
E_{muon} > 50GeV

Pit 1

Pit 2

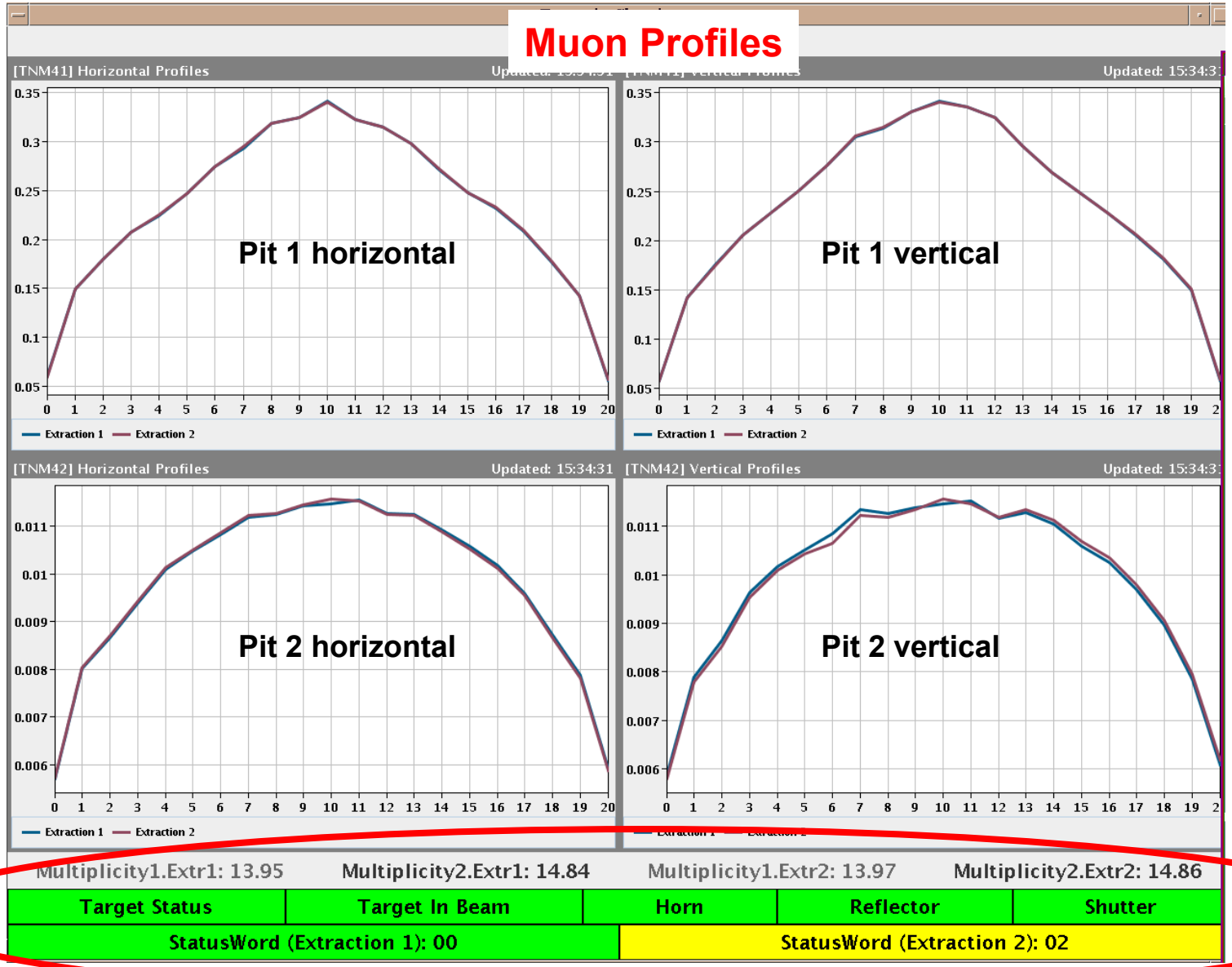
CNGS Fixed Display

Good!



CNGS Fixed Display

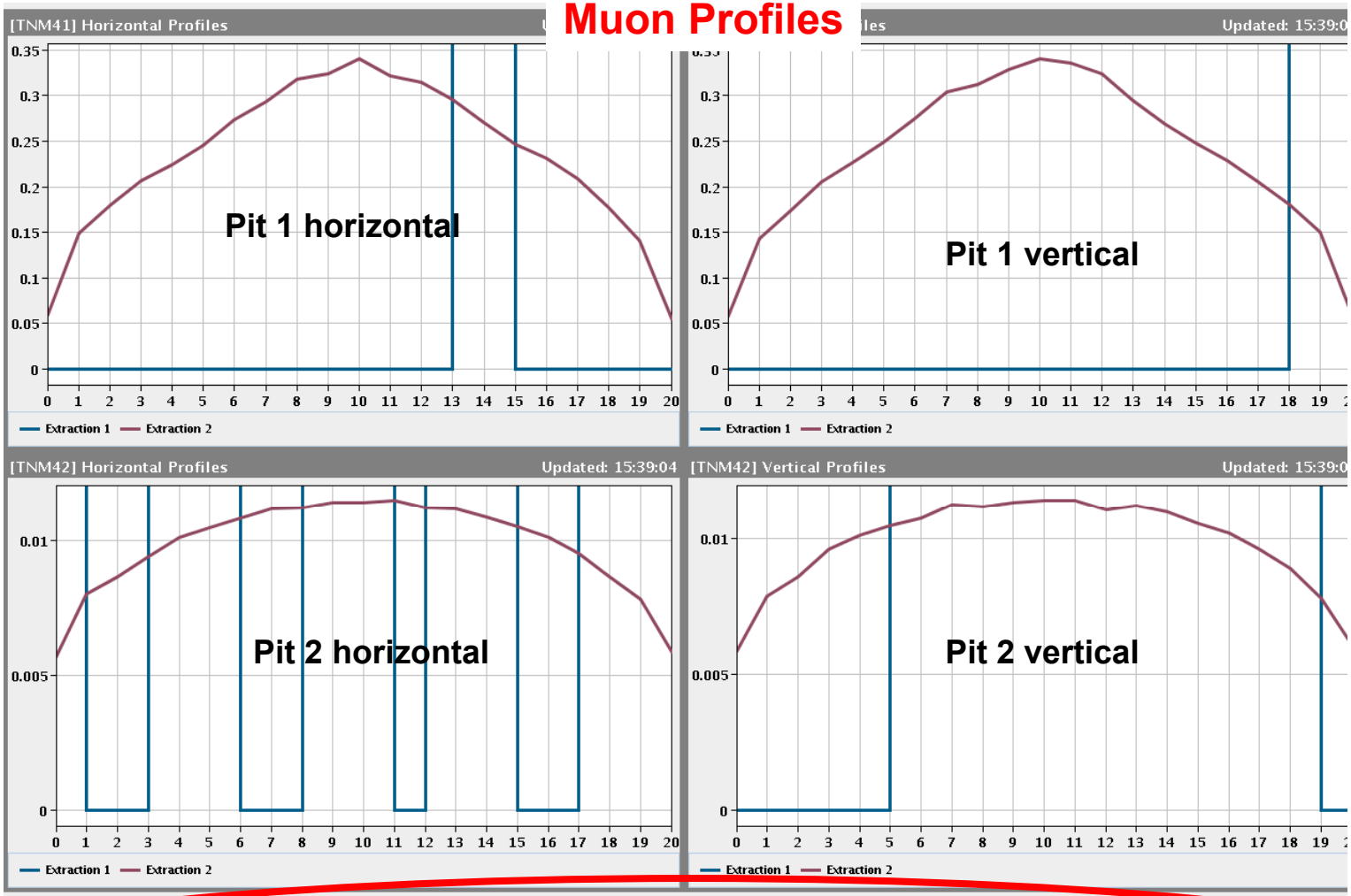
Medium



CNGS Fixed Display

Bad!

Muon Profiles



CNGS Fixed Display for Secondary Beam

- **The muon profiles**
  - for both pits (pit 1 and pit2), horizontal and vertical
- **Multiplicity**
  - Number of charged particles downstream the target per proton hitting the target
- **Target status**
  - green: everything is ok
  - red: interlocks or temperature warning or error with target both in position 'in beam' or 'out of beam'.
- **Target in beam status**
  - green: (any) target is in beam
  - red: target is out of beam
- **Horn (Reflector) status**
  - green: horn is 'ON'.
  - red: horn is 'OFF' or 'Standby' or any kind of error message.
- **Shutter status**
  - green: shutter is open, i.e. beam mode.
  - red: shutter is moving or closed, i.e. access mode.

CNGS Fixed Display for Secondary Beam

- **Beam status word**
  - **0 : beam is ok, nominal conditions, no error flag is set.**
  - **1 : Minor error conditions with respect to nominal beam values.**
    - **(e.g. I_{horn} off by 1-5% or muon centroid pit 1 (pit 2) shifted by 4-10cm (1-5cm))**
  - **2 : Major beam problem.**
    - **(e.g. I_{horn} off by 5% or muon centroid pit 1 (pit 2) shifted by more than 10cm (5cm))**
  - **3 : No beam for this extraction (intensity 25 times lower than nominal)**
  - **4 : Beam tests. Set by the operator.**
  - **20 : in case of lost data of any of the above parameters.**
  - **In case of lost data of any of the above parameters a value of 10 is added to the beam status word.**

CNGS Access

- **Documents on modified CNGS access system 2008:**
  https://edms.cern.ch/document/895947/1

For any access to CNGS tunnels and caverns:

Access via the CNGS access point in ECA4.

- **Operator in CCC launches access procedure:**
  - **Beam off**
  - **Shutter must be closed**
  - **!!! Plugs PPP TSG4 and PPP TSG41 must be open !!!**
  - **Horn/Reflector switched off and grounded**
  - **All safety elements of chain 6 must be safe**

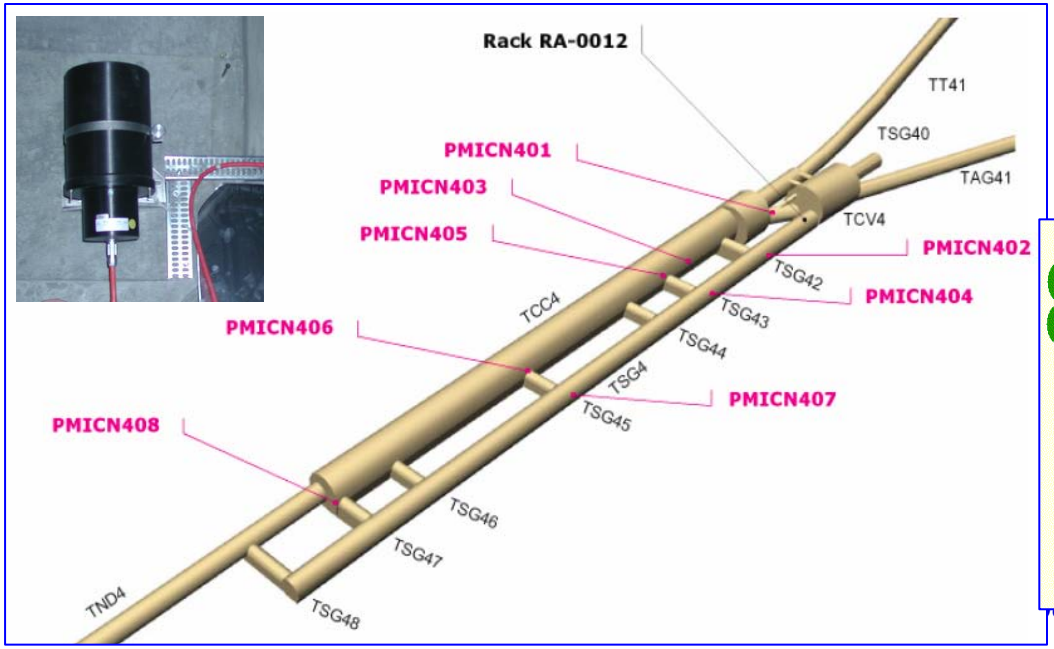
… CNGS Access

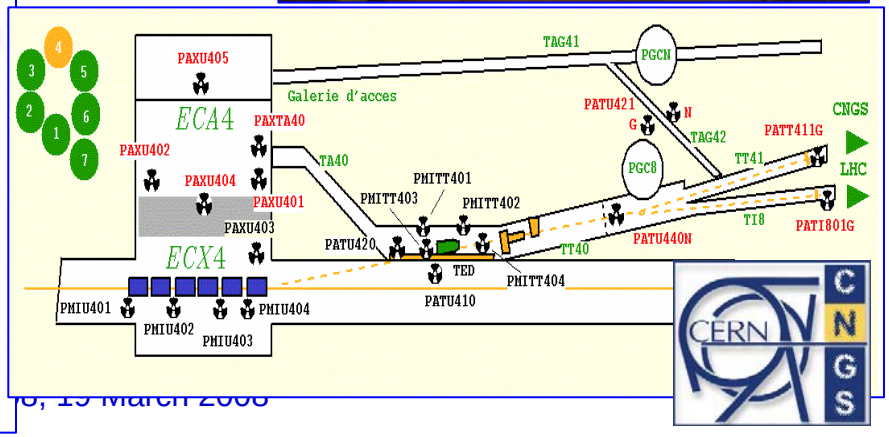
- **'Radiation-Veto' must be removed by the RP technician**
  - RP technician remotely reads monitors providing residual activity and air quality→ decides on waiting time.
  - After waiting time (usually 2 hours) and remanent dose is ok:
  - Ventilation system changed from 'beam mode' to 'access mode'
    - CCC operator calls TS/CV operation section
  - After waiting time (usually 4 hours!) RP technician removes the Radiation –Veto (switching a contact locked by a key at the access point in ECA4)
  - The RP technician makes a dose map of the area.
- **If dose is acceptable, user gets a key in the CNGS access point**
- **Access of the user together with the RP technician**

→ Dose planning mandatory for any interventions

Operational Aspects

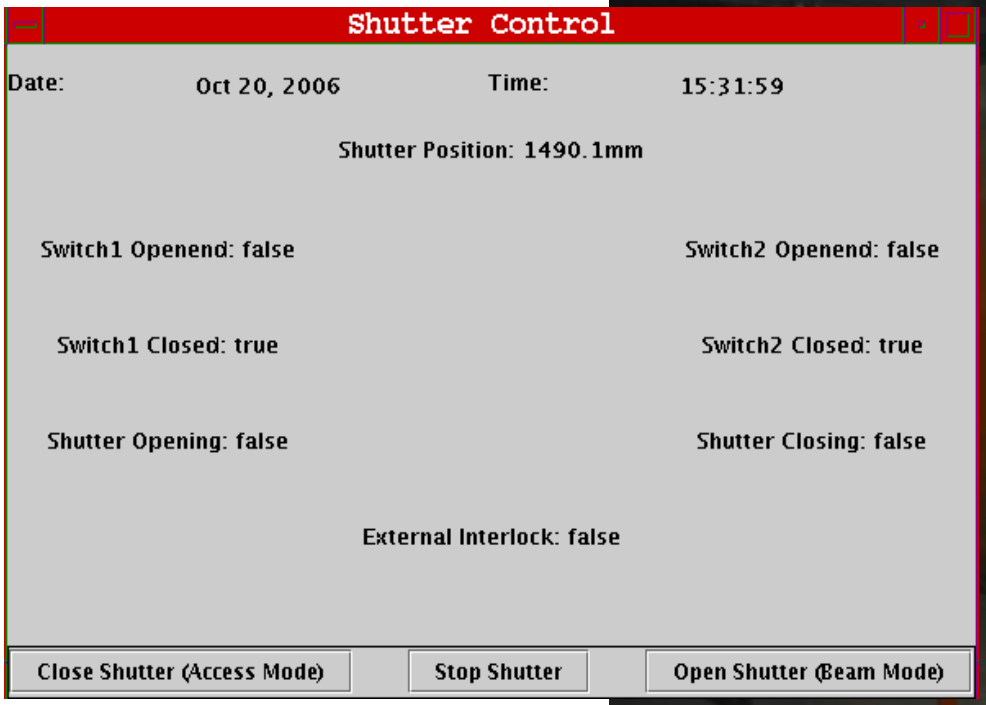
- **Continuous radiation monitoring of prompt radiation, released radioactivity and induced radioactivity**
  - **Ramses** detectors: → warning, interlocks
    - Stray radiation monitoring stations: gamma & neutron monitors
    - Induced activity monitors
    - Ventilation monitoring station: gas monitor & aerosol sampler
    - Hand & foot monitor
    - Tools & material controller
  - **ARCON** system
  - **Remote radiation survey** on overhead crane
  - **!!! RadMon Radiation Monitors !!!**

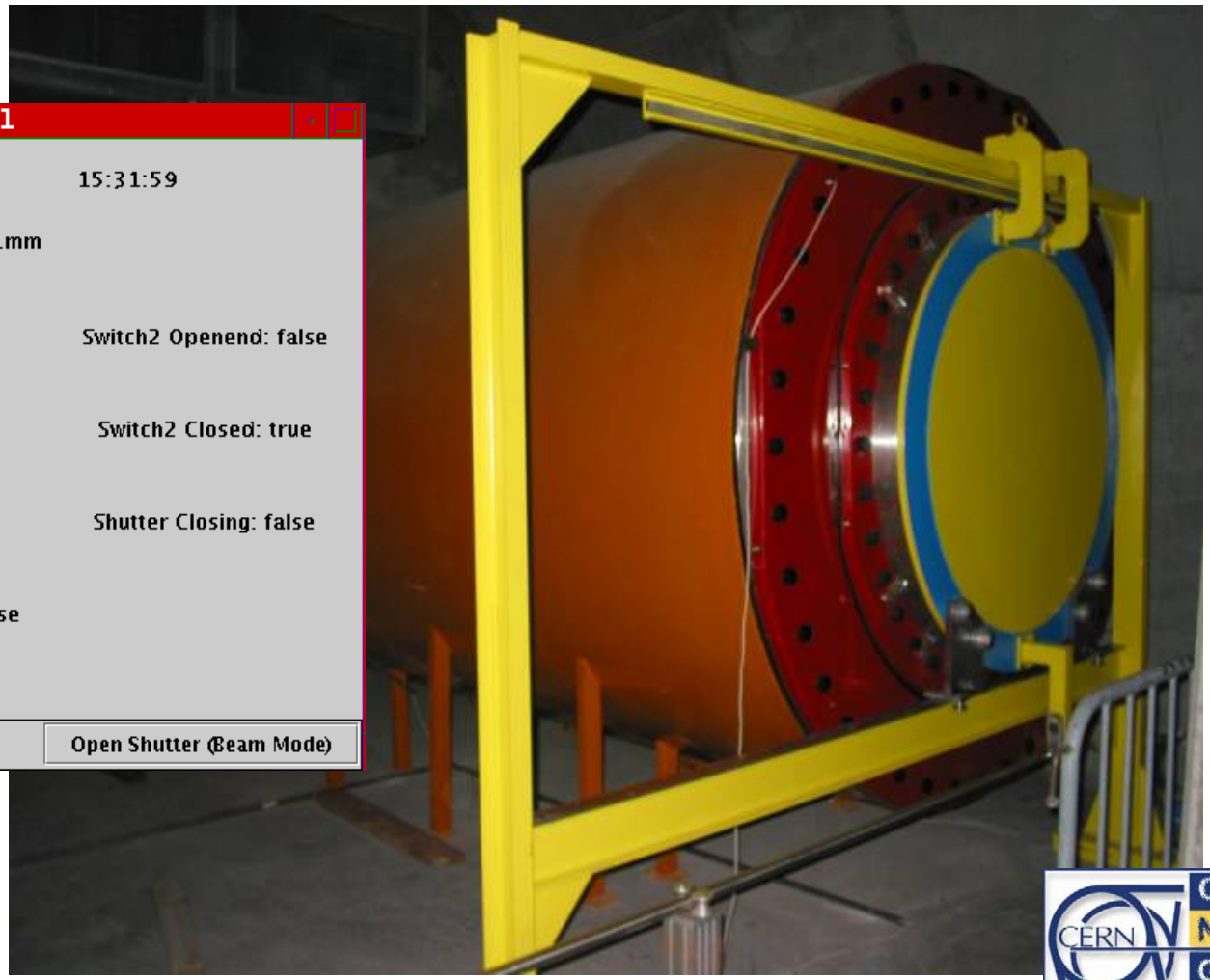




Shutter

Decay tube is closed with → 3mm Titanium window
Must be protected by a 'shutter' when access → Hardware Interlocked!!!





Further Information

- **Experimental Areas:**
  - **General:** http://ab-div-atb-ea.web.cern.ch/ab-div-atb-ea/
  - **EA-Wiki:** http://ab-div-atb-ea.web.cern.ch/ab-div-atb-ea/pmwiki/pmwiki.php
  - **Training, etc…:** http://ab-div-atb-ea.web.cern.ch/ab-div-atb-ea/documentation/training.htm
- **SPS Wiki:** http://controls-wiki.web.cern.ch/controls-wiki/OP/
- **CNGS:**
  - **General:** http://proj-cngs.web.cern.ch/proj-cngs/
  - **Operation aspects primary beam:** https://webh06.cern.ch/sps-mp-operation/
  - **Operation aspects secondary beam:** http://ab-div-atb-ea.web.cern.ch/ab-div-atb-ea/BeamsAndAreas/cngs-operation/cngs-operation.htm