GLAST Large Area Telescope:
EM Preliminary Test Results

Eduardo do Couto e Silva
SU-SLAC
Science Verification Analysis and Calibration Manager of the I&T subsystem
(representing the LAT EM Crew)

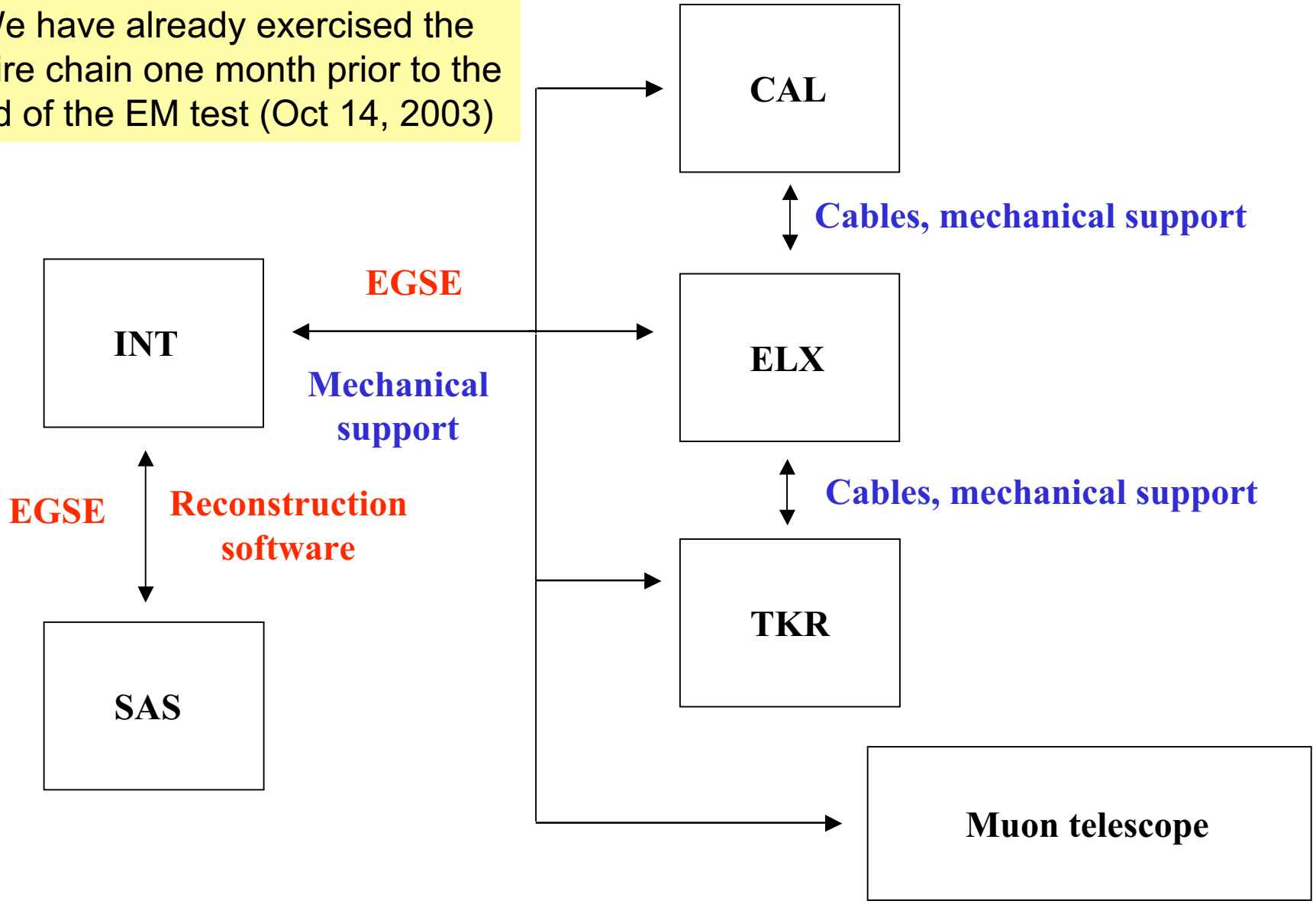
eduardo@slac.stanford.edu
+1 650-926-2698

EM Program @ SLAC

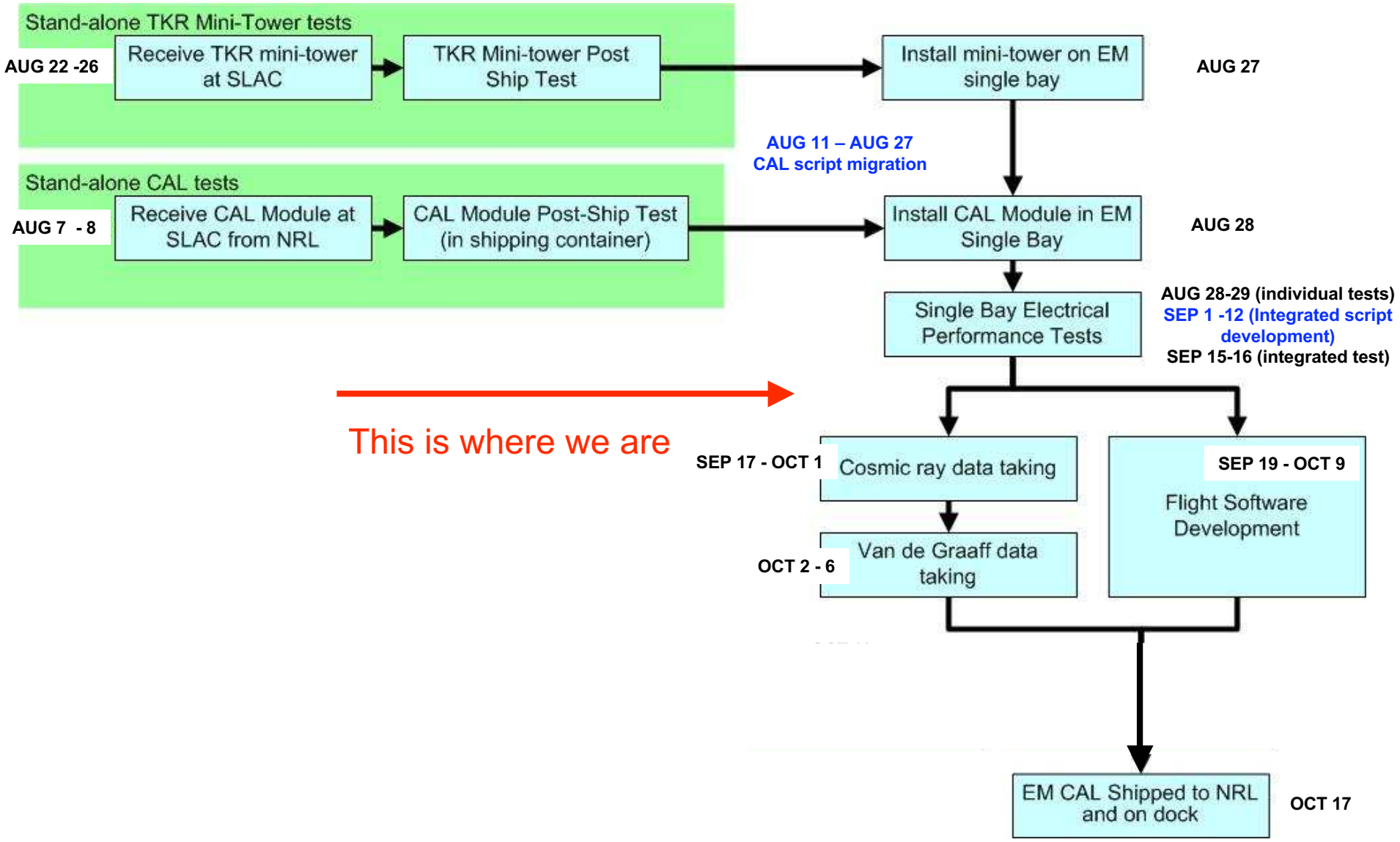
- Mechanical Integration
  - Develop I&T procedures for flight integration
- Functional Tests
  - Develop I&T EGSE framework for flight integration
  - Develop test suite for I&T flight integration
  - Test functionality of individual hardware
  - Test functionality of integrated hardware
- Flight Software Development
  - Preliminary discussions indicate that any FSW use depends on successful characterization of integrated system during functional tests
- Particle Data Taking
  - Measure position resolution in CAL using TKR tracks
  - Reconstruct Photons with TKR trigger
  - Measure VDG spectrum in EM CAL with CAL trigger

EM Interfaces

We have already exercised the entire chain one month prior to the end of the EM test (Oct 14, 2003)



EM Test Flow


Stand-alone TKR Mini-Tower tests
AUG 22 -26
Receive TKR mini-tower at SLAC
TKR Mini-tower Post Ship Test
Stand-alone CAL tests
AUG 7 - 8
Receive CAL Module at SLAC from NRL
CAL Module Post-Ship Test (in shipping container)
Install mini-tower on EM single bay
AUG 27
AUG 11 – AUG 27
CAL script migration
Install CAL Module in EM Single Bay
AUG 28
Single Bay Electrical Performance Tests
AUG 28-29 (individual tests)
SEP 1 -12 (Integrated script development)
SEP 15-16 (integrated test)
This is where we are
SEP 17 - OCT 1
Cosmic ray data taking
SEP 19 - OCT 9
Flight Software Development
OCT 2 - 6
Van de Graaff data taking
EM CAL Shipped to NRL and on dock
OCT 17

Mechanical Integration

DATE	DESCRIPTION	COMMENTS
Aug 7	CAL Arrival @ SLAC	On time delivery !
Aug 22	TKR Arrival @ SLAC	On time delivery !
Aug 27	Install TKR in single bay	Cable problems delayed integration
Aug 28	Install CAL in single bay	TKR and CAL integrated in 1 day (Sep 2)
Sep 16	Cosmic Ray Set Up Ready	Preliminary tests of scintillators have been done. We are developing one set-up fro CAL and another for TKR
Oct 1	VDG Set Up Ready	
Oct 17	CAL back at NRL dock	

Thanks to everyone's effort we are on schedule !

TKR Installation

CAL Installation

Functional Tests

DATE	DESCRIPTION	COMMENTS
Aug 7-8	Test CAL using TEM/PS and CAL EGSE	Good preliminary documentation from CAL including tests, plots and reports
Aug 11-27	CAL script migration to I&T EGSE system	First release to CAL by Sep 5. We are at a stage that the CAL LATTE scripts allow us to support the integrated system
Aug 25-26	Test TKR using another TEM/PS and I&T EGSE	We have developed a concise set of Limited Functional Tests. Problems found prior to delivery at SLAC are being investigated.
Aug 28-29	Test TKR/CAL integrated system	Done by Sep 2 thanks to the incredible effort of the EM crew
Sep 1-12	CAL script migration (if necessary) and script development for integrated system	In progress, but necessary infrastructure is ready to support integrated tests
Sep 15-16	Test TKR/CAL integrated system (set baseline for particle data taking)	

Thanks to everyone's effort we are on schedule !

Data Taking

DATE	DESCRIPTION	COMMENTS
Sep 17-26	Cosmic rays with TKR trigger vertical position	
Sep 29	Cosmic rays with TKR trigger vertical position (Threshold scan)	
Sep 30	Cosmic rays with TKR trigger vertical position (Bias scan)	
Oct 1	Cosmic rays with TKR trigger horizontal position	
Oct 2-3	VDG Data Taking TKR trigger	
Oct 6	VDG Data Taking CAL trigger	

On Sep 4 we presented our concerns: "We believe we can maintain schedule but we need help from Collaborators to "fully" characterize the system prior to data taking."

After our request we have more people on board to support the effort

TKR (Marcus, Hiro and Johann)

CAL (Gilles, Pol and Berrie)

At last the CAL goes first !

- **Highlights**
  - On time delivery with support from 3 CAL people
  - Preliminary documentation allowed I&T to evaluate the acceptance criteria
  - Although some of mechanical procedures were missing, they were developed in a timely fashion in conjunction with the I&T group
  - Since delivery, CAL and I&T have been holding weekly meetings to resolve issues and prepare for integrated system tests

TKR Mini Tower is back…

- **Highlights**
  - Italian Collaborators put a considerable effort to beef up the documentation and to understand the system prior to its delivery
  - On time delivery with support from 1 person (but he never stops to work so we can count him as 2 !)
  - Some problems identified prior to shipment continue to be investigated at SLAC, and TKR is taking the lead to solve them in conjunction with ELX and I&T (Bravo Luca !)
  - UCSC post docs have also come to SLAC to participate in the EM effort

I&T Coordination

- **Highlights**
  - **The implementation of the I&T Plan has been essential to identify processes and issues, which need to be resolved for flight integration**
  - **The rapid development of tools and procedures and the commitment of the people involved have kept the EM on schedule**
  - **The EM effort has produced a positive effect on the communication across subsystems**

ELX is guiding the tests

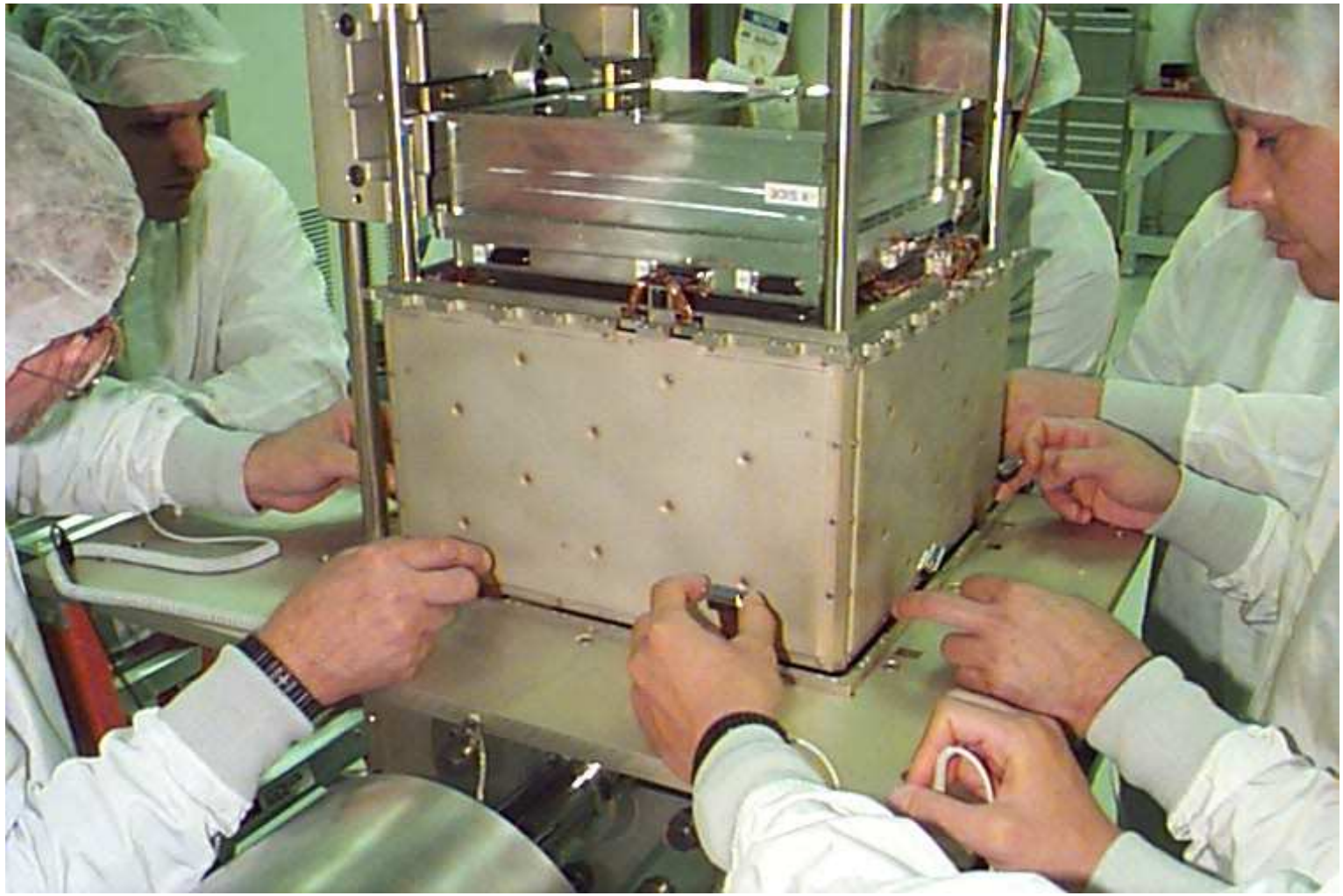
- **Highlights**
  - **The electronics crew have put extra effort in guiding the EM crew throughout the debugging procedures to fully characterize the system.**
  - **They even organized an EM dinner to foster the Team spirit (thanks Mike!)**

SAS is also on board

- **Highlights**
  - **SAS has already produced test files for offline processing in time for us to have preliminary results for this talk ! (thanks Joanne and Heather)**
  - **Their contribution will increase as we provide feedback to validate the process**

CAL/TKR Integration

CAL being lowered while the EM crew protect the TKR cables



CAL/TKR Integration

CAL being lowered using the alignment fixture

CAL/TKR Integration

These are the master minds behind the smooth mechanical integration

Online System

Slides (and work!) from Ric Claus

- **Instances**
  - **> 20 (software & hardware) – for status see next slide**
  - **~ 40 additional instances have already been requested**
- **EGSE Migration**
  - **All EGSE software delivered to I&T will conform to the I&T supported LATTE**
  - **Any missing functionality, desires, etc… please contact Ric Claus claus@slac.stanford.edu**
- **Future**
  - **Migrate to include more FSW in the system**
  - **Development towards IOC in collaboration with the IOC subsystem**

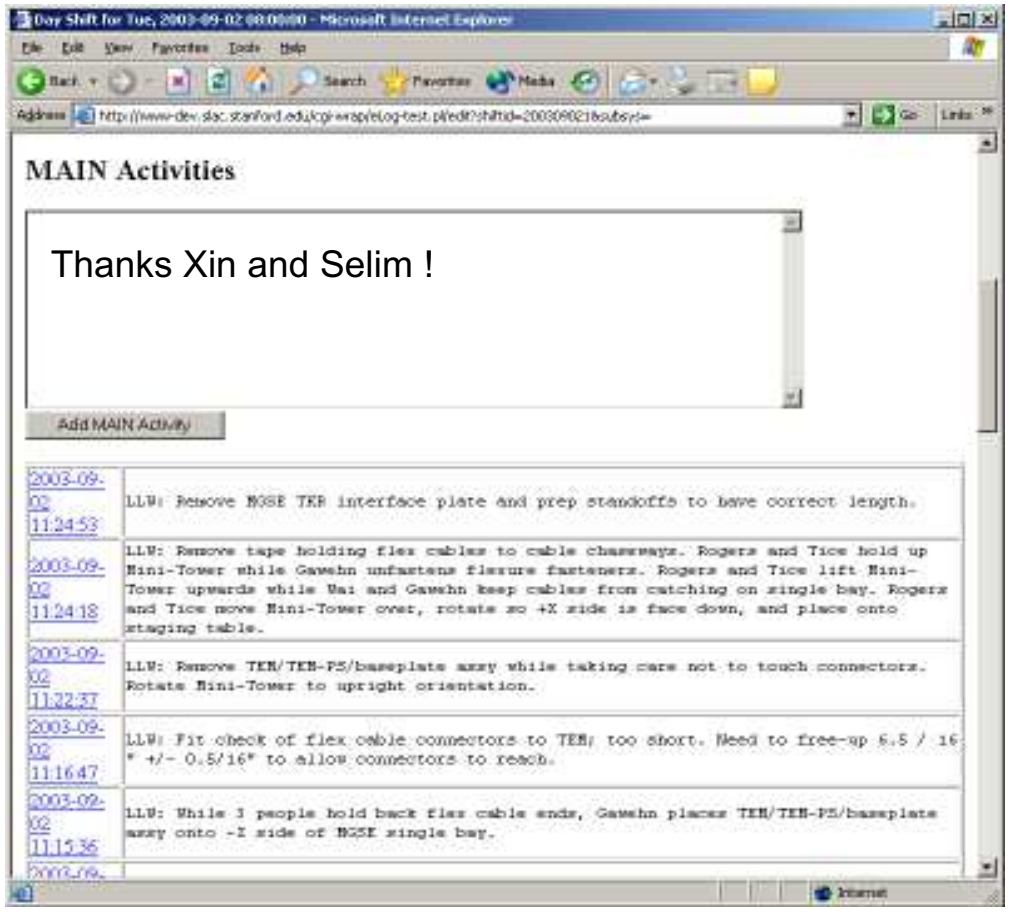
Online System Status

Slides (and work!) from Ric Claus

- **LAT Test Executive (LATTE) v1.7 released**
  - **Test Executive**
  - **Commanding**
  - **Register Browser**
  - **Event Data Handling (recording,playback,analysis)**
  - **Event Data Visualization (histograms, event display)**
  - **Monitoring (subset of housekeeping)**
- **Application scripts progressing towards production level**
  - **ACD,CAL,TKR,ELX**
- **All software is configuration managed**
  - **Code is in CVS**
  - **Test Data**
  - **Electronic log book (to allow visualization)**
- **Software verification on LAT testbed**

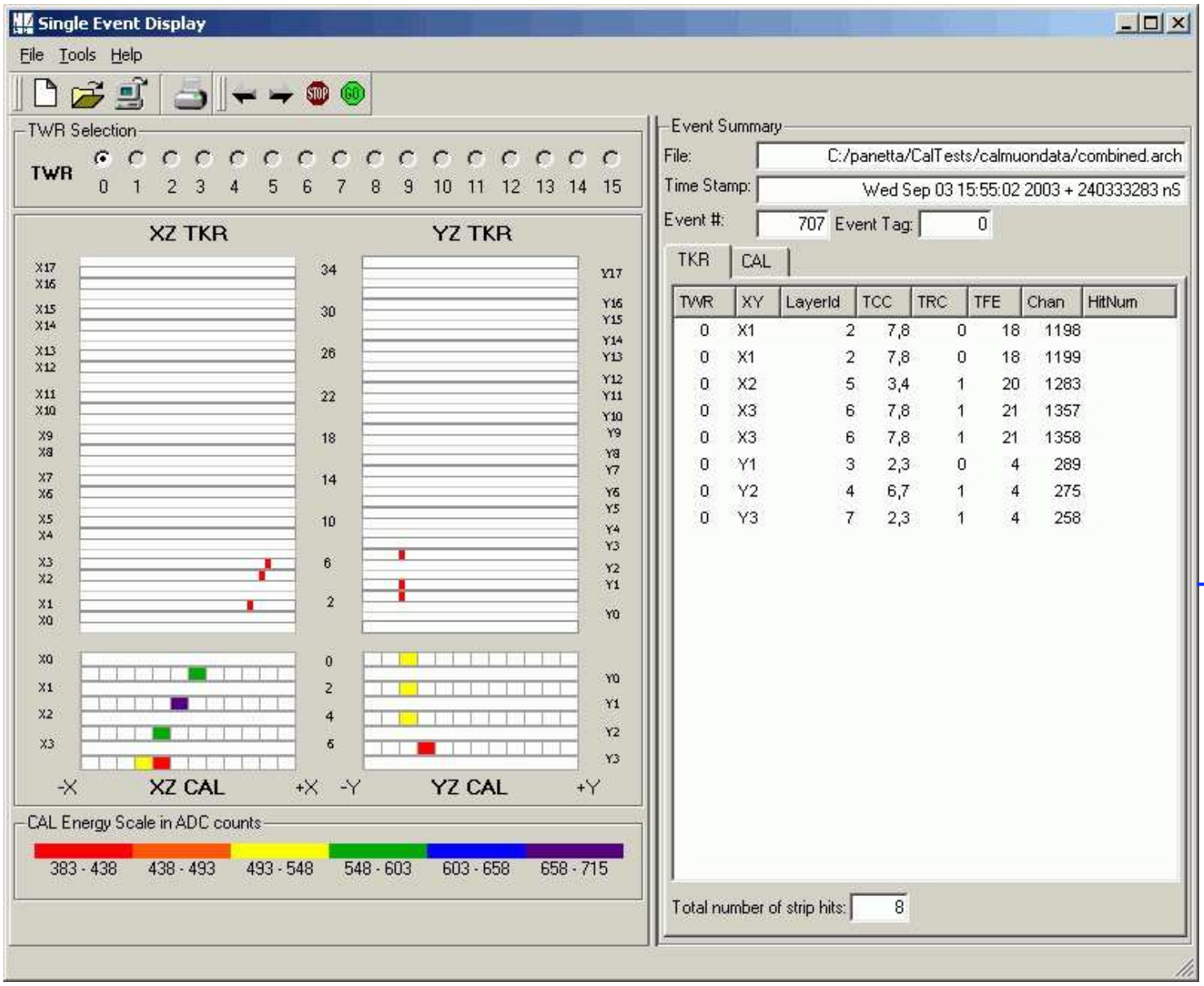
Electronic Logbook

Allows parallel activities and contains a mate/demate log (not shown in this slide).



Integrated System – GOSED

Preliminary data



GLAST
Online
Single
Event
Display

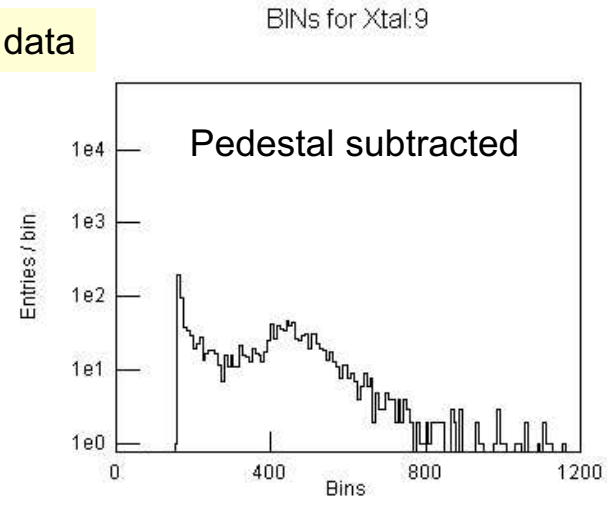
Preliminary Data taken with the integrated system

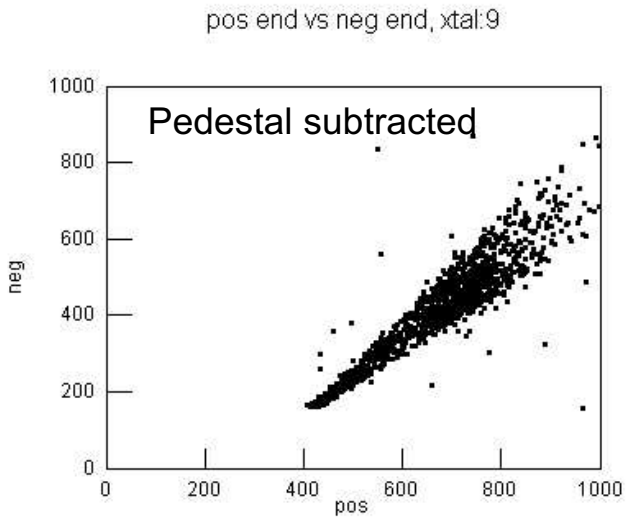
Thanks Alicia, Jim, Luca, and Selim!

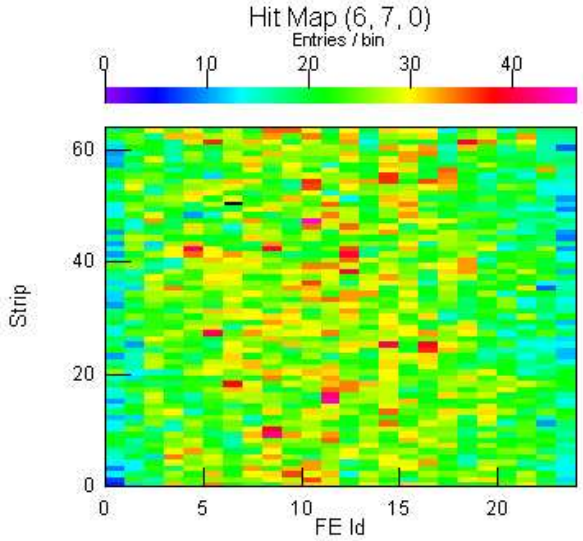
CAL
- Pedestal subtracted
- Zero suppress off
- 4 range off

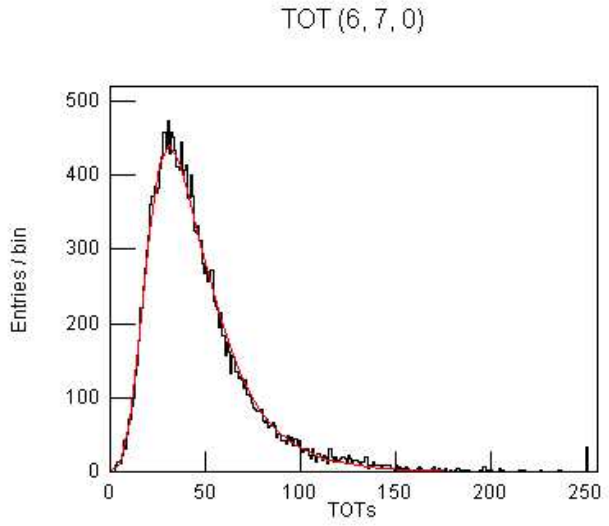
Integrated System - Online Results

Preliminary data







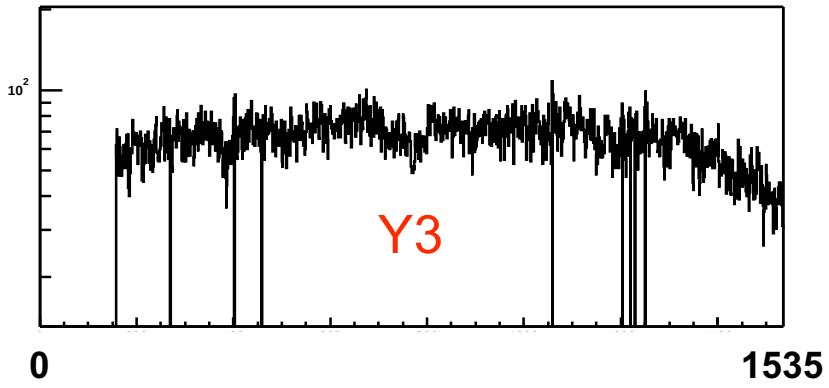


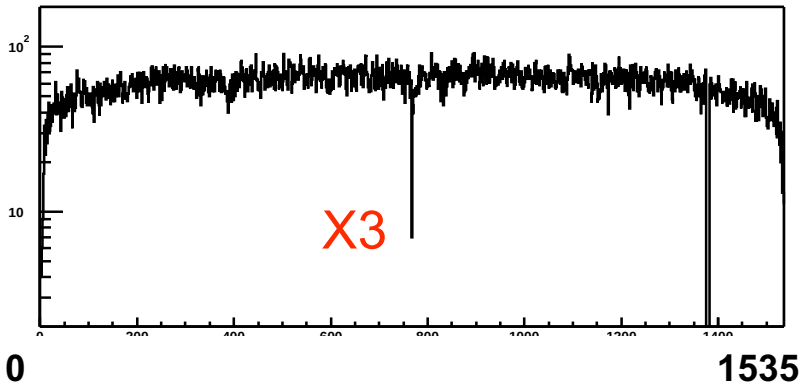
Online/Offline Interface

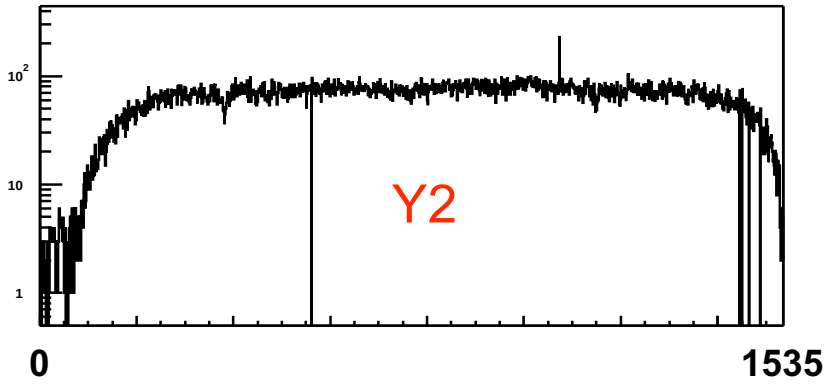
- Thanks to the effort of Ric Claus, Joanne Bogart, Heather Kelly, Leon Rochester and Tracy Usher who developed the online/offline interface.

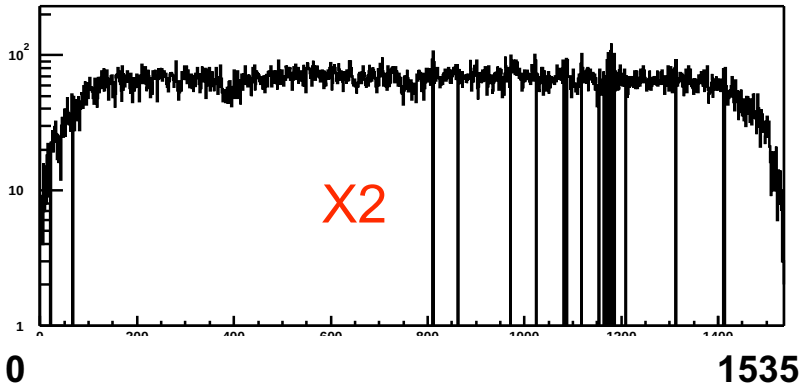
- Preliminary results presented in the following slides were produced by Xin Chen

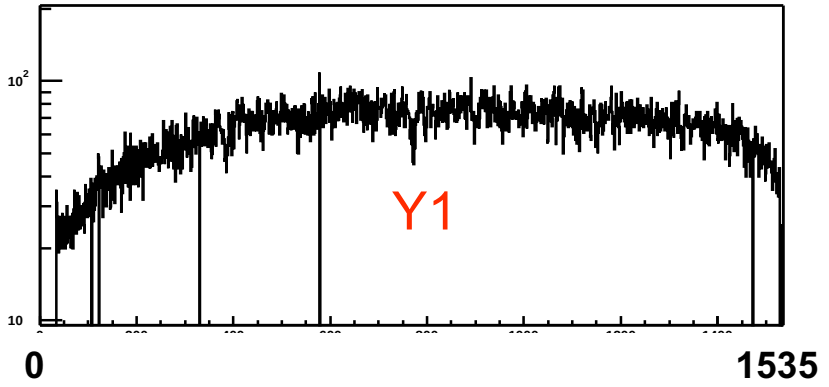
TKR Hit Strip Occupancy

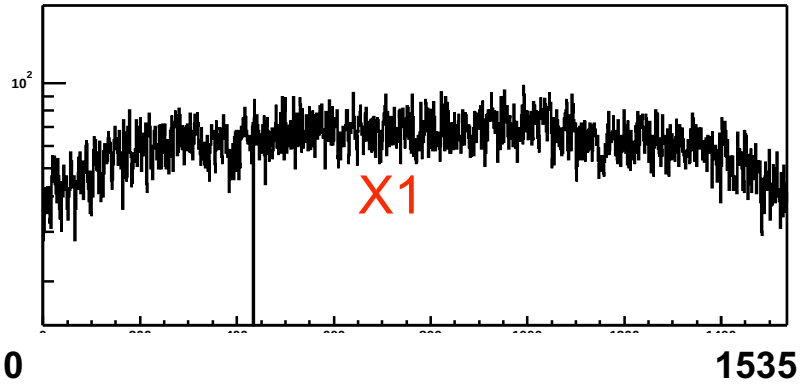




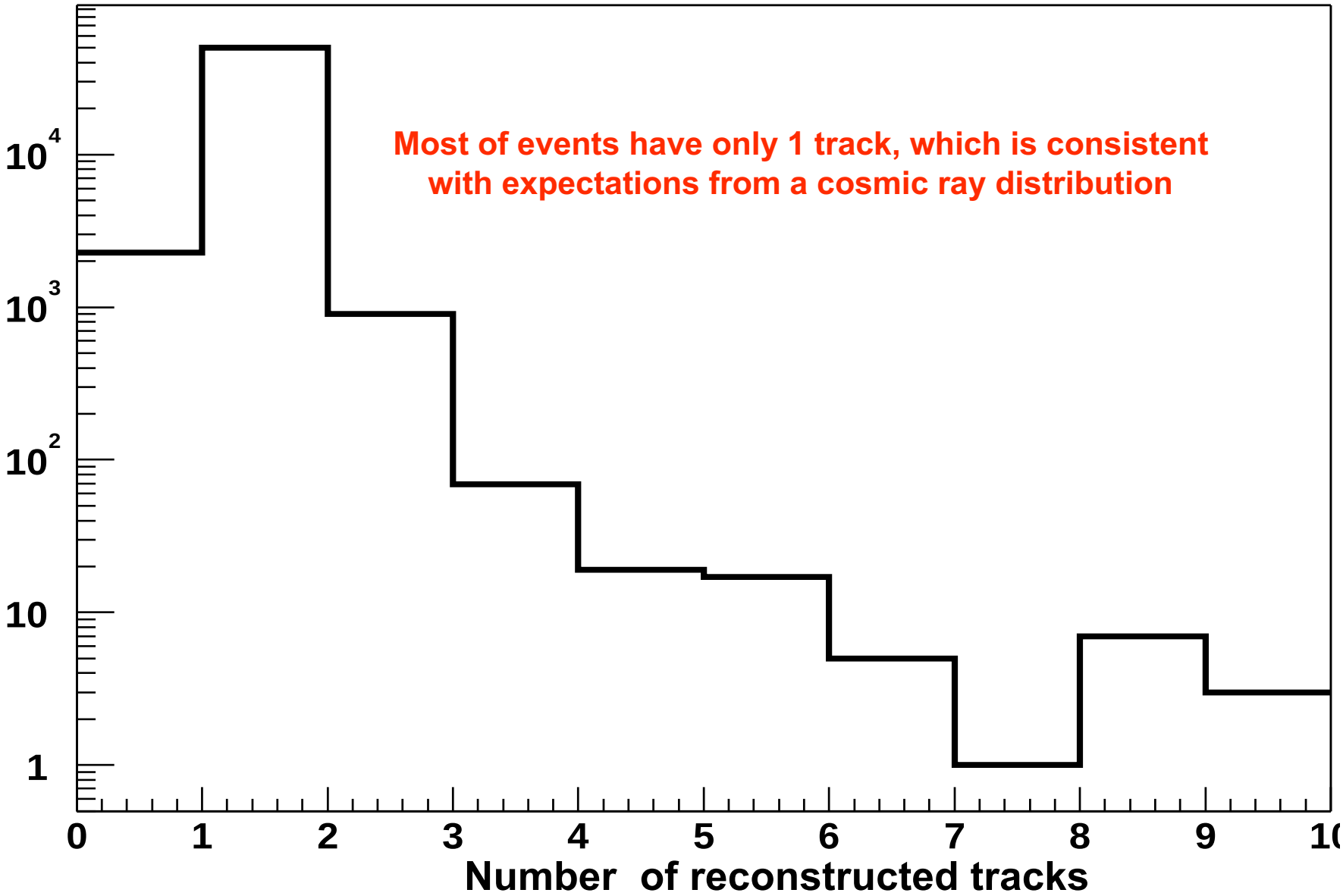




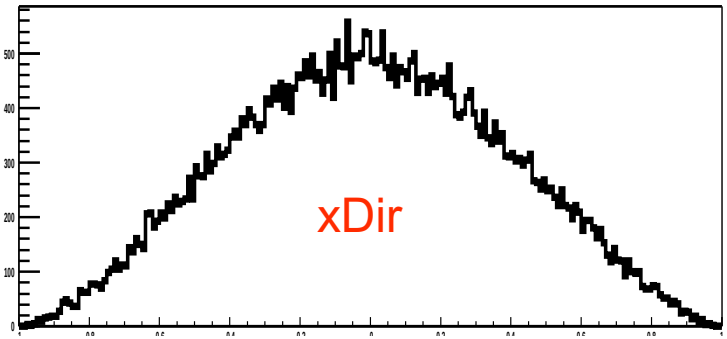


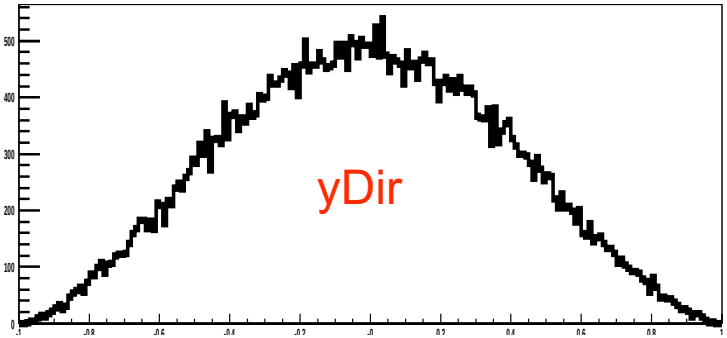


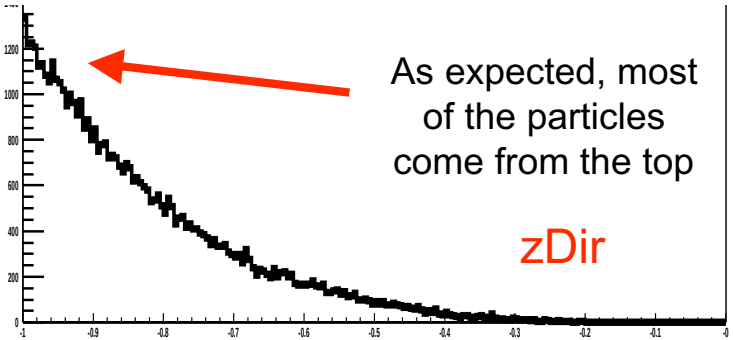
Reconstructed Tracks - Cosmic Rays



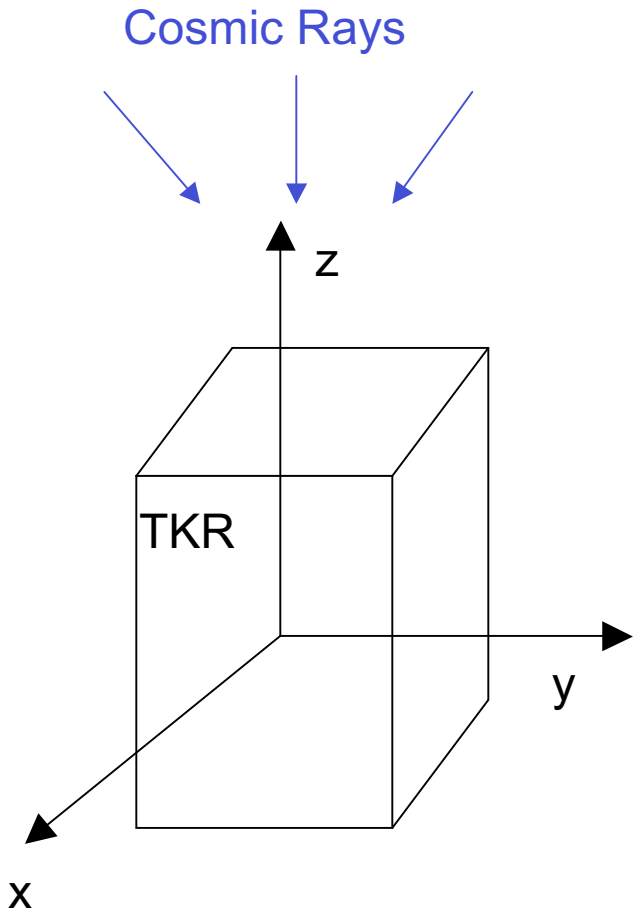
Reconstructed Direction Cosines - DATA







As expected, distributions are symmetric in X and Y



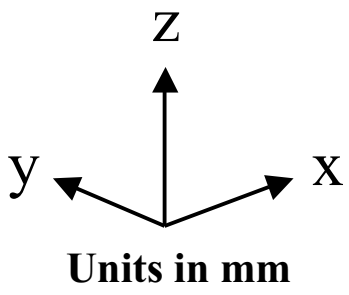
Acknowledgement

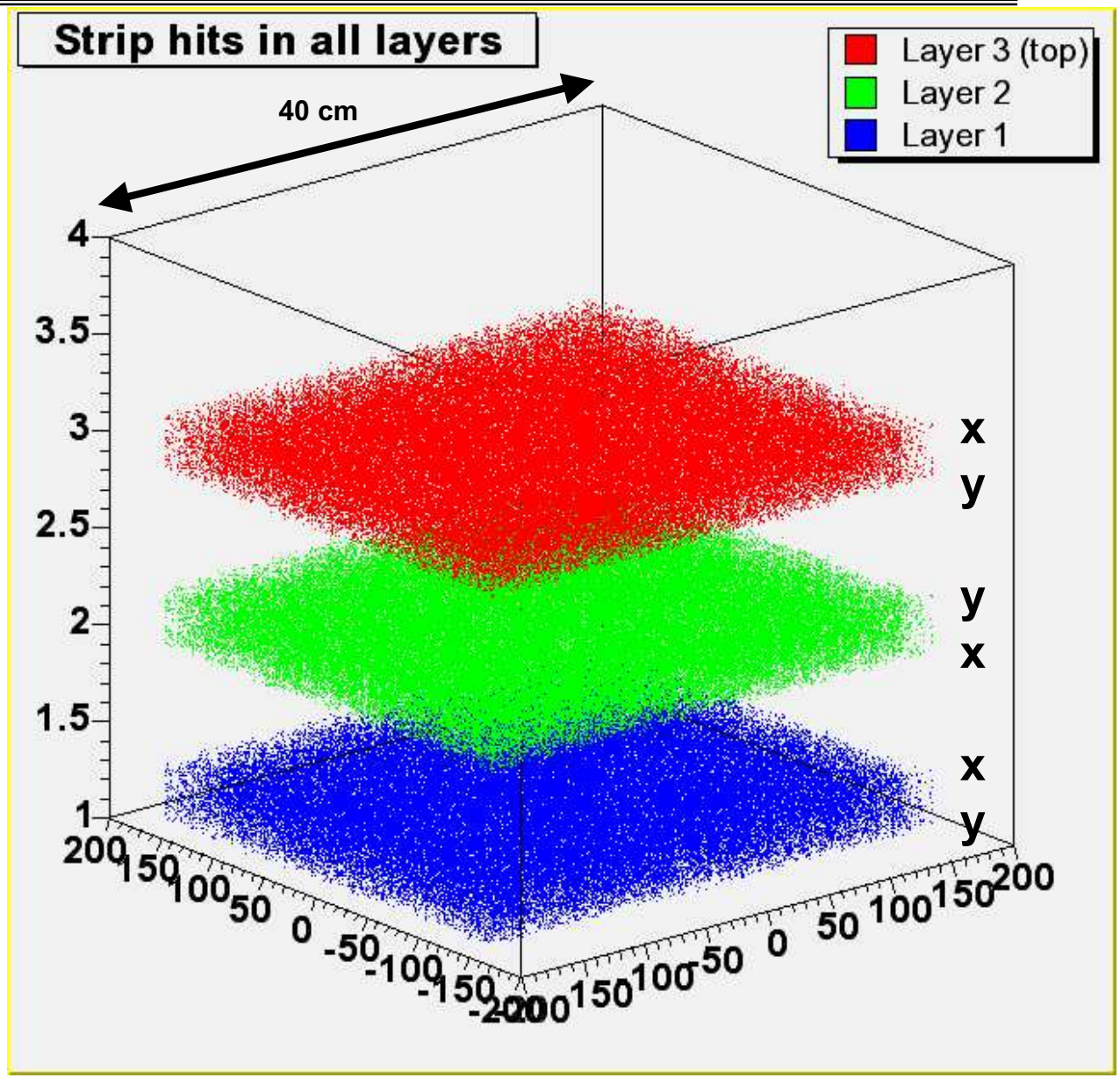
- The preliminary results presented in the following slides were produced by Jason Heinmann, a summer student who worked under the supervision of Xin Chen and Eduardo and who also benefited from discussions with Tune Kamae and Hartmut Sadrozinski.

Strip Hit Distribution in TKR (EM)

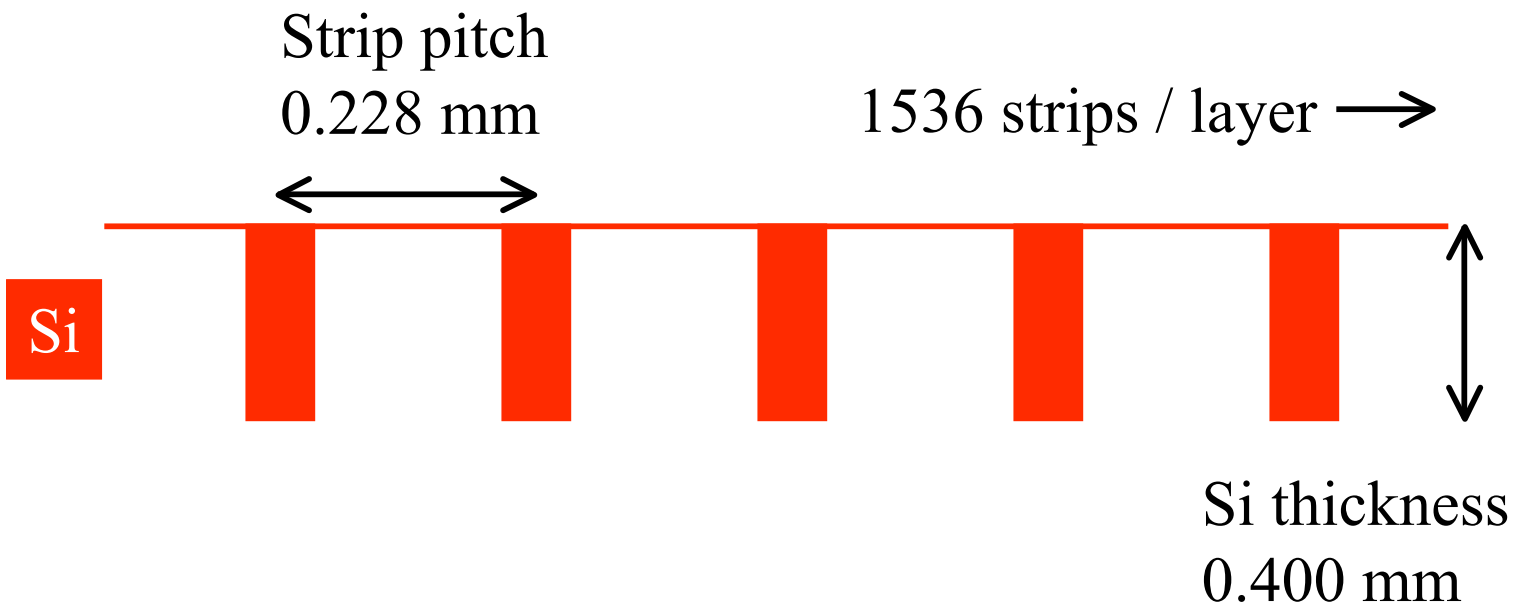
Preliminary data

We expected to see hits in every SSD…

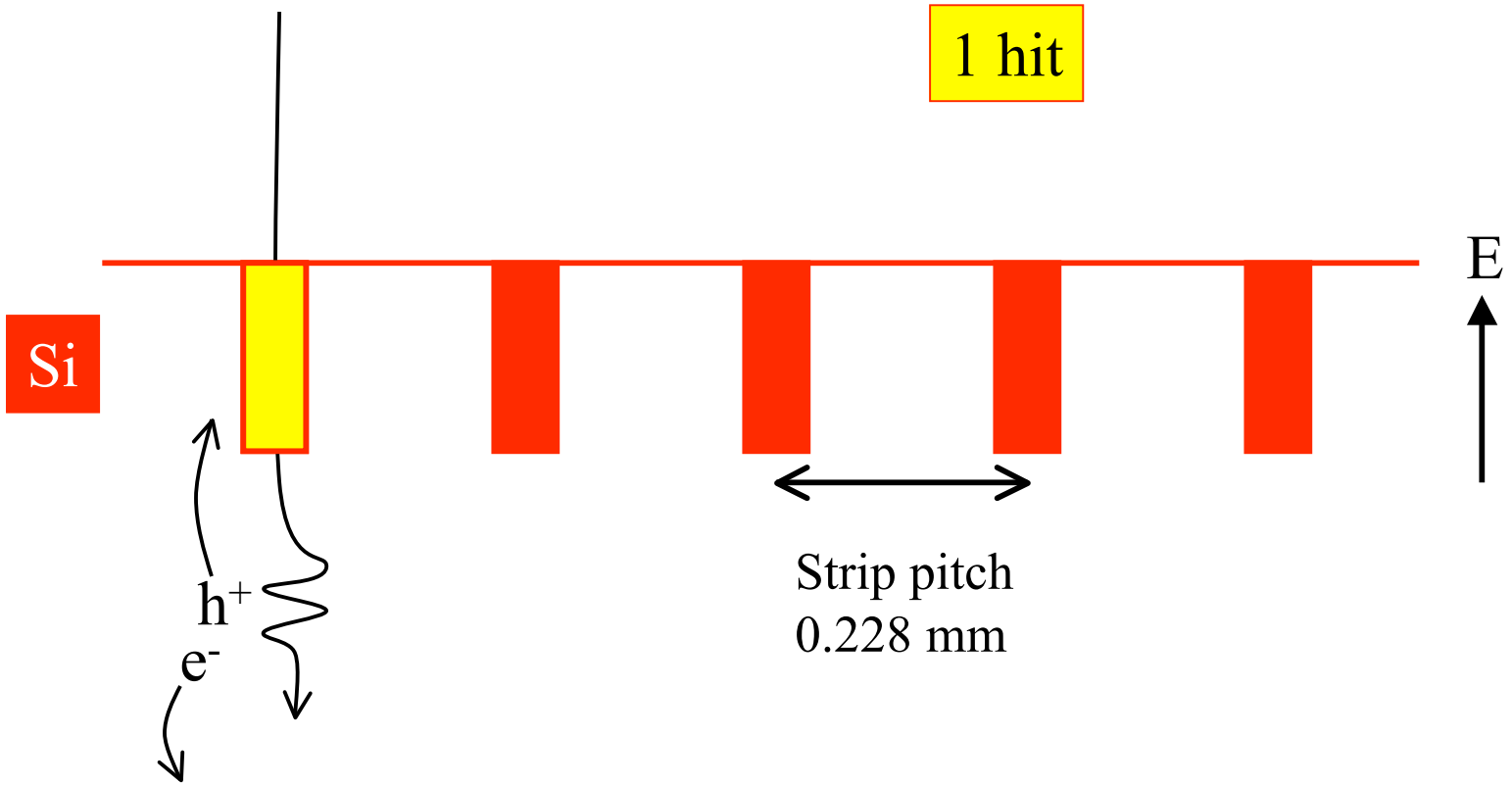




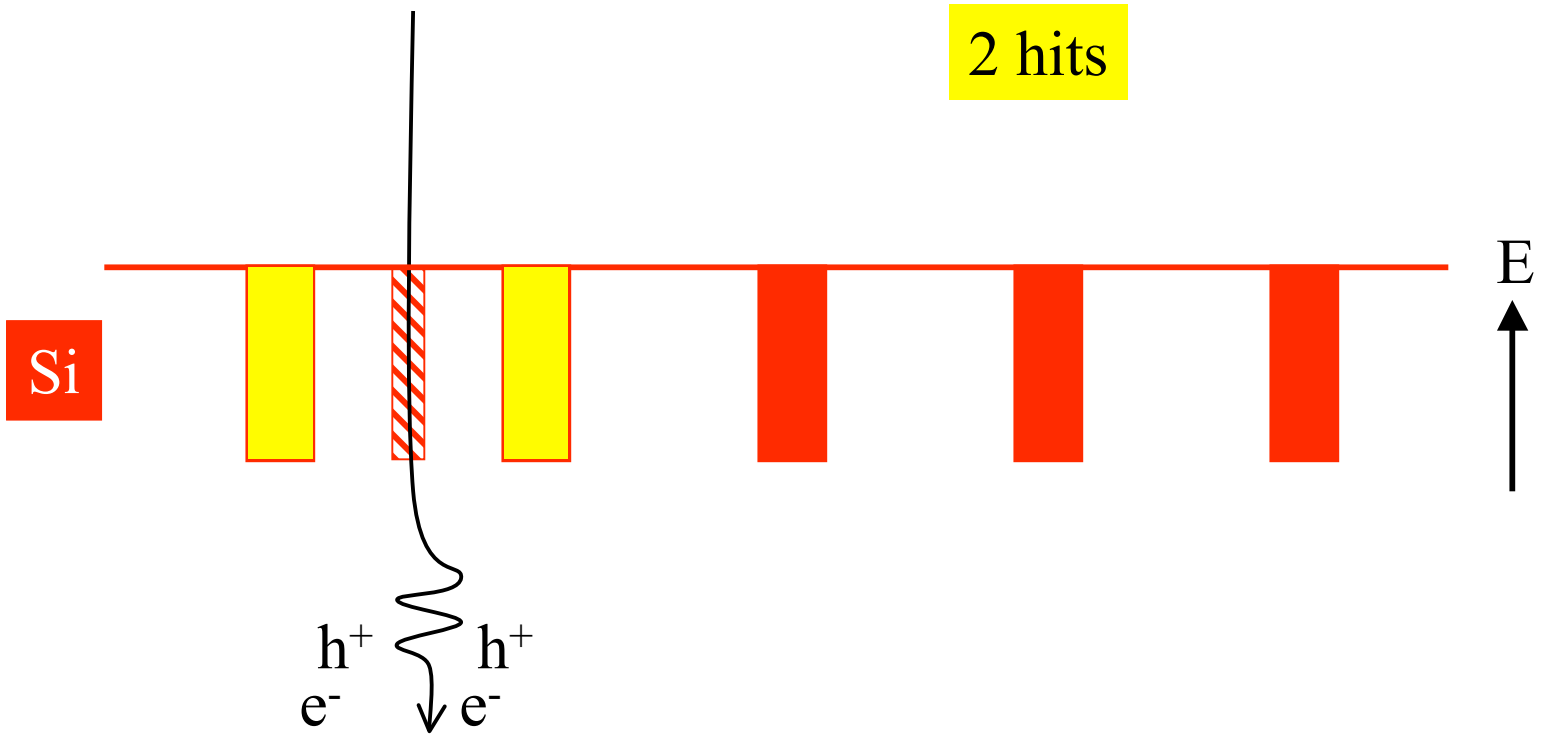
Silicon Detector – Cross Section (1)



Silicon Detector – Cross Section (2)

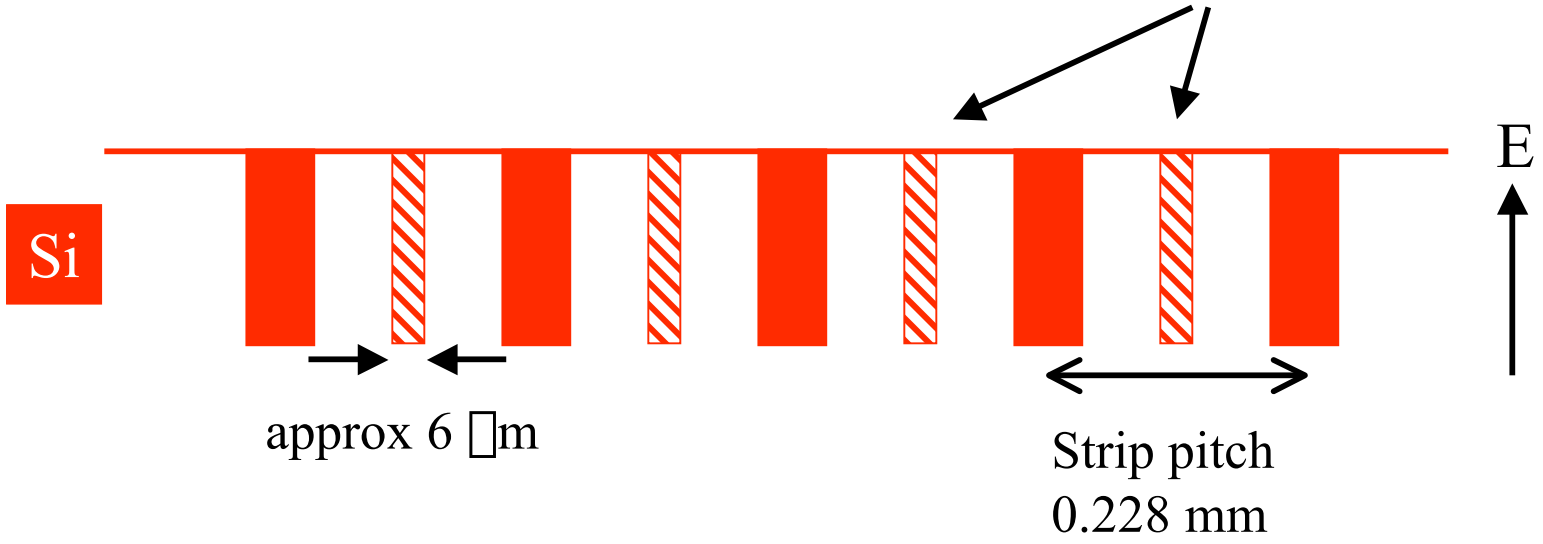


Silicon Detector – Cross Section (3)

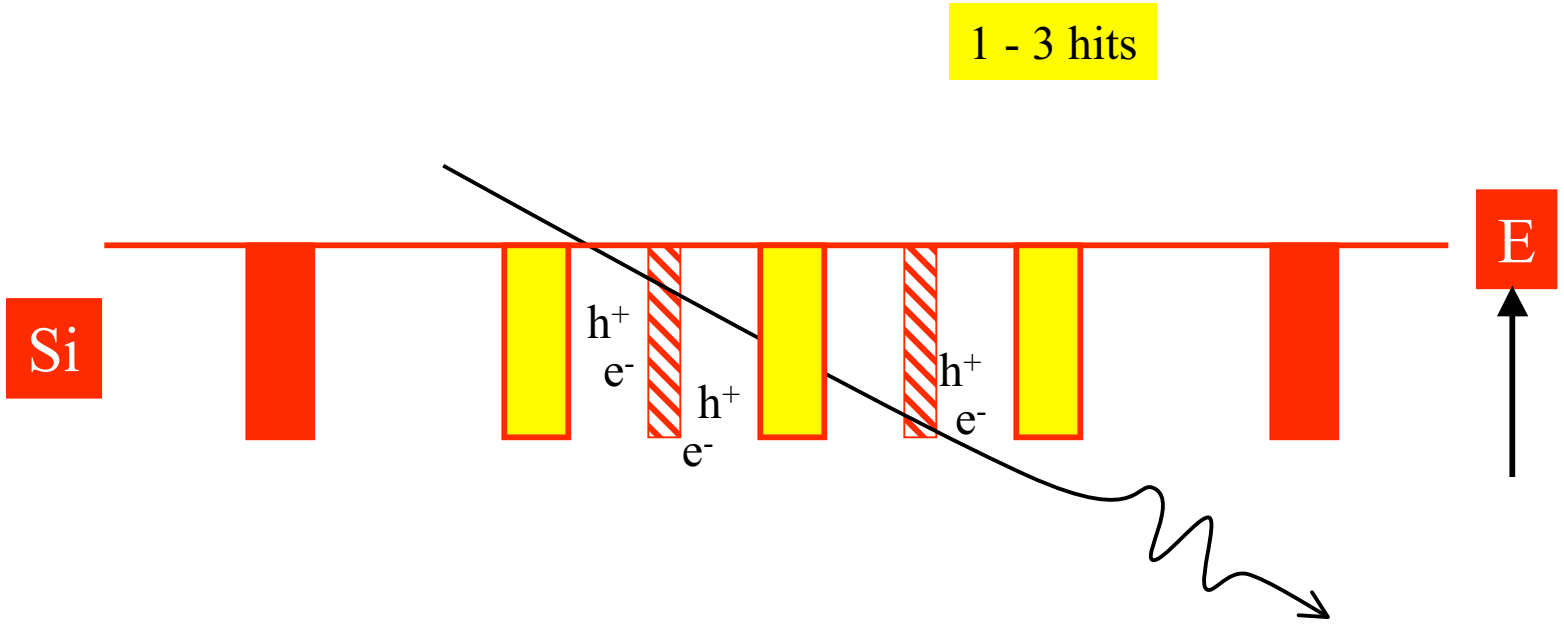


Silicon Detector – Cross Section (4)

Electron/hole pairs can drift to a neighboring strip if the track passes through a “diffusion zone„

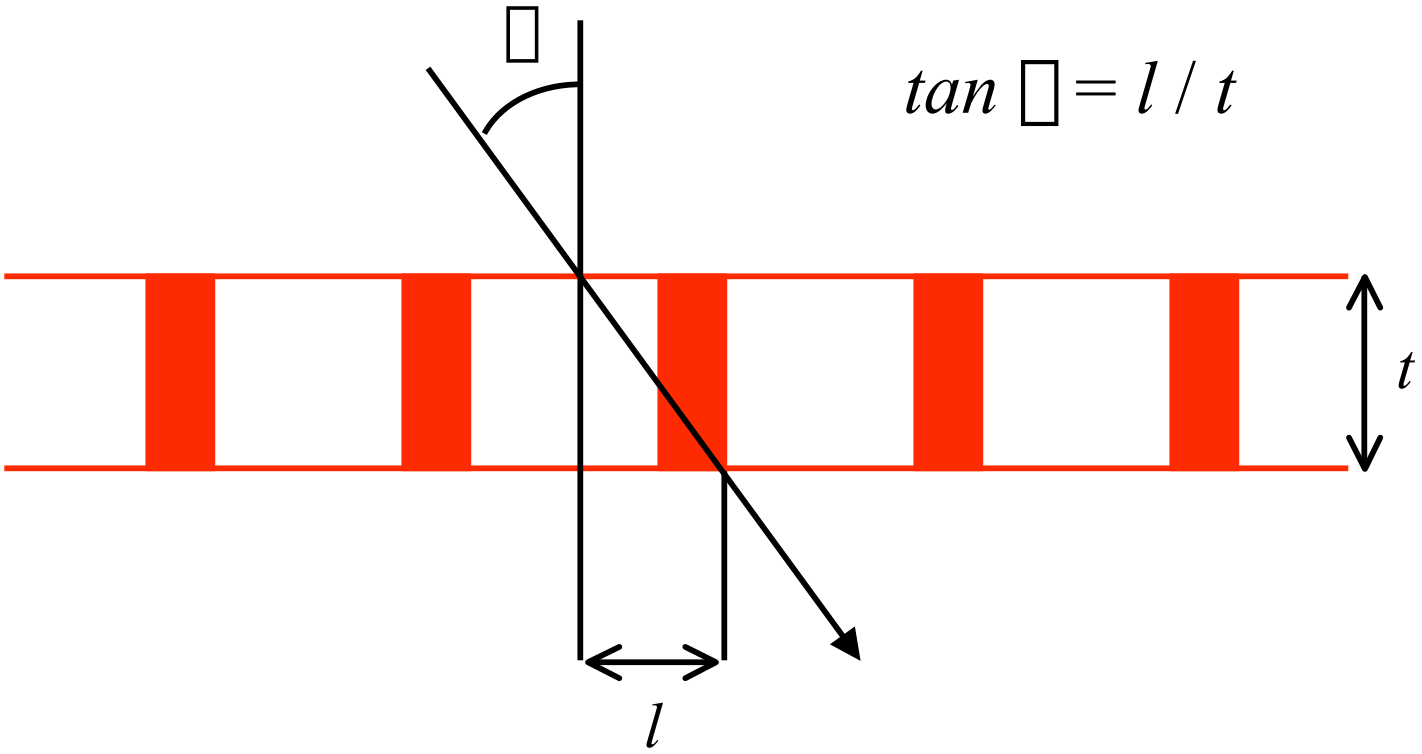


Silicon Detector – Cross Section (5)



Geometrical model for toy MC

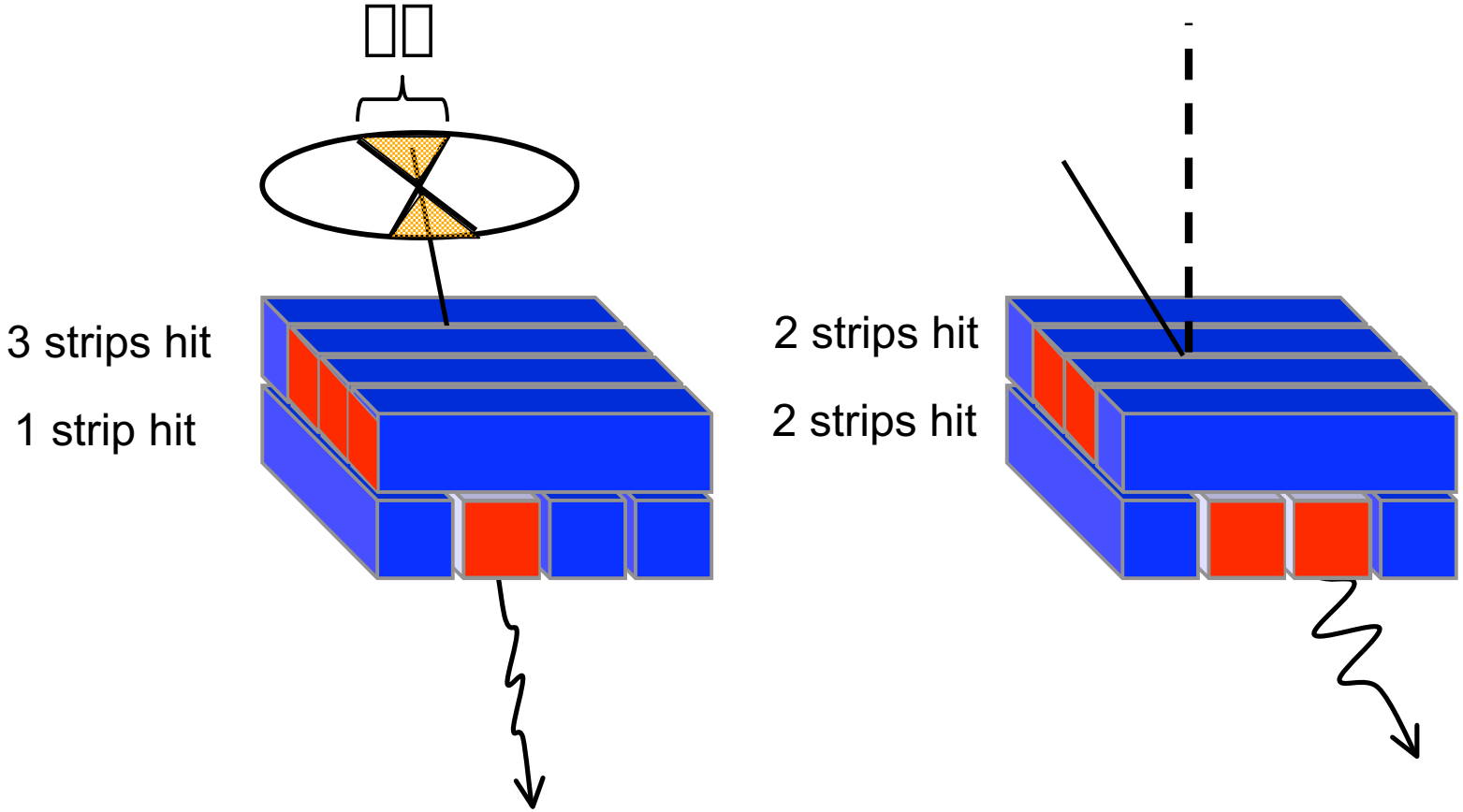
Before using the full GLEAM Monte Carlo we tested our intuition on the measurement by building a toy Monte Carlo simulation based mostly on a geometrical description



Add Path length threshold (~ _ of 228 m)
Add Diffusion zones (7 m)

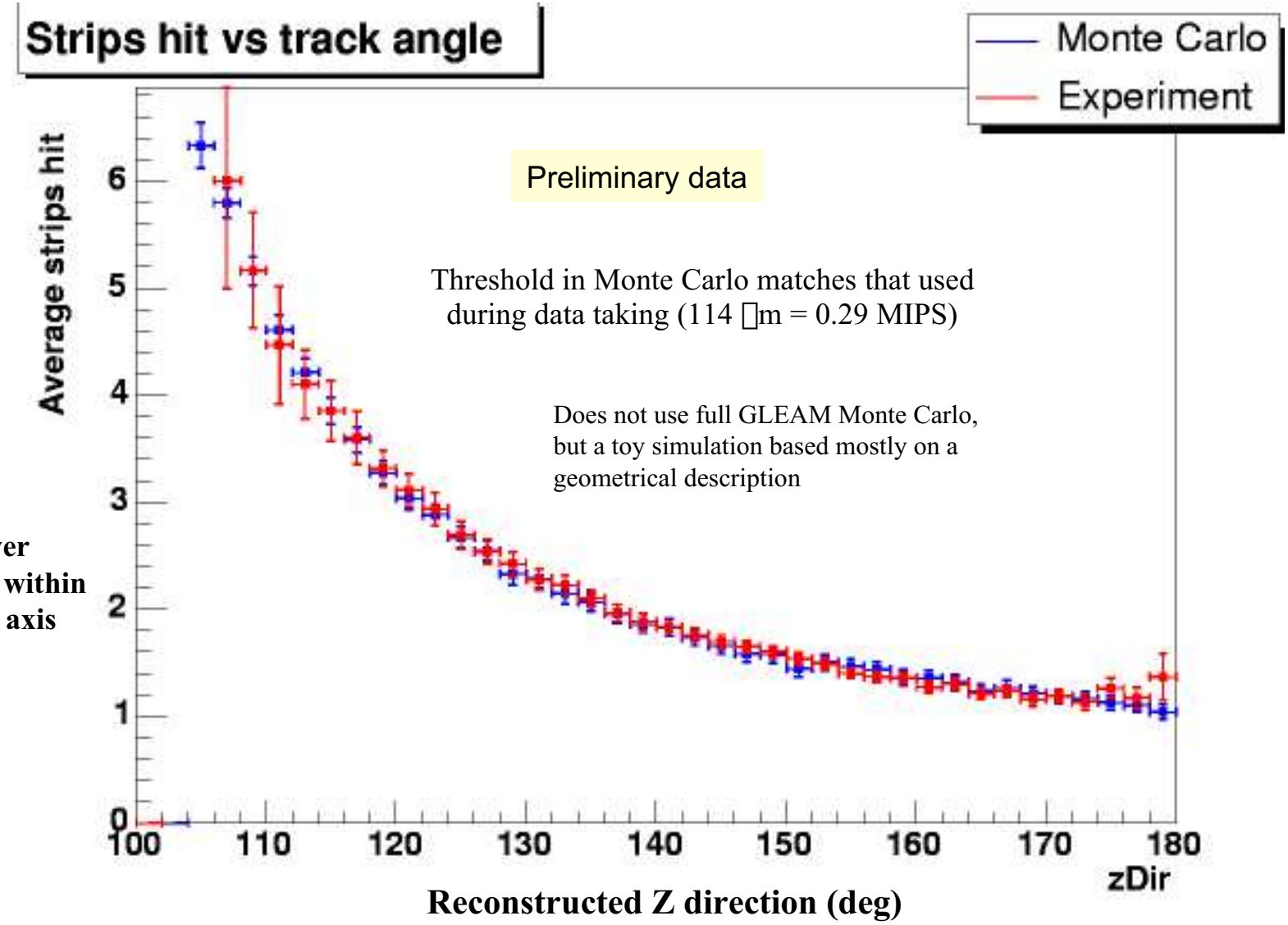
Angular correlation

Restricting the azimuthal angle to a small “pie slice,, we attain events in an approximately two-dimensional plane



Preliminary Results from EM

Number of strips hit in each X layer averaged by zenith angle



CUTS
- **1 track**
- **1 cluster per layer**
- **Projected track within 8 degrees from Y axis**

Mahalo !!

Thanks to Debbie, Diana and Chris for making life less stressful during the EM effort !

Summary

- We have successfully integrated CAL/ELX/TKR into a single bay and collected preliminary data.
- In the EM effort we have uncovered issues, which require further investigation (mostly interfaces) and begin improving the processes. These were not the subject of this talk since a full report will be provided at the end EM effort (stay tuned !)
- We are in the process of system characterization/debugging and infrastructure development for data taking.
- We are building the team spirit and we are confident we will get this “puppy” together.
- Can,t thank enough for everyone,s participation including the strong support and trust from the Project Management !