Running LEP
October 2000

R. Bailey
LEP operations

Running LEP

1989	startup
89-95	the Z years
96-99	the W years
2000	the search year

Lessons learned

The injectors

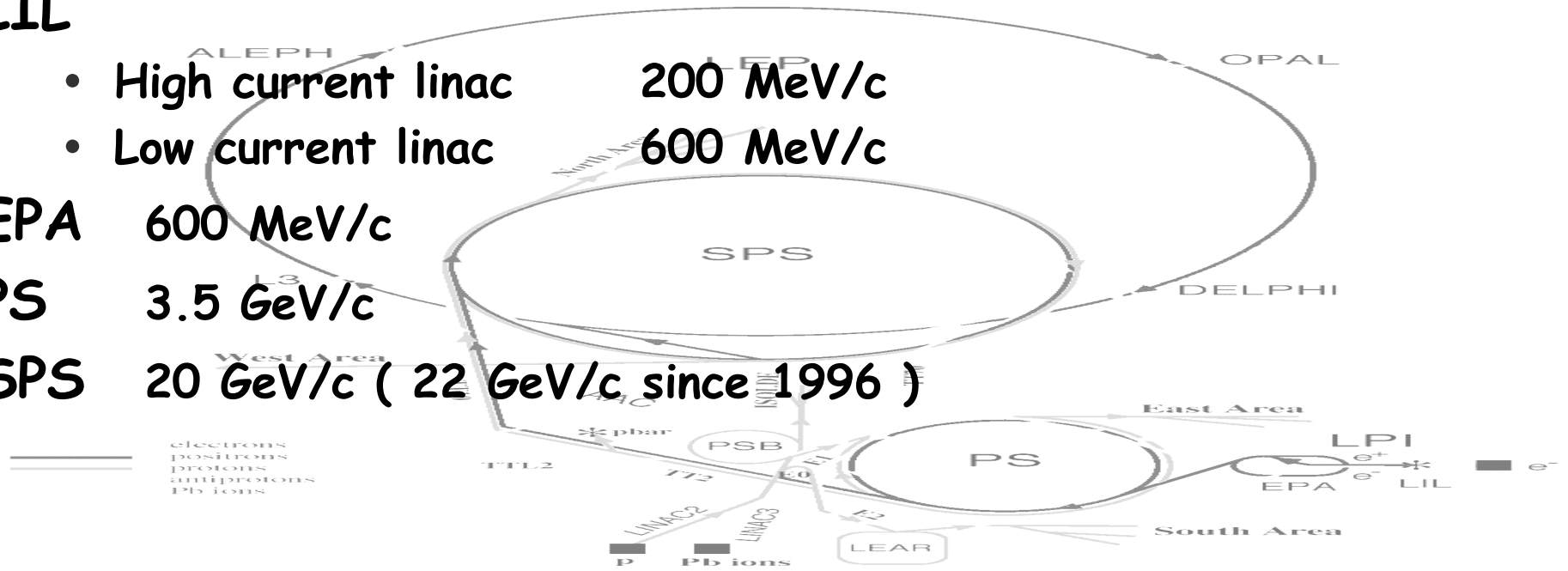
LIL

- **High current linac** **200 MeV/c**
- **Low current linac** **600 MeV/c**

EPA **600 MeV/c**

PS **3.5 GeV/c**

SPS **20 GeV/c (22 GeV/c since 1996)**



Result:

- **8 bunches of 10^{10} e^+ and e^- to LEP every 14.4 s**
- **availability almost 90%**
- **not bad !!**

Startup, 1989

Characterised by

Omnipresence of Steve Myers

Watchful eye of Emilio Picasso

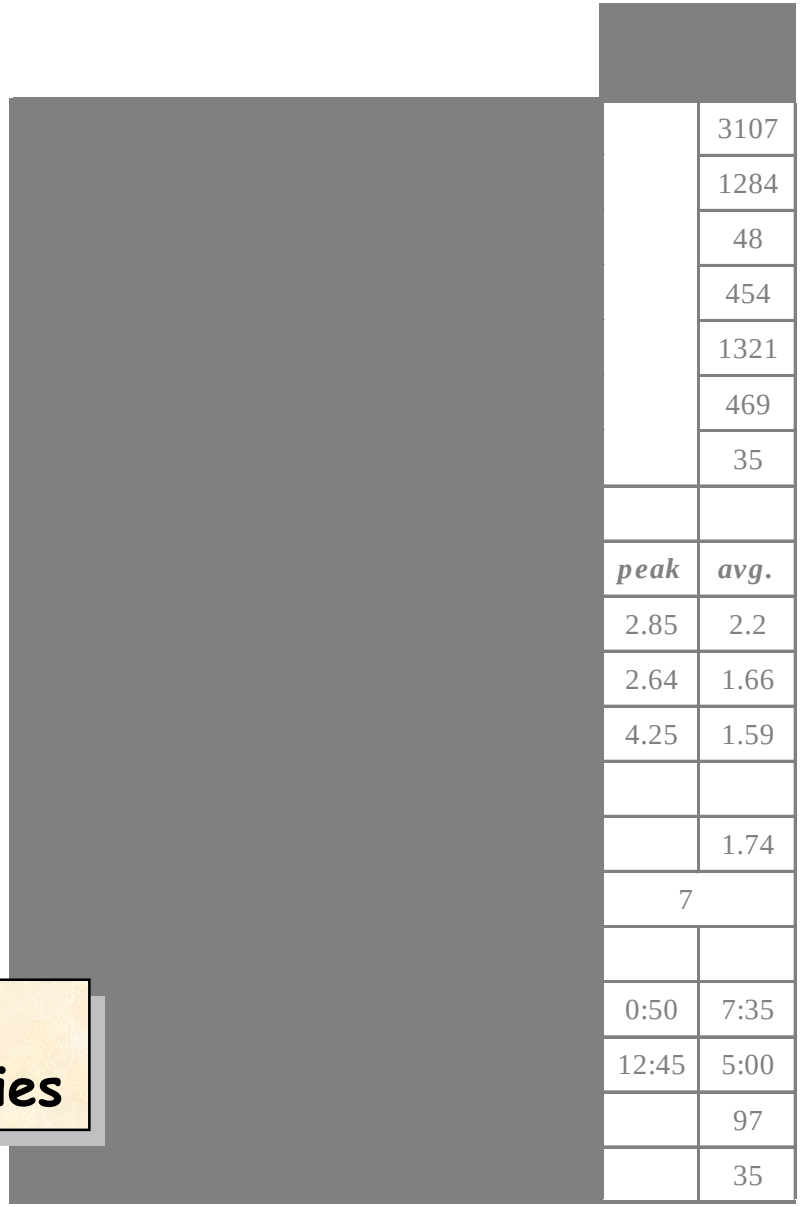
First beam July 14th

- camera / stopper problem
- wouldn't happen today !

First physics August 13th

55 days scheduled for physics
- peak luminosity 4.3 10^{30} cm^{-2} s^{-1}
- best day 64 nb^{-1}
- integrated luminosity 1.7 pb^{-1}

LEP discovered:
- only three families



	3107
	1284
	48
	454
	1321
	469
	35
peak	*avg.*
2.85	2.2
2.64	1.66
4.25	1.59
	1.74
7	
0:50	7:35
12:45	5:00
	97
	35

The Z years, 89-95

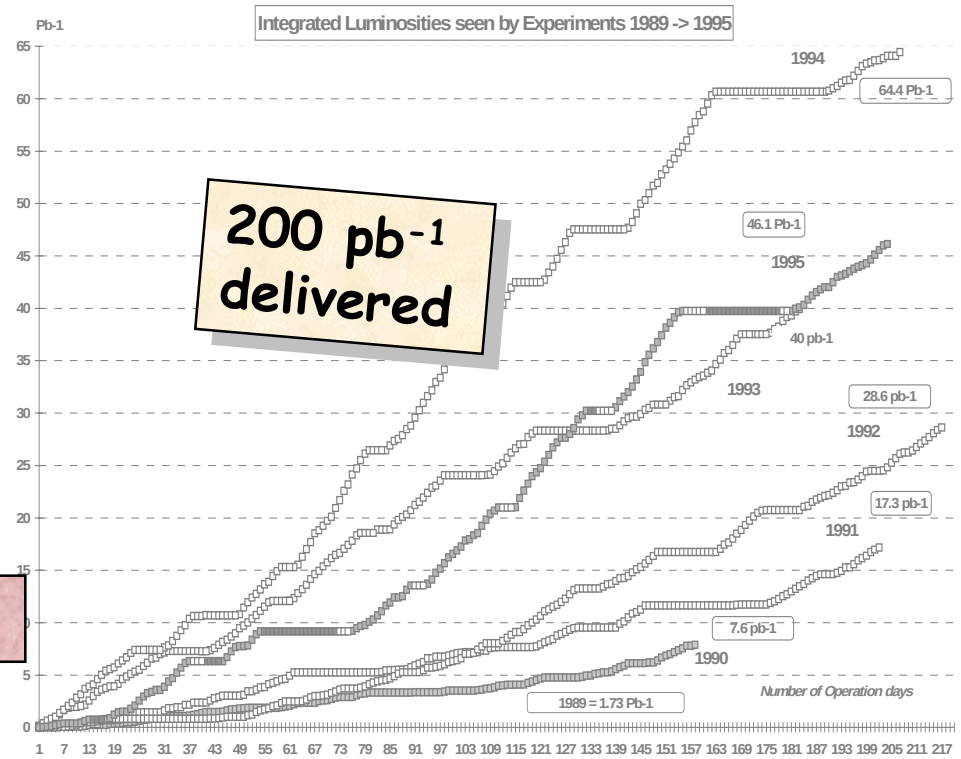
Characterised by:

- LEP and SPPbarS 89 to 91
- 4 on 4 operation 89 to 92
- 60/60, 90/90, 90/60
- Deep in the beam-beam limit
  - ➔ long fills (10h)
  - ➔ artificially blow up the beams
  - ➔ more bunches

8 bunch Pretzel scheme 93 to 94

AP, MS, BI, BT

Bunch trains 95
- 4*2 on 4*2
- 4*3 on 4*3
- 4*4 on 4*4 (sort of)



LEP discovered:
- the moon
- lake Geneva
- TGV

The W years, 96-99

Characterised by:

More and more SCRF from 96 to 99

RF ➔ 80.5,86 / 91.5 / 94.5 GeV/c

More and more gradient 99

96, 98, 100, 101 GeV/c

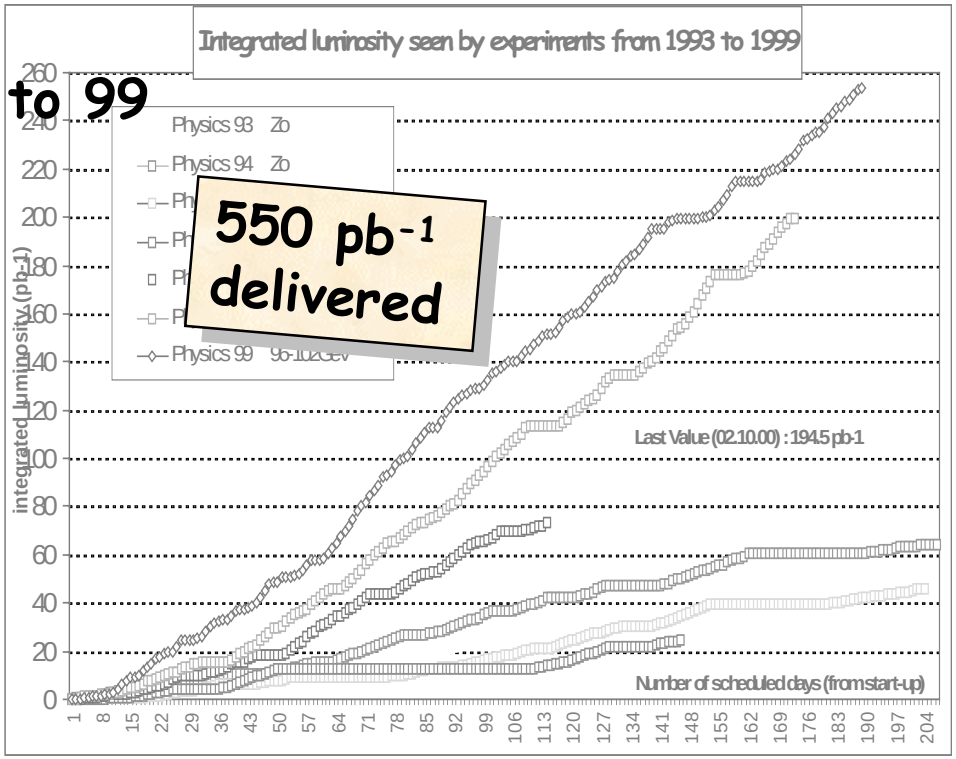
Get ε_x down $\varepsilon_x \sim \gamma^2 / J_x \cdot Q^3$

AP ➔ ➔ 90/60 has it's limitations

➔ 108/60, 108/90, 102/90

Minimise the vertical beam size

(DFS, CFS, BSE, ..)



➔1999, 98GeV	ξ_Y	0.083
	$\mathbb{L}$	10^{32} cm^{-2} s^{-1}
	$\int\mathbb{L}$	4 pb^{-1} / 24h

LEP discovered:

- beer bottles
- synchrotron light
- HOM power
- cryogenics is cool

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The search year, 2000

Characterised by:

No more SCRF !

Pushing the gradients

RF

7.35 MV/m

Pushing the energy

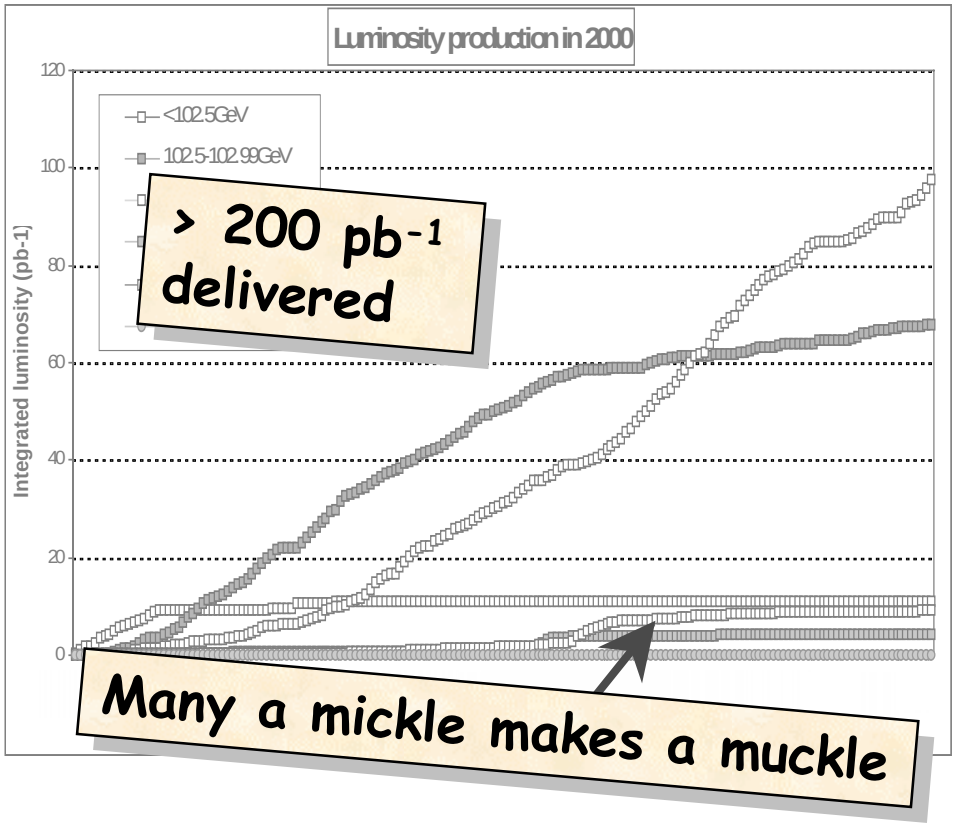
optics (well, we tried)

BFS

miniramps in physics

➔ 2, 1, 0 trip

➔ no operator beam dumps !



Record energies

102.5 to 104.5 GeV/c

Not beam-beam limited

➔ short fills, fast turnrounds

➔ 4 on 4, even 2 on 2 (sort of)

LEP discovered:

• the LHC

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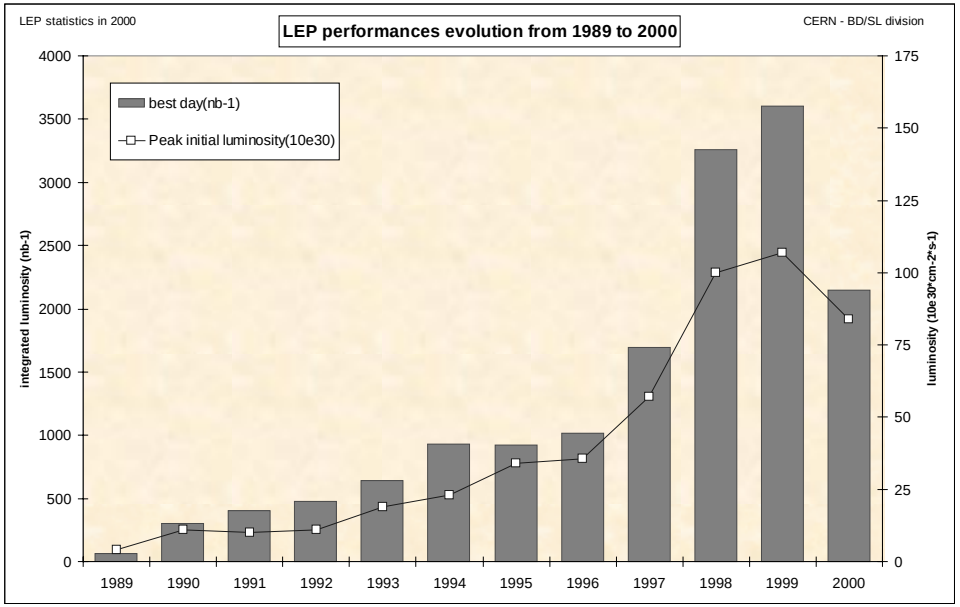
Summary

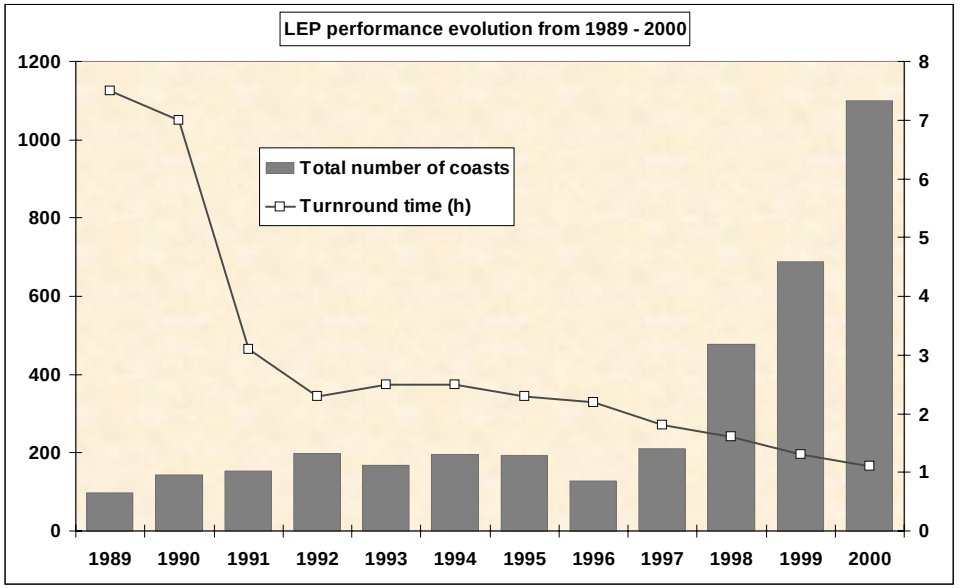
Versatile machine:

- 6 optics in operation, plus variants and more besides
- from 2 on 2 to 16 on 16 bunches in physics
- physics from 45GeV/c to 104.5GeV/c per beam

Performant machine:

- ~ 4000 physics fills have yielded ~ 1 fb^{-1} per experiment
- turnrounds reduced from over 7h to around 1h (necessity ..)
- performance levels pushed by 1-2 orders of magnitude





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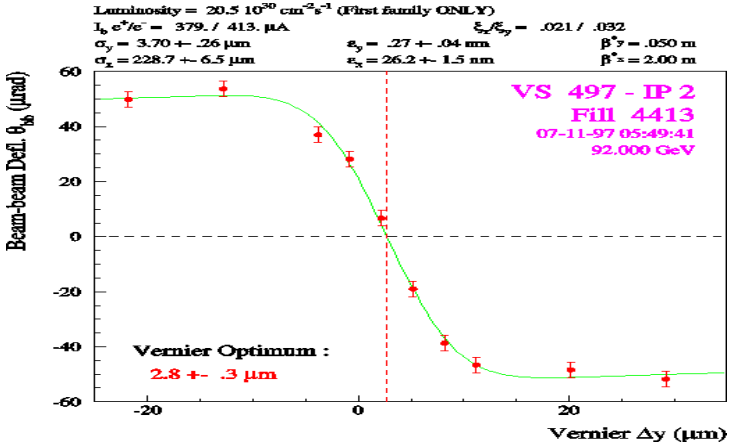
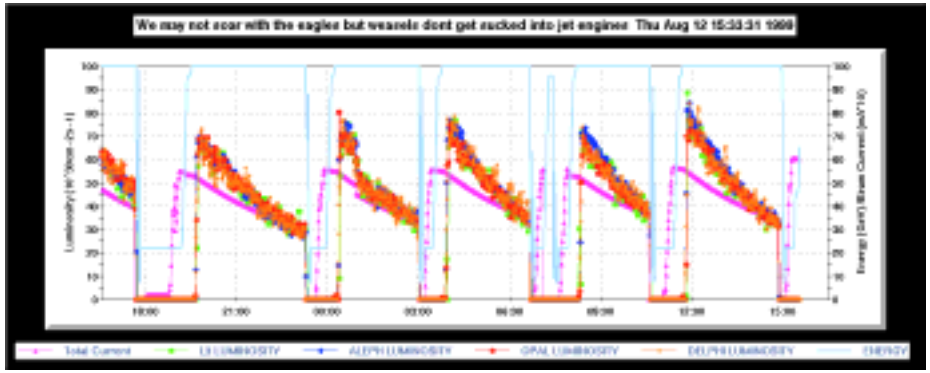
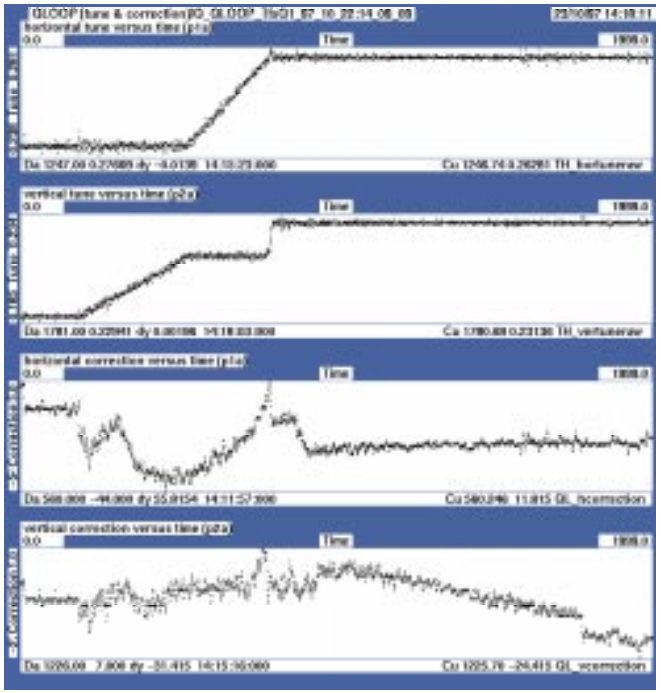
Made possible by ...







Sloppysoft

A measurement and display system

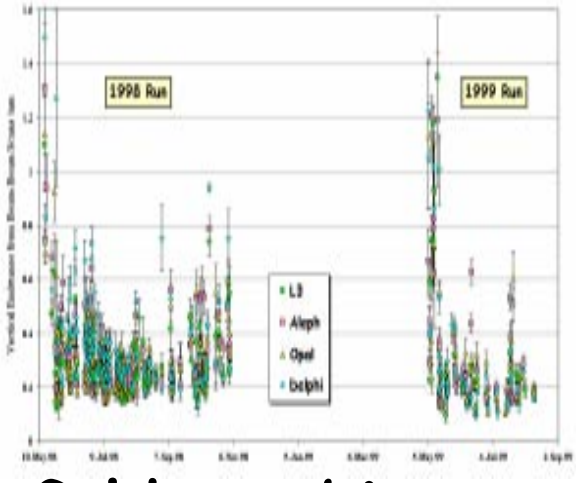
Orbit control

BCE

Q loop

XFS

beam-beam scans



and lots of lots of Golden orbits to choose from ...

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Lessons learned 1

You gotta have a sense of humour ..

The poulet sequence (June / July 1999) :
- **poulet belge a la frite**
- **poulet biologique**
- **Kentucky fried chicken**
- **poulet grille a l'huile de transformateur**

The HIGGS sequence (August / September 2000) :
- **HIGGS for president I, II and III**
- **HIGGS BUSTER I, II, III**
- **NASDAQ news : Higgs stock is falling !!**
- **You say you have the Higgs, that don't impress me much**

The extension sequence (September / October 2000) :
- **going for gold in 40 days**
- **well, silver is OK too**
- **the road to hell is paved with LEP extensions**
- **heading into the extension**

Lessons learned 2

Accelerator operations is about running equipment ..

It's also about dealing with people ..

----- CHAMONIX WORKSHOPS -----

Get to know your accelerator physics group

- they make it up
- we make it work

You can gain 20%, but you need some skill, which may be difficult for the OP group !

Get to know your equipment groups

- find the right fault
- find the right person
- tell it like it is

Thanks to
· BI, BT, CO, CT, EA, MR, MS, PO, RF
Not forgetting
· LHC cryo, LHC vac, ST, TIS, PS, SPS

Q:Do you trust the BOM data ?
A:I'm a physicist, not a priest

Get to know your users

- we make it happen
- they make it count ..
- LEP contacts keep us on our toes .. plus ..

Physics Coordinators Obituary (RIP):

L. Camilleri	89
J. Panman	90-91
G. Rolandi	92-93
T. Camporesi	94-95
P. Wells	95-96
P. Sphicas	97
P. Janot	98-00

Lessons learned 3

Operations can be many things ..

Pragmatic — Please distroy this message after you have read it

Exciting — ALEPH JUST CALLED; THEY HAVE A NICE EVENT, WITH TRACKS !

Leveling — Lost both beams

Suspicious — RF still OK, according to RF people

Vindicating — The fault message came up late - cavity 232 tripped off

Irritating — THE EIC IS NOT ON SHIFT TO BE INTIMIDATED BY PHYSICISTS !

Bemusing — I don't know who/what controls the RF voltages.
One thing's for sure, it's not me !

Humbling — If I were a positron, and I would be launched into LEP on the same trajectory as presently for e+, I would also refuse to accumulate!

Rewarding — IT WORKS !

Worst joke of the Lepfest award ?

Lots of fun (so far) …

… and the rest is Higgstory !