ECFA2008 Warsaw June 11

…from my talk on ILC detector maintenance needs at ireng07 meeting at SLAC (Sept.07)…

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For the polarization discussion@Warsaw, some thoughts on:

- Calibration
  - Z-peak @Lep 2 => ILC
- Push-pull frequency

Z-peak

- At Lep2 ,all experiments - except Opal - requested ~ 1-2 days running at the Z-peak during a year for calibration, usually because some incident (eg, beam-loss) had damaged some subdetector which had to be recalibrated.

- At Lep1 (and at SLC) this wasn't necessary because we were running at the Z-peak and taking "calibration data" (incidentally, also used for real physics) all the time.

- Therefore only the Lep2 experience can give is a guess as to what to plan for at the ILC.

Email 2005 (at Daegu ACFA8) to Mark Thomson:

Thanks Mark,

So the conculsion is, taking the year 2000 as an example and rounding, for Z-peak calibration running:

at Lep2 we had:

=>per detector<= 3/pb at the beginning of a year, and
" one run of 0.5/pb during a year

For the ILC, we might then request

at ILC:

=>per detector<= 10/pb at the beginning of a year, and
" one run of 1/pb during a year

since the detector(s) will be more demanding. Does this sound reasonable?

Cheers,

Ron

Z-peak

•So a fundamental question for the ILC machine is: how easy/difficult will it be to run at the Z-peak, if e.g. data-taking is at 250 or 350 GeV (c.m.s.) that year?

•This was without considering push-pull in 2005. An important question here is, will we need calibration data after each push-and-pull?

Push-pull frequency

Now is maybe a good time to look briefly at the physics of the ILC. From my talk at the Arlington LC Workshop January 2003:

WHY LC?

TWO-PRONG ATTACK at LC on PHYSICS beyond the SM

→ INDIRECT

PRECISION MEASUREMENT

Higgs – Top – WW – $q\bar{q}$ – GZ – M_W

⇒ High statistics
⇒ Polarized beams

e.g., $M_{Z'} \sim 5$ TeV

→ DIRECT

DISCOVERY

Susy – Alternative Theories

e.g., 'Susy Forest'

→ NECESSARY COMPLEMENT to LHC

PHYSICS $\longrightarrow$ MACHINE

Executive Summary

HIGGS

DISCOVERY & PRECISION MEAS. of
PRODUCTION, COUPLINGS

10^5 Higgs few % 20%

$\rightarrow$ 500 fb^{-1} @ $\sqrt{s} \sim m_Z + m_W + 25$ GeV
$\sim$ 230 GeV acc. to EW fits

TOP

PRECISION MEASUREMENT

Mass $\delta m_t \sim 100$ Mev

Z charges $v_t = 1 - \frac{8}{3} \cdot s_W{}^2$, $a_t = +1$ $\sim 1\%$

Mag., El. dip. mom. $\sim 1\%$, $\sim 10^{-18}$
Yukawa Coupling $g^2_{ttH} \sim 5\%$
$\rightarrow$ 300 fb^{-1}, 1000 fb^{-1} @ 400 GeV, 700 GeV
polarized beams

WW

PRECISION MEAS.

Mag.dip., El.quad. mom.

$$\mu_{\gamma,Z} = -\frac{e}{M_W}[z + \delta\kappa_{\gamma,Z} + \lambda_{\gamma,Z}]$$
$$Q_{\gamma,Z} = -\frac{e}{M_W^2}[1 + \delta\kappa_{\gamma,Z} + \lambda_{\gamma,Z}]$$

$\delta\kappa, \delta\lambda \sim 10^{-3}$

$\rightarrow$ few 100 fb^{-1} @ 500 GeV

polarized beams

SUSY

DISCOVERY & PRECISION MEAS.

Meas. all Susy parameters

$\rightarrow$ many 100 fb^{-1} up to highest energy

polarized beams

BEYOND E–W

PRECISION MEAS. & DISCOVERY

Z', f^*, H^{ns}, LQ, TC, $n_D > 4\ldots$

$\rightarrow$ few 100 fb^{-1} up to highest energy

polarized beams

Z – PEAK

PRECISION MEAS.

$\delta \sin^2\theta_W \sim 10^{-5}$, $\delta M_W \sim 6$ MeV

$\rightarrow$ 1 Giga Z

polarized beams

Example of Experimental Programme

- ILC

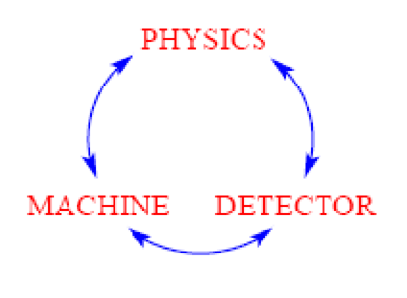
$\sqrt{s}$ =	91	500	800/1000	GeV
$\mathcal{L}$	$= 6 \times 10^{33}$	3×10^{34}	5×10^{34}	$cm^2 s^{-1}$

- PHYSICS

Year	Physics	$\sqrt{s}$ Gev	$\int \mathcal{L} dt$ fb^{-1}	Years Runnin
2019	Commissioning			1
2020	Higgs	250	200	2
2022	Top	350	200	1
2025	WW, HHH	500	500	2
2028	Susy			
+y	Yukawa ttH	750	1000	2
+NP= 10	New Physics			
y {	GZ	91	50	1
	M_W	161	100	1

$\Sigma \sim$ **25**

Now to the detector. We want:



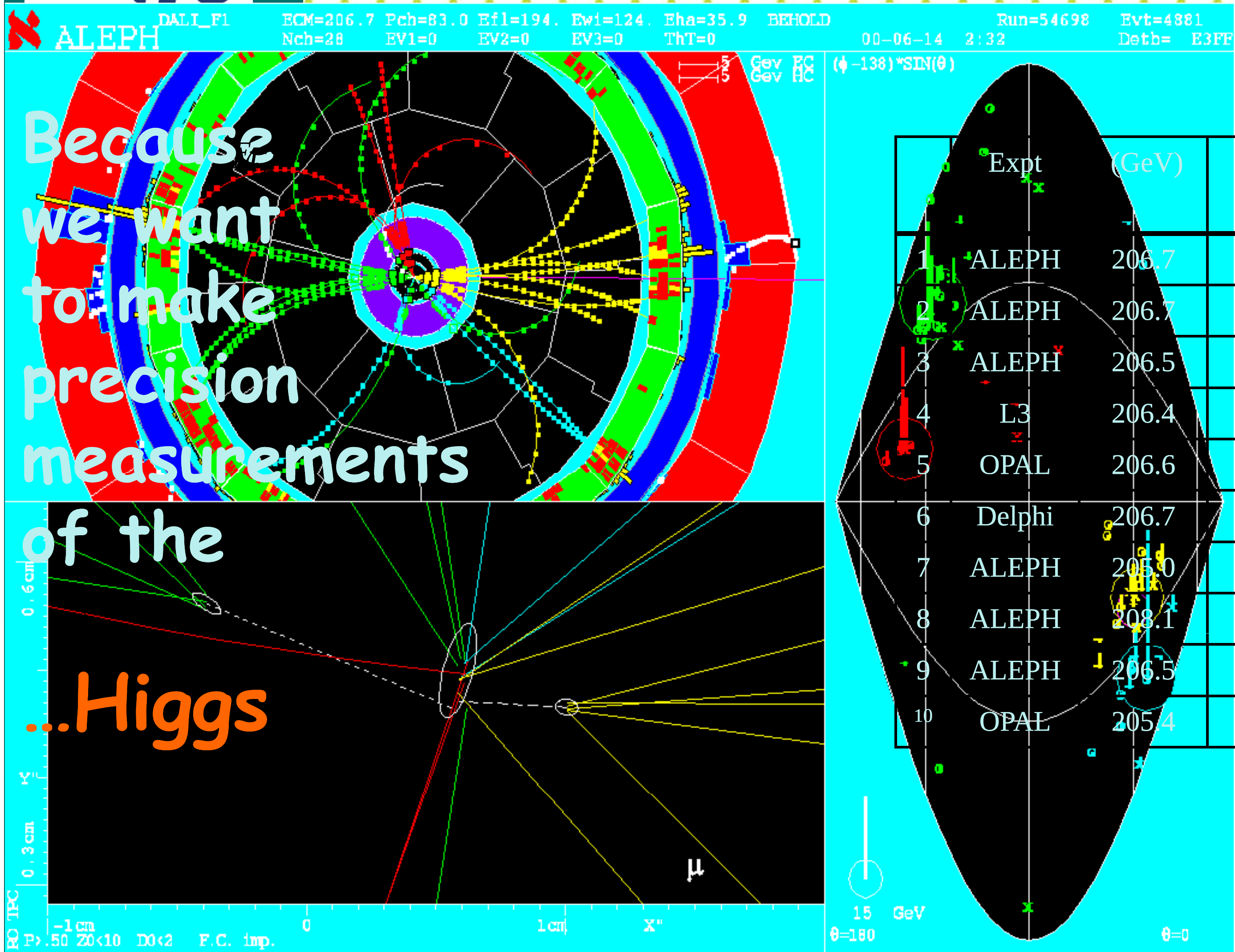
Physics → Detector Goals

• vertexing e.g. $t\bar{t}$	$\delta(\mathrm{IP}_{\phi,z}) \lesssim 5\mu\mathrm{m} \oplus \frac{10\mu\mathrm{m GeV}/c}{\mathrm{p}\sin^{3/2}\theta}$
• tracking e.g. Higgs	$\delta(1/\mathrm{p_t}) \lesssim$ Now 2x10-5/(GeV/c)
• fwd. dirn e.g. lumi, t–ch.phys.	$\delta(1/\mathrm{p_t}) \lesssim 3 \times 10^4 \mathrm{GeV/c}^{-1}$, $\delta(\theta) \lesssim 2 \times 10^{-5}, \cos\theta \lesssim 0.99$
• jet energy from Particle Flow	$\delta(\mathrm{E/E}) \lesssim$ Now 0.25/√E @ Zpeak
• hermeticity for $\not{E}$ meas.	$\sim$ 5 – 10 mrad for beampipe, only hole
• backgrounds robustness	min. material inside Ecal, $\vec{\mathrm{B}} \gtrsim 3\mathrm{T}$, granularity

R & D, prototyping to shoot for these goals

Motivation…

Because we want to make precision measurements of the …Higgs



	Expt	(GeV)	Decay Channel	(GeV/c²)	ln(1+s/b) 115 GeV/c²
1	ALEPH	206.7	4-jet	114.3	1.73
2	ALEPH	206.7	4-jet	112.9	1.21
3	ALEPH	206.5	4-jet	110.0	0.64
4	L3	206.4	E-miss	115.0	0.53
5	OPAL	206.6	4-jet	110.7	0.53
6	Delphi	206.7	4-jet	114.3	0.49
7	ALEPH	205.0	Lept	118.1	0.47
8	ALEPH	208.1	Tau	115.4	0.41
9	ALEPH	206.5	4-jet	114.5	0.40
10	OPAL	205.4	4-jet	112.6	0.40

To make progress in understanding, we have to distinguish two different phases:

(1) Running for precision measurements
(2) Running for discovery

DISCUSSION

(1) Precision measurements

-Here frequent change is not so important; once a year is enough unless a detector problem crops up.

-A well calibrated detector is essential. For this Z-peak running is one of the most valuable tools we have. At Acfa8, Mark Thompson and I made the following gestimate for ILC based on Lep2 experience:

-- 10/pb Z-peak at the beginning of a year (after detector maintenance, meaning it had been taken apart and put back together

-- 1/pb Z-peak later in case of incidents/accidents during a year.

-A similar procedure was followed at Lep2 every year and was valuable/necessary for all 4 detectors. (At Lep1 we were running on the Z-peak all the time and therefore were taking calibration data all the time.)

(2) Discovery

-Here a frequent change is important, and therefore the change should be as rapid as possible.

(For example, at Lep2 we did this, went through a “Higgs-discovery” mode, where—this is an example for the machine and not the detector--went through frequent cycles of filling to the highest possible energy, running for an hour or two, then refilling rapidly after a beam loss, in 1-2 hours typically.)

-But we have to remember that at the ILC good MDI teams and a lot of planning/training/experience will be needed to achieve the fastest possible “Formula-1-Pitstop”-type switch, and

WILL A CALIBRATION RUN BE NEEDED EACH TIME???