

# ShowLib

A set of shower libraries and associated tools for  
the Linear Collider Detector

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[www.utdallas.edu/~nijusan/ShowLib](http://www.utdallas.edu/~nijusan/ShowLib)

# Outline

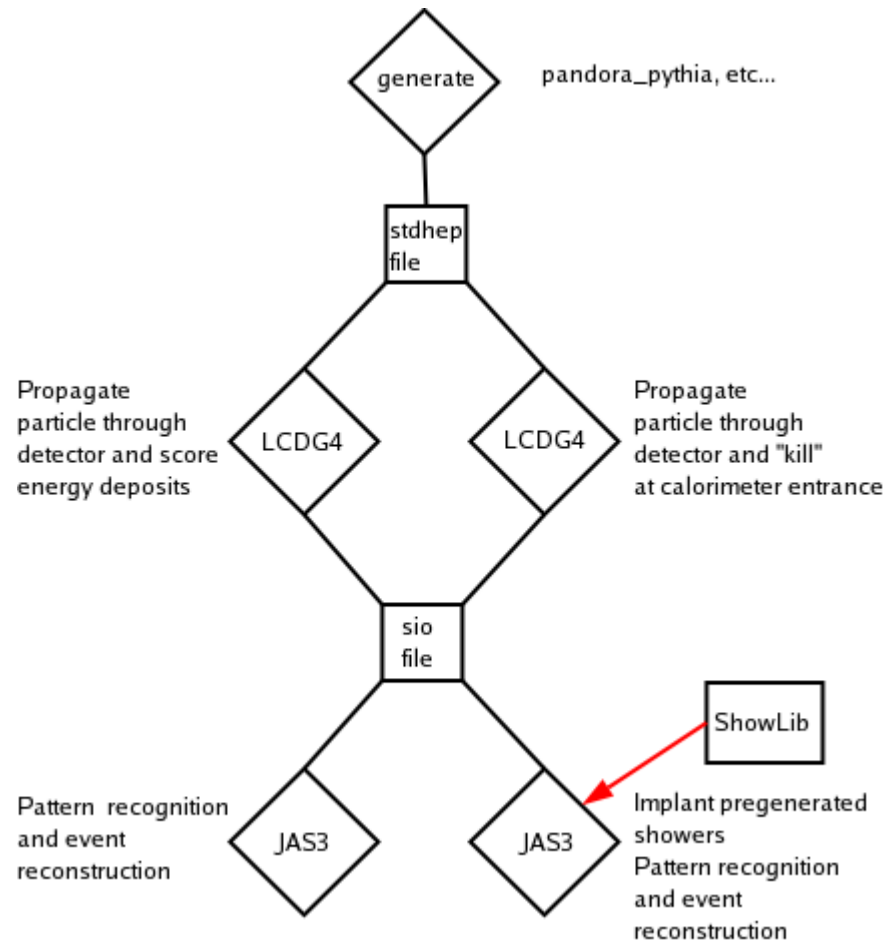
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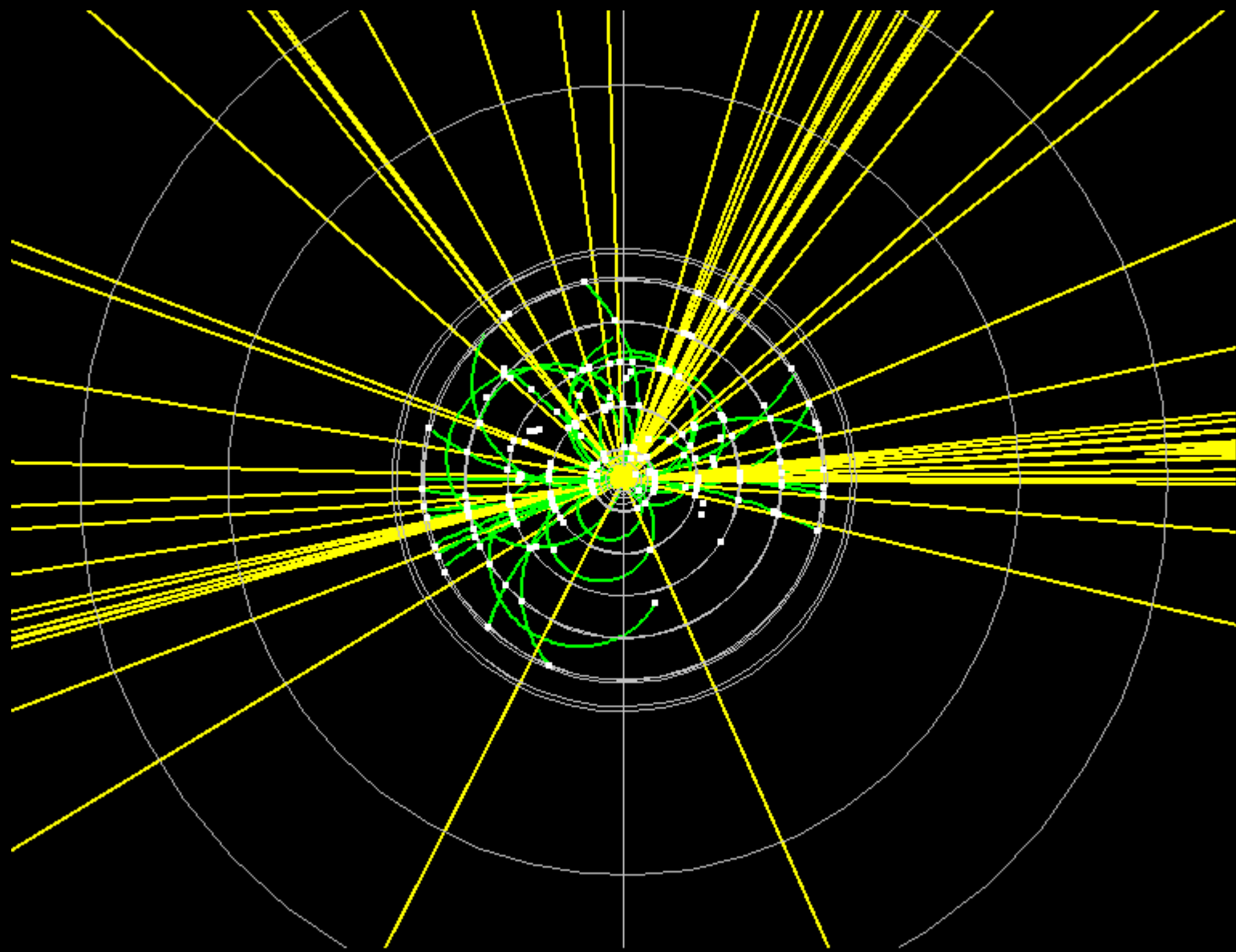
- Brief description and purpose
- Performance results
- Implementation
- Comparison to full simulation
- Details of tweaking
- Conclusions

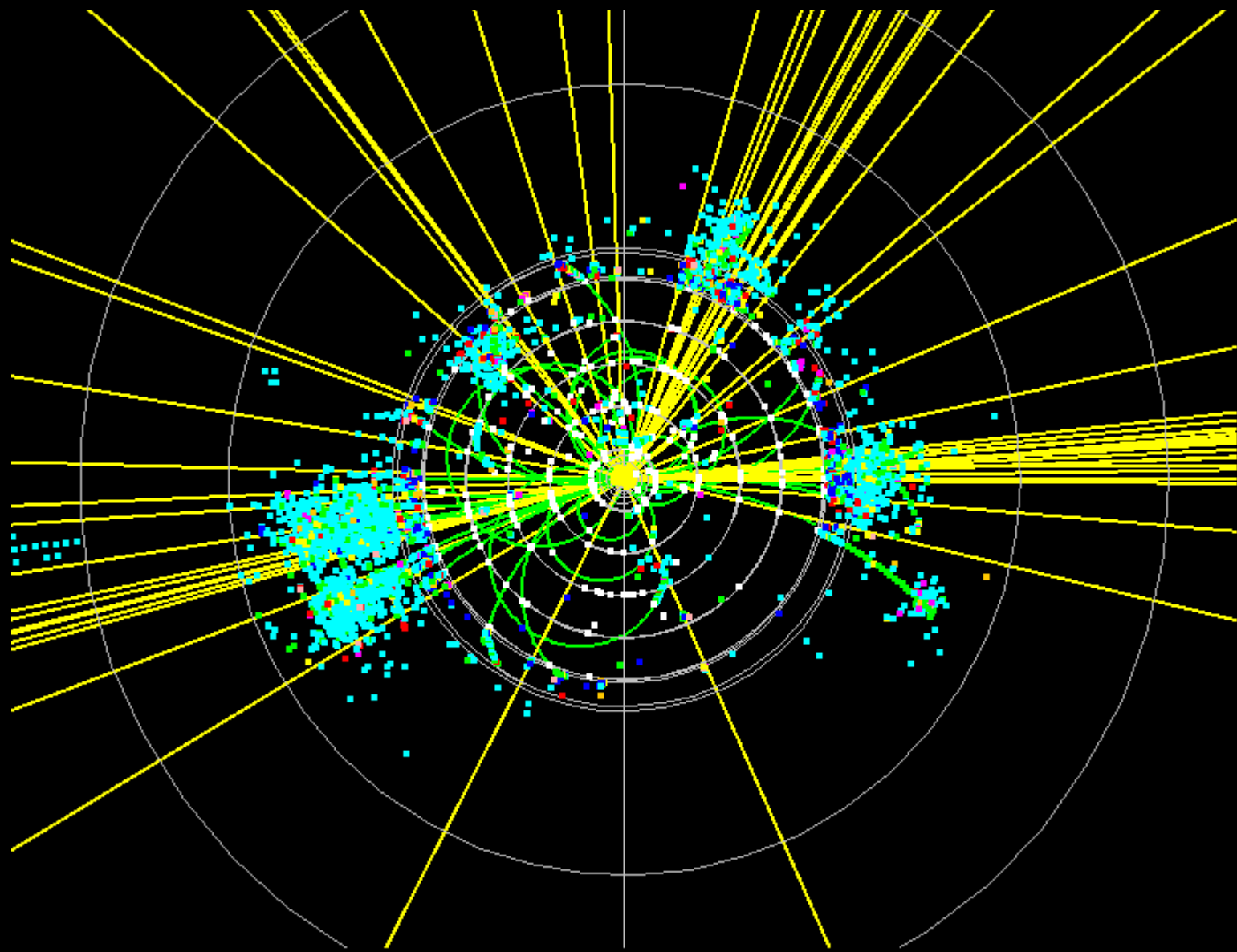
# What is a shower library and why use them

- Pre-generated calorimeter hits
  - Showers read in from disk and placed in the event during analysis
- Pseudo-fast monte carlo
  - Faster than simulating every hit
- Geant4 like detail
  - Real hit information stored in libraries

# ShowLib flowchart







# What you get

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- Suitable for typical lcd analysis
- Deep enough for 20k ~ 30k events
- Factor of 9 ~ 10 times faster than full simulation
- Easy to switch between full simulation and shower libraries
  - Just two user calls

# Performance results

Stage	Full Sim.	ShowLib
Generation	4.0s	4.0s
Simulation	475.4m	25.7m
Search and embed	N/A	24.4m
Total	475.5m	50.1m

\*Based on user time for 1000 ee -> ttbar events on 1.6GHz Athlon system

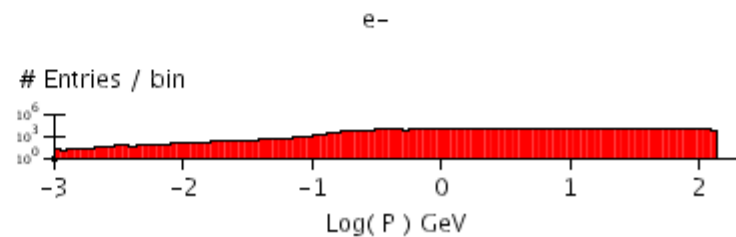
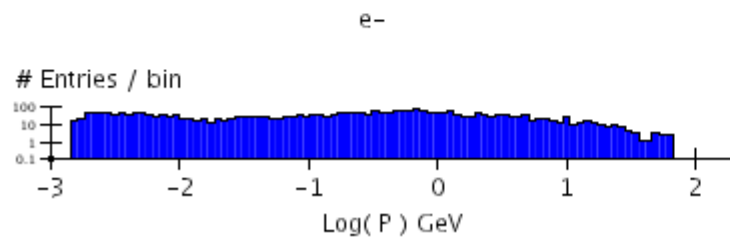
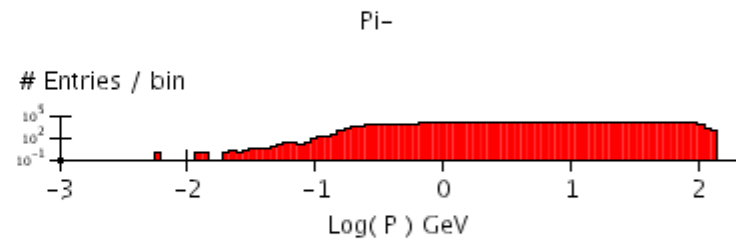
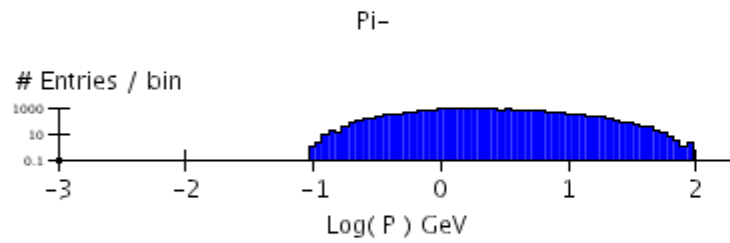
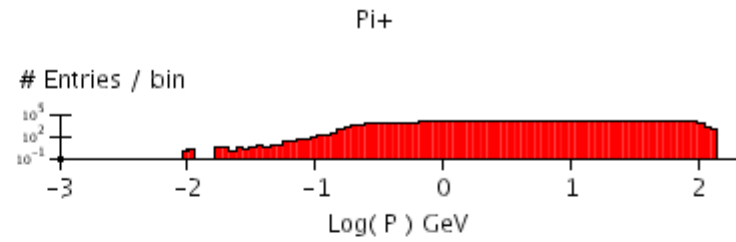
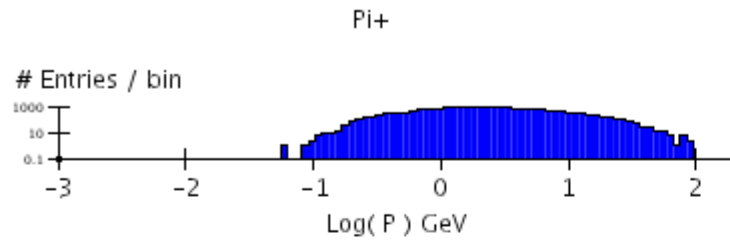


# Types of showers stored

Charged	Neutral
$e$	$\gamma$
$\pi$	$K_L$
$K$	$K_S$
$p$	$n$
	$\lambda$

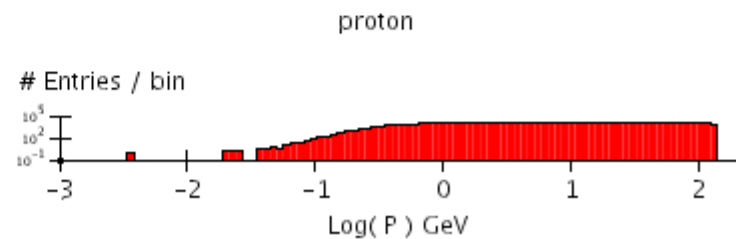
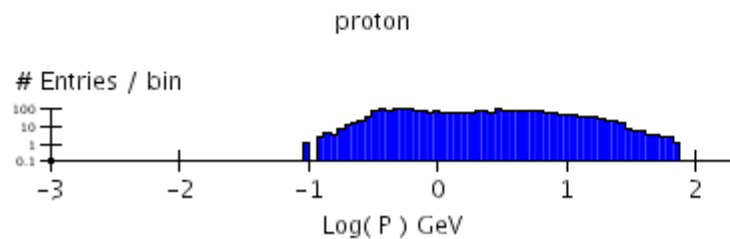
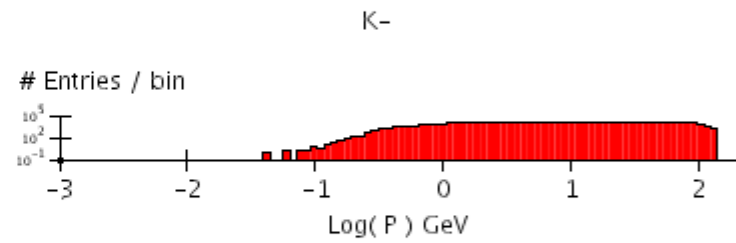
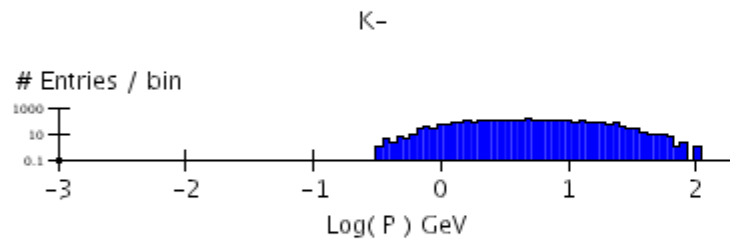
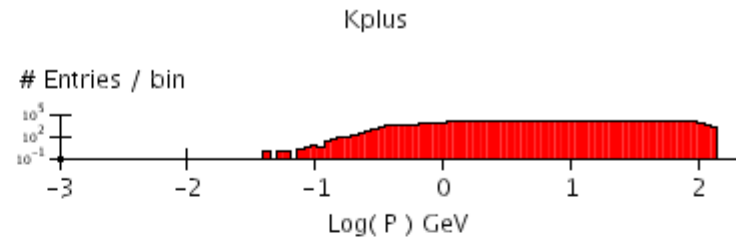
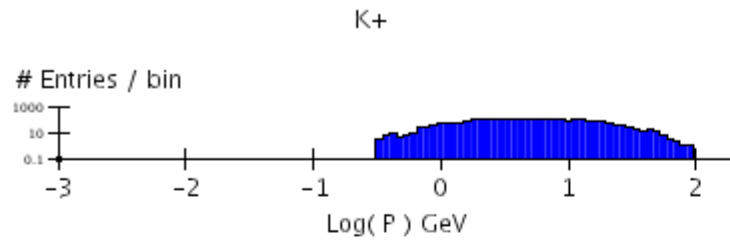
\* and respective antiparticles each stored in a separate file

# Energy Ranges



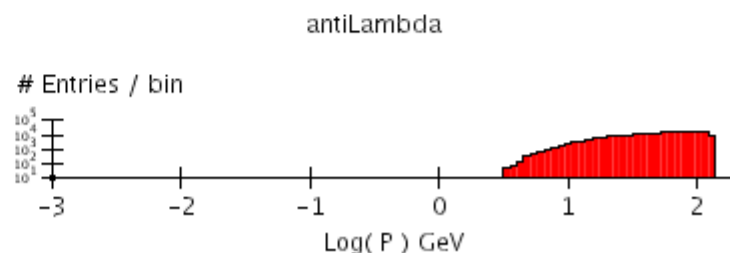
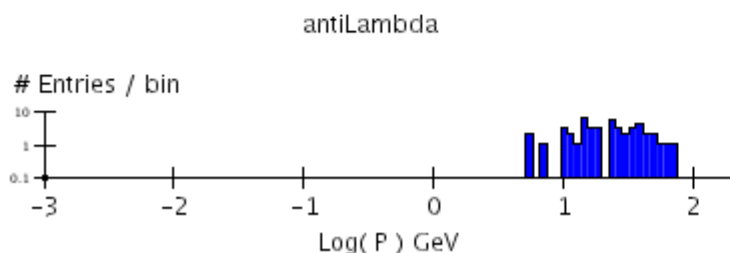
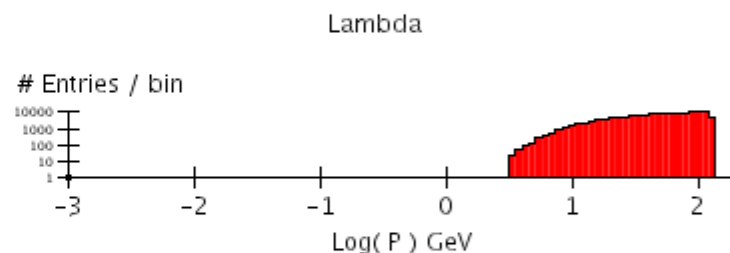
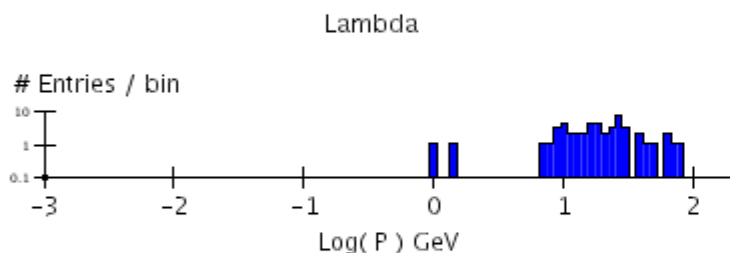
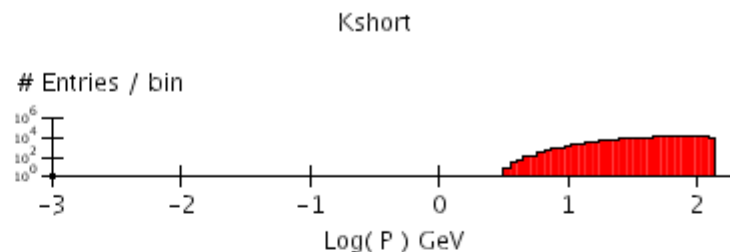
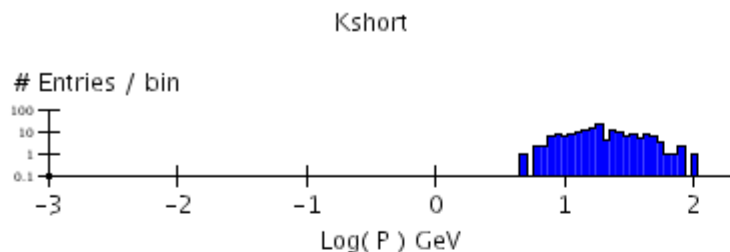
- Based on 1000  $e^+e^- \rightarrow t\bar{t}$  events
- Full simulation in blue
- ShowLib in red

# Energy Ranges cont.



- Based on 1000  $e^+e^- \rightarrow t\bar{t}$  events
- Full simulation in blue
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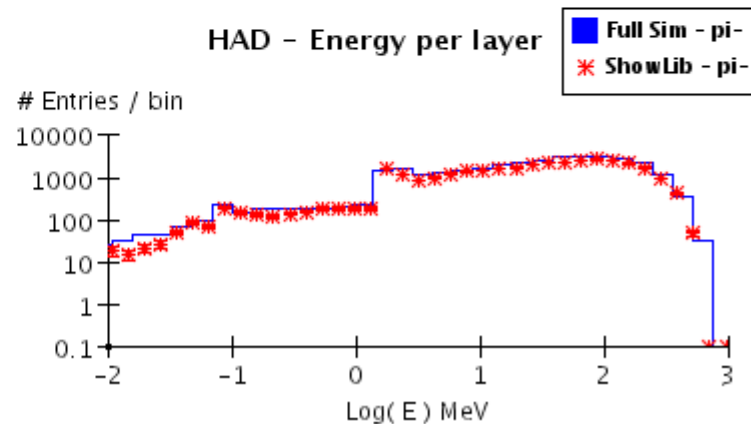
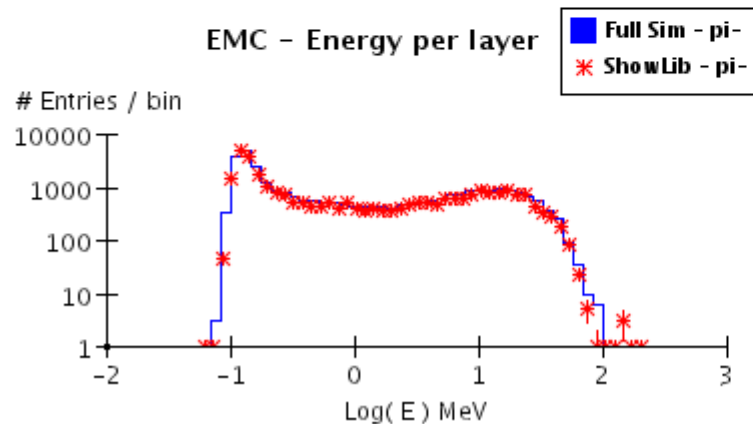
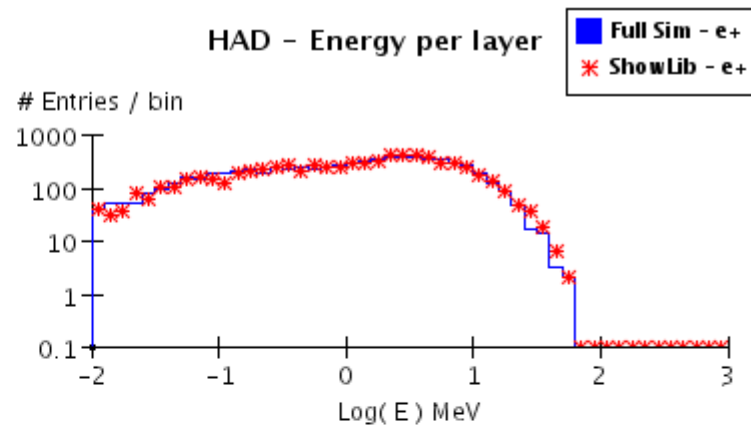
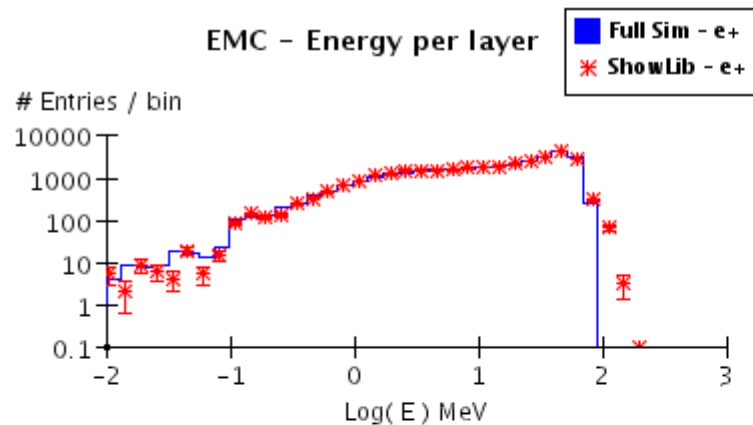
# Energy Ranges cont.

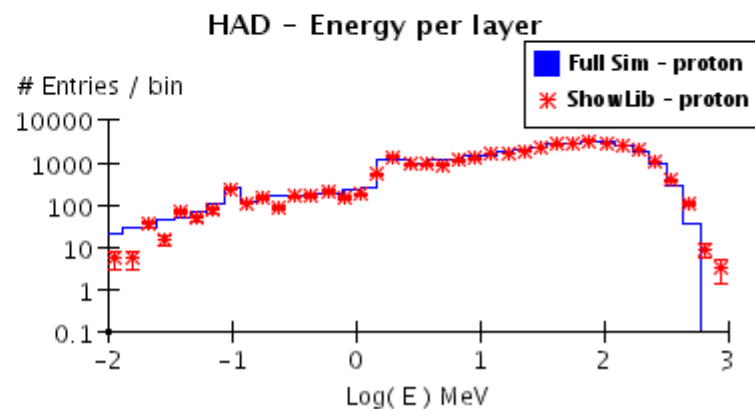
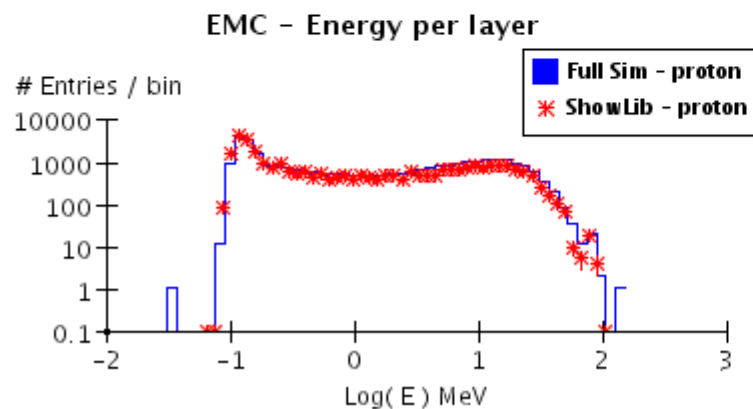
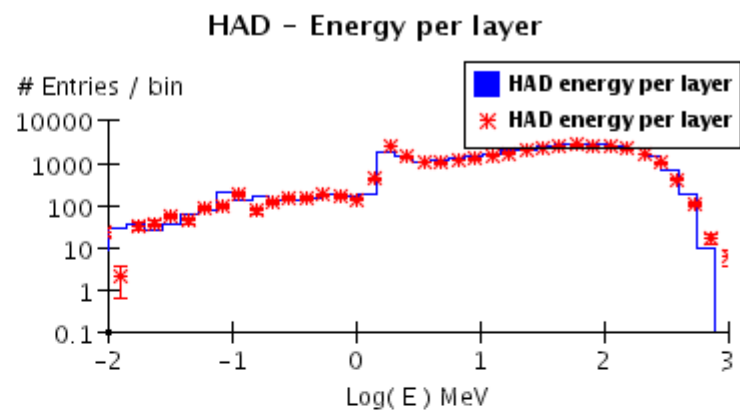
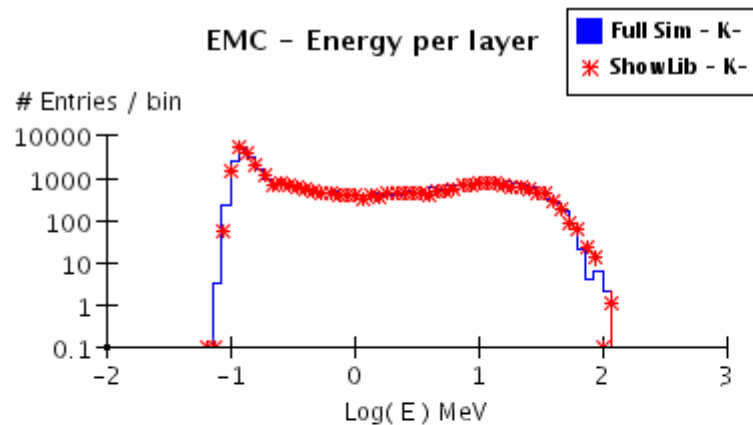


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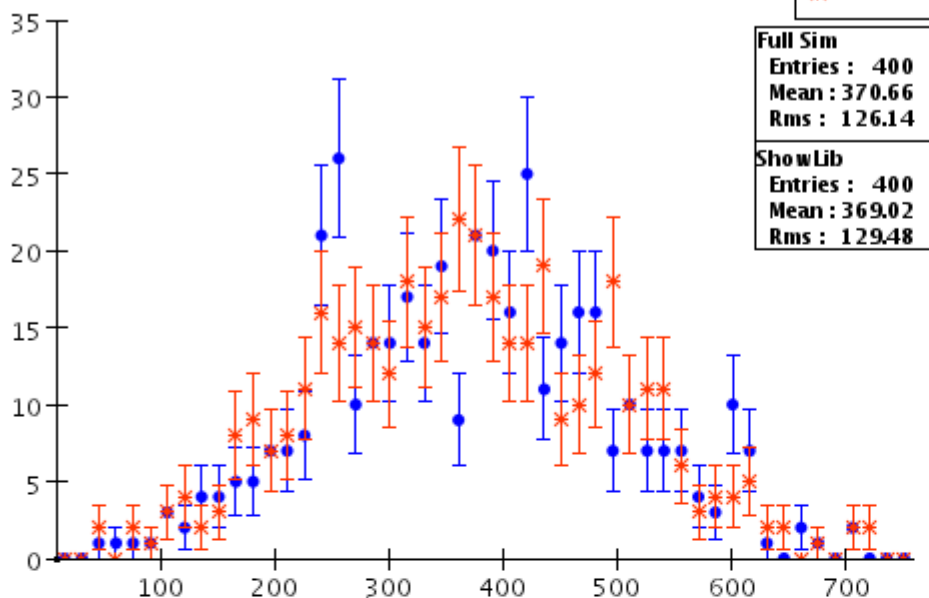
# Library size

- Libraries produced flat in  $\log(E)$  and  $\cos(\theta)$
- Neutrals:  $\sim 0.01 \text{ GeV} - 130 \text{ GeV}$
- Charged:  $\sim 1 \text{ GeV} - 130 \text{ GeV}$
- $\sim 3$  decades  $\times 231.4$  energy bins/decade
- 489.2 energy bins
- 840 theta bins  $\sim 0.5\text{cm}$  at calorimeter face
- $\sim 580,000$  showers per library  
( 600,000 )

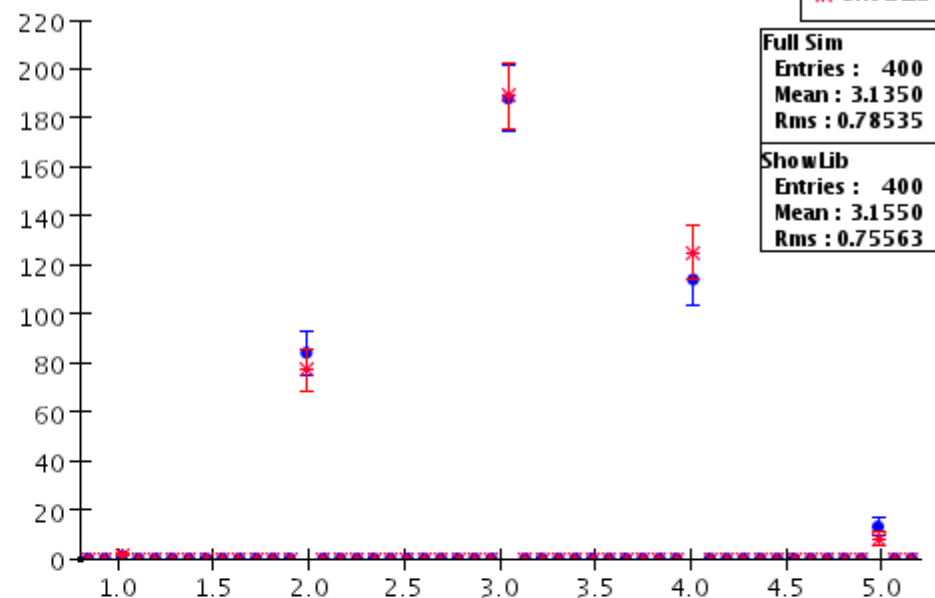




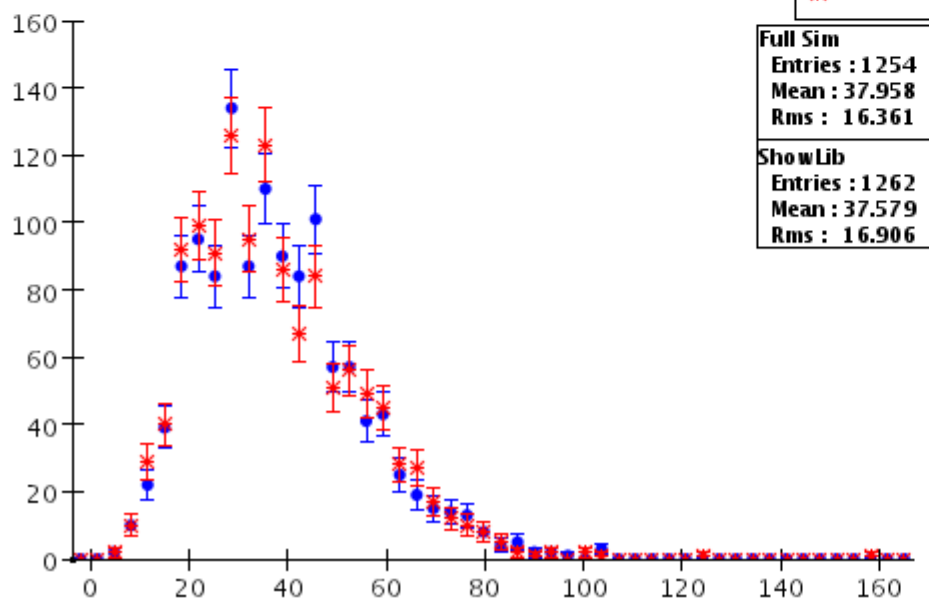
Durham Total Jet Energy



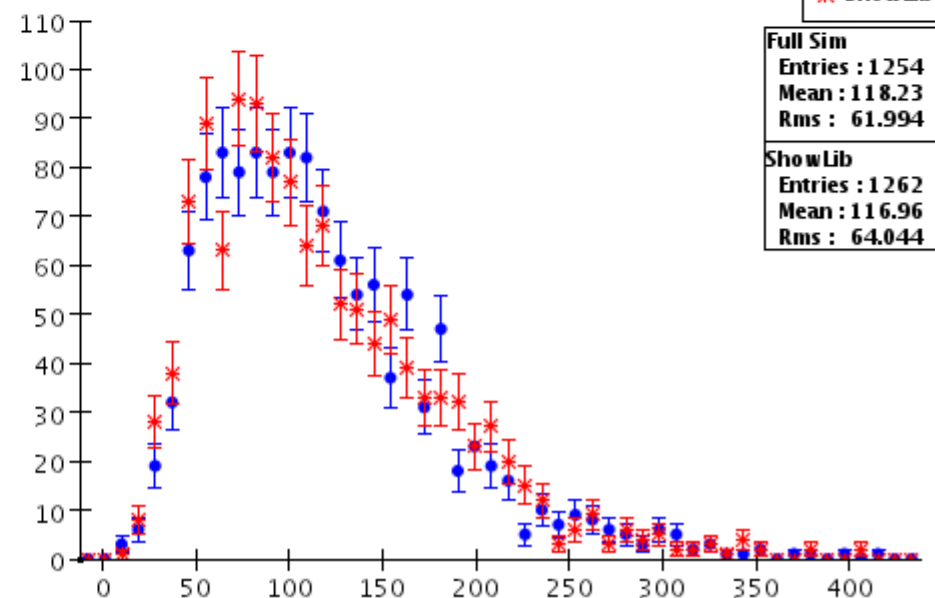
Durham clusters Njets



Durham Number of Clusters in Jet

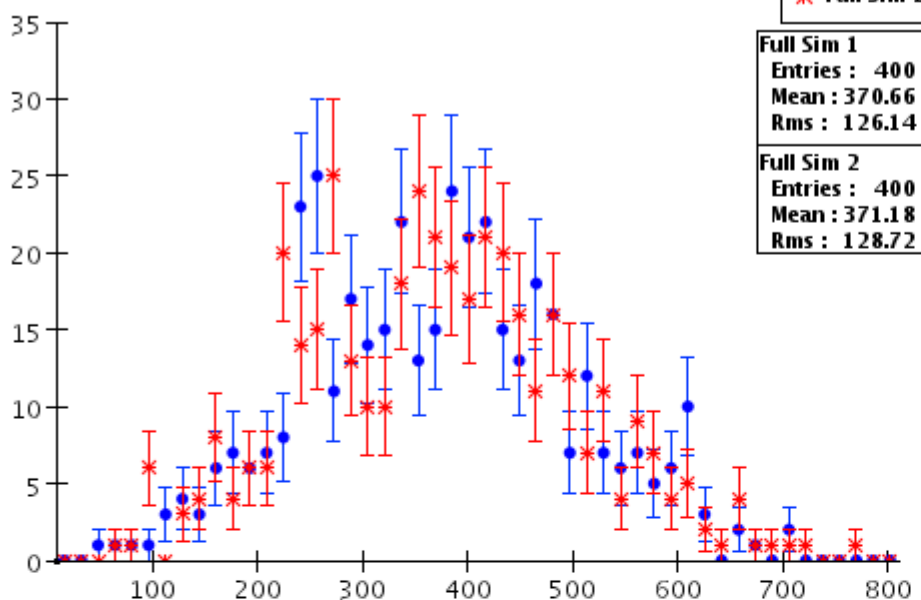


Durham Cluster Jet Energy

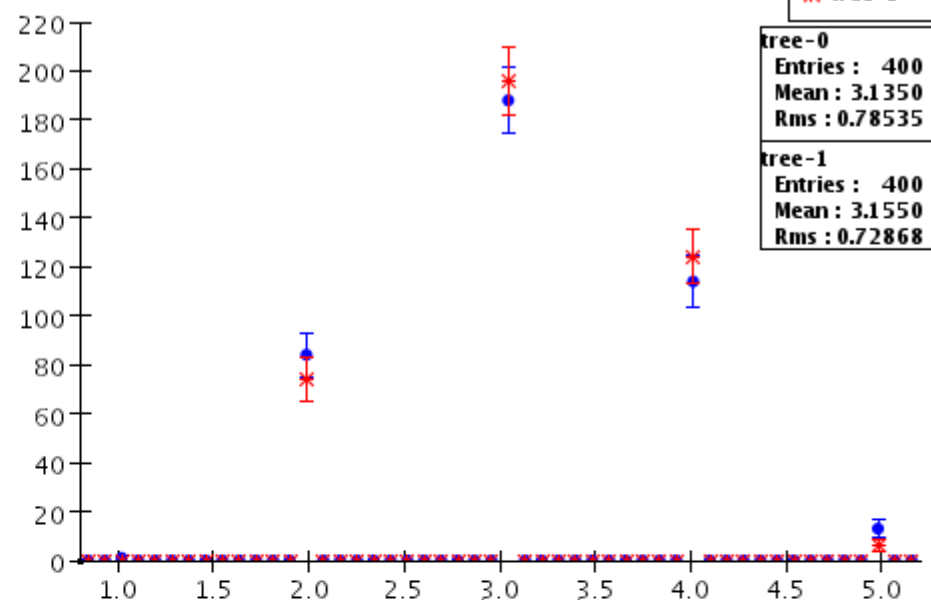




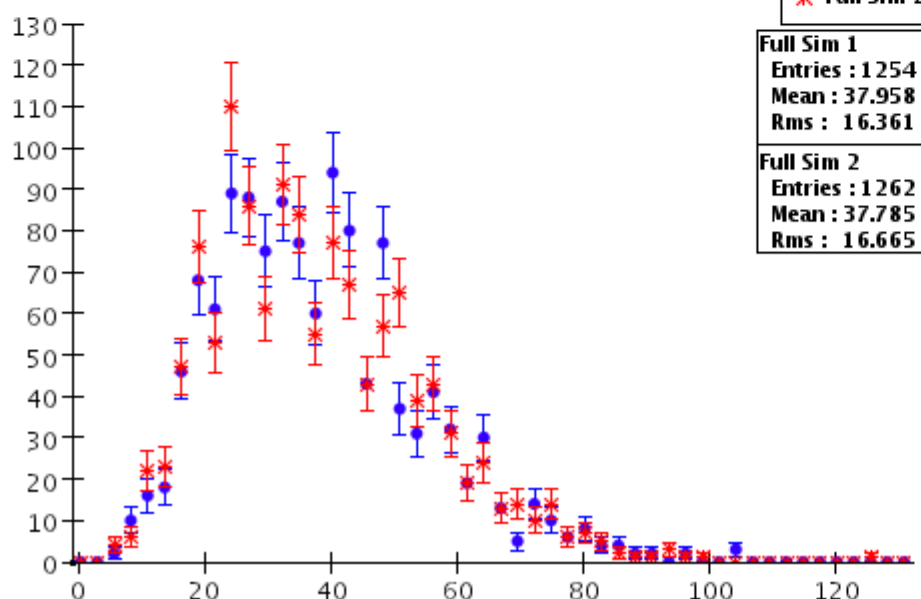
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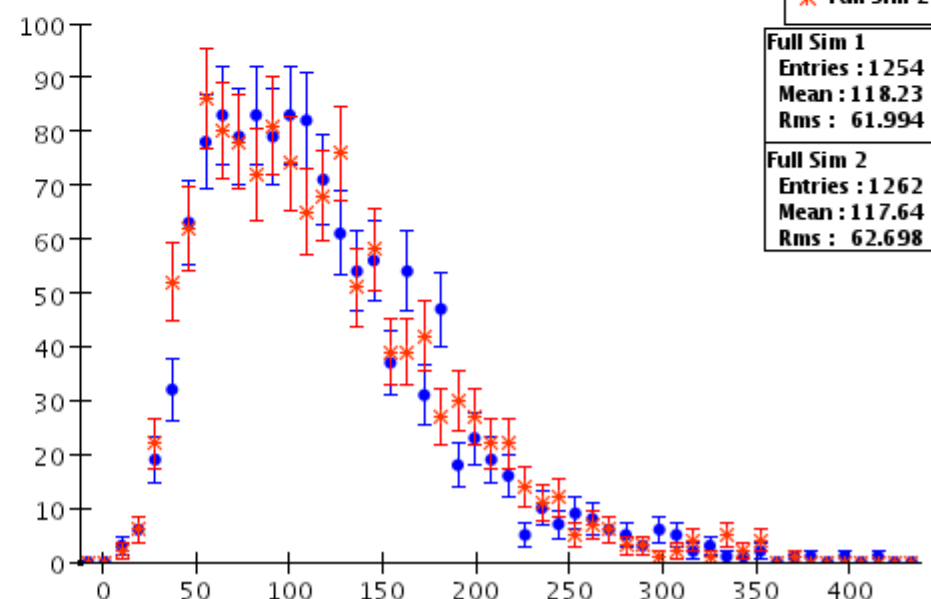
Durham clusters Njets



Durham Number of Clusters in Jet



Durham Cluster Jet Energy



# ShowLib usage

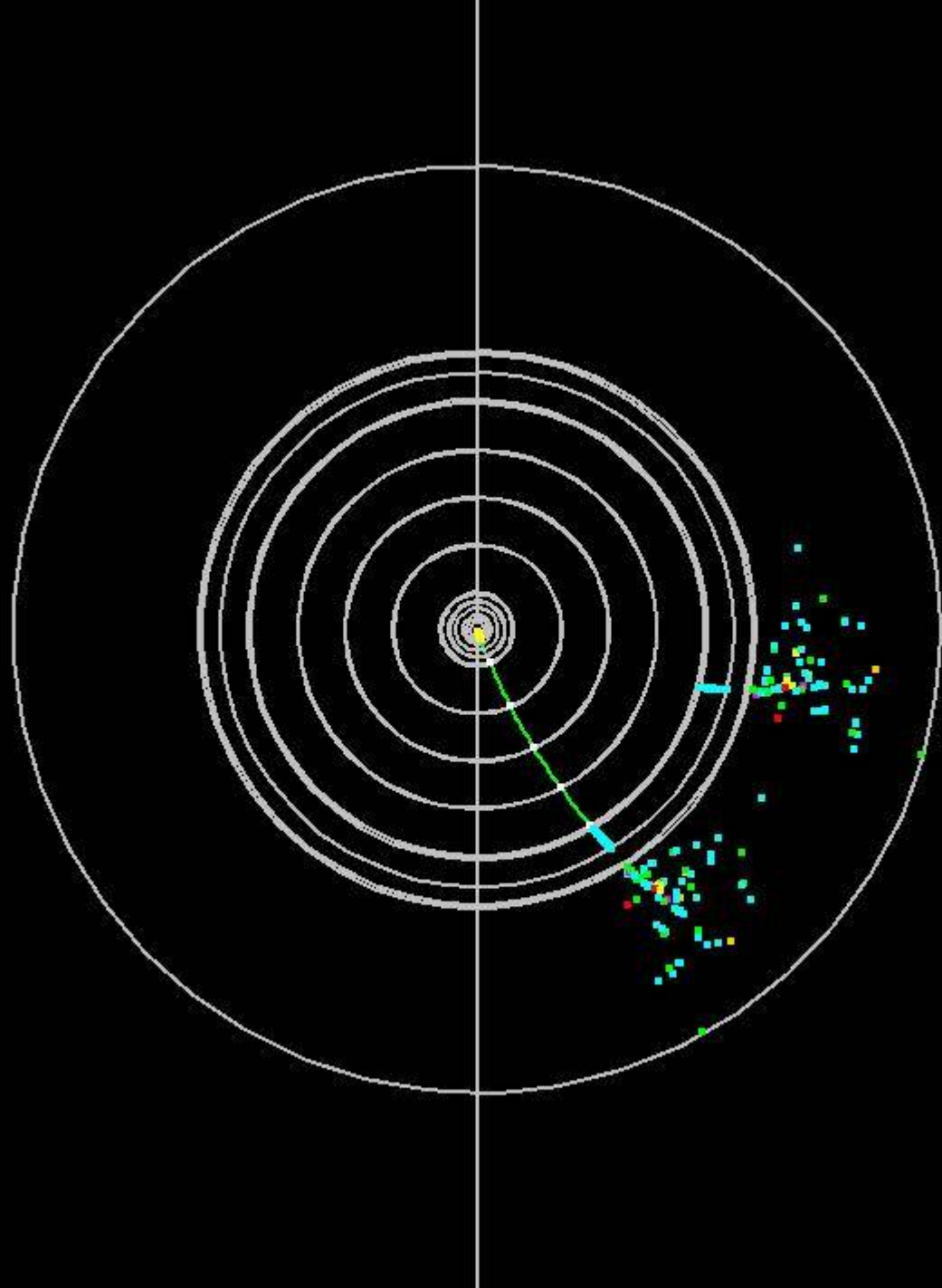
- Drop-in addition to jas3
  - Unpack inside of jas3 directory
  - Add two user calls:

Showertools.LoadShowerIndex();

Showertools.ShowerEvent( event );

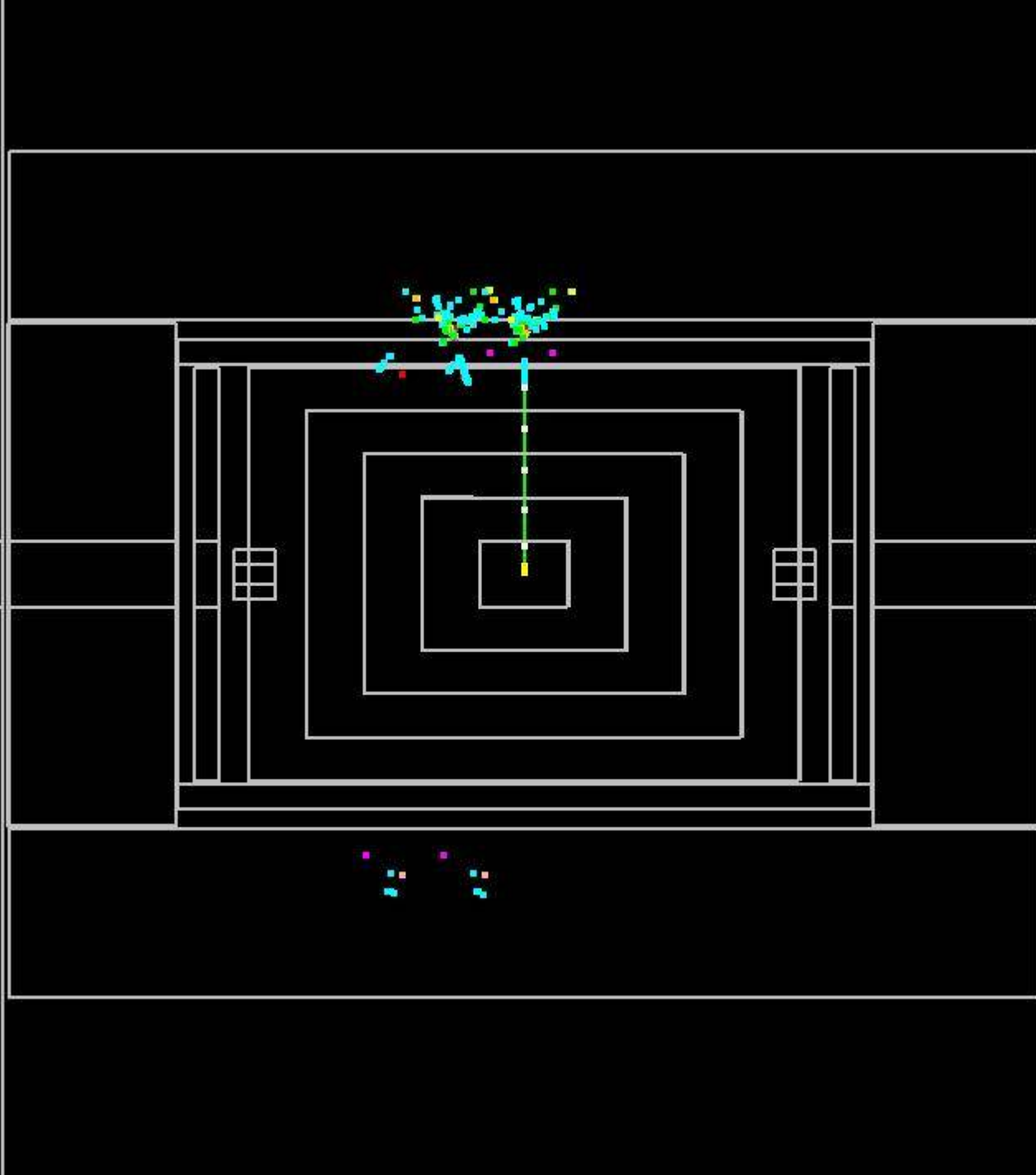
# ShowLib routine sequence

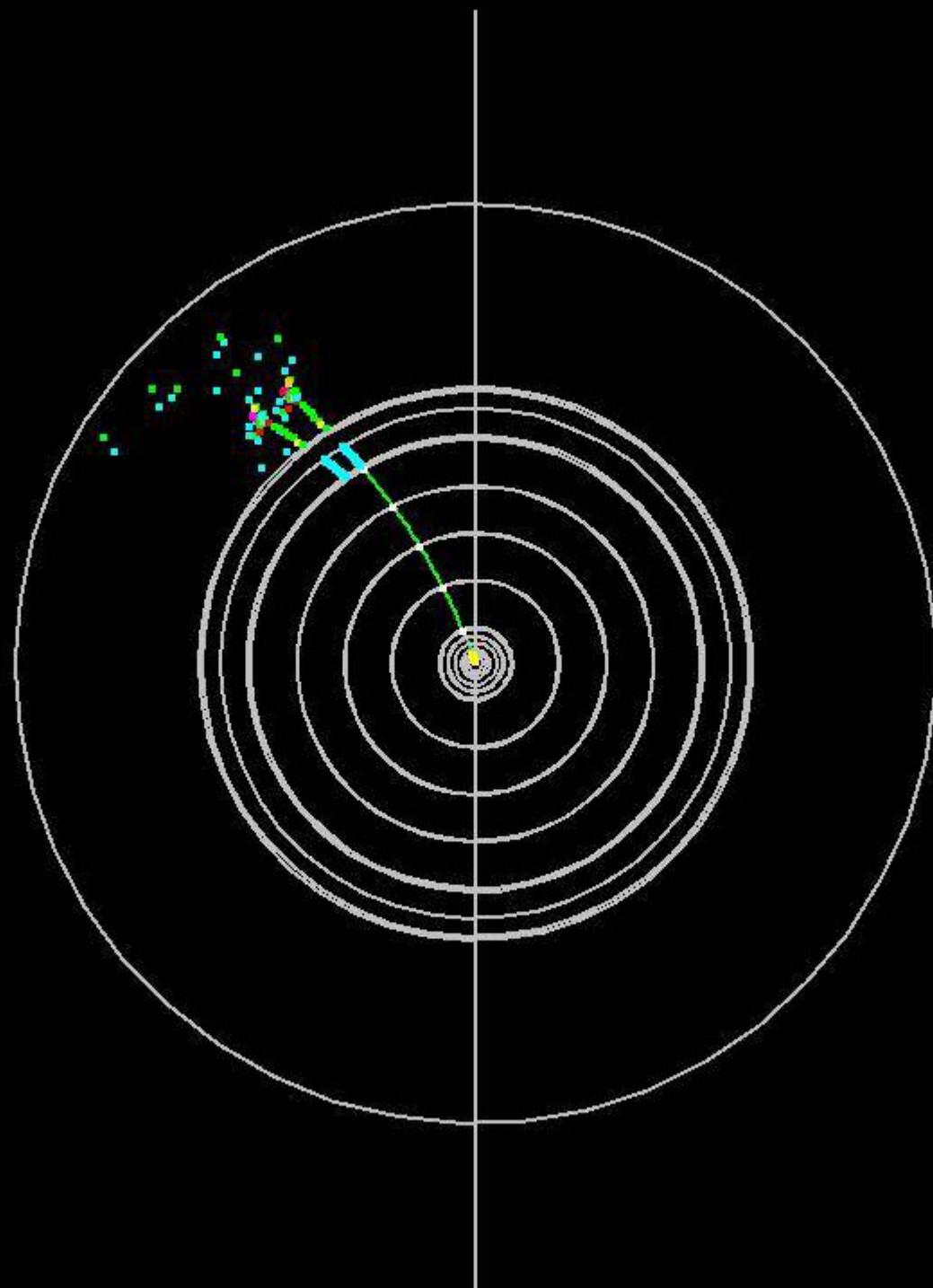
- ShowerEvent is called
- Find matching shower in library
- Rotate shower in  $\phi$
- Rotate shower in  $\theta$  (not done)
- Shift shower energy
- Embed shower in event



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# Details of shower tweaking

- Phi rotation simple due to symmetry of current detector
- Theta rotation achieved through a swim and embed technique
- “Poor man’s” energy shift done by adjusting each cell the same amount for both EMC and HAD

# Conclusions

- General design and implementation done
  - Need to create libraries for other detector designs
  - Useful for Snowmass?
  - Mokka version?
- Website with documentation and results at:  
<http://www.utdallas.edu/~nijusan/ShowLib>