Extruded Scintillator Project

Presented by Victor Rykalin

ICAR

ARGONNE MAY 2004

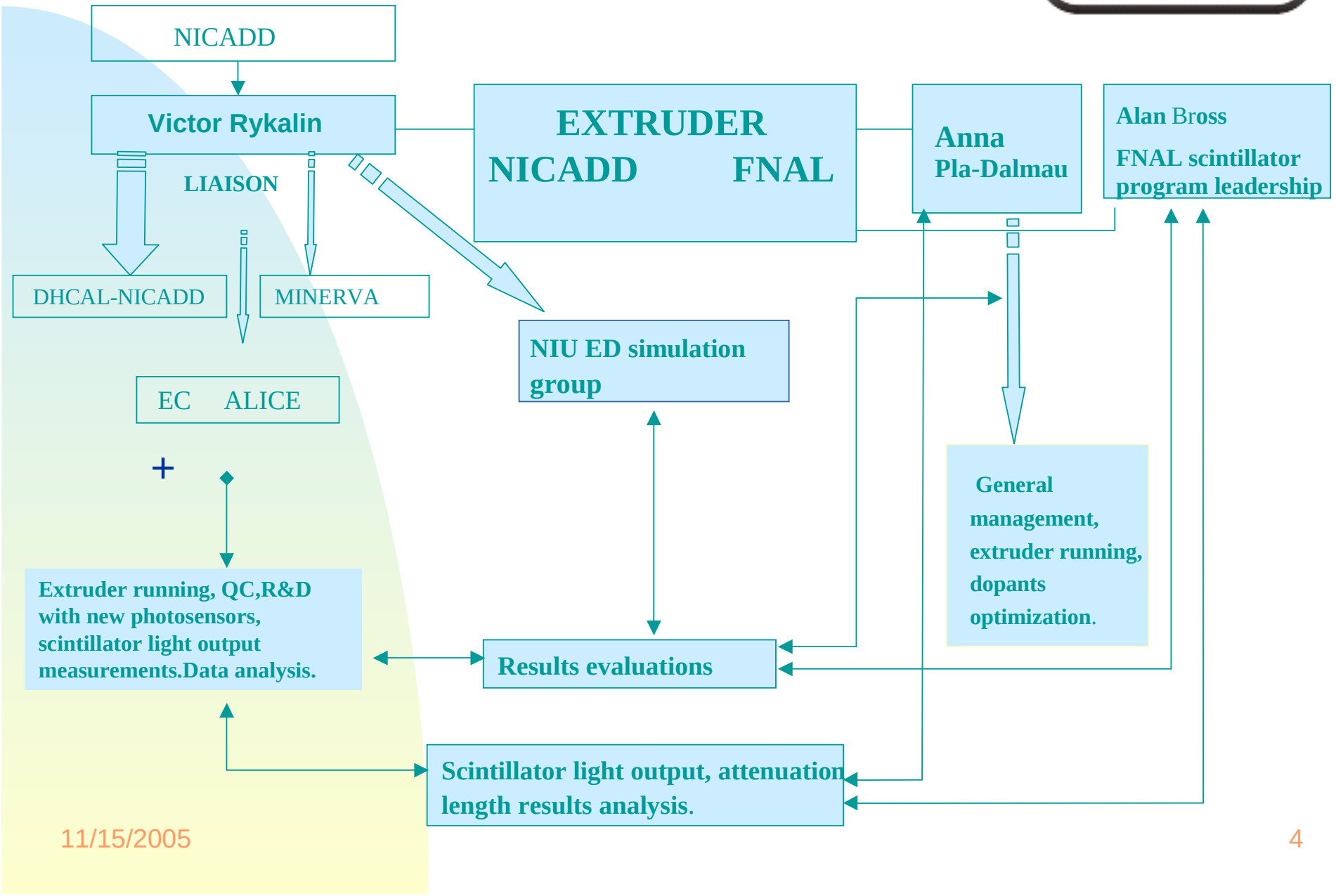
Outline

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

Our past accomplishments

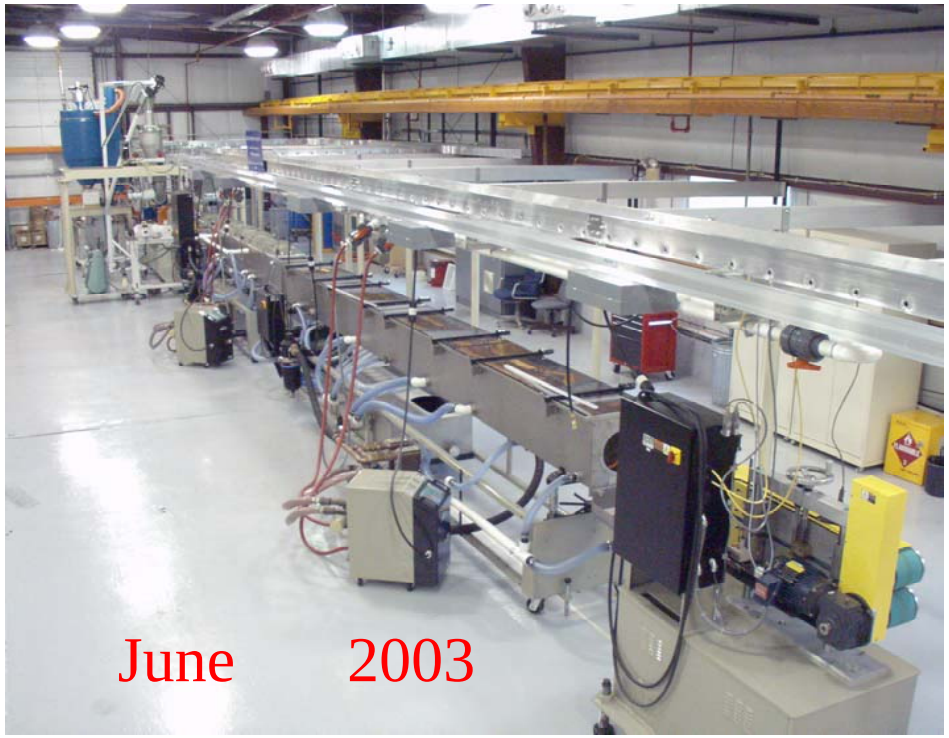
- The final decision about **extruder purchasing** was made by April 2002.
- **The extruder was delivered** to FNAL by February 24 2003.
- **The extruder was assembled**, debugged for the first test run by May 6 2003.
- The very **first samples were made** by June 2003.
- **The first results of the light 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 cm^2 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

This is a small factory !



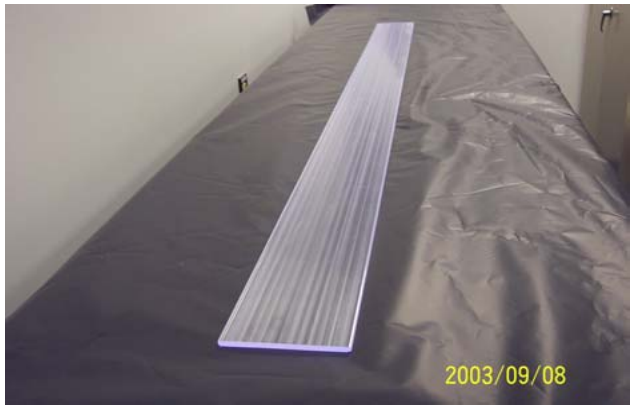
ZE 40A UTS Technical Data
OUTPUT 50-300 Pounds/hour

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

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

~80 m^2, ~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.**
  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

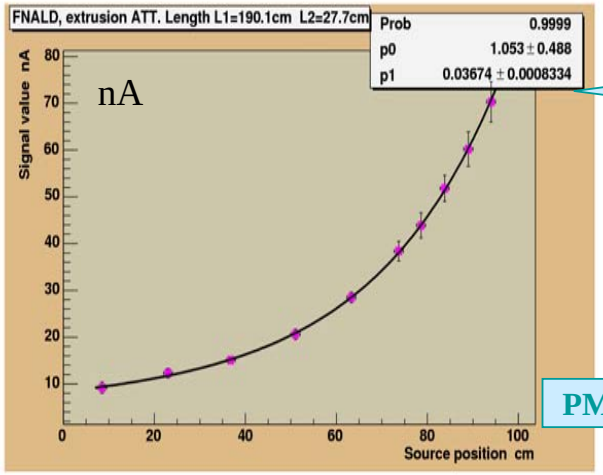
- **EXTRUDING PLASTIC SCINTILLATOR AT FERMILAB.**
  By Anna Pla-Dalmau, Alan D. Bross (Fermilab), Victor V. Rykalin (Northern Illinois U.),. FERMILAB-CONF-03-318-E (IEEE conference), Oct 2003. 3pp.

- **"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)



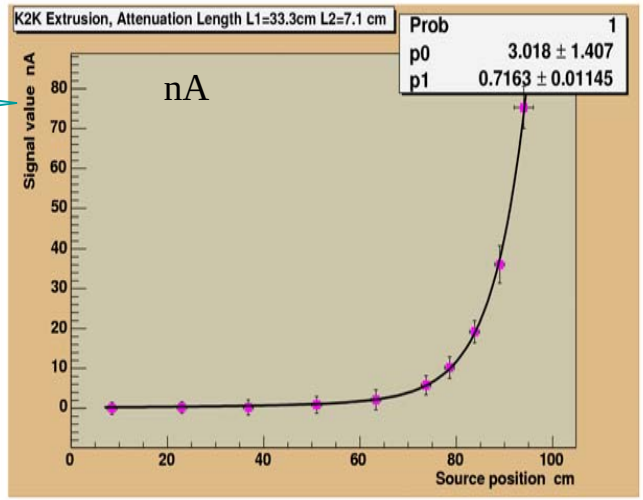
Source position, cm

Light attenuation length, 2*1 cm2

Light yield (ADC counts, normalized)

PMT

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



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 ($5*5$ cm^2)**
Uniformity LY	**$\sigma \sim 3$ %**	**NICADD (over 6 m)**
Uniformity LY	**$\sigma \sim 2.5$ %**	**WSU ($10*10$ cm^2)**
	~ 2.3 %	(SCSN-81)
Light Yield	**66 % of**	**BC408 NICADD**
	~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**

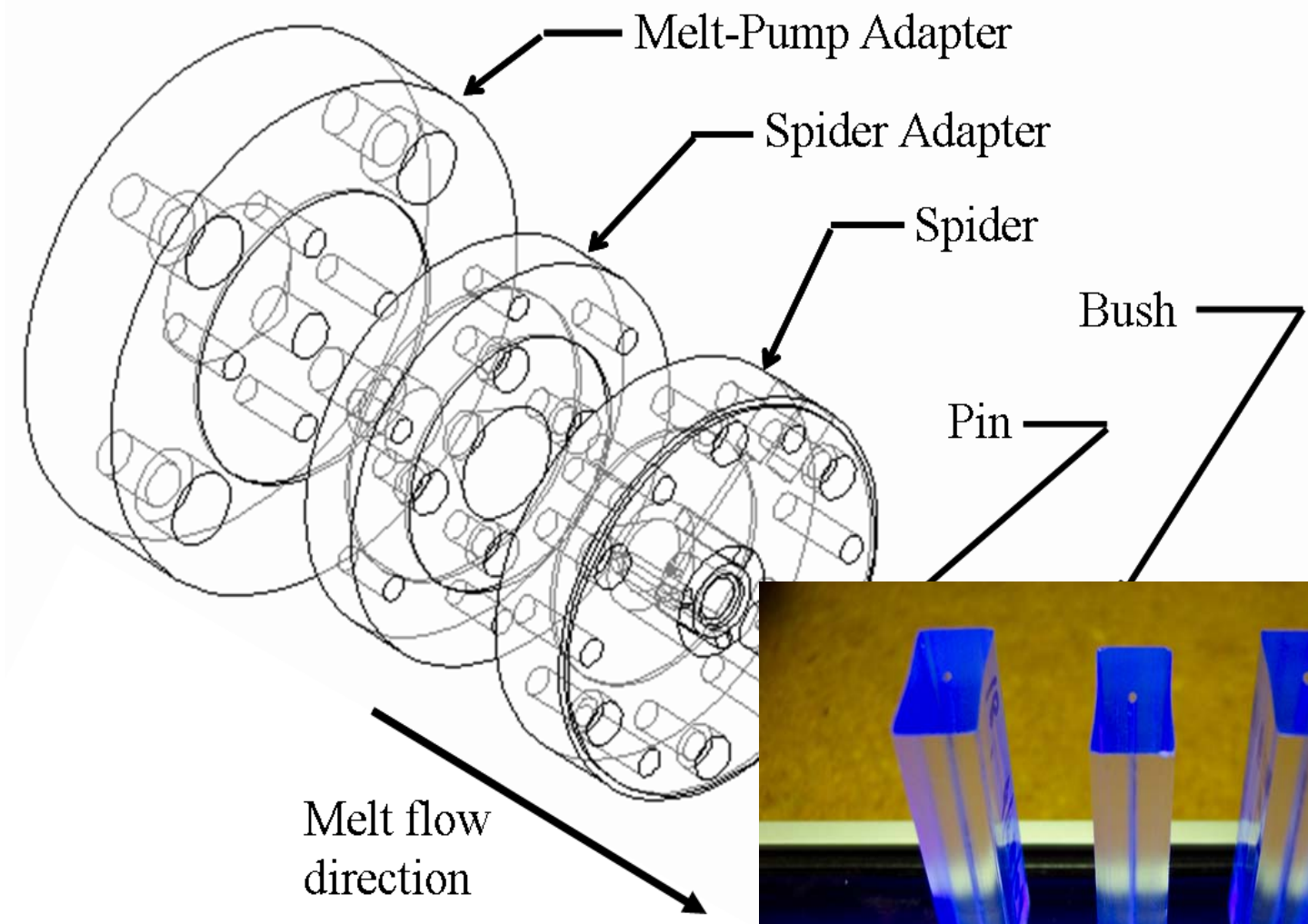
Predict three-dimensional free surfaces

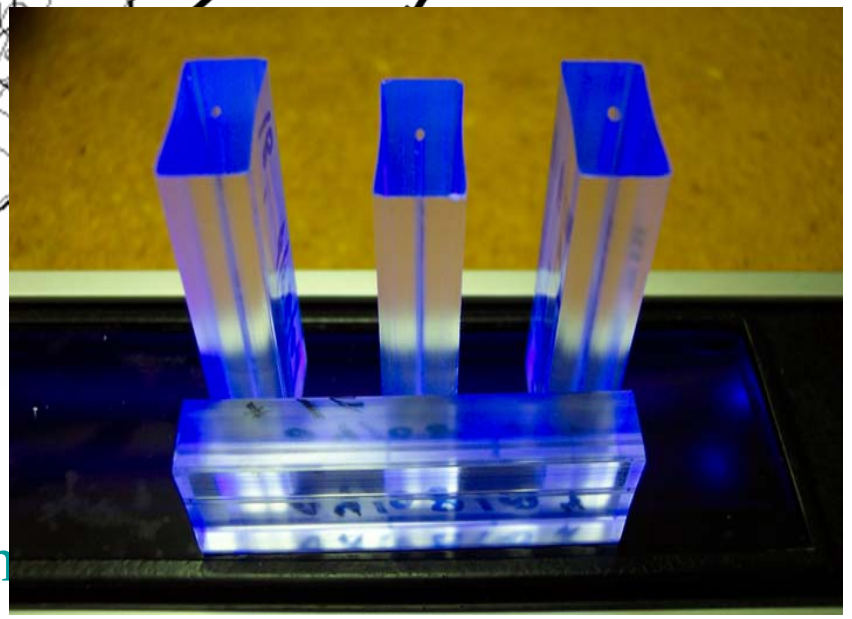
Inverse extrusion capability

Strong non-linearity

Evolution procedure

Profile simulation - Blue print - Die cut





Pin

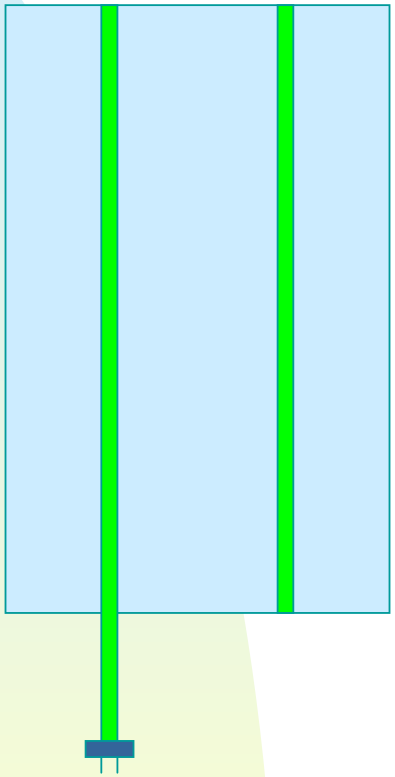
Current status. Some modifications are a must.

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

- The old hopper

- The new hopper

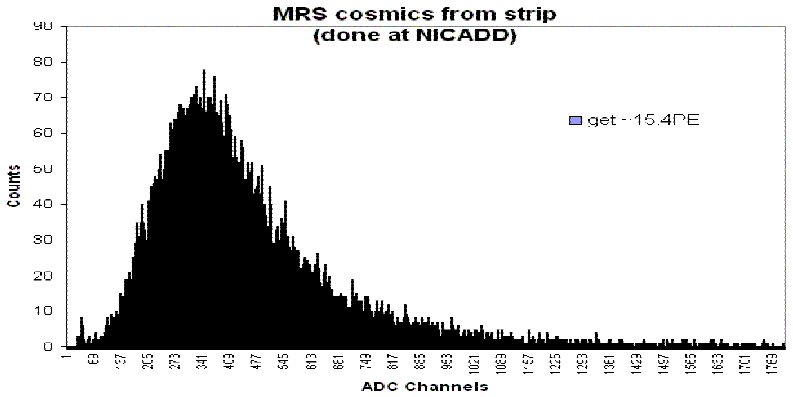
R&D for the near future projects



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

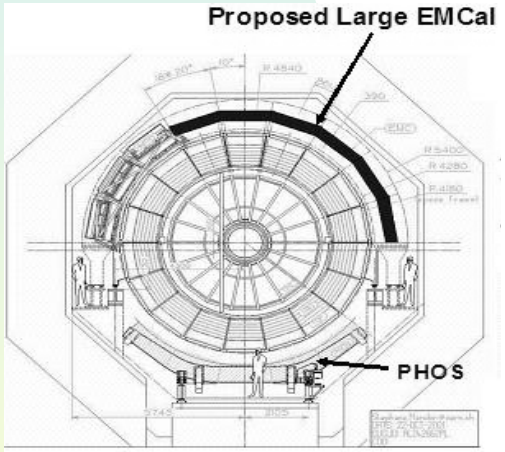
5 mm scintillator thickness, extruded hole,1.2 mm Y11 fiber, 10 cm out of scintillator, MRS readout ~ **15 PE**

PMT readout ~ 8 PE



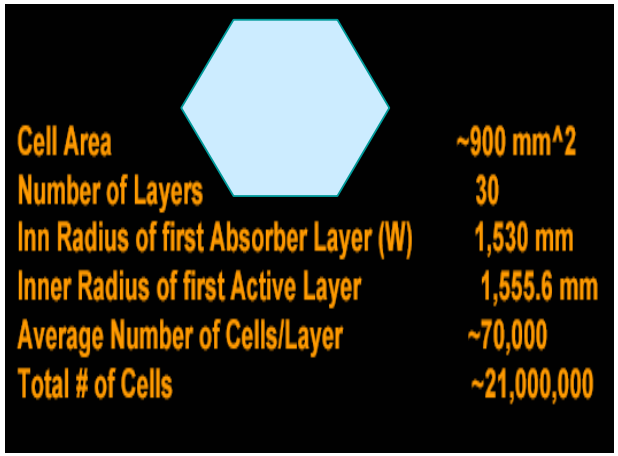
FUTURE PLANS and current R&D

- ALICE ECAL upgrade (~15 T of extruded plastic)



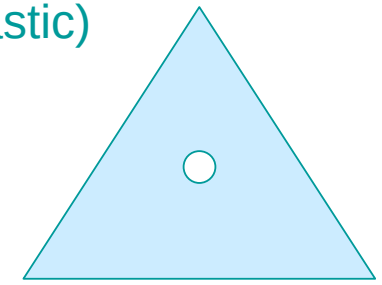
~ 38 shifts

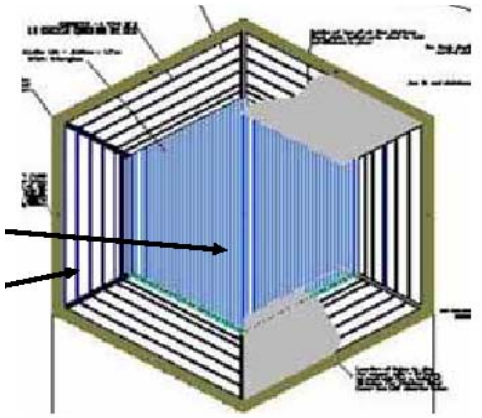
- DHCAL (~20 T)



~ 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**