

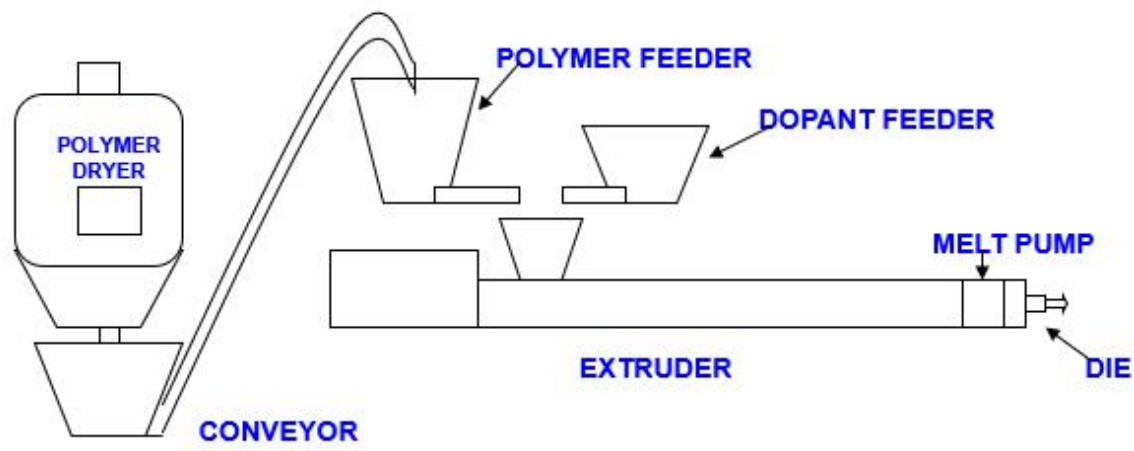
Organic Scintillator Activity at Fermilab

J. Freeman, A. Bross, B. Leung, A. Pla-Dalmau

Fermilab is one of the largest manufacturers of organic scintillator in the world, with capacity > 100tons per year. Manufacture extrusions and injection molded scintillators.

Scintillator Extrusion

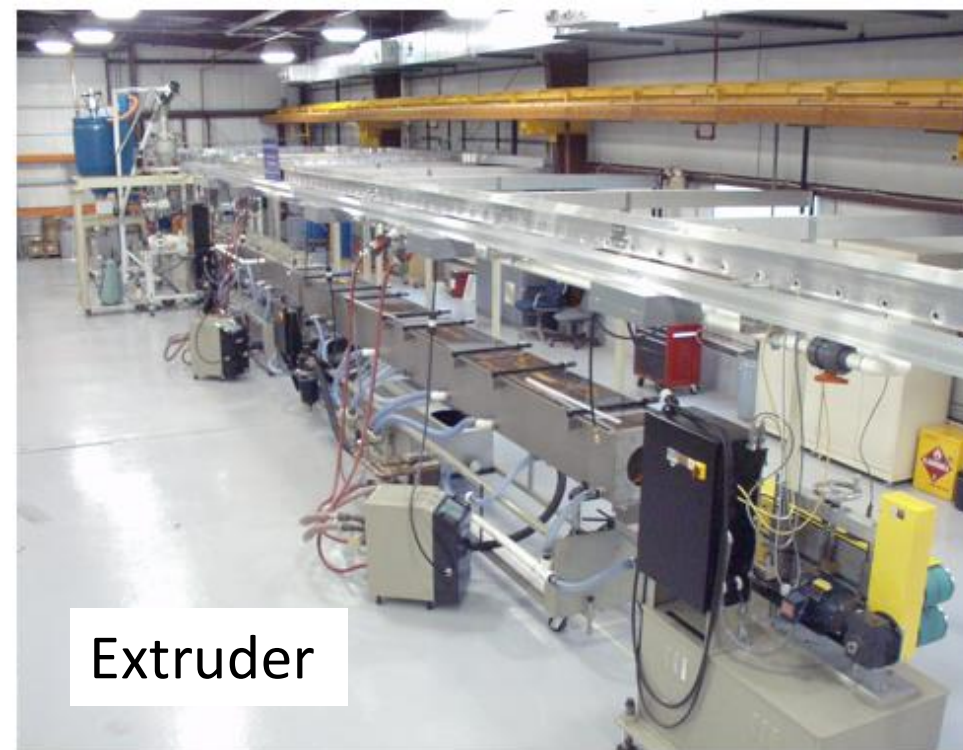
Fermilab Scintillator Extruder System



Head of system showing dryer, extruder, and cladding co-extruder

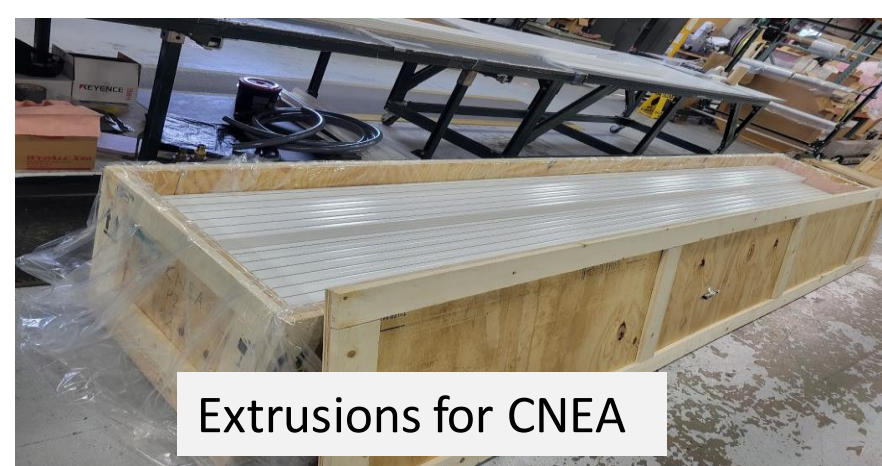


End of system moving chop-saw



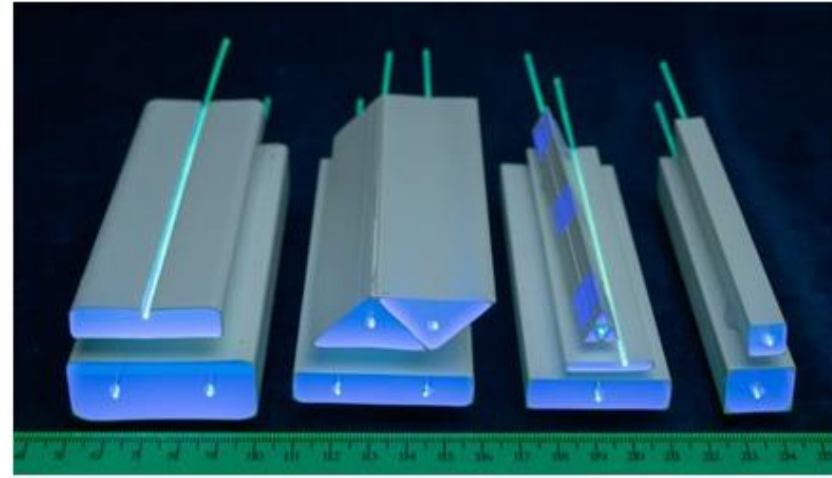
Extruder

System ~50m long.
Can make ~75kg scintillator per hour.
Cost for scintillator extrusion roughly \$20/kg.



Extrusions for CNEA

Extrusion Profiles for various experiments



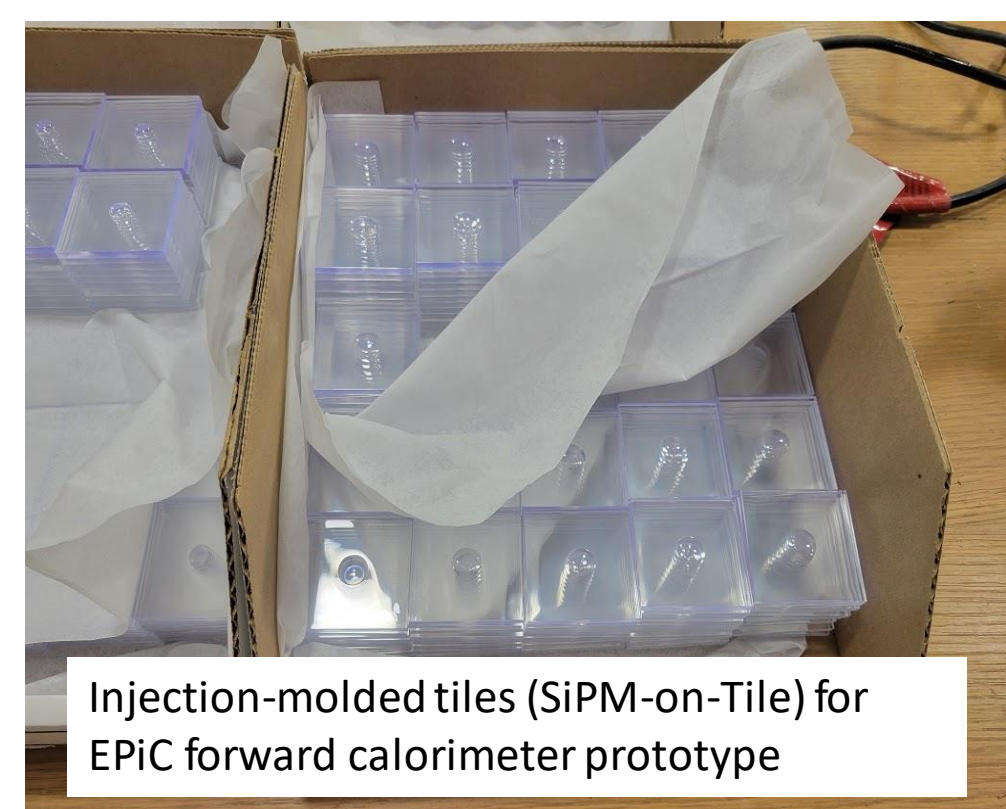
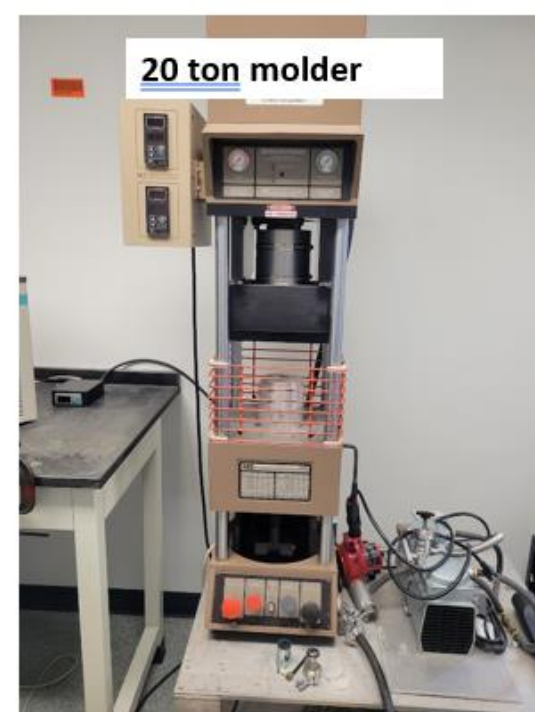
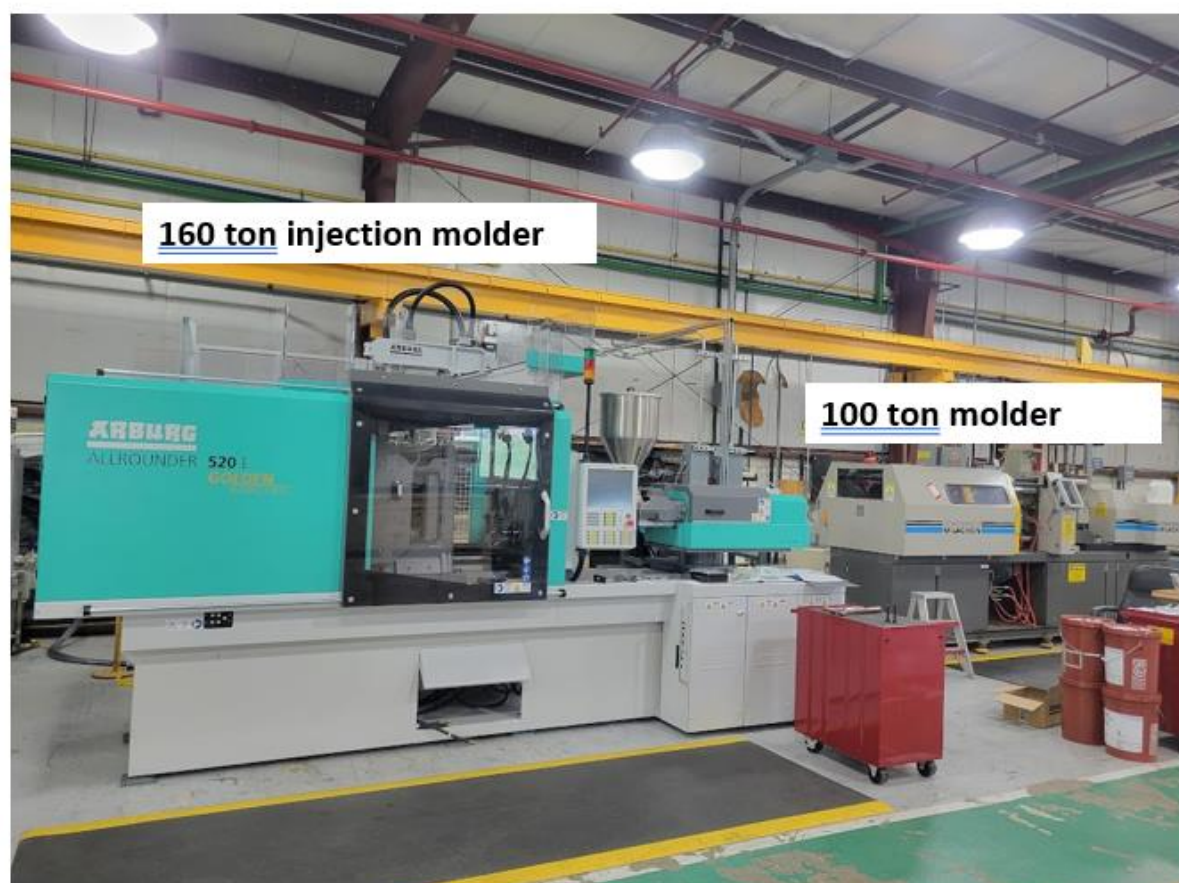
Hole(s) for fibers and white cladding coextruded. Each new shape usually needs new die.



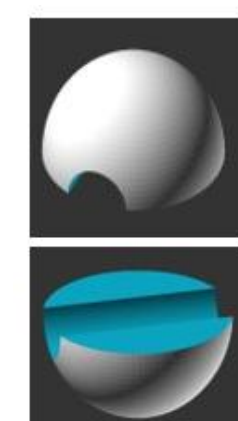
Dies for extruding different profiles

Injection-Molding

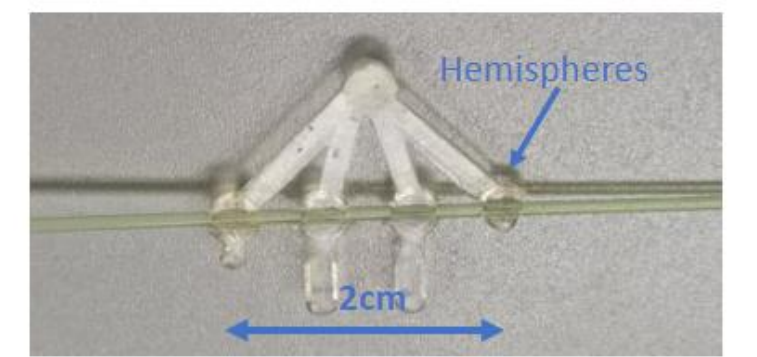
Scintillator Injection Molding Machines at FNAL



Injection-molded tiles (SiPM-on-Tile) for EPIC forward calorimeter prototype



Small scintillator hemispheres for agricultural study of Potassium-32 uptake in root system of plants. Top and bottom hemispheres glued to orthogonal fibers. 25mg weight.



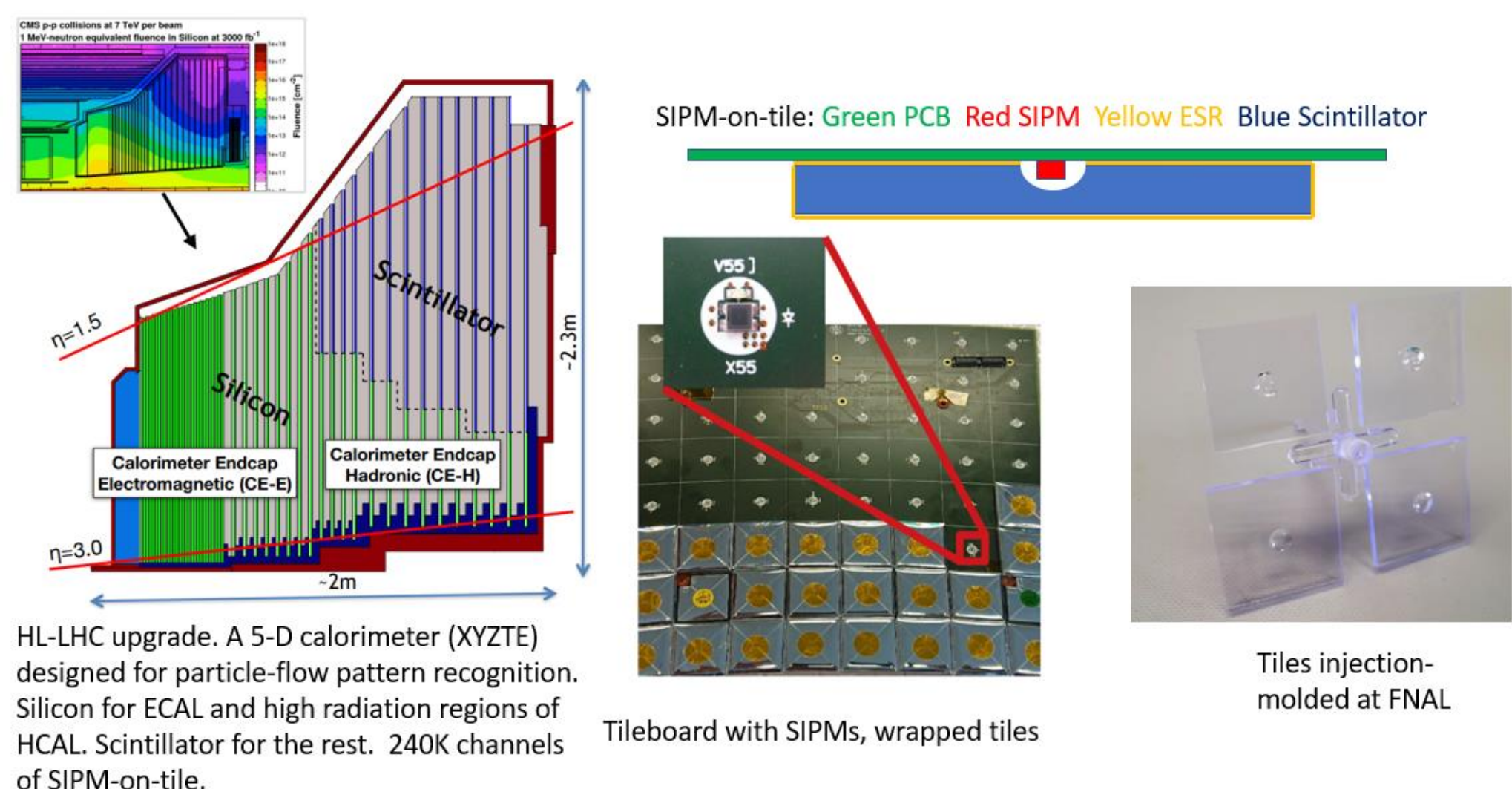
Hemispheres

2cm

Fermilab Scintillator Extrusion and Injection Molding past/planned projects

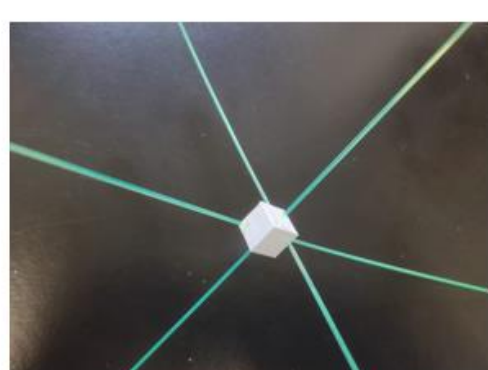
- FNAL experiments:
 - MINOS (supervision & QC)
 - MINERvA
 - Mu2e CRV
 - TMS – DUNE
 - Mu2e II
- Large projects:
 - K2K (Supervision & QC)
 - T2K: POD, ECal, INGRID
 - DoubleCHOOZ
 - Pierre Auger: CNEA, KIT
 - ICECUBE
 - IDEON – Canada
 - LDMX
 - MATHUSLA
- DOE complex:
 - ANL: STAR
 - JLAB: CLAS, CDet
 - LANL
- Smaller Projects
 - MURAVES – INFN Napoli
 - CANFRANC – Spain
 - SNOLAB -- Canada
 - INFN: Bologna, Brescia, Gran Sasso, Padova
 - Inst. Phys. Globe, France -- Volcano tomography Guadeloupe Soufrière
 - NYU – Abu Dhabi
 - Tel Aviv University – Erez City of David tomography
 - UIS – Colombia
 - Univ. Liverpool
 - LDMX Veto Prototype – Lund University
 - INO – mini ICAL Cosmic Veto
 - CMS
 - Naval Research Facility – National security
 - MATHUSLA – U. Toronto
 - LHCb
 - INFN Catania
- Injection Molding (New capability)
 - CMS HGCal
 - ePIC LFHCal – ORNL, BNL

CMS – SIPM-on-tile for HL-LHC endcap calorimeter upgrade 130K tiles

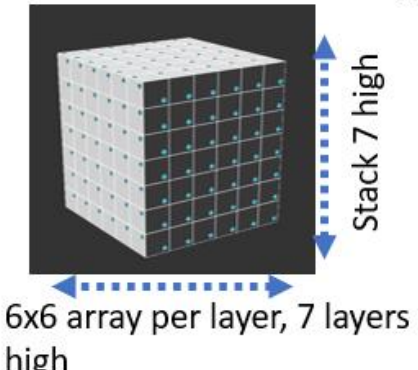


Ongoing Research

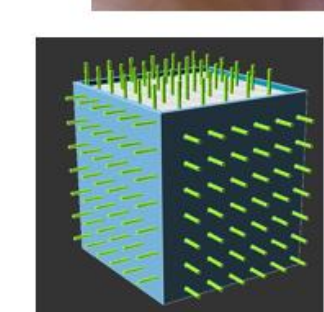
VOXELS – Volume pixels for scintillator trackers created by injection-molding. 3 orthogonal holes molded simultaneously.



Voxel Detector Prototype



6x6 array per layer, 7 layers high



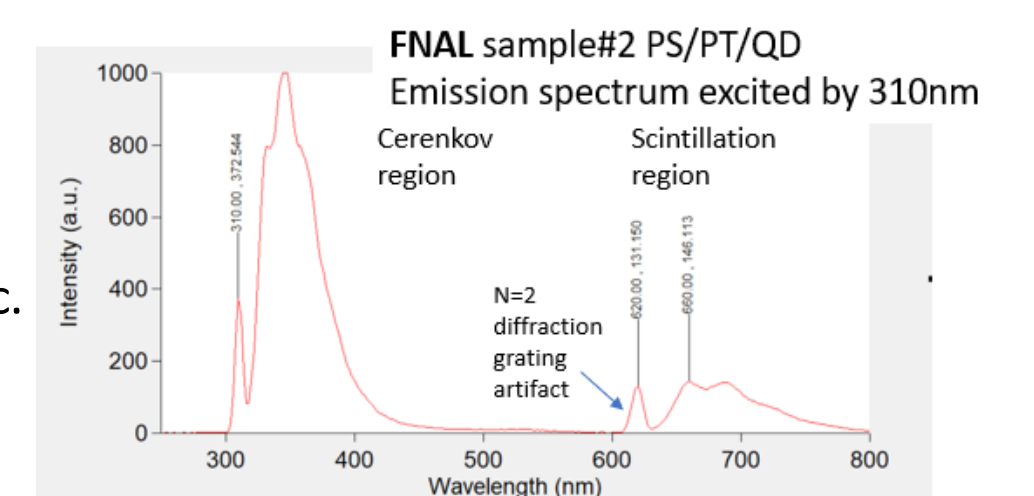
Voxels in frame



Voxel prototype with 1 layer of uncoated voxels and fibers

Quantum dot scintillator

Collaboration with Capesym, Inc. Study control of Stokes shift in scintillators



Neutron/gamma separation in injection-molded scintillator

Look at cost savings. Reduce primary dopant as much as possible as it is a cost driver. Current minimum price is ~ \$300/kg.



n/gamma separation Injection-molded scintillator with very high primary dopant concentrations

