Tungsten Powder Epoxy Scintillating Fiber EMCAL for sPHENIX

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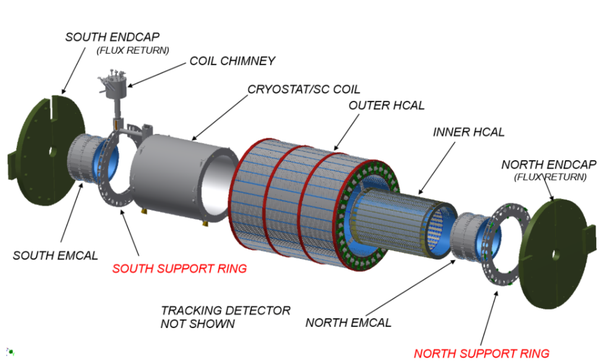
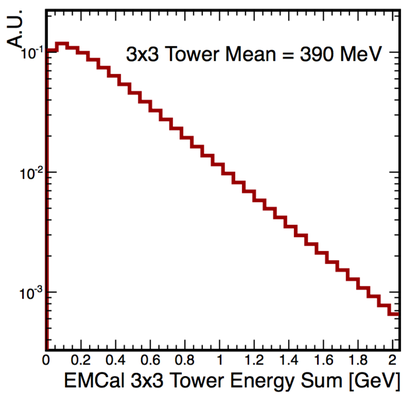
The sPHENIX detector is a proposed new detector at the Relativistic Heavy Ion Collider (RHIC). The sPHENIX physics program focuses on jets and hard probes of the quark gluon plasma (QGP). The proposed design of the electromagnetic calorimeter (EMCAL), made of a tungsten powder and epoxy composite with embedded scintillating fibers. It is designed to have a small Moliere radius and short radiation length, and will be located at a radius of about 90 cm from the interaction region. The EMCAL will have an energy resolution of approximately $12\%/\sqrt{E}$ with an η and ϕ segmentation of is 0.024 x 0.024. It will be used in conjunction with a new hadronic calorimeter (HCAL) to resolve single photons and electrons, as well as photon-jets, in the high multiplicity environment of central heavy ion collisions. Preliminary tests of the calorimeter design have taken place and we plan to test new prototypes of the EMCAL and HCAL in the spring of 2016 in the test beam at Fermilab.[1]

sPHENIX Detector

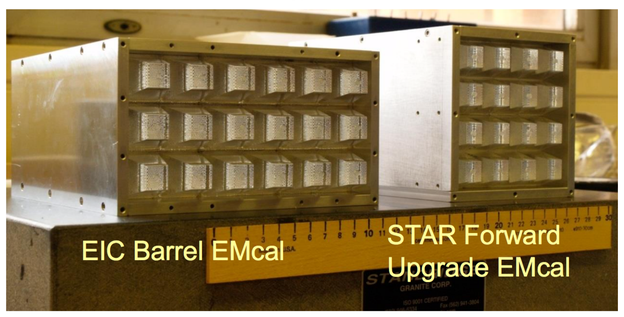


The sPHENIX detector is an upgrade to the sPHENIX detector[2] designed to address the fundamental unanswered questions about the nature of the strongly coupled Quark-Gluon Plasma (QGP), discovered experimentally at RHIC to be a perfect fluid.

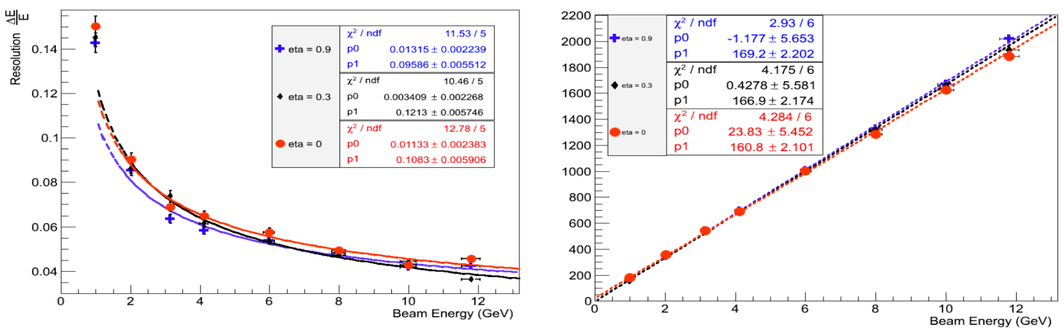
The goal is to have the detector resolution and segmentation be better than the intrinsic limitations on the photon reconstruction due to the underlying event background in a central heavy ion event.



The energy for a 3x3 tower sum (the approximate size of a single photon cluster in the calorimeter). The average energy of the tower sum is 390 MeV from the underlying event in a central HIJING Au+Au event.

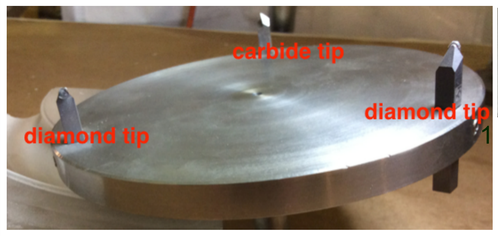


Prototype of tungsten powder and scintillating fibers (W/ SciFi) calorimeters tested at Fermilab 2014[3]. The modules on the left are the semi projective modules, and the ones on the right are the nonproductive modules.



The measured EMCAL energy resolution and response for three different rapidities.

1D Projective EMCAL module

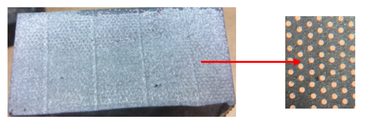


1 carbide tip

2 diamond tips

The EMCAL modules are machined down for final processing using a rotating cutter which has a different cut for each tip (first carbide, then diamond tips) allowing for a high precision.

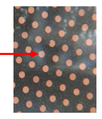
Comparison of the diamond machined modules with a saw cut.



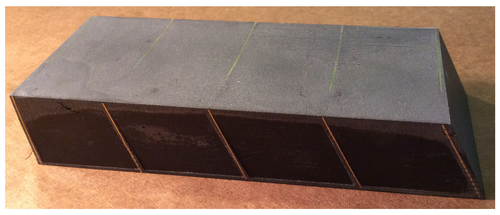
saw cut

zoomed in

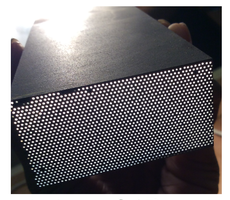
diamond cut



zoomed in



1D projective module

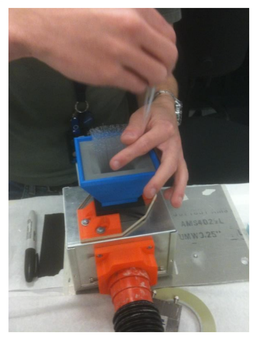


end view of 1D projective module

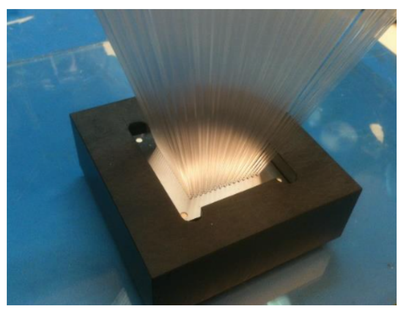
Final 1D Projective EMCAL module after machining with the diamond cutter. Final density value is 9.15 g/cm^3.

Work in Progress / Future Work

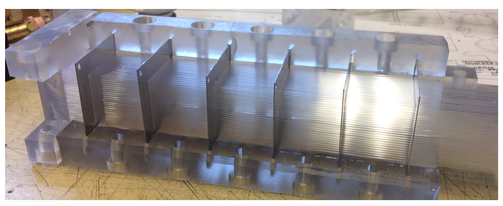
We will test the 1D projective modules at Fermilab in the spring of 2016 for FNAL T-1044[1], and will move to completing the 2D projective modules for further development.



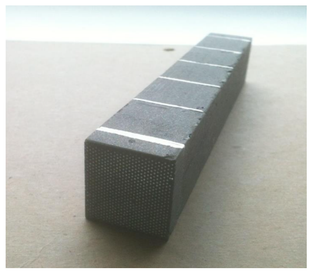
Loading the 2D projective design with a funnel and vacuum to increase speed.



meshes filled for 2D projective module



2D meshes and fibers



2D projective module

Reference:
1 Fermi National Laboratory (FNAL) test beam, FNAL T-1044
2 see the proposal arXiv:1501.06197
3 O.Tsai for FNAL T-1018