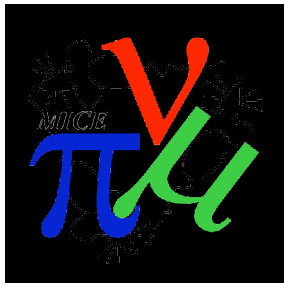
G4MICE Simulations



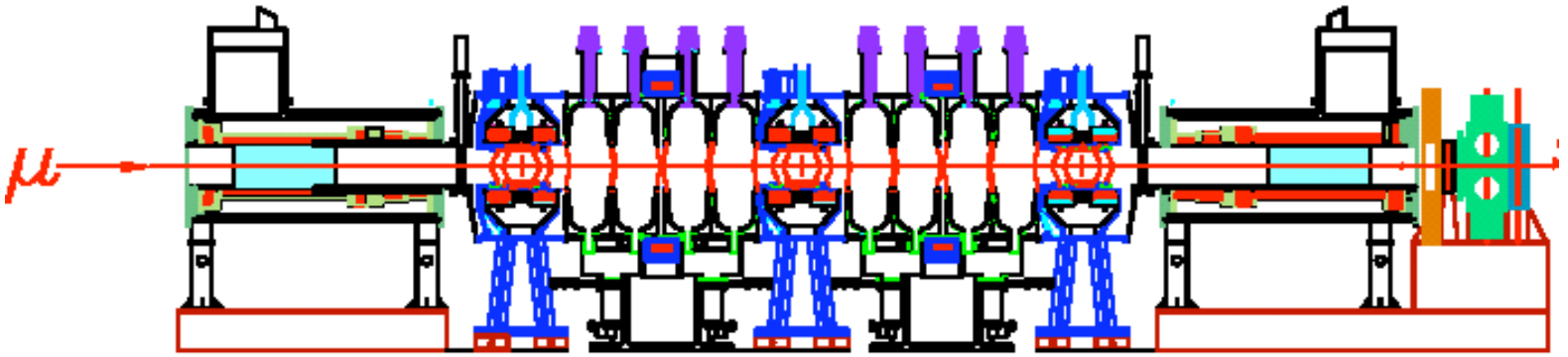
Yağmur Torun, IIT

ICAR Workshop

May 19, 2004 - Argonne

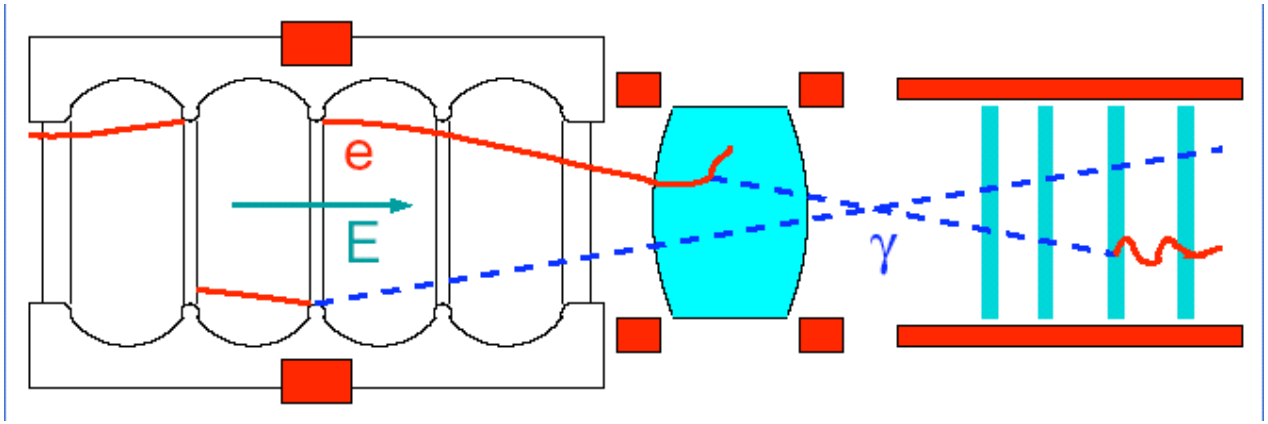
MICE

- MICE (International Muon Ionization Cooling Experiment) includes one full cell of Neutrino Factory ionization cooling channel
- Flexible configuration to perform a series of experiments for exploring muon ionization cooling
- Measurement of emittance, transmission, etc. orders of magnitude better than traditional beam instrumentation
- Detectors for particle ID and tracking
- "Software" beam from single-track events for analysis



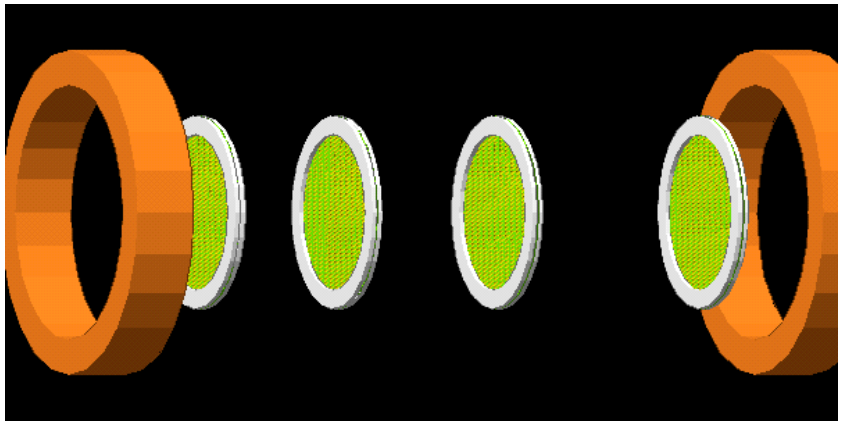
MICE Software

- MICE aims to measure beam dynamics with unprecedented accuracy and compare with simulations
- Particle detectors sprinkled among absorbers, magnets, and rf cavities; need a framework in which all are accurately modeled
- Need correct representation of beam, geometry, materials and physics (including rf-induced backgrounds and time dependent electromagnetic fields)
- Project based on GEANT4 toolkit: G4MICE



Organization

- Communication through email list and bi-weekly phone conferences set up by software coordinator (YT)
- All information on the web - http://mice.iit.edu/software
- Source code repository maintained at IIT, available through anonymous cvs, regular releases
- Regular software workshops (Apr 04, Nov 03, Mar 03, Aug 02) for focused discussion and design

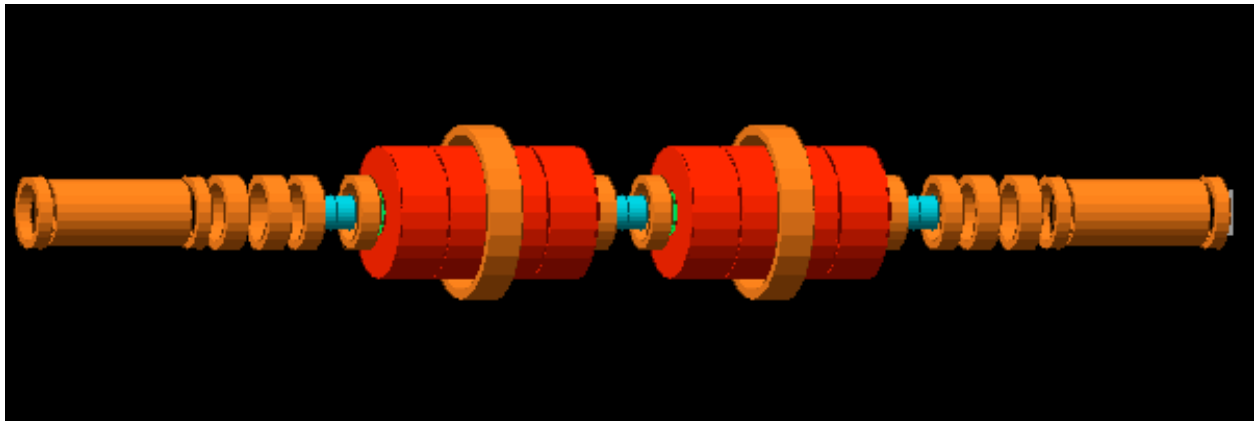


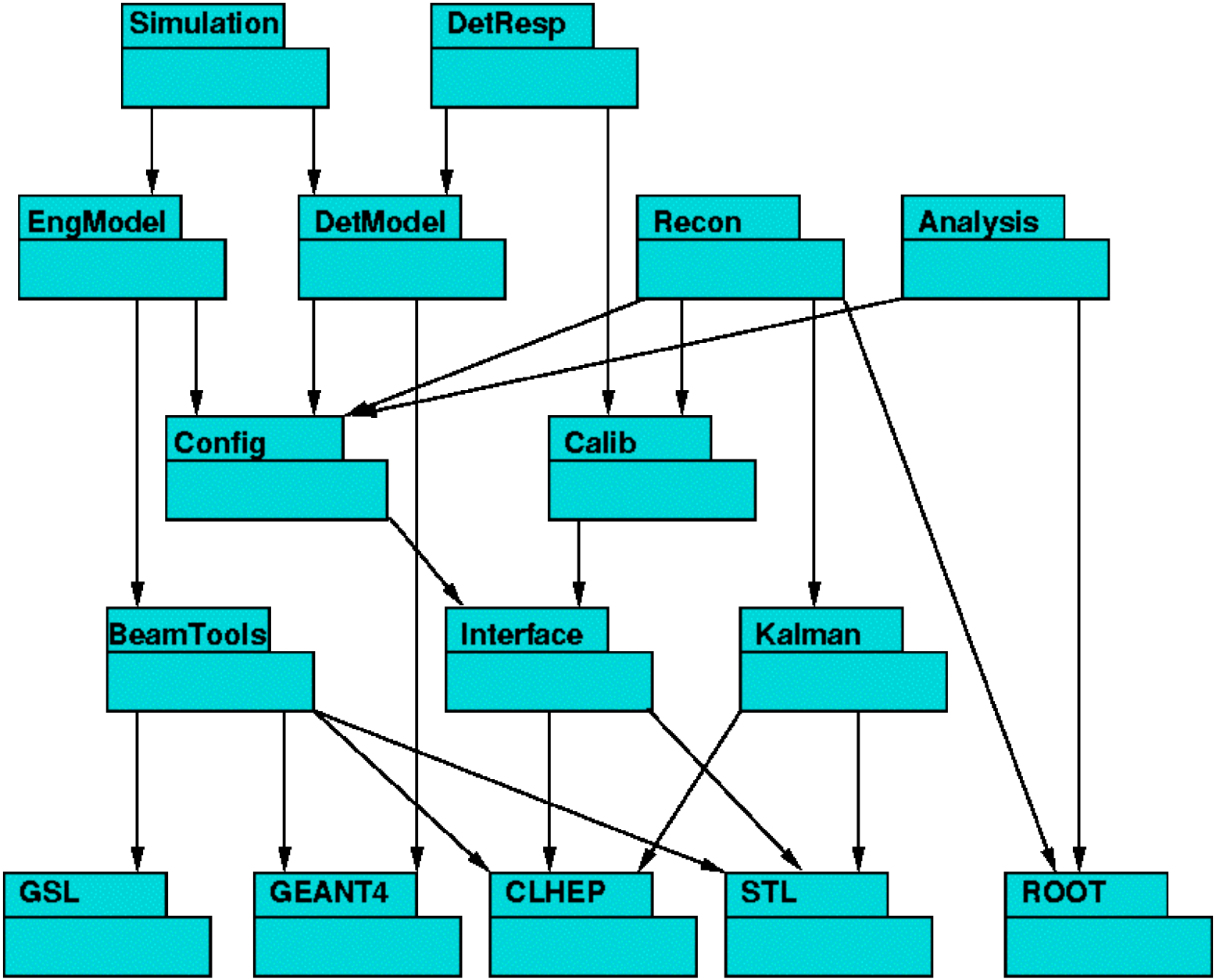
Cast

- UK: A. Khan, P. Kyberd (Brunel), M. Ellis, K. Georgiou, C. Rogers, J. Sedgbeer, A. Tapper (Imperial), U. Bravar (Oxford), K. Tilley (RAL), K. Walaron (Sheffield)
- US: S. Kahn (BNL), T. Roberts, Y. Torun, H. Wilson (IIT), I. Rakhno (UIUC), G. Hanson, A. Klier (UC Riverside)
- Switzerland: V. Grichine, E. Gschwendtner, O. Voloshyn, R. Sandstrom (Geneva)
- Italy: M. G. Catanesi (INFN Bari), A. Tonazzo (INFN Roma III)

Progress

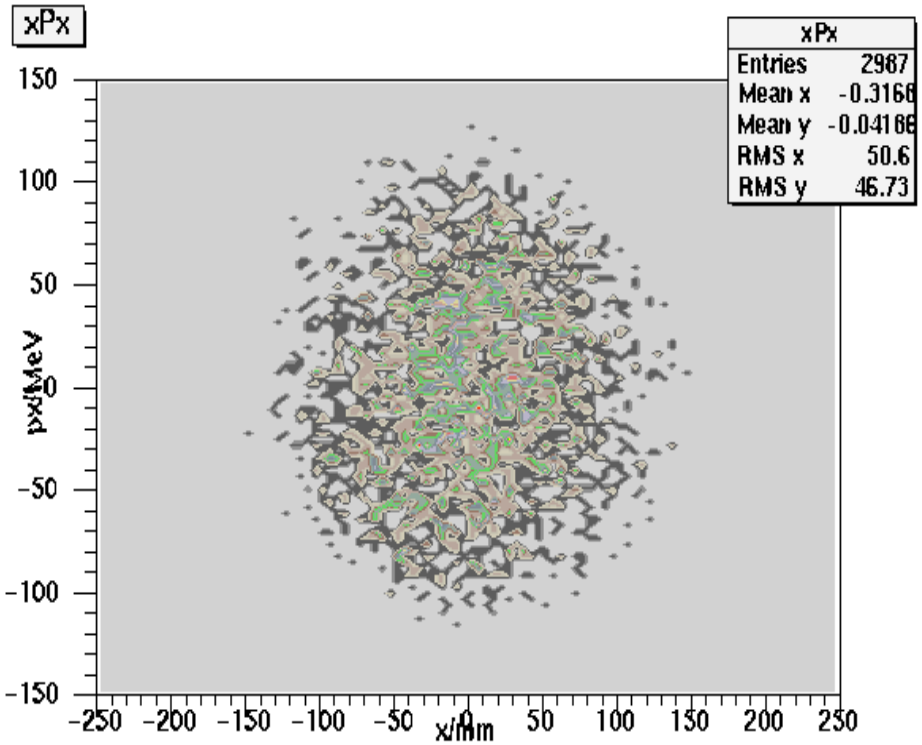
- Built approximate model of experiment
- Basic simulation chain finished
- Used G4MICE to investigate performance of scintillating fiber and TPG trackers
- Used G4MICE to optimize calorimeter and Cerenkov design
- Used G4MICE to investigate particle ID performance
- Initiated comparison of beam dynamics with other codes
- Designed robust architecture for long term use




Simulation
DetResp
EngModel
DetModel
Recon
Analysis
Config
Calib
BeamTools
Interface
Kalman
GSL
GEANT4
CLHEP
STL
ROOT

Full Channel - x/mm vs px/MeV

G4MICE



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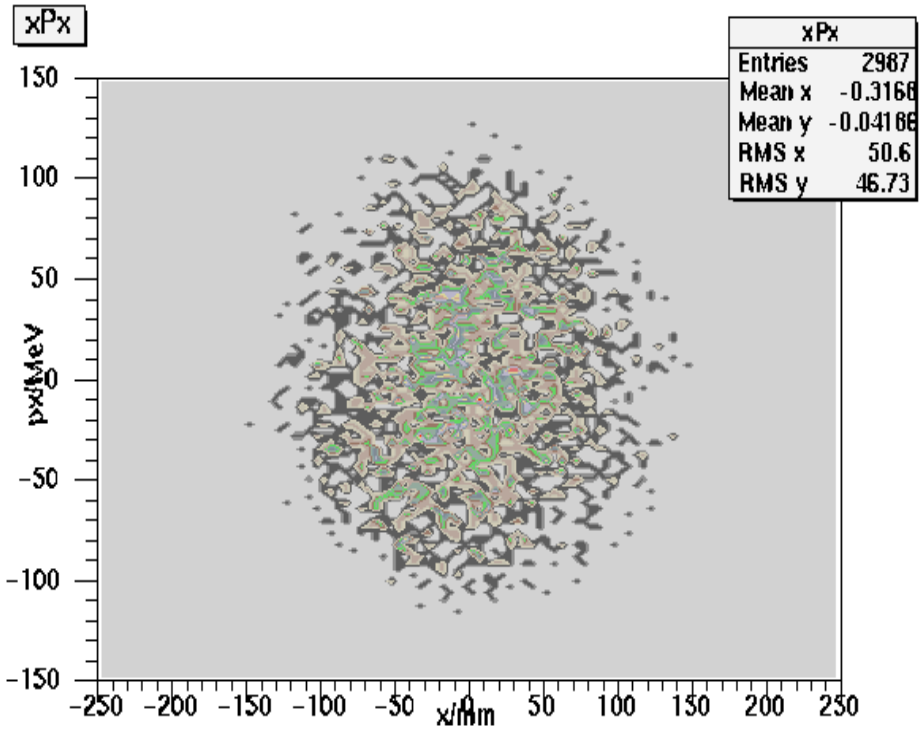
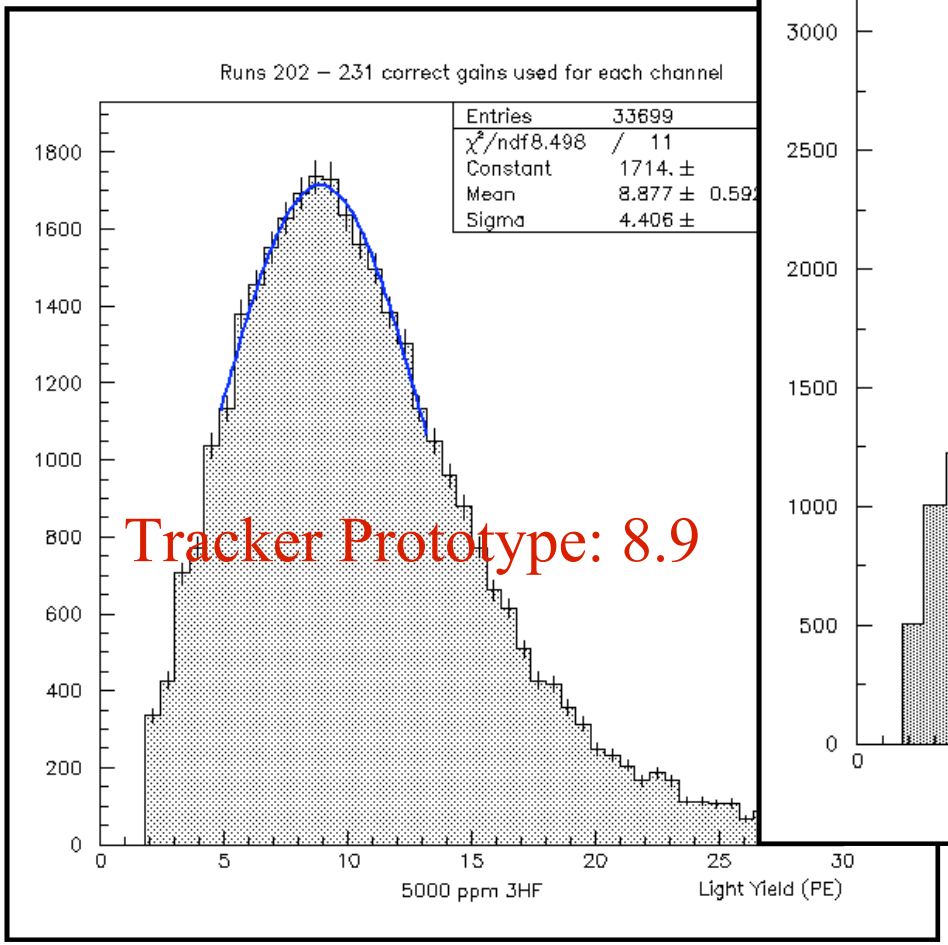
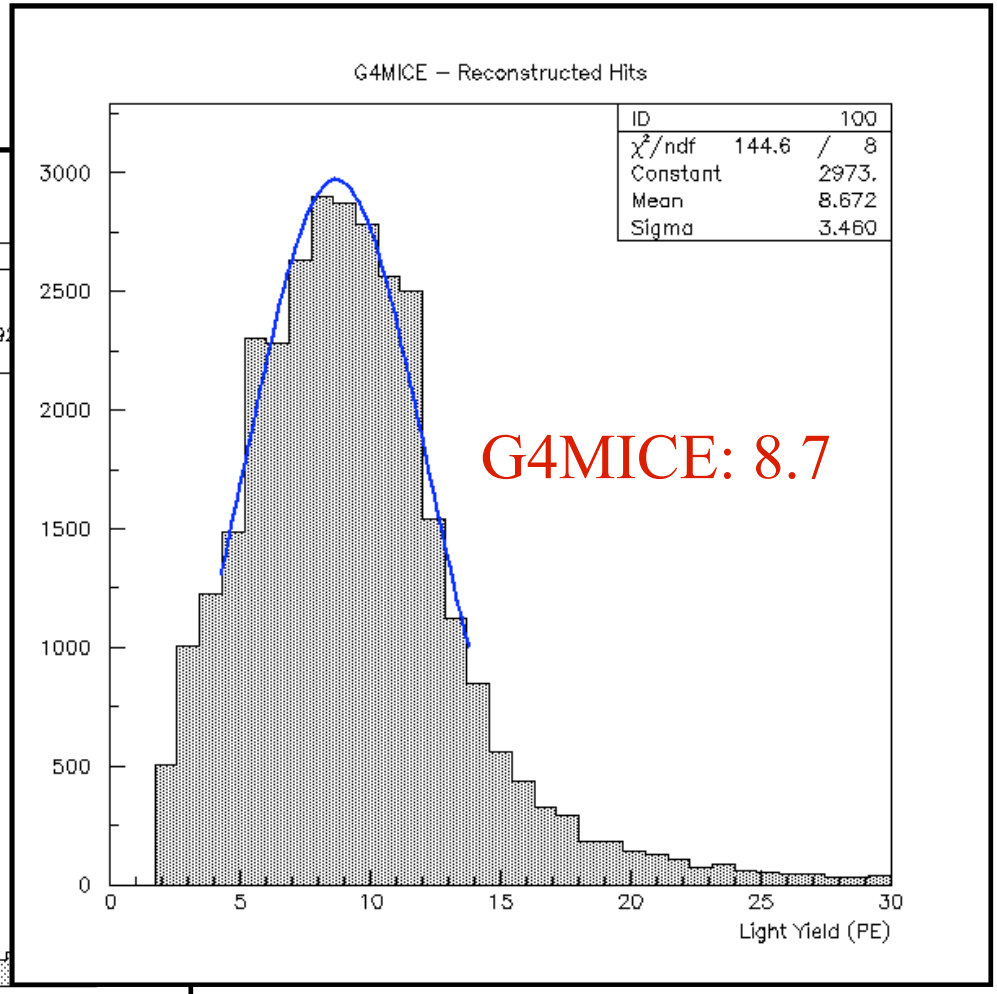


C. Rogers

Scintillating Fiber Tracker

Light Yield (Cosmic & G4MICE)



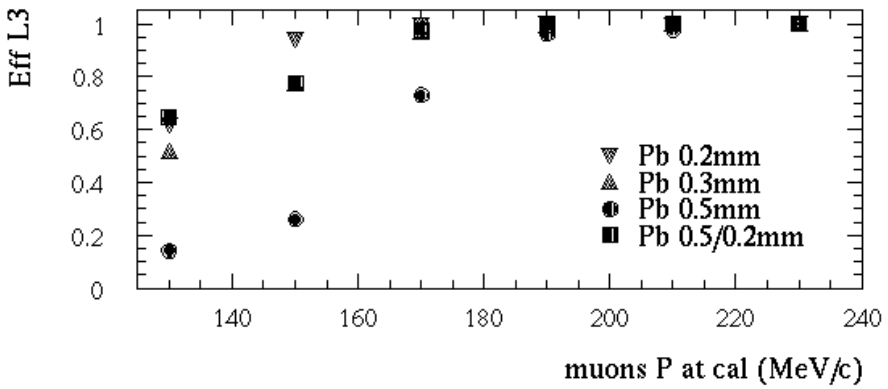


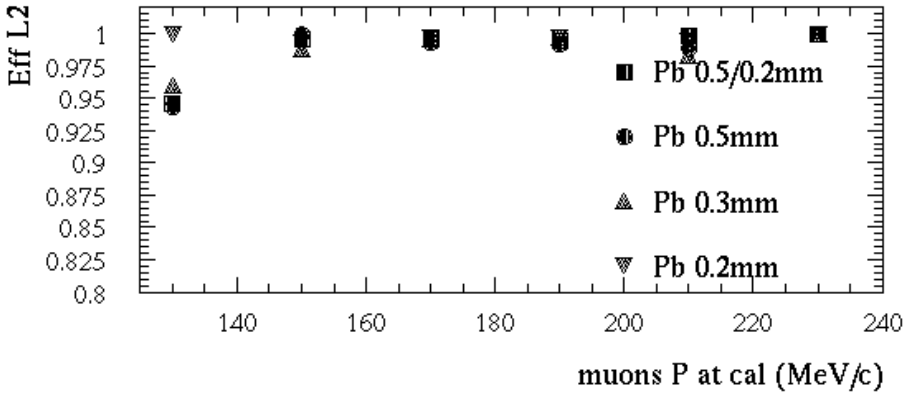
M. Ellis

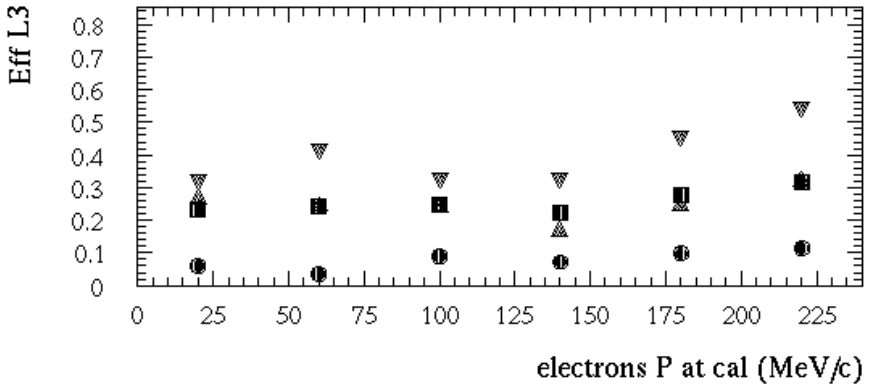
Calorimeter

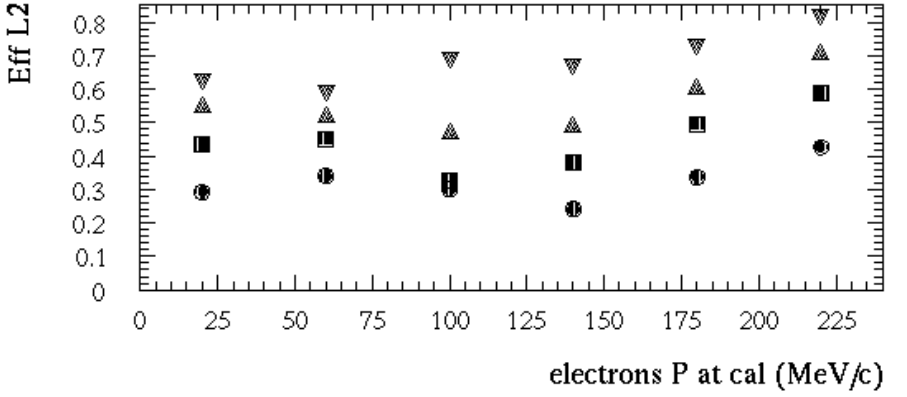
Optimization of lead absorber thickness

Eff. for signal>threshold in 3rd or 2nd layer vs momentum
(useful mainly for trigger purposes)









A. Tonazzo

Status

Magnets modeled including materials, fields calculated from coil geometry and currents

- Liquid hydrogen absorber vessels and windows with correct shape and thickness profiles
- Detailed geometry and materials for all detectors
- Inefficiencies and noise included in digitized signals
- Particles tracked with time-dependent EM fields from rf cavities
- All relevant physics processes included in tracking
- Detailed implementation of beam contamination and rf-induced background
- Building analysis tools for physics results

Plans

- Unit tests in preparation to validate all subsystems
- Beamline being incorporated into the simulation
- Full description to be completed Summer
- Detailed simulation of tracker and particle ID performance and background sensitivity in progress
- Switch to new architecture in the Fall
- Batch system on the GRID
- Build hooks to DAQ when ready
- Find more (or greater fractions of) people