Main Detectors for PREX and CREX

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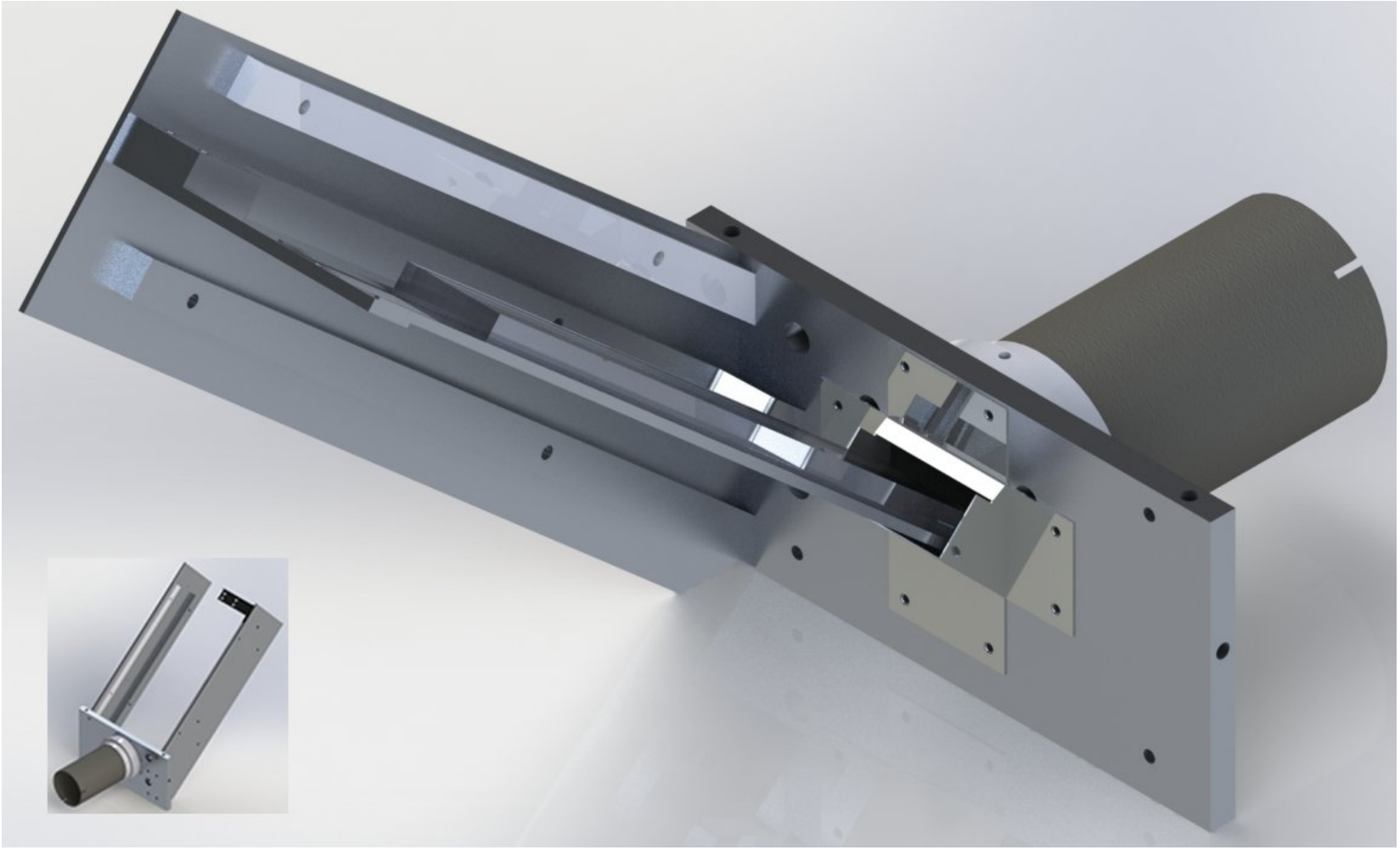
Main Detectors for PREX and CREX

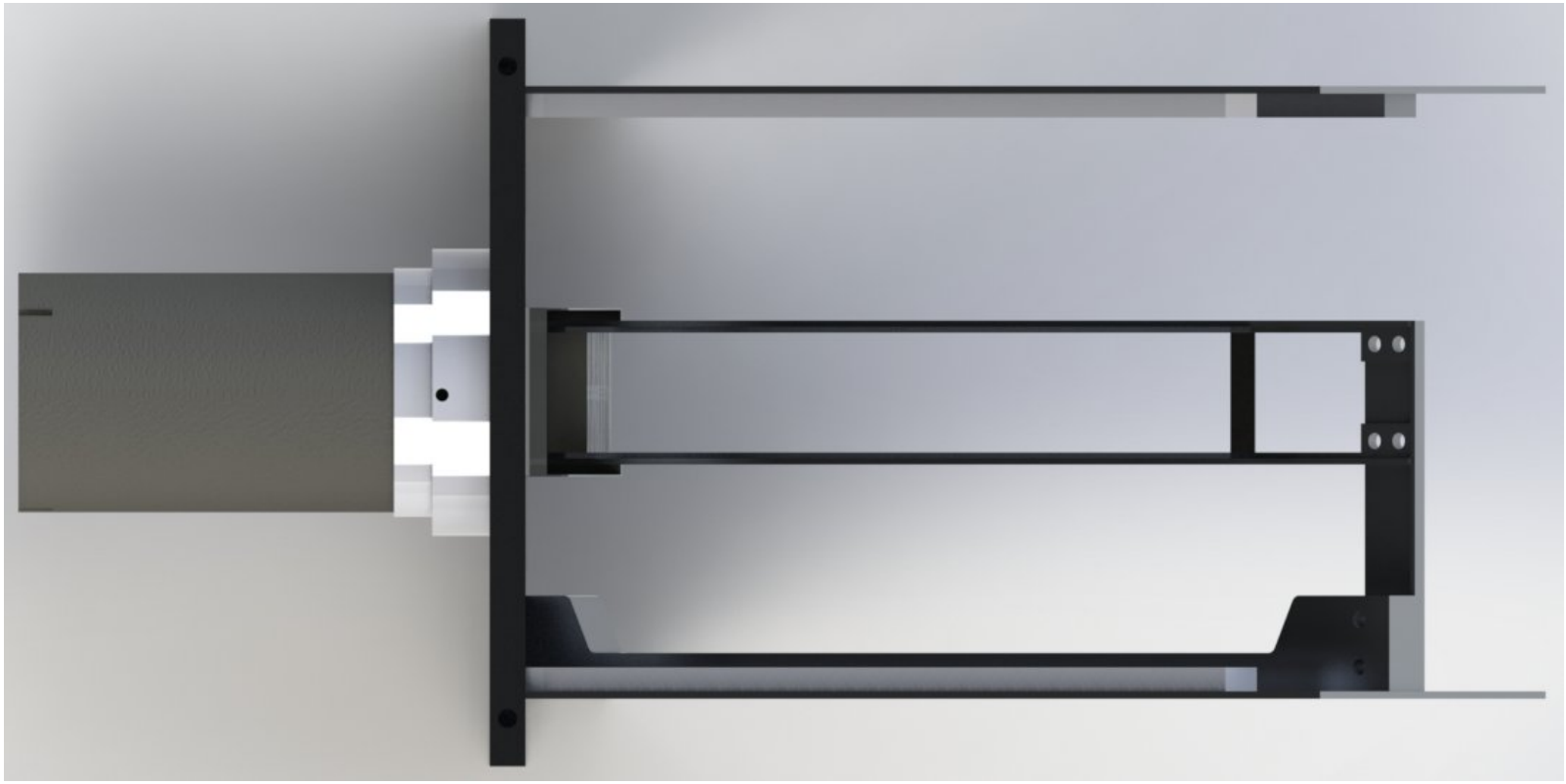
Outline

- Detector design (∼finalized)
- Optical simulation (∼benchmarked)
- Results from 2015 MAMI testbeam
- Plans for upcoming testbeam
- GEM trackers (very brief)
- Summary and Plans

PREX/CREX Detector Design

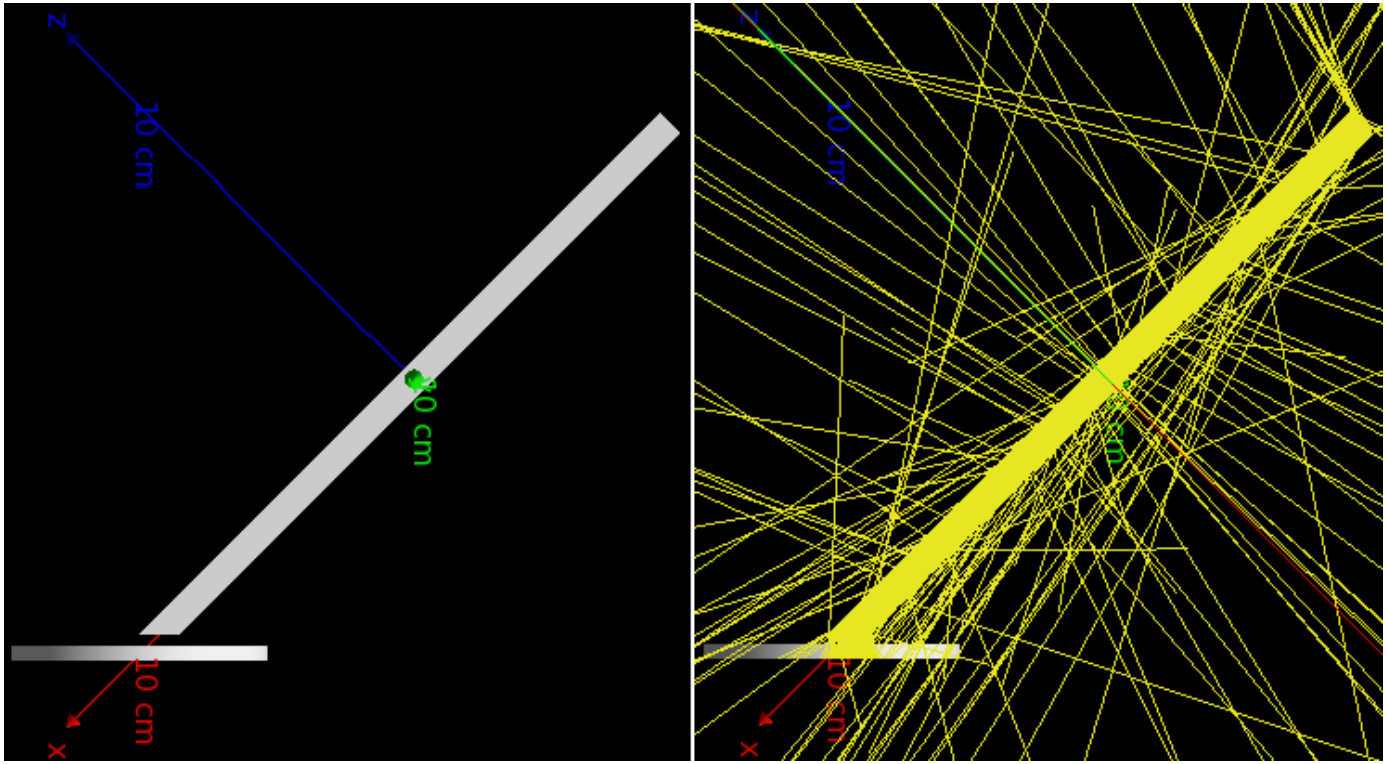


PREX/CREX Detector Design



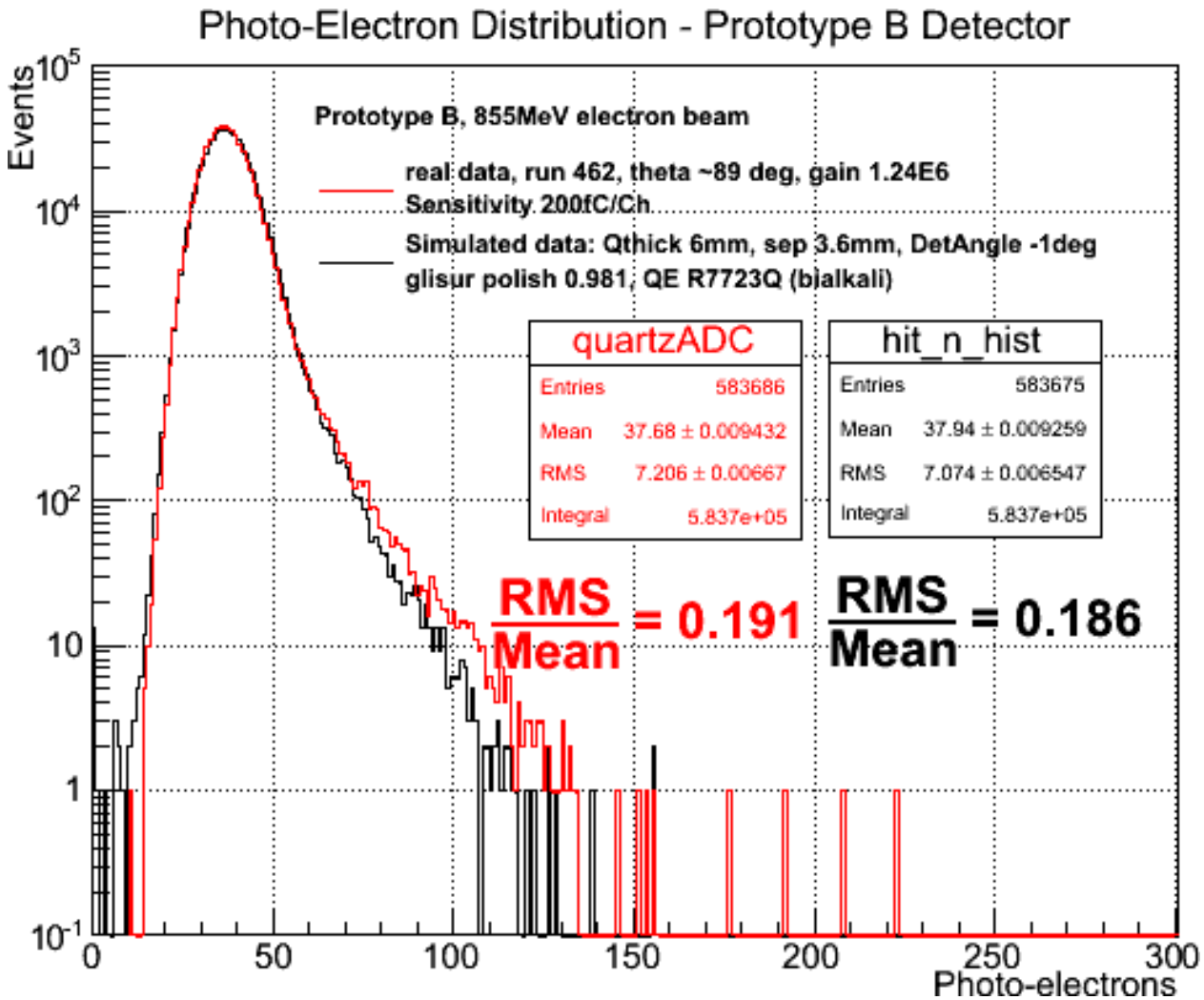
Scattered electron's view

Optical Simulations: Geometry and Event vis.



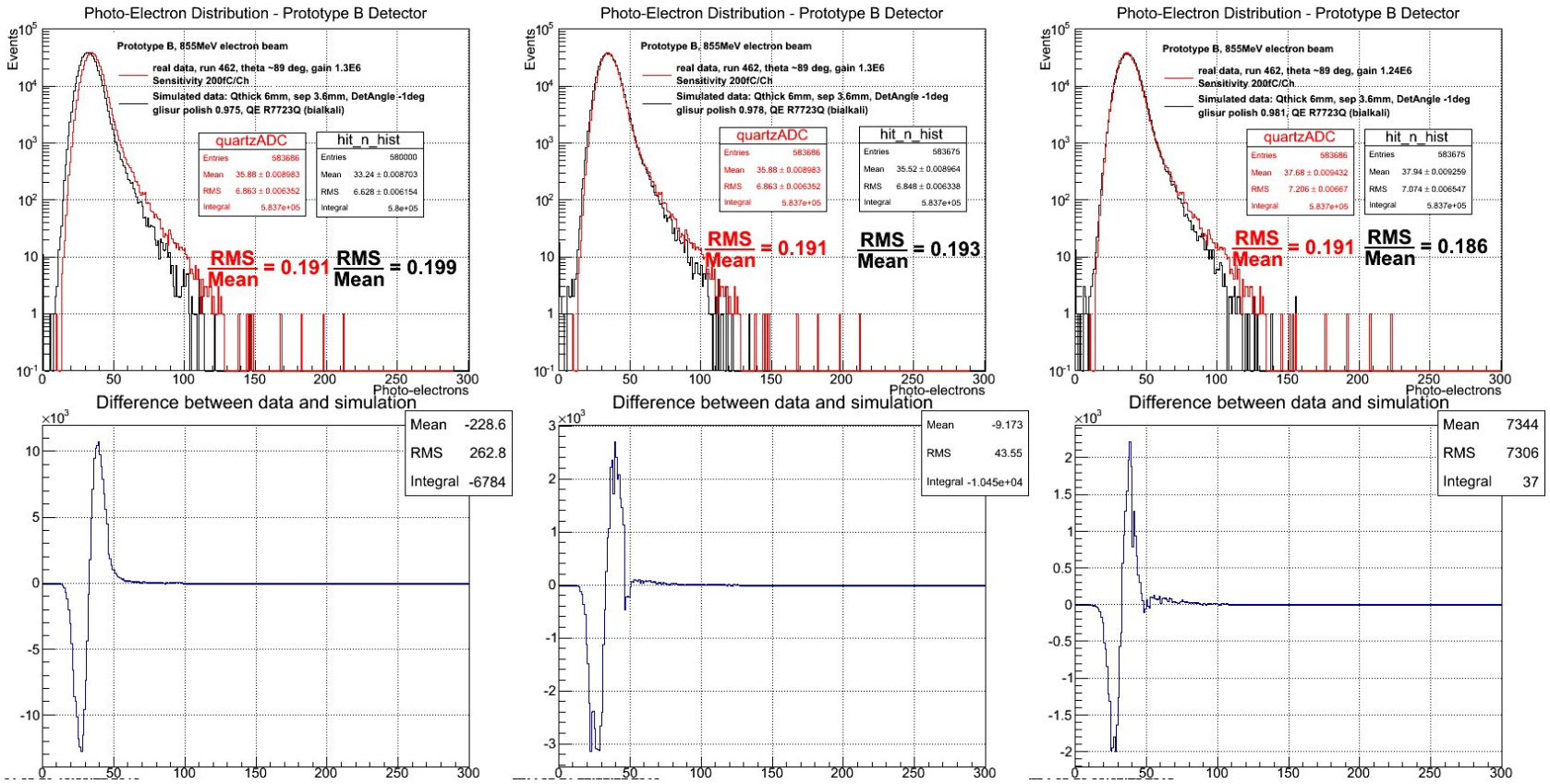
- Electron enters quartz at 90 deg (coming from below quartz)
- Showing 6 mm thick PREX-I quartz geometry
- Quartz is 3.6 mm from pmt window (no light guides used)
- Using 2 inch R7723Q pmt
- Simulating MAMI testbeam: 855 MeV pin-point electron beam

Optical Simulations: Comparison with Data



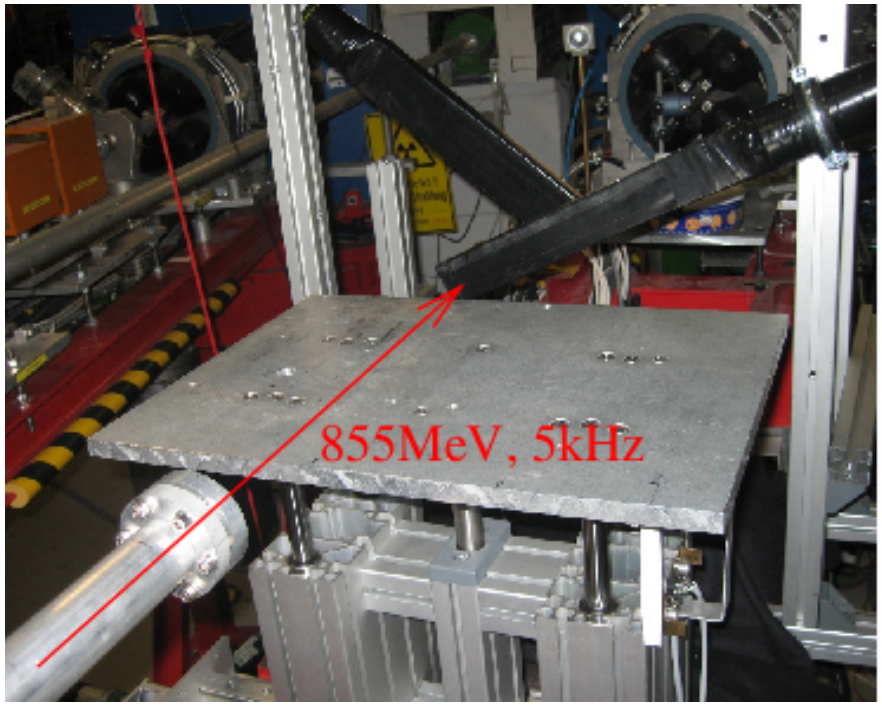
No light guides used; quartz properties ∼benchmarked

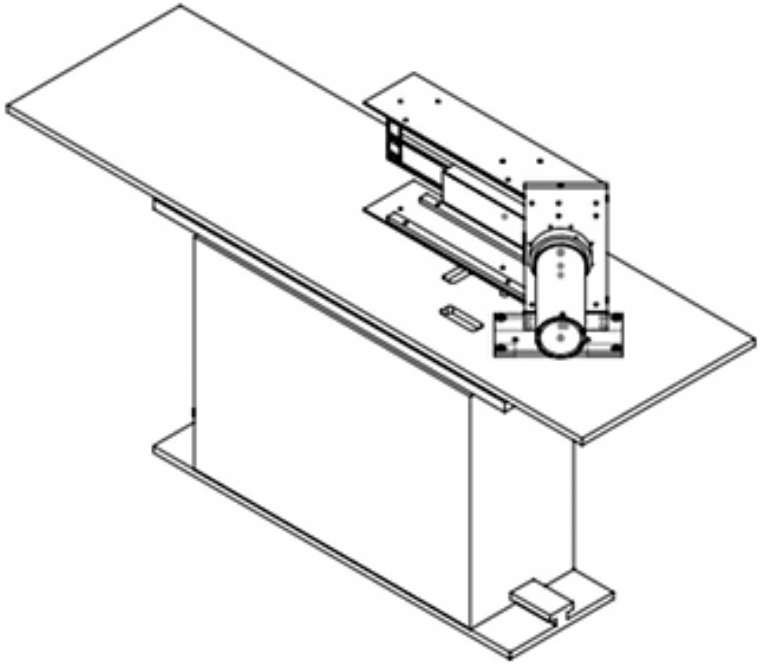
Optical Simulations: Tuning quartz properties



Polish: 0.975	Polish: 0.978	Polish: 0.981
gain: 1.3E+6	gain: 1.3E+6	gain: 1.24E+6 ±5%
ADC Sens: 200 fC/ch	ADC Sens: 200 fC/ch	ADC Sens: 200 fC/ch

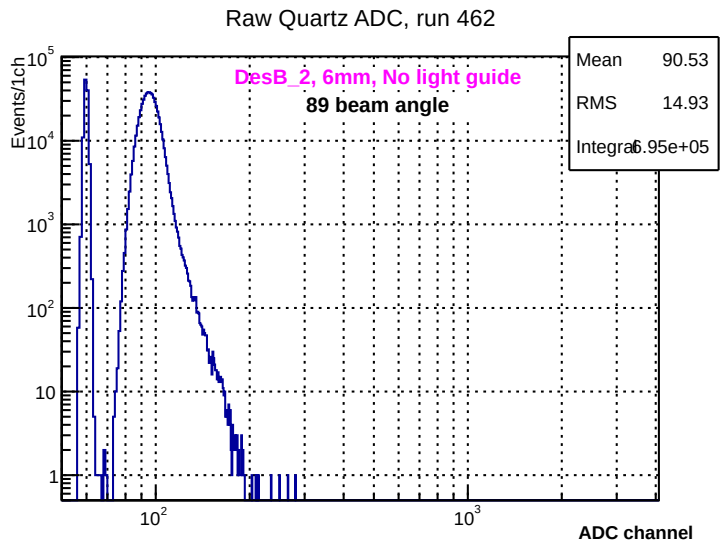
MAMI Testbeam (PREX/CREX Detector Tests)

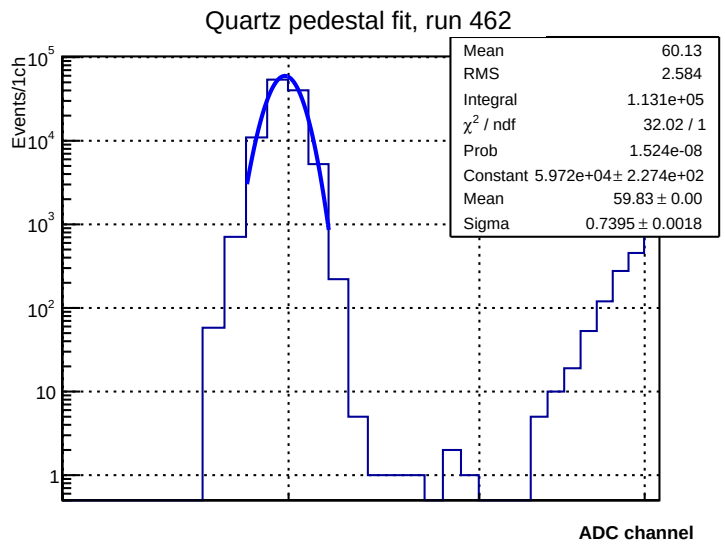


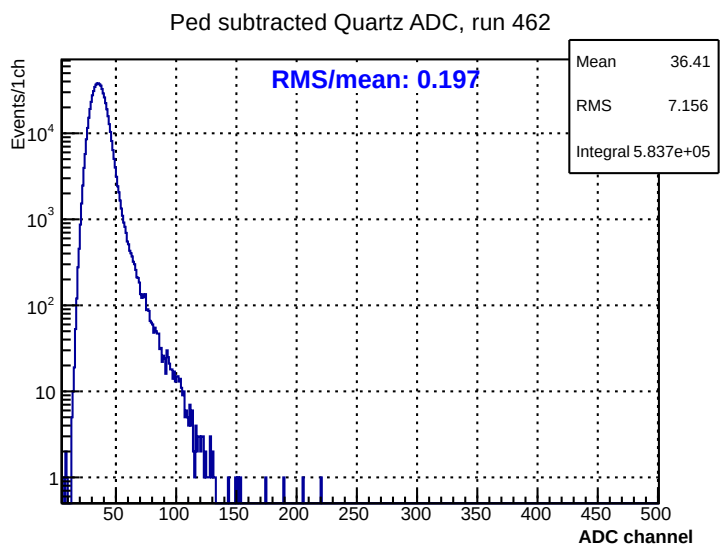


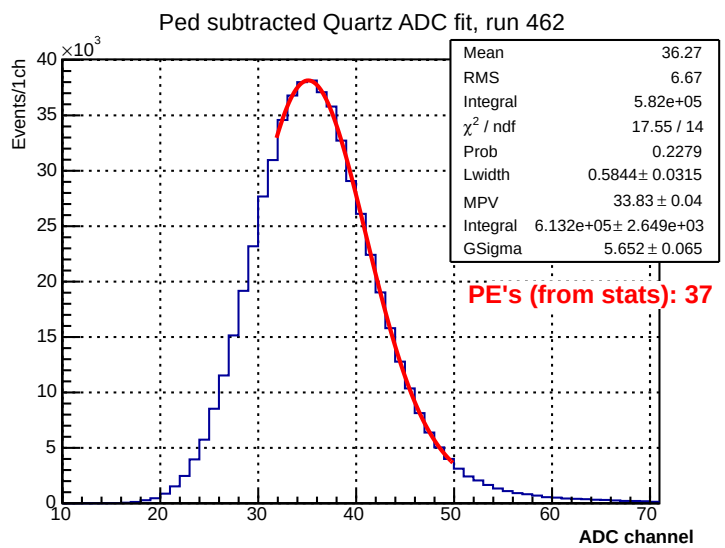
- Last testbeam: May 29 - June 1, 2015: MOLLER, PREX/CREX
- About 1.5 shift for PREX/CREX prototype tests:
  –2 prototypes tested: Angle scans with and without LG (6 mm)
  –Longpass filter study with no-LG 6mm
  –Angle scan for no-LG with 10 mm thick quartz

Testbeam Data: 6mm, no-LG, 89deg incidence

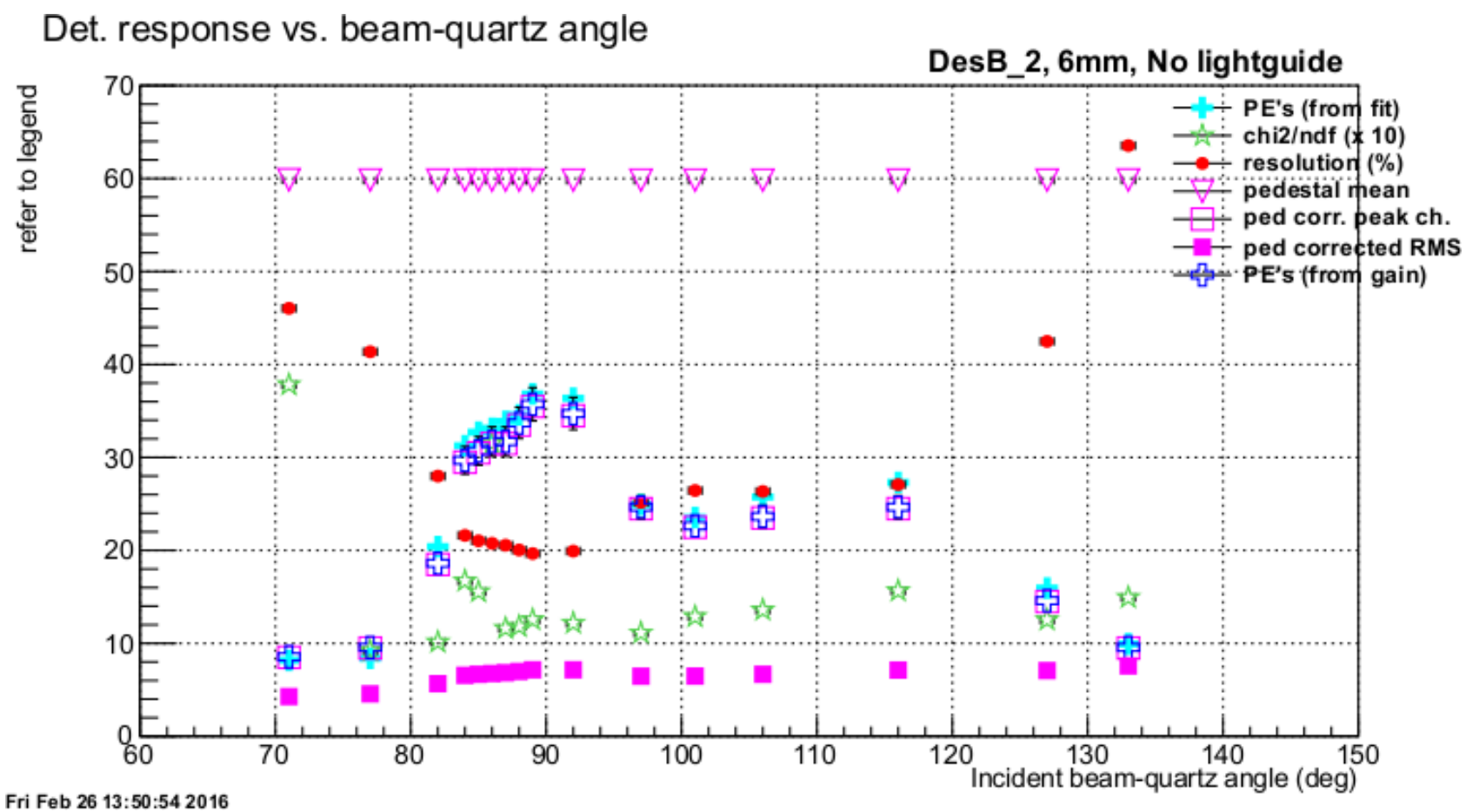




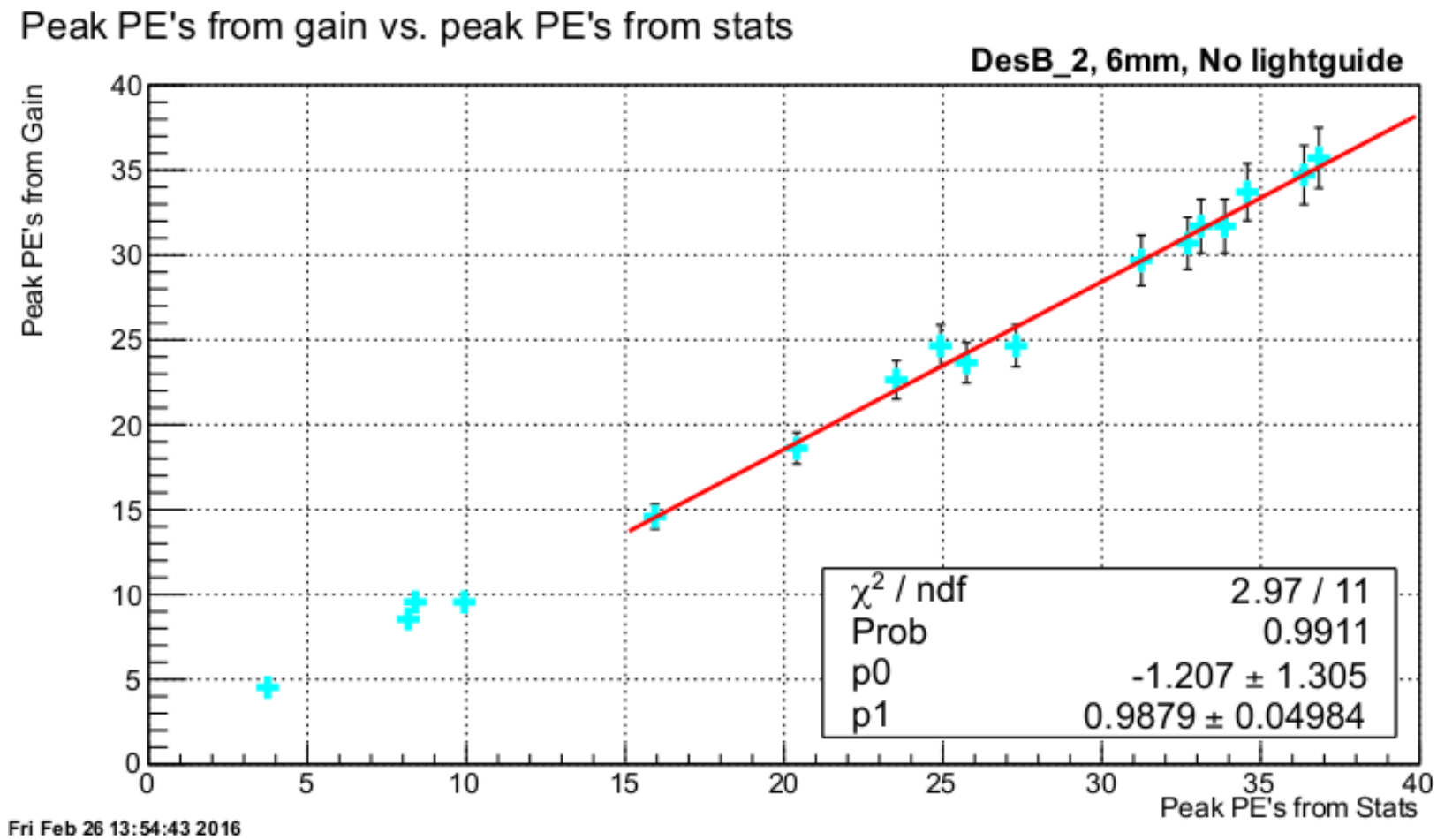




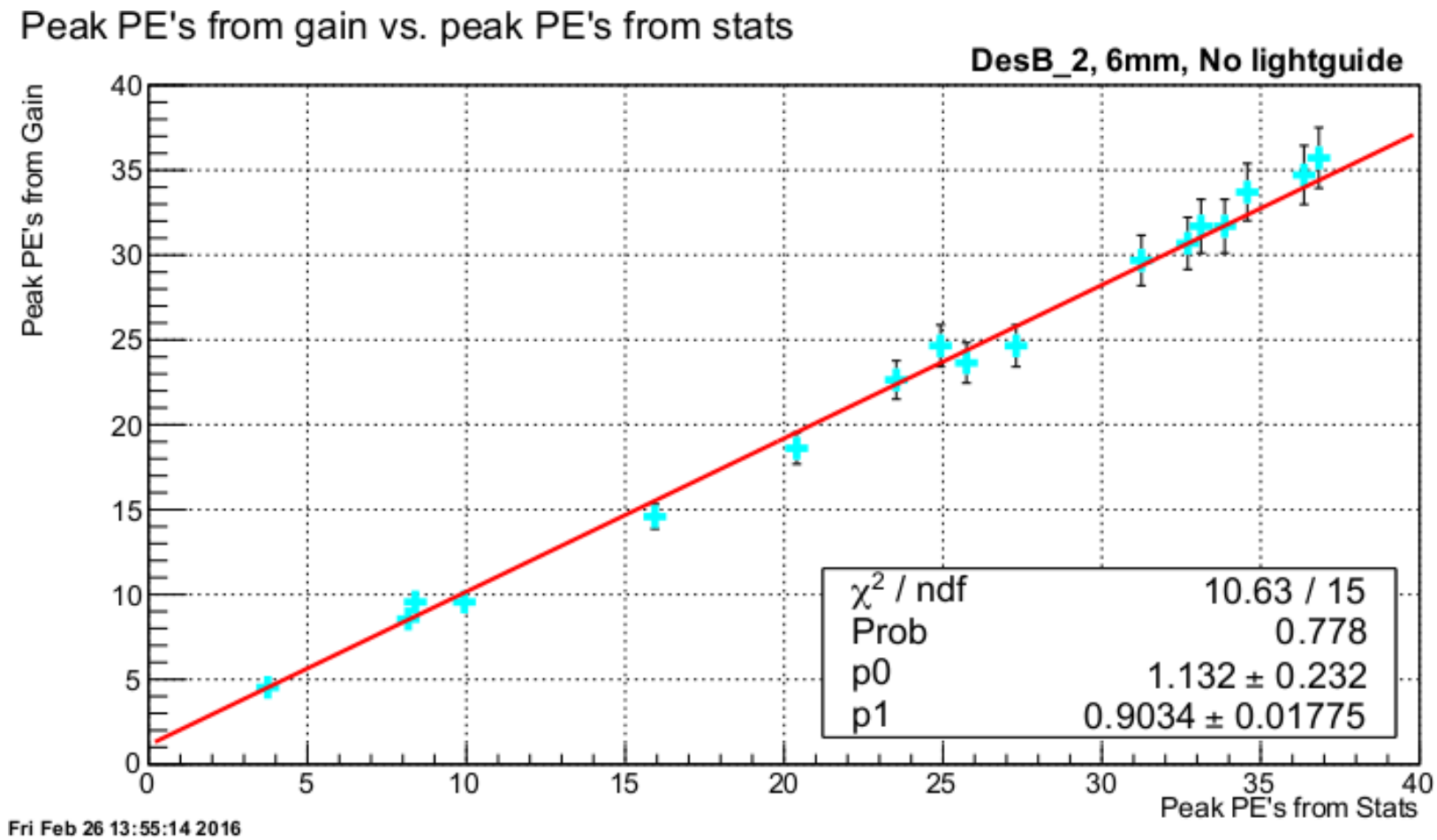
MAMI Testbeam: no-LG, 6mm angle scan



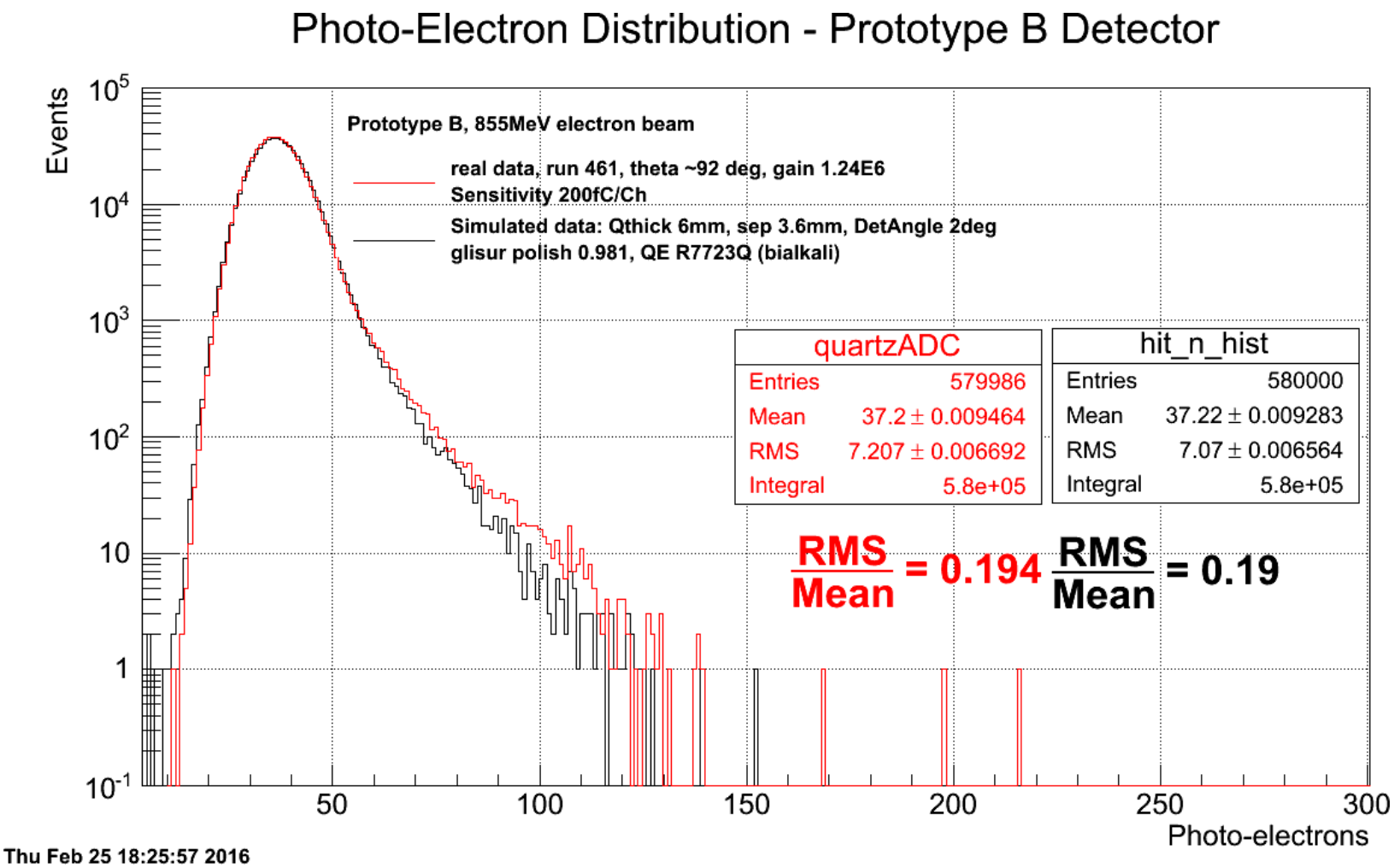
6mm, no-LG angle scan PE comparisons: Gain vs. Stat widths



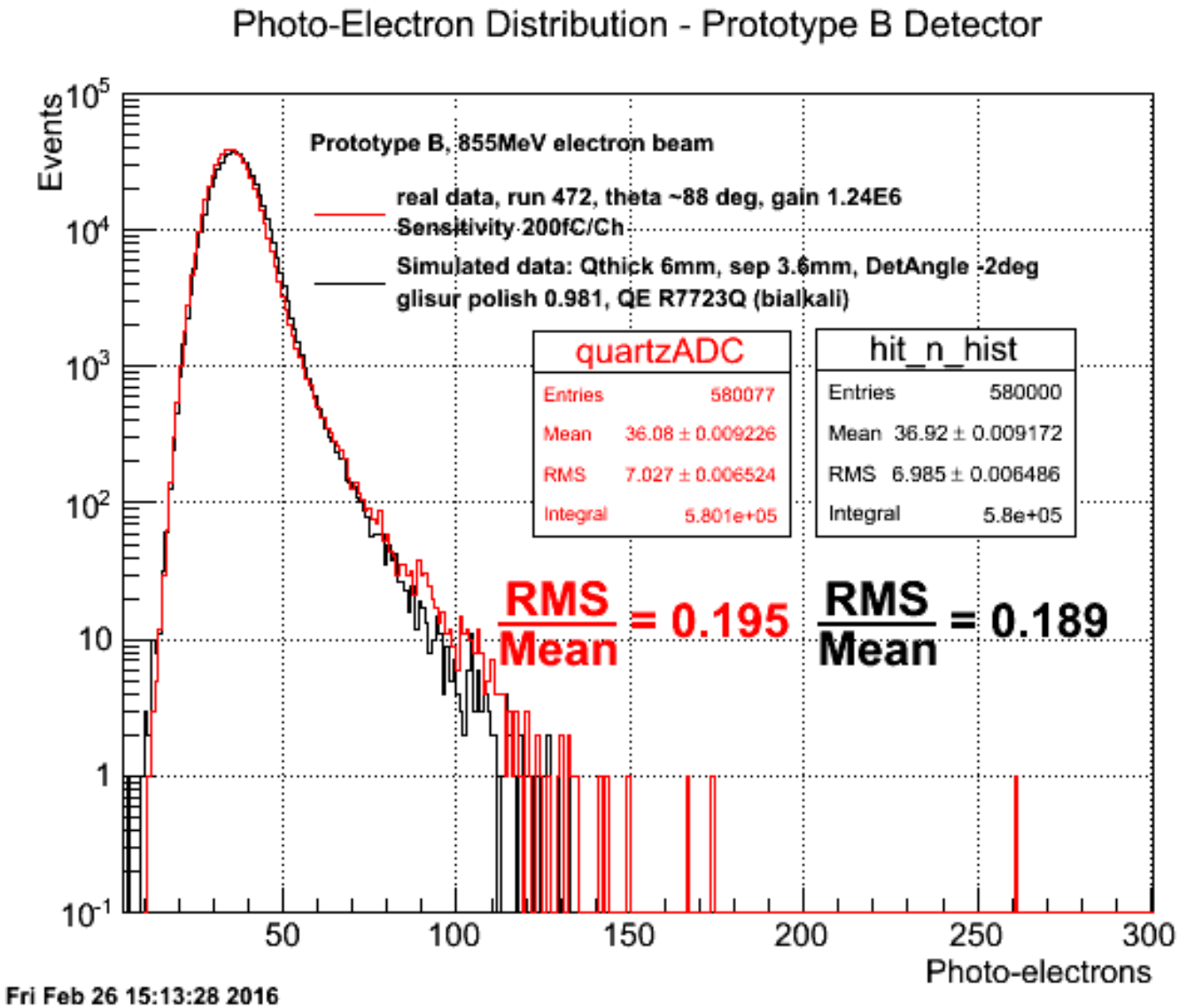
6mm, no-LG angle scan PE comparisons: Gain vs. Stat widths



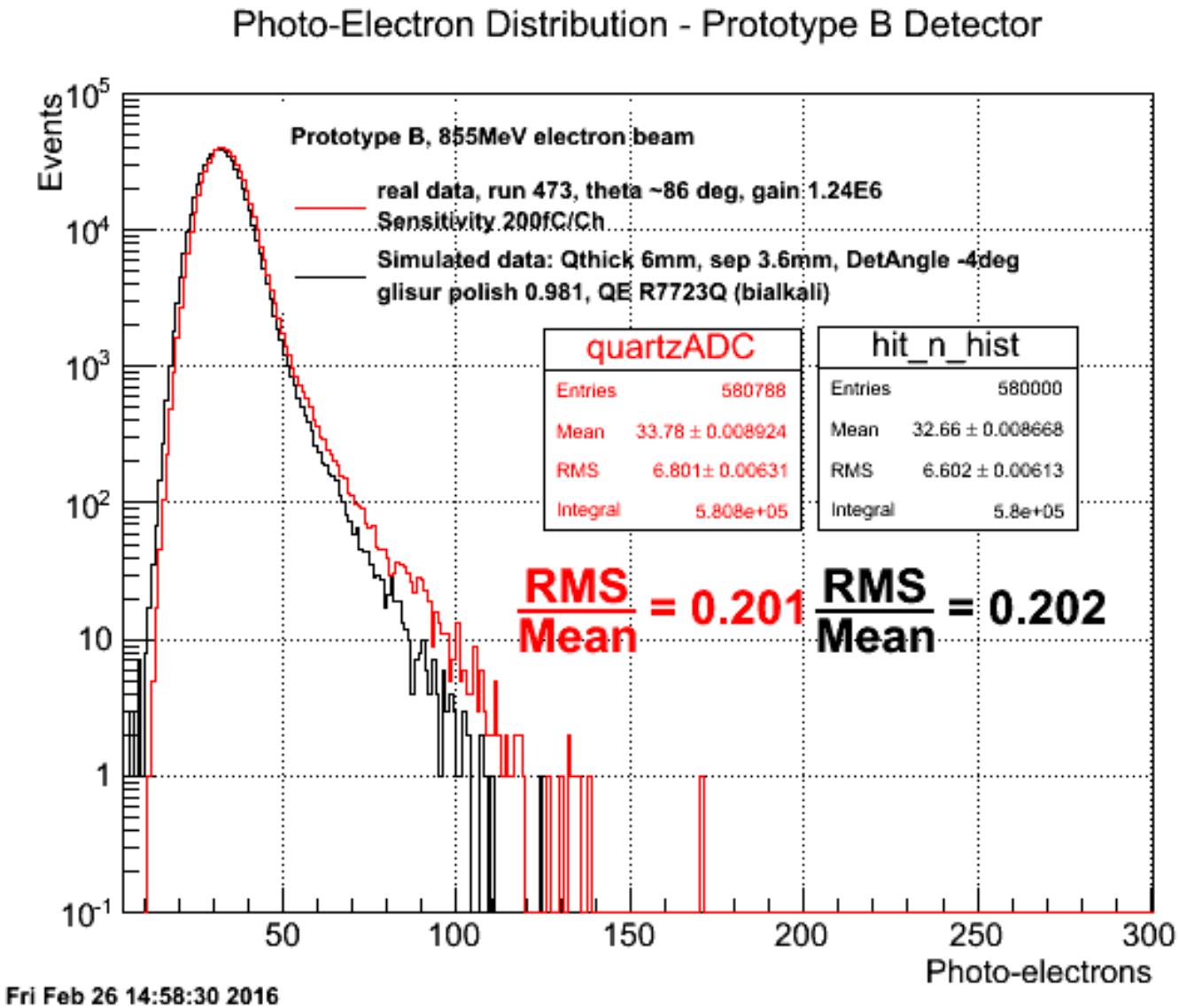
Comparison: 6mm, no-LG, 92deg incidence



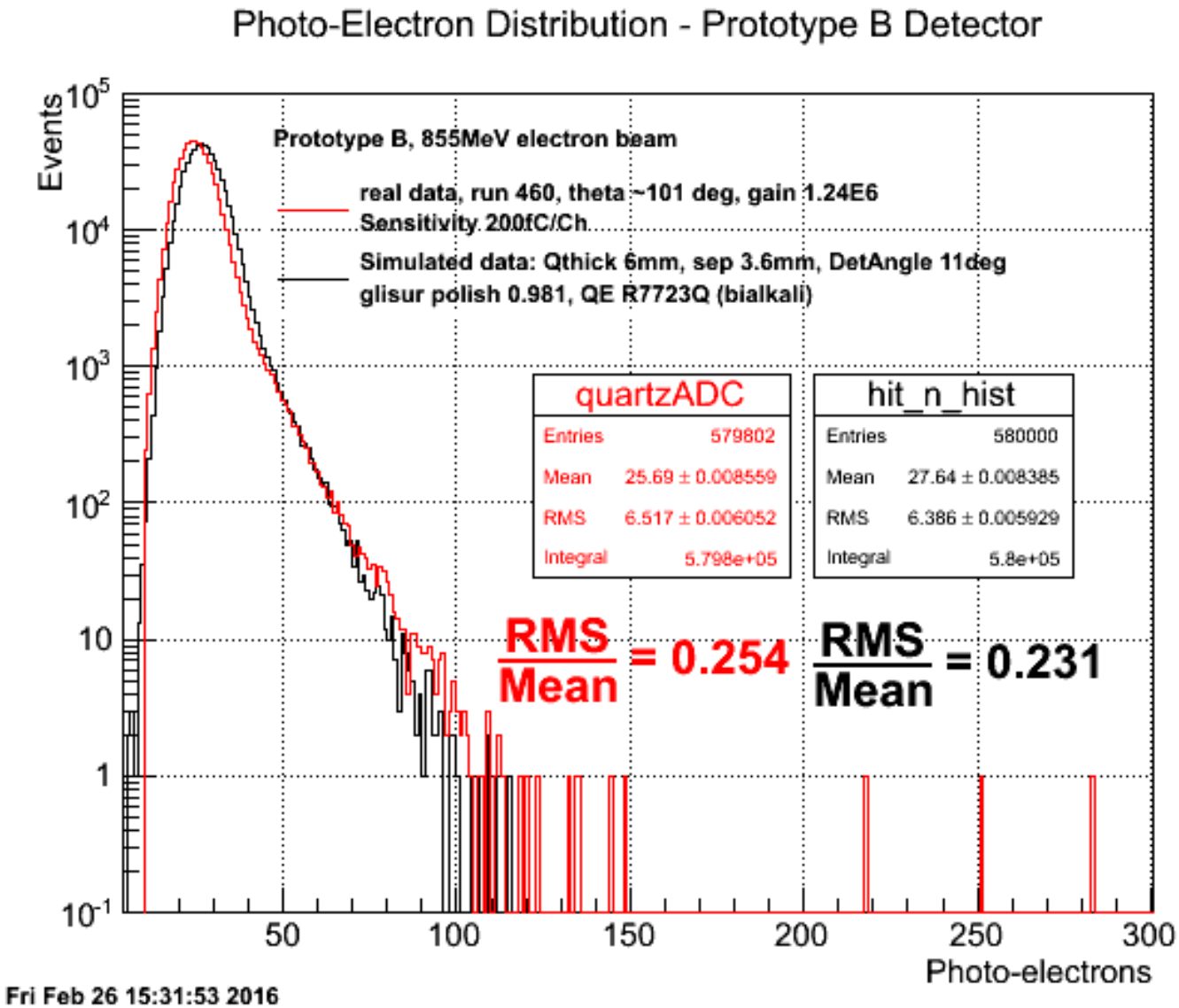
Comparison: 6mm, no-LG, 88deg incidence



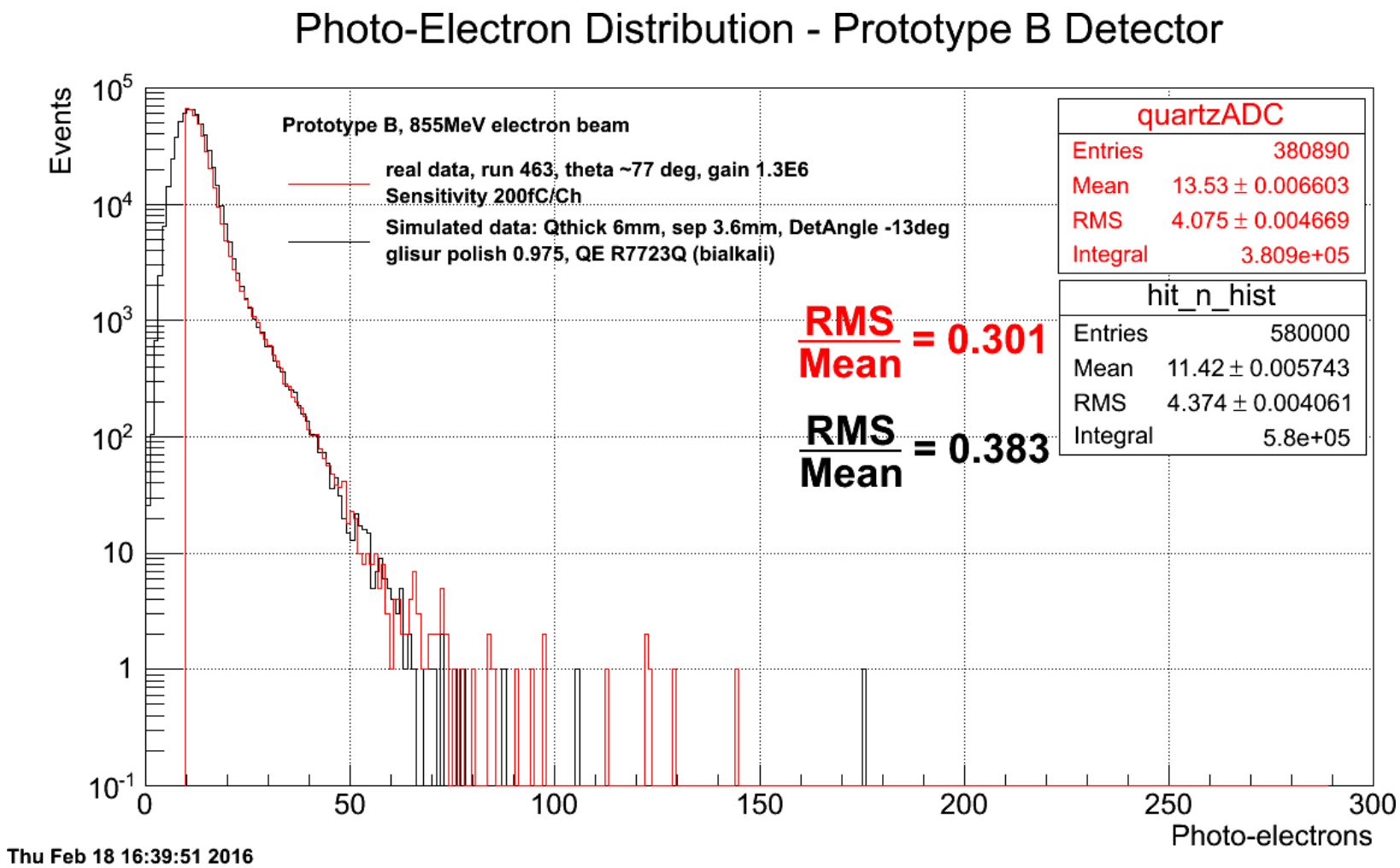
Comparison: 6mm, no-LG, 86deg incidence



Comparison: 6mm, no-LG, 101deg incidence

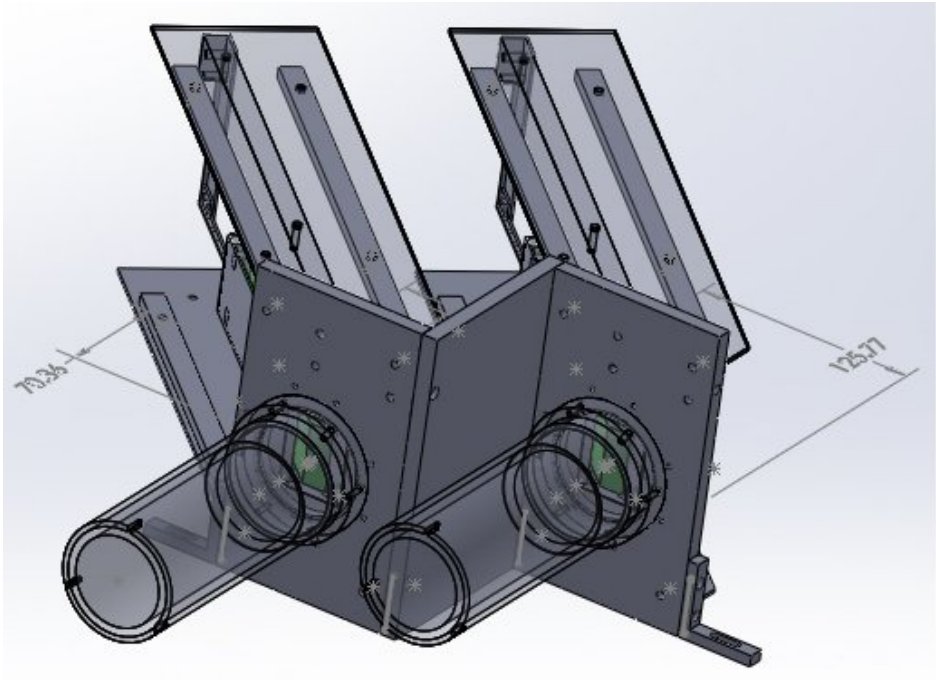


Comparison: 6mm, no-LG, 92deg incidence

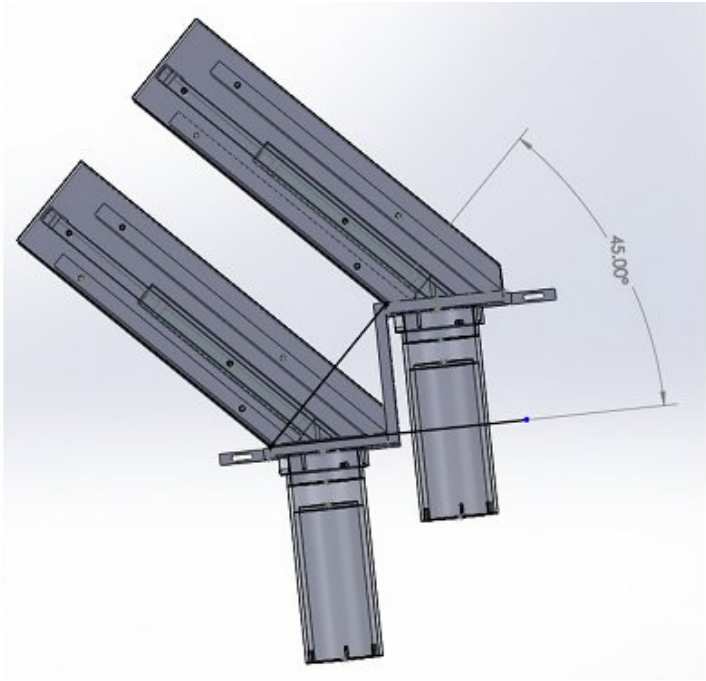


Plans for next MAMI Testbeam (May 2016)

Side-angled view



Top view



Will test PREX tandem detector mount using ”thin” 6 mm quartz upstream and ”thick” 10 mm quartz downstream

GEM Trackers for PREX/CREX

- Contacted Rui De Oliveira at CERN last November to discuss possibility of purchasing custom (10 by 20 cm^2) complete CERN GEM chamber kits
- A couple weeks later he sent me a rough cost estimate and I asked for a formal quote for:
  - –5 triple gem chambers assembled and tested
  - –5 spare framed foils
- Placed the order last month – 12 weeks lead-time
- Also joined Nilanga's big electronics order: We're getting 6 MPD VME modules and 55 UVA-style APV FE cards
- Complication is mostly in the readout. Still need to design and build custom APV FE bussing PCB and HV distribution scheme (will modify UVA design for our system)

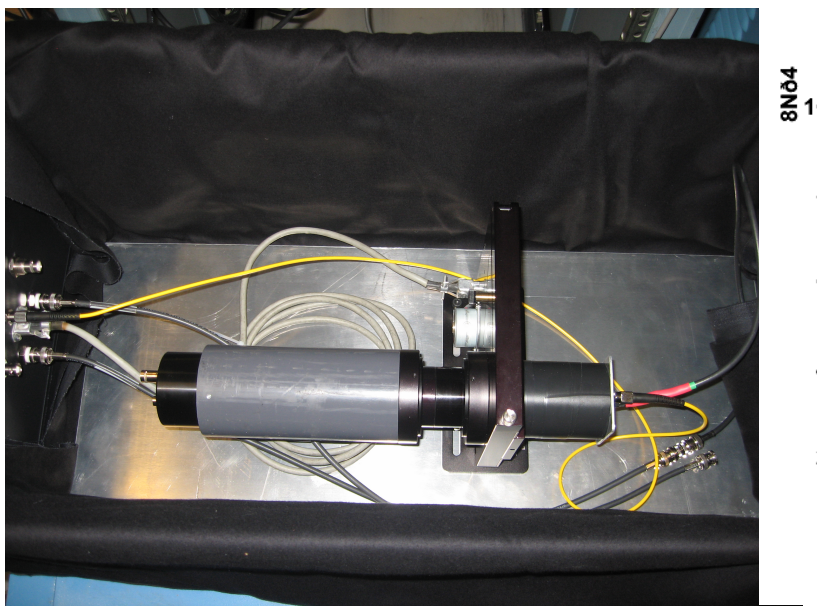
Summary and Plans

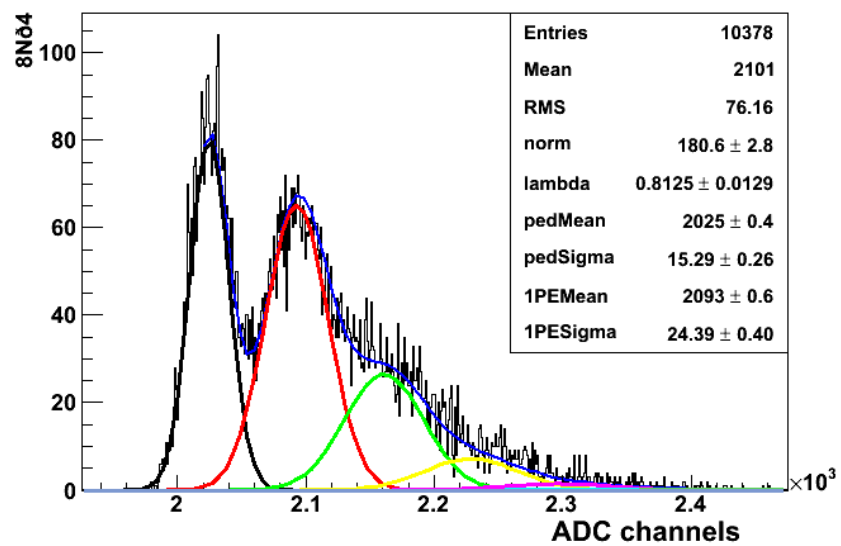
- PREX II det design near final: no-LG / uses quartz TIR as LG
- Final CREX design waiting for focal plane footprint–for quartz (and pmt) size–but will also use no-LG design
- G4 optical simulations for no-LG, 6mm configuration in very good agreement; continuing to refine and study
- Simulations for designs with LG's require additional tuning (need to sample reflectivities as function of angle and λ)
- Working to simulate complete angle scans for 6mm and 10mm quartz as well as long pass filter study (and compare with data)
- Planing to test 6 mm/10 mm tandem PREX detector at MAMI this May
- 10 by 20 cm^2 GEM tracker system under development...more next time

Extra Slides

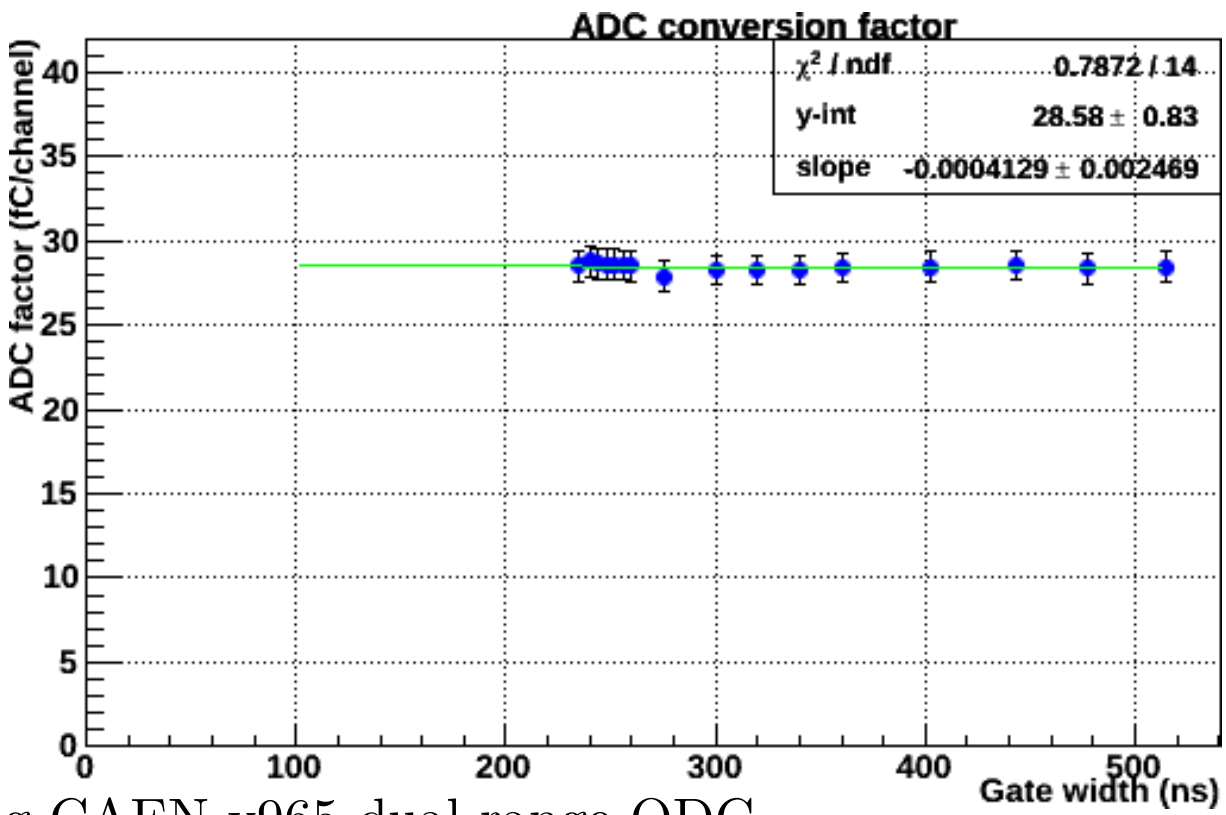
PMT Gain Measurements

- ADC charge sensitivity calibrated
- Gains measured using linearity apparatus with CAEN LED driver, ND filter wheel, and CAEN fast amplifier
- PE peaks extracted using multi-Poisson fit algorithm
- Purchased 4 new R7723Q pmts (with Mod. base); also have two pmts on loan from Jlab





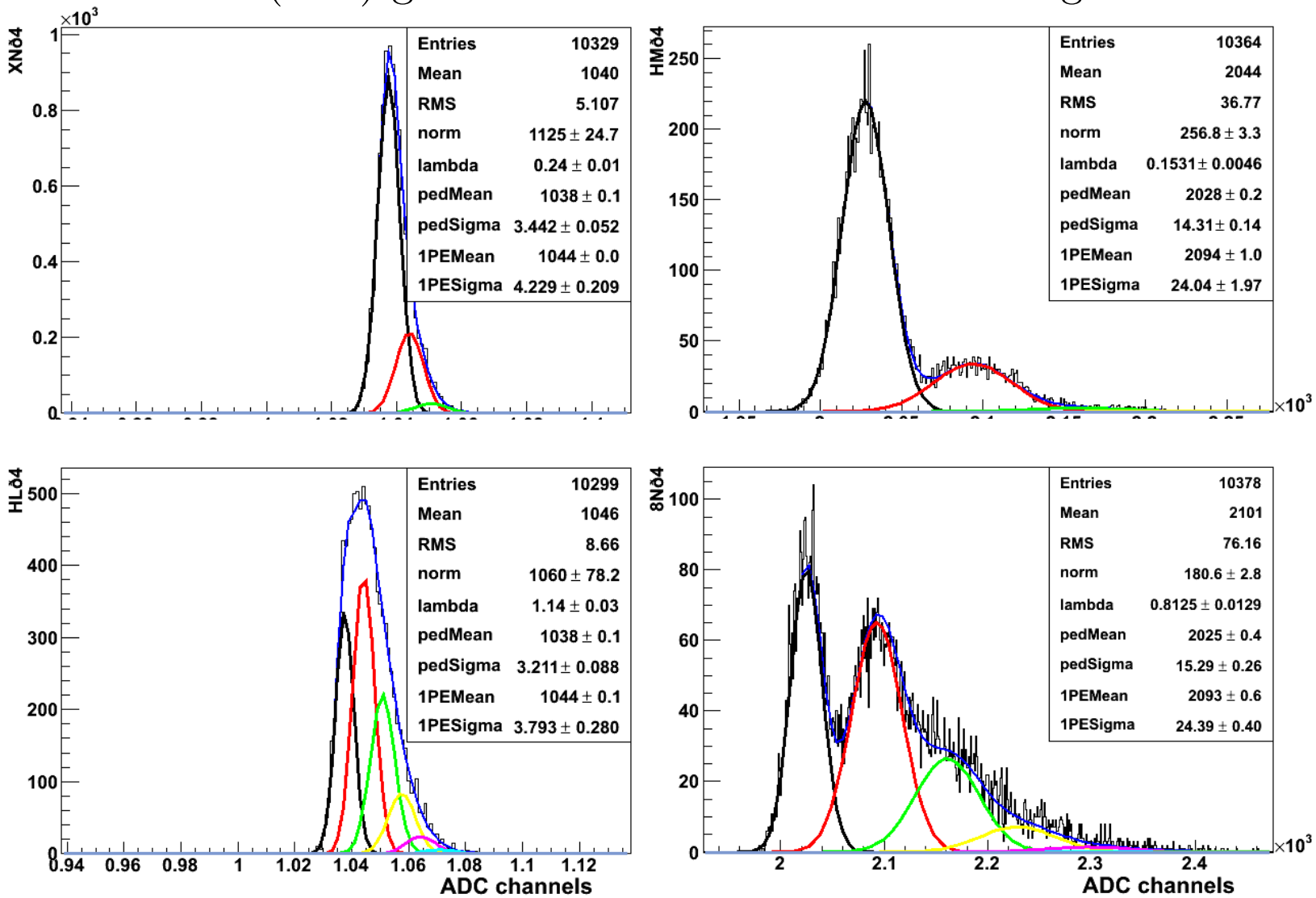
PMT Gain Measurements (ADC Charge Sensitivity)



- Using CAEN v965 dual range QDC
- Spec. gives 25 and 200 fC/ch sensitivities
- We found ∼28.6 and ∼230 fC/ch with about ∼3% uncertainty

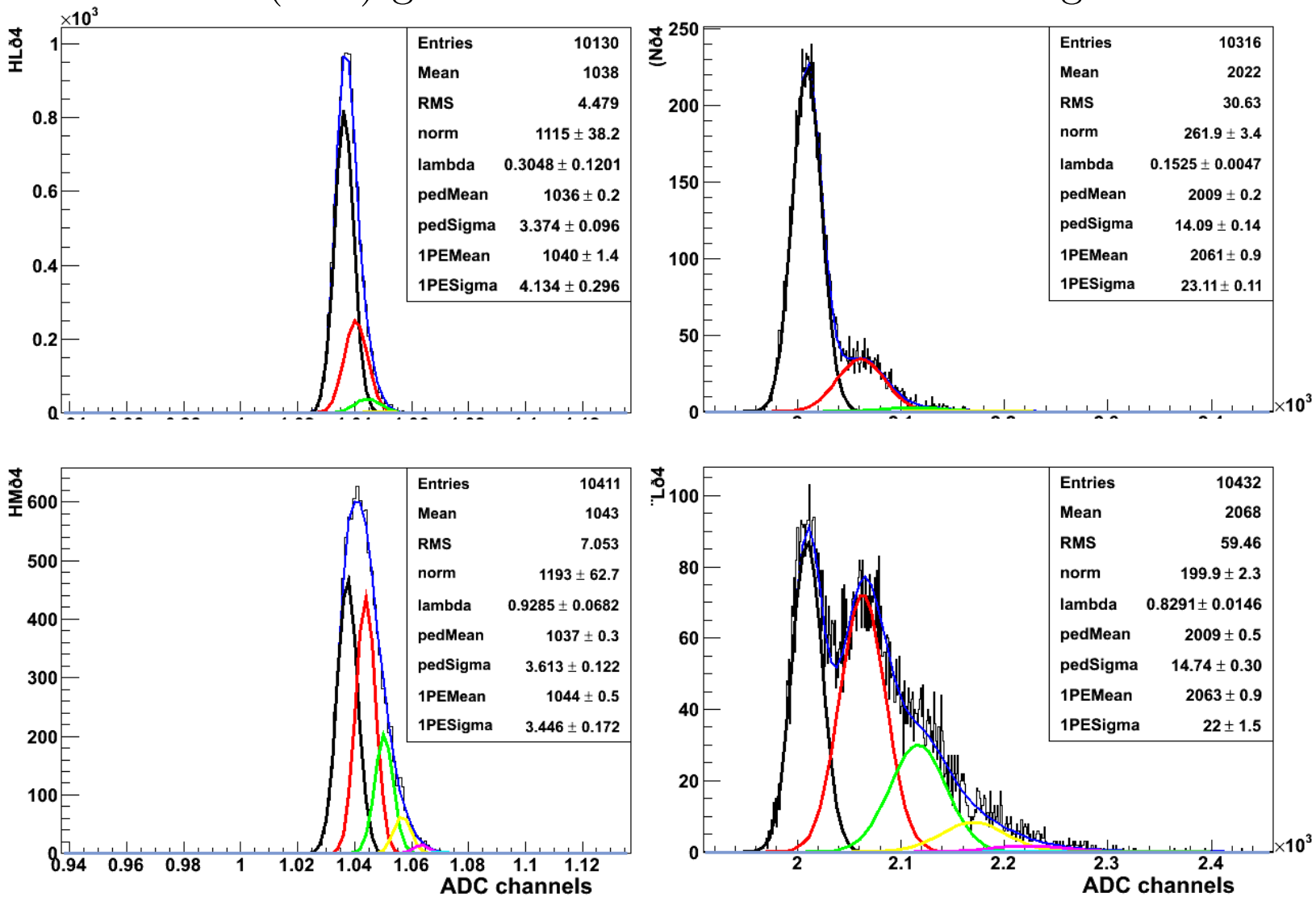
PMT Gain Measurements

- PMT 1 (new) gain at -2000 V for two different light levels:



PMT Gain Measurements

- PMT 2 (new) gain at -2000 V for two different light levels:



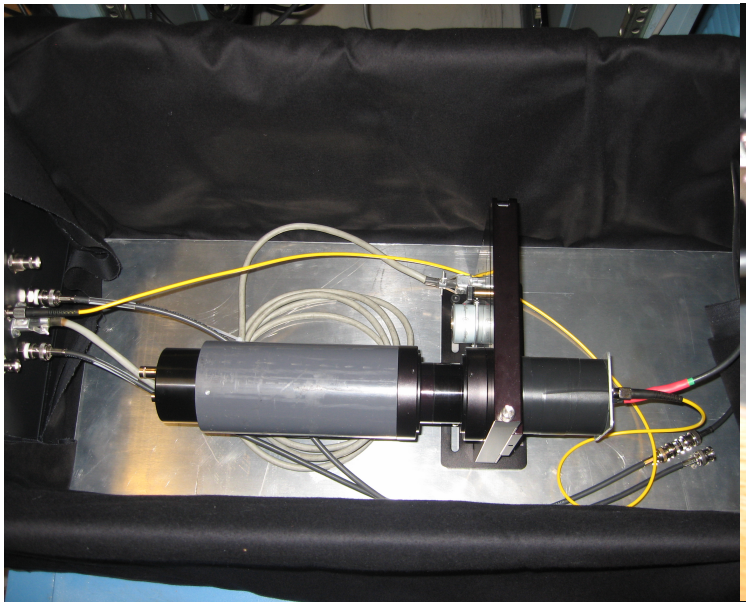
PMT Gain Measurements

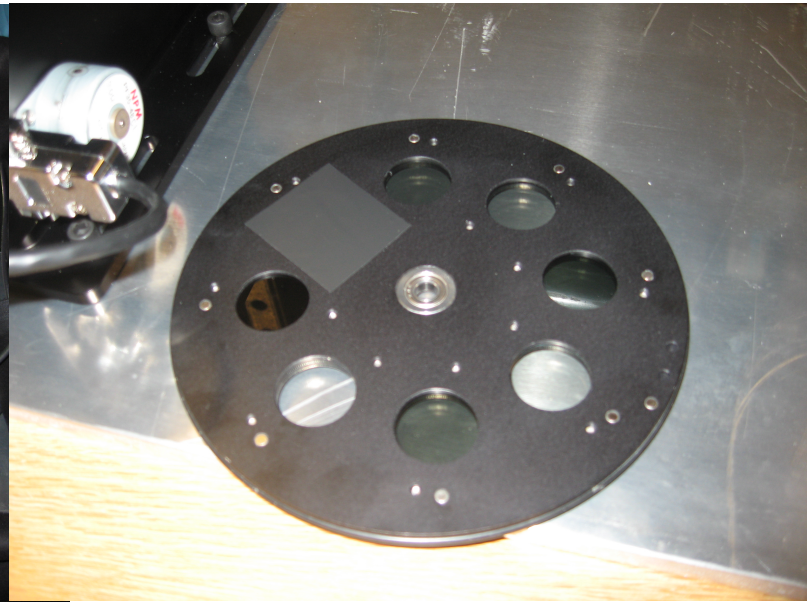
RUN	LED amplitude	PMT	Amp	Gain ($\times 10^6$)
1410	4,50	1	No	1.33
1412	5,50	1	No	1.16
1417	4,50	1	Yes	1.23
1419	5,50	1	Yes	1.25
1424	4,50	2	No	0.75
1426	5,50	2	No	1.16
1431	4,50	2	Yes	0.96
1433	5,50	2	Yes	0.99

Table 1: Table of gain measurements at -2000 V. Estimated uncertainty is about $\pm 5\%$. Gains measured without amplifier are somewhat sensitive to fitting, while gains measured with amplifier are have uncertain amplification.

Path to Linearity Measurements

- Test apparatus constructed (based on Luis' setup):
  - –Two LEDs (one steady, one flashing) ⟶ filter wheel ⟶ diffuser ⟶ pmt
  - –Integrating DAQ using Qweak ADC: have HAPPEX timer and ported drivers for linuxROC, NEED help porting drivers for Qweak ADC!!!– Paul King volunteered to help





Linearity Study Strategy

- Using apparatus to map out pmt gains over large range of HV
- Will use these gains to calibrate PE's from real data tests. Can then use estimated e^- flux combined with PE's/e^- to estimate anticipated pmt anode currents during PREX II and CREX
- LED light level is then adjusted to yield those anticipated PE rates
- For various HV's, LED asymmetries are measured for each filter setting and the degree of non-linearity is extracted from fits to the data.
- Choose HV setting that gives best linearity while utilizing ~full range of 18-bit ADCs