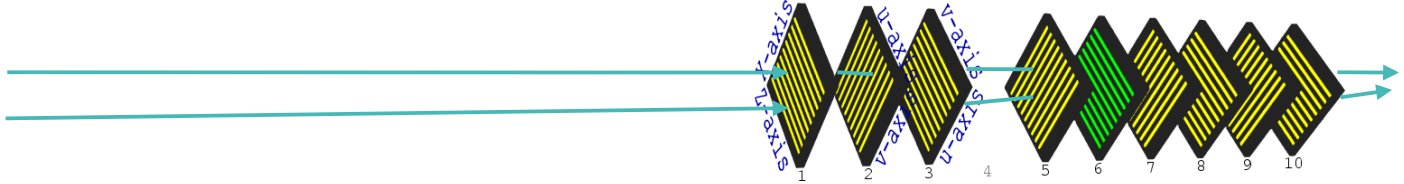
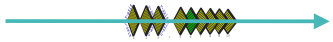
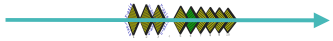


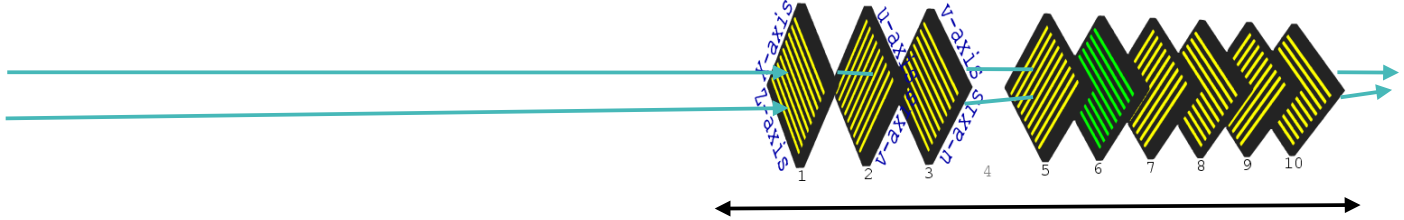
Performance of irradiated MCz detectors in a test beam environment



14th RD50 workshop

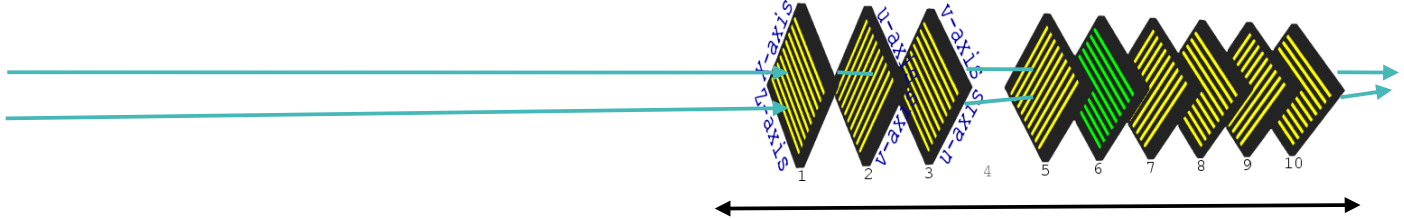


Teppo Mäenpää, Helsinki Institute of Physics
SiBT Collaboration



Introduction

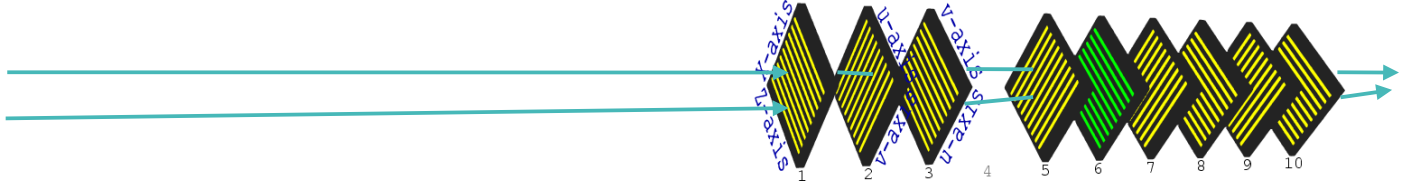
- *SiBT (Silicon Beam Telescope)* is a position sensitive device measuring muon/pion tracks in test beam at CERN
- Originally built in 1991: rebuilds 1998 and 2007
- Initiated by HIP; operated by a collaboration of 5 institutes
- Provides high quality reference tracks for detector R&D



Recent achievements

- DAQ speed increased 10-fold. Wafer temperature monitoring.
- We tested eg. 4 MCz detectors in 2008

- Two independent analyses on the same data - we have an estimate of the reliability of plots
- There are some inconsistencies still.



Introduction to the results

- I present the following plots:

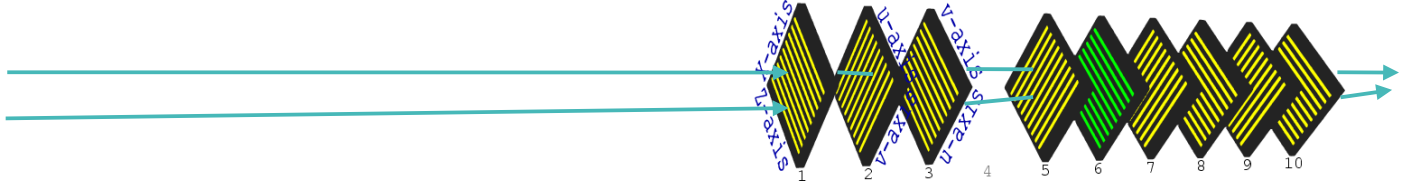
- Noise vs. bias voltage

  Noise values associated to individual strips are standard deviation of CMN subtracted raw data in virtual pedestal runs

  "Noise of a run" is the median of strip noise values after masking out bad strips.

- Signal vs. bias voltage

- Non-clustered signal vs. bias voltage



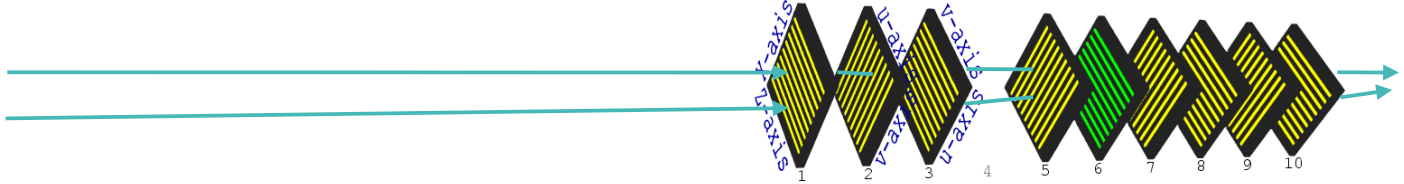
Introduction to the results

- I present the following plots:

- Noise vs. bias voltage
- Signal vs. bias voltage

  Signal is the MPV of convoluted Laudau-Gaussian fit to histogram containing strip signal sums from clusters found in the vicinity of a reference track. For clusters wider than 2 strips, only those used by eta algorithm are added to the sum.

- Non-clustered signal vs. bias voltage

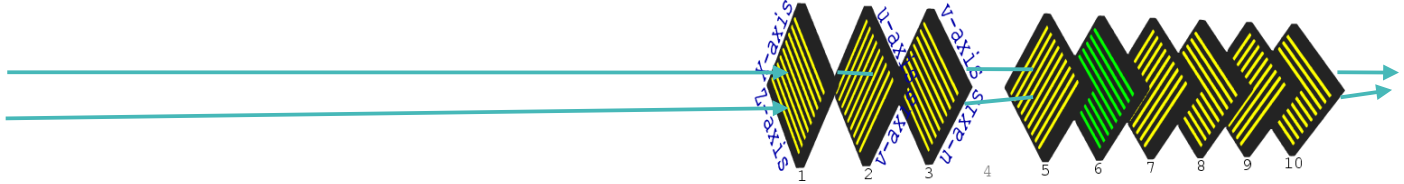


Introduction to the results

- I present the following plots:

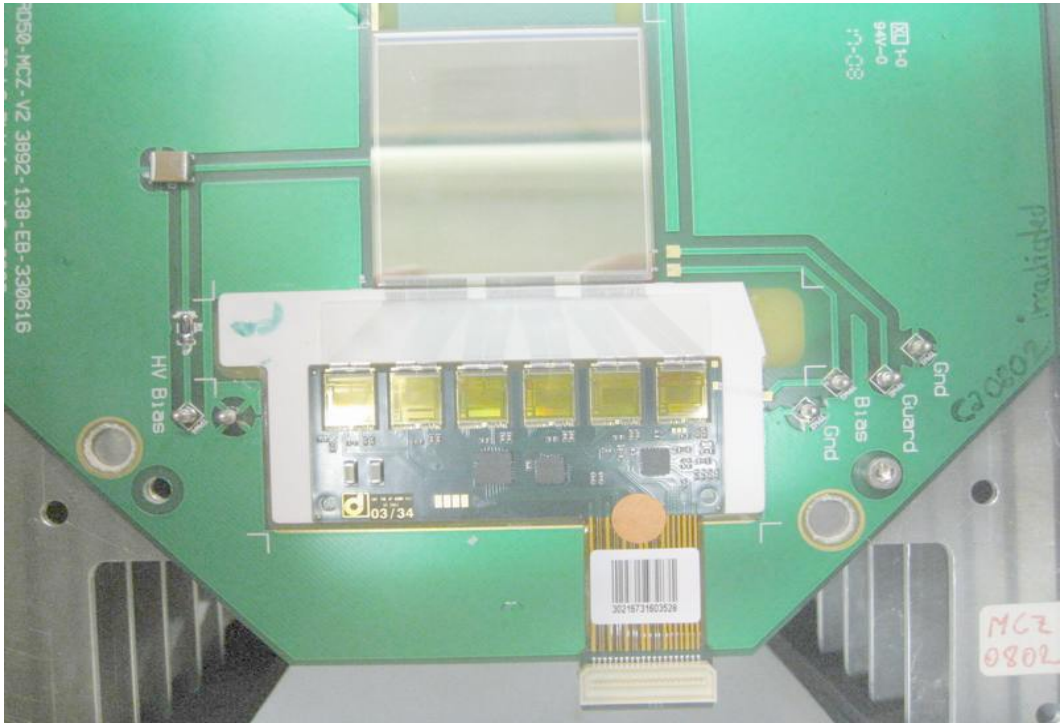
- Noise vs. bias voltage
- Signal vs. bias voltage
- Non-clustered signal vs. bias voltage

  Signal is the MPV of convoluted Laudau-Gaussian fit to histogram containing pedestal and common mode subtracted strip signal sums from **n strips closest to the reference track.**

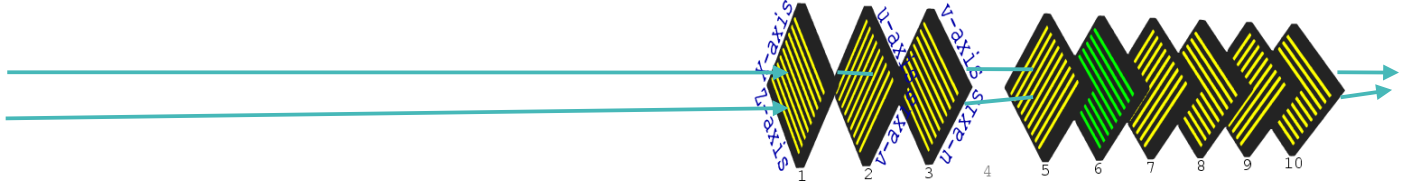


Introduction to the results

- I present the plots for the MCz detectors irradiated to
  - $6.1*10^{14}$,
  - $1.1*10^{15}$ and
  - $1.6*10^{15}$ n_{eq}/cm^2:

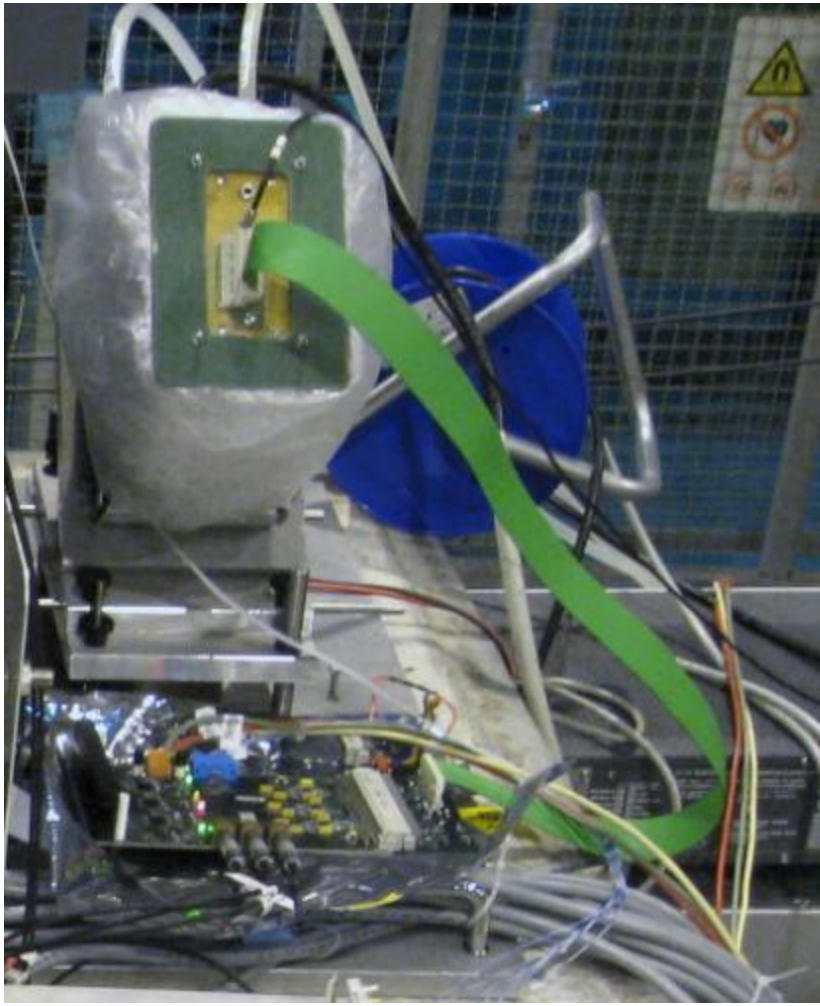


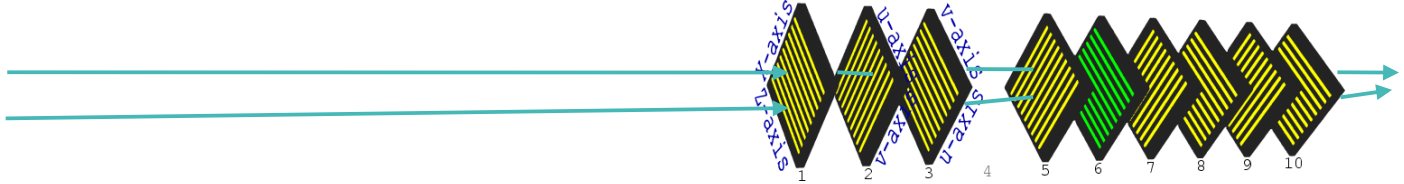
- The detectors are
  full size 768 strip MCz with 60 µm pitch made at HIP



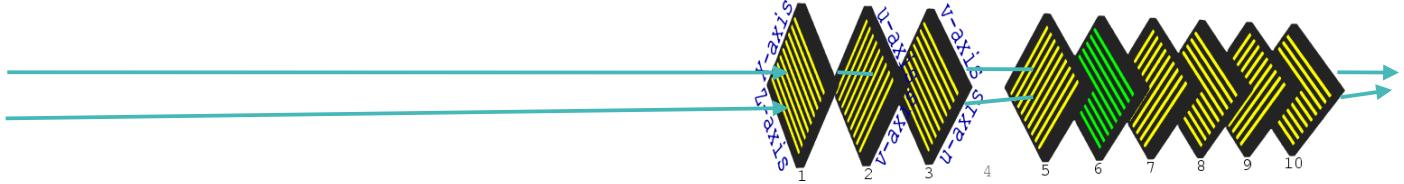
The MCz irradiated to 2.8*10^{15}

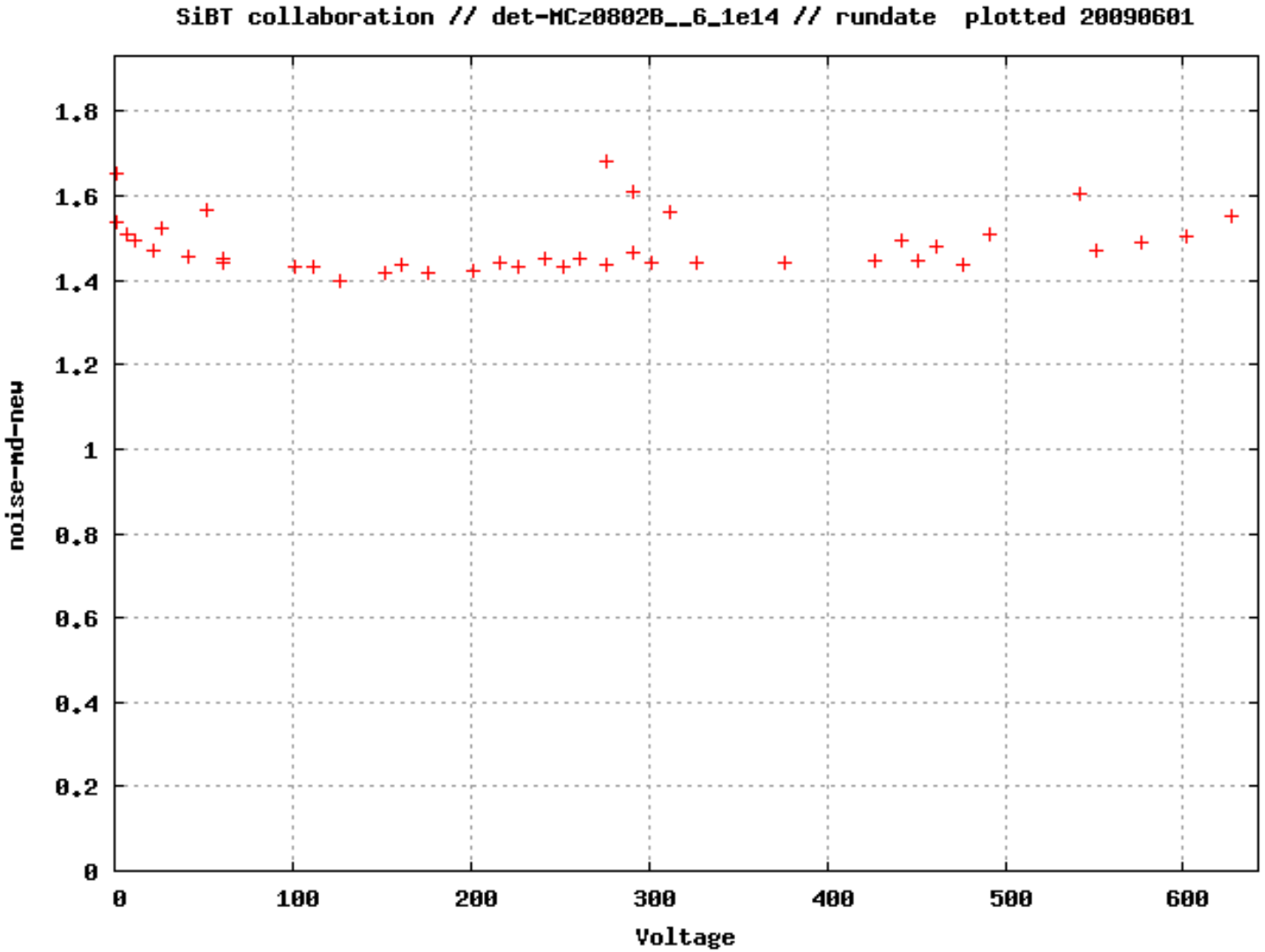
- Most irradiated device tested
- Tested in a high-T-range container
- Highest noise of all detectors
- Lowest signal of all detectors
- Excess non-Gaussian noise in data → attempts to reliably remove this noise have so far failed
- The noise disturbs signal measurement too.
- Results not reliable → pending.



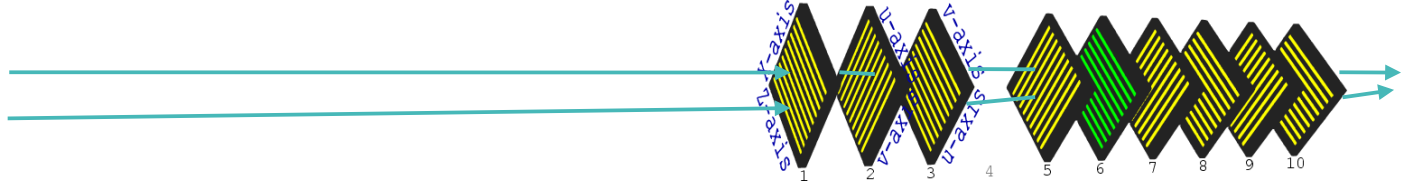


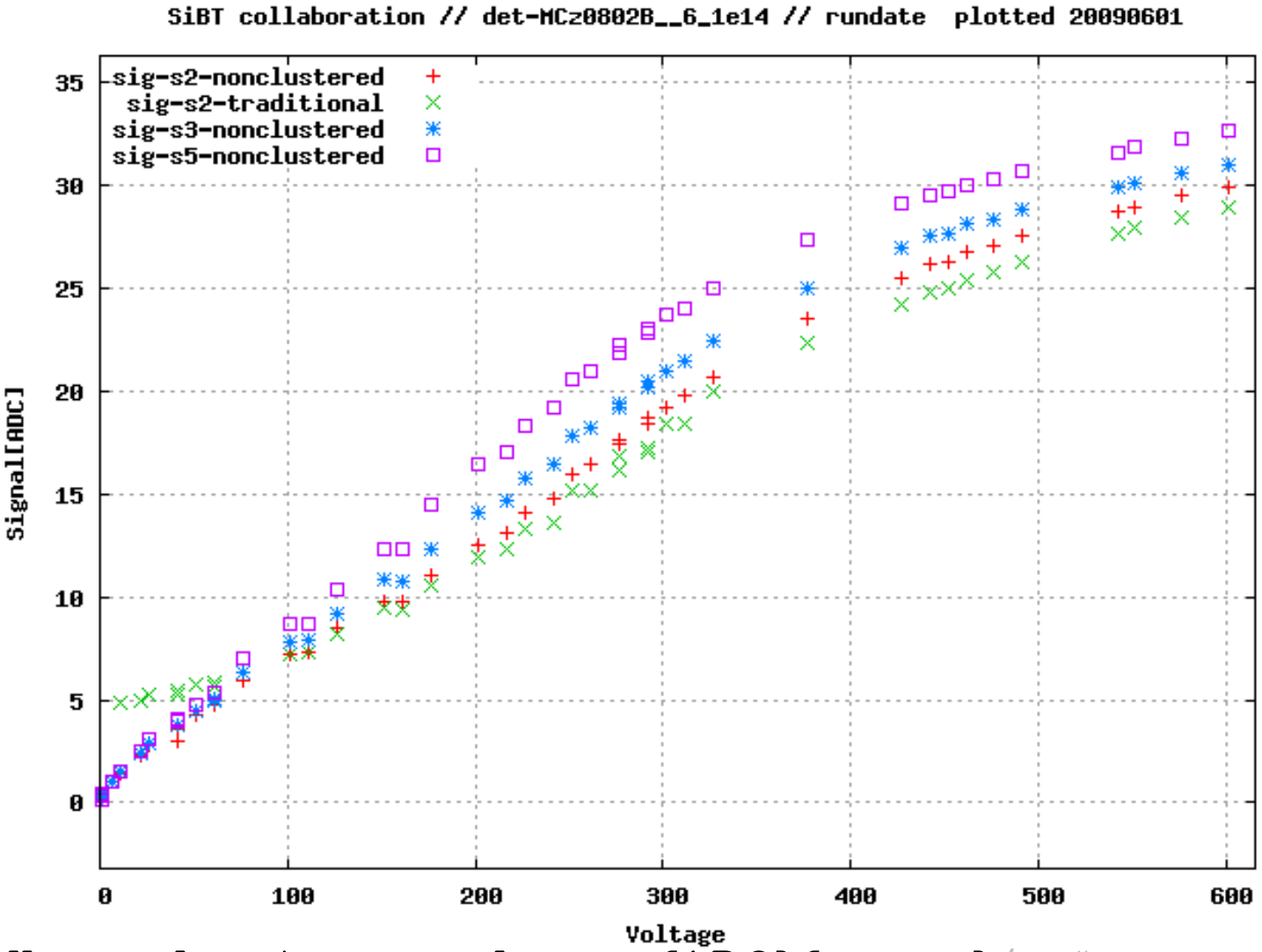
Now it finally starts



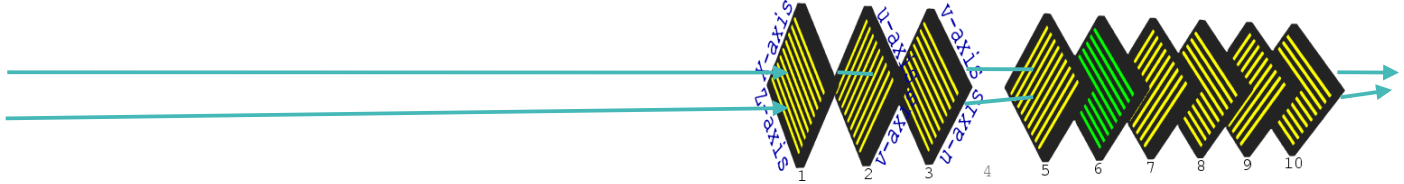


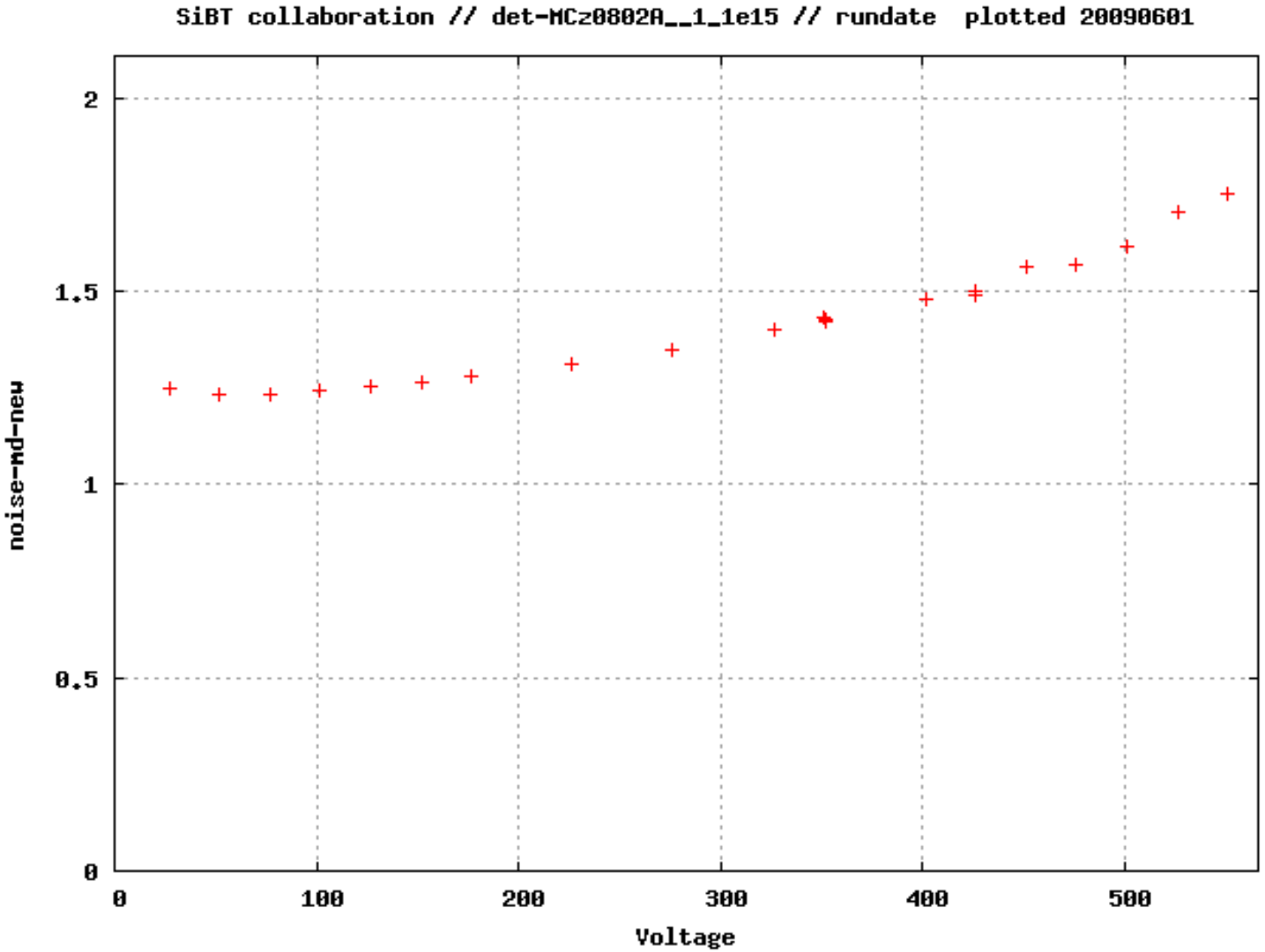
- All signal and noise values in [ADC]



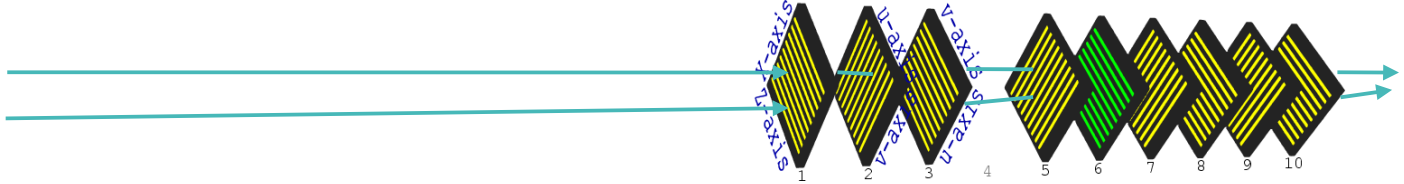


- All signal and noise values in [ADC] [~610e-] (33*610 ~20000)

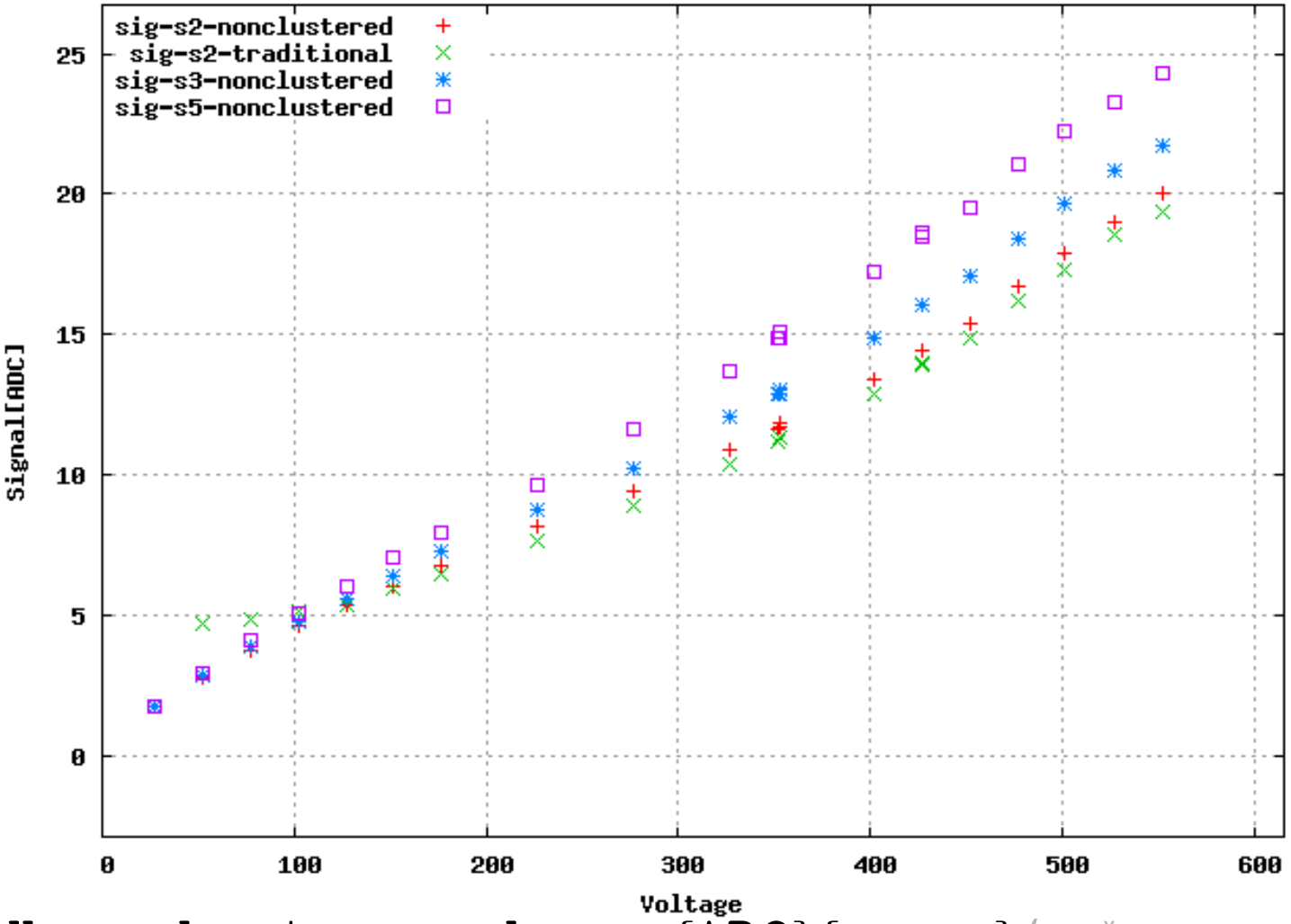




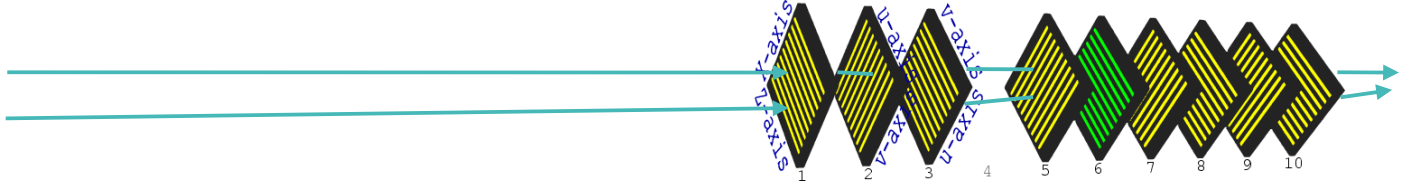
- All signal and noise values in [ADC]

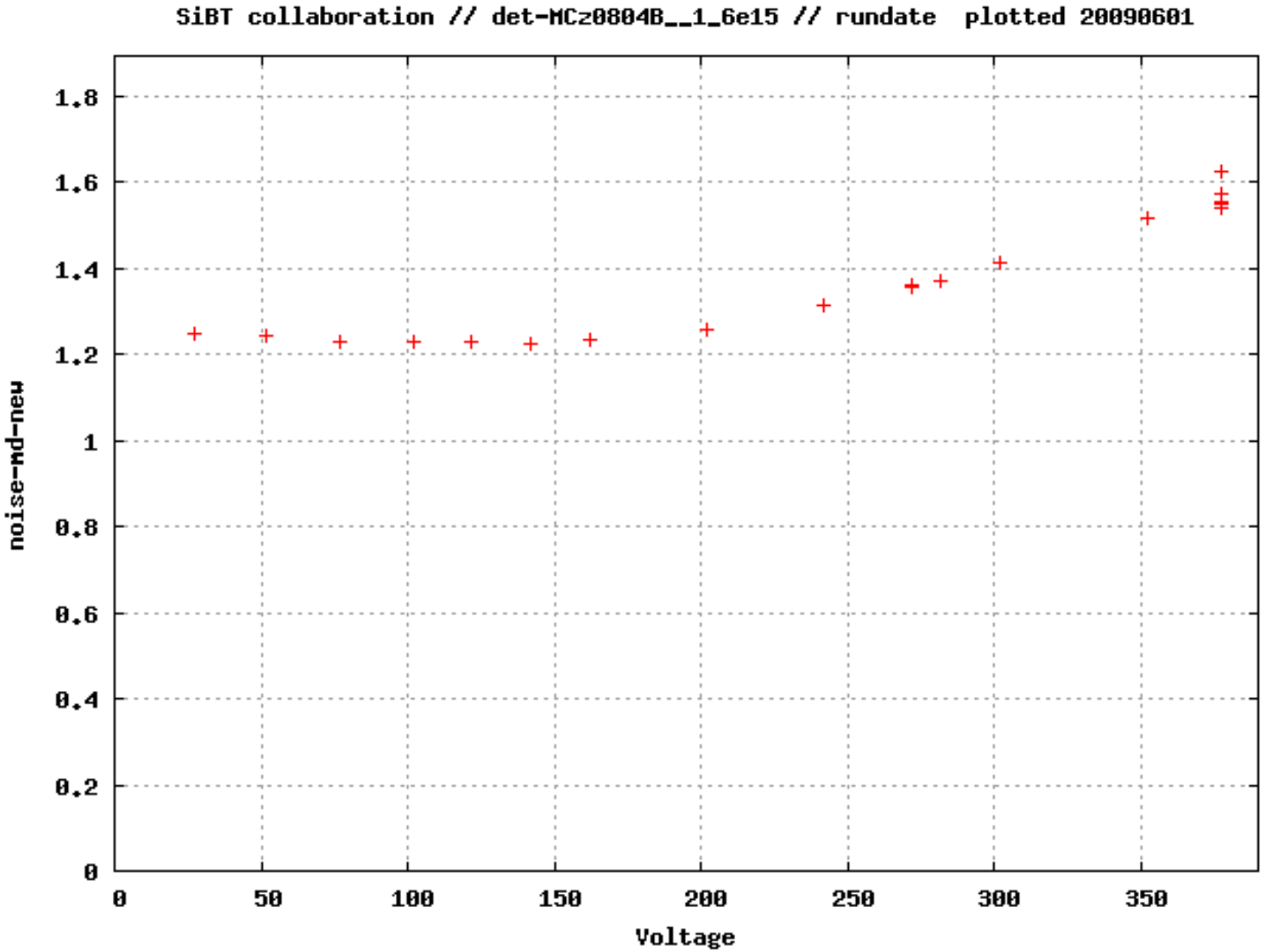


SiBT collaboration // det-MCz0802A__1_1e15 // rundate plotted 20090601

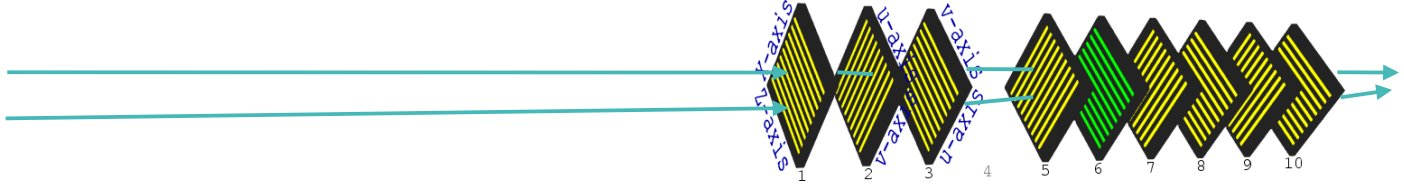


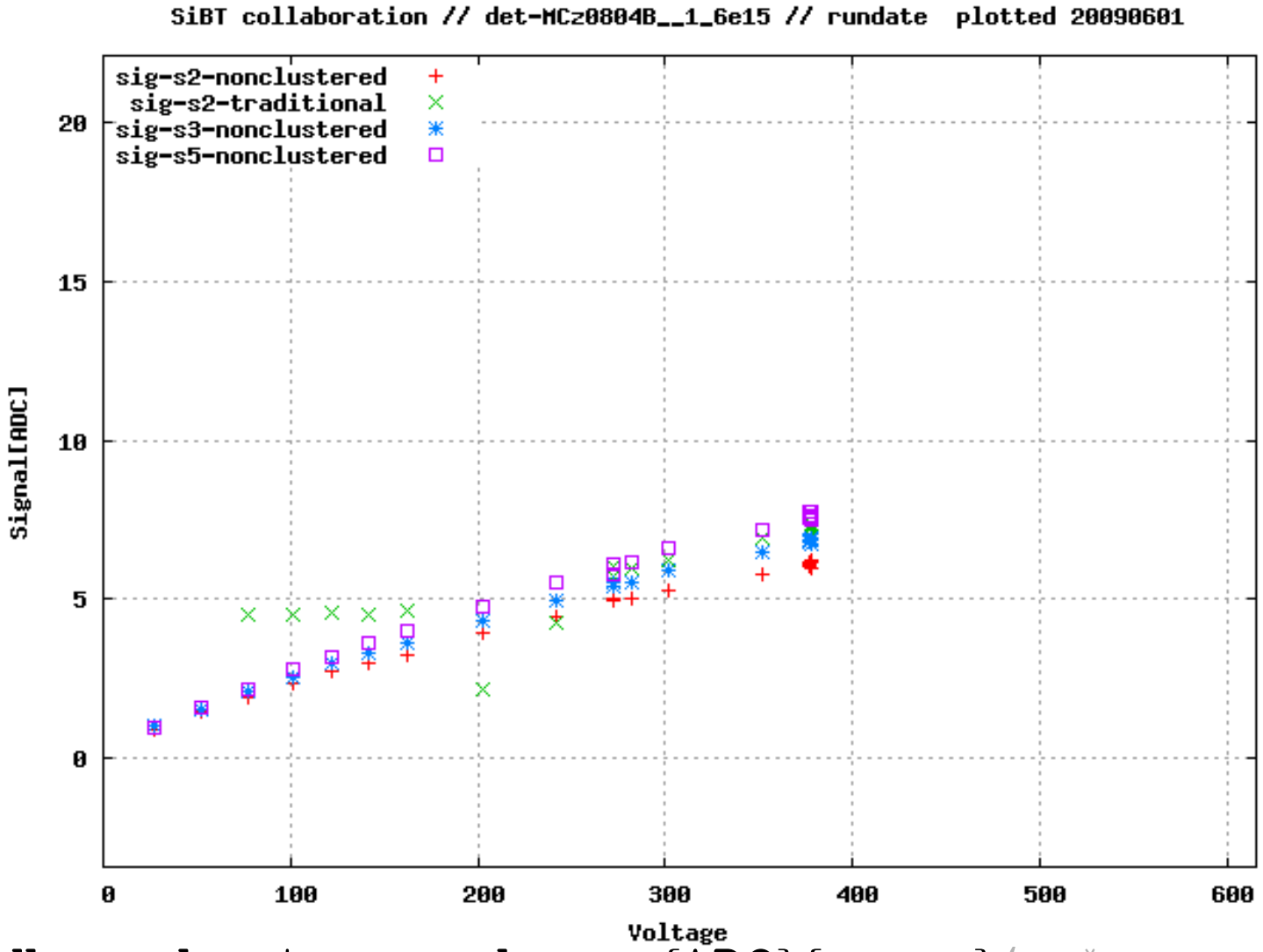
- All signal and noise values in [ADC] [~610e-] (23*610 ~14000)



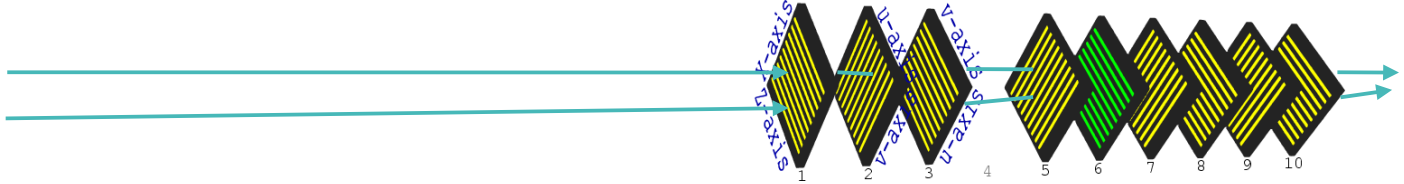


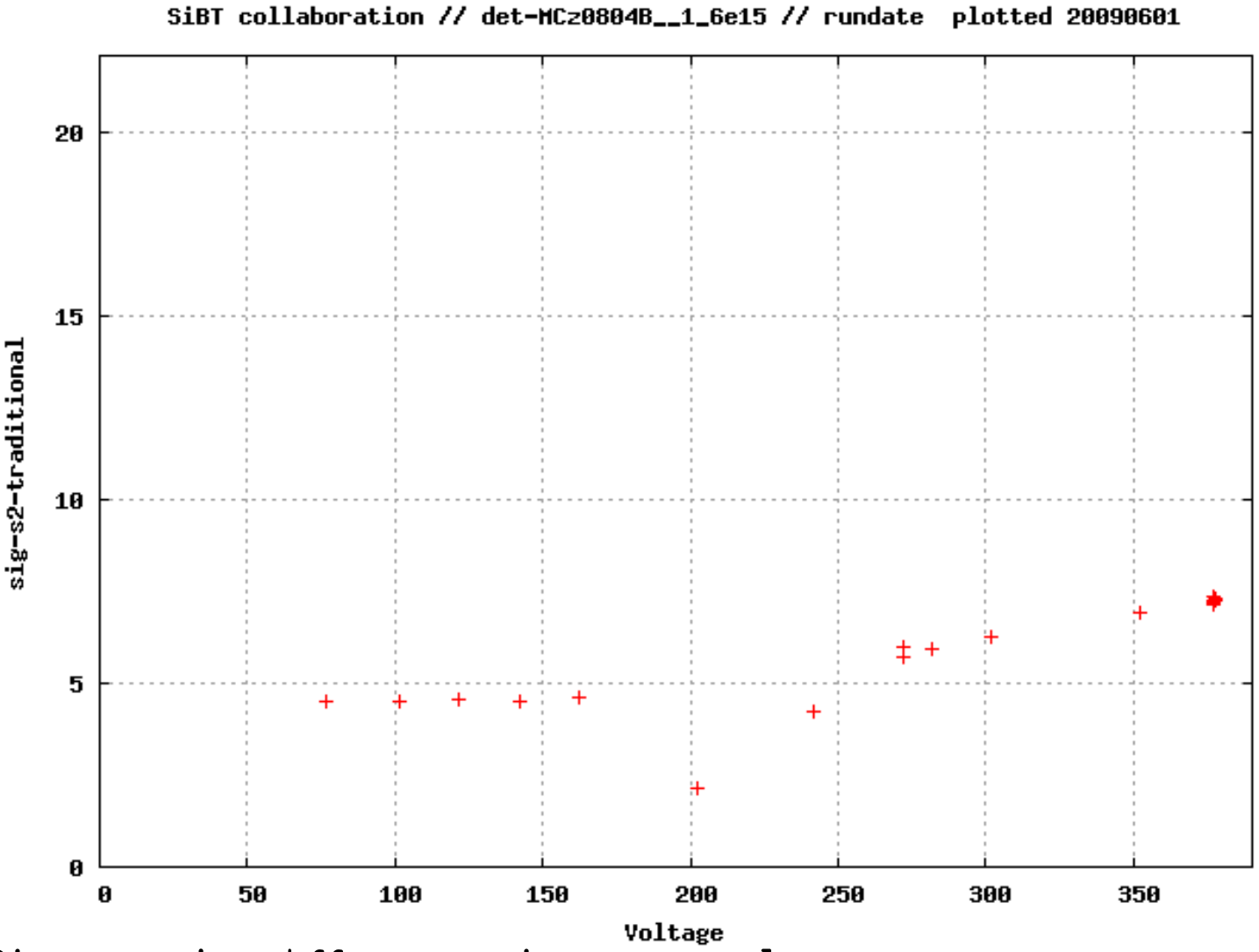
- All signal and noise values in [ADC]



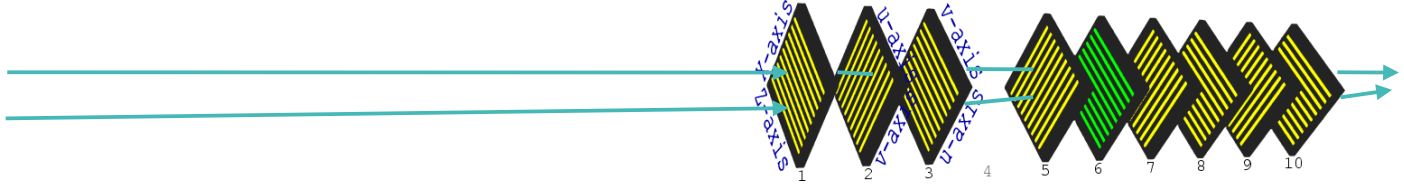


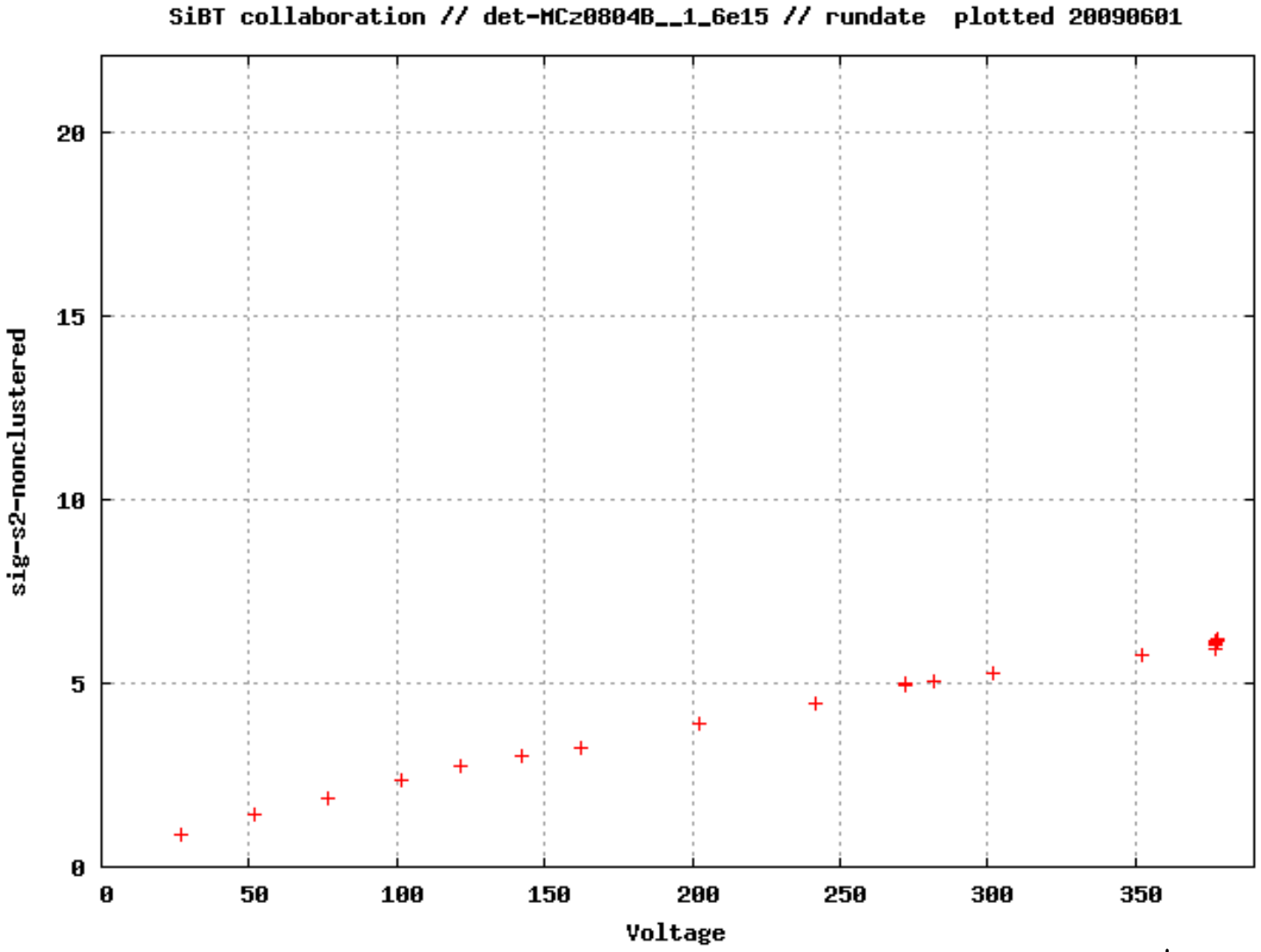
- All signal and noise values in [ADC] [~610e-] (8 * 610 ~5000)



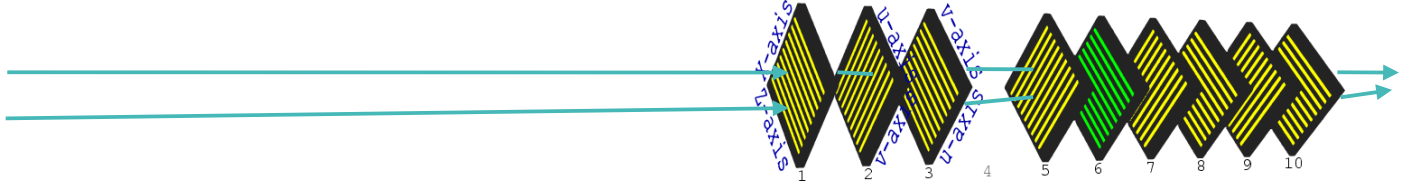


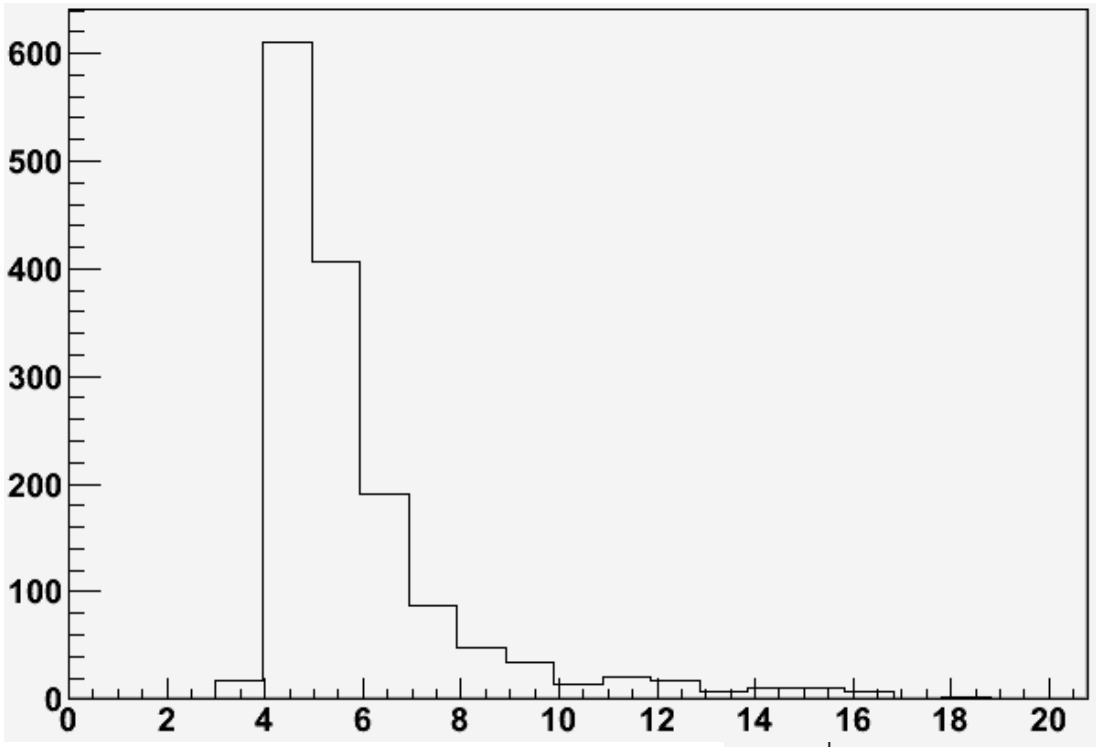
- Observe the difference between clustering ..

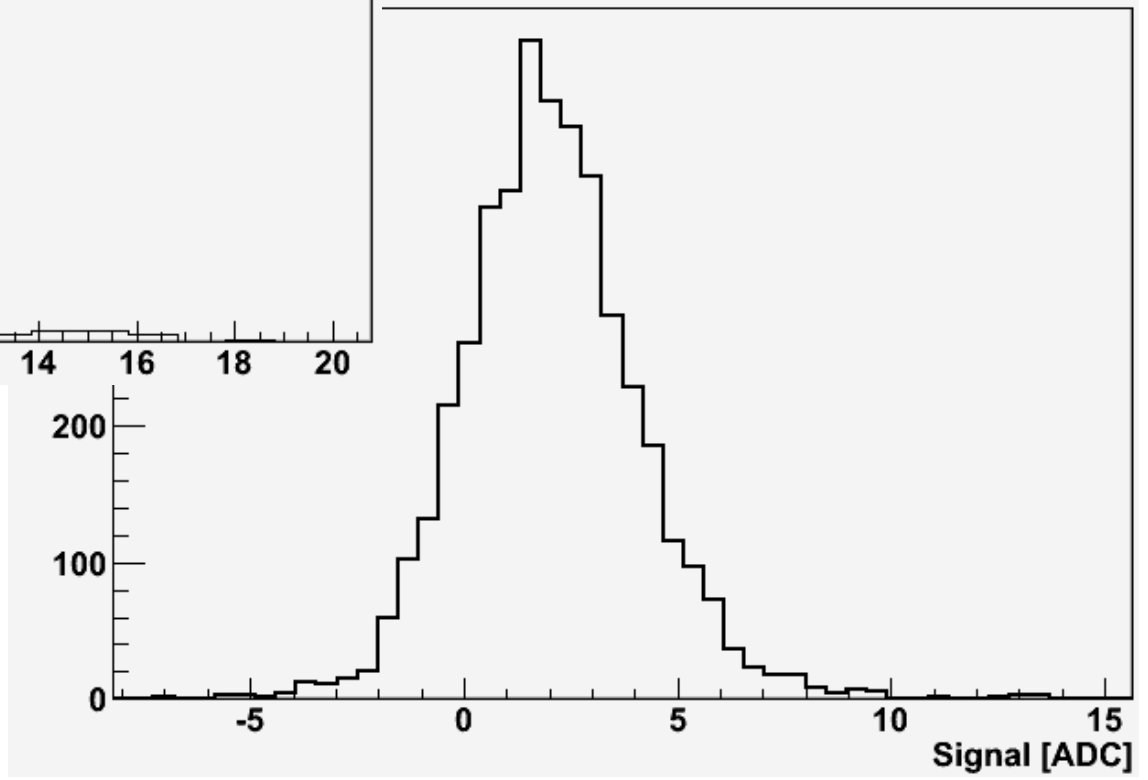




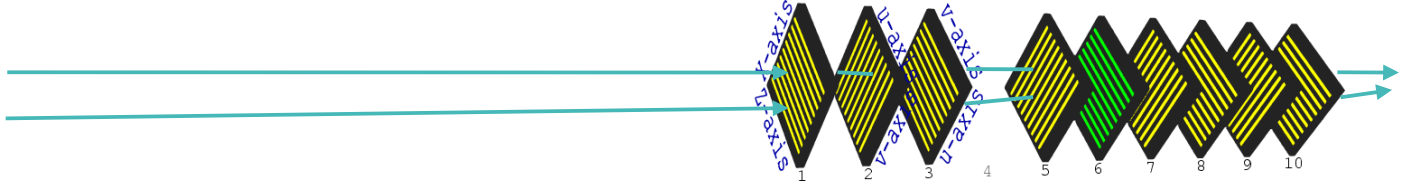
- .. and non-clustering







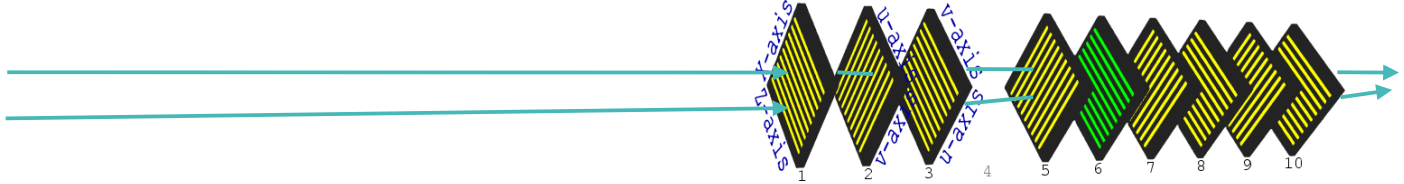
- Distribution of cluster signal values



Cluster-less analysis

- Cluster finding is omitted for devices under test
- *n* strips closest to a reference track are declared to contain a "cluster"
- Requires high quality reference data. If not, "wrong" strips are selected.

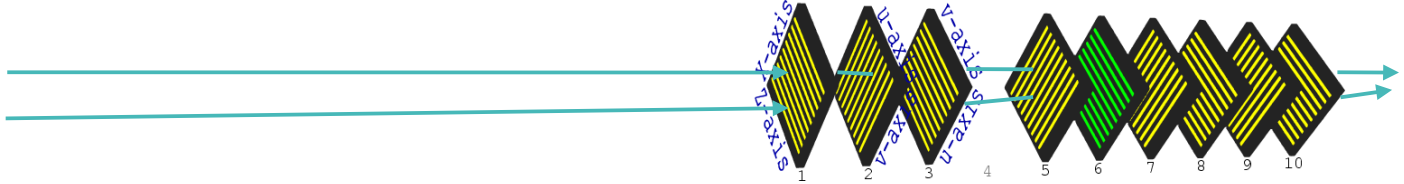
- Efficiency and predictive are always 1 by definition (= not measured)



Cluster-less analysis

- Non-clustering analysis allows studying detector performance in low-SNR conditions.

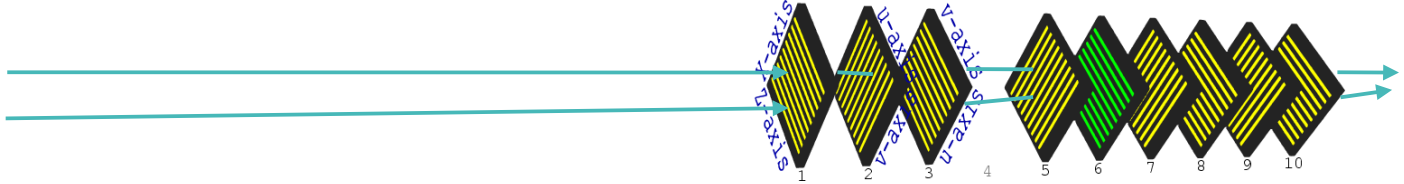
- Non-clustering analysis allows studying the amount of charge seen by far strips.



Cluster-less analysis

- Risk of biased results → Analysis using strip values of the preceding strips. Non-zero outcome → analysis is biased.

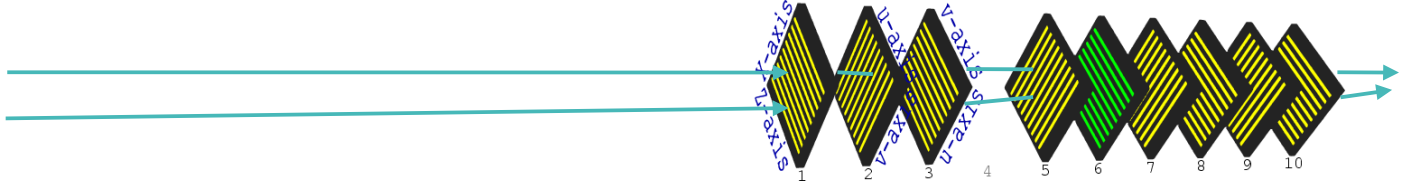
- Example: problems due to "almost good enough" reference data.
- Example: resolution measurement.



Cluster-less analysis

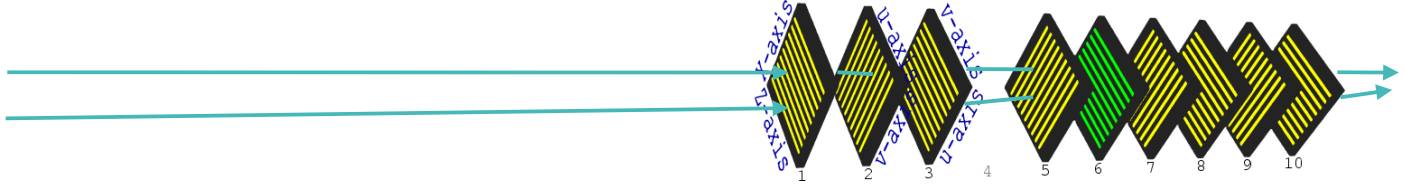
- Use of clustering analysis contains S/N cut values used in cluster construction as free parameters.

- Use of non-clustering analysis contains the cluster width as a free parameter



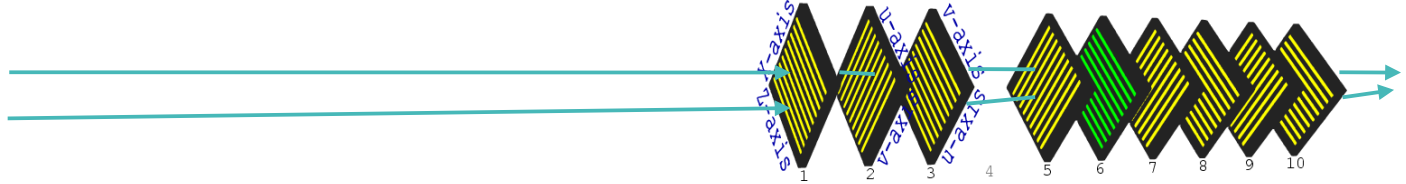
Conclusions

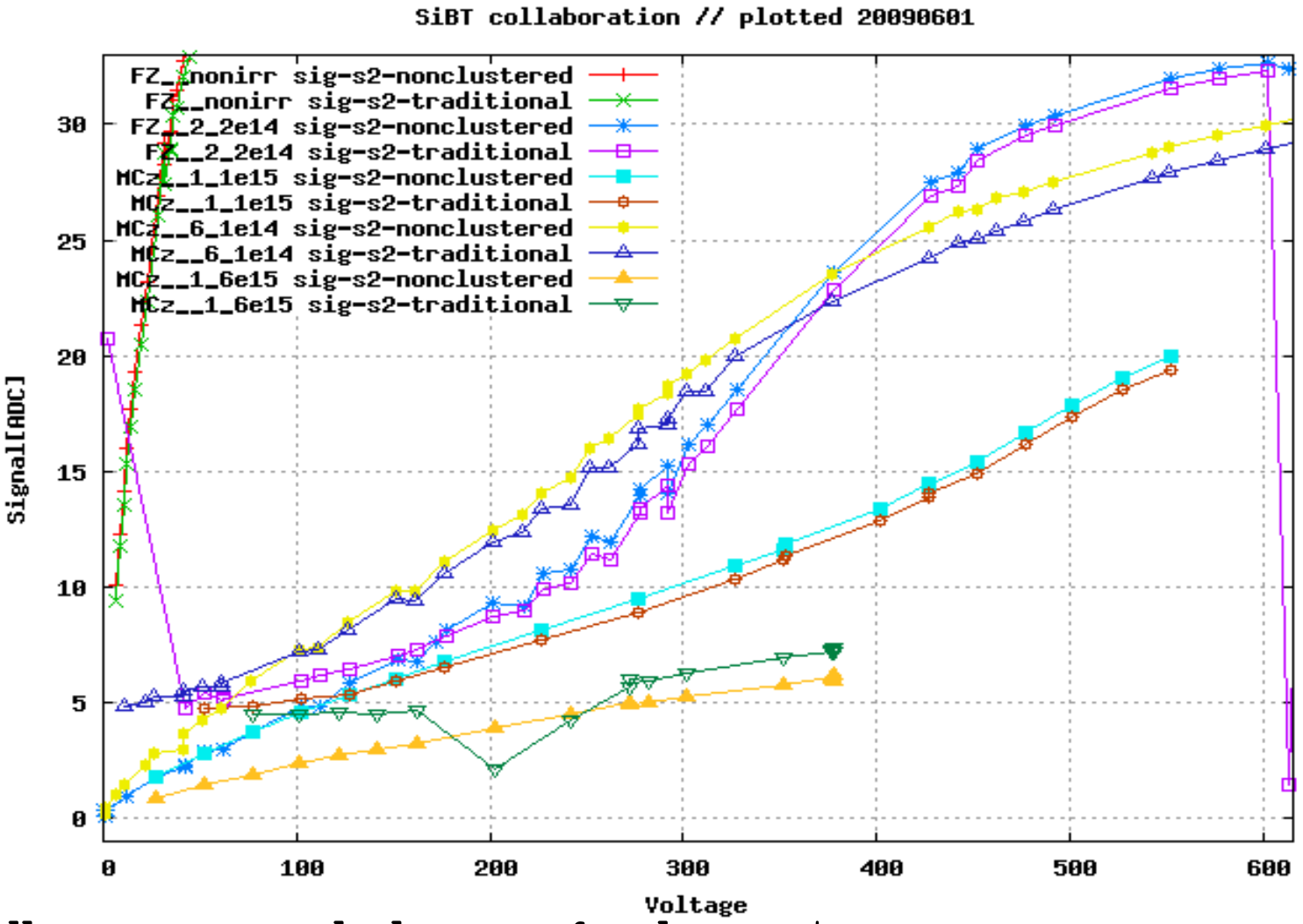
- Successful measurements on irradiated MCz detectors in 2008
- Alternative analysis method to obtain reliable results in a low-S/N condition



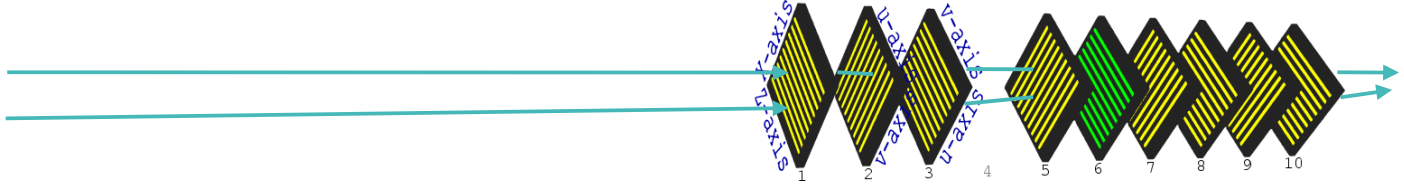
Thank you

- Dummy slide, just to increase the page count.

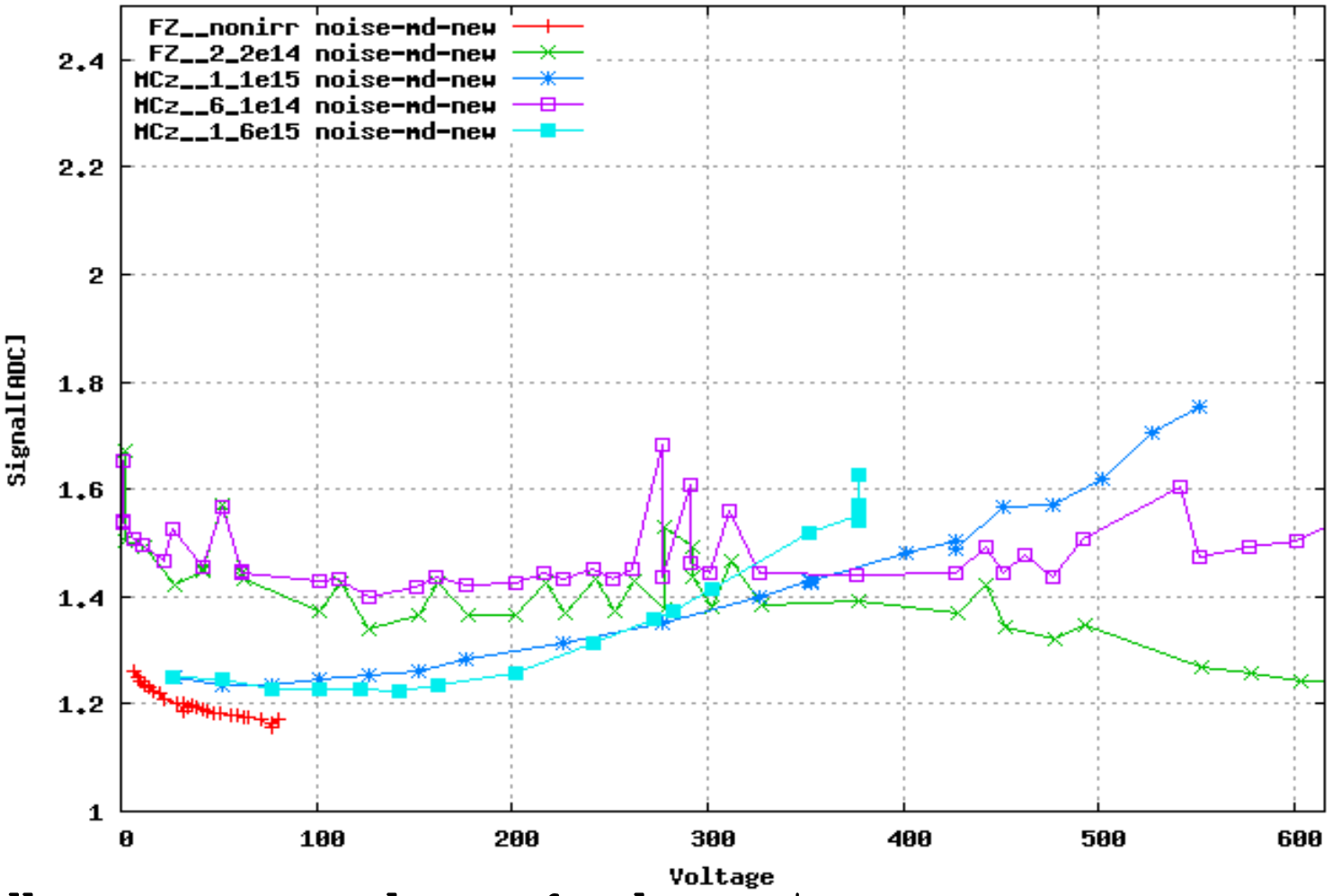




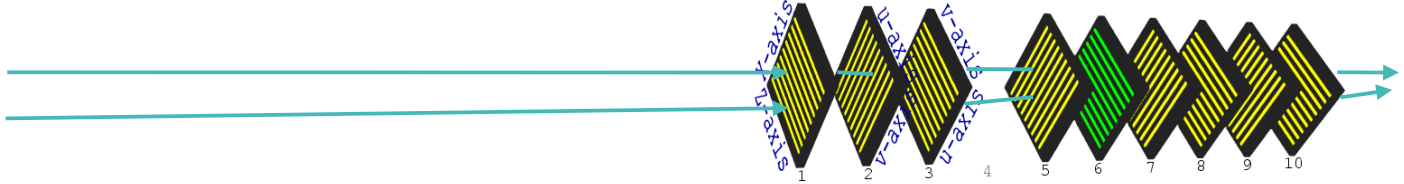
- All-in-one signal plots, to facilitate discussion.



SiBT collaboration // plotted 20090601

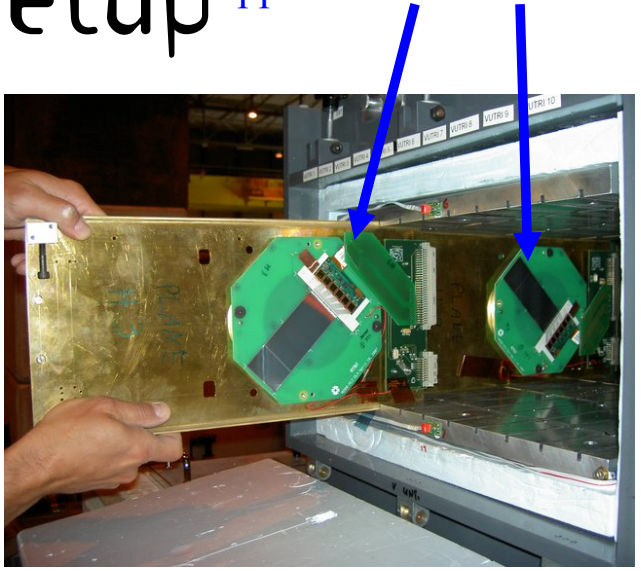


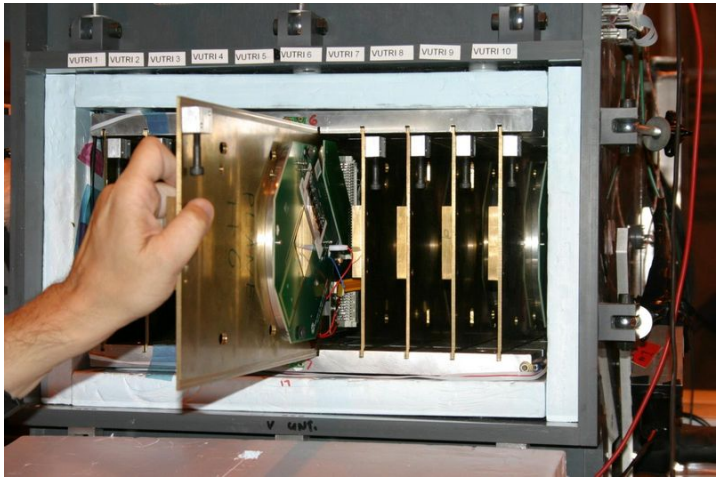
- All-in-one noise plot, to facilitate discussion.

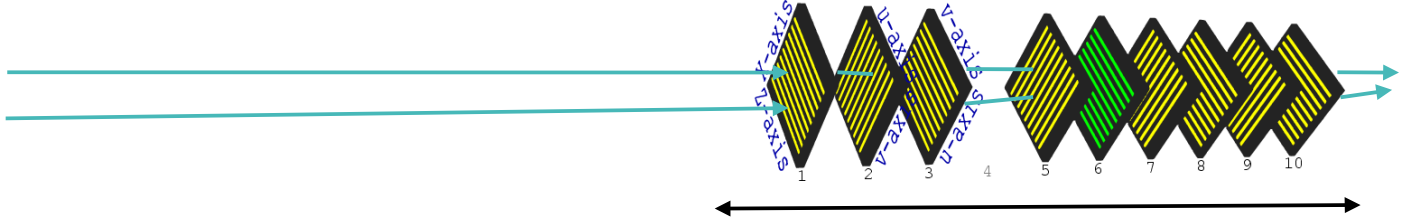


Layout of SiBT Setup

- Cooled box (typically -10°C) with 10 slots for detectors (active area 10 cm x 4 cm, 640 strips, pitch 60 µm)
- Scintillators for triggering on both sides
- Present configuration:
  - 8 reference detectors
  - adjacent detectors have strips in opposite directions
  - test detectors







Limitations in 2008 data

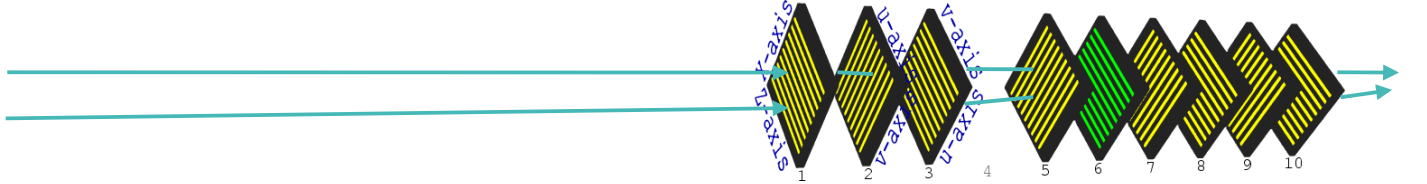
- In 2008 there was excess noise induced to most irradiated MCz

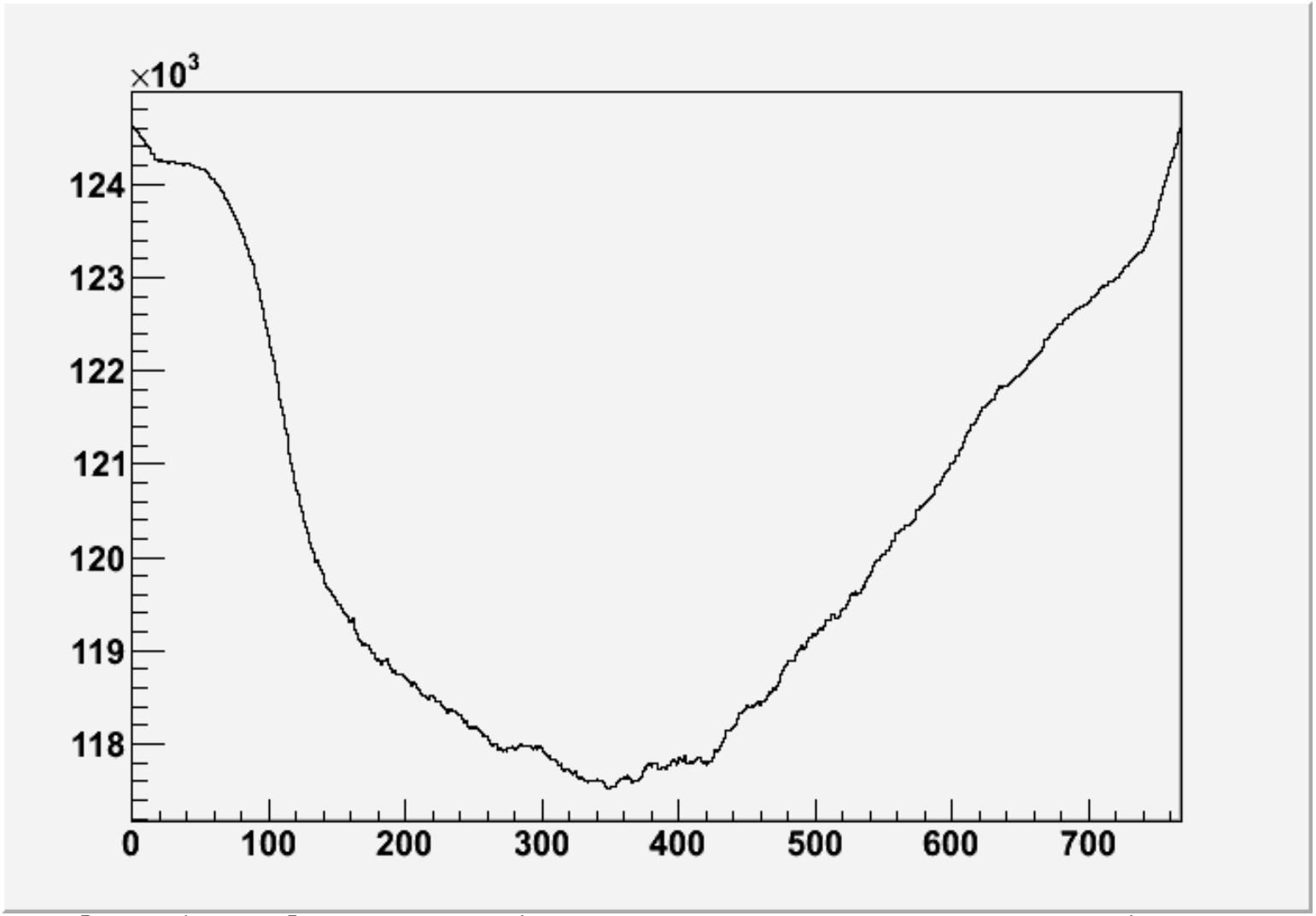
  → Very challenging to analyse in a reliable way.

- Small analogue gain → quantization noise.

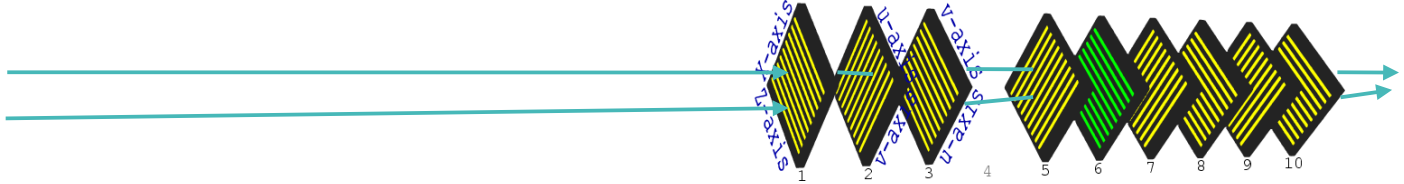
  Increasing gain for 2009 measurements could benefit new noise measurements

  Increasing gain for 2009 measurements could make comparison to old data more difficult than necessary





- Virtual pedestal run: number of entries vs. strip number.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v-axis
1
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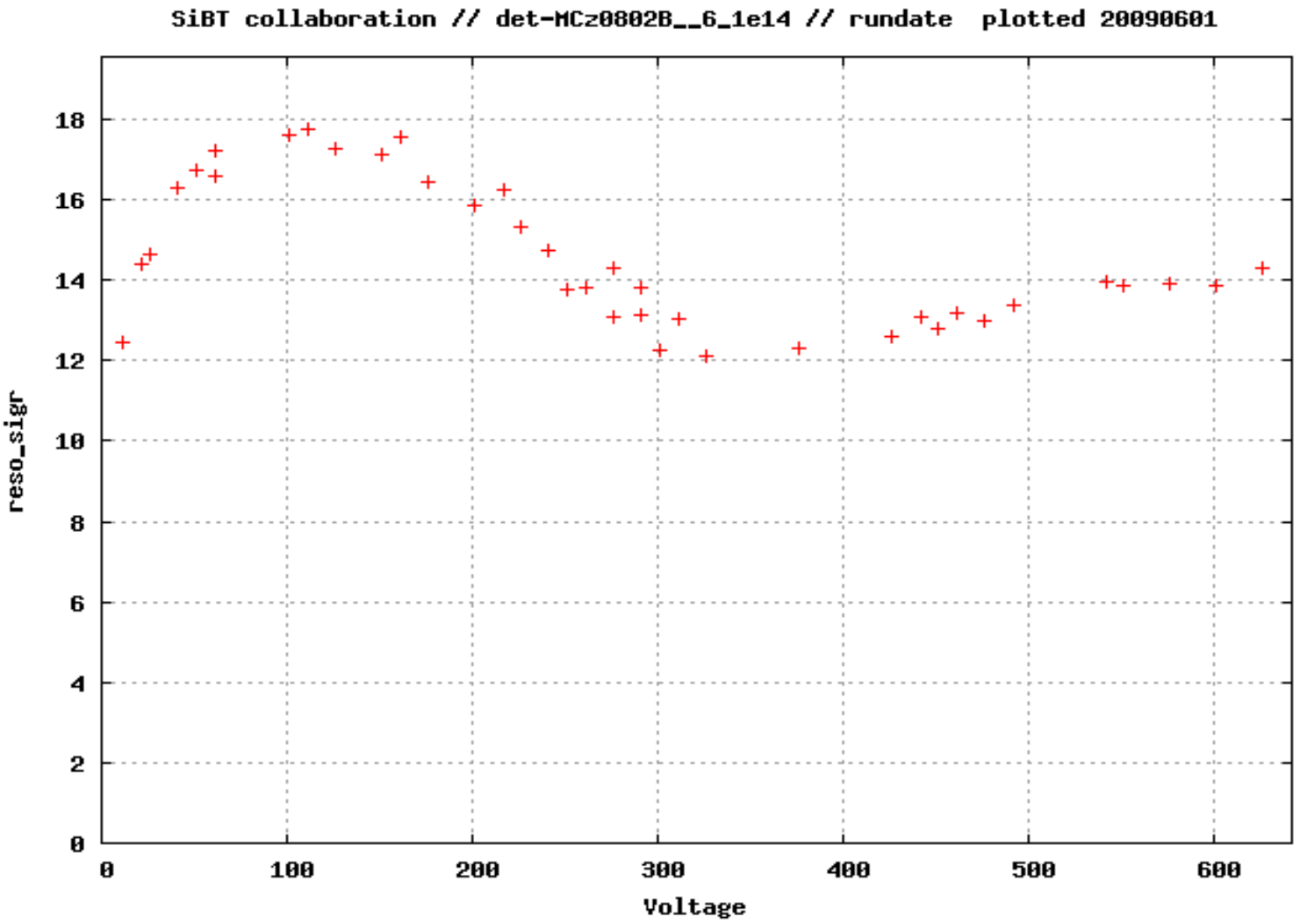
10


SiBT collaboration // det-MCz0802B__6_1e14 // rundate plotted 20090601
reso_sigr
Voltage
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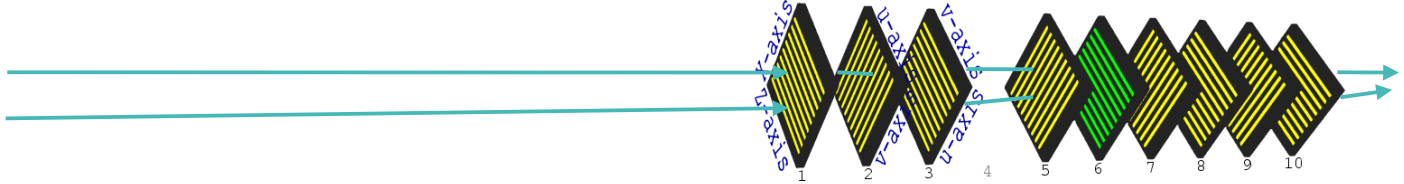
v-axis
u-axis
v-axis
u-axis
v-axis
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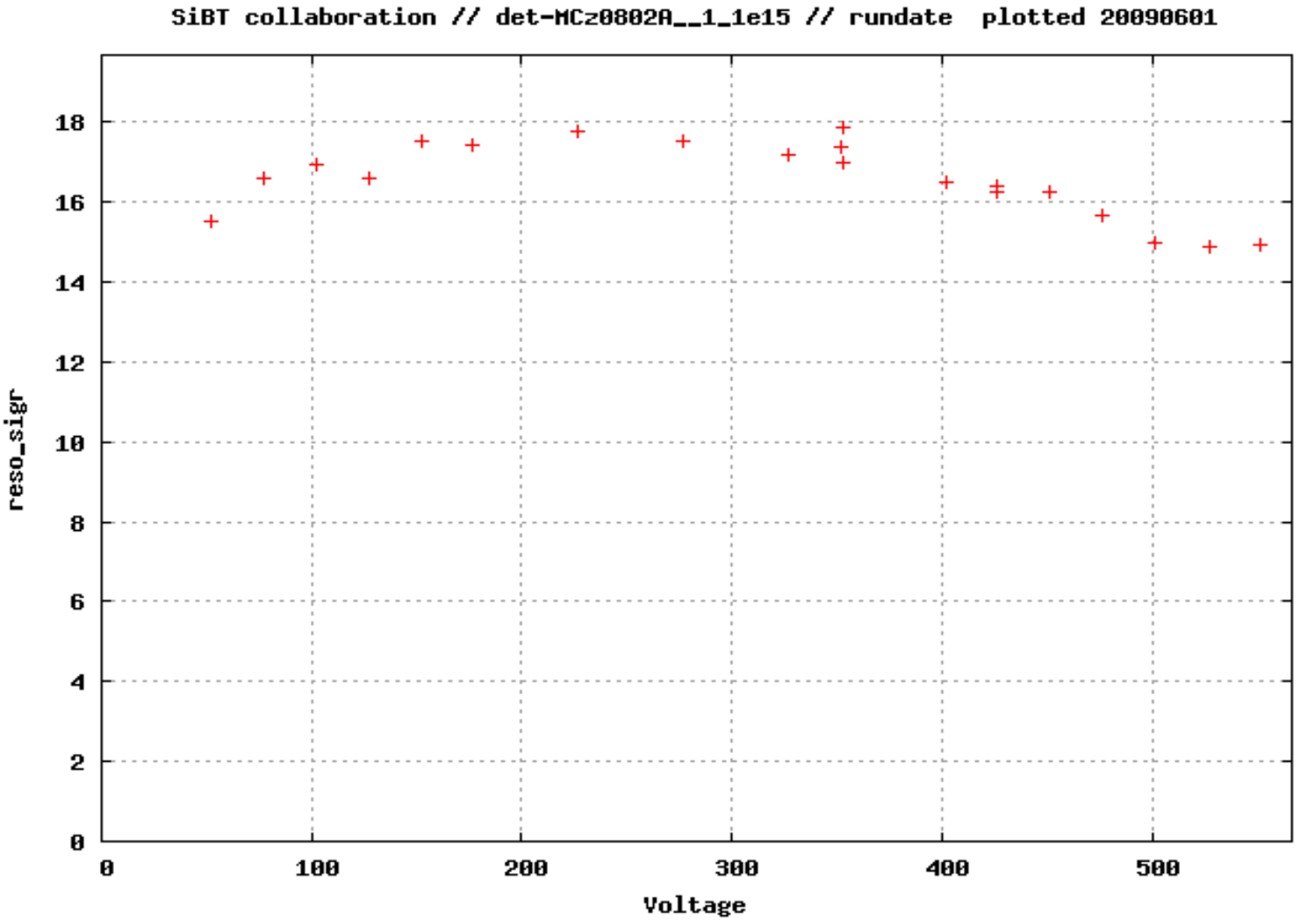
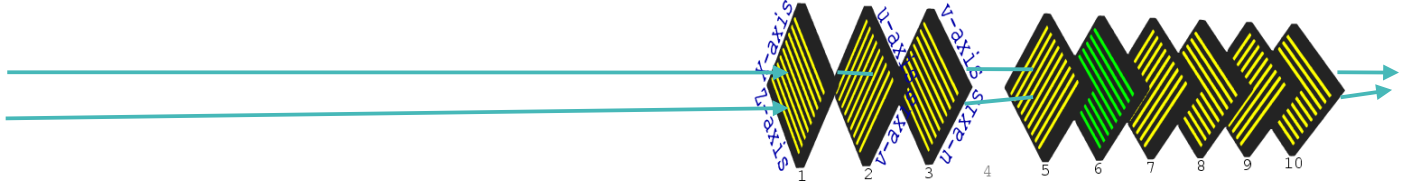
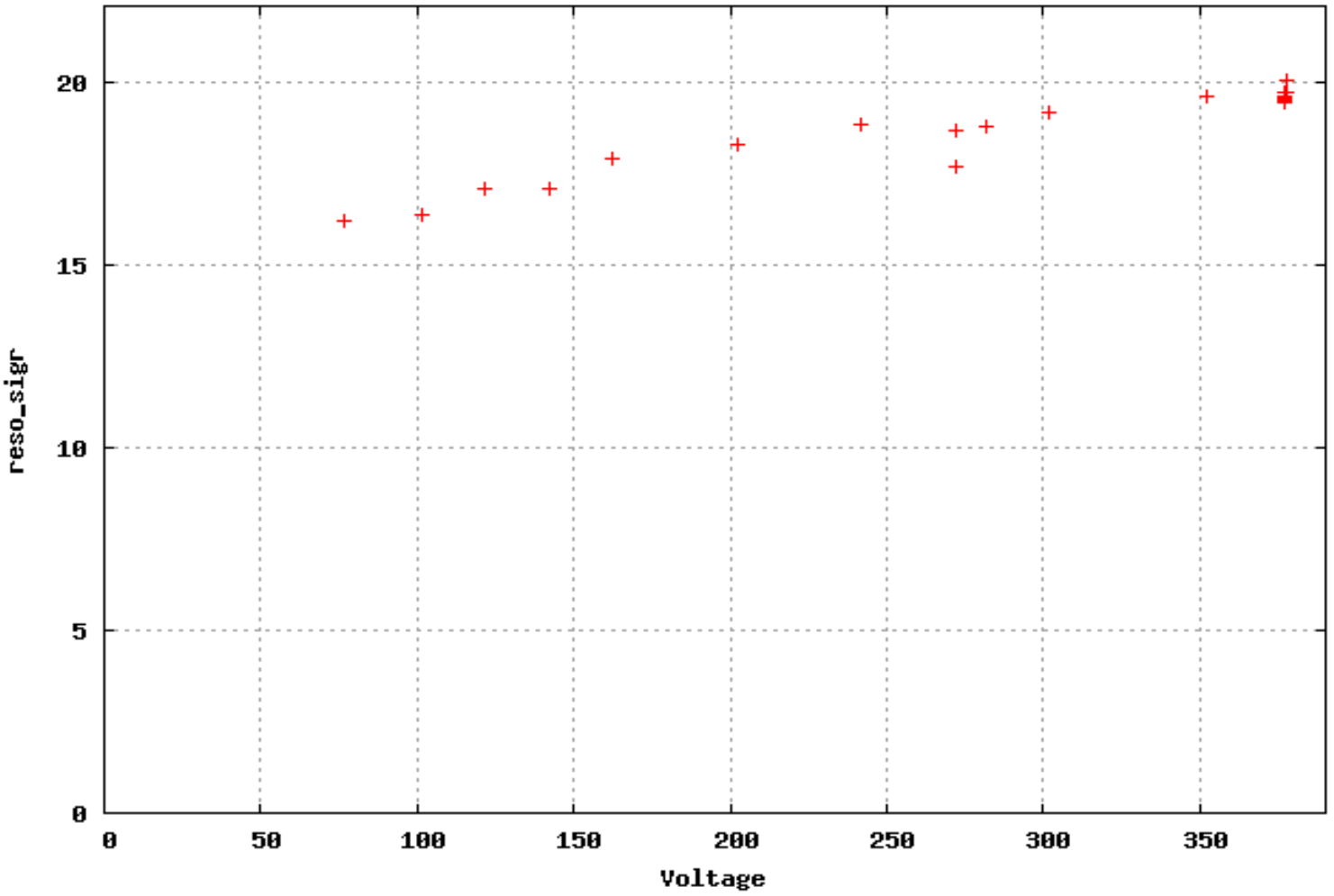
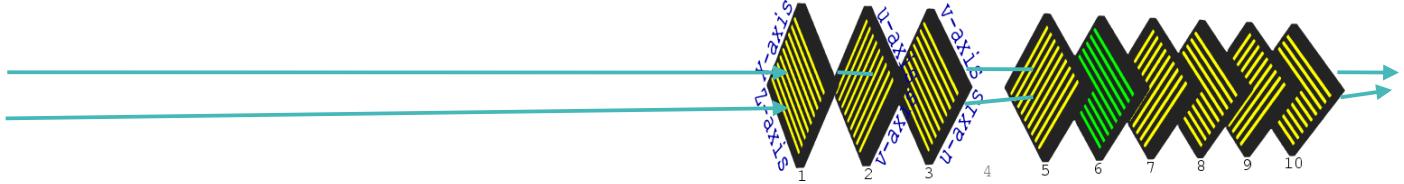
9
10

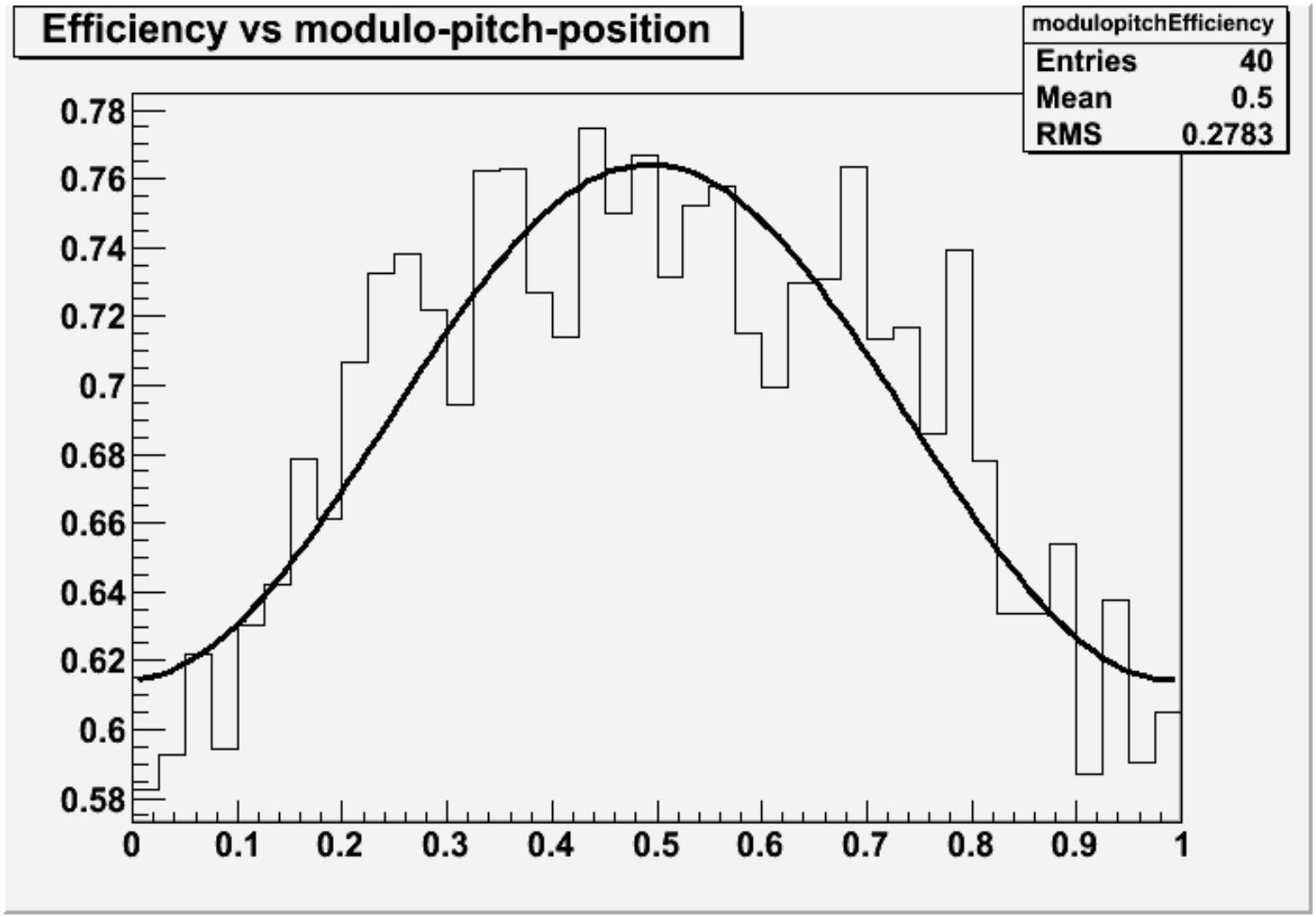

SiBT collaboration // det-MCz0802A__1_1e15 // rundate plotted 20090601
reso_sigr
Voltage
0
2
4
6
8
10
12
14
16
18
0
100
200
300
400
500



SiBT collaboration // det-MCz0804B__1_6e15 // rundate plotted 20090601




y-axis
u-axis
v-axis
1
2
3
4
5
6
7
8
9
10


Efficiency vs modulo-pitch-position
modulopitchEfficiency
Entries 40
Mean 0.5
RMS 0.2783
0.78
0.76
0.74
0.72
0.7
0.68
0.66
0.64
0.62
0.6
0.58
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1