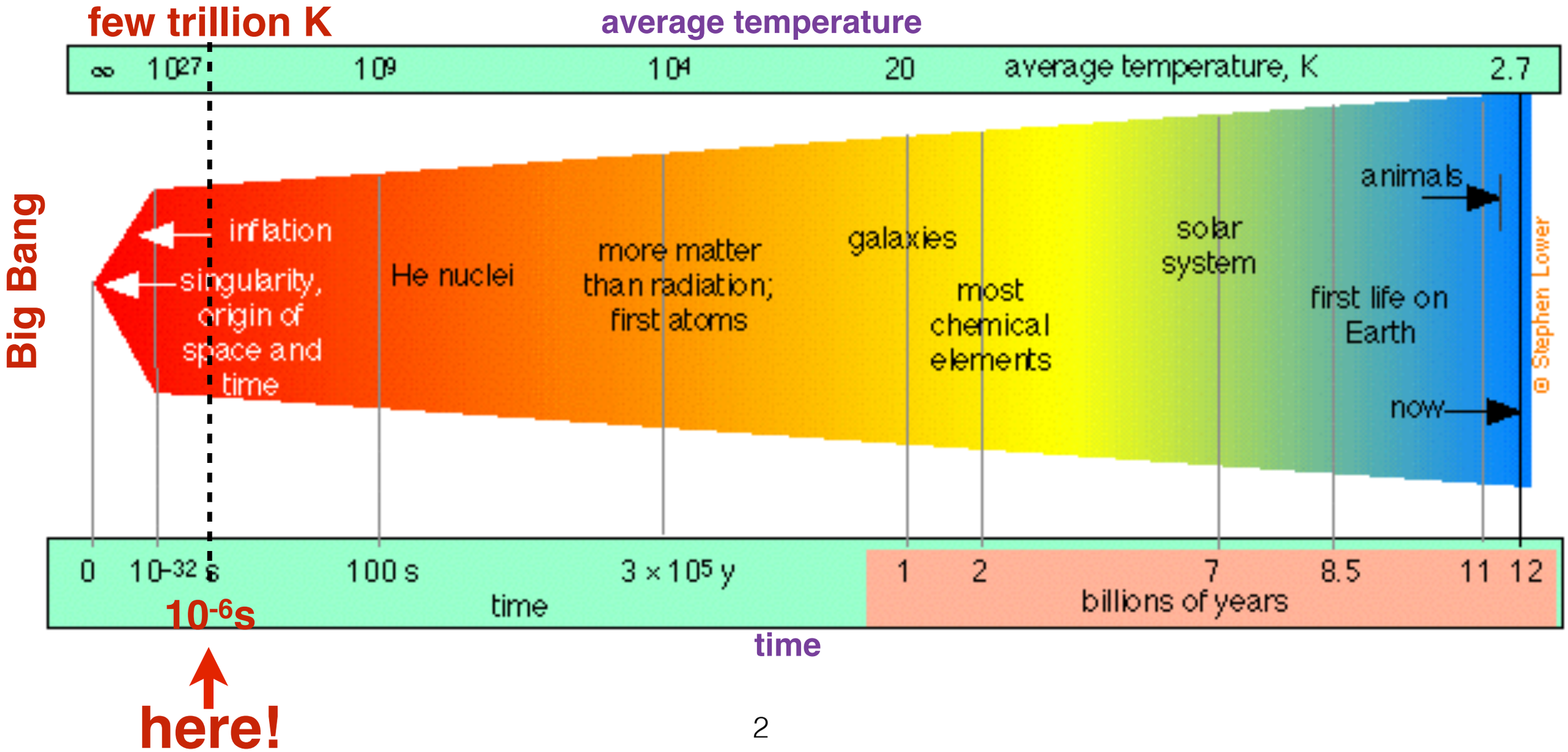
Preliminary Results of a Tungsten Powder Epoxy Scintillating Fiber EMCAL for sPHENIX

Vera Loggins
University of Illinois Urbana Champaign

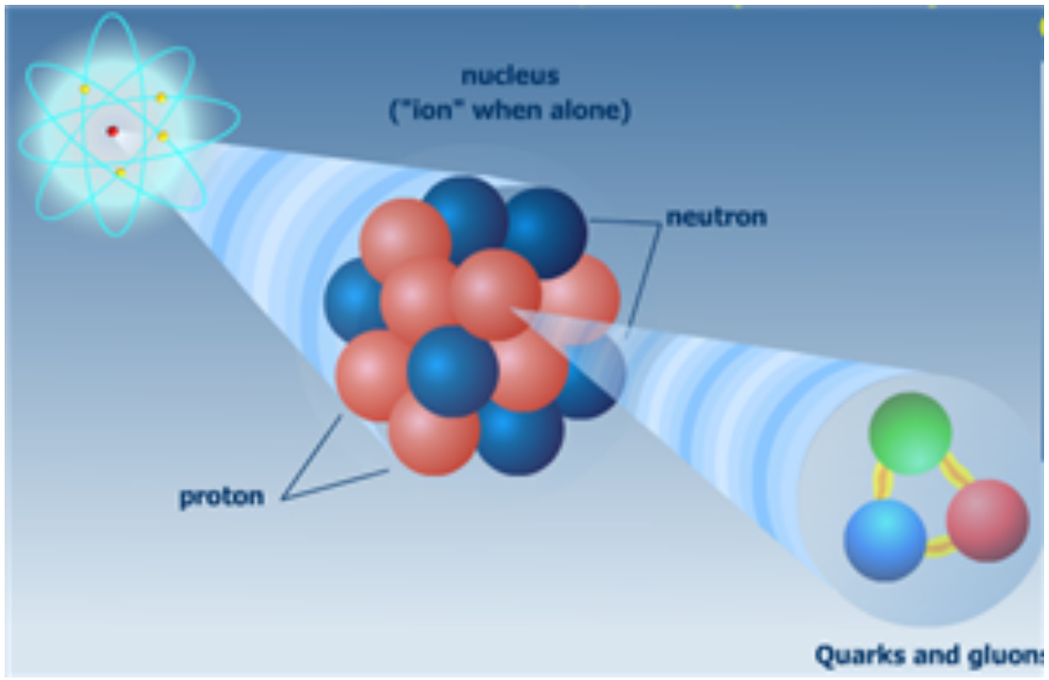
22nd International Spin Symposium

Motivation of Research

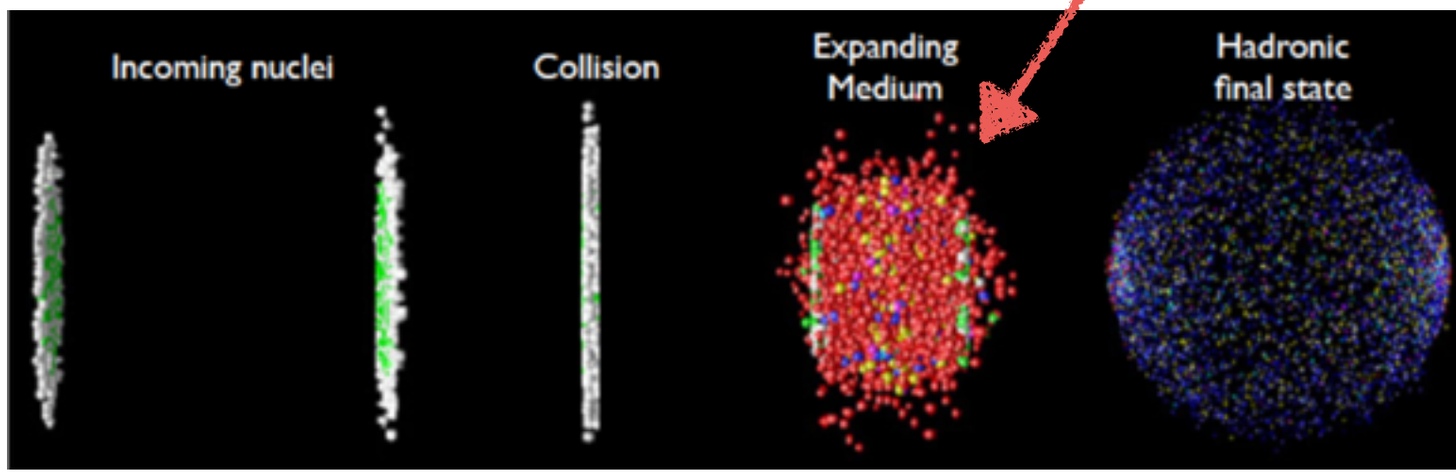
- Presently, the understanding is that all matter and energy of the universe sprang from a single point.
- We recreate the conditions of the early Universe, in particular a form of medium created, the Quark Gluon Plasma (QGP).



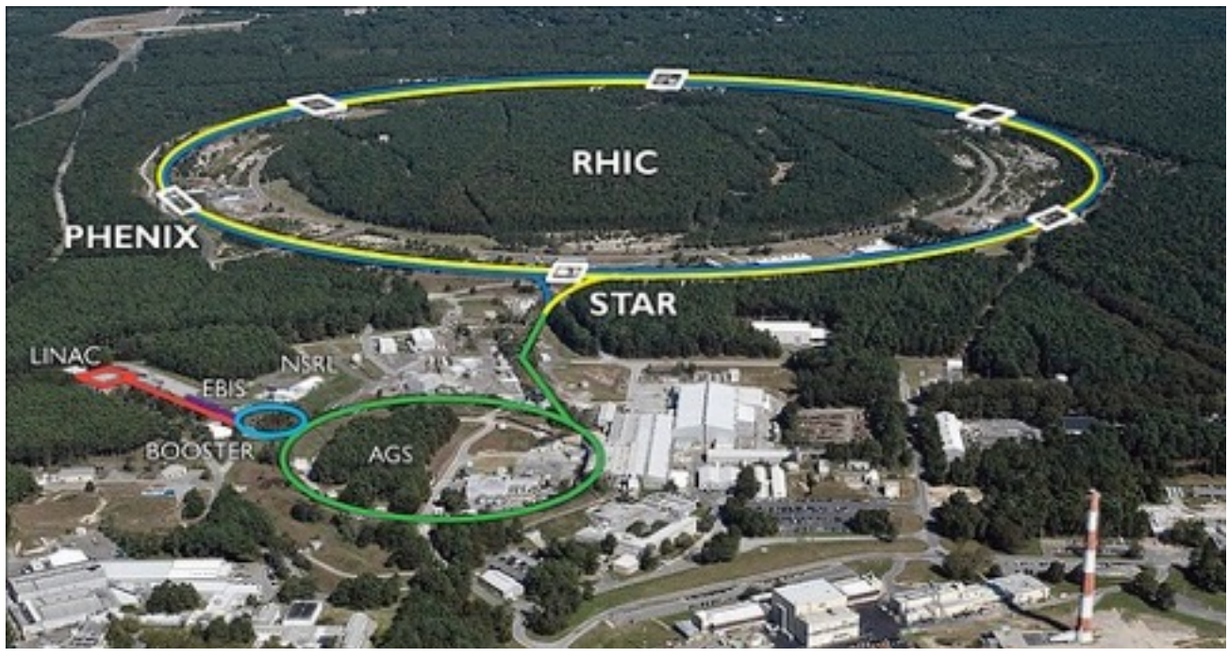
Motivation of Research



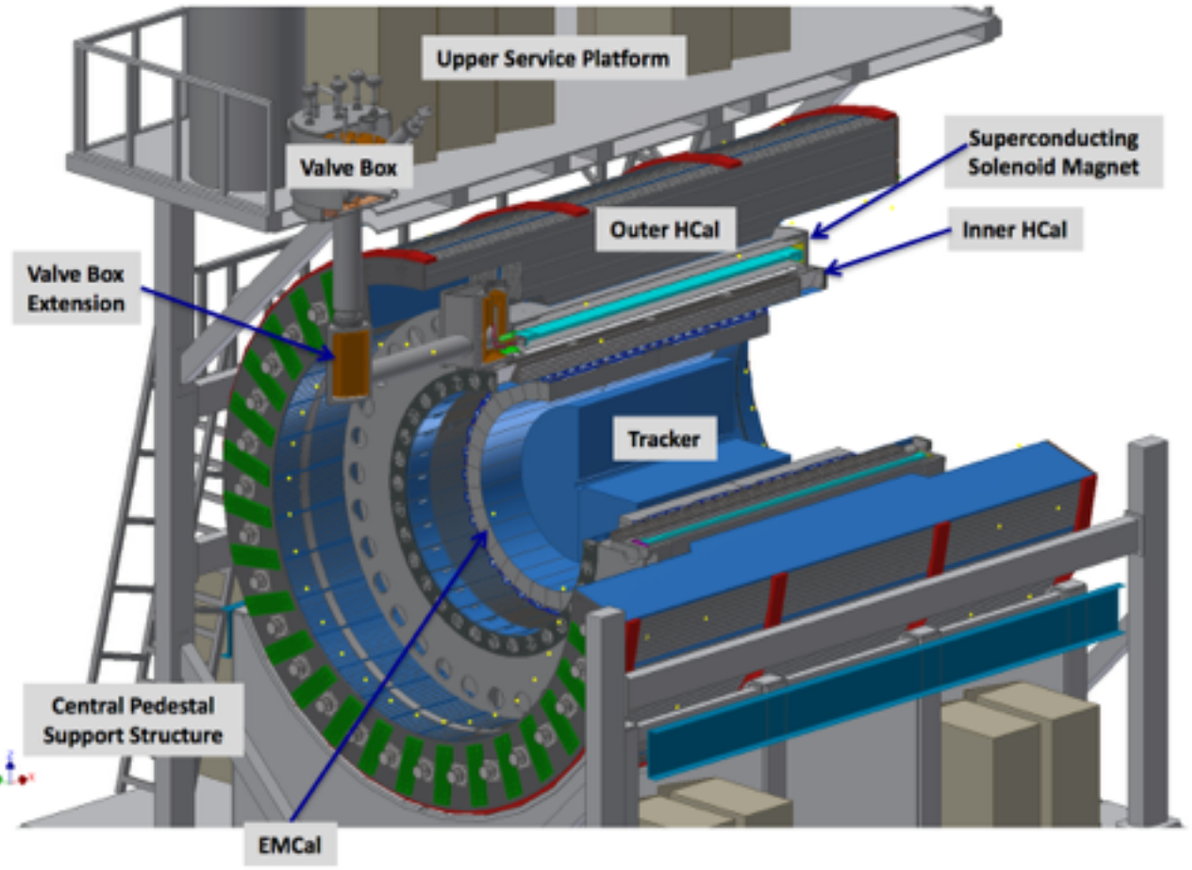
Stages of a large nuclei collision

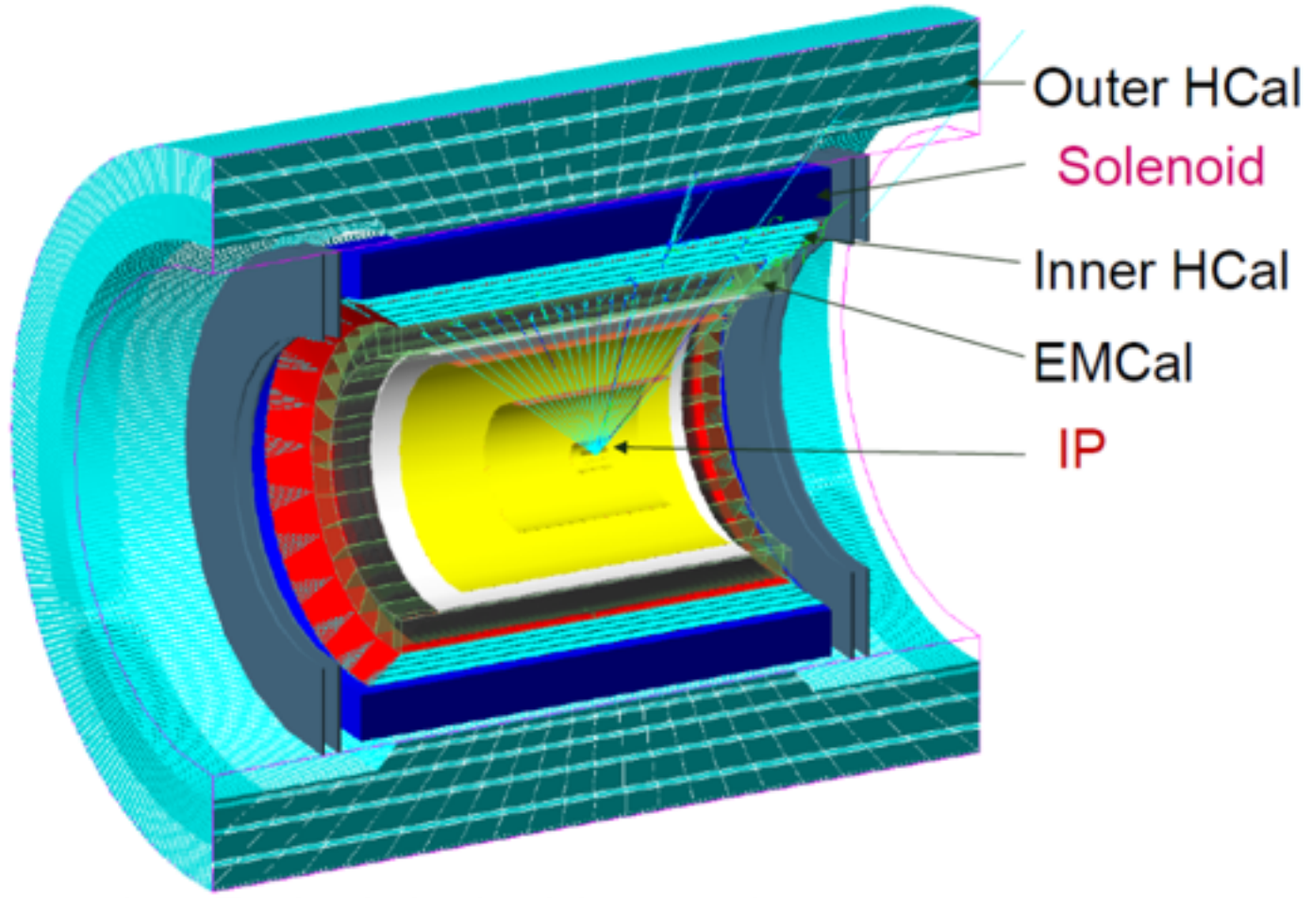


Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory on Long Island in New York



sPHENIX





- sPHENIX is a proposed new detector at the Relativistic Heavy Ion Collider.
- sPHENIX focuses on jet and hard probes as well as quarkonia to address the fundamental questions about the nature of the strongly coupled quark-gluon plasma (QGP).
- sPHENIX will also have the ability to study jets in polarized proton-proton and proton-nucleus collisions, and may be a part of the electron ion collider.

http://www.phenix.bnl.gov/phenix/WWW/publish/documents/sPHENIX_proposal_19112014.pdf

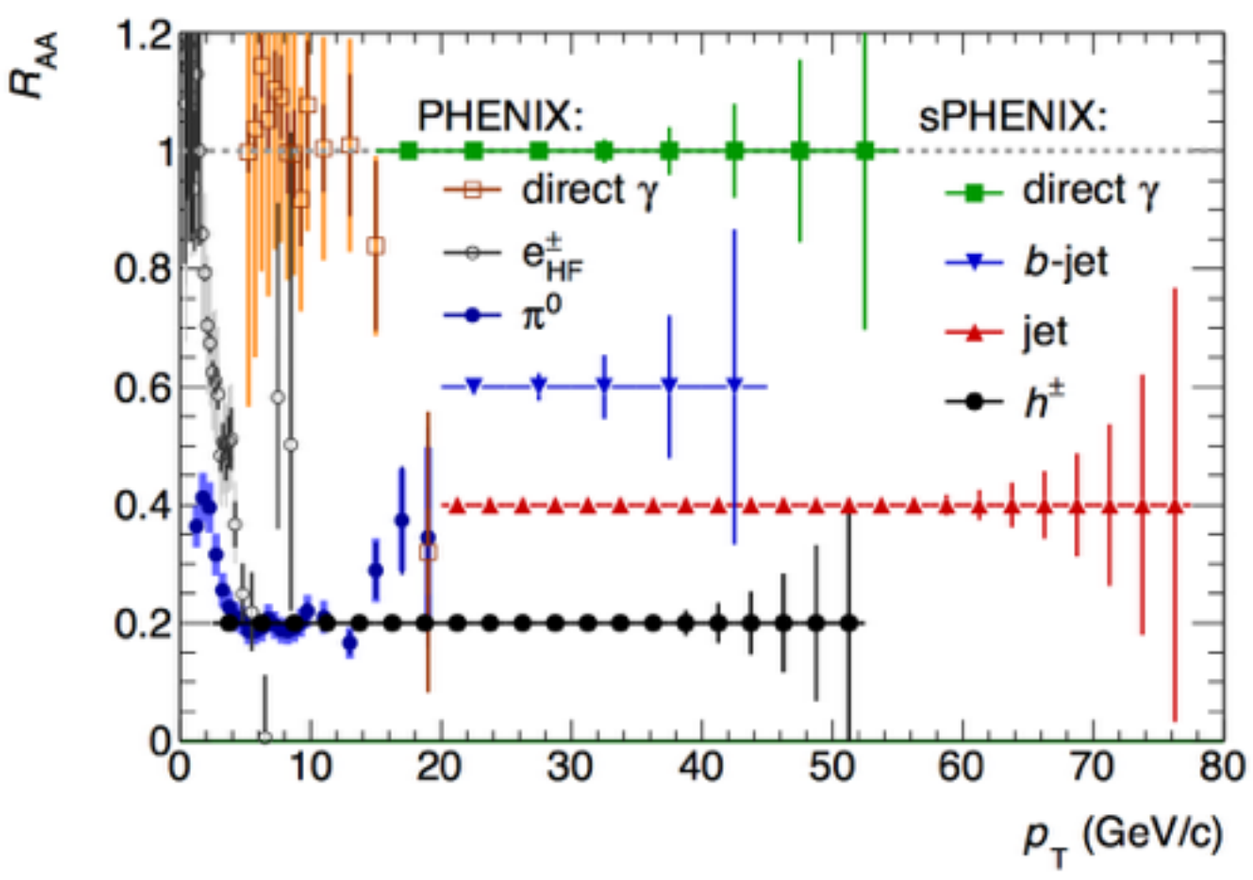
sPHENIX Requirements

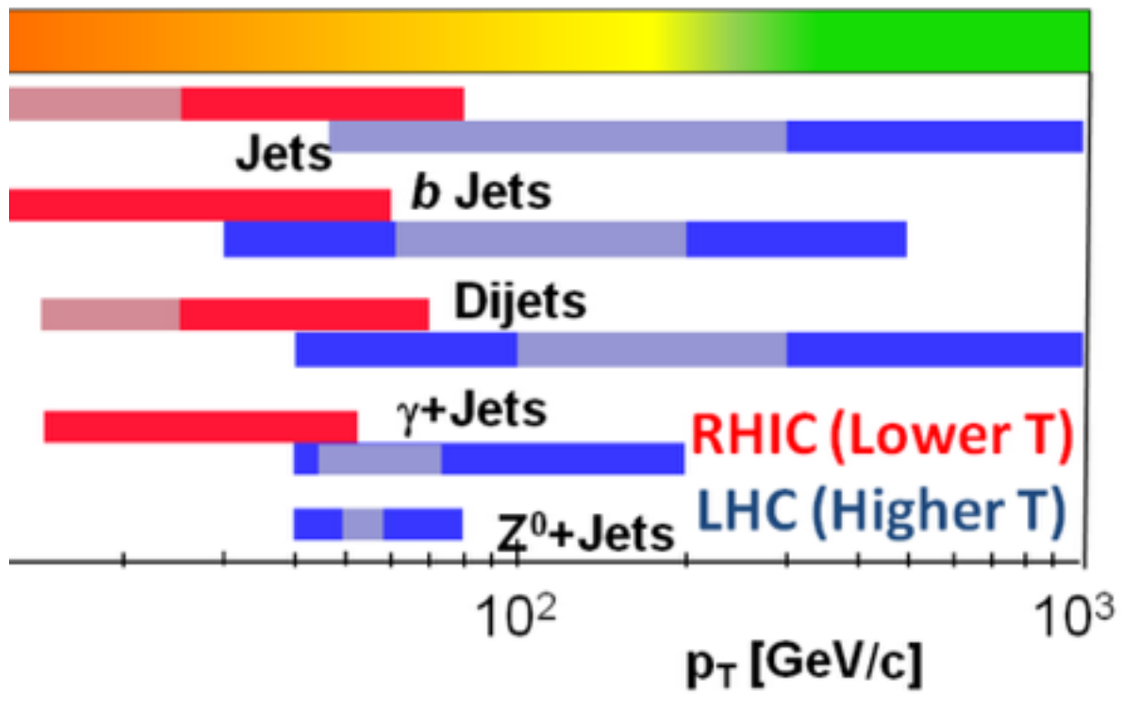
Physics:

- Measure jets, γ-jets, and direct single γ's up to high p_T.
- Identify electrons and measure their energies for measuring Υ's.
- Kinematic range will have more overlap with the LHC.

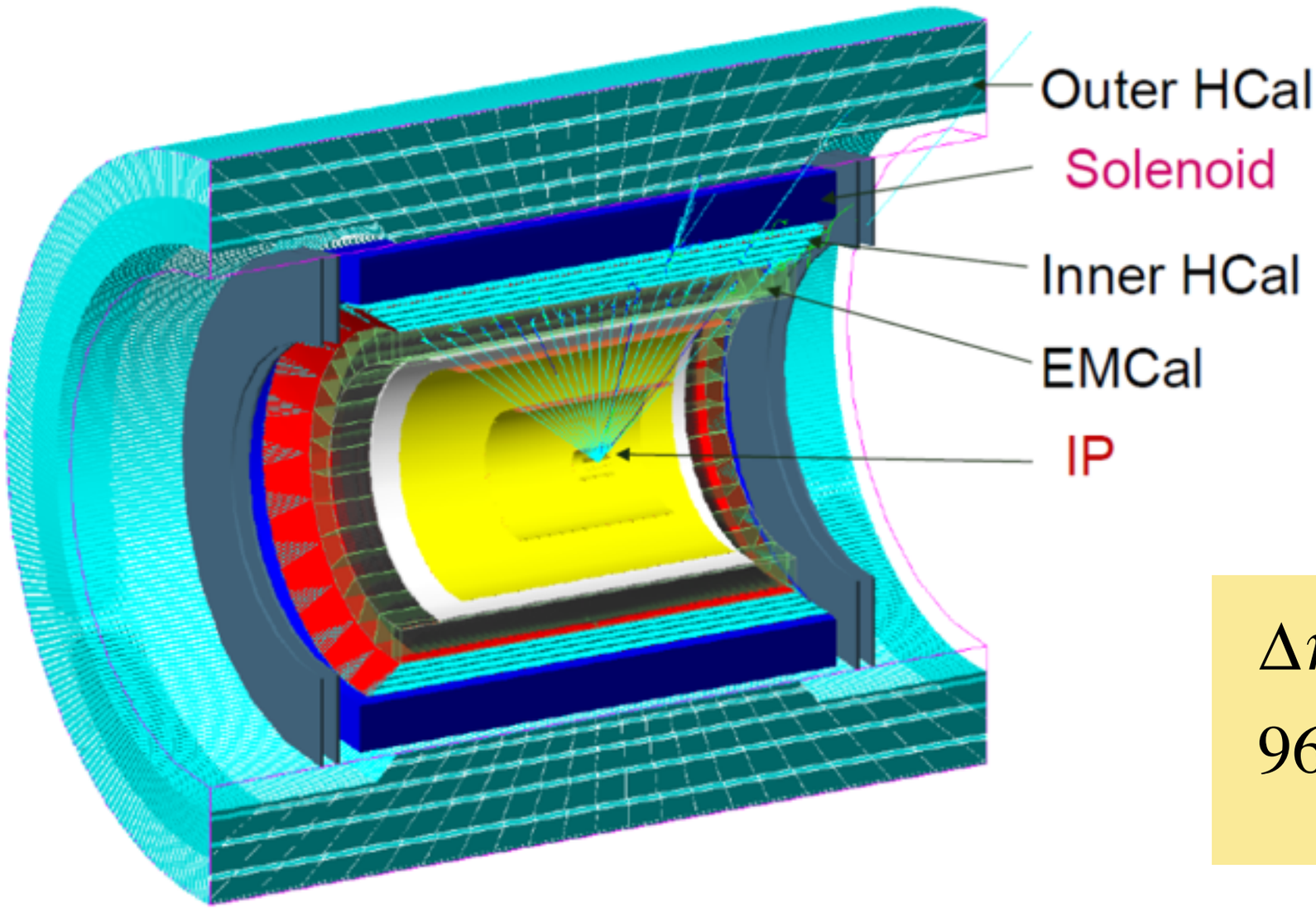
Detector:

- Large solid angle coverage (± 1.1 in η, 2π in ϕ)
- good energy resolution
- Fit inside the BaBar magnet
  - minimal radial space (dense)
  - compact (short X_0, small R_M)
  - high segementation for heavy ion physics

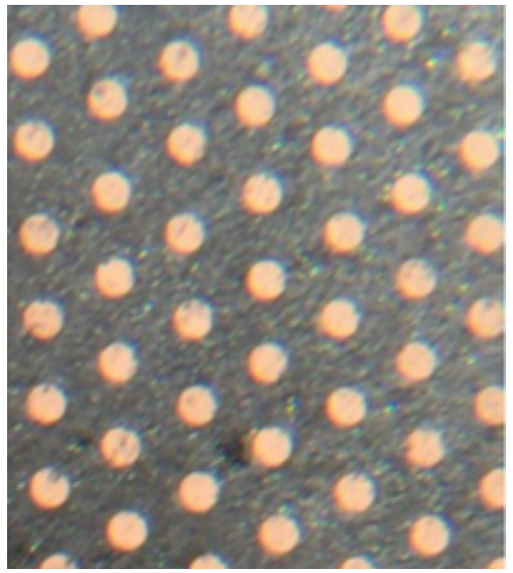




sPHENIX EMCAL



tungsten-fiber block



$\Delta\eta \times \Delta\phi \approx 0.025 \times 0.025$

96×256 readout channels

inner radius must be ~ 90 cm for tracking & particle ID

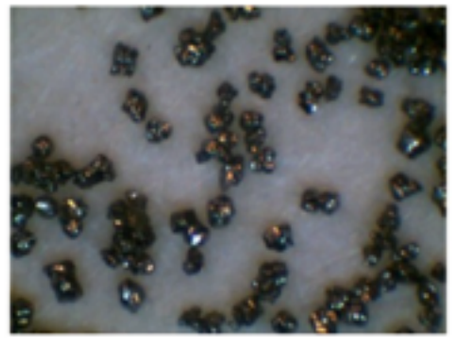
Inner radius must be small

ΔR=116 cm - 90 cm (26cm)

EMCAL Materials

Absorber

Matrix of Tungsten powder and epoxy w/embedded scintillating fibers



magnified view of powder

Scintillating Fiber (Kuraray SCSF78)

Diameter 0.47 mm, spacing 1mm

scintillating fibers

mesh to hold fibers

Calorimeter Specs

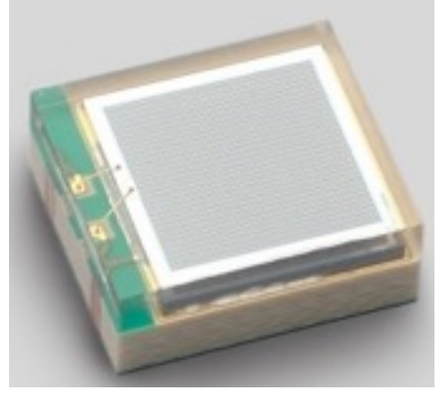
Density ~ 10g/cm^3

X_o ~ 7mm (18 X_o total), R_M~2.3 cm

Readout

Silicon Photomultipliers (SiPMs)

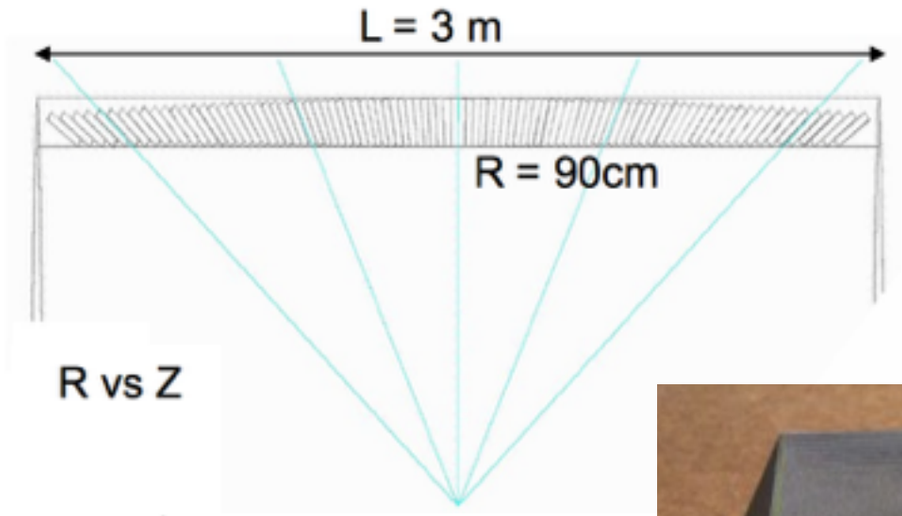
Works inside magnetic field

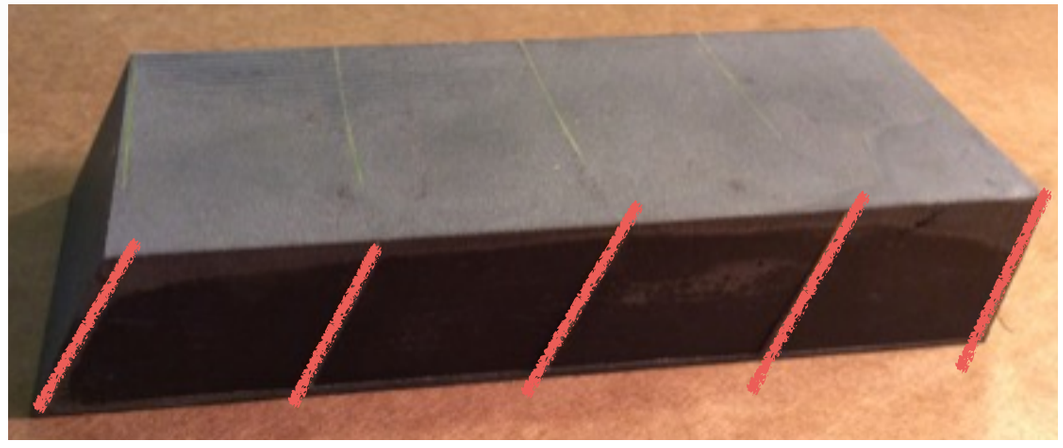


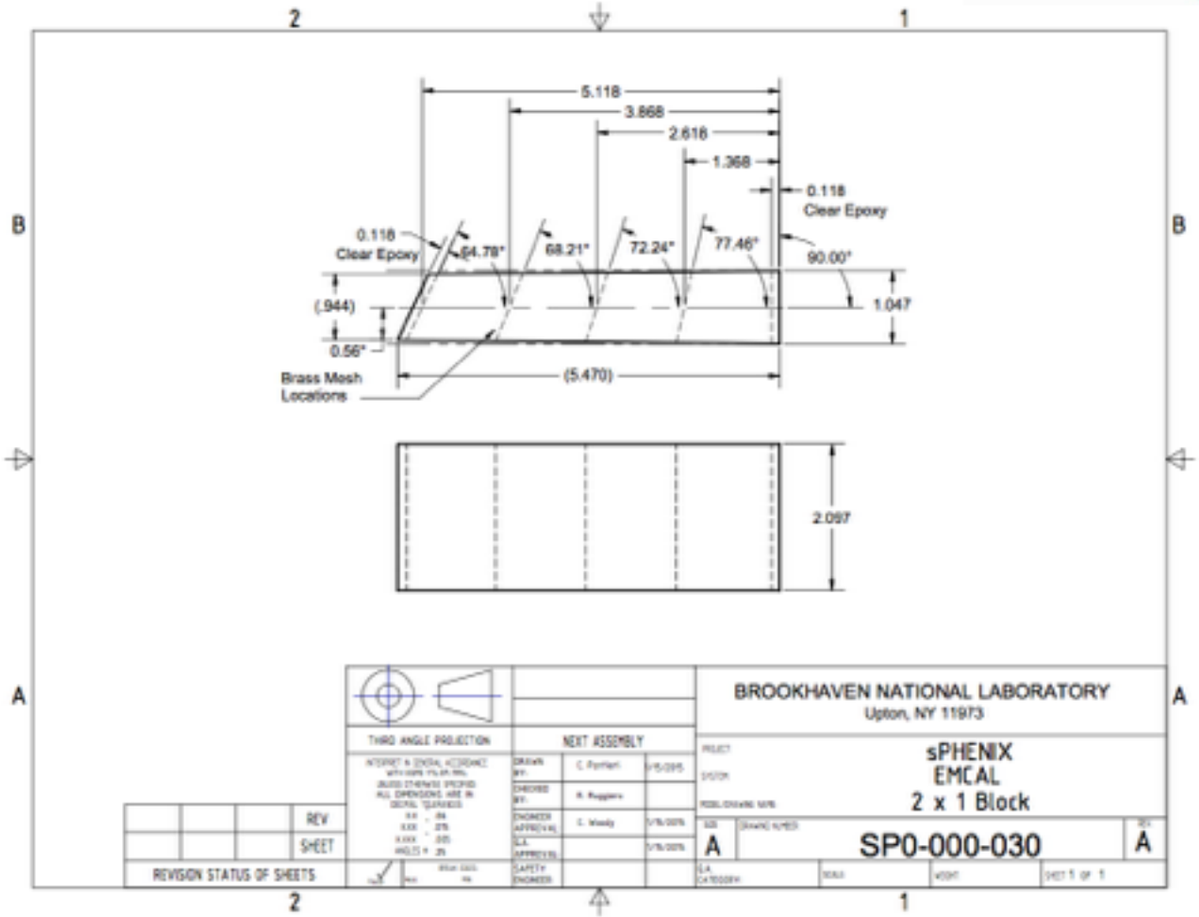
Hamamatsu S12572-015P

Projectivity

The reason for a 2D (fully) projective design is due to the high multiplicity in central heavy ion collisions.





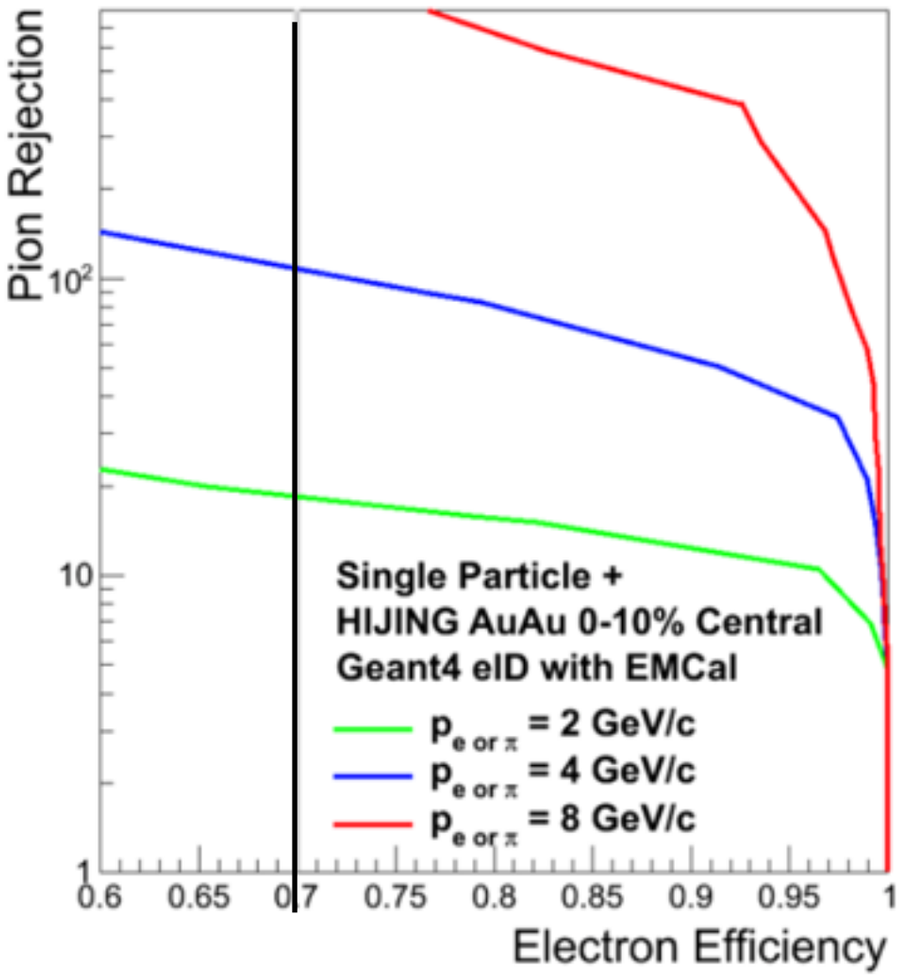


The first way to make the fibers projective was to tilt them in 1D.

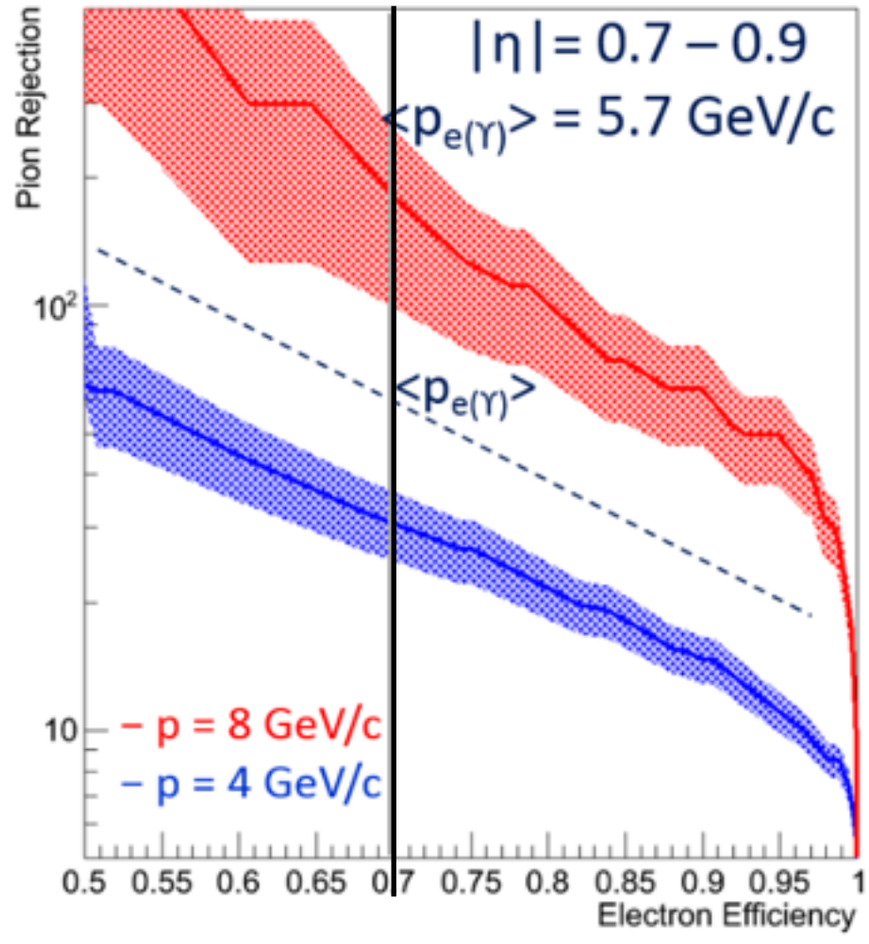
Projectivity

Pion Rejection vs. Electron Efficiency

Projective in polar direction

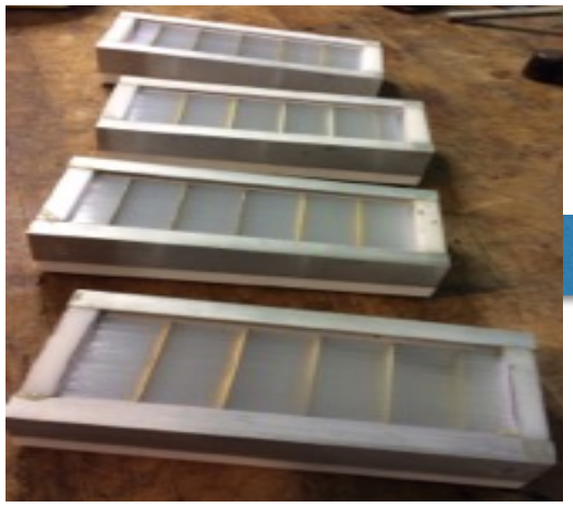


Non-Projective in polar direction



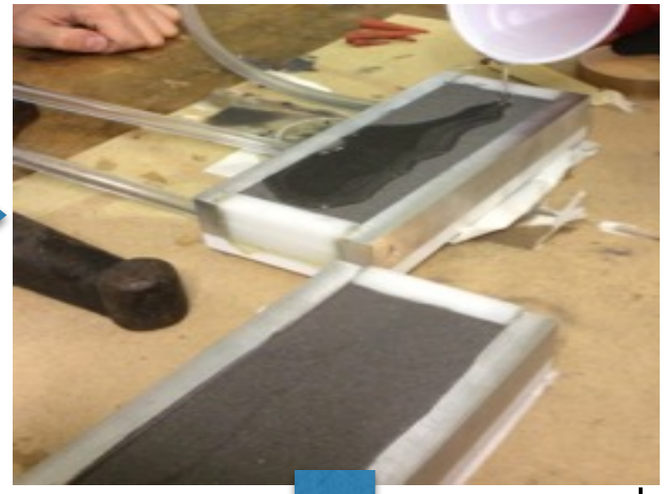
Pion rejection is considerably lower for the non-projective case. This is problematic for Y measurements which are already rare probes.

sPHENIX EMCal Production @UIUC



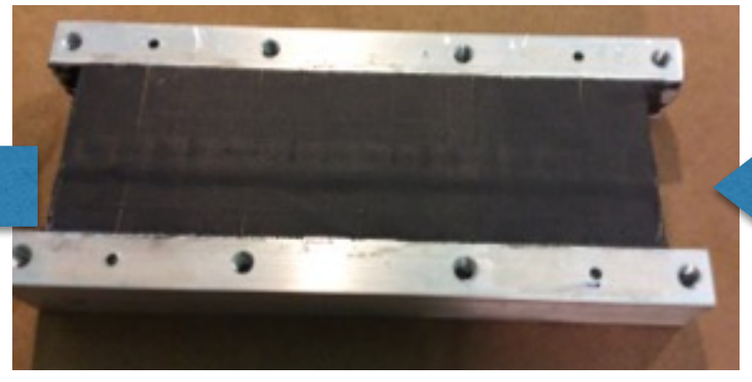
fibers & meshes

fibers, meshes,
& tungsten

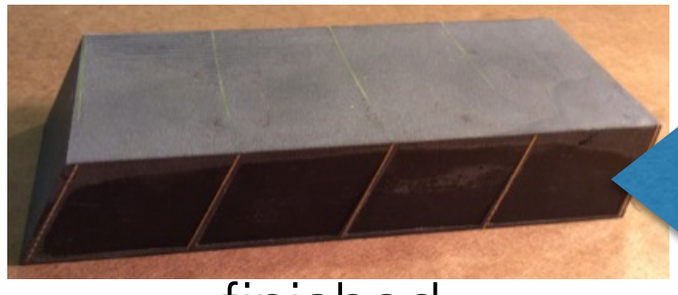


epoxy added

epoxy drying for 24 hours



module ready to be machined



finished

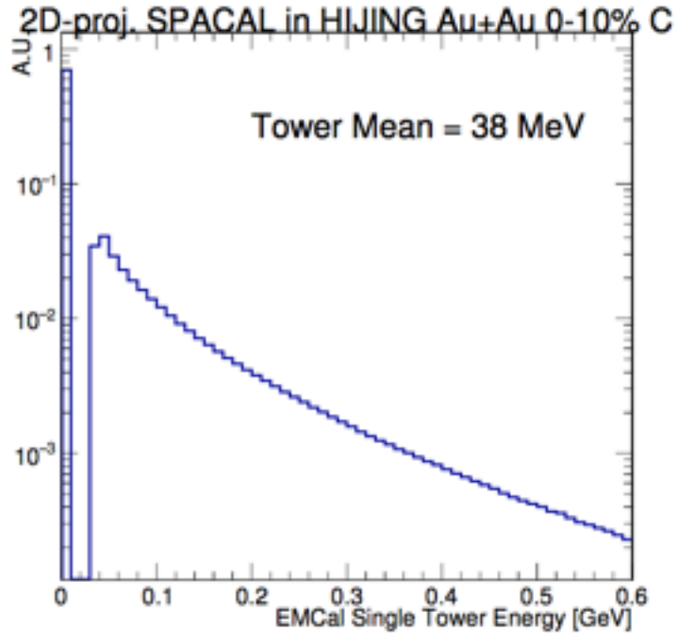
Collaborate with Brookhaven National Laboratory for assembly

Segmentation Requirement

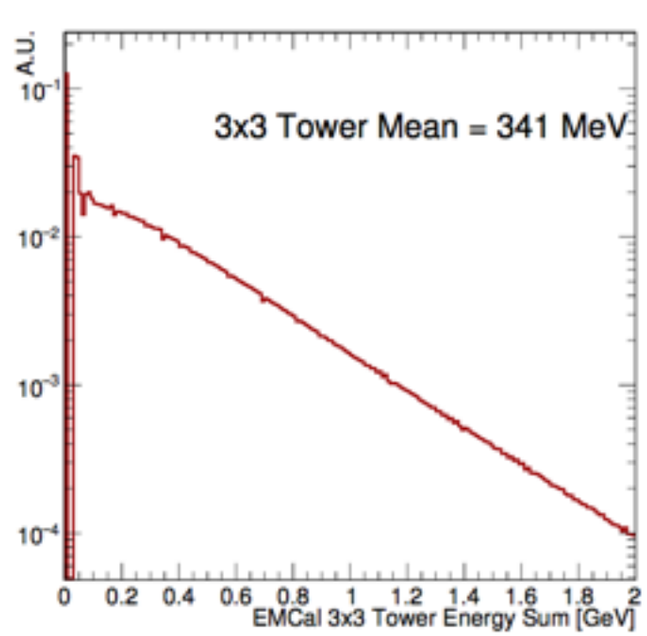
The goal is for detector resolution and segmentation to be better than the limitations on photon reconstruction due to the underlying event background in a heavy ion event.

Hijing Central Au+Au

Average energy per tower ~38 MeV



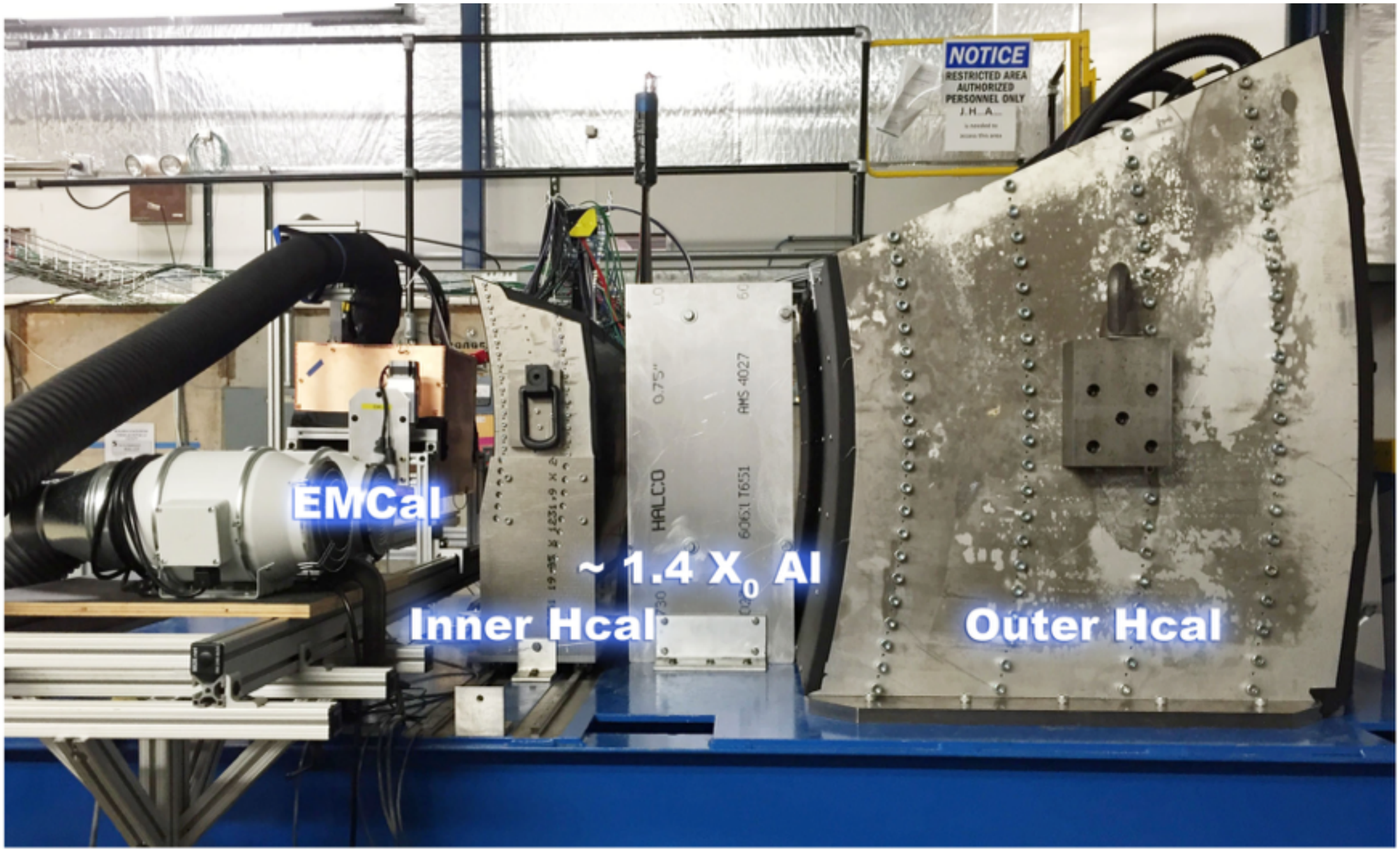
Energy in a 3x3 tower sum ~341 MeV



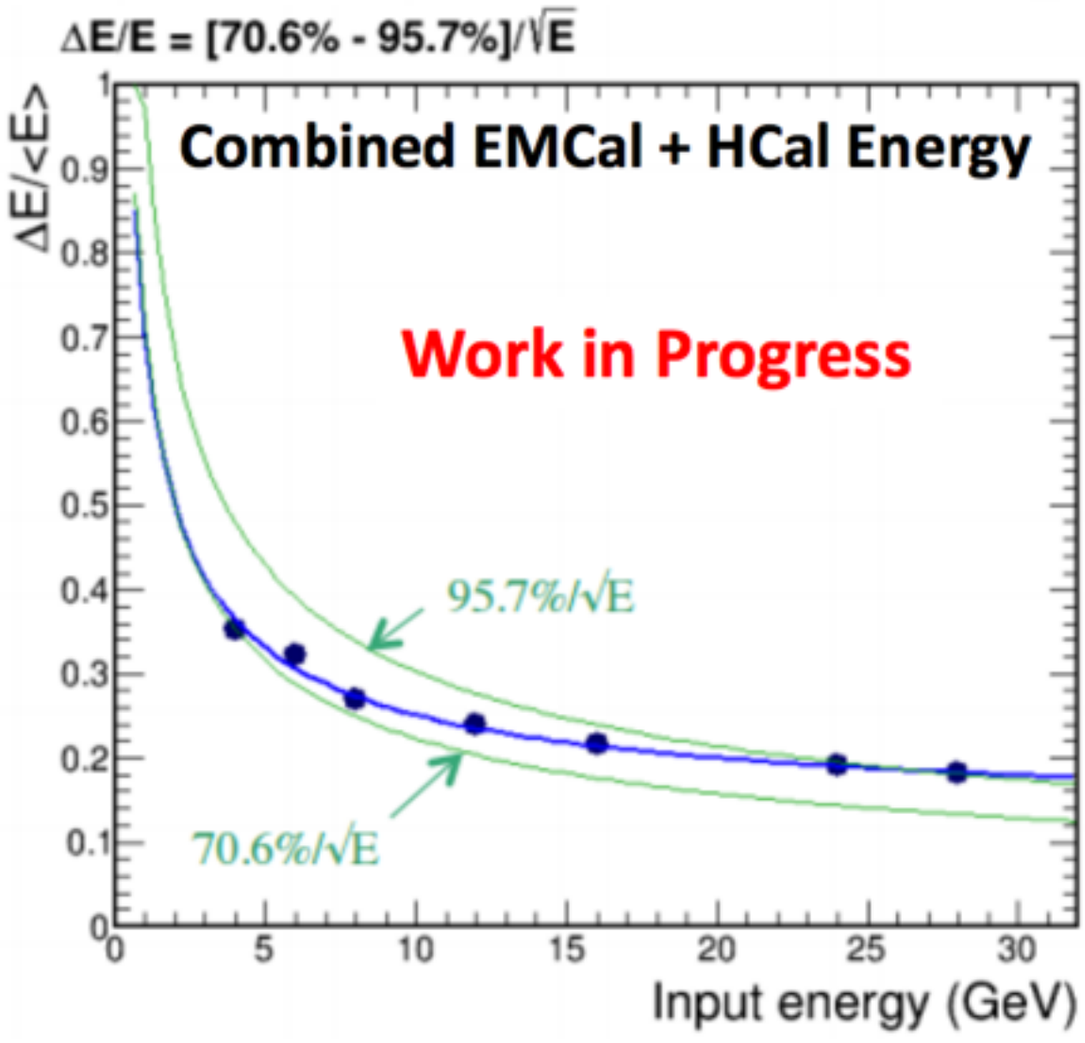
3x3 tower~size of single photon cluster

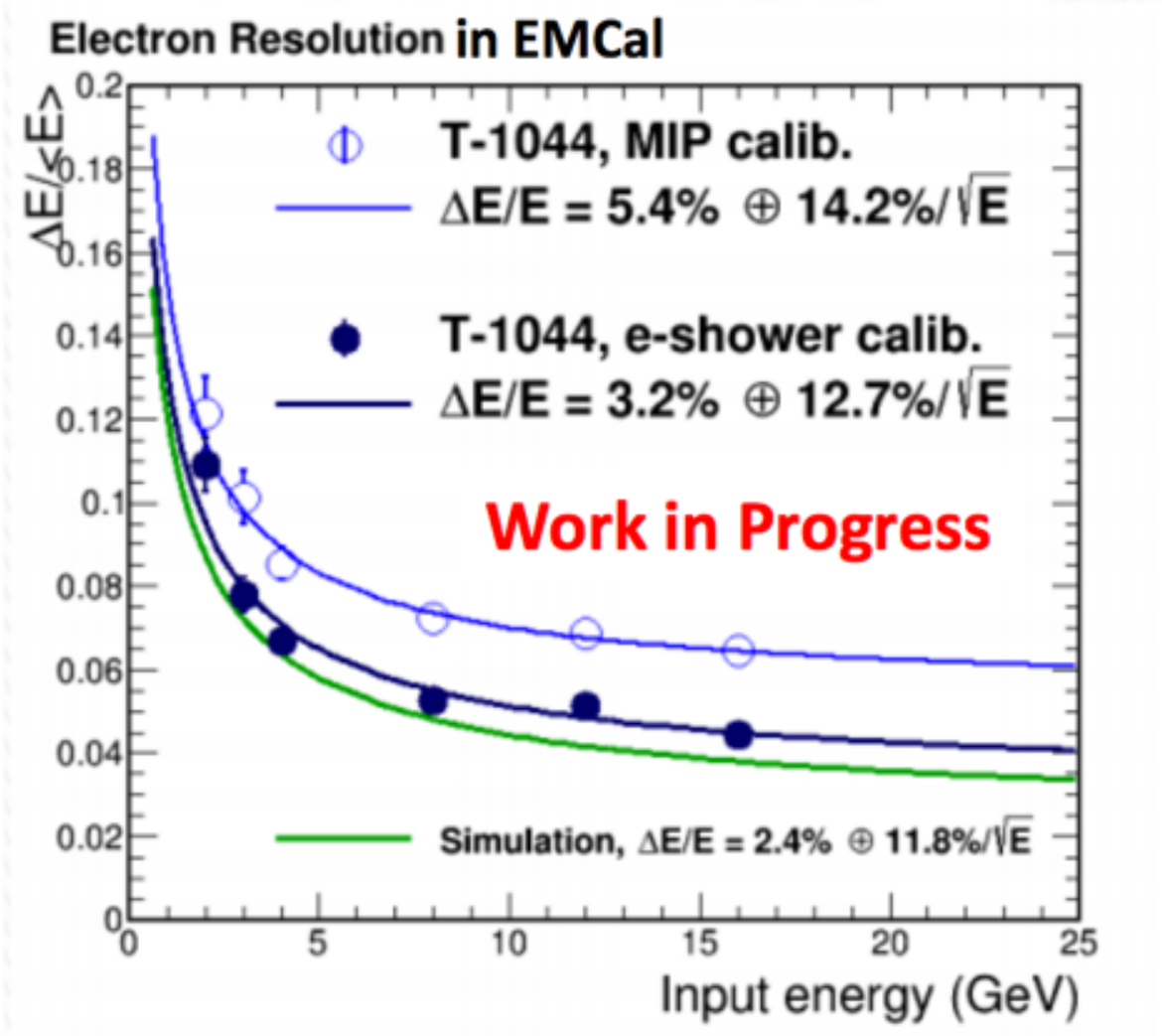
Average energy of tower~341 MeV from the underlying event in central Hijing Au+Au event.

Fermilab Test Beam 2016



Fermilab Test Beam 2016





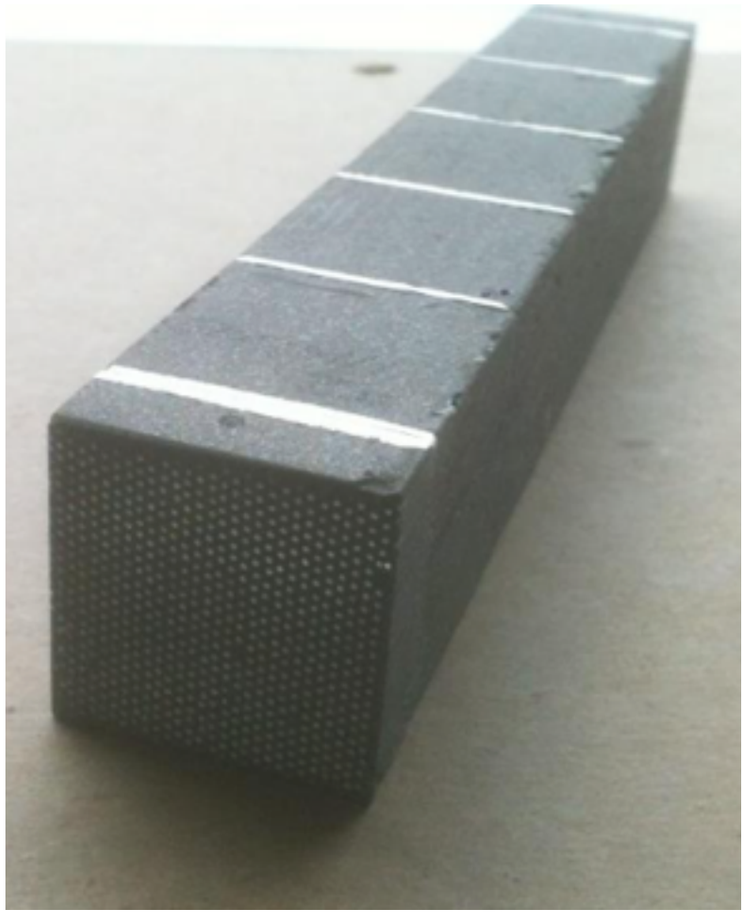
Meets design goals of <100%/√E and <15%/√E for EMCal

RHIC/AGS User's Meeting June 2016

https://www.bnl.gov/aum2016/content/workshops/Workshop_2b/campbell_sarah.pdf

Future Plans

- We have completed the first Test Beam with EMCal prototype version 1 8x8 towers of 1D projective blocks.
- Version 2 prototyping of *2D* projective blocks is underway.
- sPHENIX is part of plans for BNL after a final PHENIX run in 2016.
- We look forward to Physics in 2021.
- Second Test Beam in February 2017!



2D projective module by BNL