» RHIC Polarimetry «

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for the RHIC Polarimetry Group

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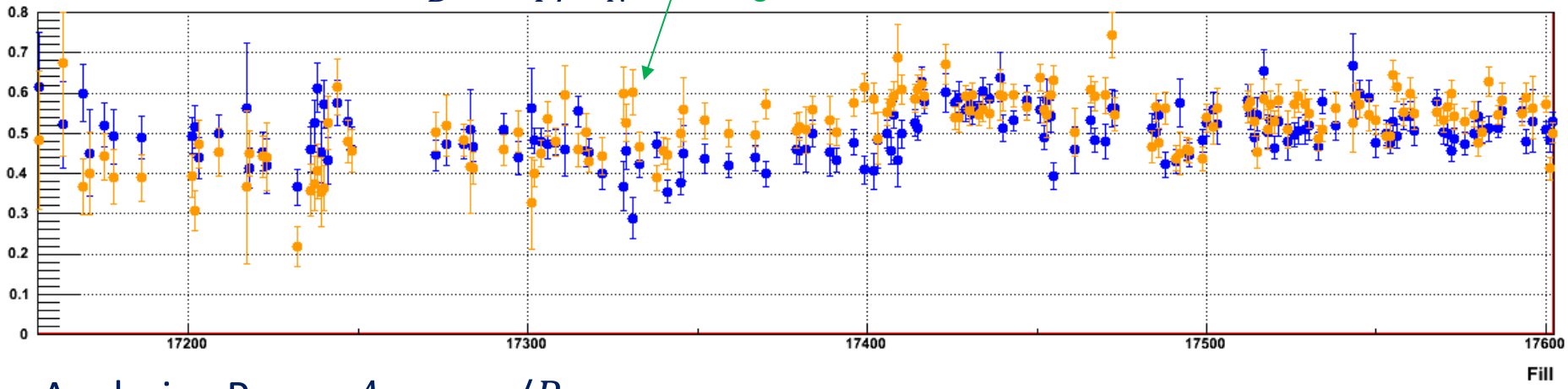
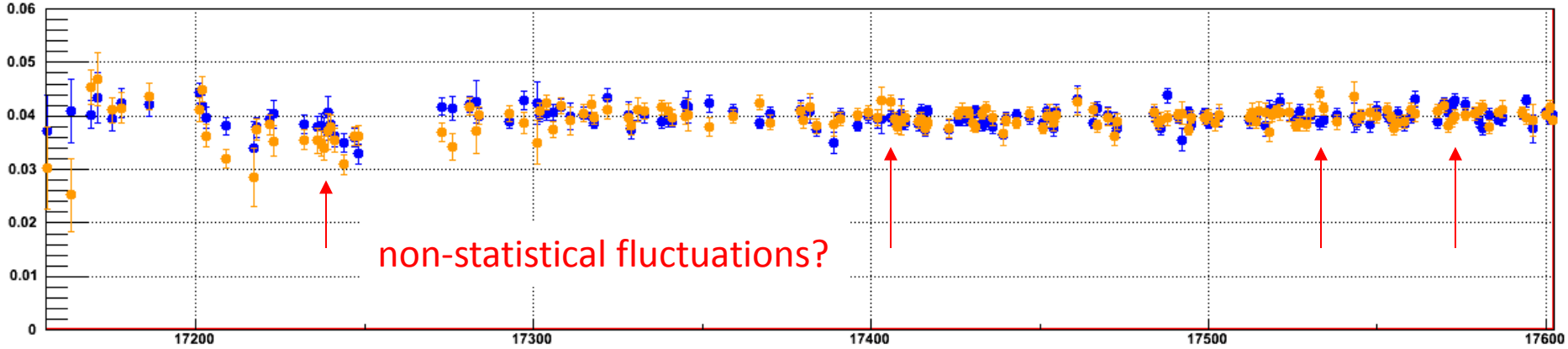
BROOKHAVEN
NATIONAL LABORATORY

Online Results 2013 (HJET)

Beam Polarizations $P_B = \varepsilon_T / A_N$

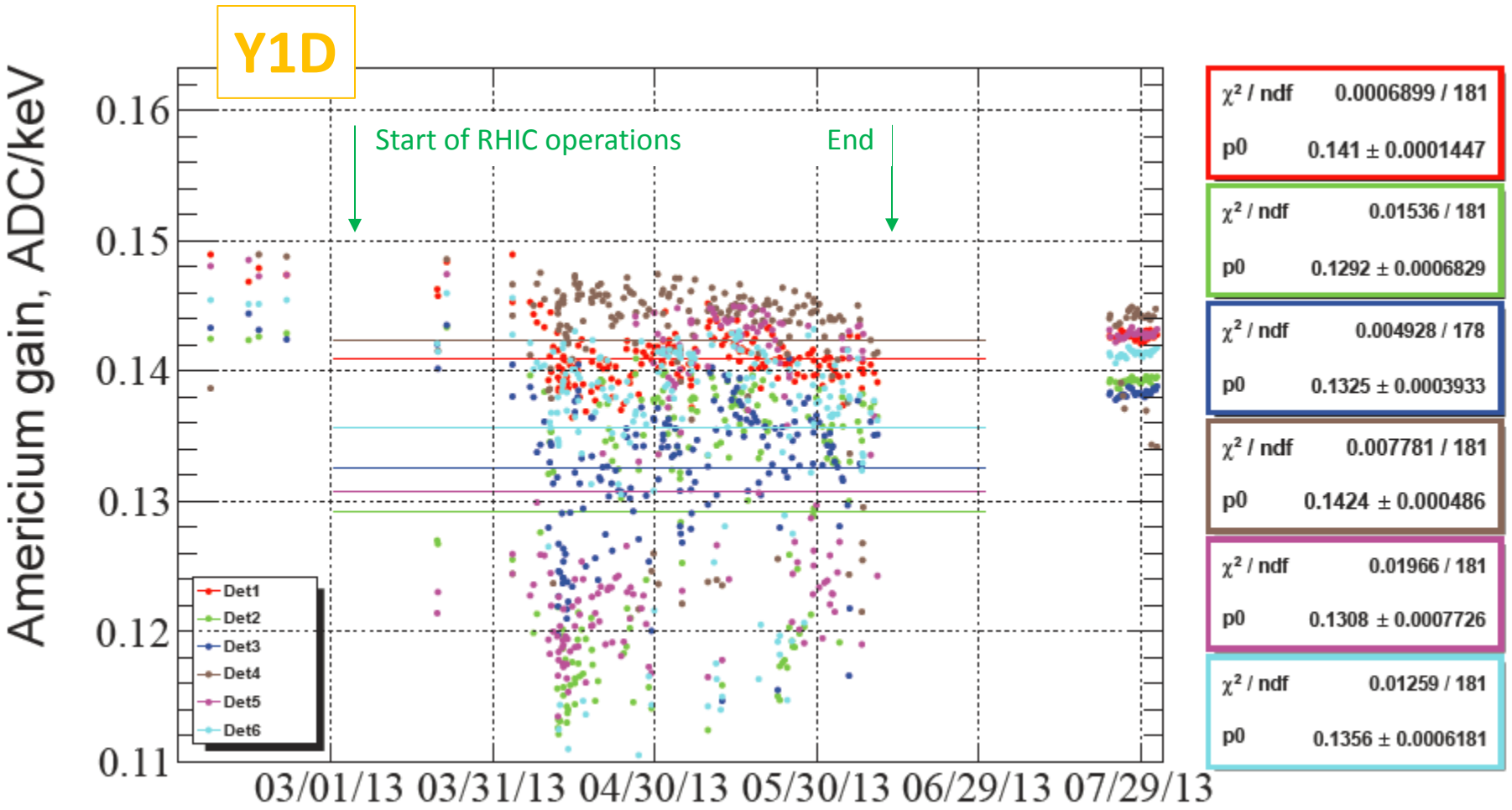


Analyzing Power $A_N = \varepsilon_T / P_T$



Concern about correlations with beam parameters

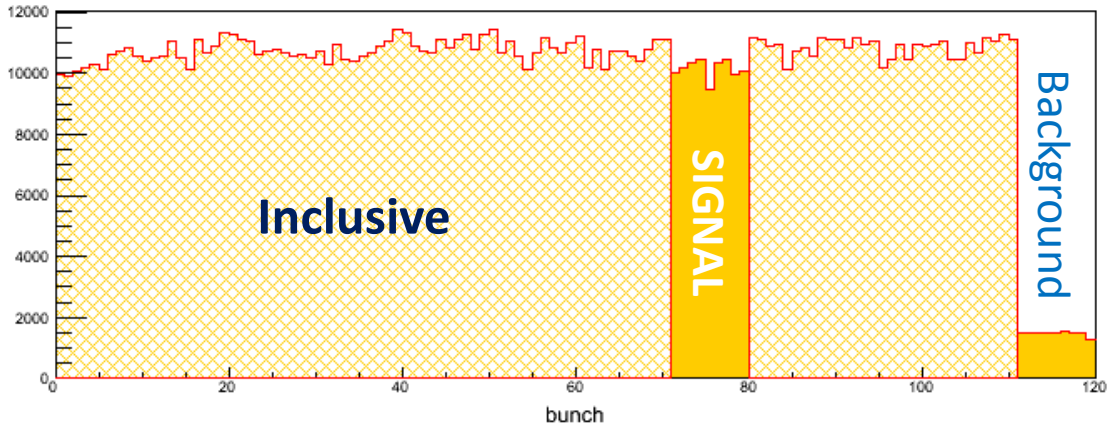
α-Calibrations (pC Polarimeters)

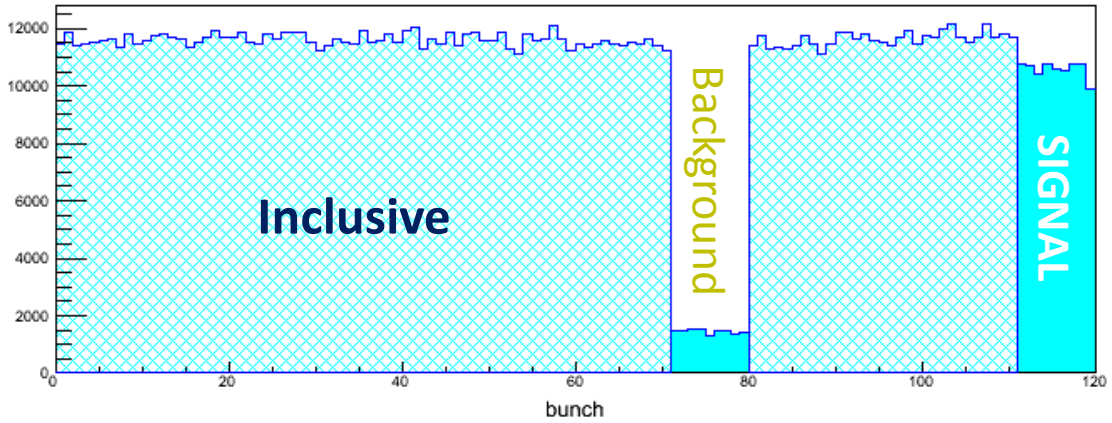


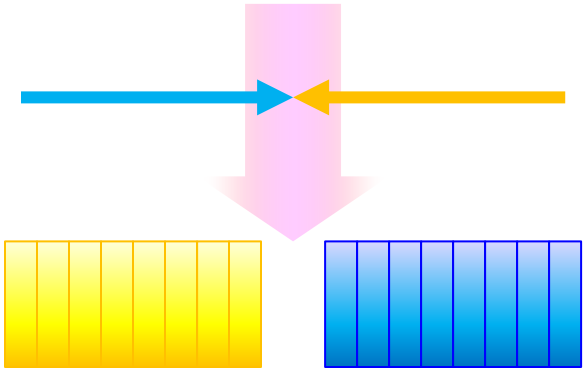
Large fluctuations observed in all pC detectors

» Hydrogen Jet Polarimeter «

Asymmetries & Background







$$P_Y = -\frac{\varepsilon_Y}{\varepsilon_T} P_T \qquad P_B = -\frac{\varepsilon_B}{\varepsilon_T} P_T$$

$$\varepsilon_S = \frac{\varepsilon - r \cdot \varepsilon_B}{1 - r}$$

Signal: ε_S

Background: ε_B

Inclusive: ε

Background fraction: r

Elastic Recoil Protons

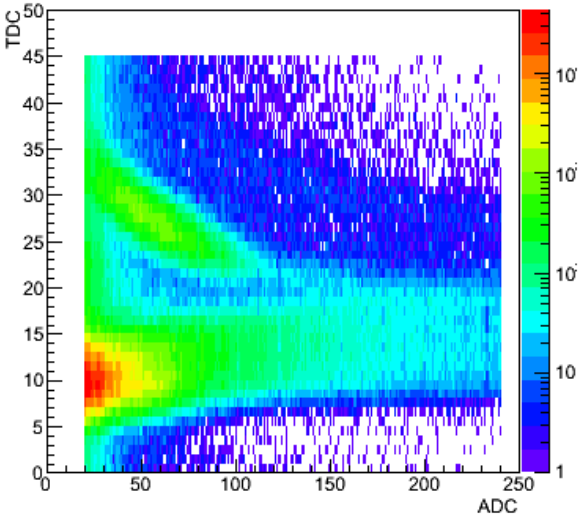
Example strip (68) from fill 17600

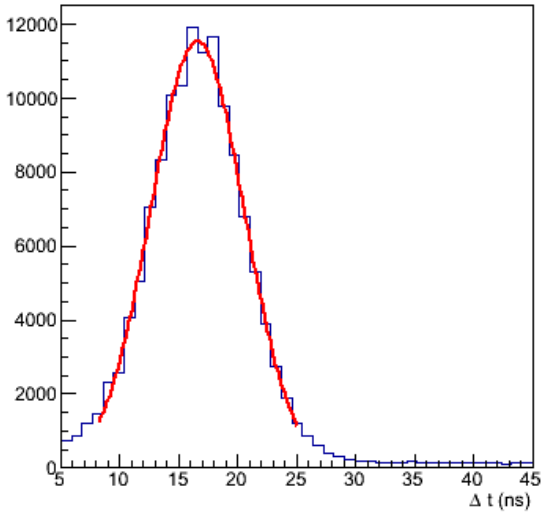
ADC & TDC from waveform
Energy (gain) calibration

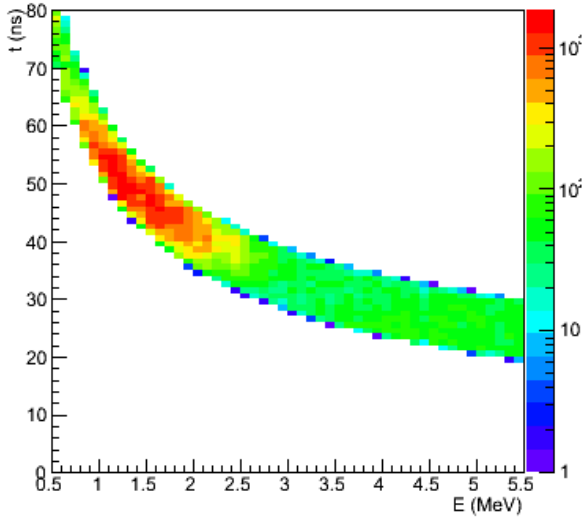
Choose energy range for strip

Select elastic recoil protons:

$|\Delta t_{elastic}| < 5$ ns





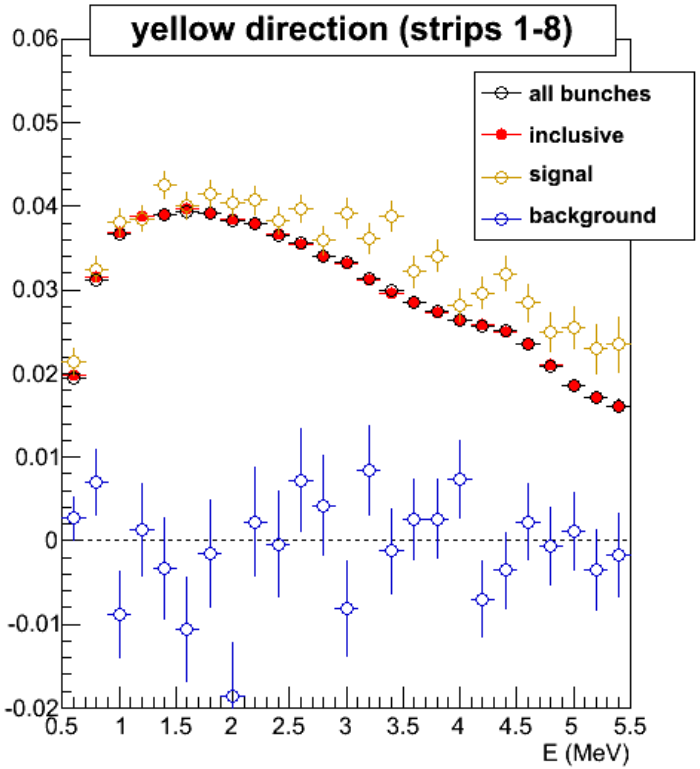


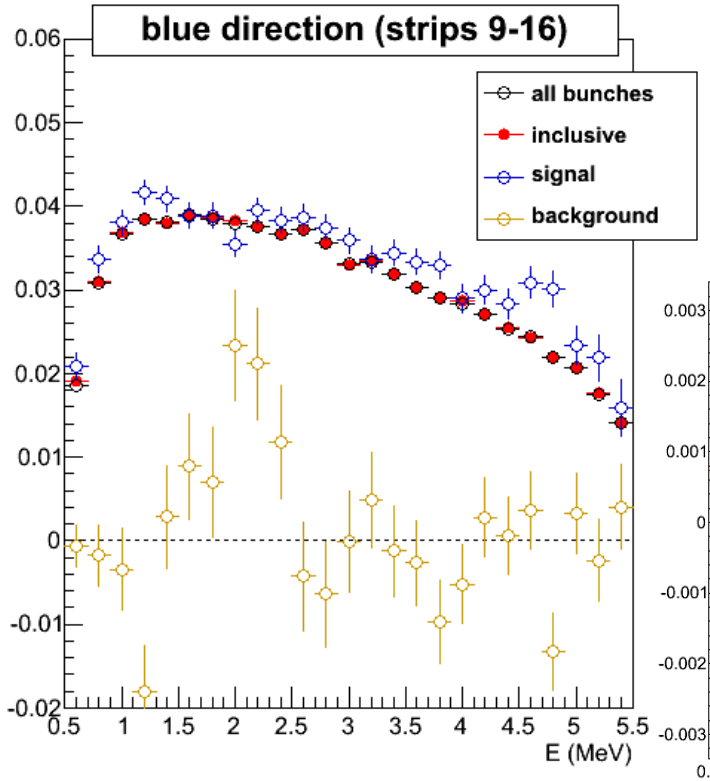
$$E_{kin} = \frac{1}{2} m_P v^2 = \frac{1}{2} m_P \left(\frac{d}{t - t_0} \right)^2$$

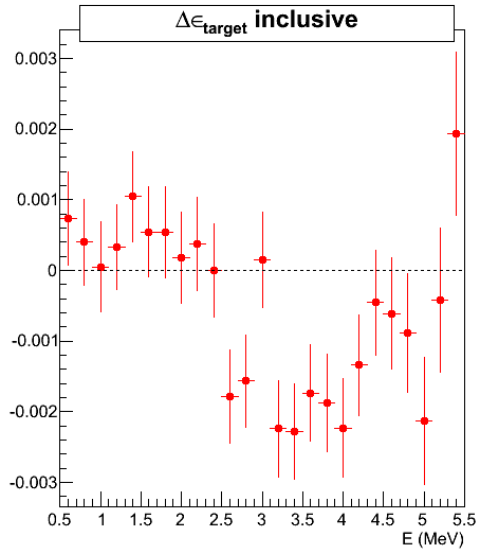
Jet Target Asymmetries

Full run 13 statistics! This is all of the available data*.

(*) *Excludes a handful of fills with less than 90 min. of jet operation.*



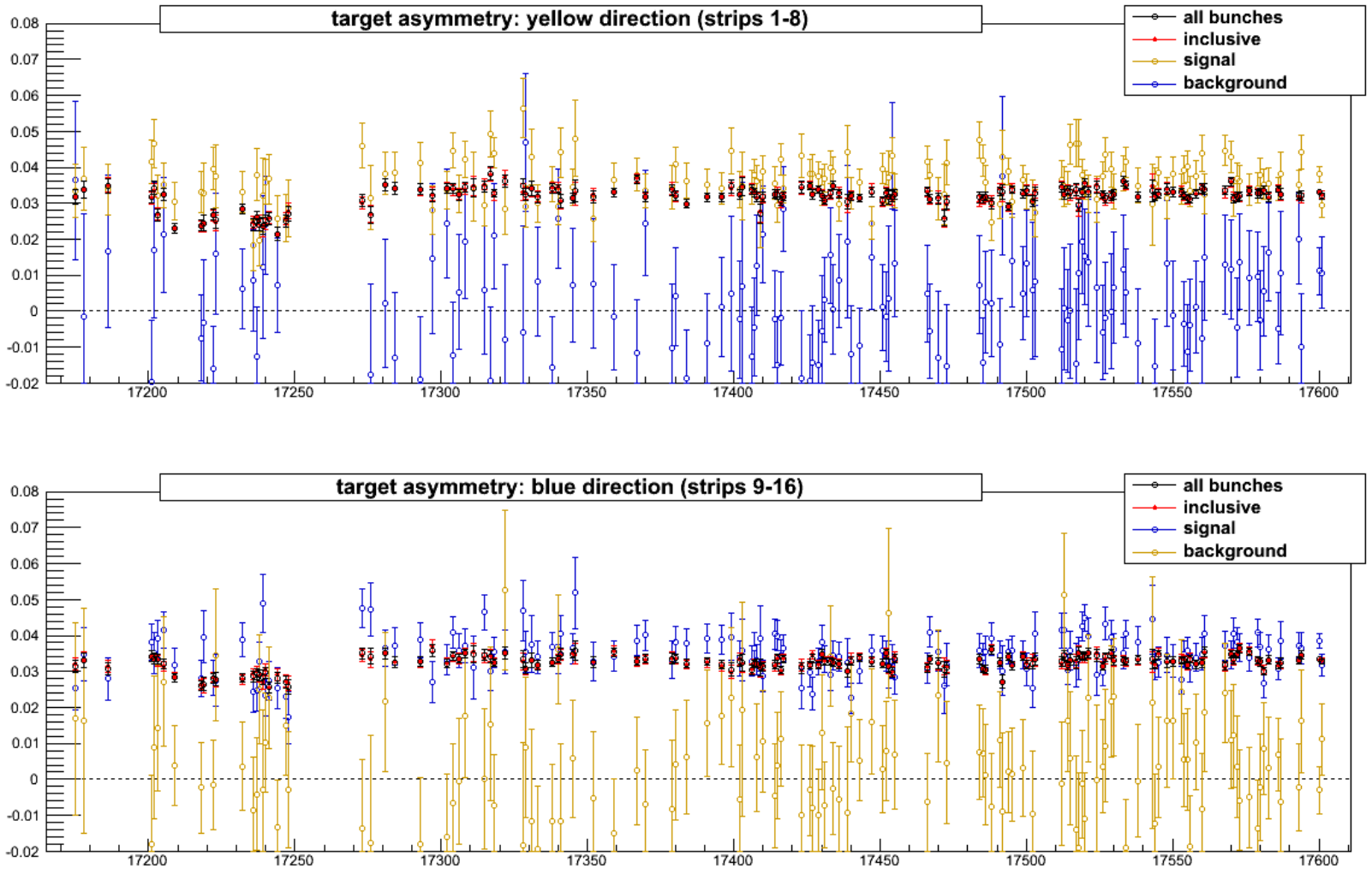




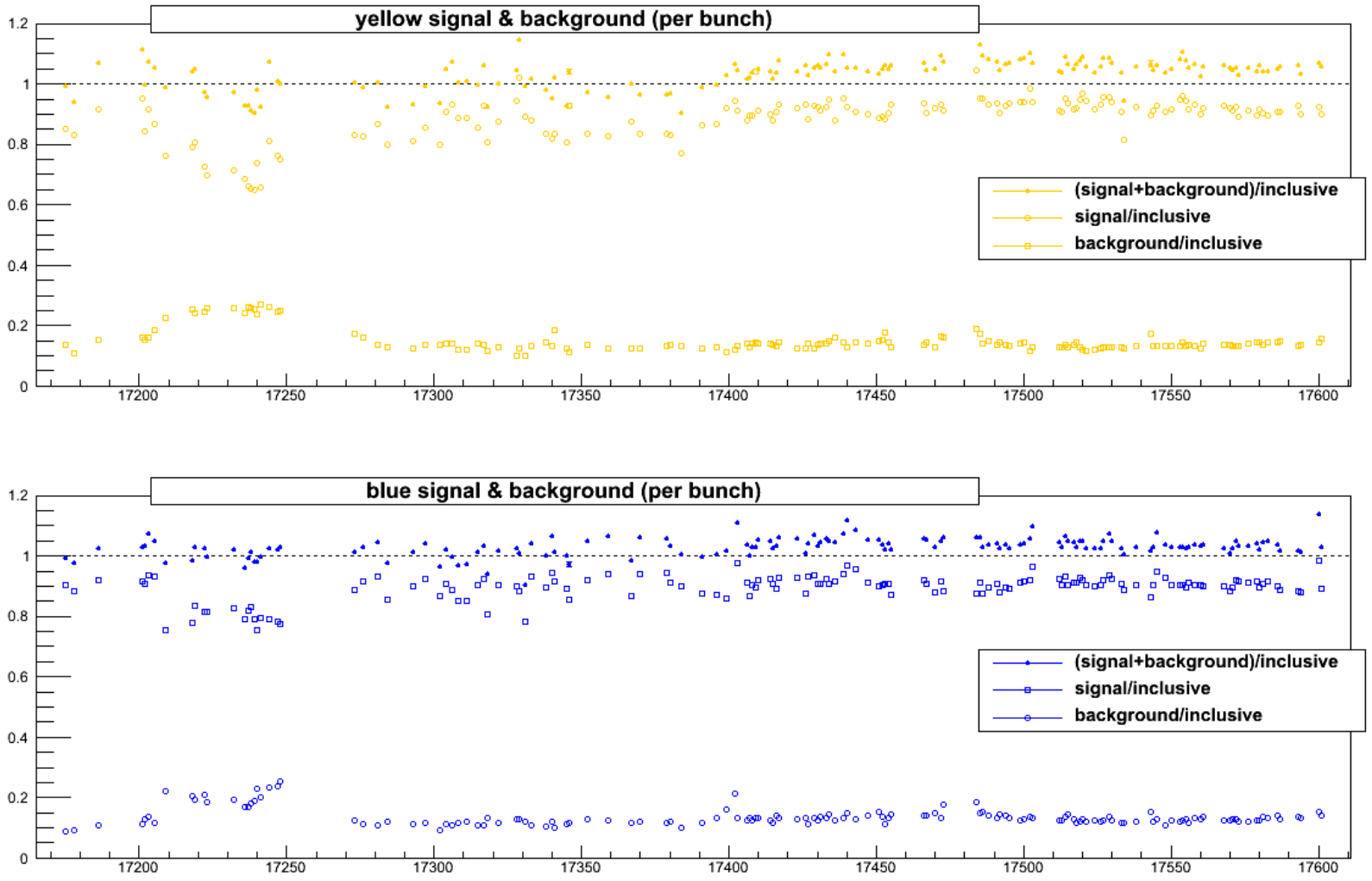
Asymmetries are transformed to blue beam coordinates (target asymmetry flipped)

Difference between *signal asymmetries* is consistent with zero.

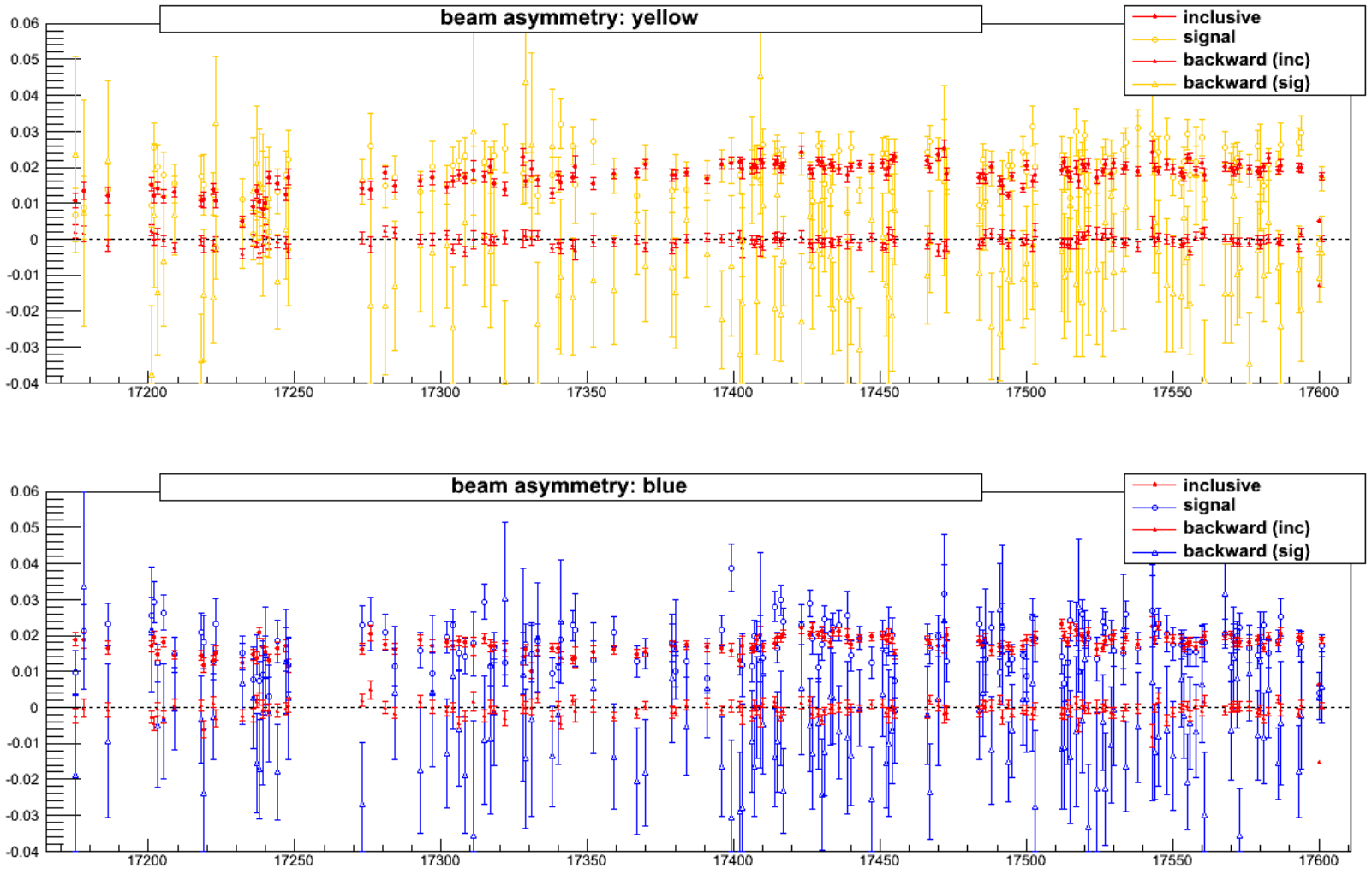
Fill Dependence



Background Fraction

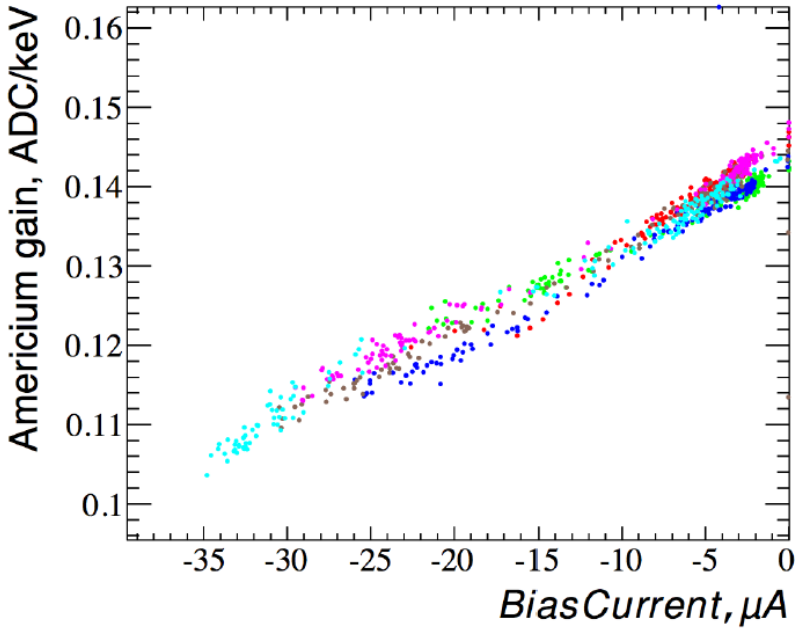


Beam Asymmetries

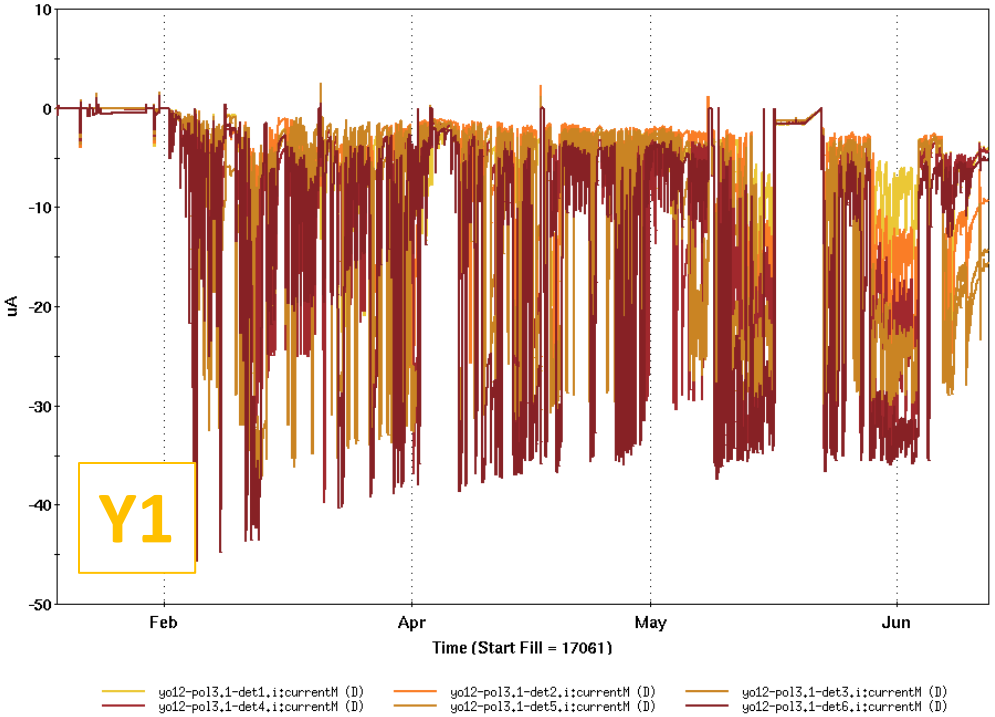


» Carbon Polarimeters «

Gain Variations

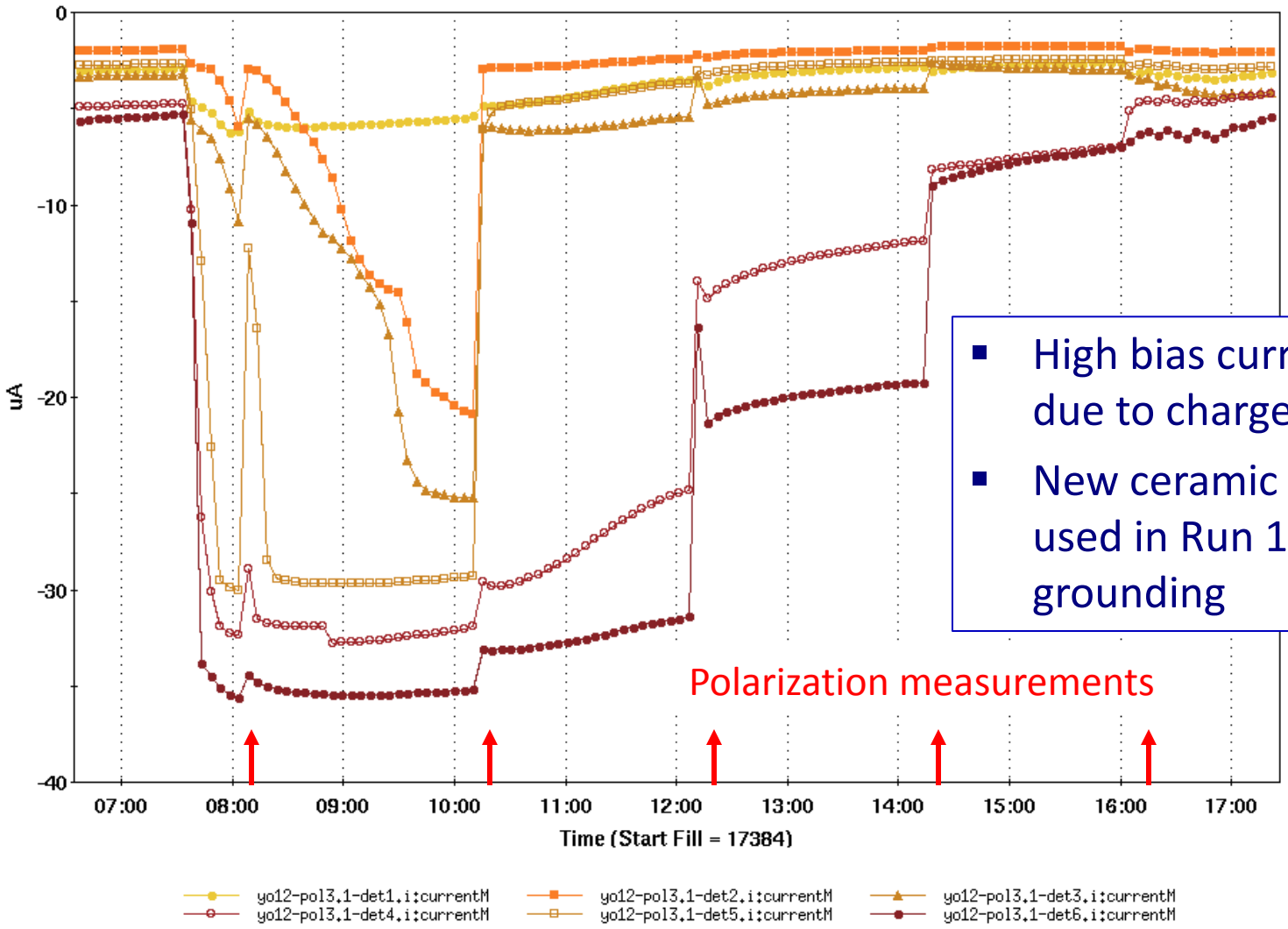


- α-calibrations typically done at the end of each fill
- Essential for identification of recoil Carbon



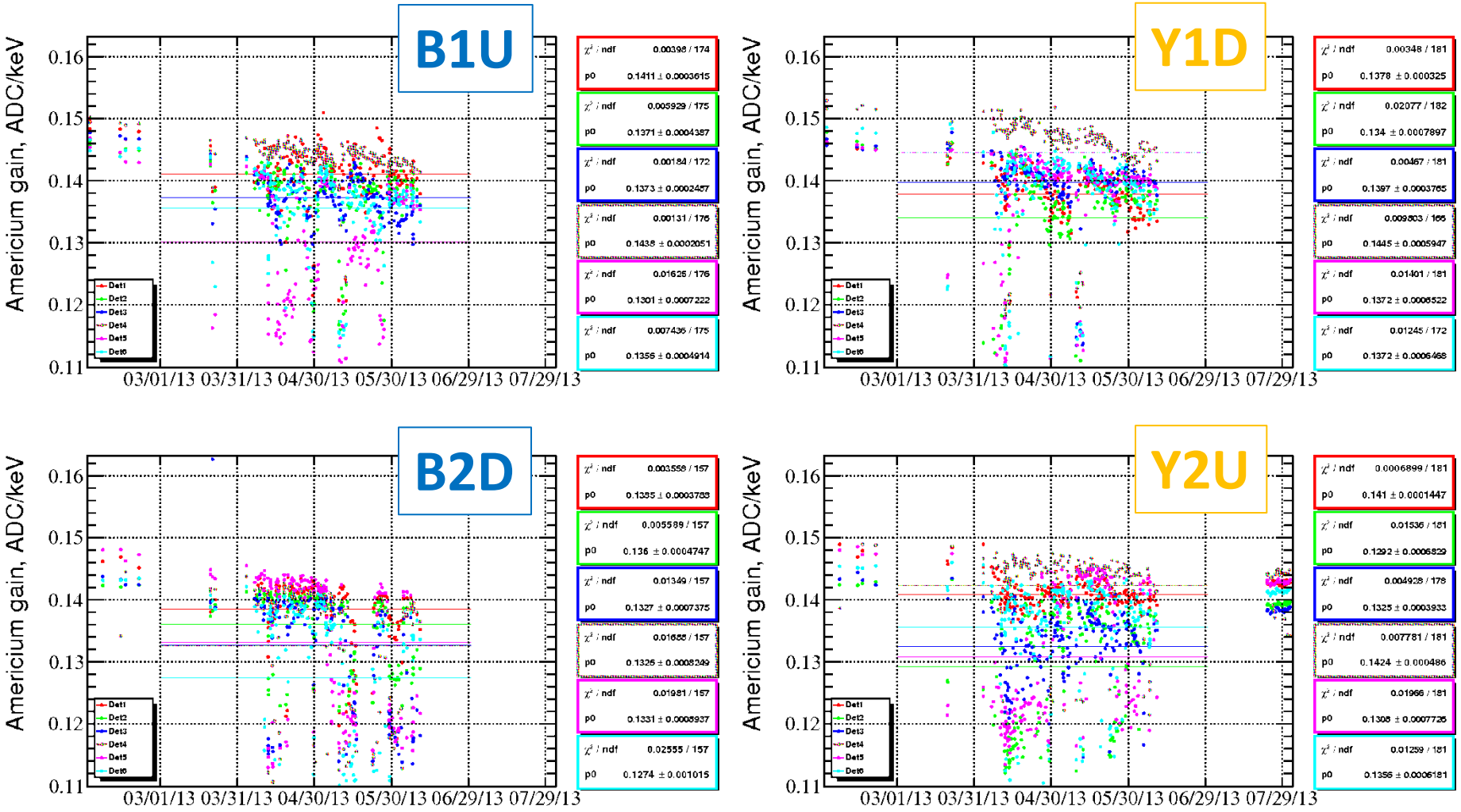
- Large variations observed between different calibrations
- Correlated with leakage bias current

Leakage Bias Current (Example)

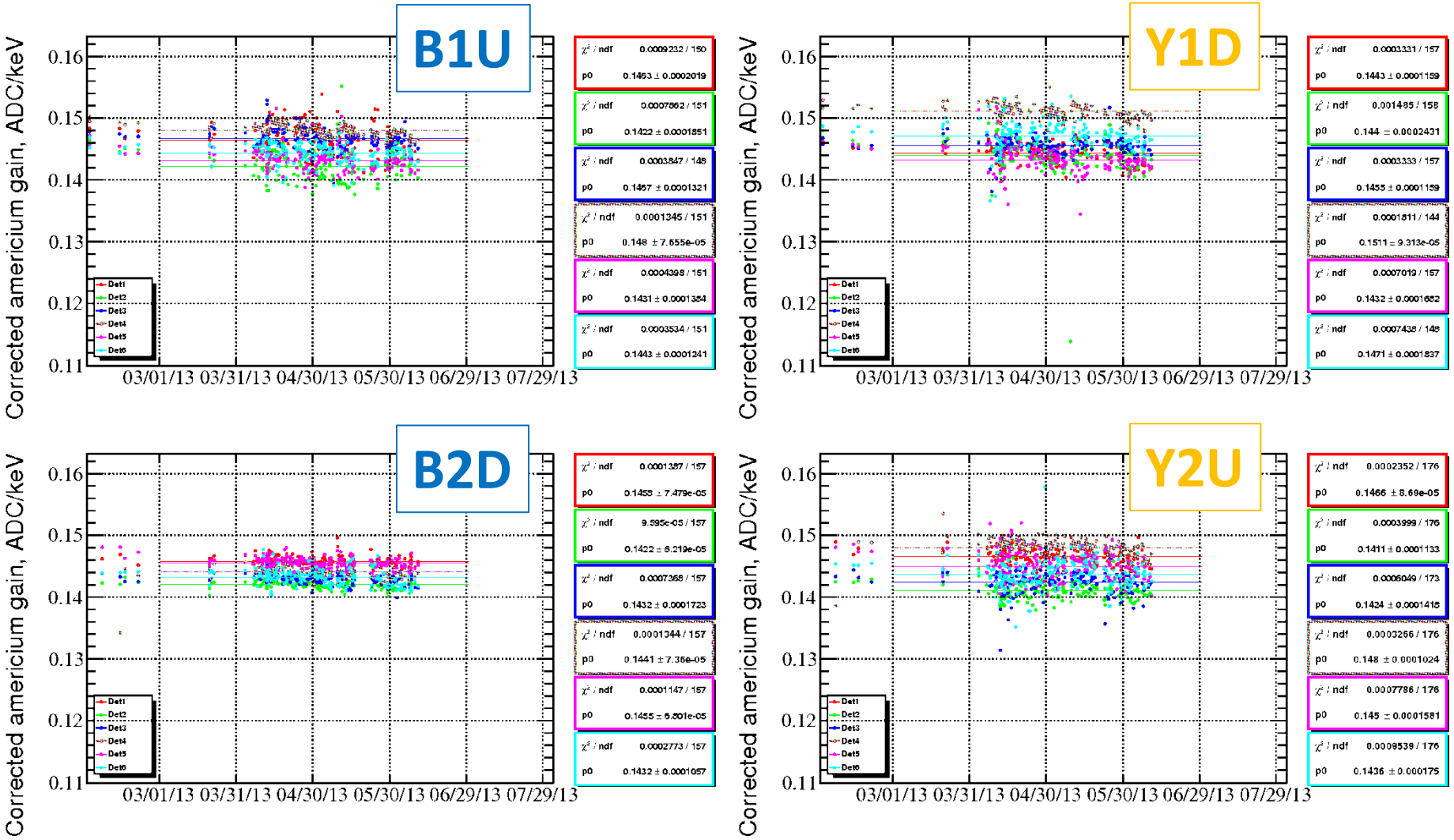


- High bias currents probably due to charge up
- New ceramic boards were used in Run 13 with different grounding

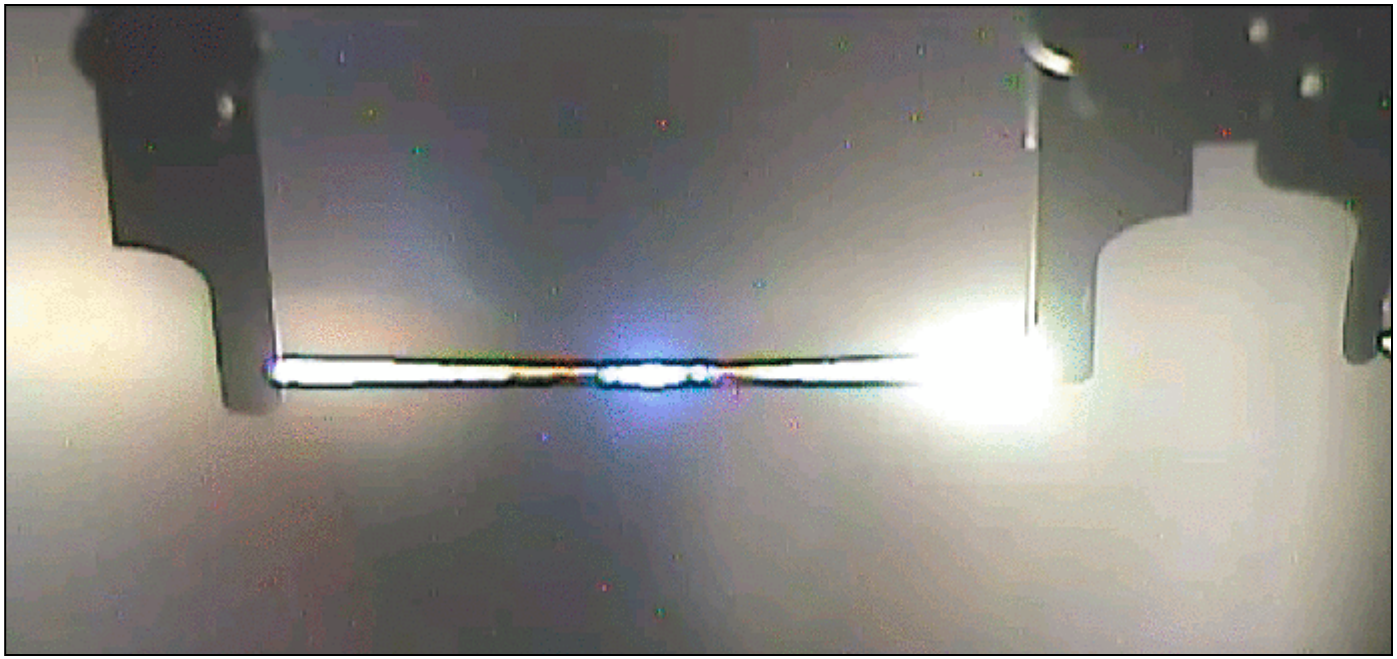
Gains from α-Calibrations



Gains Corrected for Bias Current

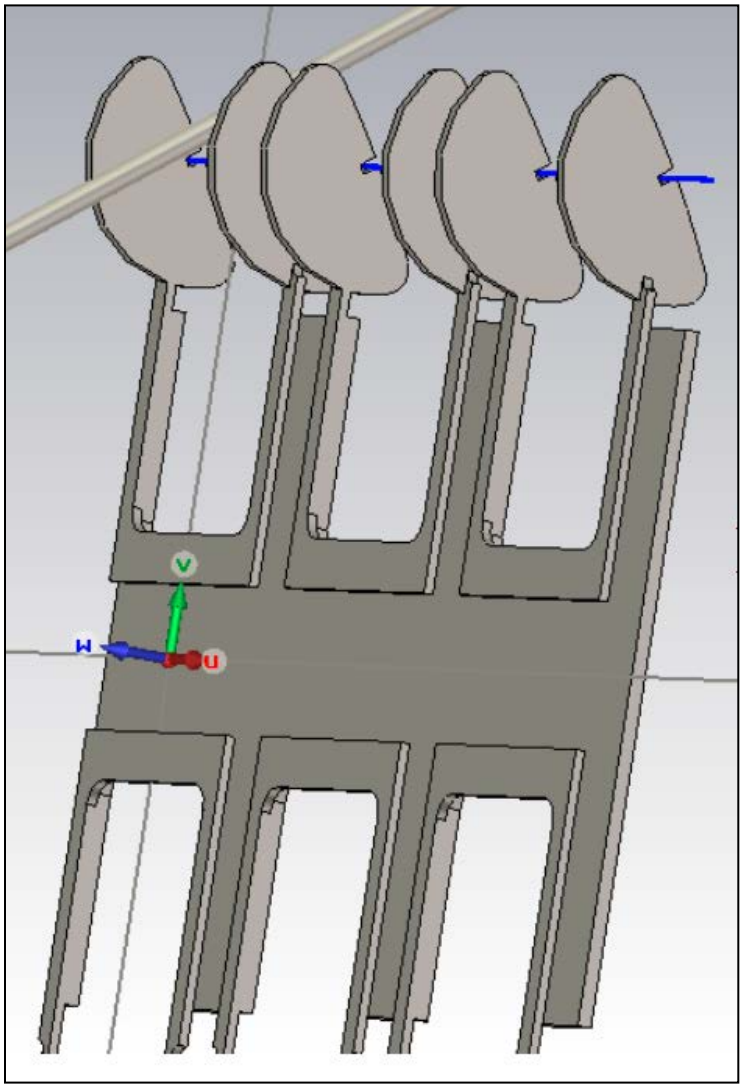


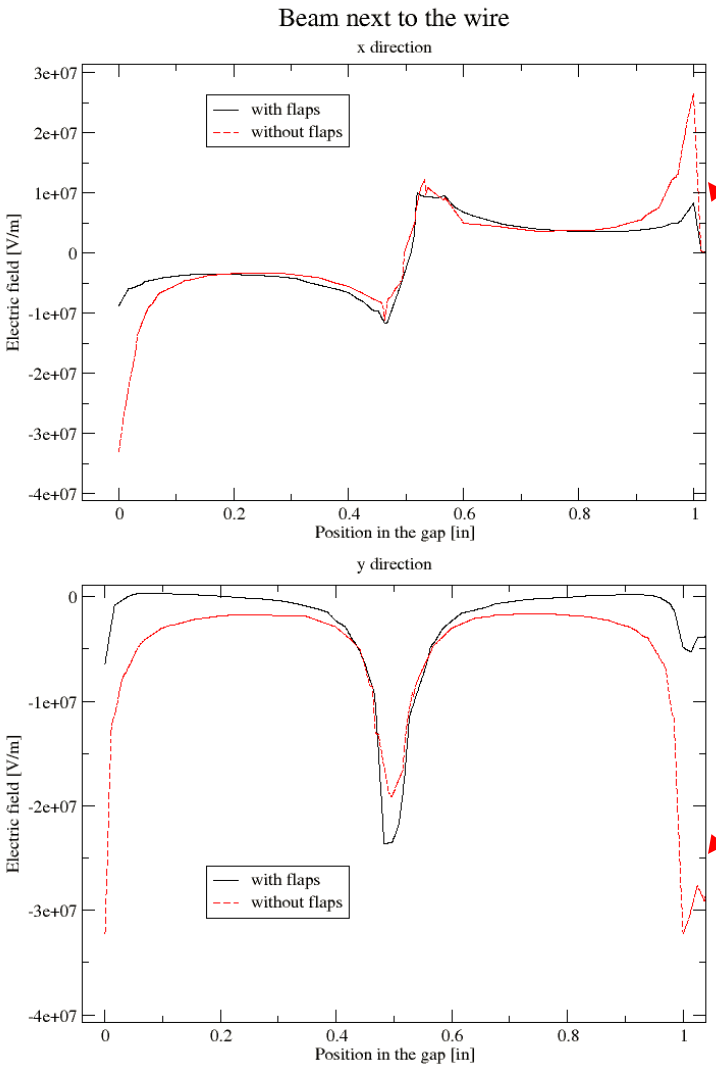
Target Lifetime



- Target tails start to glow when outside of beam
- Most targets break near the end
- Induced electron motion from high-frequency electromagnetic fields in the machine (200 MHz RF) → provide surface for the field lines to spread out

Electric Field at Target Location





avoid spikes at the ends

simulation by J. Kewisch

Beam Test in Run 14

- Fin Setup was tested during He-Au running in June-July 2014
  - Detectors had to be removed for test
  - Comparison of brightness of glowing
  - Au beam peak current 1.4 A
  - Fins reproducibly dim the glowing of the targets
  - Same can be achieved by reducing voltage on 200 MHz RF (650 kV → 100 kV)
  - Combination of fins and lowered voltage is best for limited space and target switches
- Fins should be installed on all targets (consistency)
  - More work initially, but worth if no new targets are needed during the run

» Run 15 Preparation «

Hydrogen Jet Polarimeter

- Replacement of Si detectors in HJET
  - Larger acceptance (vertical)
  - Ordered from Hamamatsu (mid Sep)
  - Ceramic boards from Instrumentation Div. (Oct)
- Measurement of molecular component of hydrogen jet
  - Major systematic uncertainty - last done before run 4
  - Installation of electron beam for measurement in Oct
  - Dependence on nozzle temperature
- New DAQ computer (similar to pC DAQ)
- Online analysis with new GUI
  - Flexible to use → same as offline analysis → fast feedback

Carbon Polarimeters

- Calibration procedure is established at end of fill
  - Leakage bias current effect can be corrected (mostly)
  - Better to avoid large bias currents
  - Changes to ceramic boards in Run 13 not entirely clear
- Target lifetime
  - Add fins to all target holders (after target installation)
  - Creates additional work initially, but will save target replacements during the run
  - Use thick targets on all positions
- New DAQ computers (similar to HJET DAQ)

Run 15 Operation

General considerations for polarized proton beams

- Bunch pattern
  - Alternating patterns with flipped bunch polarizations
  - Same as before: align with bunch number, not consecutive filled bunches (if empty bunches for electron lenses)
- Bunch intensity
  - Observed low intensity for first few bunches (probably due to phasing between AGS and RHIC)
  - Problematic for relative luminosity determination

Run 15 Operation

- Jet operation in p+A
  - Ion beams on the jet target will lead to largely increased background in the detectors
  - It is desirable to have only the proton beam on the jet target
  - Displace proton and ion beam as much as possible
  - Jet target can be moved mechanically to overlap with proton beam
- α-Calibration is done after each fill for pC polarimeters
  - Use a similar procedure for HJET

Summary

- Currently finalizing the run 13 offline analysis
- DAQ computers will be replaced
- Hydrogen jet polarimeter
  - Measurement of molecular component in target
  - Replacement of detectors
  - Beam displacement for p+A operation required
- pC polarimeters
  - New target holders for improved lifetime of targets
- Alternating bunch patterns for polarized proton beams