
Running LEP October 2000

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LEP operations

Running LEP

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

Lessons learned

The injectors

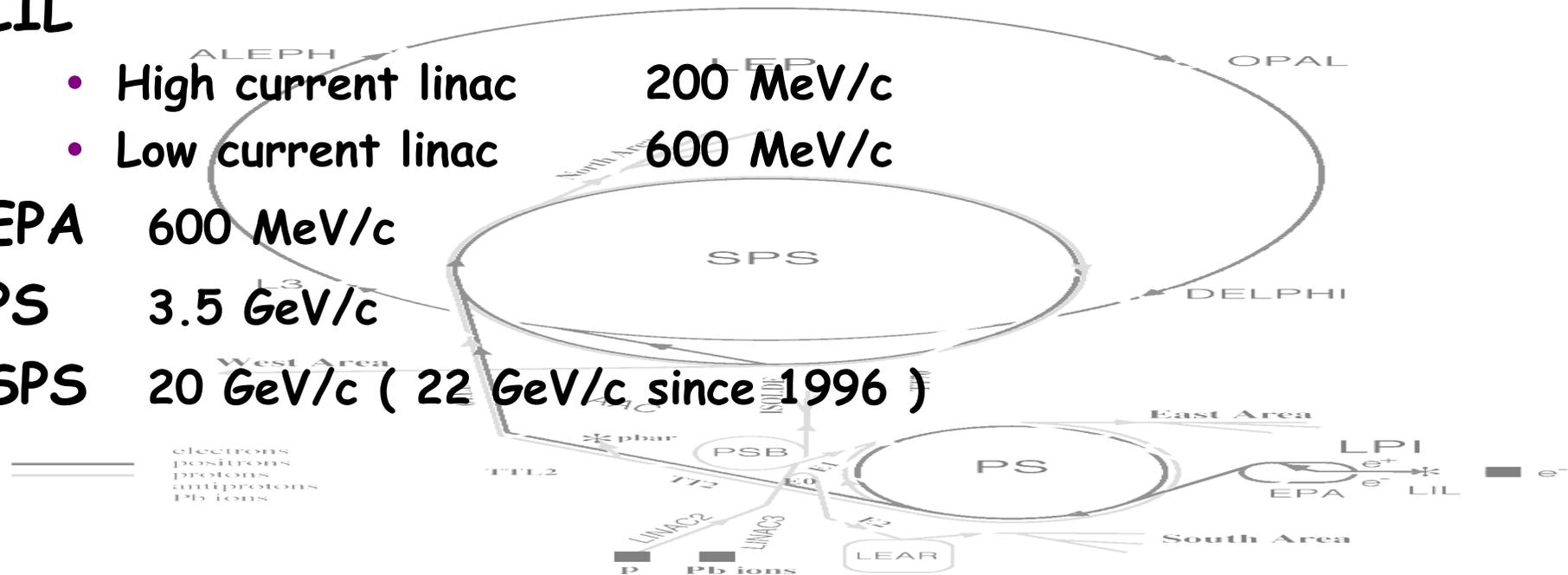
LIL

- 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 $4.3 \cdot 10^{30} \text{ cm}^{-2} \text{ s}^{-1}$
- best day 64 nb^{-1}
- **integrated luminosity 1.7 pb^{-1}**

LEP discovered:
 • only three families

		1989	
Total hours scheduled	Hrs.		3107
Sched. hours for commissioning	"		1284
Scheduled hours for setting-up	"		48
" hours for MD	"		454
" hours for physics ****	"		1321
Beam in coast	"		469
Efficiency	%		35
		<i>peak</i>	<i>avg.</i>
Max. current at injection	mA.	2.85	2.2
Colliding Intensity	mA.	2.64	1.66
Initial luminosity	$\text{cm}^{-2} \text{ s}^{-1} *$	10^{30}	4.25
Best luminosity	$\text{cm}^{-2} \text{ s}^{-1} *$	10^{30}	
Integrated luminosity	pb-1		1.74
Beta at the experiments (v)	cm	7	
Round time	hrs.	0:50	7:35
Coast duration	hrs.	12:45	5:00
Number of coasts			97
Lost coasts percentage	%		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

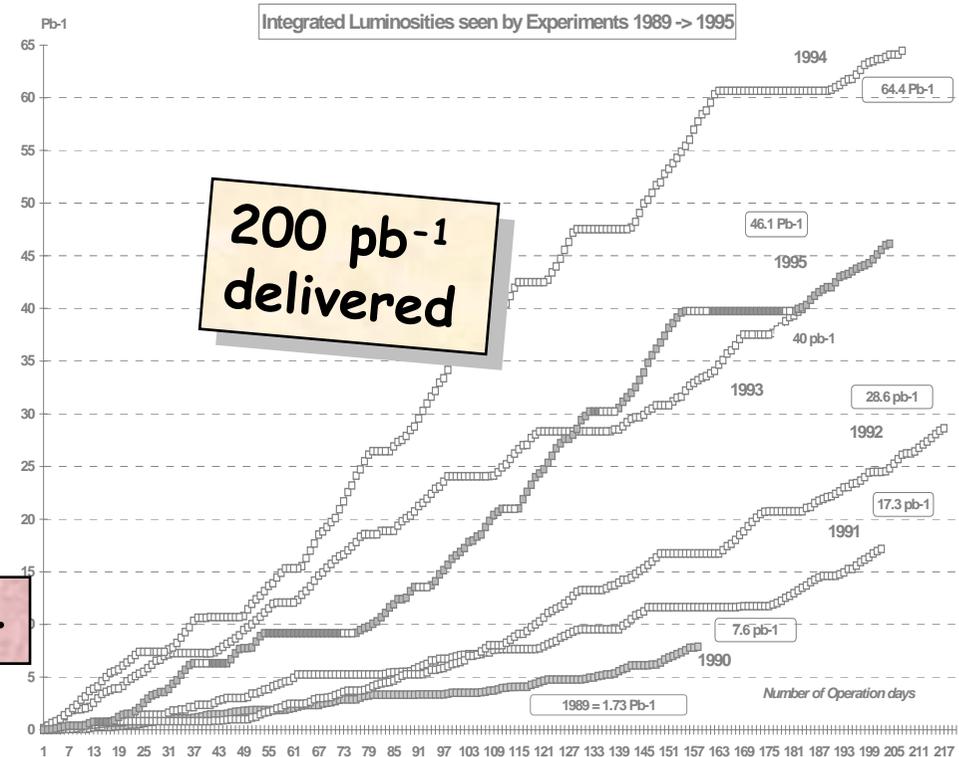
AP, MS, BI, BT

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

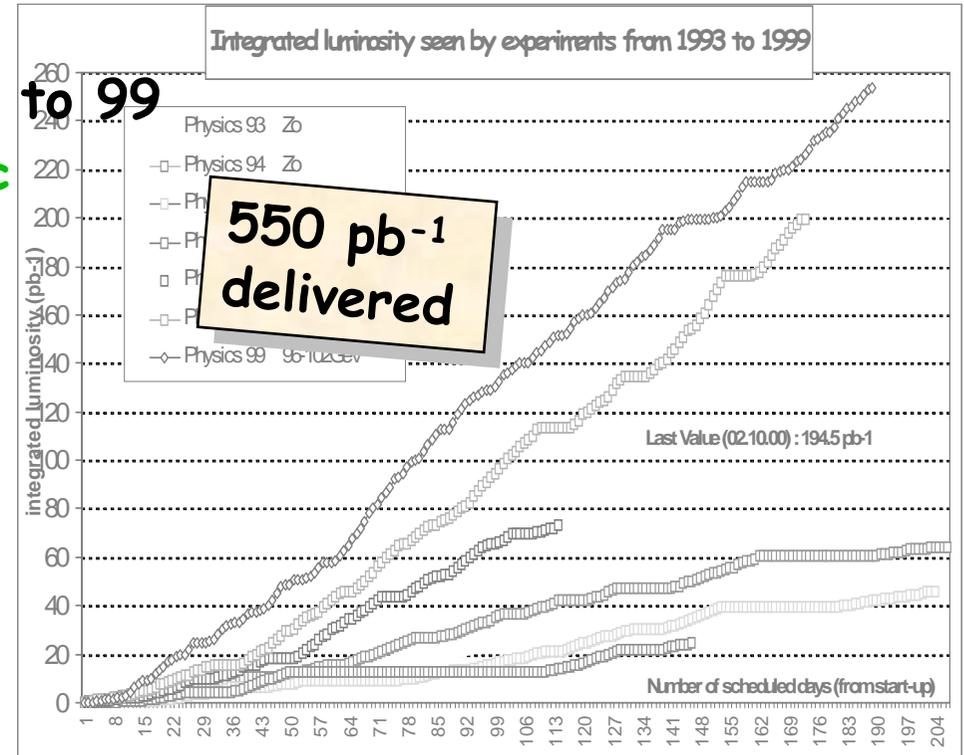
RF → 80.5,86 / 91.5 / 94.5 GeV/c
 More and more gradient 99
 96, 98, 100, 101 GeV/c

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

AP → → 90/60 has it's limitations
 → 108/60, 108/90, 102/90

Minimise the vertical beam size
 (DFS, CFS, BSE, ..)

→ 1999, 98 GeV ξ_Y 0.083
 \ominus $10^{32} \text{ cm}^{-2} \text{ s}^{-1}$
 $\int \ominus$ 4 pb⁻¹ / 24h



LEP discovered:

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

The search year, 2000

Characterised by:

No more SCRF !

Pushing the gradients



7.35 MV/m

Pushing the energy

optics (well, we tried)

BFS

miniramps in physics

→ 2, 1, 0 trip

→ no operator beam dumps !

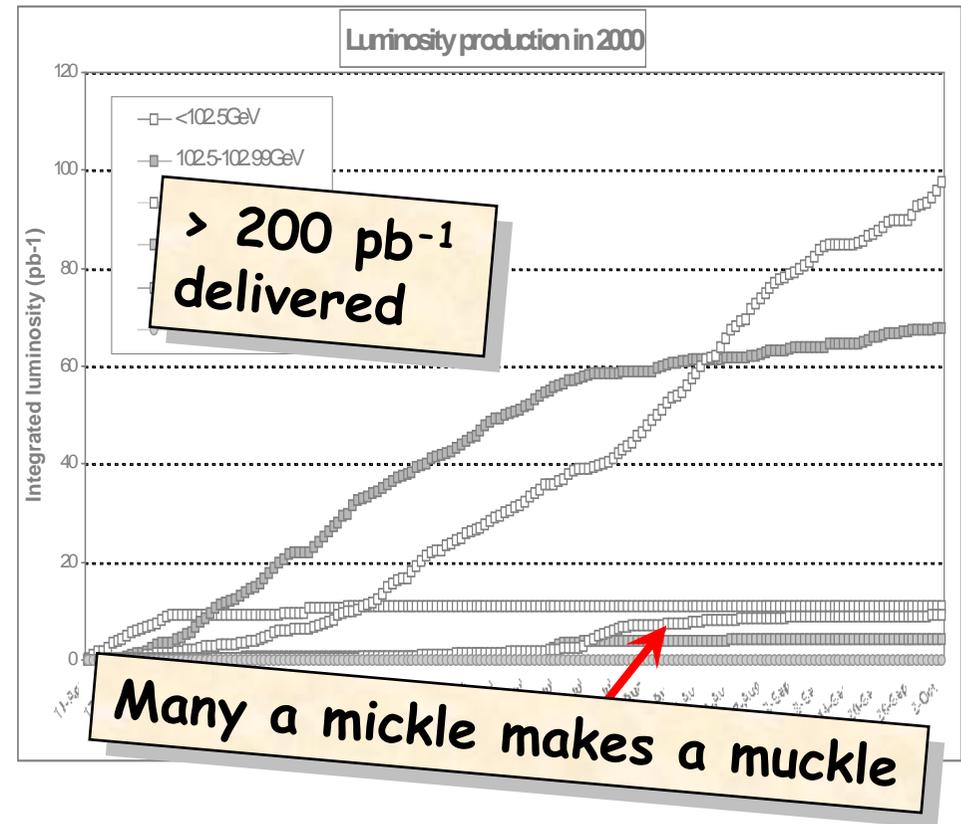
Record energies

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

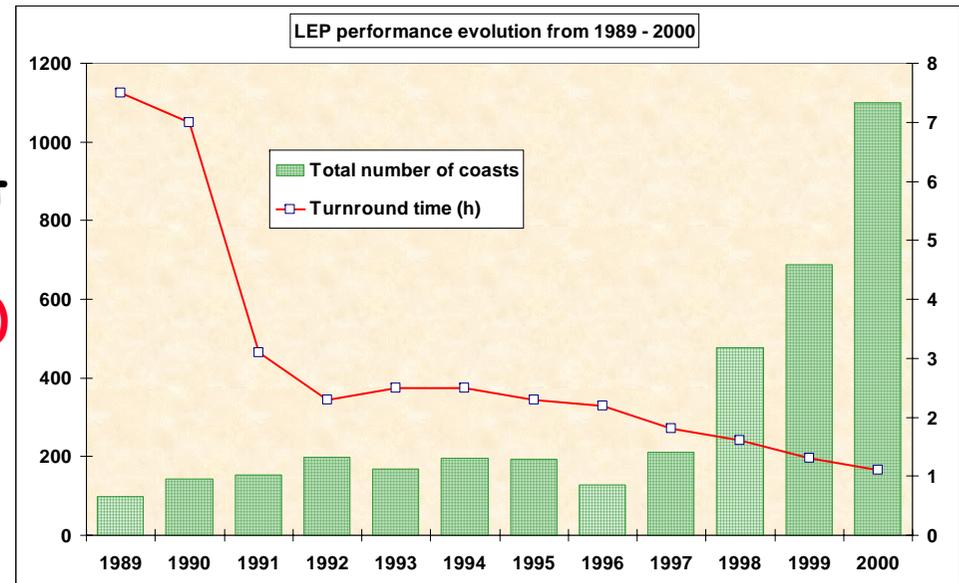
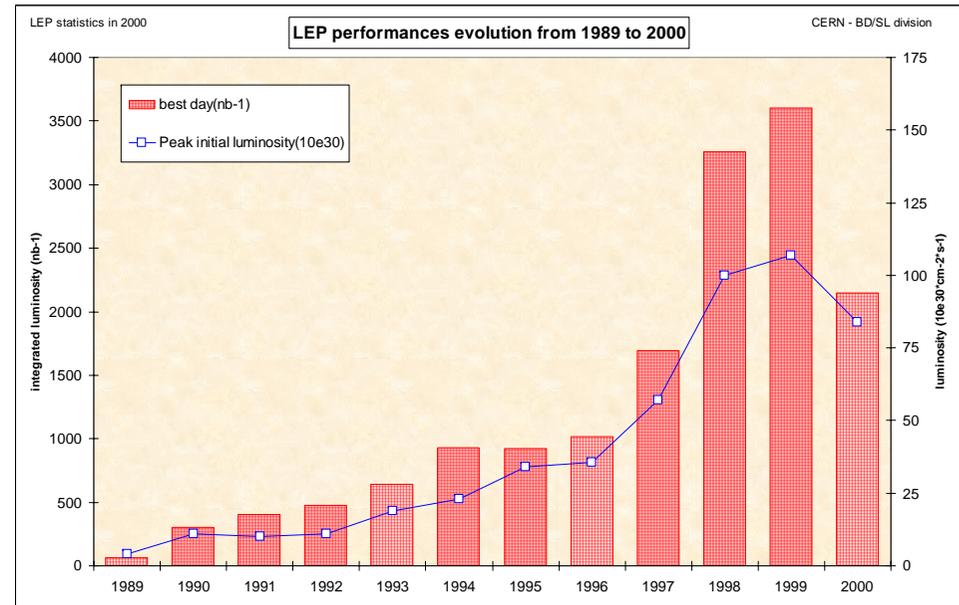
Summary

Versatile machine:

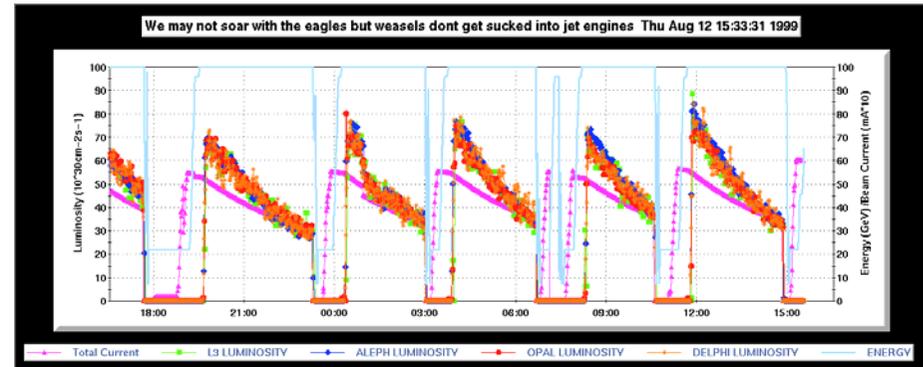
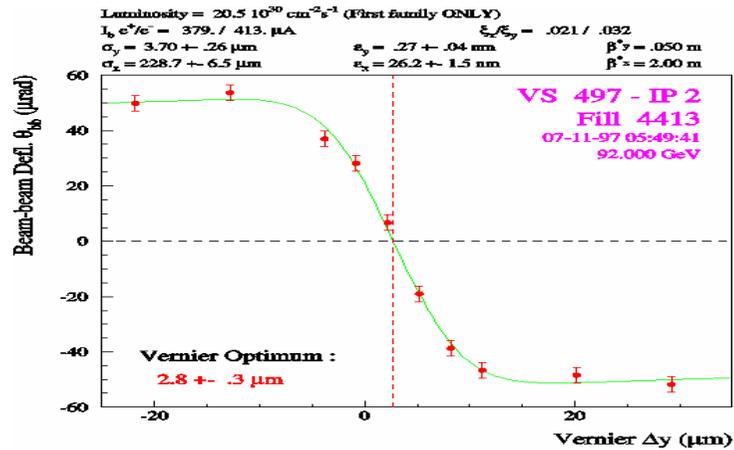
- **6 optics** in operation, plus variants and more besides
- from **2 on 2** to **16 on 16** bunches in physics
- physics from **45GeV/c** to **104.5GeV/c** per beam

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**



Made possible by ...



Sloppysoft
 A measurement and display system

Orbit control

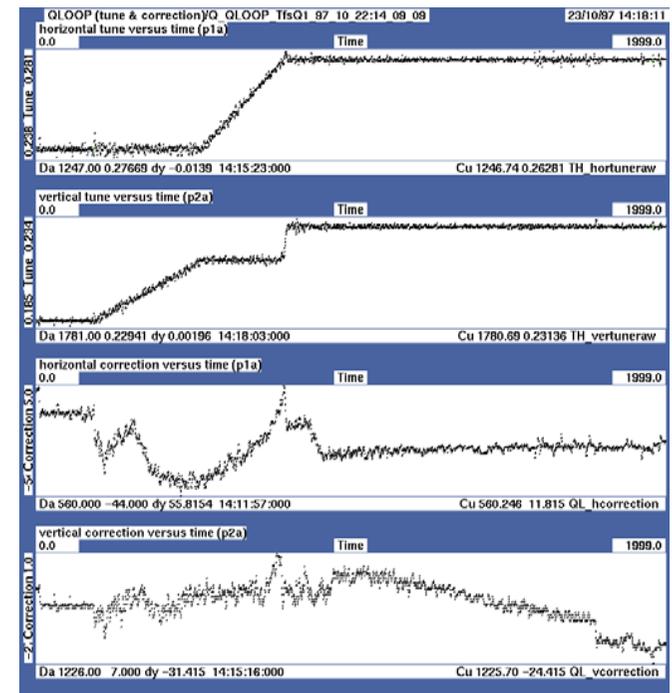
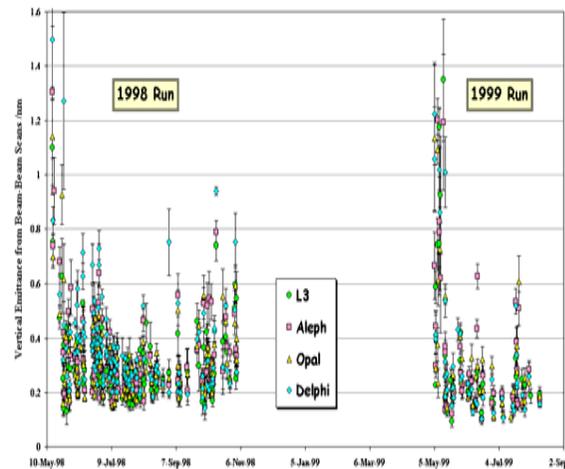
BCE

Q loop

XFS

beam-beam scans

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



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

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

Thanks to

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

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** !