Extruded Scintillator Project

Presented by Victor Rykalin

ICAR

ARGONNE MAY 2004
Outline

- Our past accomplishments.
- Current situation.
- Plans.
Our past accomplishments

- The final decision about **extruder purchasing** was made by April 2002.
- **The extruder was delivered** to FNAL by February 24, 2003.
- **The extruder was assembled**, debugged for the first test run by May 6, 2003.
- The very **first samples were made** by June 2003.
- **The first results of the light output and uniformity response of the FNAL-NICADD extruded scintillator** were reported at CALOR 2004 ITALY.
- **The collaboration, supported by NICADD, between NICADD NIU and Engineering Department NIU** was established by September 2002.
- The simulations of the different dies were performed and 2*1 cm² die was cut at FNAL site 2003-2004.
- Very preliminary tests of the new die were carried out and the results are promising.
General management, extruder running, dopants optimization.

Scintillator light output, attenuation length results analysis.

Results evaluations

NIU ED simulation group

Anna Pla-Dalmau
FNAL

EXTRUDER
NICADD
FNAL

Victor Rykalin
LIAISON

DHCAL-NICADD
MINERVA

EC
ALICE

Extruder running, QC, R&D with new photosensors, scintillator light output measurements. Data analysis.

Alan Bross
FNAL scintillator program leadership

Organizational Chart
Lab 5, FNAL - NICADD extrusion line, before and after installation

This is a small factory!

February 2003

June 2003

5/19/2004
ZE 40A UTS Technical Data

**OUTPUT**  50-300 Pounds/hour

- Screw diameter
- Screw speed
- Drive power
- Exp. Output
- Height
- Weight
- Theoretical life

- 44 mm
- 1200 RPM
- 200 HP
- Det. By trials (180 P/h)
- ~1100 mm
- ~3500 kg
- ~40000 hours

One 8 hours shift output, 50kg/h, 2.7 cm/s  (10cm wide, 5 mm thick)

~80 m², ~400 kg
Extruder up and running
Publications related to FNAL-NICADD extruded scintillator project.

- STUDY OF NEW FNAL-NICADD EXTRUDED SCINTILLATOR AS ACTIVE MEDIA OF LARGE EMCAL OF ALICE AT LHC.

- SMALL SCINTILLATING CELLS AS THE ACTIVE ELEMENTS IN A DIGITAL HADRON CALORIMETER FOR THE E+E- LINEAR COLLIDER DETECTOR.

- EXTRUDING PLASTIC SCINTILLATOR AT FERMILAB.


Some characteristics of the extruded scintillator

**FNAL-NICADD,**
L = 27.7 cm (fast component)

**K2K (MINOS technology)**
L = 7.1 cm (fast component)

### Light attenuation length, 2*1 cm²

- **BC404**: 3.25 ± 0.22
- **BC408**: 2.70 ± 0.15
- **F-NICADD**: 2.01 ± 0.30
Brief summary of the FNAL-NICADD extruded scintillator characteristics.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
<th>Material/Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>$\sigma \sim 0.6%$</td>
<td>NICADD (Over 40 m)</td>
</tr>
<tr>
<td>Uniformity LY</td>
<td>$\sigma \sim 2.2%$</td>
<td>NICADD (5*5 cm$^2$)</td>
</tr>
<tr>
<td>Uniformity LY</td>
<td>$\sigma \sim 3%$</td>
<td>NICADD (over 6 m)</td>
</tr>
<tr>
<td>Rad. Hardness (gamma)</td>
<td>5% LY degradation</td>
<td>FNAL</td>
</tr>
</tbody>
</table>

Light Yield

- 66% of BC408 NICADD
- ~100% of Kuraray SCSN-81 WSU

Rad. Hardness

- 5% LY degradation after 1 Mrad
Die simulation - bridge to save time, improve profile of the extrusion!

- Collaboration with ME NIU department
  - POLYFLOW package software
  - Finite-element code
  - Predict three-dimensional free surfaces
  - Inverse extrusion capability
  - Strong non-linearity
  - Evolution procedure
Profile simulation - Blue print - Die cut

- Melt-Pump Adapter
- Spider Adapter
- Spider
- Bush
- Pin
- Melt flow direction
Current status. Some modifications are a must.

Industrial Vision System (IVS) will be a good addition to the size control and to the color change.

- The old hopper
- The new hopper
R&D for the near future projects

Tail catcher for DHCAL prototype test (Extruded scintillator, WLS + MRS readout)

5 mm scintillator thickness, extruded hole, 1.2 mm Y11 fiber, 10 cm out of scintillator, MRS readout \(\sim 15\) PE
PMT readout \(\sim 8\) PE
FUTURE PLANS and current R&D

- CMS ECAL upgrade (~15 T of extruded plastic) ~ 38 shifts
- MINERVA (~10 T of extruded plastic) ~ 25 shifts
- DHCAL (~20 T) ~ 50 shifts

All projects intend to use extruded scintillator!
Topic three. Plans

- Triangle dies simulation, die cut, die test (MINERVA)
- Tail catcher prototype (existing die), test run.
- CMS ECAL prototype (existing die), test run.
- To test extruder at higher speed (75 kg/h)
- Possible IVS implementation.
- TEST stand at lab 5 (for QC, level 0), creating and commissioning (LY, Mech/tolerance, LY uniformity)
- R&D with solid state photo-sensors.
- To create and to support the NICADD-FNAL extruder web site