Operation of LEP at 91.5 GeV

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Beam Energy and RF

LEP RF system in 1997 :

86 Cu cavities (1.4 MV/m)
224 SC Nb/Cu cavities (6 MV/m → *Total voltage = 2640 MV*
16 SC Nb cavities (5 MV/m)

Allows beam energies up to E = ~ 94 GeV

Energy Loss/Turn > 2 GeV above 91 GeV !!

Operational RF performance :

- > 95% of total voltage available for operation (2540 MV)
- 160 MV margin for Power Converter/2 klystron trips

→ *Operational energy E = 91.5 GeV*

- Mean time between RF trips : increased from 50 to 70 minutes
- 10% of the LEP fills lost due to RF trips

Beam Size Optimisation

Horizontal Plane :

- J = 1.6 (RF frequency shift)
  → E must be reduced by 0.4 GeV !
- H : Low emittance lattice
  → High phase advance (90 to 108 deg/cell)

$$\text{Emittance} \sim H E^2 / J$$

Dispersion Invariant

Damping Partition Number

Vertical Plane :

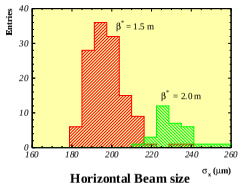
- J ~ 1.0
- H : Residual vertical dispersion

"Golden Orbits"
(obtained by trial and error)

*Reduce β**

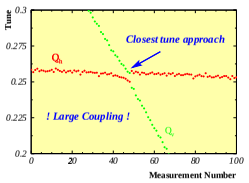
Limits : Chrom. correction, Dynamic Aperture
Experiments backgrounds

Sextupole arrangement !



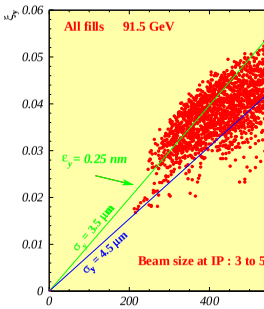
Horizontal Beam size

Very good coupling correction



Correct to : $\Delta Q < 0.0001$

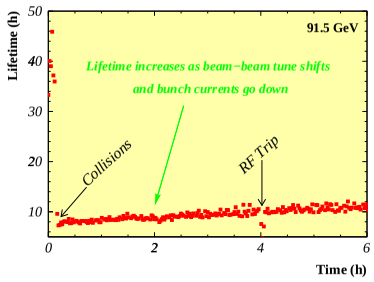
Beam−beam Tune



Vertical Beam−beam tune shifts :

- Exceed 0.05 per Interaction Point a
- Some beam−beam blow−up at high
- Peak Luminosities > 5 10^{31} cm^{-2} s^{-1}

Beam Lifetimes



Single beam lifetimes :

- Approx. 40 hours (Compton scattering on thermal photons)
  ... with good vacuum conditions !

Lifetimes with collisions :

- Dominated by beam−beam Bremsstrahlung.
- ~ 1 / ξ
- Typical lifetimes are 5 to 10 hours.

Luminosity Production

Luminosity Improvements :

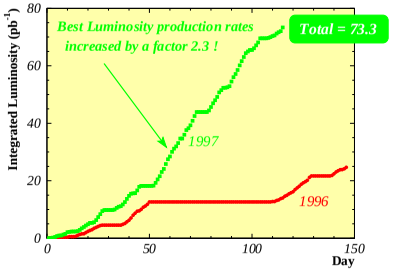
Horizontal beam size	1.4
20% higher bunch currents	1.5
Efficiency, turn−around	1.2
Total	2.3

Optics :

- 90/60 for regular operation
- 102/90 tested in the last 2 weeks

102/90 is used for the 1998 LEP run !

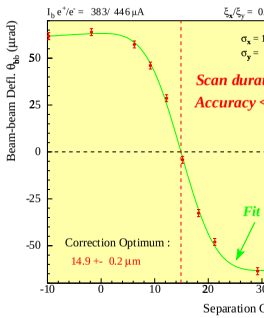
Smaller Horizontal Emittance !
Large Dynamic Aperture !
0.4 GeV higher energy for the same RF volts !



Performance :

- 63.8 pb^{-1} E = 90.5/ 91.0/ 91.5/ 92 GeV
  7.3 pb^{-1} E = 65/ 68 GeV
  2.2 pb^{-1} E = 45.5 GeV
- Efficiency = Time in Physics/Total Time = 44%
- Best 24 hour period : 1.9 pb^{-1}

Collision Offse



Collision Offsets Adjustment :

- Beam−beam deflection angles are measured usi
- The collision offsets are scaned with local bumps
  electrostatic separators.
- A fit to the deflection angle data provides the op
  the electrostatic elements as well as information