



Extruded Scintillator Project

Presented by Victor Rykalin

ICAR

ARGONNE MAY 2004



Outline

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

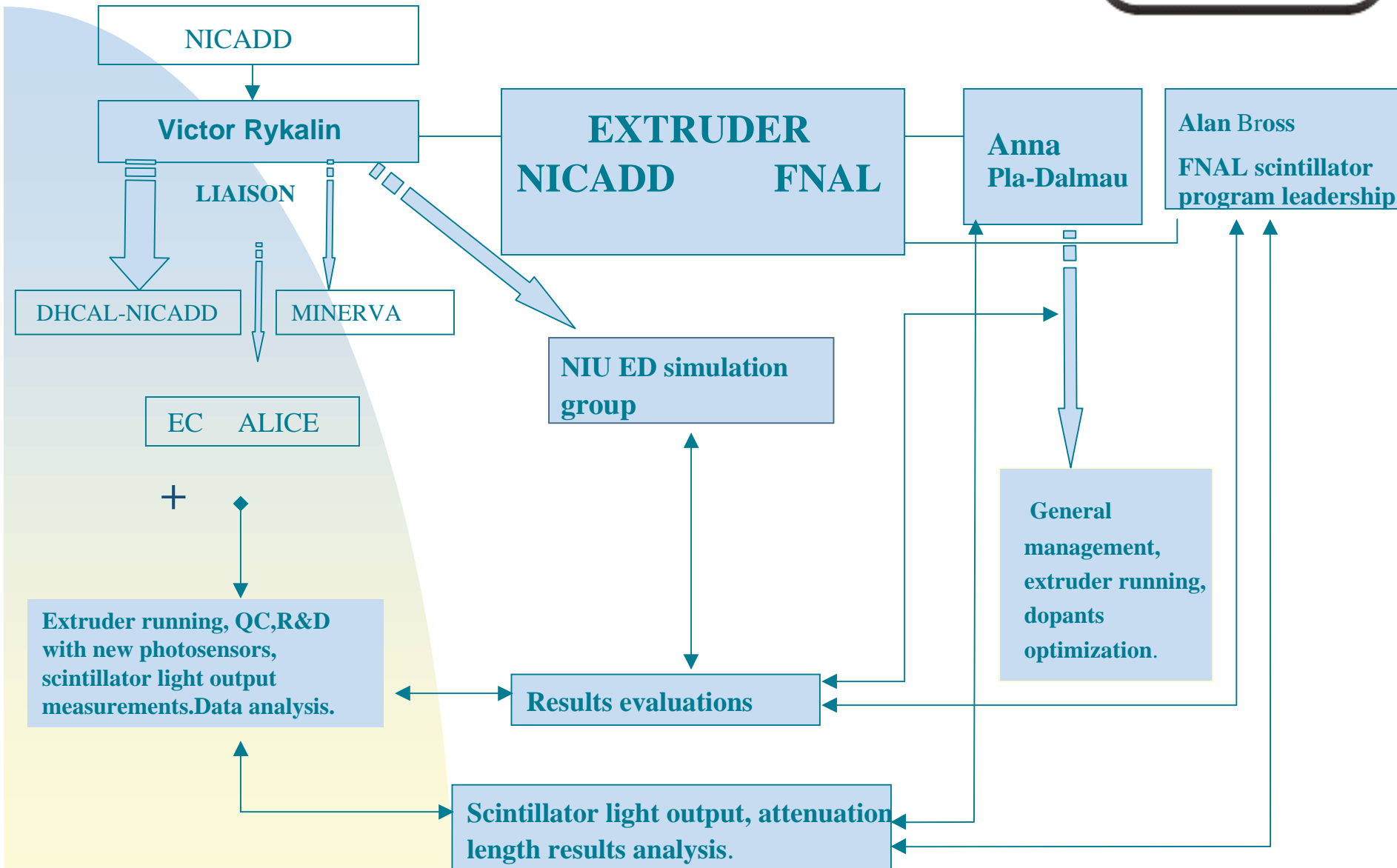


Our past accomplishments

- 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.



Organizational Chart



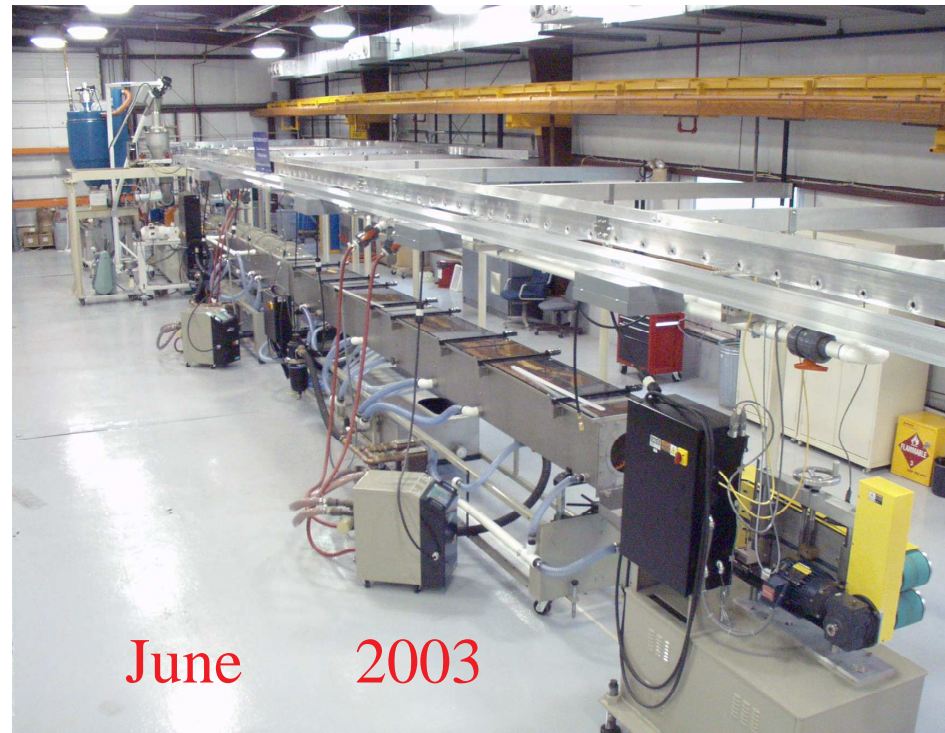


Lab 5, FNAL -NICADD extrusion line, before and after installation



February 2003

This is a small factory !



June 2003



ZE 40A UTS Technical Data OUTPUT 50-300 Pounds/hour

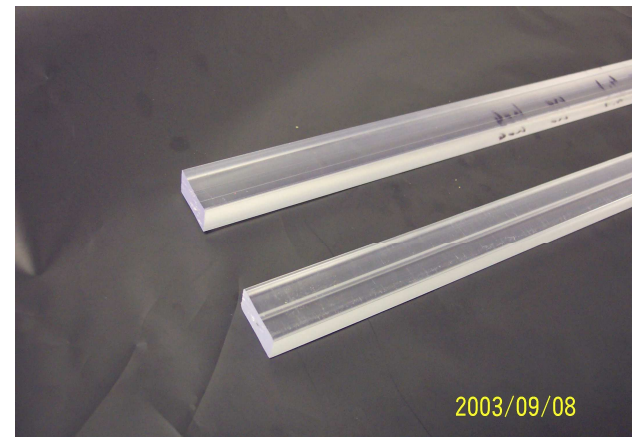
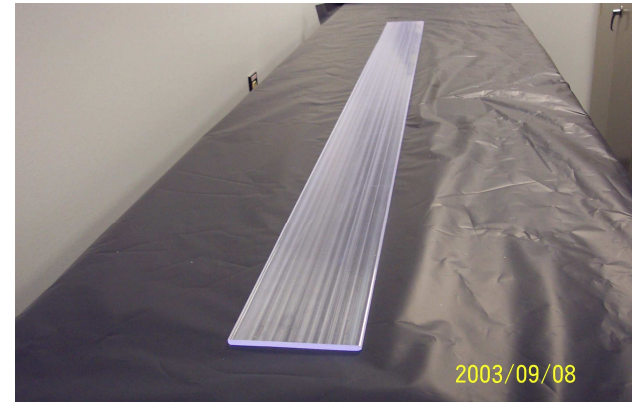
- Screw diameter
- Screw speed
- Drive power
- Exp. Output
- Height
- Weight
- Theoretical life
- 44 mm
- 1200 RPM
- 200 HP
- Det. By trials (180 P/h)
- ~1100 mm
- ~3500 kg
- ~40000 hours

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

~80 m², ~400 kg



Extruder up and running



5/19/2004

Publications related to FNAL-NICADD extruded scintillator project.

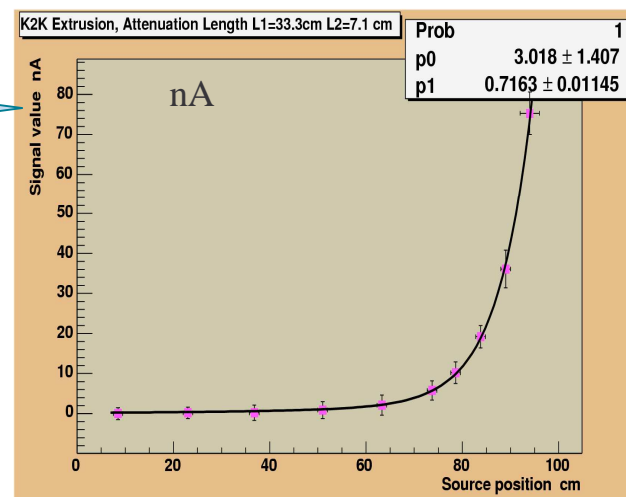
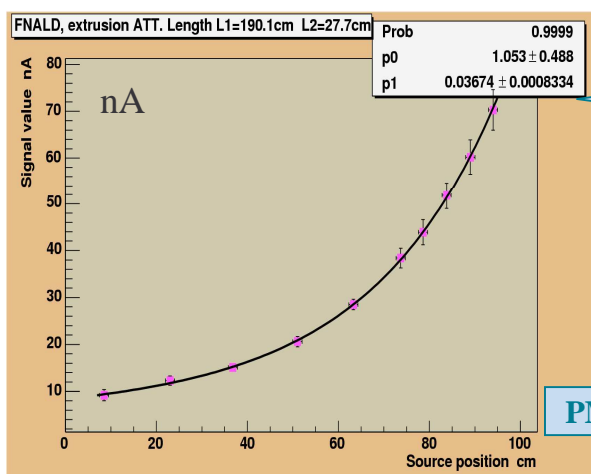
- **STUDY OF NEW FNAL-NICADD EXTRUDED SCINTILLATOR AS ACTIVE MEDIA OF LARGE EMCAL OF ALICE AT LHC.**
By [O.A. Grachov](#), [T.M. Cormier](#), [A. Pla-Dalmau](#), [A. Bross](#), [V. Rykalin](#) ([Wayne State U.](#) & [Fermilab](#) & [Northern Illinois U.](#)),. FERMILAB-CONF-04-046 (Calor 2004 Italy), May 2004. 7pp.
- **SMALL SCINTILLATING CELLS AS THE ACTIVE ELEMENTS IN A DIGITAL HADRON CALORIMETER FOR THE E+E- LINEAR COLLIDER DETECTOR.**
By [A. Dyshkant](#), [D. Beznosko](#), [G. Blazey](#), [D. Charkraborty](#), [K. Frances](#), [D. Kubik](#), [M.I. Martin](#), [J. McCormick](#), [V. Rykalin](#), [V. Zutshi](#) ([Northern Illinois U.](#)), [A. Pla-Dalmau](#) ([Fermilab](#)),. FERMILAB-PUB-04-015, Feb 2004. 11pp.
Submitted to J.Phys.G
- **EXTRUDING PLASTIC SCINTILLATOR AT FERMILAB.**
By [Anna Pla-Dalmau](#), [Alan D. Bross](#) ([Fermilab](#)), [Victor V. Rykalin](#) ([Northern Illinois U.](#)),. FERMILAB-CONF-03-318-E (IEEE conference), Oct 2003. 3pp.
- **“Towards a Scintillator Based Digital Hadron Calorimeter for the Linear Collider Detector”, IEEE volume 51, N4** By [A. Dyshkant](#), [D. Beznosko](#), [G. Blazey](#), [D. Charkraborty](#), [K. Frances](#), [D. Kubik](#), [M.I. Martin](#), [J. McCormick](#), [V. Rykalin](#), [V. Zutshi](#)
- **“Extrusion Simulation and Experimental Validation to Optimize Precision Die Design,” ANTEC 2004, The Annual Technical Conference, Society of Plastics Engineers, Chicago, May 16-20, 2004** [Vaddiraju, S.R.](#), [M. Kostic](#), [L. Reifschneider](#), [A. Pla-Dalmau](#), [V. Rykalin](#), and [A. Bross](#)

Some characteristics of the extruded scintillator

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

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

Light attenuation
 length, $2 * 1 \text{ cm}^2$



Light yield (ADC
 counts, normalized)

Source position, cm

Source position, cm

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.

Thickness	$\sigma \sim 0.6 \%$	NICADD (Over 40 m)
Uniformity LY	$\sigma \sim 2.2 \%$	NICADD (5*5 cm²)
Uniformity LY	$\sigma \sim 3 \%$	NICADD (over 6 m)
Uniformity LY	$\sigma \sim 2.5 \%$ $\sim 2.3 \%$	WSU (10*10 cm²) (SCSN-81)
Light Yield	66 % of	BC408 NICADD
	$\sim 100\%$ of	Kuraray SCSN-81 WSU
Rad. Hardness (gamma)	5 % LY degradation after 1 Mrad	FNAL



Die simulation - bridge to save time, improve profile of the extrusion!

- **Collaboration with ME NIU department**

POLYFLOW package software

Finite-element code

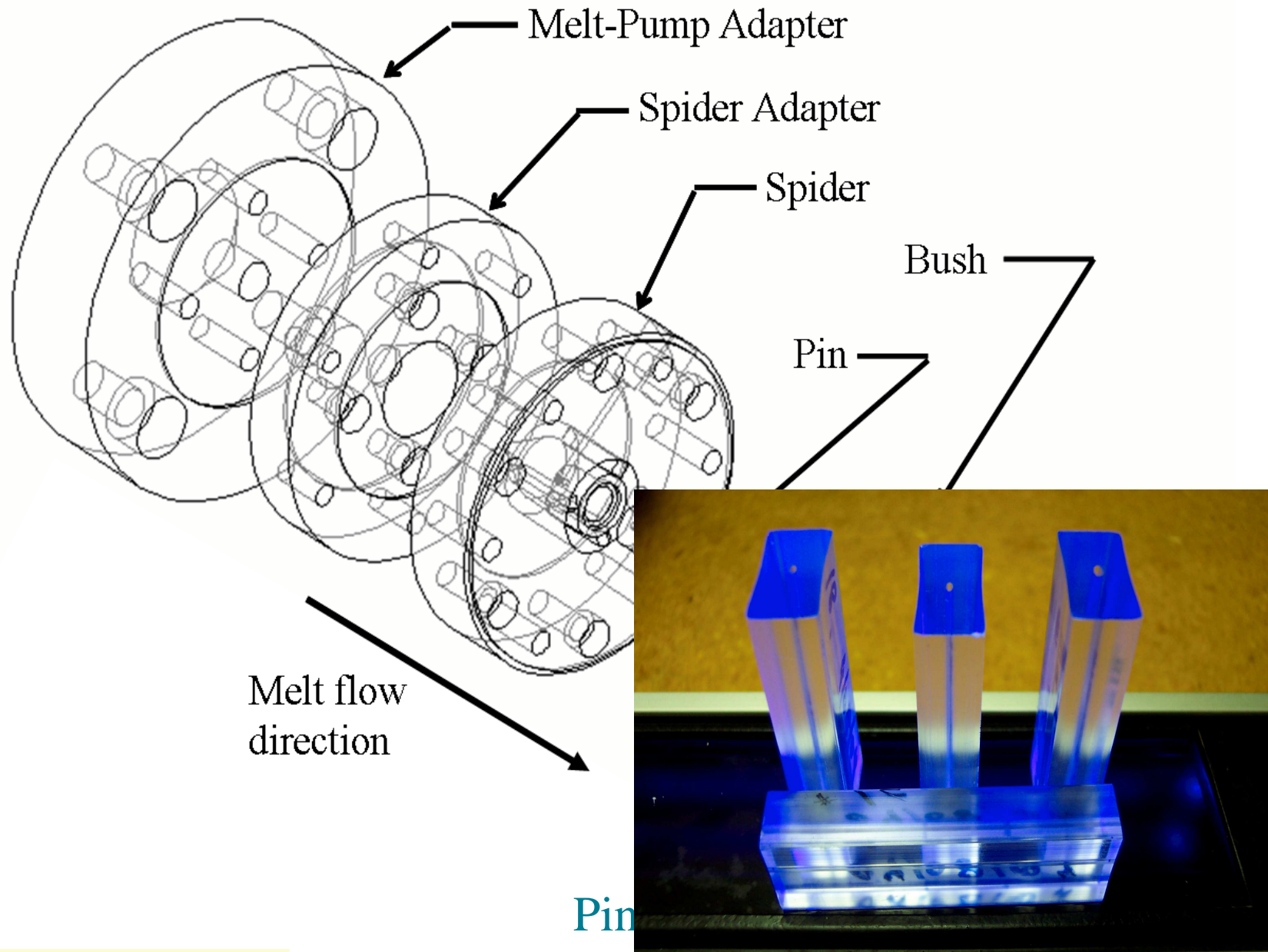
Predict three-dimensional free surfaces

Inverse extrusion capability

Strong non-linearity

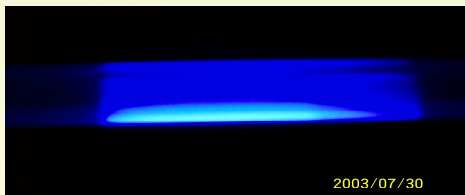
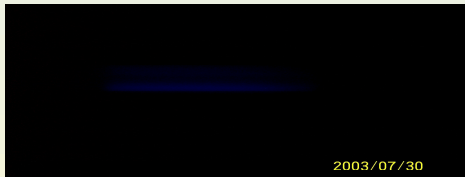
Evolution procedure

Profile simulation - Blue print - Die cut



Current status. Some modifications are a must.

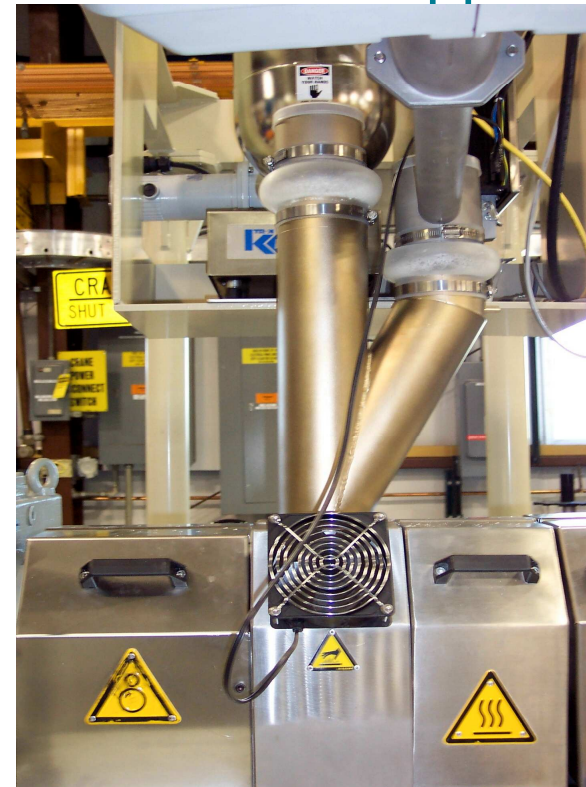
Industrial Vision System (IVS) will be a good addition to the size control and to the color change



■ The old hopper



■ The new hopper

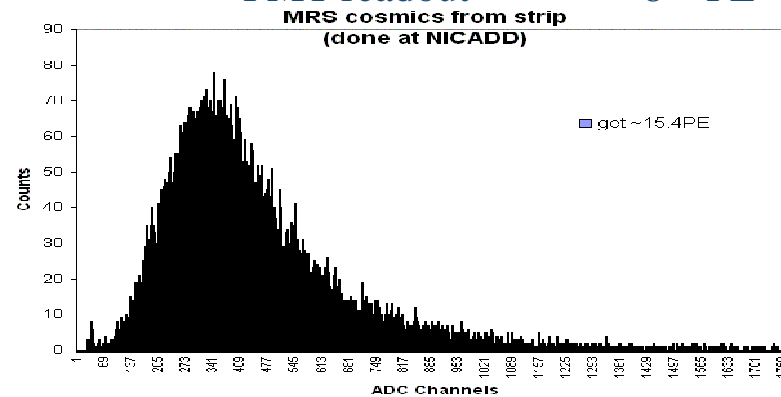


R&D for the near future projects

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

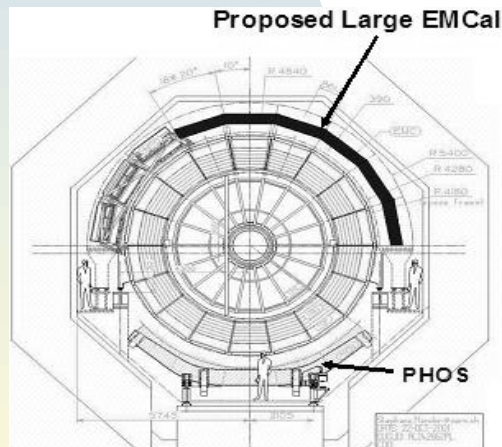
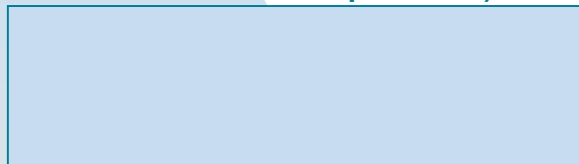
5 mm scintillator thickness, extruded hole, 1.2 mm Y11 fiber, 10 cm out of scintillator, MRS readout ~ **15 PE**

PMT readout ~ 8 PE



FUTURE PLANS and current R&D

- **CMS ECAL upgrade** (~15 T of extruded plastic)



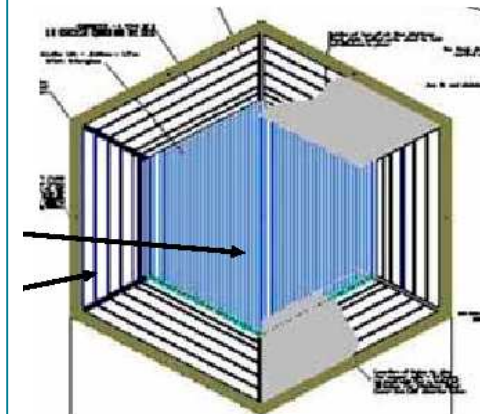
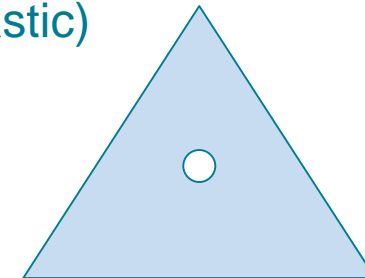
~ 38 shifts

DHCAL (~20 T)

Cell Area	~900 mm ²
Number of Layers	30
Inn Radius of first Absorber Layer (W)	1,530 mm
Inner Radius of first Active Layer	1,555.6 mm
Average Number of Cells/Layer	~70,000
Total # of Cells	~21,000,000

~ 50 shifts

MINERVA (~10 T of extruded plastic)



~ 25 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.**
- **IEEE conference report** on extruded scintillator October 2004, Rome.
- **To create and to support the NICADD-FNAL extruder web site**