Updates from the calorimeter system

M. Aleksa, J. Faltova, C. Helsens, A. Henriques,
C. Neubüser, A. Zaborowska

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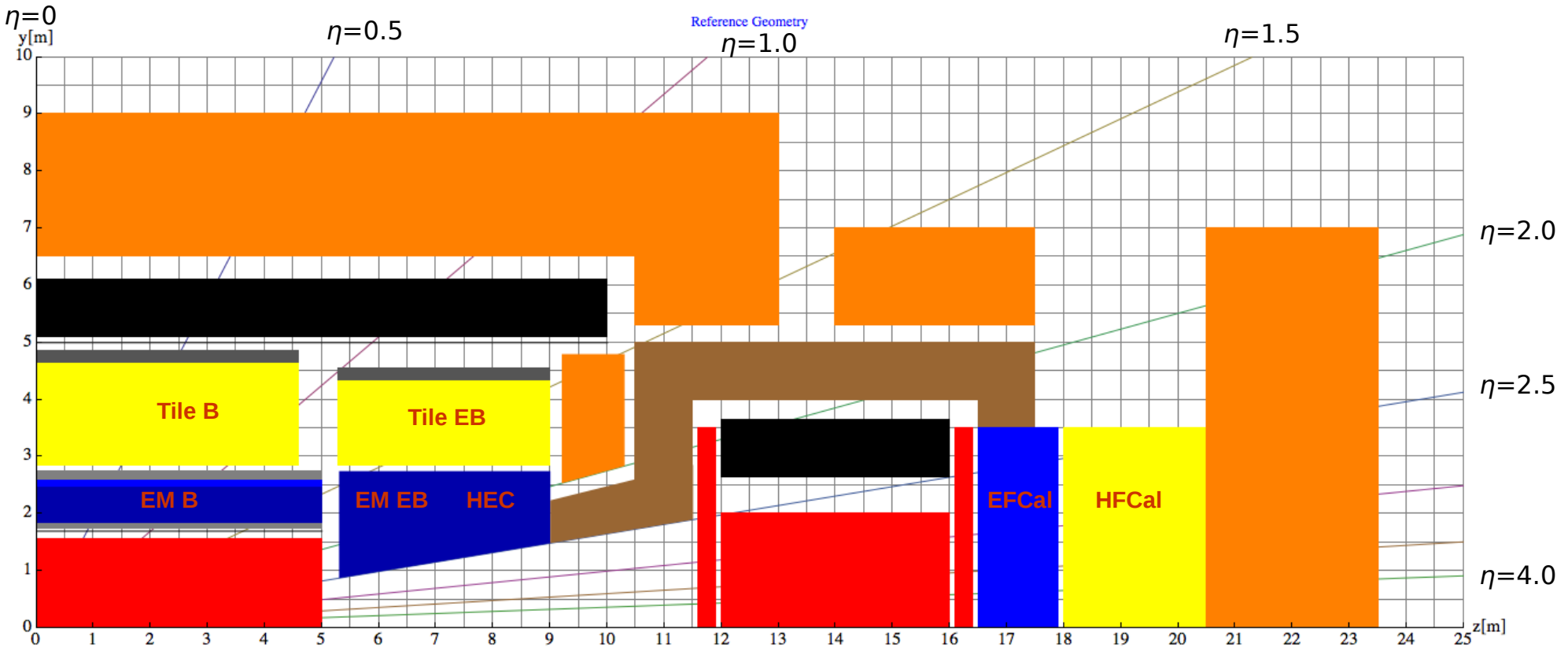
FCC calorimeter system



Electromagnetic (EM) calorimeters

- Barrel (EM B)
- Extended Barrel (EM EB)
- Forward calorimeter (EFCal)

Hadronic calorimeters

- Barrel (Tile B)
- Extended Barrel (Tile EB)
- Hadronic endcap (HEC)
- Forward calorimeter (HFCal)

- **Note: Technology has not been chosen yet**
  - Current baseline: Fe + Scintillators (Tile B, Tile EB), Pb + LAr (all the rest)

Segmentation & number of channels

All details could be found in the Excel sheet attached to the agenda

NAME	Technology	η coverage	# long. layers	$\Delta\eta$ x $\Delta\varphi$	# channels
EM B	LAr	< 1.7	8	0.01 x 0.01	1,589,891
EM EB + HEC	LAr	1.5 – 2.5	8	0.01 x 0.01	365,207
EFCal	LAr	2.3 – 6.0	8	0.01 x 0.01	44,157
HFCal	LAr	2.3 – 6.0	8	0.01 x 0.01	108,832
Tile B	Tile	< 1.3	10	~0.022 x 0.025	261,689
Tile EB	Tile	1.0 – 1.8	9	~0.024 x 0.025	82,489
Total (*)	LAr				**2,108,087**
	Tile				**344,178**

(*) Important: Numbers are our best first guesses

- Based on detector geometry only, we can go to even finer segmentation in both LAr & Tile
  - Larger number of read out channels → higher cost
- Forward calorimeters (EFCal, HFCal): segmentation not clear at all

Cell sizes to be optimised

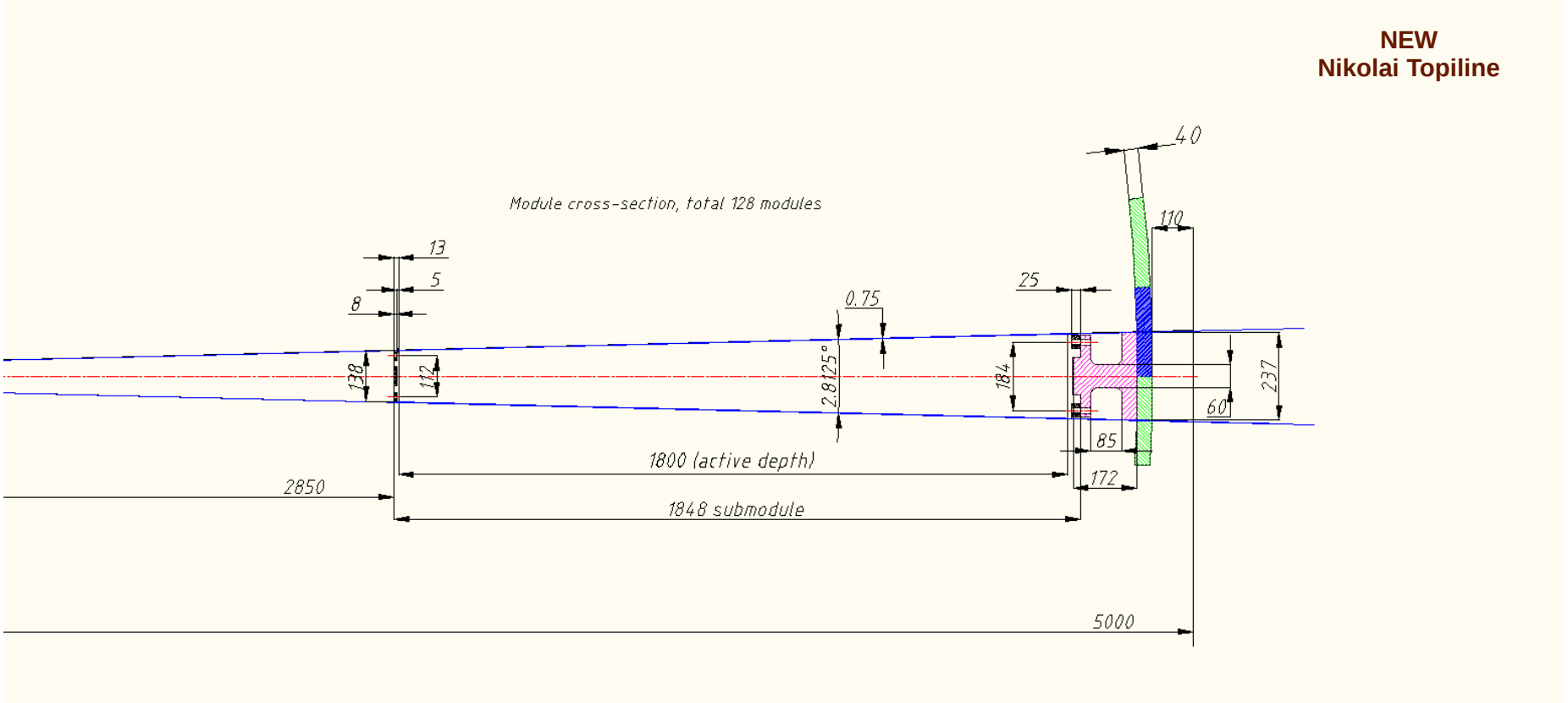
Tile calorimeter geometry

- **Similar to ATLAS TileCal, but with higher granularity**
  - Fe + Scintillator
- **Granularity**
  - Segmentation in φ
    - 128 modules
    - Scintillator readout by two halves ($\Delta\varphi$ = 0.025)
  - Segmentation in η
    - Sequence of 18 mm in z corresponds to $\Delta\eta$ ~ 0.005 in barrel (ultimate segmentation)
    - Final segmentation in multiples of the sequence
  - Longitudinal segmentation
    - Consider 10 (9) layers in R in the barrel (extended barrel)
    - Depth of each layer from ~ 0.5 to 1.2 interaction lenghts

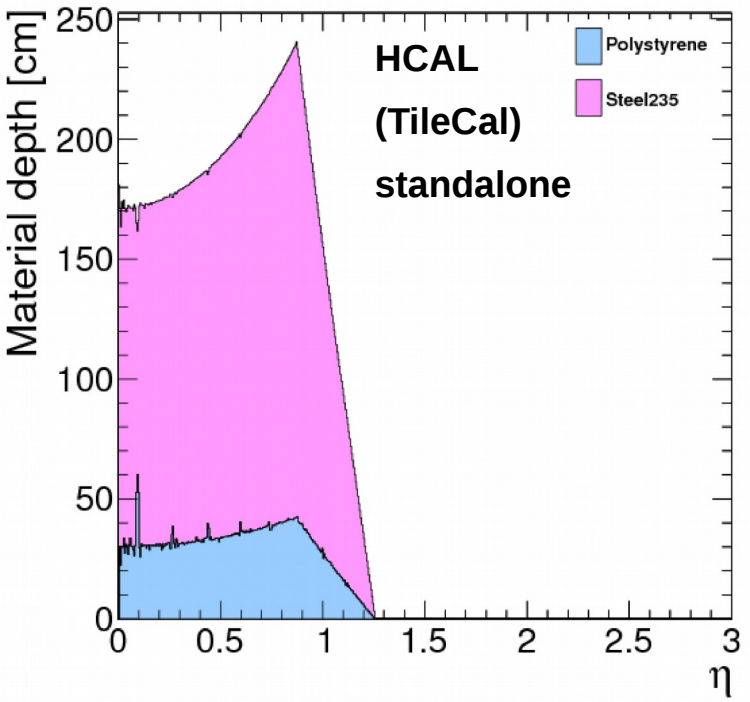
Structure of TileCal modules

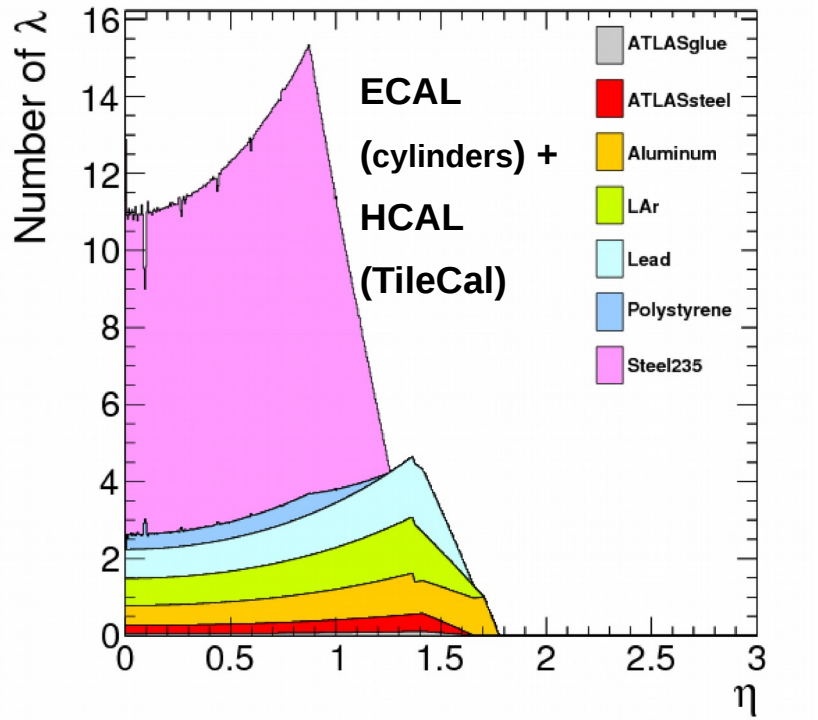
- **Feasibility of building 128 TileCal modules**
  - New: Support structure
  - Detailed calculations ongoing

  → **Seems promising**



Calorimeter barrel material scans





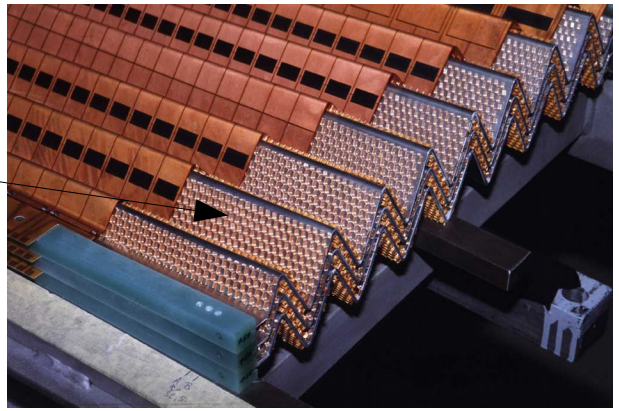
- **Number of interaction lengths (|η| < 0.9)**
  - between 9 and 12 for HCAL only
  - between 11 and 15 for ECAL + HCAL
- **Spikes caused by the Tile periodic structure**

Towards realistic ECAL geometry

- **Technology: Pb + LAr**

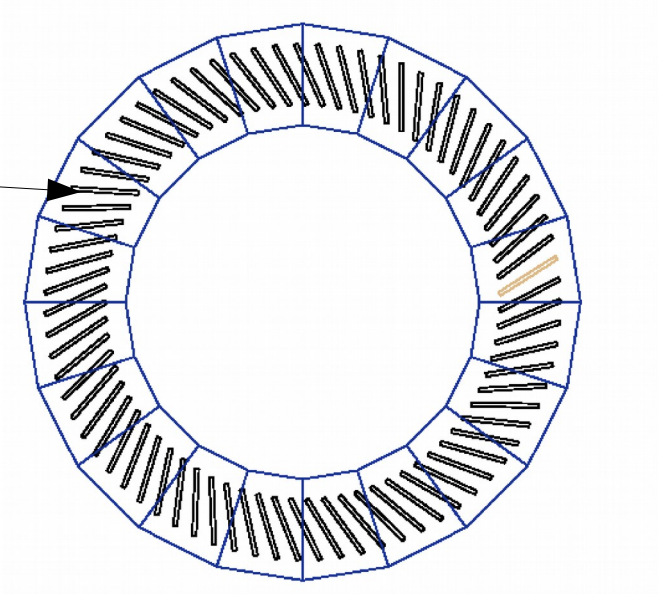
ATLAS

- Accordion-like structure
- High precision in the construction needed
  - Imperfections have a large impact on the energy resolution



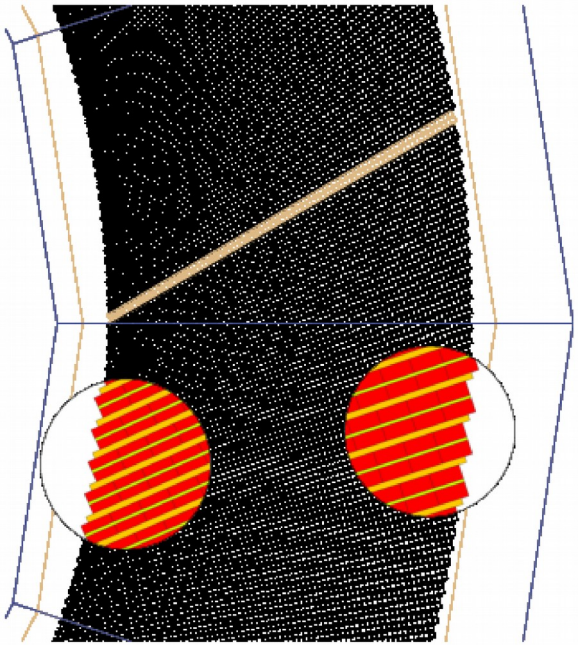
FCC: “Sunny” ECAL

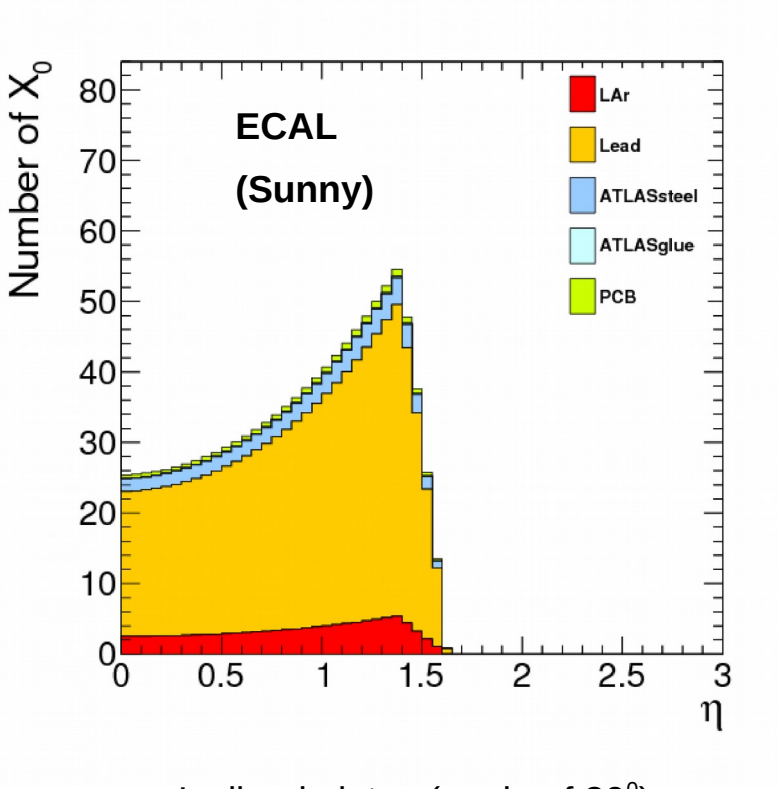
- Inclined absorber plates
- Easy to construct
- The size of LAr gap increases with *R*
  - Energy resolution has to be studied
- Possibility of introducing 1 or 2 bends on the plates



“Sunny” ECAL

- **Lead + steel + glue absorber plates**
- **Printed Circuit Board (PCB) readout**
- **LAr active medium**





Inclined plates (angle of 30^0)

2 mm Pb, 3 – 5.4 mm LAr

(LAr/Pb ratio: 1.5 – 2.7)

No cryostat

η = 0: 0.423 X_0/cm

Status of the calorimeter software

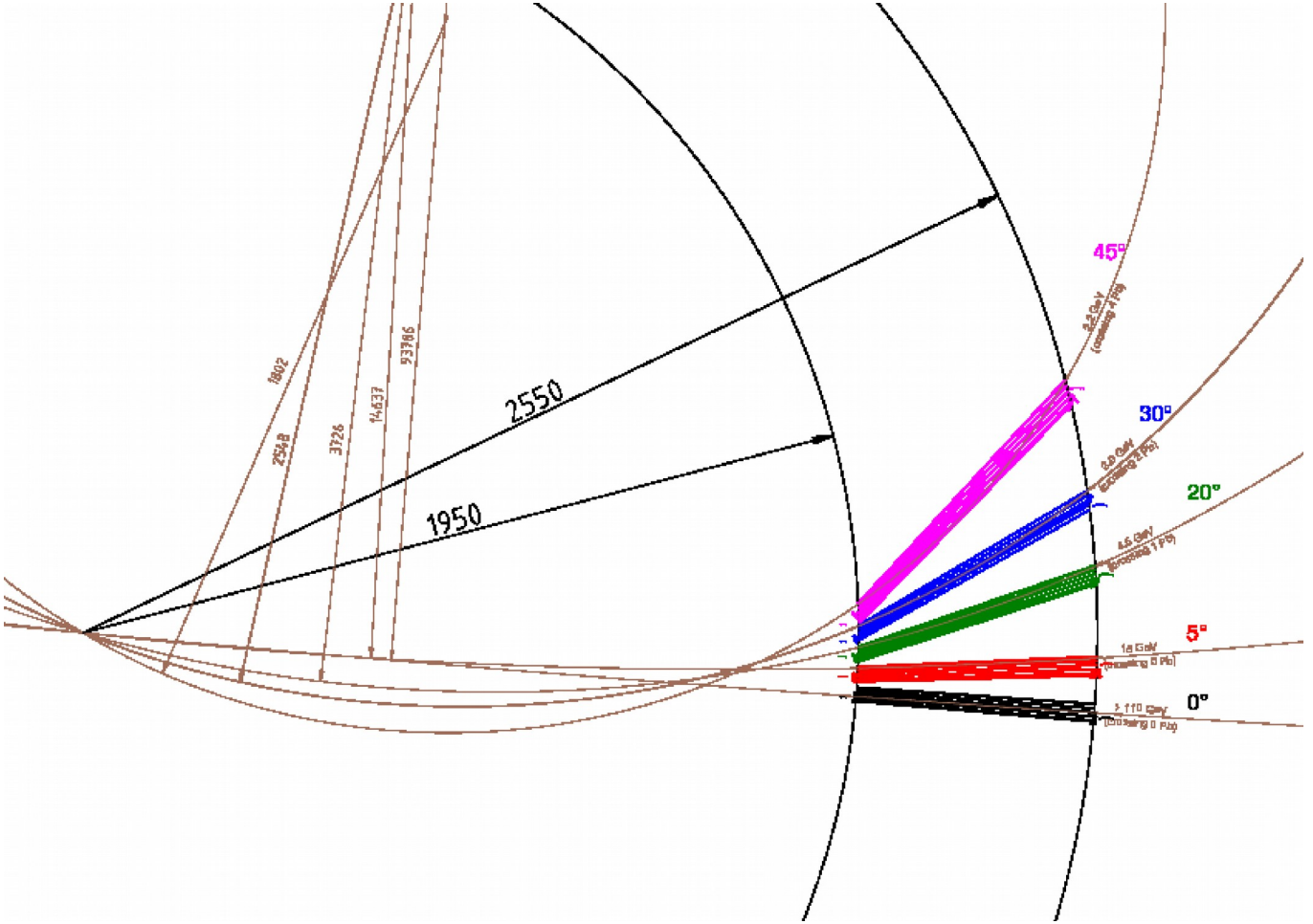
- **Geometry description**
  - HCAL geometry being validated against Geant4 standalone
  - Implementation of new ECAL geometry ready, validation ongoing
- **Combined calorimetry reconstruction**
  - Example of sliding window clustering algorithm prepared
  - Fixing last caveats at the moment

Conclusions

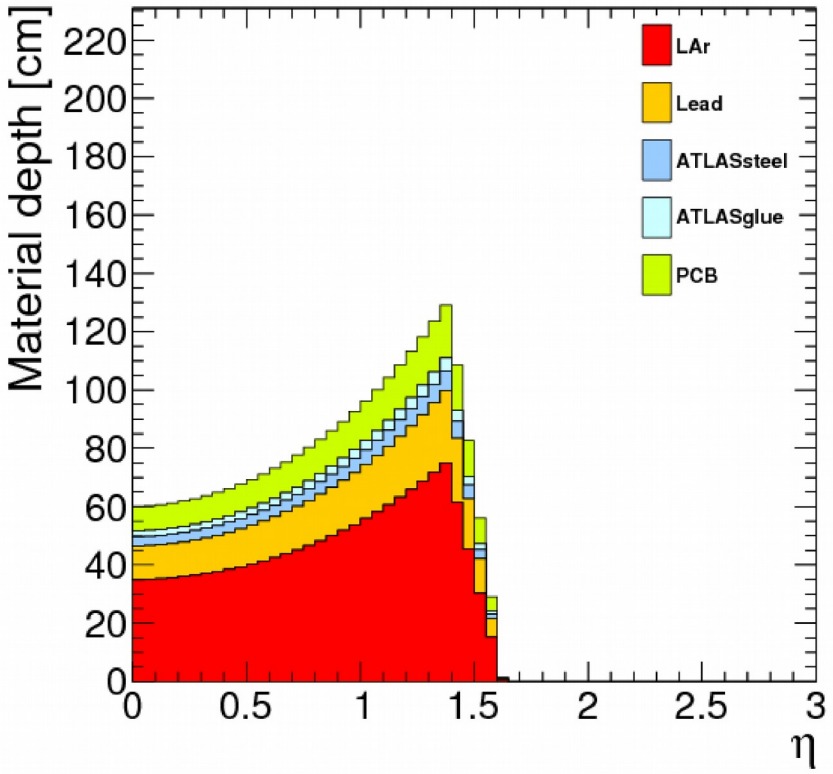
- **Discussion of granularity of the calorimeter system**
- **Building of the proposed TileCal modules seems feasible**
- **First version of a realistic ECAL geometry implemented**
- **Material scans for ECAL and HCAL barrels performed**
- **More plots next time …**

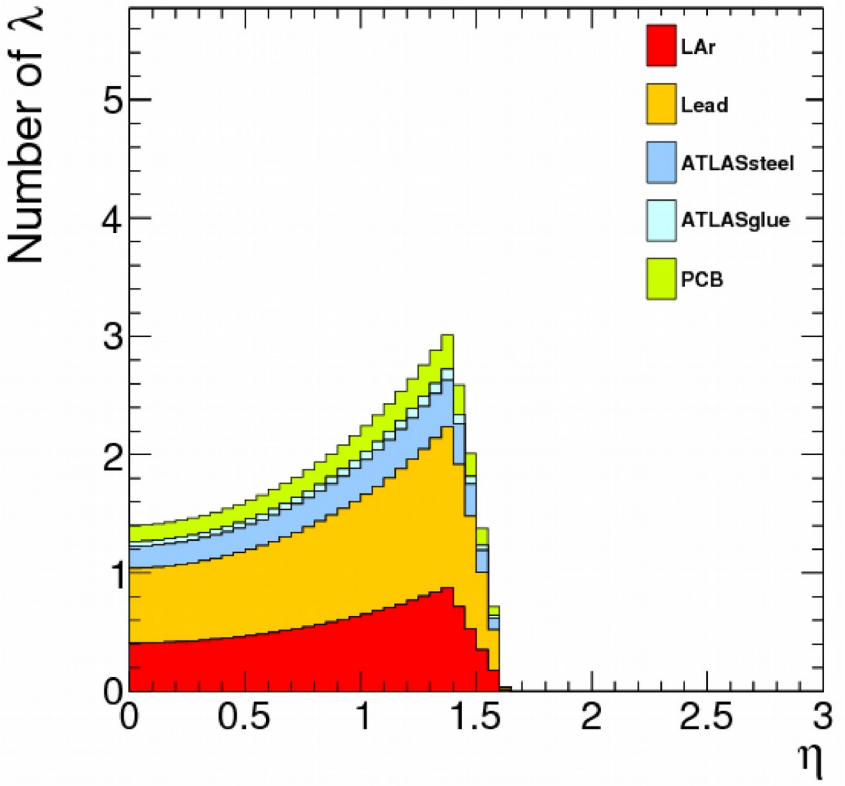
BACKUP

Inclination angle



“Sunny” ECAL material scans





ECAL cylinders – material scans

Cylinders - no cryostat
2mm Pb **4mm** lAr
$^{lAr}/_{Pb}$ ratio: 2.0

for $\eta = 0$: 0.496 X_0/cm