Ideas on a Tungsten HCAL Prototype

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Motivation
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Commercial available Tungsten Plates
Workshop in Annecy
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CLIC09 Workshop 15/10/09

Motivation

- Physics at CLIC with a center of mass energy of 3 TeV requires to build a calorimeter system with rel. small energy leakage.

  => Design value for $\lambda_{int} \geq 1$ (ECAL) + 7 (HCAL)

- Space available for barrel HCAL inside (reasonable sized) coil: $\Delta r \approx 1.40$ m

  => need to use a more dense material than Fe

- Why not use W as absorber material in HCAL??

Motivation

- No experience with W as absorber material in HCAL
- λ_{int} (W) = 10 cm , X_0(W) = 0.35 cm
- λ_{int} (Fe) / λ_{int} (W) = 1.7, X_0(Fe) / X_0(W) = 5
- For a W absorber:
  - less visible energy (ionization)
  - more neutrons (spallation)
- PFA analysis requires very fine granularity in both ECAL and HCAL
- For colorimeter design simulations need to be reliable and understood to a rather precise level.

Goals and Objectives for a W HCAL Prototype

- Validate and adjust simulations for HCAL performances
  - Linearity / energy
  - Resolution /energy
  - Shower structure in comparison to Fe
  - Time structure of signal (neutrons)
  - Compare scintillator with gaseous detectors
  - Experience with W plates

  Later
  - Other detector technologies
  - Combine with ECAL proto
  - …

Mechanical Properties of Tungsten

	Pure W	INERMET 176*	Steel
% Tungsten	100	92.5	-
Alloying materials	-	Cu, Ni	-
Elasticity (Young) [GPa]	400	350	200
Density [g/cm^3]	19.3	17.6	7.85
% Elongation at yield	< 5**	5	30-50

*Alloys used must be paramagnetic, **Tests required

Plate size and tolerances

- Currently available plate sizes

Pure Tungsten	INERMET
1200 mm x 1600 mm	400 mm x 600 mm

- Thickness of 10 mm is feasible for both
- Flatness tolerance ca. 1.5 mm
  - < 1 mm possible
- Thickness tolerance ± 0.5 mm
  - With machining ± 0.1 mm (cost ↑)

Mini Workshop in Annecy on 24/9/09

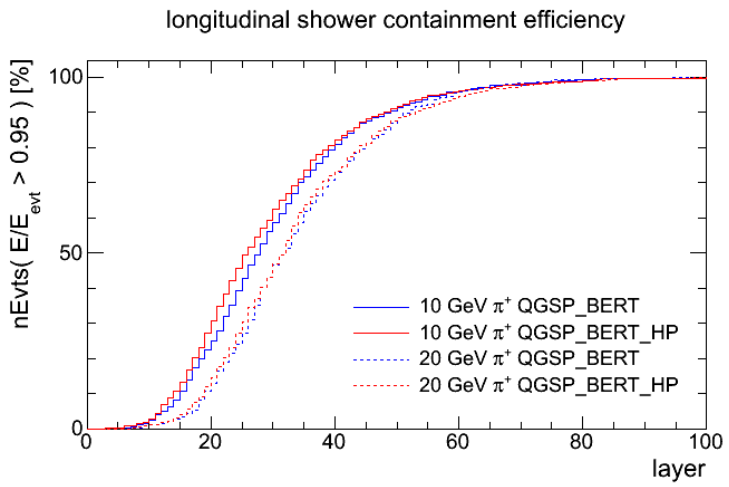
- The LCD-CERN, CALICE-DESY and LAPP groups agreed to work together and construct a W-HCAL prototype starting 2010.

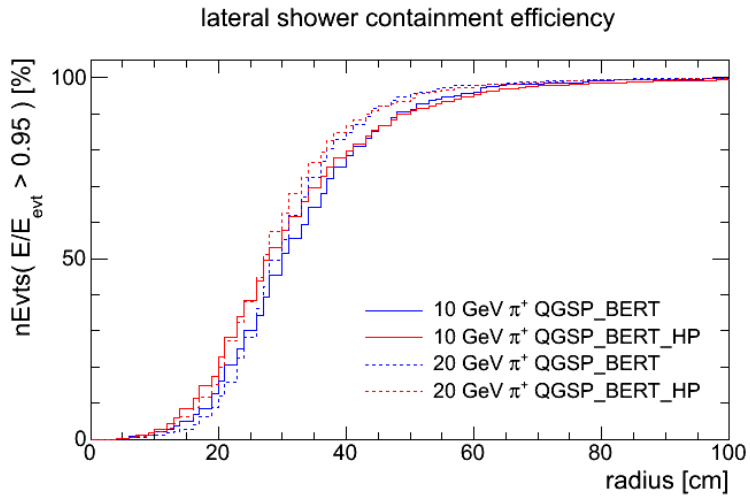
- More collaborators should be found

- The aim is to have first test beam measurements in autumn 2010

Proposal for a W HCAL Prototype

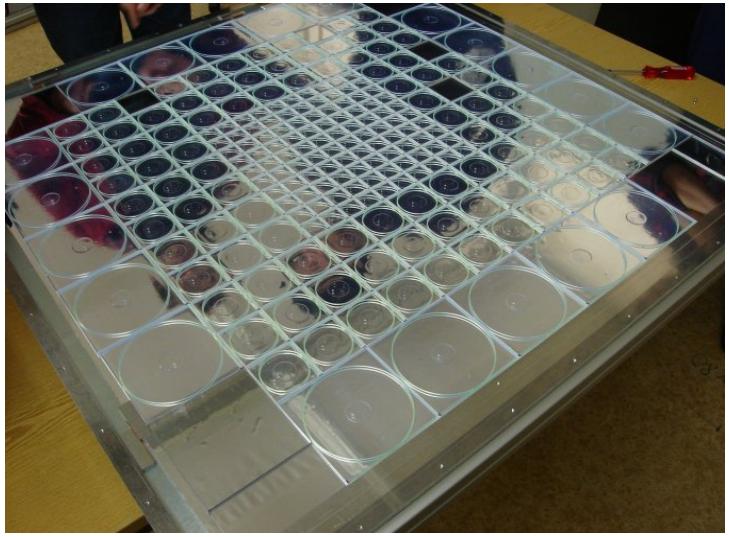
- Start 2010 with a “small” prototype:
  - Start with ~20 W plates size 80x80 cm^2, 1 cm thick
  - Use as much as possible existing equipment from CALICE (detector planes, readout electronics, DAQ, mechanical infrastructure…..)
  - First test beam at PS/SPS in autumn 2010
  - Later increase depth to 40 or more layers





Detectors to be used

- In 2010 start with existing CALICE scintillator cassettes

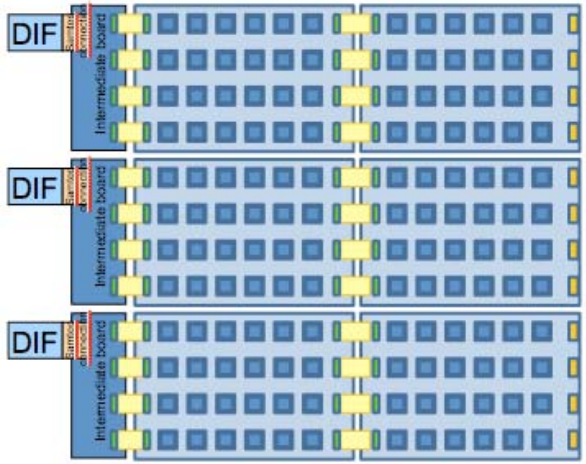


Overall size 90 x 90 cm^2
Central area equipped with small (3 x 3 cm^2) cells

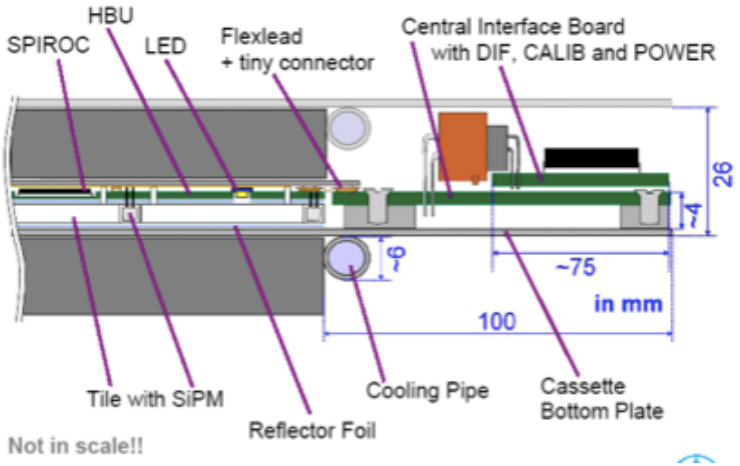
Equipped with readout and calibration

Future Detector Planes

- Micromegas detector planes with a cell size of 1x1cm^2 and digital read out



- Scintillator planes with a cell size of 3x3cm^2 over the whole surface and analog readout



Conclusion

- Tungsten offers maybe the possibility to build a compact HCAL with fine granularity readout at CLIC.

- No experience with W in an HCAL

  => need to validate W as absorber material in a prototype.

- Use of existing equipment from CALICE enables to get to first experimental result already by next year