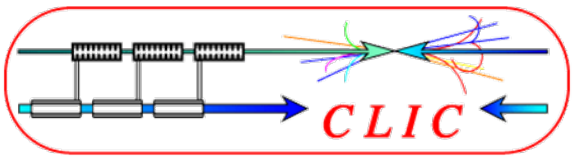
Coil and HCAL Parameters for CLIC

Solenoid and Hadron-calorimetry for a high energy LC Detector
15. December LAPP

Christian Grefe
CERN



Content

- ILC detectors (ILD, SiD)
- Coil & HCAL options
- HCAL leakage studies
- possible HCAL dimensions
- outlook

ILD (november 2008)

- HCAL
  - R_{min} = 206 cm, R_{max} = 333 cm
  - 48 layers of Fe/Scint (2.0 cm + 0.5 cm)
  - λ = 6.0 , X_0 = 55,3
  - segmentation: 3.0 cm x 3.0 cm
  - 16 fold (outside), 8 fold (inside)

- Coil
  - R_{min} = 344 cm, R_{max} = 419 cm
  - B = 3.5 T

SiD 02

- HCAL
  - R_{min} = 141 cm, R_{max} = 253 cm
  - 40 layers of Steel/Gas (2.0 cm + 0.8 cm)
  - $\lambda = 5.1$, $X_0 = 46.5$
  - segmentation: 1.0 cm x 1.0 cm
  - 12 fold

- Coil
  - R_{min} = 255 cm, R_{max} = 338 cm
  - B = 5.0 T

CLIC 000

- HCAL
  - R_{min} = 141 cm, R_{max} = 265 cm
  - 45 layers of W/Scint (2.0 cm + 0.75 cm)
  - $\lambda = 9.5$, $X_0 = 257.7$
  - segmentation: 1.0 cm x 1.0 cm
  - cylindrical

- Coil
  - R_{min} = 280 cm, R_{max} = 363 cm
  - B = 5.0 T

Coil options

- larger coil
  - larger HCAL (more containment)
  - larger tracker (better momentum resolution / better particle flow)
- smaller coil
  - less cost
- larger field
  - less background (beamstrahlung) especially in the vertex detector
  - better momentum resolution / better particle flow
- smaller field
  - smaller return yoke for same stray field → less weight / less cost
- from a particle flow point of view, a larger tracker / coil radius is preferred over higher field → M. Thomson (http://indico.cern.ch/contributionDisplay.py?contribId=268&sessionId=2&confId=30383)

Calorimeter options

- ECAL
  - containment of EM showers (in order to separate from hadronic showers)
- HCAL
  - the bigger, the better (more containment)
  - barrel limited by coil radius, only choice is material (short interaction length) → W, U, Pb, brass, steel, …
  - less limitations for endcap, but one needs to account for higher radiation in the very forward region (detector parts)
  - the forward region is extremely important for CLIC, since many events are highly boosted at 3 TeV

What do we look for?

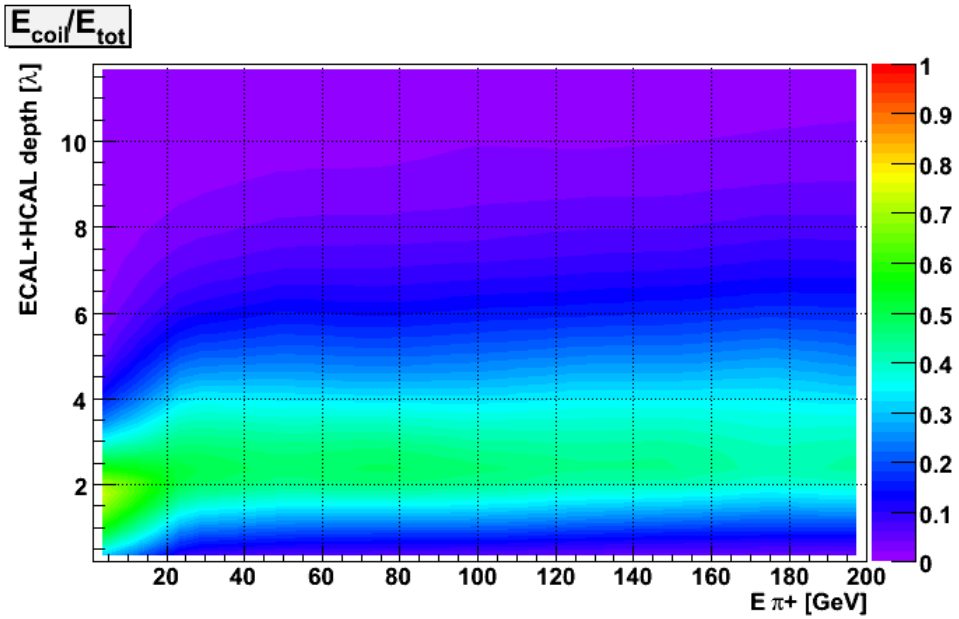
- 3 TeV center of mass energy
- interesting physics has 4 or more jets
  - single jet energy up to ~750 GeV
  - jet consists of 1 or 2 high energetic particles and many low energetic ones
    → single particle energy up to ~300 GeV
- since we are limited by the coil, a tailcatcher seems inevitable
  - energy deposited in coil (~2 λ) might be reconstructed from HCAL and tailcatcher information

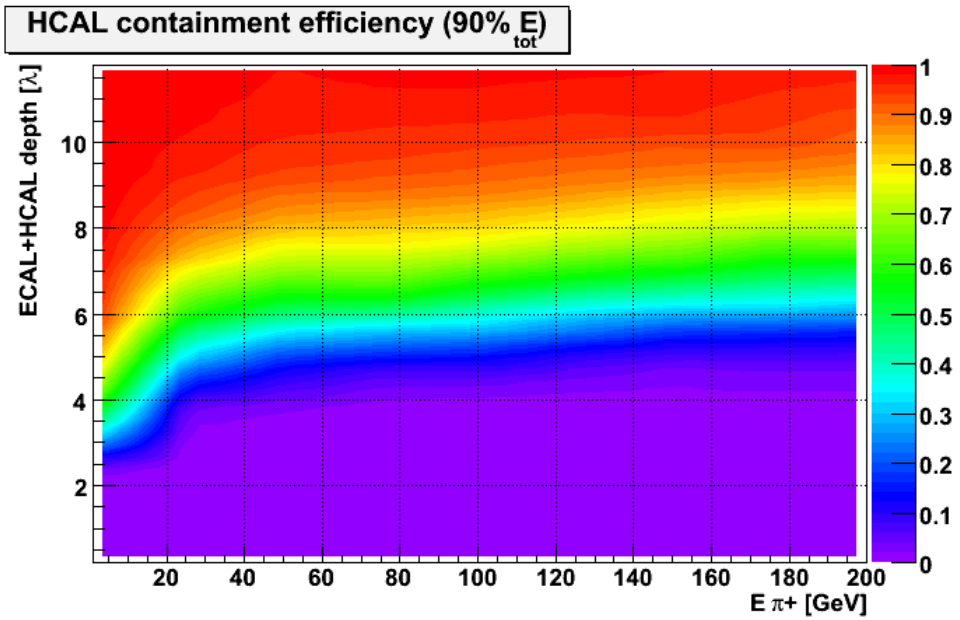
HCAL leakage studies

- investigate the λ needed to contain most of the energy depending on single particle or jet energy
- used a CLIC000ish HCAL stack (layers: 2.0cm W + 0.75 cm Scint)
- simulation of single π^+, u jets and b jets at various energies
- virtually cutting out HCAL, coil and tailcatcher regions in order to test energy reconstruction
- the coil is estimated with 2 λ material
- we use 1 λ as a tailcatcher
- ECAL will also contribute ~1 λ, which is now included in the calorimeter region

Average energy depositions

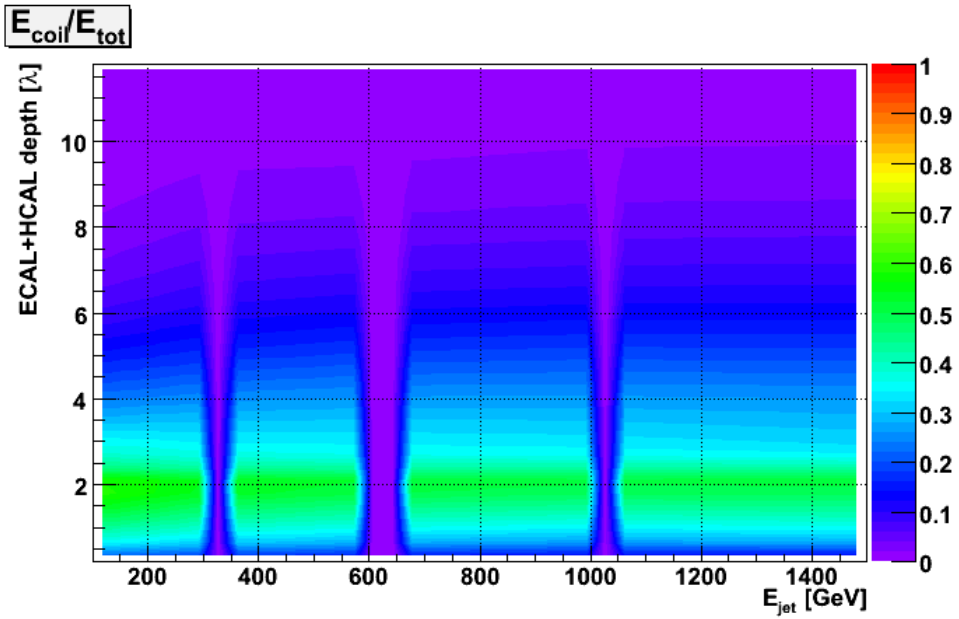
- single π^+

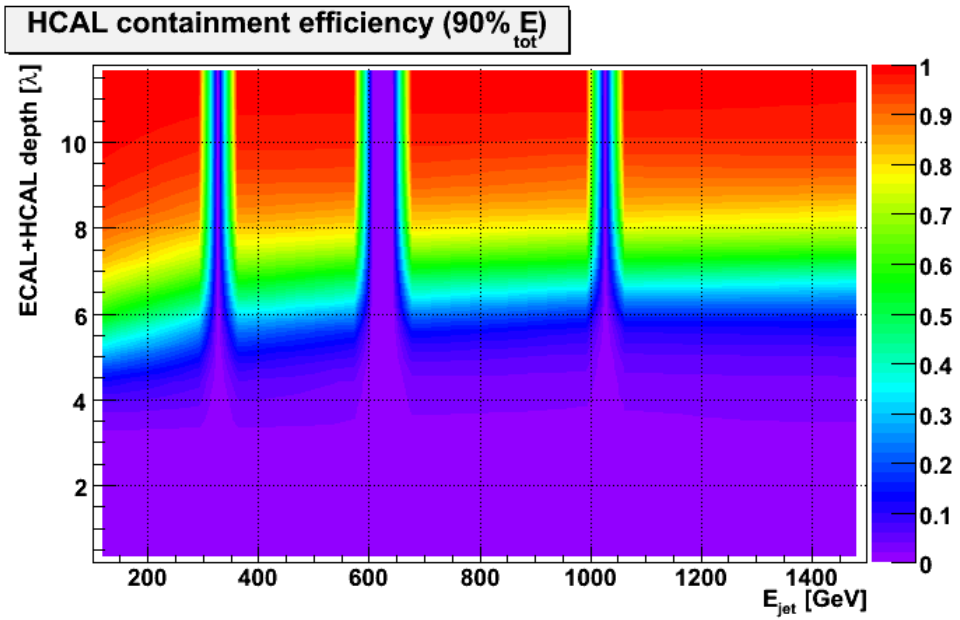




Average energy depositions

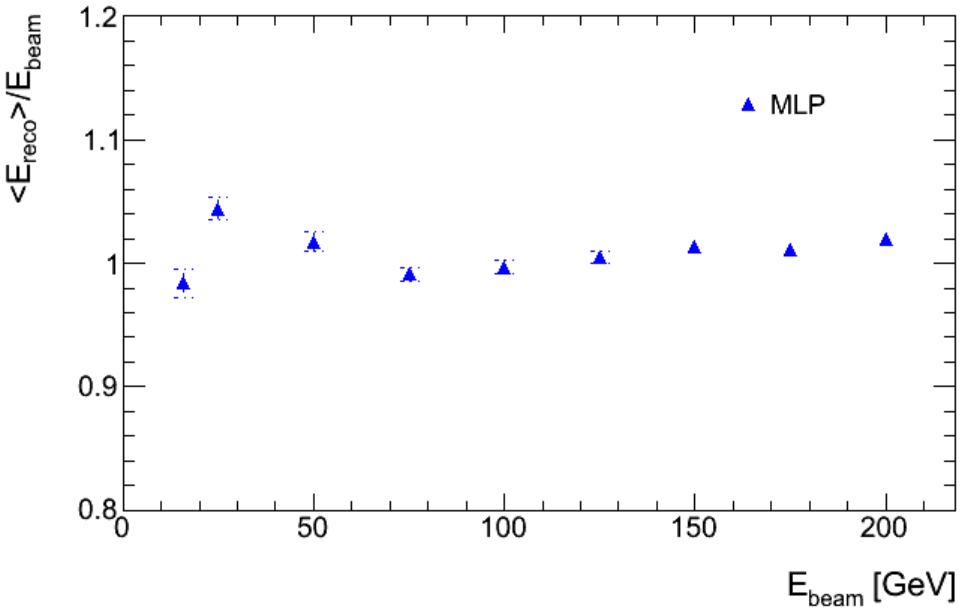
- u jets

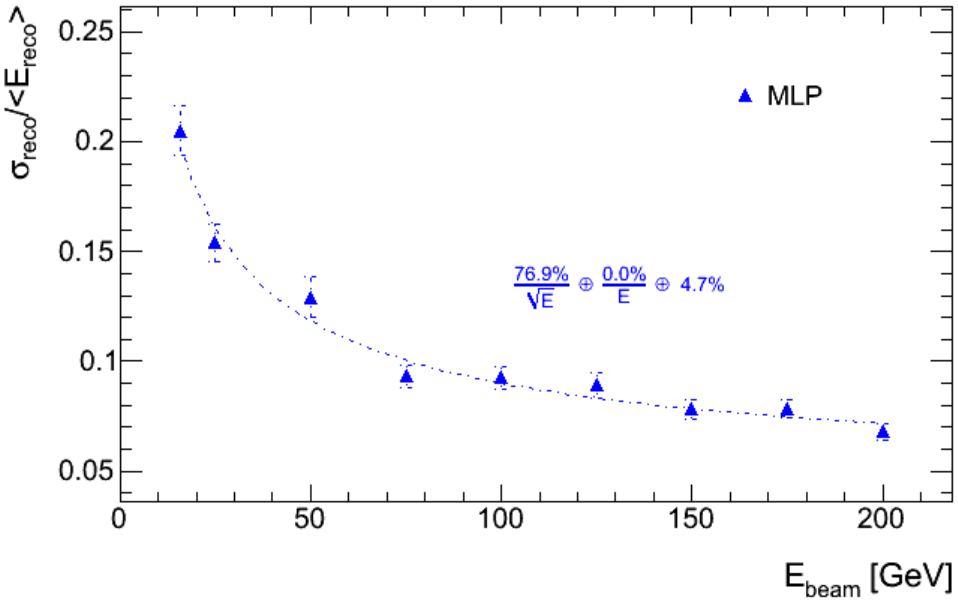




First test of energy reconstruction

- 6 λ calorimeter + 2 λ coil + 1 λ tailcatcher
- single π^+

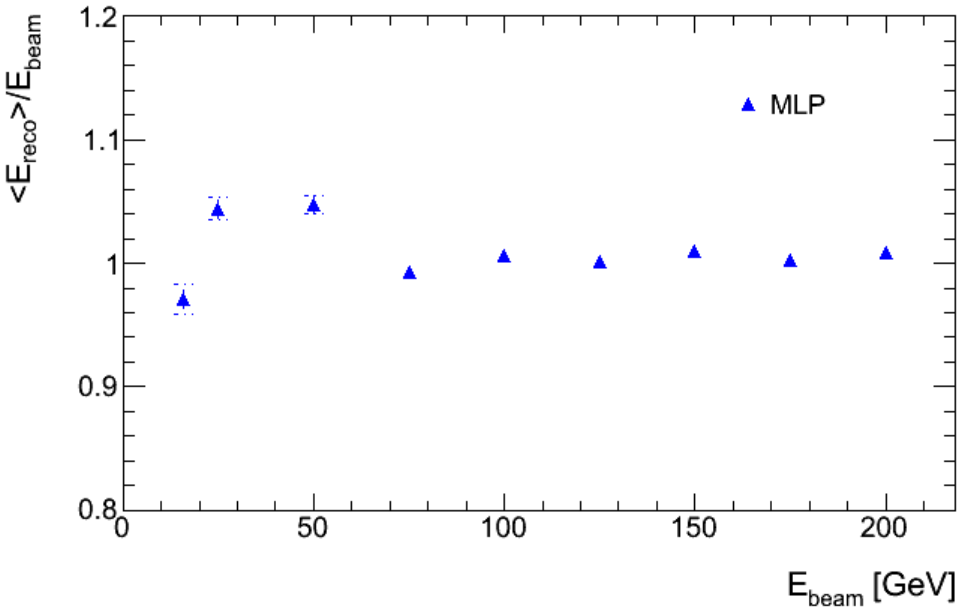


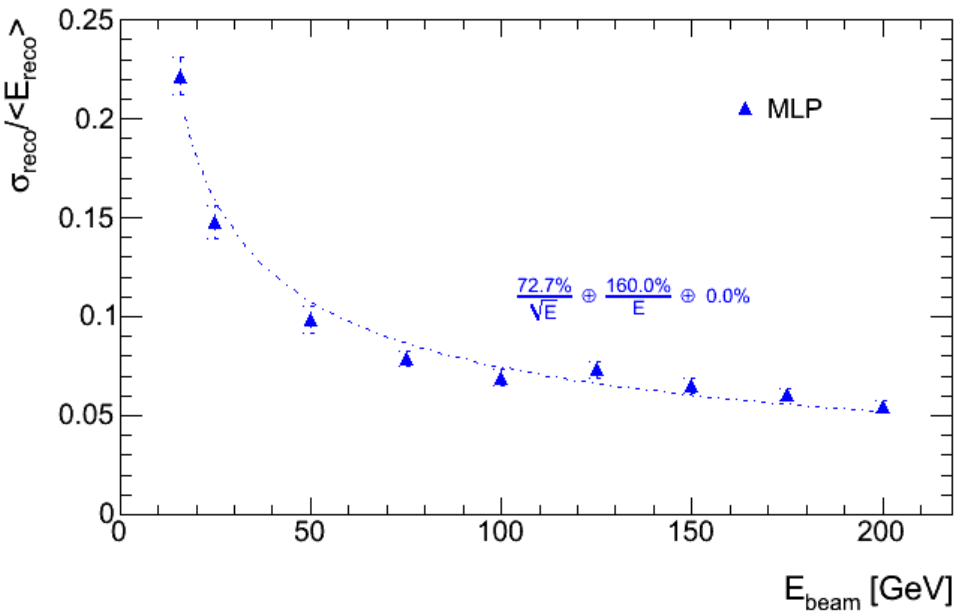


Peter Speckmayer

First test of energy reconstruction

- 8 λ calorimeter + 2 λ coil + 1 λ tailcatcher
- single π^+





Peter Speckmayer

HCAL materials

- possible materials and their properties

	W	U	Pb	Cu	Zn	Fe
density [g/cm^3]	19.3	19.0	11.4	8.96	7.13	7.87
Interaction length [cm]	9.95	11.03	17.59	15.32	19.42	16.77
radiation length [cm]	0.35	0.32	0.56	1.44	1.74	1.76

HCAL barrel dimensions

- 7 λ case (layer: 2.0 cm absorber + 0.75 Scint), R_{min} = 141 cm, 12 fold

	W	U	W + Pb (50/50)	W + Fe (50/50)	Brass (60/40)	Fe
layers	34	37	42	42	55	55
R_{max} [cm]	243	252	267	267	303	303
weight [t]	850	959	959	852	840	805
λ	7.16	7.06	7.01	7.13	7.10	7.08
X_0	194.7	234.4	195.5	144.6	72.3	63.6
λ/ X_0	27.2	33.2	27.9	20.3	10.2	9.0
outermost plate [cm x cm]	126 x 551	130 x 568	137 x 595	137 x 595	157 x 667	157 x 667

Outlook

- towards CLIC001:
  - choose the needed λ in the calorimeter
  - decide on a reasonable coil size
  - see which material(s) could do the job
- simulations
  - more simulation (especially jets)
  - redo simulations in the “real” detector
  - try particle flow and see where its limits are