ADRIANO:
***A D**ual **R**eadout **I**ntegrally **A**ctive **N**on-segmented **O**ption for Future Colliders*

Corrado Gatto

INFN

On behalf of:

TWICE Collaboration

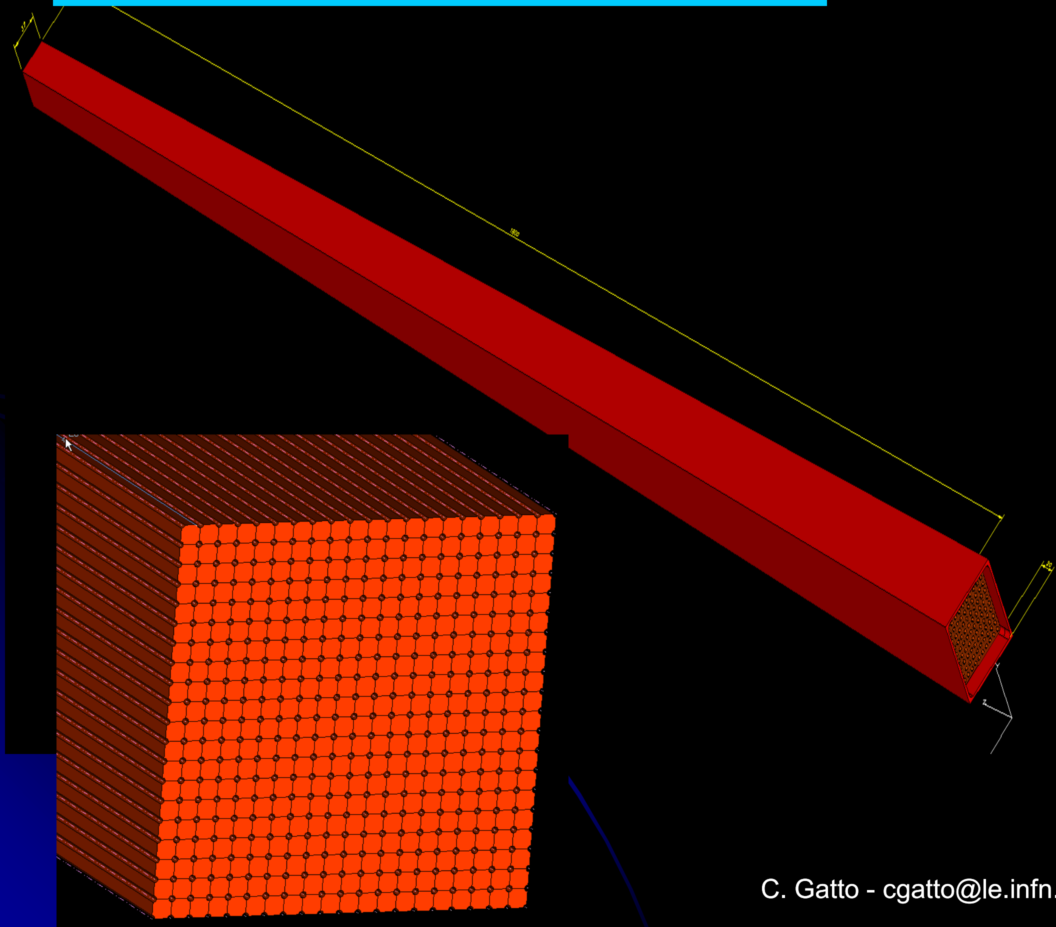
Merging the advantages of sampling and total active techniques

ADRIANO technique: i.e. embedd scintillating fibers into heavy glass

- Active Cerenkov component is Optical Heavy Glass
  - It functions as an **active absorber**
  - No scintillation light
  - Lots of Cerenkov photons thanks to n_l=1.85
- Scintillating component are scintillating fibers
  - **Optically separated** from Cerenkov absorber
  - Control the scintillation/Cerenkov signal with appropriate pitch between fibers
  - Faction of surface to instrument with photodetectros = 8%

ADRIANO: A Dual-Readout Integrally Active Non-segmented Option

- Fully modular structure
- 2-D with longitudinal shower COG via Light division techniques



- Cells dimensions: 4x4x180 cm^3

  Absorber and Cerenkov radiator: SF57HHT

  Cerenkov light collection: 8 BCF92 fiber/cell

  Scintillation region: SCSF81J fibers, dia. 1mm, pitch 4mm (total 100/cell) inside 100μm thin steel capillary

  Particle ID: 4 BCF92 fiber/cell (black painted except for foremost 20 cm)

  Readout: front and back SiPM

  COG z-measurement: light division applied to SCSF81J fibers

The *ADRIANO* 4π Calorimeter

ADRIANO Calorimeter

Lead glass + scintillating fibers

Fully projective layout

~1.4° aperture angle

4x4 cm^2 cells

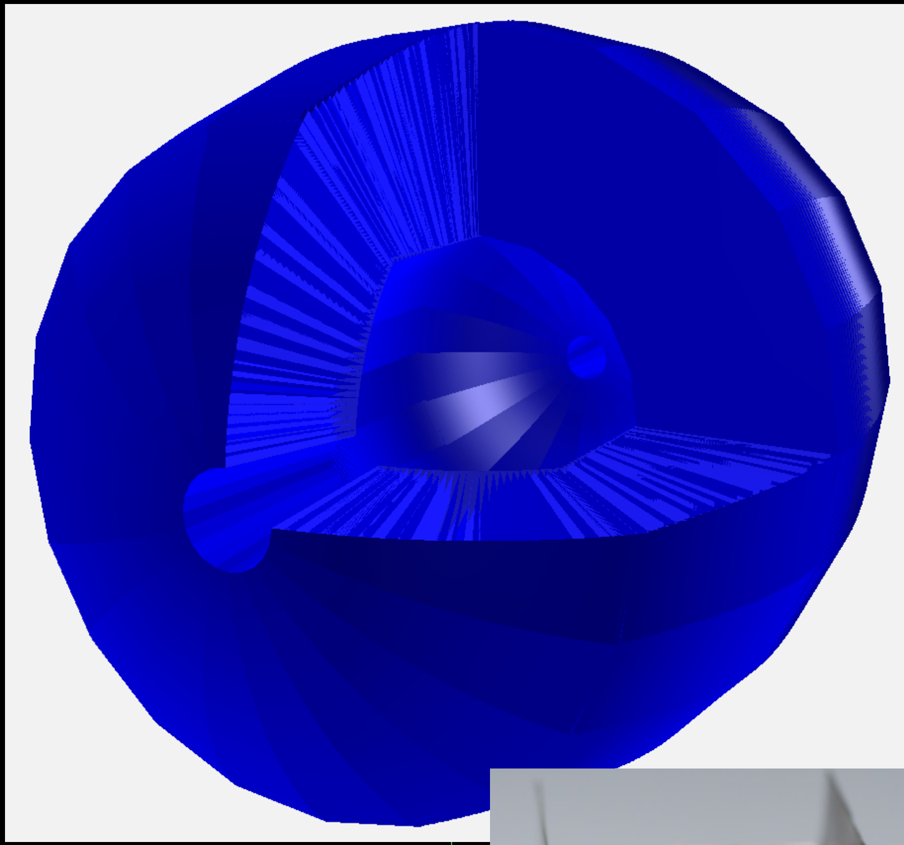
Length = 180 cm

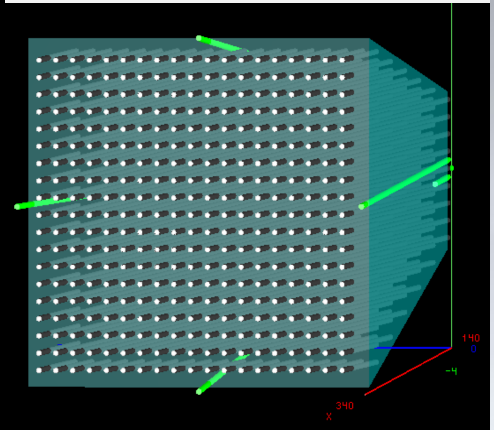
Azimuth to 2.8°

$<\lambda_{int}>$ ~ 8 ; X/Xo ~ 100

Barrel: 16384 cells

Endcap: 7450 cells/ea

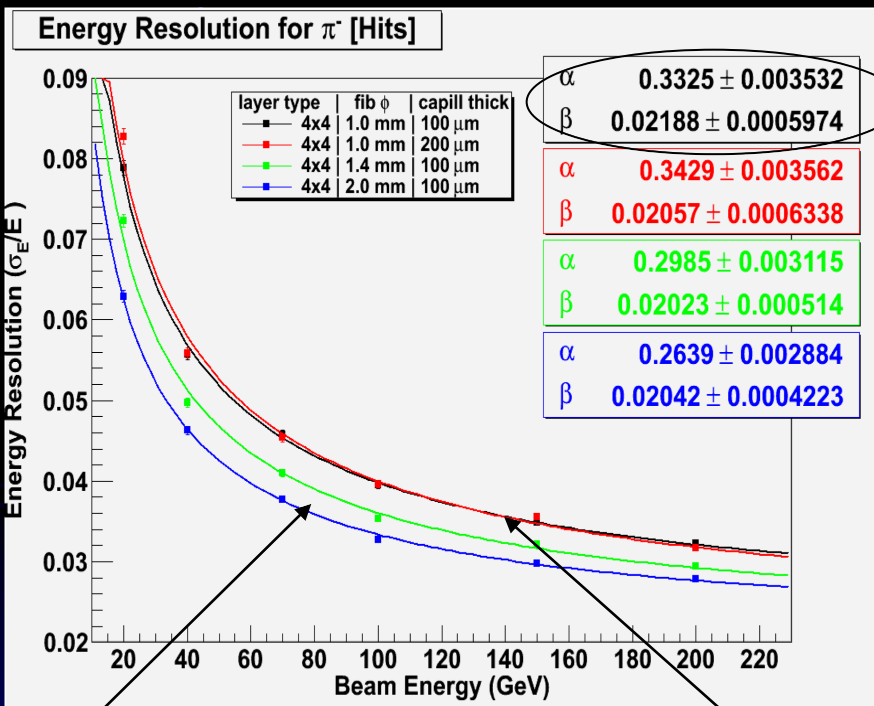




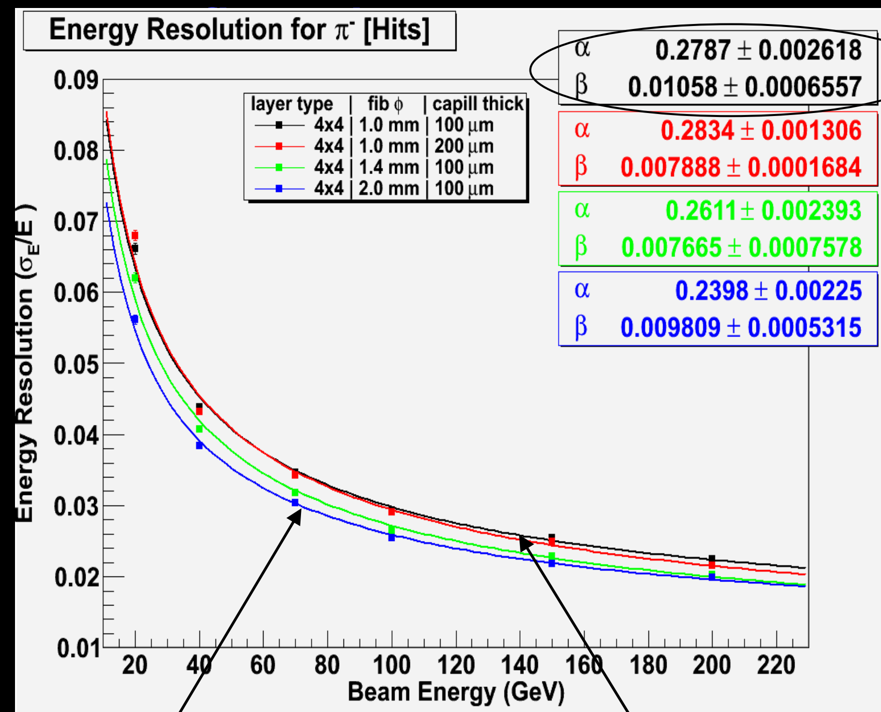
Pion beams

ADRIANO Hadronic Resolution: Dual Readout vs Triple Readout (various fiber layouts)

ADRIANO in Dual-readout



ADRIANO in Triple-readout



$\sigma_E / E = 26\% / \sqrt{E} \oplus 2.2\%$

$\sigma_E / E = 33\% / \sqrt{E} \oplus 2.2\%$

$\sigma_E / E = 24\% / \sqrt{E} \oplus 1\%$

$\sigma_E / E = 28\% / \sqrt{E} \oplus 1\%$

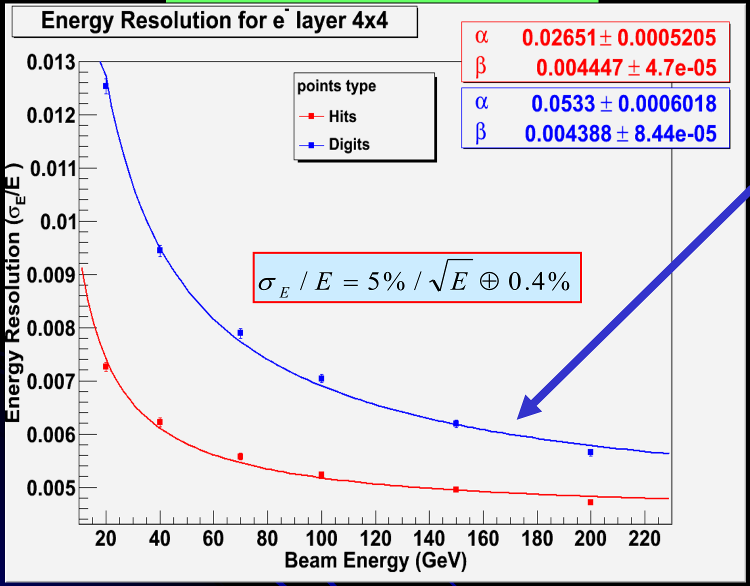
Baseline configuration
Fiber Φ = 1mm
Fiber pitch = 4mm

ILCRoot simulation

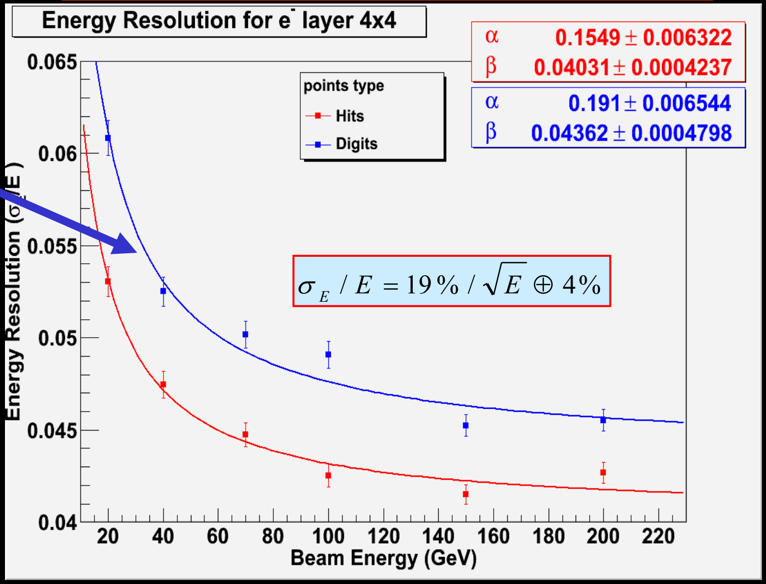
ADRIANO Resolution for EM Showers (with and without instrumental effects)

- Compare standard Dual-readout method vs Cerenkov signal only (after electron-ID)
- Blue curve includes instrumental effects. Red curve is for perfect readout

Use only Cerenkov light



Dual-readout (scintillating+Cerenkov)



Blue curve includes

- **SiPM's ENF**
- **Constant noise**
- **Fiber non-uniformity**
- **14 bit ADC**
- **3pe threshold**

- Using Cerenkov signal only for EM showers gives **5%/√E** energy resolution while full fledged dual-readout gives only **19%/√E** (including FEE effects)

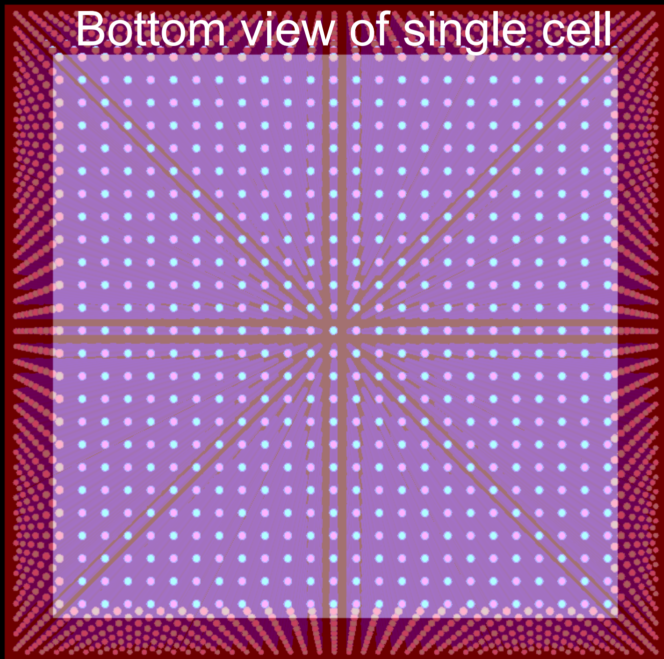
ADRIANO does not need a front EM section

ILCRoot simulation

ADRIANO calorimetry in TWICE Collaboration

- TWICE collaboration has been recently formed
- It exploit new techniques based on heavy glass (no sampling calorimetry nor crystals)
- It covers R&D on a broad range of aspects related to high performance hadronic and EM calorimetry :
  - Production and characterization of large area SiPM
  - Custom FEE
  - Construction and tests of calorimeter prototype
  - Liquid scintillator
  - Total active multiple-readout calorimetry
  - Scintillating heavy glass for dual-readout homogeneous calorimetry
  - *ADRIANO* calorimetry
- It gathers 6 INFN institutions + University of Szeged (Hungary), 25 Physicist & Engineers + technical support
- Material science and Ceramic Engineering groups are also participating
- It has been recently approved and funded by INFN for the next 3 years, including a test beam at FNAL
- At present is looking for International Collaborators (ongoing talks with Fermilab)

Hadronic Calorimeter Cells



Prospective view of clipped cell

1 mm diameter

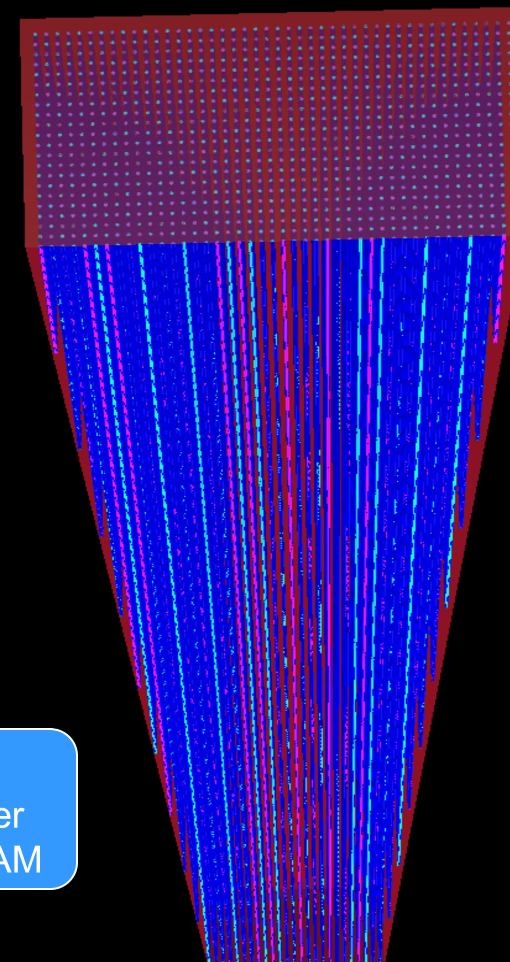
Plastic/Quartz fibers

Aperture Numb r=0.50

(C fibers

Same absorber/fiber ratio as DREAM

Top cell size:~ 8.1 × 8.1 cm^2



Bottom cell size: ~ 4.4 × 4.4 cm^2

Number of fibers inside each cell: ~1600 equally subdivided between Scintillating and Cerenkov

Fiber stepping ~2 mm

Cell length: 150 cm

Each tower works as two independent towers in the same volume