



# LArSoft Simulation and Reconstruction Software

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# Outline



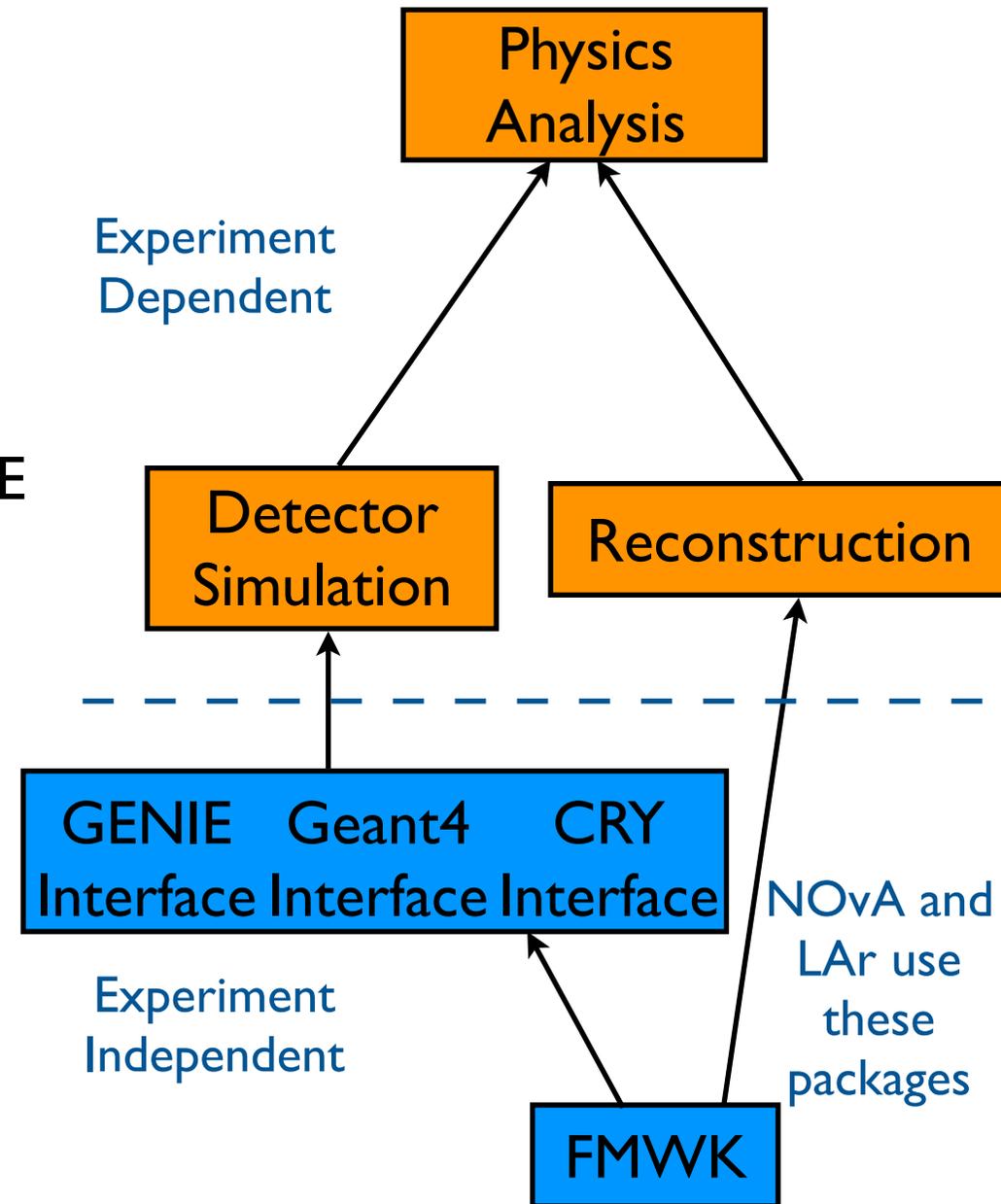
- Overview of NuSoft
- LArSoft - the simulation and reconstruction code



# Neutrino Software @ FNAL



- Recent effort made to get FNAL neutrino experiments on common framework, using common tools
- NOvA, ArgoNeuT,  $\mu$ BooNE using FMWK
- Use of common framework enables sharing of interfaces to flux files, GENIE (neutrino generator), Geant4, etc
- Water Cherenkov software can also easily be built on FMWK
- Enables direct comparisons between different detector technologies, people working on multiple experiments only learn one framework

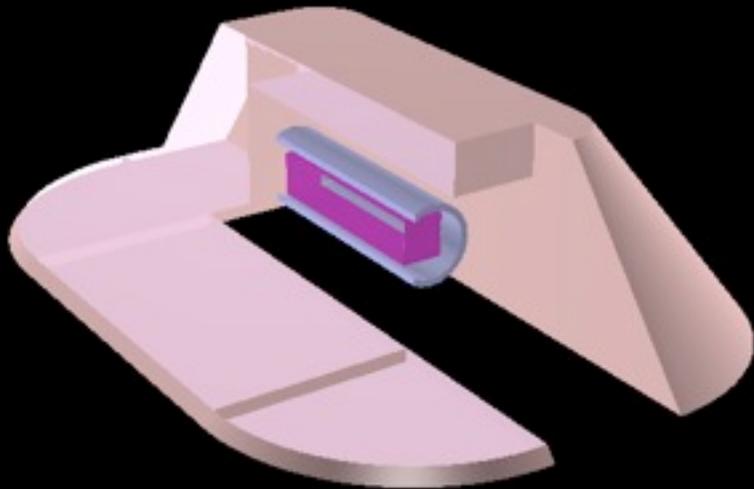


# LArSoft

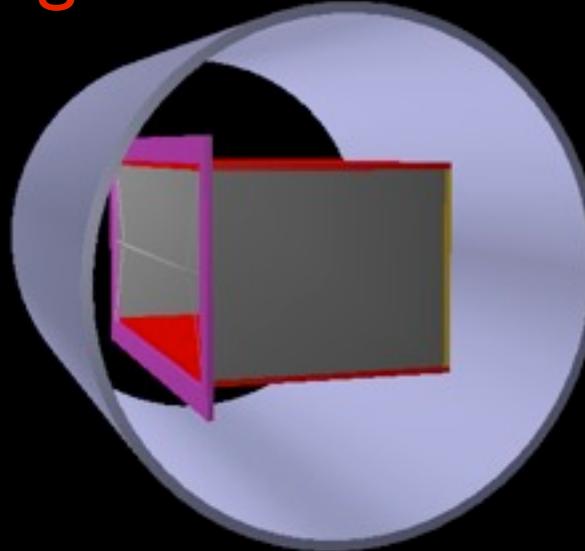


- LArSoft is a distribution of code for the LAr experiments - MTS, ArgoNeuT,  $\mu$ BooNE, LBNE
- Each detector just needs to add a new geometry description
- Reconstruction knows how to access different geometries, but not dependent on any one

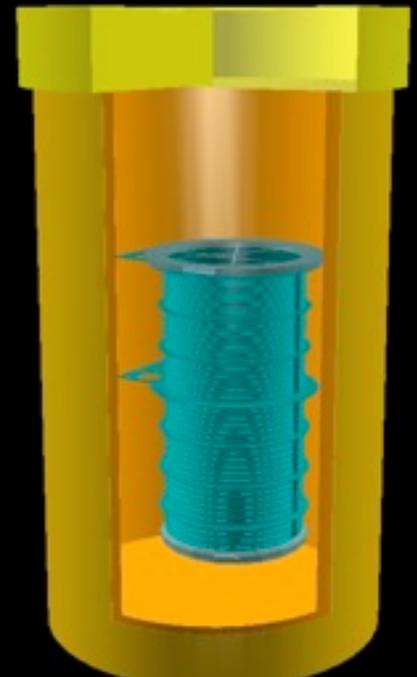
$\mu$ BooNE



ArgoNeuT



Bo

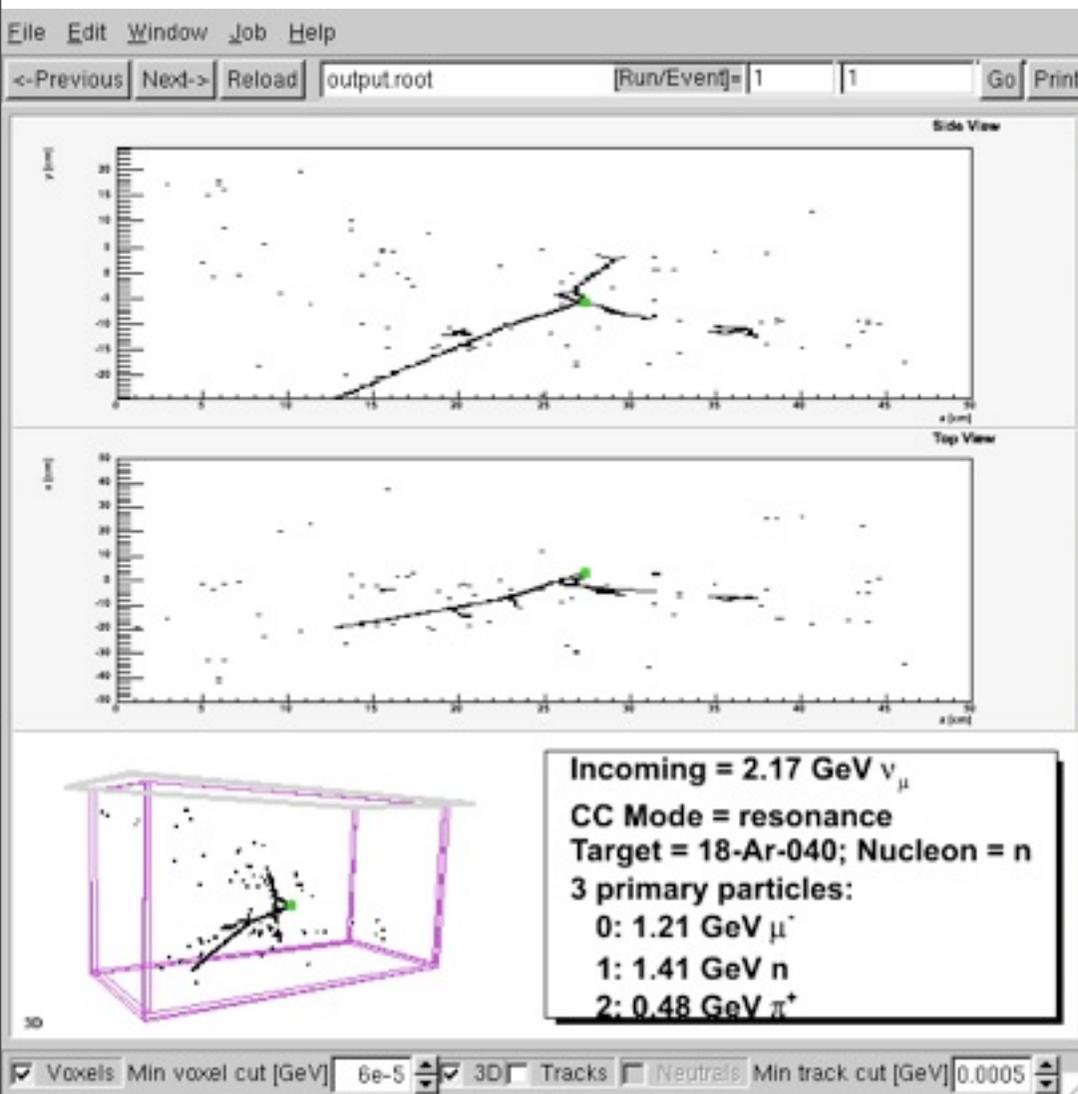


# Current State of Development

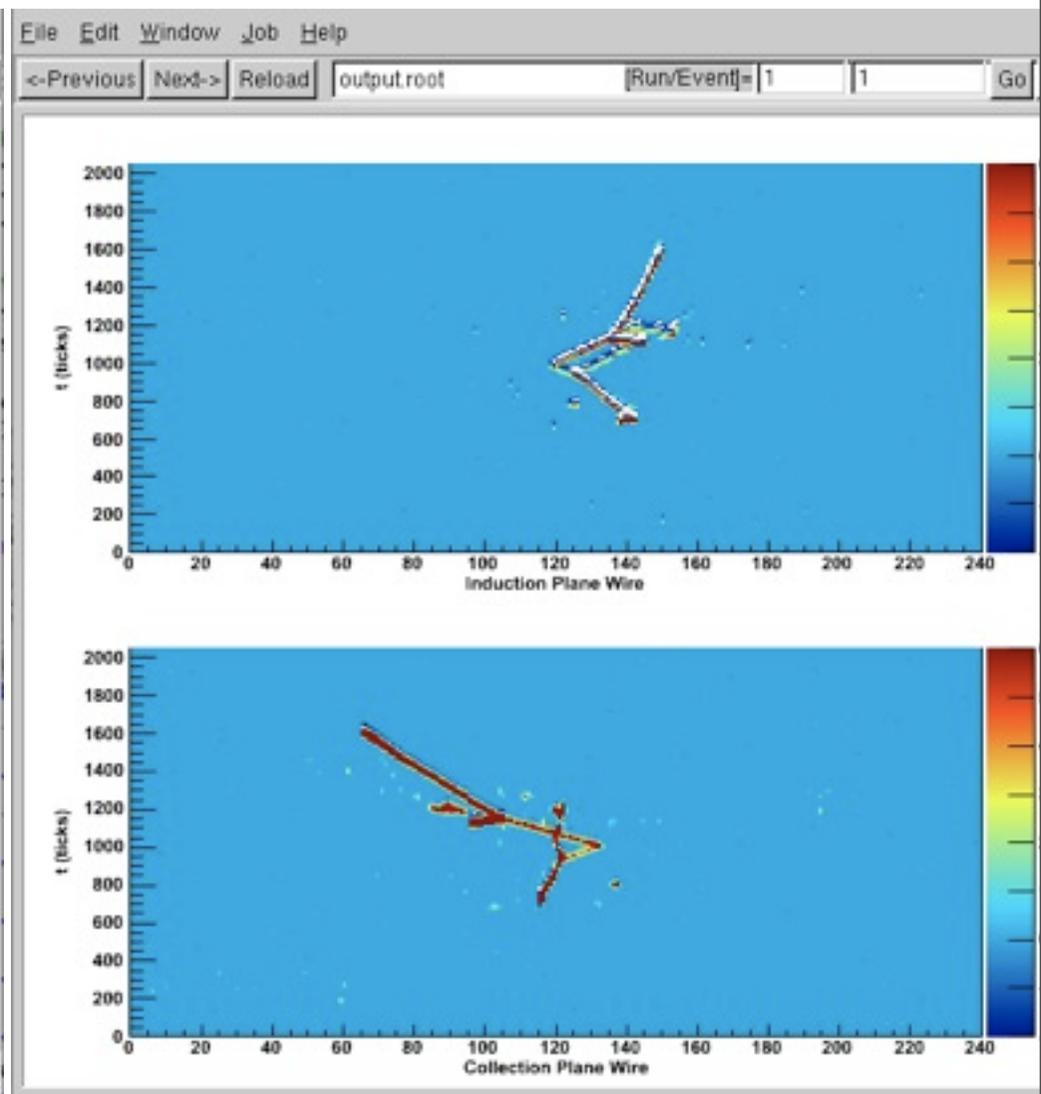


- LArSoft effort began in fall 2008
- LArSoft has benefited from needs of ArgoNeuT,  $\mu$ BooNE
- Monte Carlo simulation provides
  - Direct access of event generators for cosmic rays (CRY) and neutrino interactions (GENIE)
  - Direct access to Geant4 for energy deposition simulation
  - Conversion of energy to ionization electrons and readout simulation
- On-going studies comparing data to simulation
- Hit finding routines nearly complete
- Current need is for effort on reconstruction algorithms

# Example ArgoNeuT MC Event

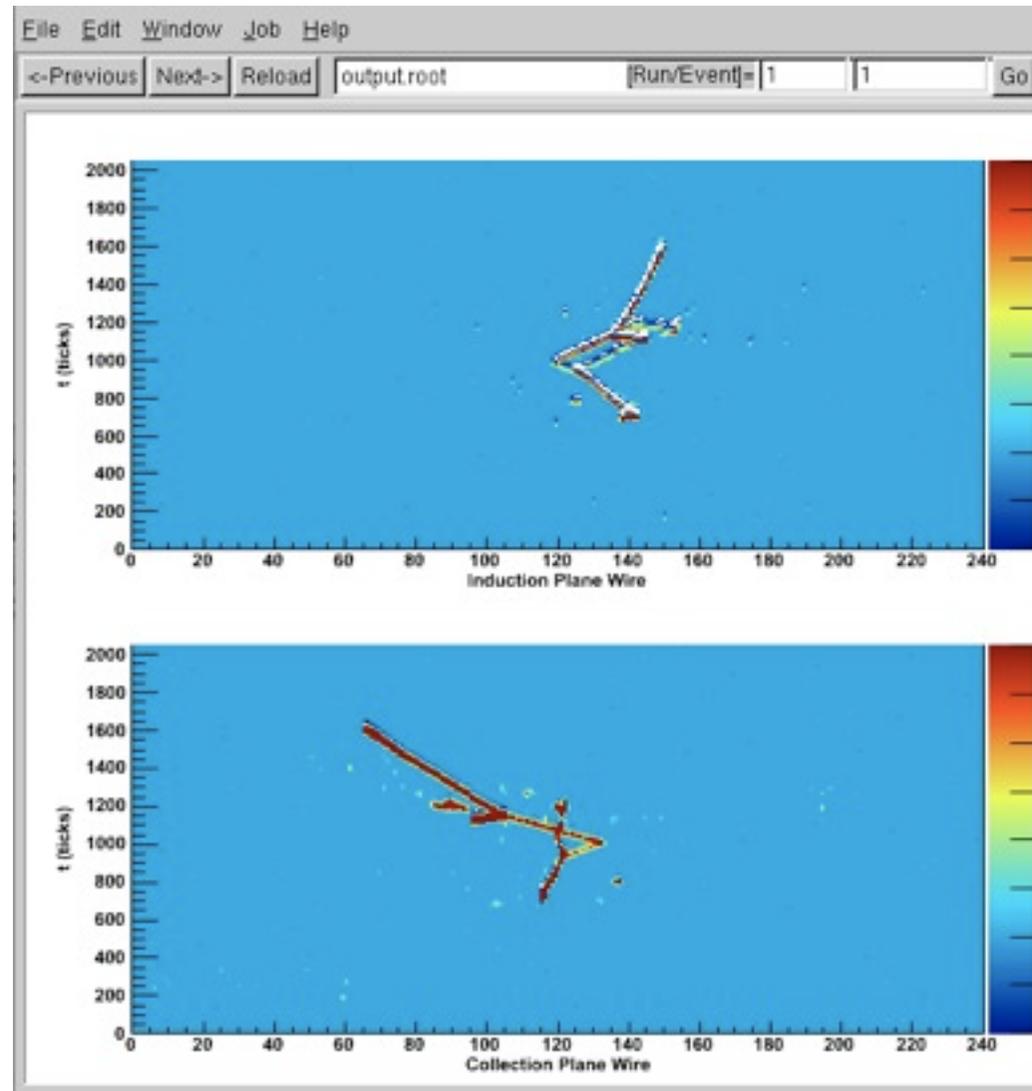


MC Energy  
Deposition View



Simulated  
Digitization View

# Example ArgoNeuT MC Event



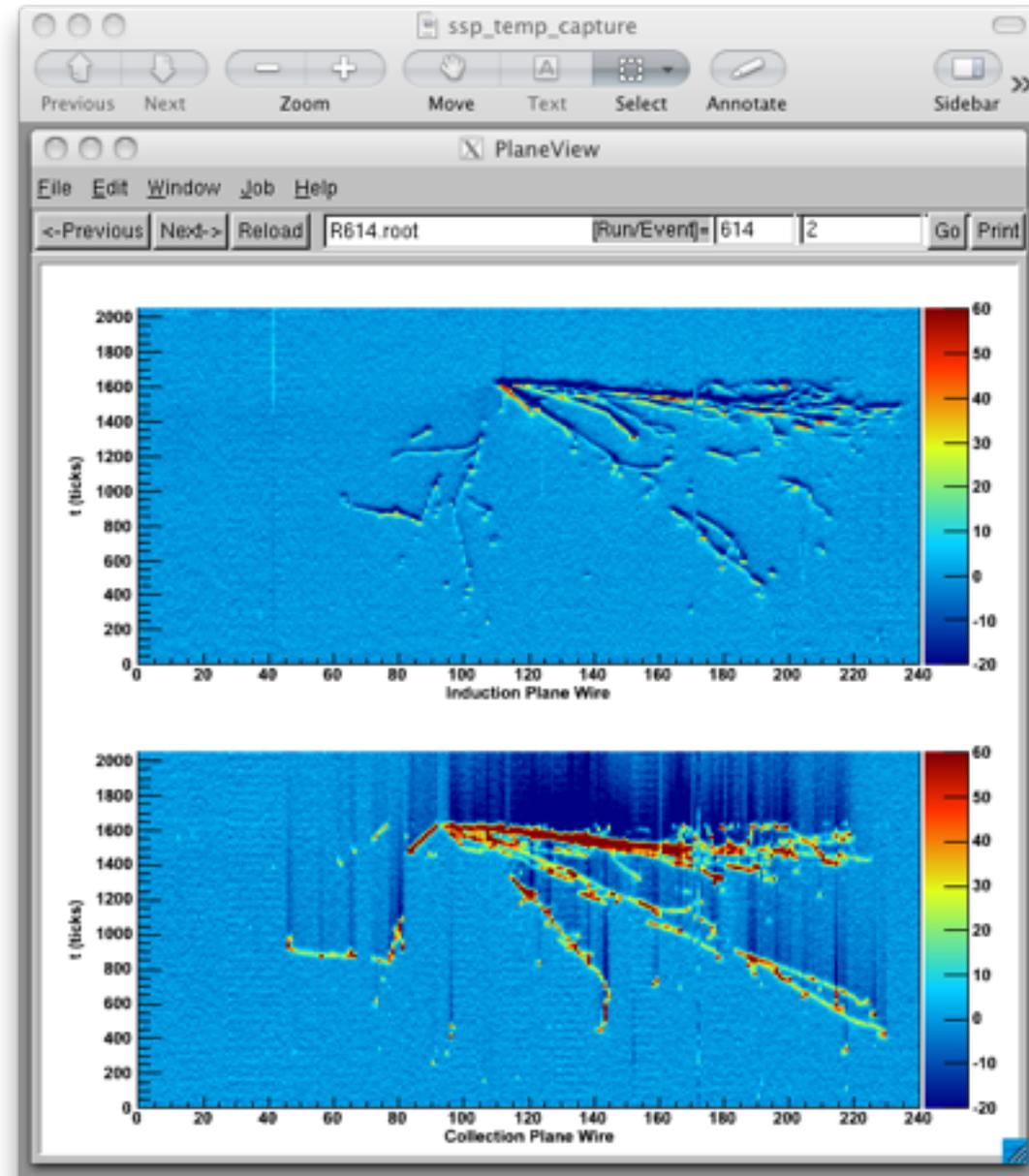
MC Energy  
Deposition View

Simulated  
Digitization View



# Reconstruction

- Recent ArgoNeuT event shown at right
- Shows that reconstruction will be a challenge
- Separation of different tracks, particle ID etc will be more complicated than in detectors with poorer resolution



# Computer Vision Reconstruction



- Computer vision is a branch of computer science that attempts to extract information from images
- Since LArTPC events are similar to pictures, seems like a good avenue to pursue
- Many different algorithms available in this field - distance transforms, skeletonization, center-line extraction
- This technique looks promising as each example shows ability to pick out central track and associated energy depositions
- Work also starting on more traditional reconstruction methods



# Current Contributors



- The list of LArSoft contributors is growing - several members from Columbia/Nevis, FNAL, MIT, Michigan State, and Yale
- Projects include
  - Improvements to detector geometry descriptions
  - Event display improvements
  - Simulation of light and photodetectors
  - Automated reconstruction of hits, tracks, and showers

# Conclusions



- The simulation software is mature enough to allow for production of simulated events
- New detectors can be added to the software with little effort
- The automated reconstruction effort is beginning, many promising reconstruction techniques being explored
- Expect to have ability to do 3D reconstruction by next fall