



# Noise Bias Scan

## Outline, Goals, and Procedure

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**KU CMS summer research project meeting**

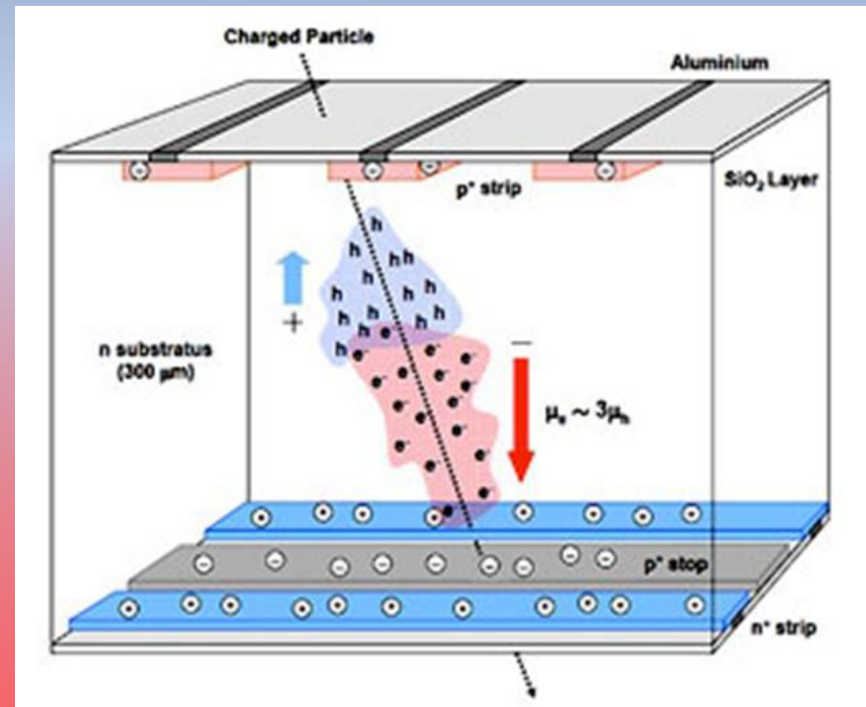
**7/31/2014**



# Depletion Voltage



- Each strip of the detector has a “full depletion voltage”
- Strips act as a capacitor, read out even when no events
- This is a property of the silicon
- Base readout of each strip is the pedestal
- RMS of the pedestal is the noise
- For depletion, the noise of a strip is at a minimum
- Minimized at the depletion voltage

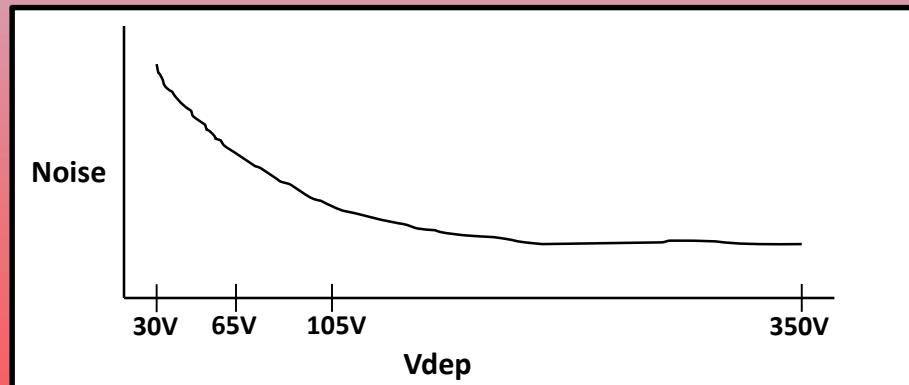




# Radiation, Noise Scan



- The detector is subject to increasing radiation damage
- Changes the  $V_{dep}$  over time
- Noise Bias Scan is a way to monitor the  $V_{dep}$
- Special pedestal runs scan the bias voltage
- Data read from strips at bias voltage points, starting at low voltage, and reaching up to 350V in  $\sim 20$  steps
- Noise data taken from pedestals, analysis follows. (more on this in “software procedure”)



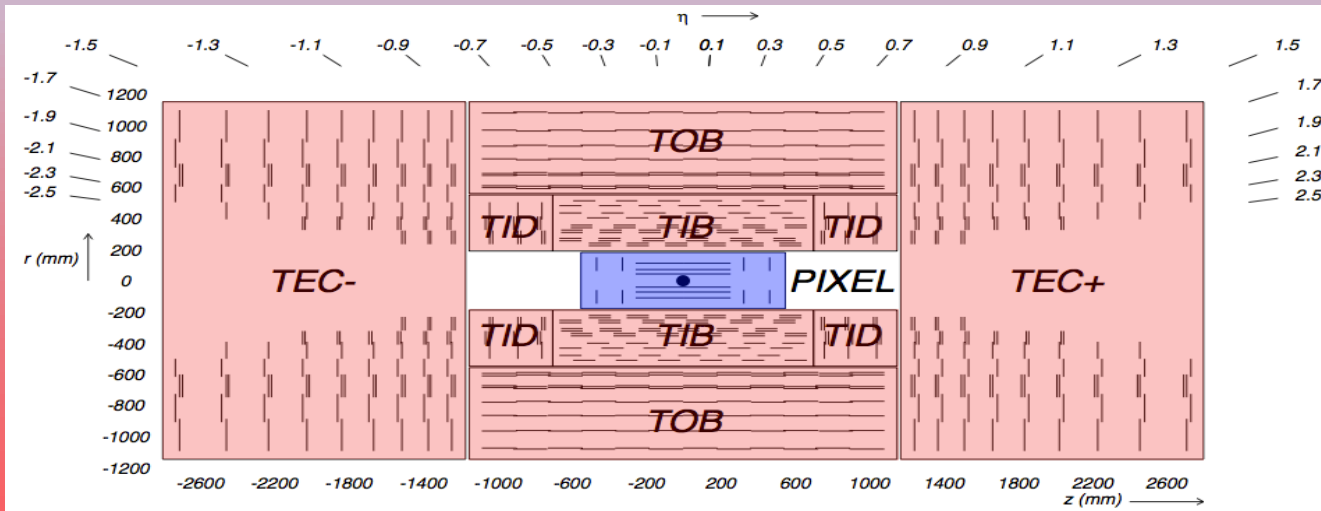


# Physics Goals



What do we aim to gain from this information?

- Silicon strip tracker modules damaged over time by radiation from colliding beams
- Causes higher leakage current over time, higher Vdep
- Won't be able to provide enough current to the tracker
- Keeping track of radiation damage is important to monitor the health of the tracker
- Can test current models of the damage against data (FLUKA)



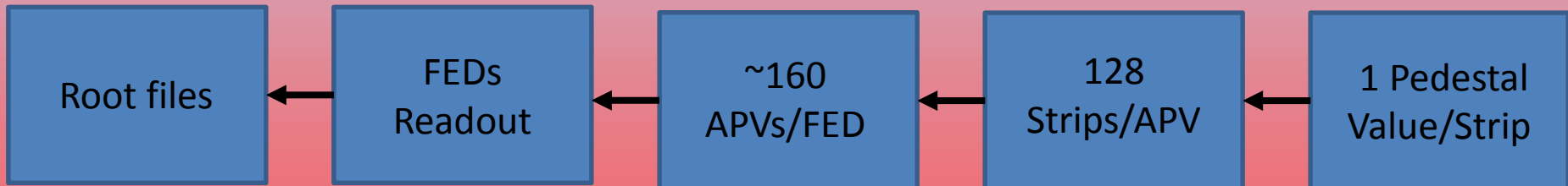


# Data



## How is this data taken?

- Taken during a pedestal run in parallel on the four partitions.
- At each voltage step, pedestal data read out from the FEDs (Front end Drivers) in ADC counts.
- FED readout gives information about each APV, which gives information on each strip.
- Information gets compounded into root file, SiStripCommissioning online analysis.



Info on the FEDs: <http://www.te.rl.ac.uk/esdg/cms-fed/conferences/lecc-2003-amsterdam/coughlan.pdf>  
<http://cds.cern.ch/record/479708/files/p444.pdf?version=1>



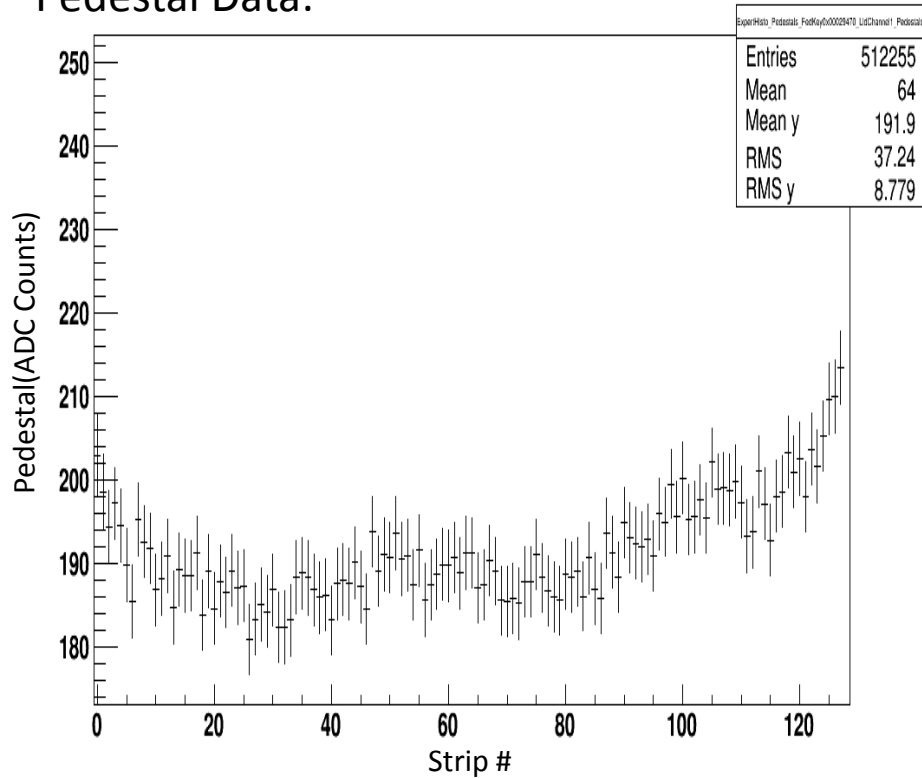
# Data



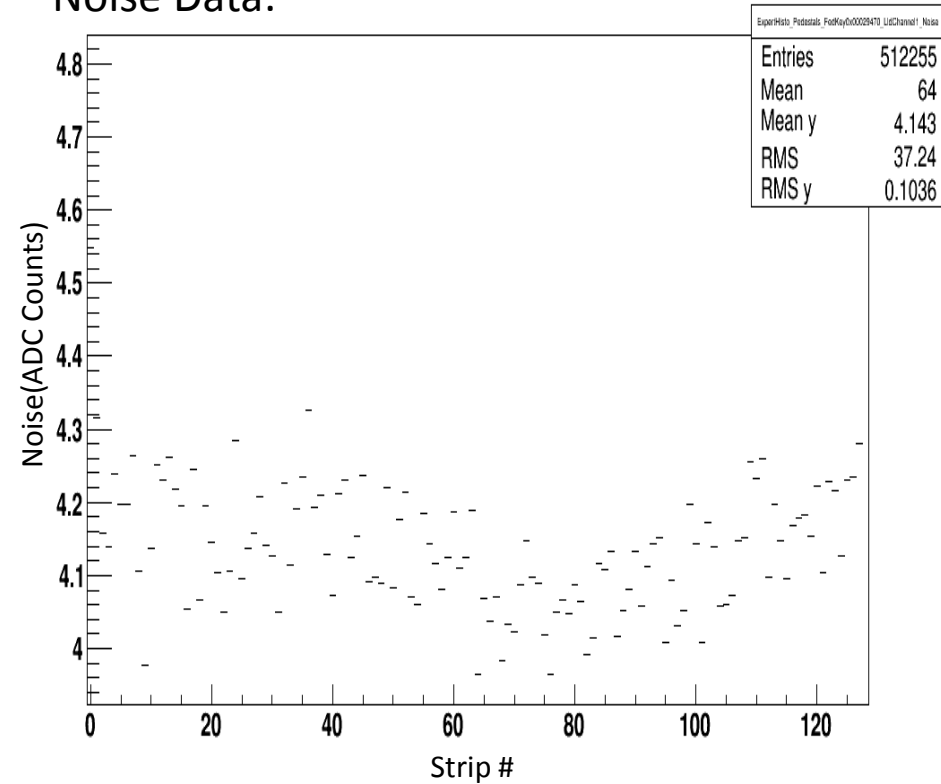
## What does this data look like?

Data for Sep2012 Run 203247 TECM 350V(1 APV)

### Pedestal Data:



### Noise Data:





# Data

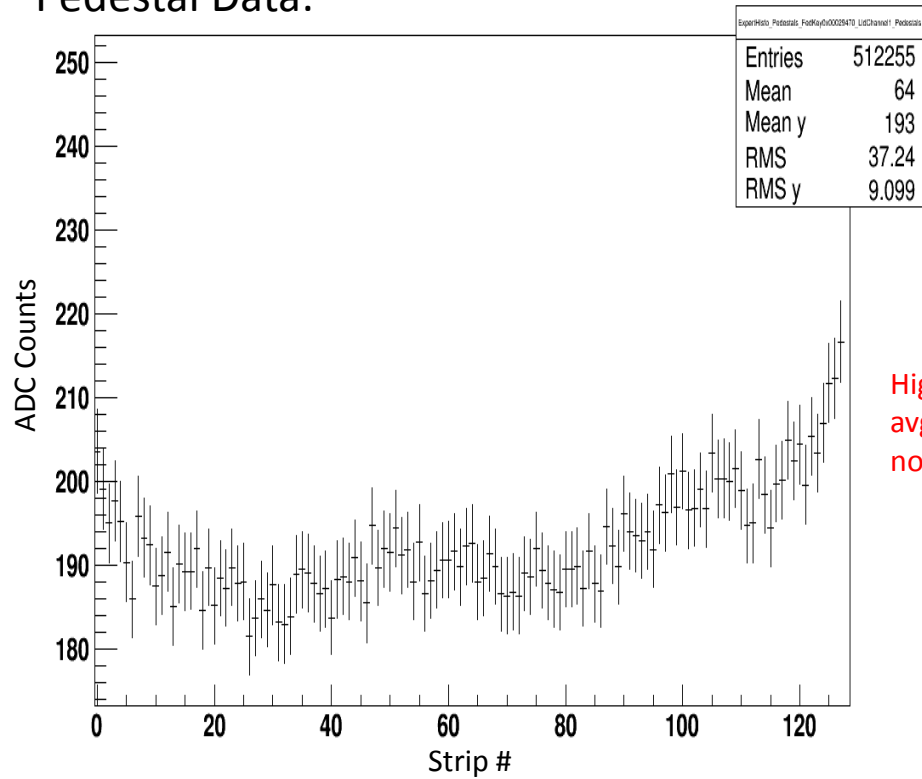


## What does this data look like?

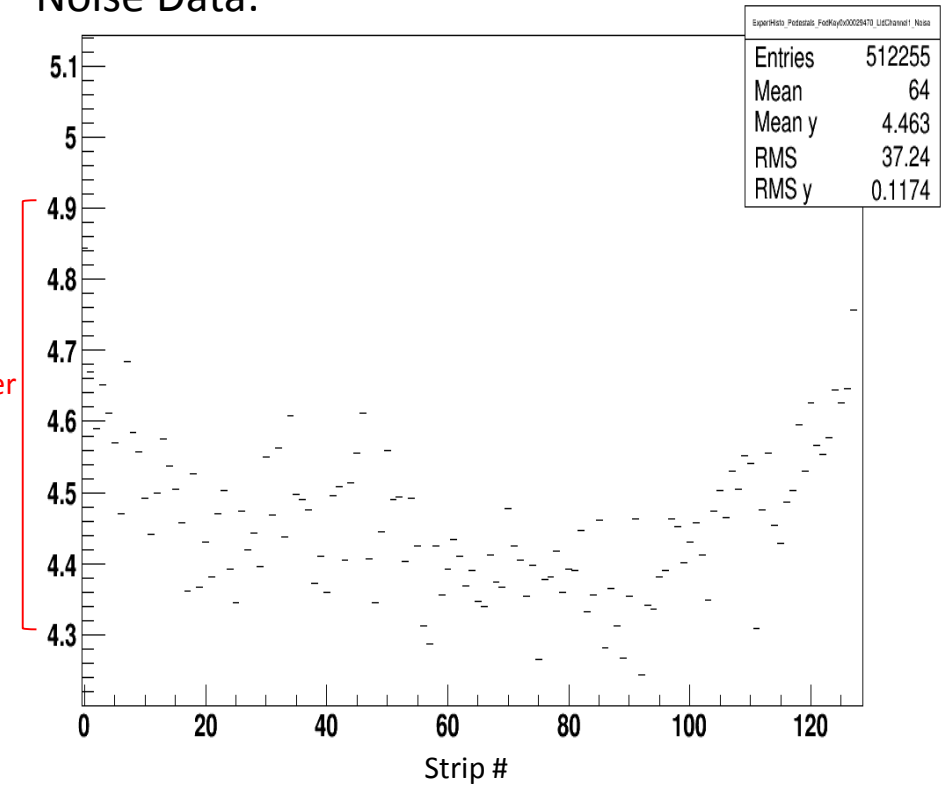
Data for Sep2012 Run 203270 TECM 30V(1 APV)

-Expect to see higher noise in low V

### Pedestal Data:



### Noise Data:



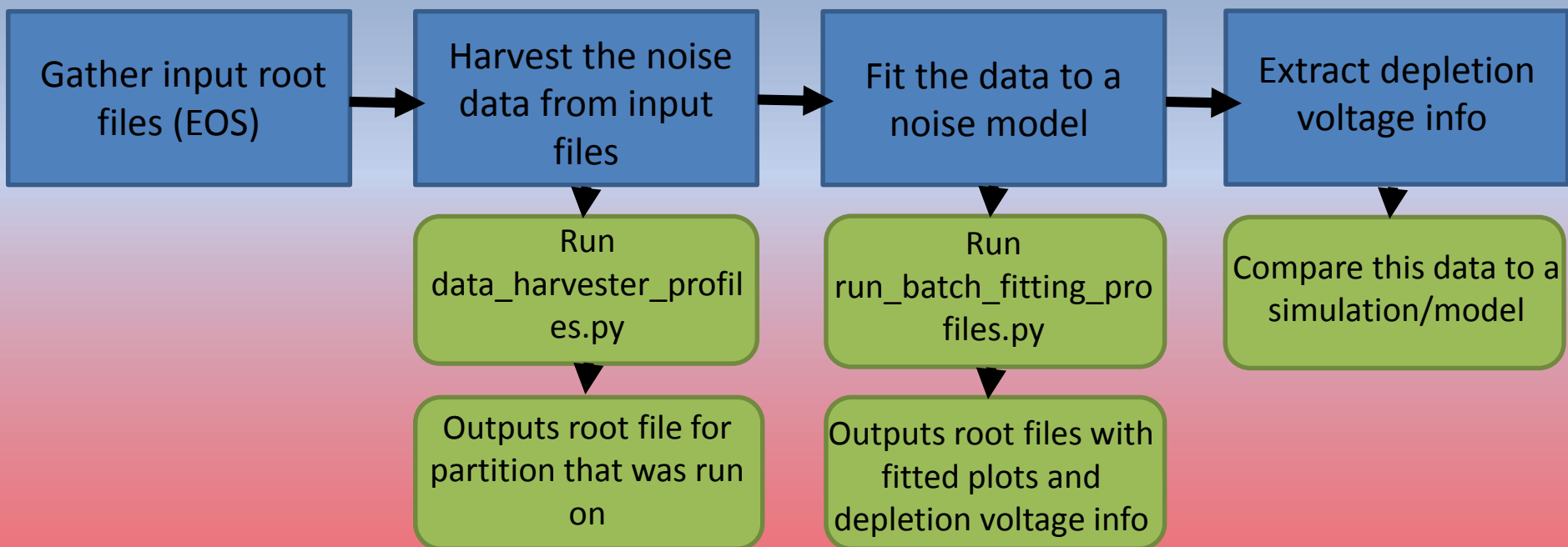


# Software Procedure



How do we go about analyzing this data?

-The analysis is done in several steps:



All scripts can be found at: [/afs/cern.ch/user/d/dorzels/work/HWdir/CMSSW\\_6\\_0\\_1/src/NoiseBiasScan](https://afs.cern.ch/user/d/dorzels/work/HWdir/CMSSW_6_0_1/src/NoiseBiasScan)





# Software Procedure

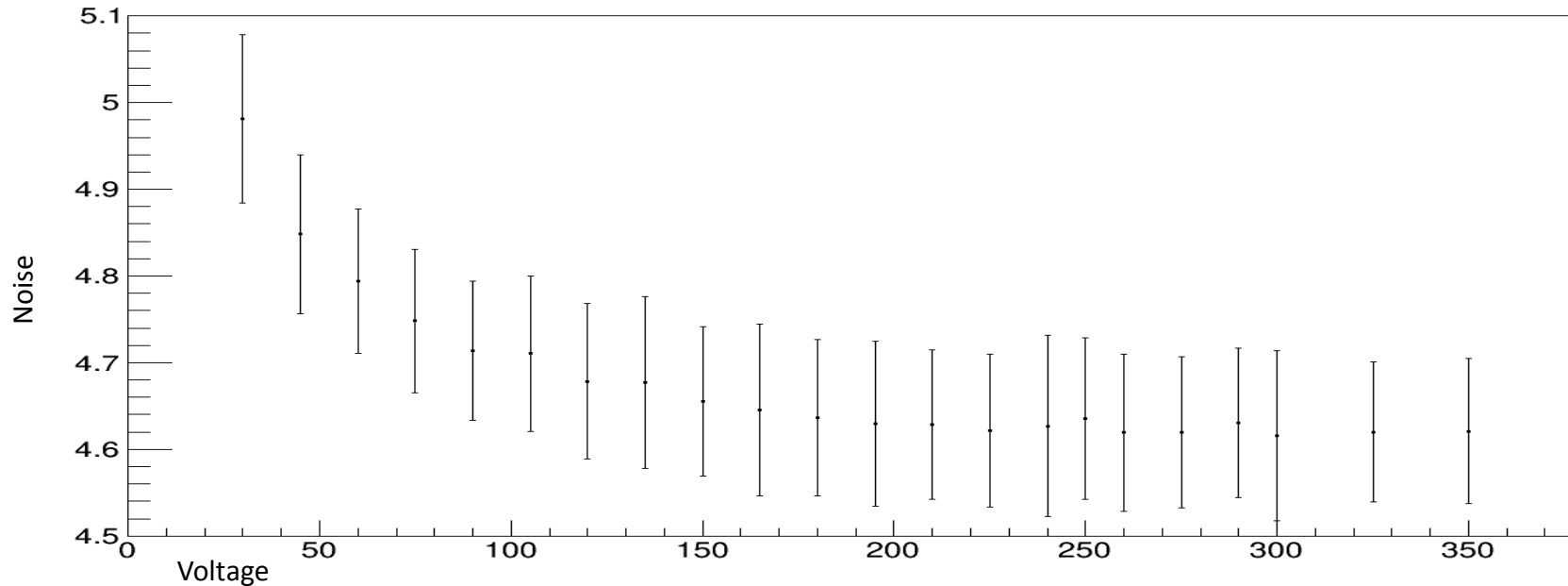


## Harvesting the noise data:

-data\_harvester\_profiles.py:

- Loops over all APVs in a set of root files
- Trims noisy/dead APVs
- Collects mean noise values for each APV in each module at each voltage step
- Outputs root files with plots:

Sep 2012 TECM \FecCrate3\FecSlot15\FecRing1\CcuAddr123\CcuChan19\Ildchannel1\APV0

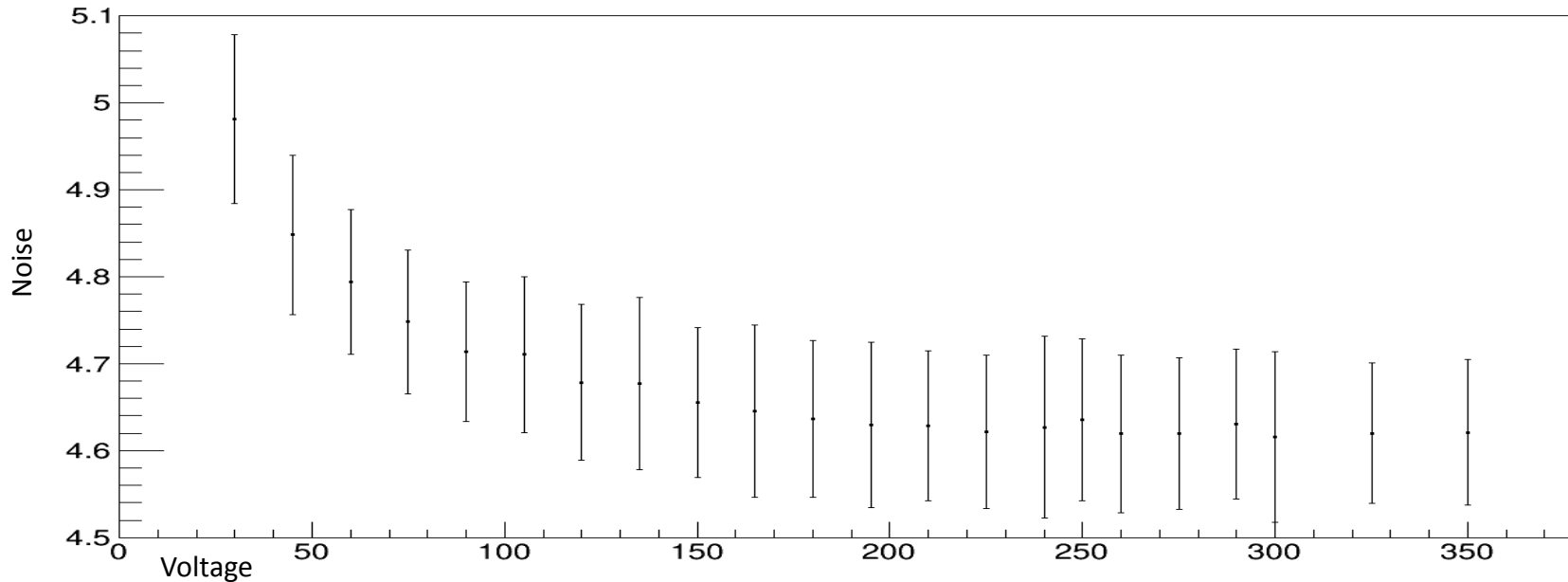




# Software Procedure



Sep 2012 TECM \FecCrate3\FecSlot15\FecRing1\CcuAddr123\CcuChan19\IIdchannel1\APV0



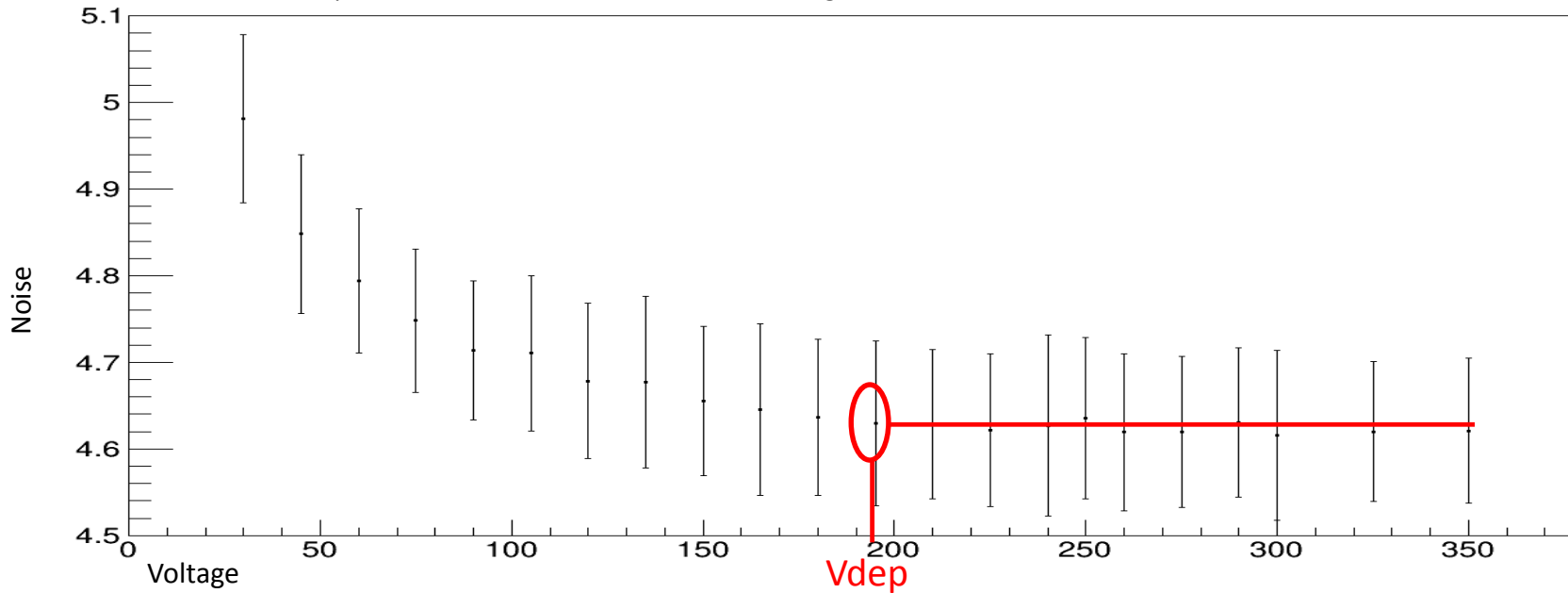
- Looking at average noise on one APV for each voltage point
- Noise evens out at high voltages
- Need to find “knee” of curve by fitting
- The knee gives us full depletion voltage



# Software Procedure



Sep 2012 TECM \FecCrate3\FecSlot15\FecRing1\CcuAddr123\CcuChan19\Ildchannel1\APV0



-Looking for “evening out”

-Knee around 190V



# Software Procedure



## Getting depletion voltage from fits:

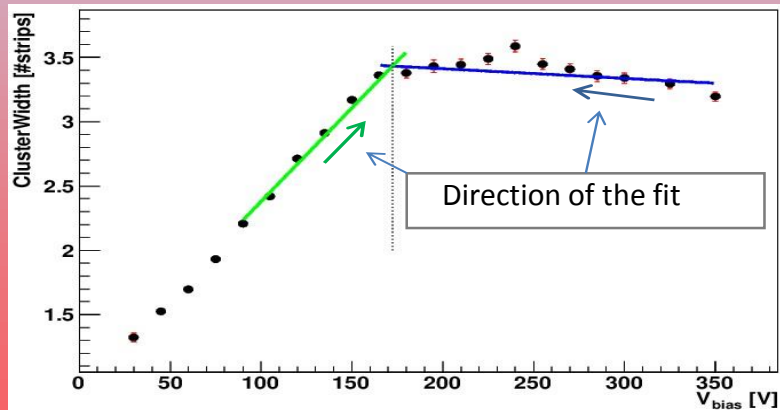
-running `run_batch_fitting_profiles.py`:

- takes as input the root files outputted by `data_harvester_profiles.py`
- fits each plot for each APV to a model we specify
- outputs root file for each module with fitted plots, voltage depletion info

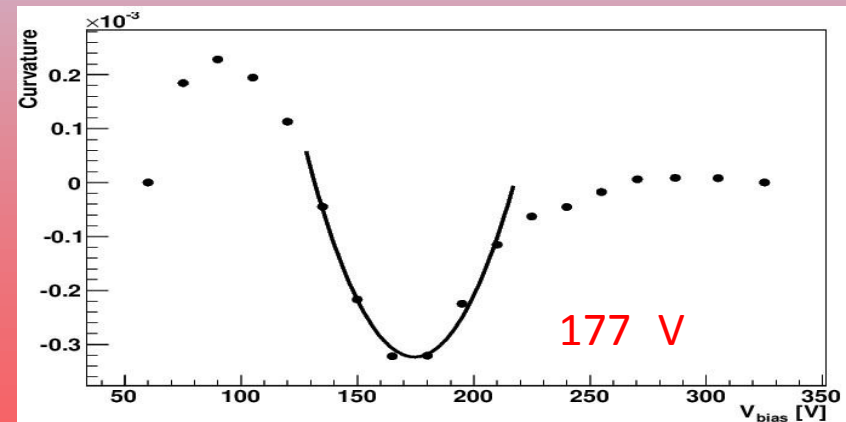
Possible fitting techniques:

- in contact with Signal Bias Scan experts for fitting methods
- looks at leakage current
- Must fit a knee as well

Two lines (Signal Bias):



Kink extraction (Signal Bias):





# Moving Forward



- Get full list of input files, in one location
- Get all scripts working, outputting correctly
- Revise scripts to possibly fit a new model
- Revise scripts to run on just one input file (merged by another script)
- Talk with Signal Bias about fitting methods
- Eventually have depletion voltage plots for all modules



# Backup



# Useful links



Other talks/info on radiation damage of the tracker:

<https://indico.cern.ch/event/156565/contribution/3/material/slides/3.pdf>

[http://web.physik.rwth-aachen.de/~feld/RWTH/Doktorarbeiten/dissertation\\_richard\\_bremer.pdf](http://web.physik.rwth-aachen.de/~feld/RWTH/Doktorarbeiten/dissertation_richard_bremer.pdf) (page59)

<https://indico.cern.ch/event/200290/session/1/contribution/22/material/slides/0.pdf>

Files used in this talk:

root://eocms.cern.ch/eos/cms/store/user/gbenelli/NoiseBiasScan/Sep2012/TECM/TECM\_203247\_350.root

root://eocms.cern.ch/eos/cms/store/user/gbenelli/NoiseBiasScan/Sep2012/TECM/TECM\_203247\_30.root

Twiki pages:

<https://twiki.cern.ch/twiki/bin/view/Main/NoiseMethodVdeplMonitoringProject>

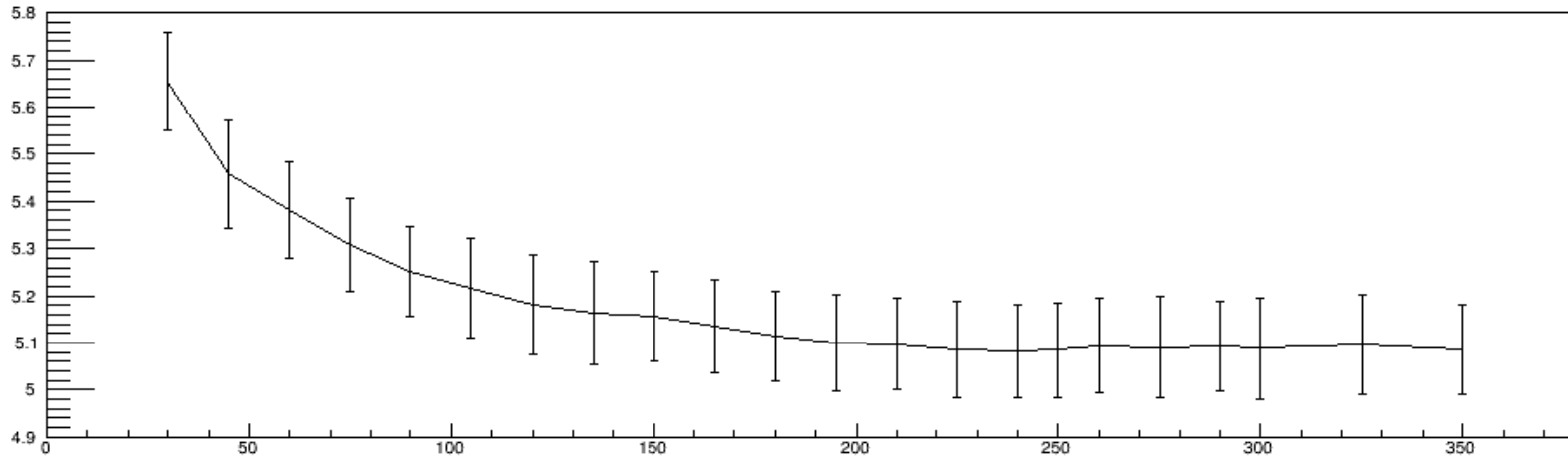
[https://twiki.cern.ch/twiki/bin/view/Sandbox/DylanOrzelSandbox#noise\\_bias\\_scan](https://twiki.cern.ch/twiki/bin/view/Sandbox/DylanOrzelSandbox#noise_bias_scan) (will be updated)

<https://twiki.cern.ch/twiki/bin/viewauth/CMS/SiStripSignalHVScans> (list of past HV scans)



Slightly more noticeable evening out of noise:

ExpertHisto\_NoiseHVScan\_FedKey0x0003e0f0\_LldChannel1\_NoiseHVScanProfileAPV1\_Sep2012\_TECM



ExpertHisto\_NoiseHVScan\_FedKey0x0003e0f0\_LldChannel1\_NoiseHVScanProfileAPV0\_Sep2012\_TECM

