



Study of New FNAL-NICADD Extruded Scintillator As Active Media of Large EMCal of ALICE at LHC.

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Content

INTRODUCTION

SCINTILLATOR PRODUCTION

DESIGN PARAMETERS OF TILE

TEST STAND

LIGHT YIELD (Cosmic Ray Measurements)

LIGHT YIELD VARIATION (Uniformity Test)

SUMMARY



Introduction

Proposed Large EMCal

Physics:

-neutral pions, photons and electrons at high transverse momentum , trigger

Conceptual Design:

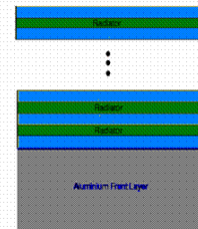
$$\Delta\eta \times \Delta\phi = 1.4 \times 2\pi/3$$

~20k Towers

Minimum size of ~ 5cm x 5 cm

Towers projective

Tile/WLS fiber sampling technique

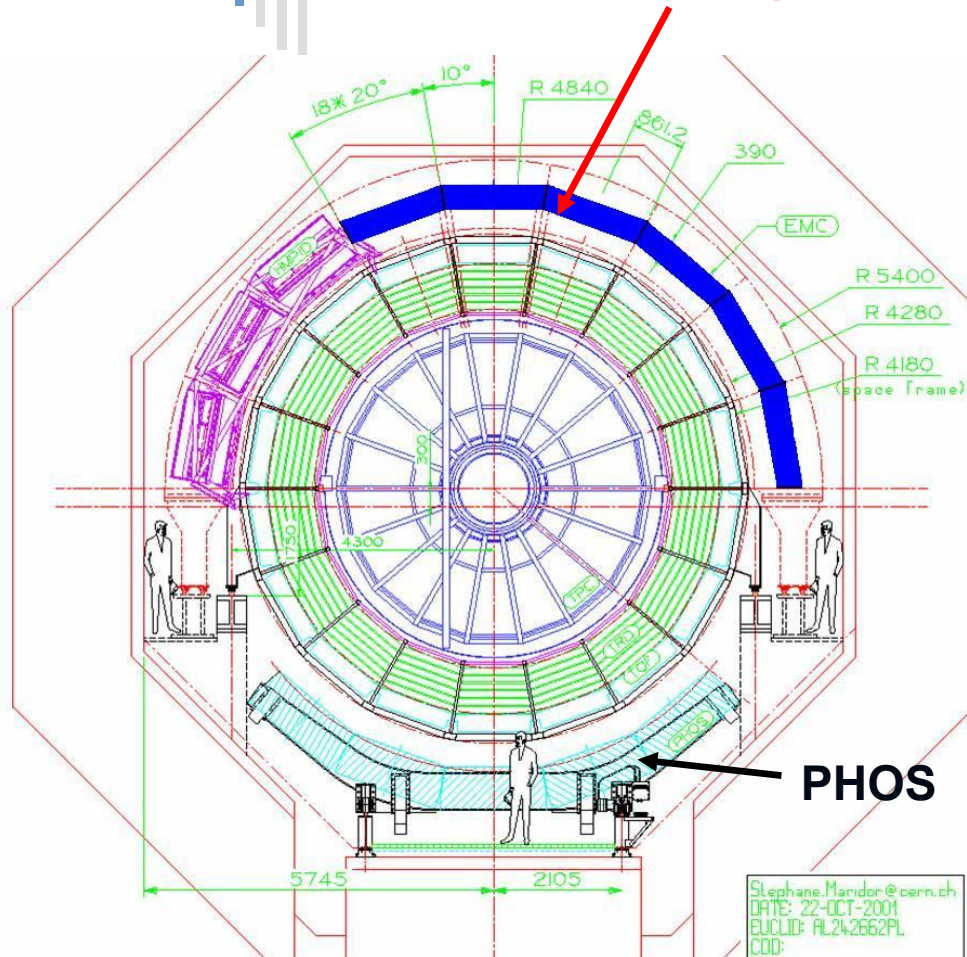


24 Layers of 5 mm Lead

25 Layers of 5 mm Scintillator

Pb/Scintillator with mega-tile technology

CDF Endplug upgrade , endcap and barrel calorimeters of the STAR)
(NIM A360, 1995; NIM A499,2003)



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CDD:





Introduction

**Large EMCal : ~ 200 T of detector and utilities
> 15 T of scintillating material
thousands of different tile geometries**

Injection Molding Scintillator	UNIPLAST	\$20/kg
Cast Scintillator	BICRON, KURARAY	\$40-\$70/kg
Extruded Scintillator	FNAL-NICADD	\$5-\$8/kg



Introduction

Requirements:

Light yield ≥ 2 photoelectrons/MIP

Uniformity of response over the surface of tile $\leq 3\%$ r.m.s.

Resolution (simulated) $(\sigma_E/E)^2 = (12.2\%/\sqrt{E})^2 + (0.4\%)^2$

Kuraray scintillator: - has been used many times in large scale applications
- commonly used material for calorimetry

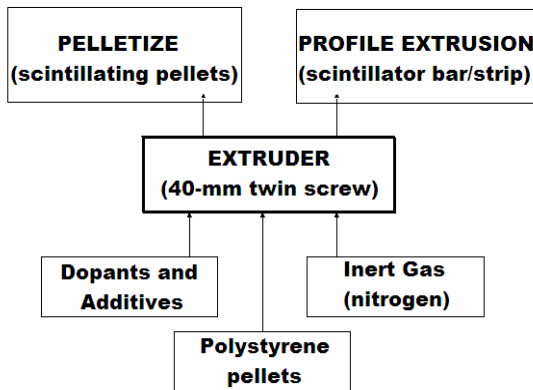
Kuraray (SCSN-81)

FNAL-NICADD

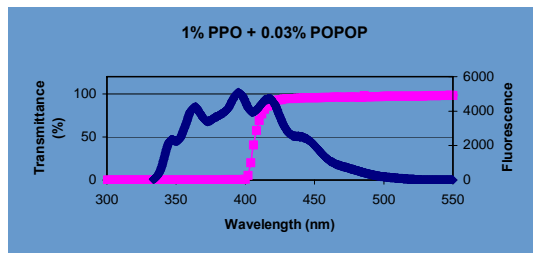
(Comparative measurements of light yield and light yield variation)

Scintillator Production

FNAL-NICADD Extrusion Line



Continuous process utilized in the preparation of extruded plastic scintillator



Transmittance and fluorescence spectra of FNAL-NICADD extruded scintillator



Berstorff 40-mm twin-screw extruder

Two K-Tron feeders

Conair vacuum and cooling tanks, belt puller and saw

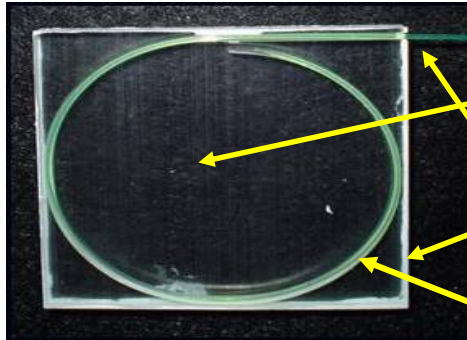
Novatec compressed-nitrogen dryer

Thickness: 4.87 +/- 0.03 mm

The optical characteristics of bulk material is the same as that of the MINOS extrusions (FERMILAB-Conf-03-318-E)



Design Parameters of Tile



Material

Scintillator: Kuraray SCSN-81 and FNAL-NICADD

Reflective Paint: 20621 White Acrylic Enamel

Wrapping Material (reflector): Tyvek (Style 1422A)

WLS Fibers: Kuraray Y11(200 ppm), MS, 0.83 mm

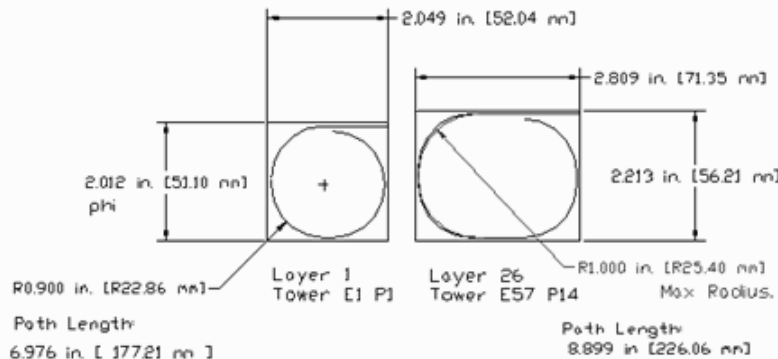
WLS Fiber Groove

Shape: Sigma Groove, Rectangle

Depth: 2.0 mm

Width: 1.0 mm

Distance from Edges: 2.7 mm

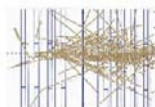


F.Pompei, WSU

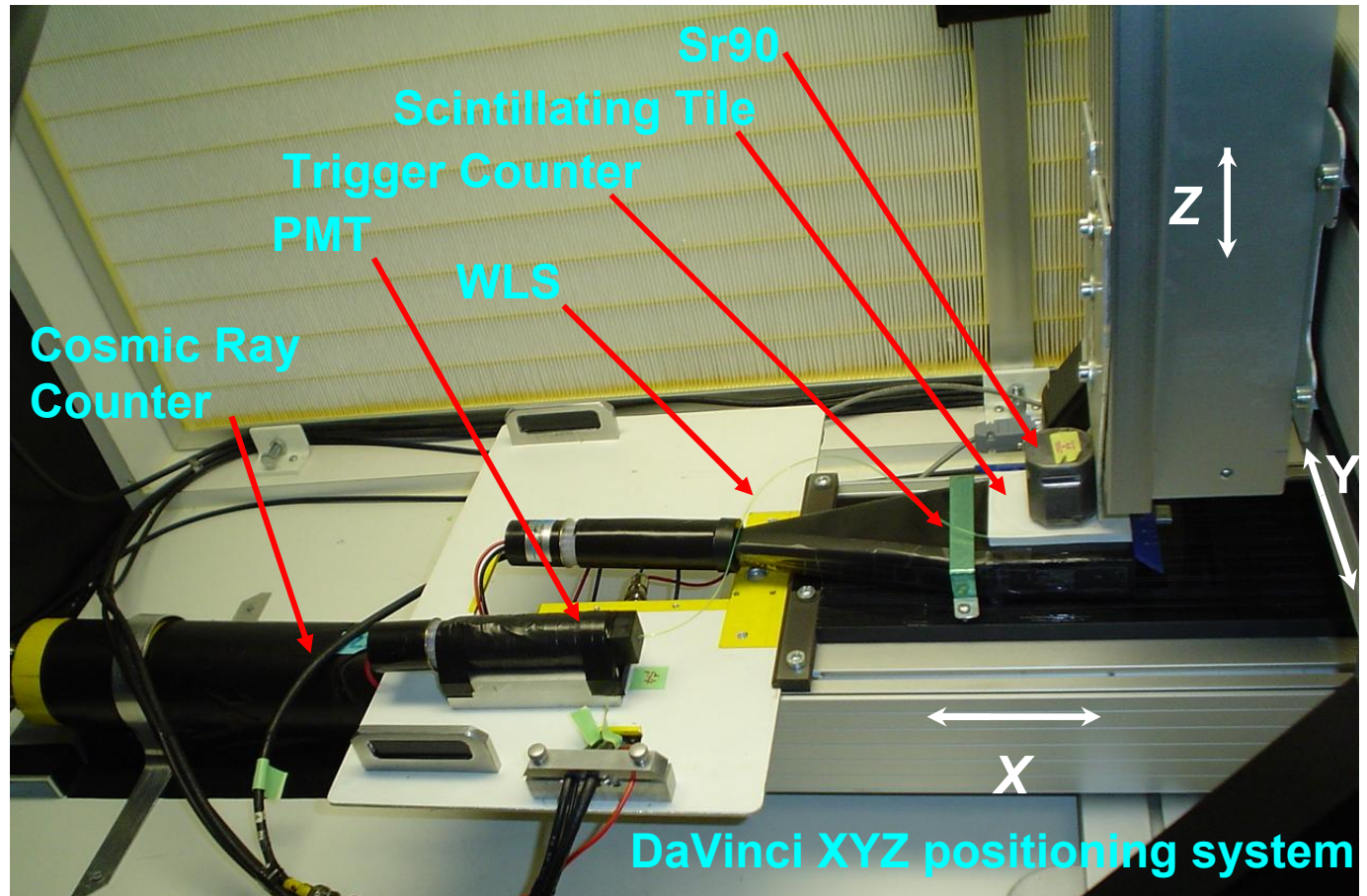


Test Stand

- **Light Yield (Cosmic Ray Measurements)**
- **Light Yield Variation (Uniformity Measurements)**

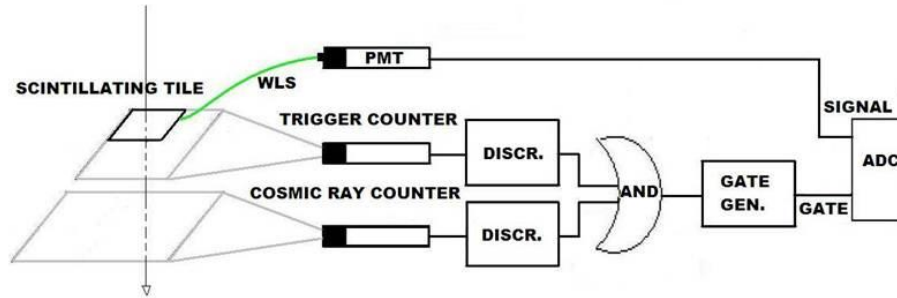


Test Stand



Resolution : 0.01 mm
Accuracy: < 0.1 mm
Repeatability: < 0.01 mm
X travel : 200 mm
Y travel : 250 mm
Z travel : 127 mm

Light Yield



Logic Scheme

Trigger Counter

75mm x 75mm x 25mm

WLS

Y11, MS(200ppm), 0.83mm Ø, 60-cm length

PMT

HAMAMATSU R6094

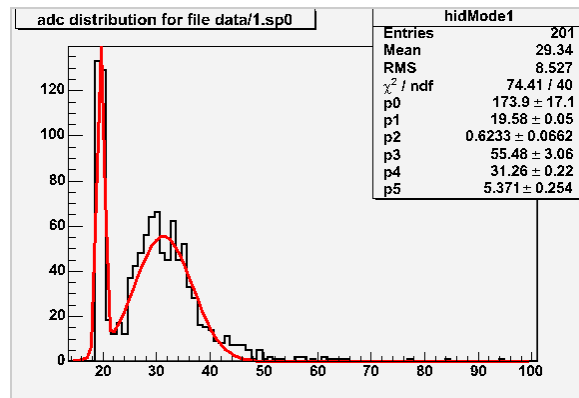
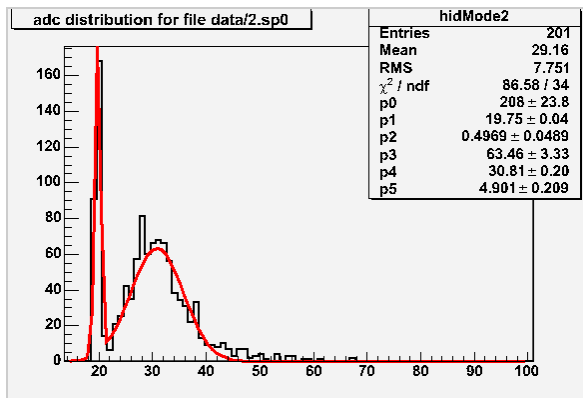
Cosmic Ray Counter

120mm x 120mm x 5mm

Trigger – coincidence of counters

ADC – LeCroy2249A

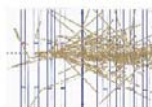
DAQ – PC and CAMAC



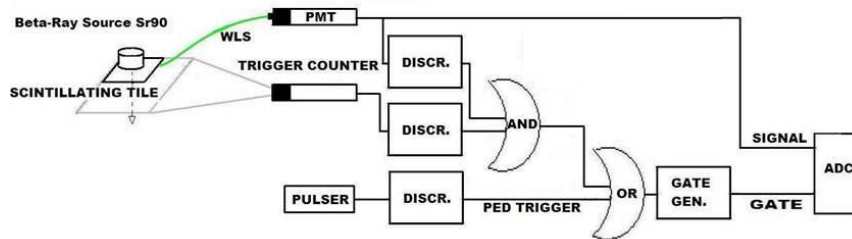
FNAL-NICADD SCINTILLATOR

KURARAY SCSN81 SCINTILLATOR

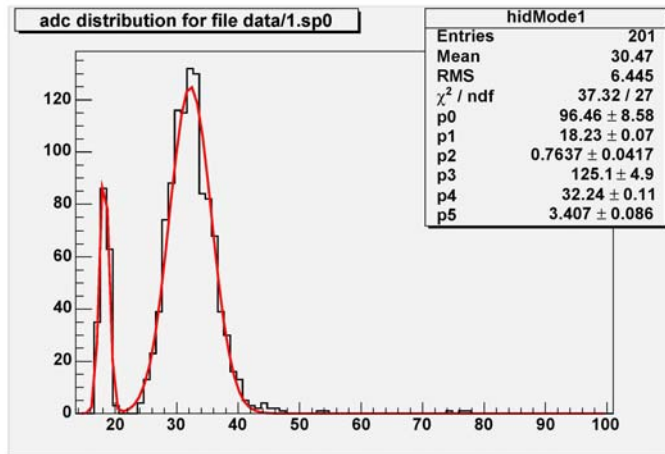
8.0 ph.e./mip



Light Yield Variation (Uniformity Test)



Logic Scheme



DaVinci XYZ
positioning system

Trigger Counter

75mm x 75mm x 25mm

WLS

Y11, MS(200ppm), 0.83mm Ø, 60-cm length

PMT

HAMAMATSU R6094

Radioactive Source

Beta source Sr(90) – 10uCi

Collimator:

Lead,

thickness – 5mm,

hole 2-mm diameter

ADC – LeCroy2249A

DAQ – PC and CAMAC

Light Yield Variation (Uniformity Test)

Radioactive Source

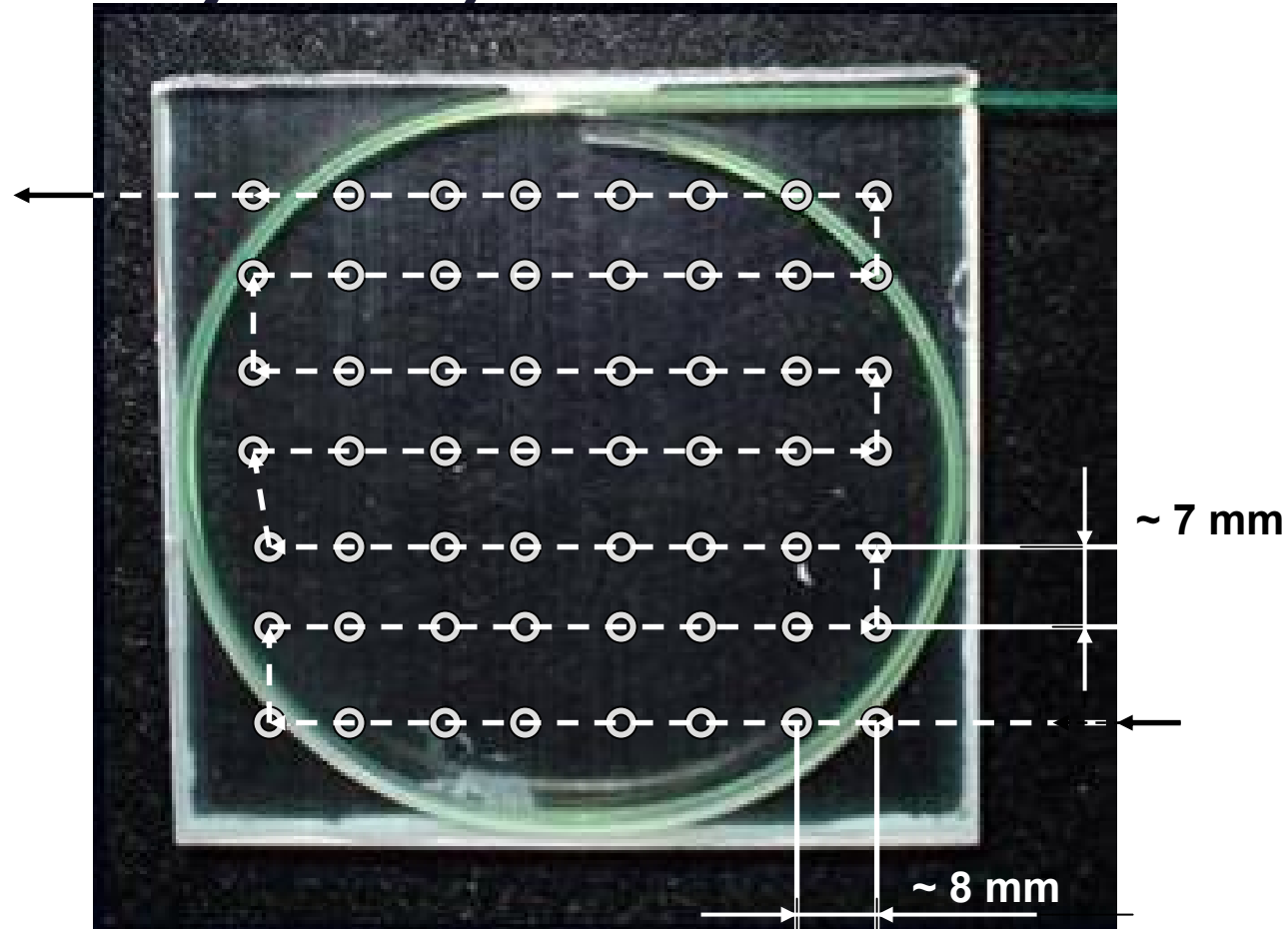
Beta source Sr(90) – 10uCi

Collimator:

Lead,

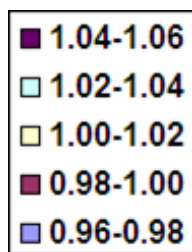
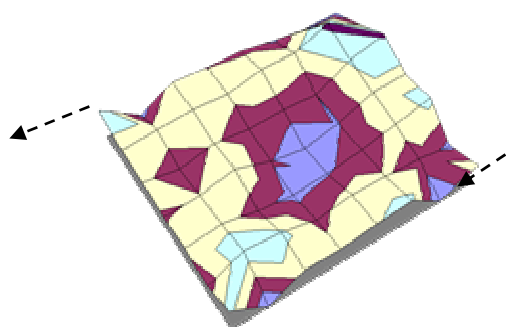
thickness – 5mm,

hole 2- mm diameter

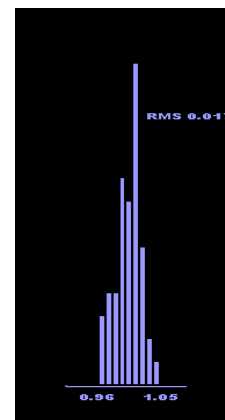


Light Yield Variation (Uniformity Test)

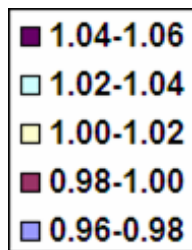
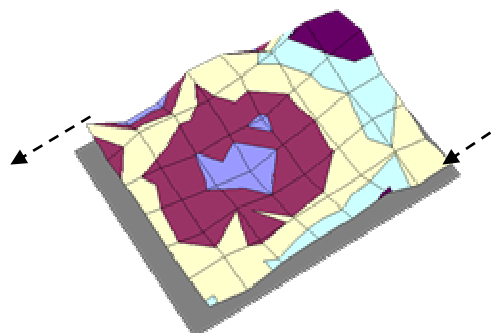
Kuraray SCSN 81 Scintillator



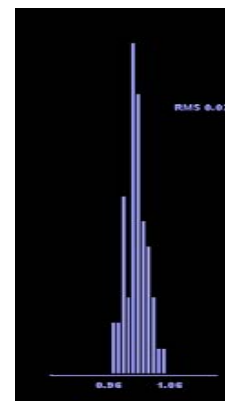
RMS 1.7%
Max.Div. - 4%,+5%



FNAL-NICADD Scintillator



RMS 2.2%
Max.Div. - 4%,+6%





Summary

- For relatively small sizes of scintillating tile with σ -groove, SCSN-81 and FNAL-NICADD extruded scintillating material produces approximately the same results.
- FNAL-NICADD extruded scintillator would be an acceptable choice, as active media of Large EMCal for ALICE
- The final scintillator selection will be based on mechanical tolerances and results of beam studies of calorimeter prototype