Monitoring APV25-SRS Electronics with amoreSRS

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Outline

- AMORE Framework:
  - Basic Description of the framework
  - Installation of the package
- Introduction to the amoreSRS package:
  - Installation and Compilation of the package
  - APV25 Raw data Monitoring and Built-in Detector Analysis Package
- Guidelines for running amoreSRS
  - Review of amoreSRS configuration files
  - Monitoring APV25-SRS initialization
  - Running basics detector characterization

AMORE Framework

- AMORE is a Data Quality Monitoring (DQM) software system developed for ALICE experiments.
- It is founded on the widely-used data analysis framework ROOT and uses the DATE monitoring library
- AMORE is based on a publisher-subscriber paradigm where a large number of processes, called agents, execute detector-specific decoding and analysis on raw data samples and publish their results in a pool. Clients can then connect to the pool and visualize the monitoring results through a dedicated user interface
- https://ph-dep-aid.web.cern.ch/ph-dep-aid/
- http://indico.cern.ch/getFile.py/access?contribId=39&resId=1&materialId=slides&confId=3580
- http://pos.sissa.it/archive/conferences/093/024/ACAT2010_024.pdf
- For installation of AMORE framework, contact RD51 WG5

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Installation et Compilation de amoreSRS

- Download amoreSRS from my cern lxplus public account
  - cp –r kgnanvo/public/amoreSRS* .
- Create the amoreAgent SRS01
  - newAmoreAgent and follow the instruction to create
- Compilation of amoreSRS package
  - cd amoreSRS
  - Make clean
  - Make install

amoreSRS package

- src/publisher/SRSPublisher
  - Main ➔ contain all the instructions to run amoreSRS
  - Upload Configuration files (amore.cfg, mapping …), control run type, run conditions …
- src/publisher/SRSAPVEvent
  - Decode APV data, perform strip numbering correction, pedestal subtraction, zero suppression, create hits objects
- src/publisher/SRSHit
  - Hit object ➔ contains hit info, strip number, adc count, …
- src/publisher/SRSCluster
  - Cluster object ➔ contains cluster info: cluster position, cluster adc count …
- src/publisher/SRSEventBuilder
  - Select whether the event is good or not and build the cluster informations

amoreSRS package

- src/publisher/SRSFECEventDecoder and src/publisher/SRSFECPedestalDecoder
  - Decode the SRS FEC Raw data and create an SRSAPVEvent instance for each APV Raw Data
  - There is a separate decoder for Pedestal run and Physic run
- src/publisher/SRSPedestal and src/publisher/SRSRawPedestal
  - Produce pedestal data (mean and rms) and save the data into ROOT histogram
- src/publisher/SRSHistoManager
  - This code is where all the histos specified in the histogram.cfg are created and filled during amoreSRS run
  - The histograms are saved in ROOT file as well as as plots at the end of the run
- src/publisher/SRSTrack ans src/publisher/SRSTrackFit
  - Perfom the fit and tracking

amoreSRS package

- src/common/SRSConfiguration
  - Upload amore.cfg configuration file and set the run parameters to SRSPublisher
- src/common/SRSMapping
  - Decipher the mapping configuration and set the mapping for the run
- src/ui/SRSUI
  - This code contain the instruction for customized online display of the histogram during the amoreSRS run
  - The plots to be displayed are specified in display.cfg configuartin firl

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amoreSRS Configuration files

- amore.cfg: *path is hard-coded into amoreSRS code (in SRSPublisher.cxx)*
  - Set the path of the output files and the 3 other config files to be uploaded by amoreSRS during run,
  - Set the type of run (raw data, pedestal, output to root files …)
  - Also use to set other parameters such as zero suppression. output data type, condition of the run …
- Mapping configuration file: *path set in amore.cfg*
  - Set the mapping to the apv25 FE to the detector and to the SRS system
- Histogram configuration files: *path set in amore.cfg*
  - This is where we set the histogram to be generated during amoreSRS run
- Display configuration file: *path set in amore.cfg*
  - This is used to set what kind of data to monitor during the run

amore.cfg

Hard coded in amoreSRS ➔ "$AMORESRS/configFileDir/amore.cfg

```
File Edit Options Buffers Tools Conf Help
ZEROSUPCUT    5
CHMASKCUT     20
MINCLUSTSIZE 2
MAXCLUSTSIZE 10
MAXCLUSTMULT 3
#MAXorTOTALCHARGES maximumCharges
MAXorTOTALCHARGES totalCharges

ROOTDATATYPE  HITS_ONLY
#ROOTDATATYPE  CLUSTERS_ONLY
#ROOTDATATYPE  OTHER

STARTEVENTNUMBER 0
EVENTFREQUENCYNUMBER 1
CYCLEWAIT 2

MAPFILE      /home/amoreTutorial/configFileDir/mappingTUT.cfg
HISTCFG      /home/amoreTutorial/configFileDir/histogramTUT.cfg
DISPCFG      /home/amoreTutorial/configFileDir/displayTUT.cfg
PEDFILE      /home/amoreTutorial/pedestalDir/pedestalTUT.root
RAWPEDFILE   /home/amoreTutorial/pedestalDir/rawPedestalTUT.root
RUNNAME     /home/amoreTutorial/results/

#RUNTYPE      RAWPEDESTAL
#RUNTYPE      PEDESTAL
#RUNTYPE      RAWDATA
RUNTYPE      PHYSICS
#RUNTYPE      TRACKING
#RUNTYPE      ROOTFILE
```

Parameters for the clusterization

Content of the output of root files

run parameters

Paths for config, pedestal data and output files

Different types of run

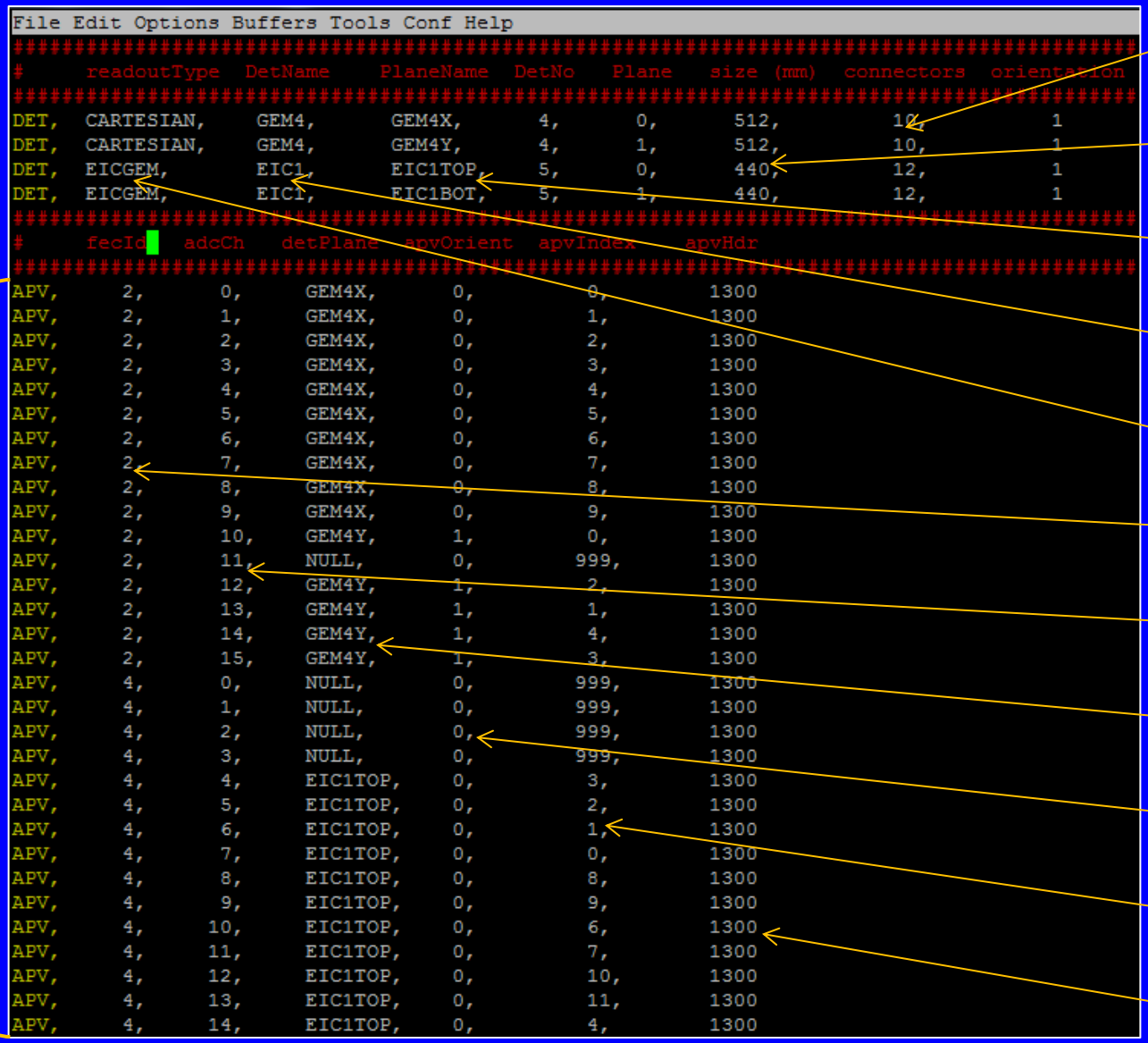
amoreSRS run types

- RAWPEDESTAL: Generate some data needed for the PEDESTAL run ➔ Should always be ran before the running PEDESTAL
- PEDESTAL: Run to get pedestal rms noise and offset for each apv channel in form of a ROOT histograms
- RAWDATA: run to look at APV25 raw data frames ➔ useful for APV25 - SRS initialization
- PHYSICS: Run for detector characterization ➔ clusterization, cluster position in 1D and 2D , cluster sizes, pulse height distribution etc …
- TRACKING: Run for tracking and residual analysis ➔ Useful for spatial resolution
- ROOTFILE: Run to output the hits or clusters information in root file

mappingTUT.cfg (old version)

```
##########################################################################################
#     readoutType  DetName     PlaneName  DetNo   Plane   size (mm)  connectors  orientation
##########################################################################################
DET,  CARTESIAN,     GEM4,       GEM4X,      4,      0,      512,         10,          1
DET,  CARTESIAN,     GEM4,       GEM4Y,      4,      1,      512,         10,          1
DET,  EICGEM,        EIC1,       EIC1TOP,    5,      0,      440,         12,          1
DET,  EICGEM,        EIC1,       EIC1BOT,    5,      1,      440,         12,          1
##########################################################################################
#     FEC Name  APV Name       FECId    ADCchNo   apvIndex     APV Hdr   Sigma Cut
##########################################################################################
FEC,     FEC2,   GEM4XApv0,      2,        0,        0,        1300,        4
FEC,     FEC2,   GEM4XApv0,      2,        1,        1,        1300,        4
FEC,     FEC2,   GEM4XApv0,      2,        2,        2,        1300,        4
FEC,     FEC2,   GEM4XApv0,      2,        3,        3,        1300,        4
FEC,     FEC2,   GEM4XApv0,      2,        4,        4,        1300,        4
FEC,     FEC2,   GEM4XApv0,      2,        5,        5,        1300,        4
FEC,     FEC2,   GEM4XApv0,      2,        6,        6,        1300,        4
FEC,     FEC2,   GEM4XApv0,      2,        7,        7,        1300,        4
FEC,     FEC2,   GEM4XApv0,      2,        8,        8,        1300,        4
FEC,     FEC2,   GEM4XApv0,      2,        9,        9,        1300,        4
FEC,     FEC2,   GEM4YApv1,      2,        10,       0,        1300,        4
FEC,     FEC2,   NULL,           2,        11,       999,      1300,        4
FEC,     FEC2,   GEM4YApv1,      2,        12,       2,        1300,        4
FEC,     FEC2,   GEM4YApv1,      2,        13,       1,        1300,        4
FEC,     FEC2,   GEM4YApv1,      2,        14,       4,        1300,        4
FEC,     FEC2,   GEM4YApv1,      2,        15,       3,        1300,        4
FEC,     FEC4,   NULL,           4,        0,        0,        1300,        4
FEC,     FEC4,   NULL,           4,        1,        999,      1300,        4
FEC,     FEC4,   NULL,           4,        2,        2,        1300,        4
FEC,     FEC4,   NULL,           4,        3,        999,      1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        4,        3,        1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        5,        2,        1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        6,        1,        1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        7,        0,        1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        8,        8,        1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        9,        9,        1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        10,       6,        1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        11,       7,        1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        12,       10,       1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        13,       11,       1300,        4
FEC,     FEC4,   EIC1TOPApv0,    4,        14,       4,        1300,        4
```

mappingTUT.cfg (new version)



```
File Edit Options Buffers Tools Conf Help
##########################################################################################
#     readoutType  DetName    PlaneName  DetNo   Plane   size (mm)  connectors  orientation
##########################################################################################
DET,  CARTESIAN,    GEM4,      GEM4X,      4,      0,      512,         10,          1
DET,  CARTESIAN,    GEM4,      GEM4Y,      4,      1,      512,         10,          1
DET,  EICGEM,       EIC1,      EIC1TOP,    5,      0,      440,         12,          1
DET,  EICGEM,       EIC1,      EIC1BOT,    5,      1,      440,         12,          1
##########################################################################################
#     fecId  adcCh   detPlane  apvOrient  apvIndex    apvHdr
##########################################################################################
APV,     2,      0,     GEM4X,      0,         0,        1300
APV,     2,      1,     GEM4X,      0,         1,        1300
APV,     2,      2,     GEM4X,      0,         2,        1300
APV,     2,      3,     GEM4X,      0,         3,        1300
APV,     2,      4,     GEM4X,      0,         4,        1300
APV,     2,      5,     GEM4X,      0,         5,        1300
APV,     2,      6,     GEM4X,      0,         6,        1300
APV,     2,      7,     GEM4X,      0,         7,        1300
APV,     2,      8,     GEM4X,      0,         8,        1300
APV,     2,      9,     GEM4X,      0,         9,        1300
APV,     2,     10,     GEM4Y,      1,         0,        1300
APV,     2,     11,     NULL,       0,       999,        1300
APV,     2,     12,     GEM4Y,      1,         2,        1300
APV,     2,     13,     GEM4Y,      1,         1,        1300
APV,     2,     14,     GEM4Y,      1,         4,        1300
APV,     2,     15,     GEM4Y,      1,         3,        1300
APV,     4,      0,     NULL,       0,       999,        1300
APV,     4,      1,     NULL,       0,       999,        1300
APV,     4,      2,     NULL,       0,       999,        1300
APV,     4,      3,     NULL,       0,       999,        1300
APV,     4,      4,     EIC1TOP,    0,         3,        1300
APV,     4,      5,     EIC1TOP,    0,         2,        1300
APV,     4,      6,     EIC1TOP,    0,         1,        1300
APV,     4,      7,     EIC1TOP,    0,         0,        1300
APV,     4,      8,     EIC1TOP,    0,         8,        1300
APV,     4,      9,     EIC1TOP,    0,         9,        1300
APV,     4,     10,     EIC1TOP,    0,         6,        1300
APV,     4,     11,     EIC1TOP,    0,         7,        1300
APV,     4,     12,     EIC1TOP,    0,        10,        1300
APV,     4,     13,     EIC1TOP,    0,        11,        1300
APV,     4,     14,     EIC1TOP,    0,         4,        1300
```

Info on the detectors to readout

APV25 mapped to the SRS ADC/FEC Card s

Nb of connectors on the plane

Size of the detector plane

detector plane or sectors

detector

detector readout type

FEC Id == DATE Equip Id

ADC Channels

detector plane or sectors

APV channel inversion

APV Position on the detector

Apv data frame headear

histogramTUT.cfg

```
File Edit Options Buffers Tools Conf Help
#=============================================================================
#Type,    Histo Name,        Histo Title,              GEM Plane1   GEM Plane2
#=============================================================================
BINNING2D,   HITMAP,             256,  INF,  INF, 256, INF, INF
HITMAP,      XPosCorrGEM1_1,  X-Correlation GEM1 vs. GEM1, GEM1X,  GEM1X
BINNING2D,   HITMAP,             128,  INF,  INF, 128, INF, INF
HITMAP,      Hit2DCOLZLogNonZGEM1,  GEM1 Hit Position Map, GEM1X,  GEM1Y
BINNING2D,   HITMAP,             250,  INF,  INF, 250, INF, INF
HITMAP,      adcCounts2DCOLZLogNonZGEM1,  GEM1 ADC Sum Map, GEM1X,  GEM1Y
PAIRED,      adcCounts2DCOLZLogNonZGEM1,  Hit2DCOLZLogNonZGEM1,250, 250, 5
#=============================================================
#Type,     Histo Name,        Histo Title,        GEM Plane1
#=============================================================
# Detector cluster hit event by event
HITPEDOFFSET,  PedSubHitGEM1X, GEM1 Hit in X, GEM1X
HITZEROSUP,    zeroSupHitGEM1Y, GEM1 Hit in Y, GEM1Y
# Hit or cluster positon distribution
BINNING,   HITDIST,            256, INF,  INF
HITDIST,   clusterDistGEM1X,     GEM1  Position Distr. in X,  GEM1X
HITDIST,   clusterDistGEM1Y,     GEM1  Position Distr. in Y,  GEM1Y
# Pulse Height distribution  (ADC count)
BINNING,    SPECTRUM,        100, 0, 2000
SPECTRUM,   SpectrumGEM1X,   GEM1 cluster Charge Distr in X, GEM1X
SPECTRUM,   SpectrumGEM1Y,   GEM1 cluster Charge Distr in Y, GEM1Y
# Cluster size and cluster multiplicity
BINNING,     CLUSTSIZE,        11, 0, 10
CLUSTSIZE,   clusterSizeGEM1X,    GEM1 cluster Size Distr in X, GEM1X
CLUSTSIZE,   clusterSizeGEM1Y,    GEM1 cluster Size Distr in Y, GEM1Y
#=============================================================================================================
# TRACKING,  Det,   trigFlag,     TrackerFlag,     ResFlag,   xOffset,  yOffset,  zOffset, nBins,  min,   max
#=============================================================================================================
@DETECTORS,  GEM1,  isTrigger,     isTracker,    isResidual,    1.23,     2.16,     1117,    101,   -1,    1
@DETECTORS,  GEM2,  isTrigger,     isTracker,    isResidual,    16.45,    0.32,     3163,    101,   -1,    1
@DETECTORS,  GEM3,  isTrigger,     isTracker,    isResidual,    7.38,    -67.45,    2678,    101,   -1,    1
@DETECTORS,  GEM4,  isNoTrigger,   isNoTracker,  isResidual,   -26.1,     58.3,     1497,    101,   -1,    1
#=============================================================================
# 3D DISPLAY,       Title,        ntupleSizeX,   ntupleSizeY, ntupleSizeZ
#=============================================================
@EVENT3DDISPLAY, "tracker display",    50,          50,         3200
```

histogramTUT.cfg

- BINNING, HITDIST, 256, INF, INF

Reset the binning (number of bins *256*) for a 1D histo of type *HITDIST*, *INF* mean default value for min and max

- BINNING2D, HITMAP, 256, INF, INF, 256, INF, INF

Reset the binning (number of bins: *256*) for a 2D histo of type *HITMAP, INF* mean default value for min and max

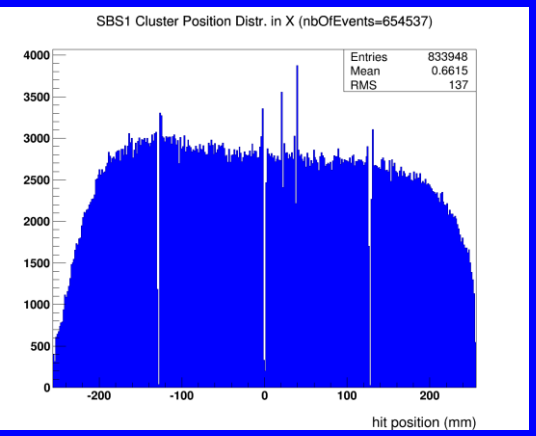
- HITMAP, Hit2DCOLZLogNonZGEM1, GEM1 Hit Position Map, GEM1X, GEM1Y

Define a 2D histo of type: *HITMAP*, name: *Hit2DCOLZLogNonZGEM1*, title: *GEM1 Hit Position Map*, the 2D histogram is filled with point define by cluster position *in GEM1X*, *GEM1Y*

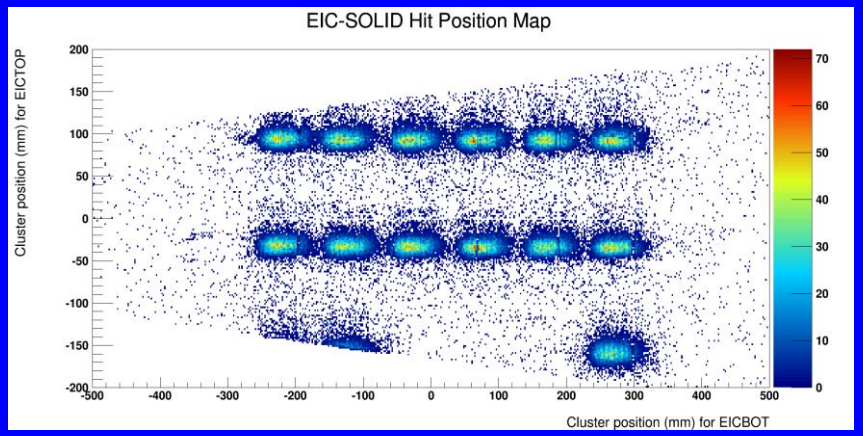
- HITZEROSUP, zeroSupHitGEM1Y, GEM1 Hit in Y, GEM1Y

Define a 1D histo of type: *HITZEROSUP*, name: *zeroSupHitGEM1Y*, title: *GEM1 Hit in Y*, the 1D histogram is filled with cluster hits (strips pos. + adc counts) in *GEM1Y*

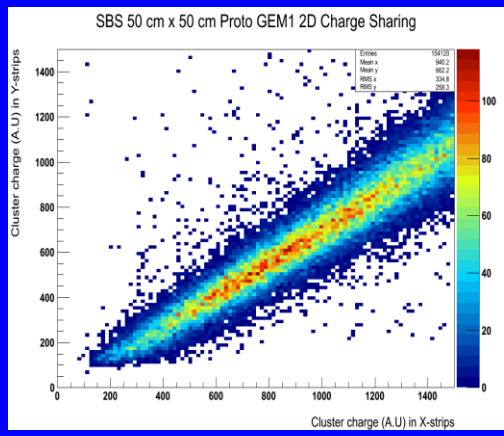
Few plots with Histogram.cfg



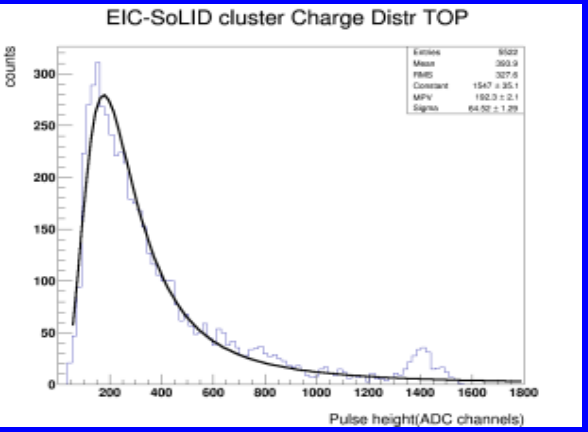
Cluster position distribution



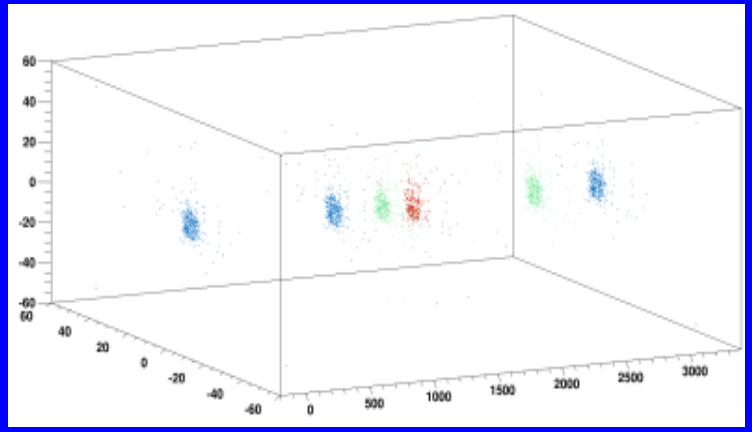
2D hit map (cluster position)



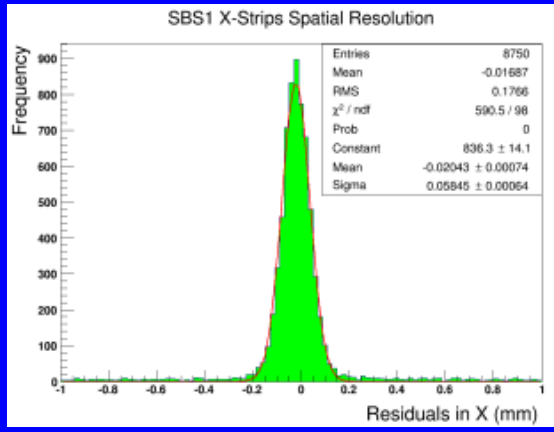
Charge sharing correlation



Cluster ADC distribution



3D detector space points



Residual x (track) – x (detector)

displayTUT.cfg

```
File Edit Options Buffers Tools Conf Help
################ DEFINITION OF THE CANVASES ###################
# CANVAS,   CANVASNAME,        NTABX,    NTABY,   SIZEX,    SIZEY
#############################################################
#CANVAS,   RAWDATA_ALLAPVs,    2,        2,       1920,    920
#CANVAS,   RAWDATA_FEC2,       4,        4,       1275,    850

CANVAS,   HIT,                1,        1,       1920,    920
CANVAS,   CLUSTERPOSITION,    2,        2,       1920,    920
CANVAS,   OTHER,              2,        1,       1920,    920
#CANVAS,   RESIDUALS,      2,        2,       1920,    920
#CANVAS,   NTUPLE,         1,        1,       1920,    920

################ DEFINITION OF HISTOGRAMS TO DISPLAY ##########
# CANVASNAME,     HISTONAME
#############################################################
HIT,   PedSubHitGEM1X

CLUSTERPOSITION, clusterDistGEM1X
CLUSTERPOSITION, hitDistGEM1X
CLUSTERPOSITION, Hit2DCOLZLogNonZGEM1
CLUSTERPOSITION, adcCounts2DCOLZLogNonZGEM1

OTHER,   clusterSizeGEM1X
OTHER,   clusterSizeGEM1Y
OTHER,   SpectrumGEM1X
OTHER,   SpectrumGEM1Y

RESIDUALS, GEM1X
RESIDUALS, GEM2X
RESIDUALS, GEM3X
RESIDUALS, GEM4X
```

Definition of the canvas

Size of the canvas

Arrangement of the tabs in the canvas

Name of the canvas

Name of ROOT object (histograms …) as defined in histogramTUT.cfg

Hands-On APV25-SRS Initialization with DATE using amoreSRS

Running amoreSRS

Running amoreSRS online

amoreAgent -a SRS01 -s @aloneldc: -e 100 -c 10

option -e == nb events/cycle xxxx -c == nb cylce/run

Running amoreSRS from a raw data file

amoreAgent -a SRS01 -s /path/rawdatafile.raw -e 100 -c 10

amore GUI display

amore -d SRS - m SRSUI

eventDump command

eventDump @aloneldc: -f /tmp/data -n 1000

monitor 10000 events from LDC @aloneldc: and dump them into file /tmp/data

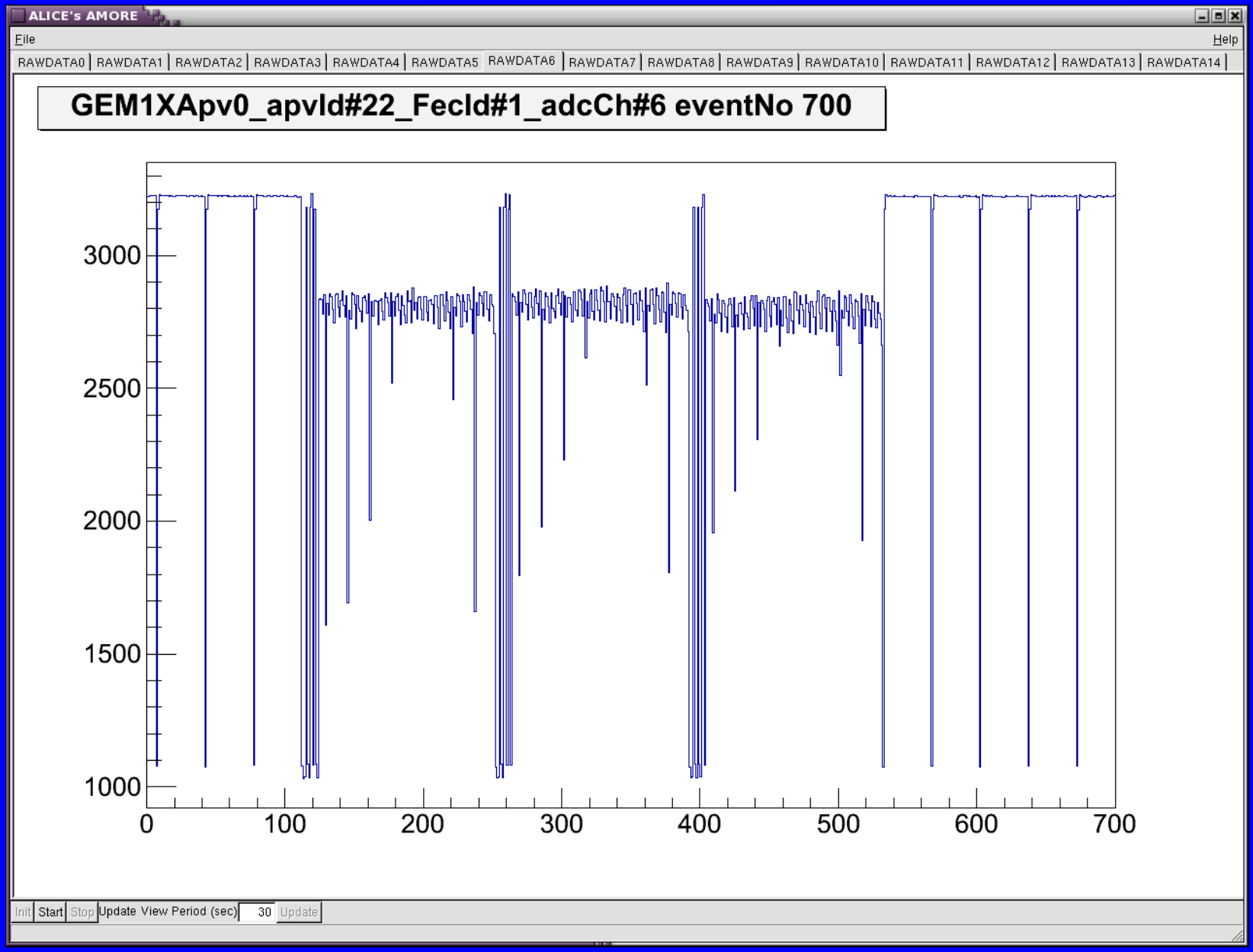
amoreSRS Raw Data

- Set RUNTYPE RAWDATA in amore.cfg to monitor the SRS apv25 raw data during the initialization of SRS system
- Set CANVAS RAWDATA_ALLAPVs and comment all other canvas for online display of all apvs raw data frame

```
File Edit Options Buffers Tools Conf Help
ZEROSUPCUT    5
CHMASKCUT     20
MINCLUSTSIZE 2
MAXCLUSTSIZE 10
MAXCLUSTMULT 3
#MAXorTOTALCHARGES maximumCharges
MAXorTOTALCHARGES totalCharges

ROOTDATATYPE  HITS_ONLY
#ROOTDATATYPE  CLUSTERS_ONLY
#ROOTDATATYPE  OTHER

STARTEVENTNUMBER 0
EVENTFREQUENCYNUMBER 1
CYCLEWAIT 2

MAPFILE       /home/amoreTutorial/configFileDir/mappingTUT.cfg
HISTCFG       /home/amoreTutorial/configFileDir/histogramTUT.cfg
DISPCFG       /home/amoreTutorial/configFileDir/displayTUT.cfg
PEDFILE       /home/amoreTutorial/pedestalDir/pedestalTUT.root
RAWPEDFILE    /home/amoreTutorial/pedestalDir/rawPedestalTUT.root
RUNNAME      /home/amoreTutorial/results/

#RUNTYPE       RAWPEDESTAL
#RUNTYPE       PEDESTAL
RUNTYPE       RAWDATA
#RUNTYPE       PHYSICS
#RUNTYPE       TRACKING
#RUNTYPE       ROOTFILE
```

```
File Edit Options Buffers Tools Conf Help
############## DEFINITION OF THE CANVASES ###################
# CANVAS,  CANVASNAME,       NTABX,   NTABY,  SIZEX,   SIZEY
#############################################################
CANVAS,  RAWDATA_ALLAPVs,   2,       2,      1920,   920
#CANVAS,  RAWDATA_FEC2,      4,       4,      1275,   850

#CANVAS,  HIT,              1,       1,      1920,   920
#CANVAS,  CLUSTERPOSITION,  2,       2,      1920,   920
#CANVAS,  OTHER,            2,       1,      1920,   920
#CANVAS,  RESIDUALS,     2,       2,      1920,   920
#CANVAS,  NTUPLE,        1,       1,      1920,   920

############## DEFINITION OF HISTOGRAMS TO DISPLAY ############
# CANVASNAME,    HISTONAME
#############################################################
HIT,  PedSubHitGEM1X

CLUSTERPOSITION, clusterDistGEM1X
CLUSTERPOSITION, hitDistGEM1X
CLUSTERPOSITION, Hit2DCOLZLogNonZGEM1
CLUSTERPOSITION, adcCounts2DCOLZLogNonZGEM1

OTHER,  clusterSizeGEM1X
OTHER,  clusterSizeGEM1Y
OTHER,  SpectrumGEM1X
OTHER,  SpectrumGEM1Y

RESIDUALS, GEM1X
RESIDUALS, GEM2X
RESIDUALS, GEM3X
RESIDUALS, GEM4X
NTUPLE, eventDisplayNtuple
```

Monitoring the SRS initialization with amoreSRS Raw Data



APV25-SRS Slow Control Parameters

1. Start DATE run with the X-ray source on the GEM detector
    1. Check the raw data with amoreSRS
    2. Save 1K events into raw data file with eventDump command
    3. Check the event size
2. Open the initialization file then
    1. Change the value for **BCLK_TRGDELAY** to adjust the latency
    2. Change the value for **BCLK_TRGBURST** to modify the number of timeslots
    3. Change the value for **EVBLD_DATALENGTH** to modify the event size
    4. Play with other parameters

Pedestal run

1. Pedestal Run with DATE
    1. Change again the value for **BCLK_TRGDELAY** to take a pedestal run
    2. Save the pedestal into a file
2. Produce the pedestal data with amoreSRS
    1. Perform RAWPEDESTAL run first (appropriate setting in amore.cfg)
    2. Perform PEDESTAL run
    3. Check the output pedestal data (root file and plots)

X-ray spectrum with the GEM

1. Physics Run with DATE
    1. Change again the value for **BCLK_TRGDELAY** to get the apv signal back
    2. Check raw data signal in X and Y coordinates of the detector
2. Detector characterization with amoreSRS
    1. Look at the hit in X and Y event by event (edit histogramTUT.cfg and displayTUT.cfg accordingly)
    2. Plot the adc distribution in X and Y
    3. Plot the 2D hitMap and the charge sharing correlation plot
    4. Plot the cluster size distribution in X and Y
    5. Increase the gain on the chamber and look its effect on the saturation of apv25 electronics

Disclaimer

- At least two active flavors of amoreSRS
  - One amoreSRS version at Florida Tech (USA) developed and maintained by Mike Phipps (mphipps2010@my.fit.edu), Jessie Twigger (jtwigger2010@my.fit.edu)
  - One version by myself (kgnanvo@virginia.edu, kgnanvo@cern.ch) at University of Virginia
  - The two versions are quite different, so if you chose one option, you should stick to it and contact the people developing it.
- The price to pay to use amoreSRS
  - I would help with the installation, debugging and running amoreSRS every time I could, but the package is not a plug and play software so you should be prepared to commit your time into understanding the code and the configuration files structure