

Micromegas DAQ system mmDAQ

Marcin Byszewski

At this moment 2 machines are running DAQ:
Micromegas lab
ATLAS USA15

Outline

- Requirements
- Usage
 - User Interface
 - Output format
- Technical Details
 - Internal structure
 - Event building
- Things To Do
- Reference Slides – (configuration files)

Requirements

- Requirements / Short Characteristics:
 - Online Monitoring
 - Zero Suppression
 - ROOT File Format
 - Portable (system requirements)
 - Lightweight
 - Easy to install, use
- 2 machines running DAQ:
 - Micromegas lab older PC - max 150 ev/s (6APV chips)
 - ATLAS USA15 new HP laptop - max 400 ev/s

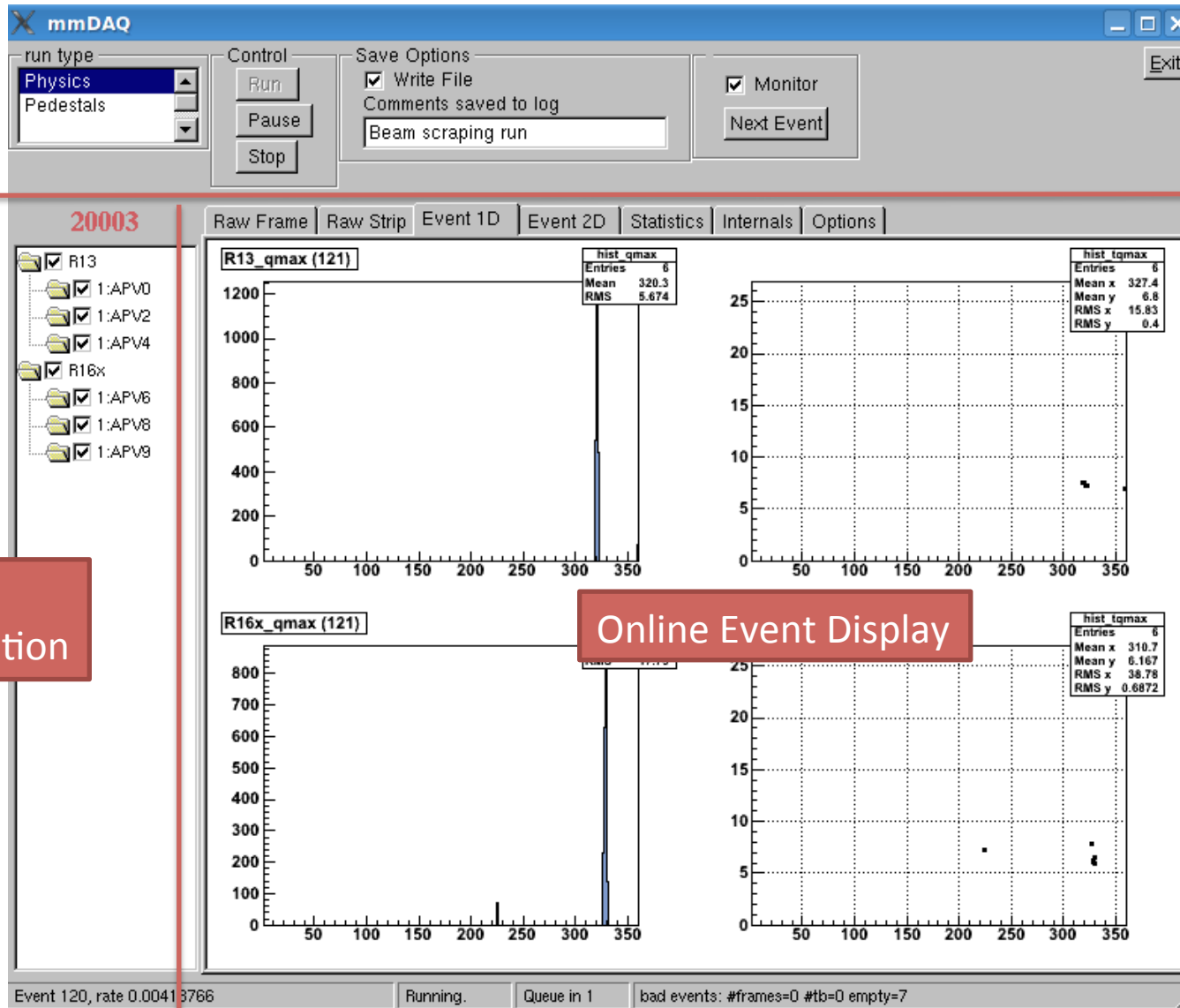
Usage

- Online monitoring User Interface
- Data format (ROOT ntuples)
- Log File

User Interface

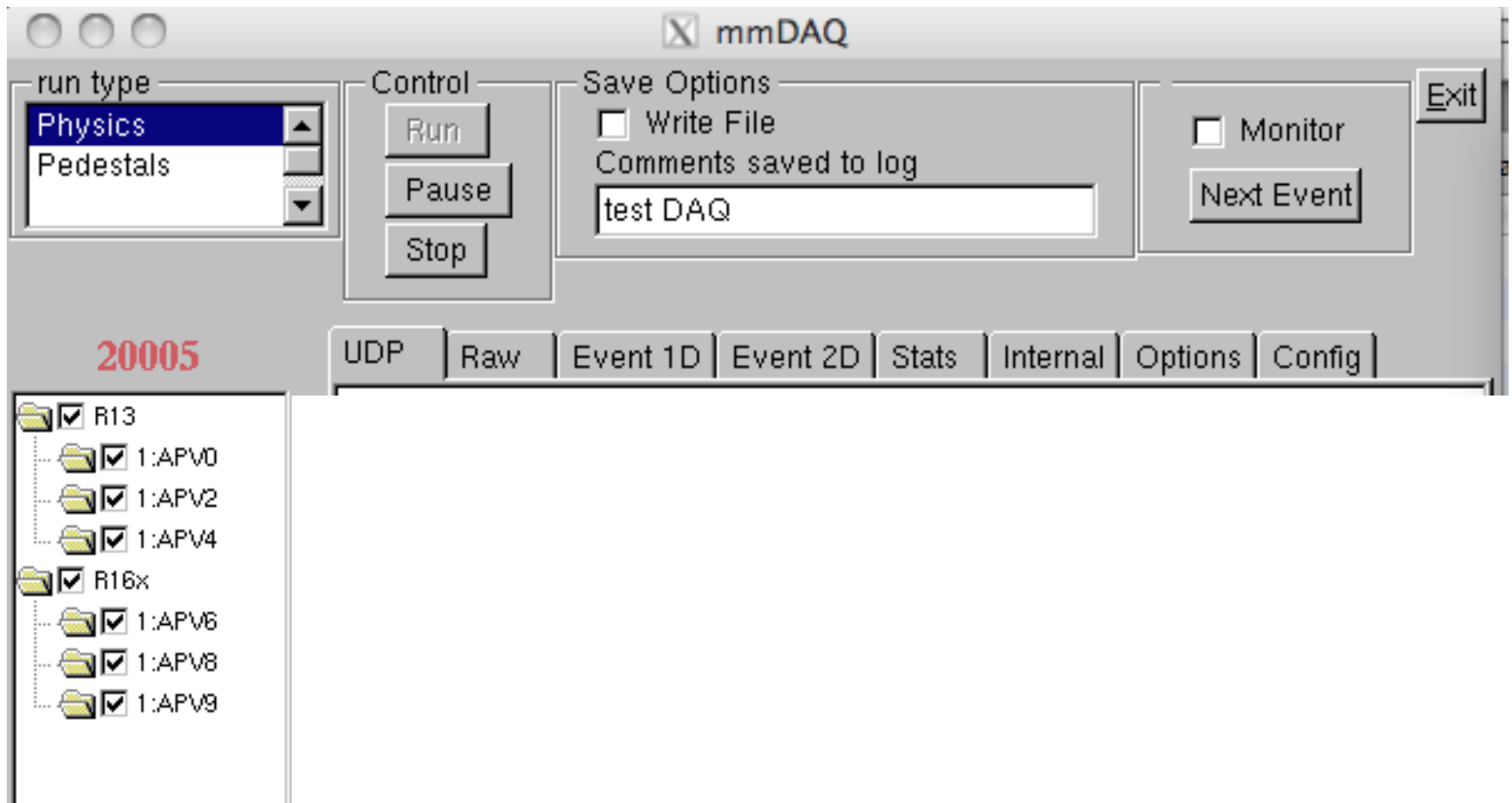
Run Control

Current Configuration



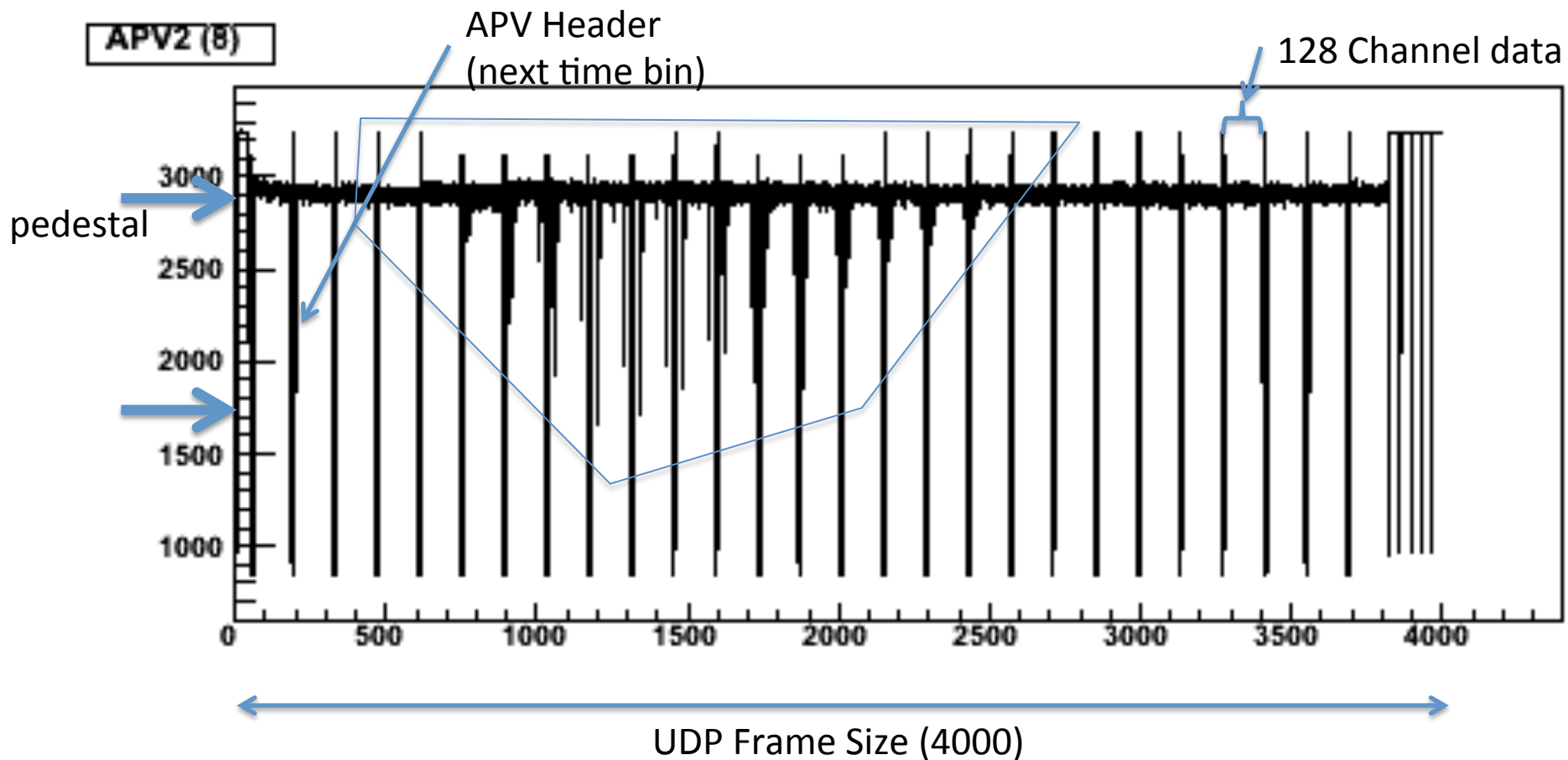
Online Event Display

User Interface - Run Control

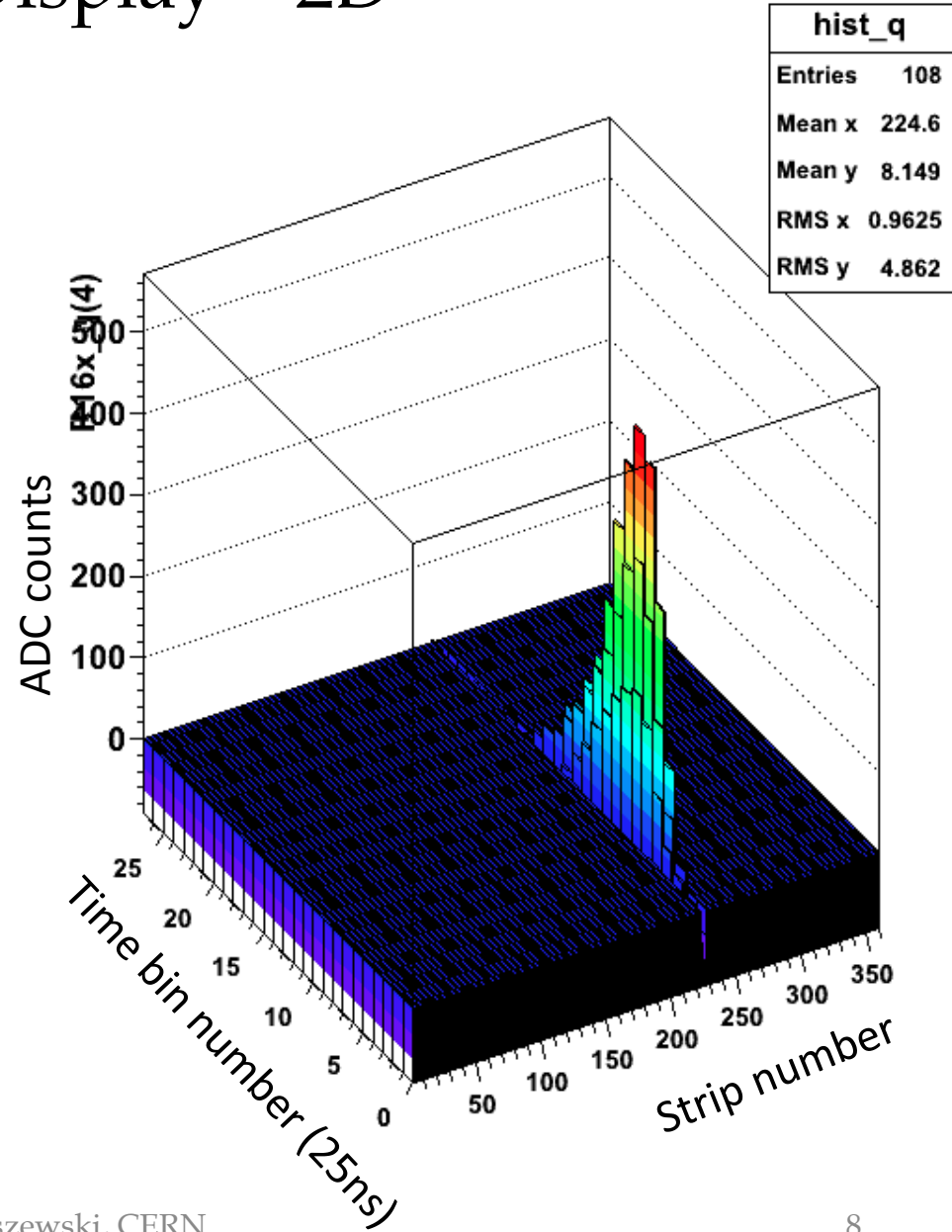
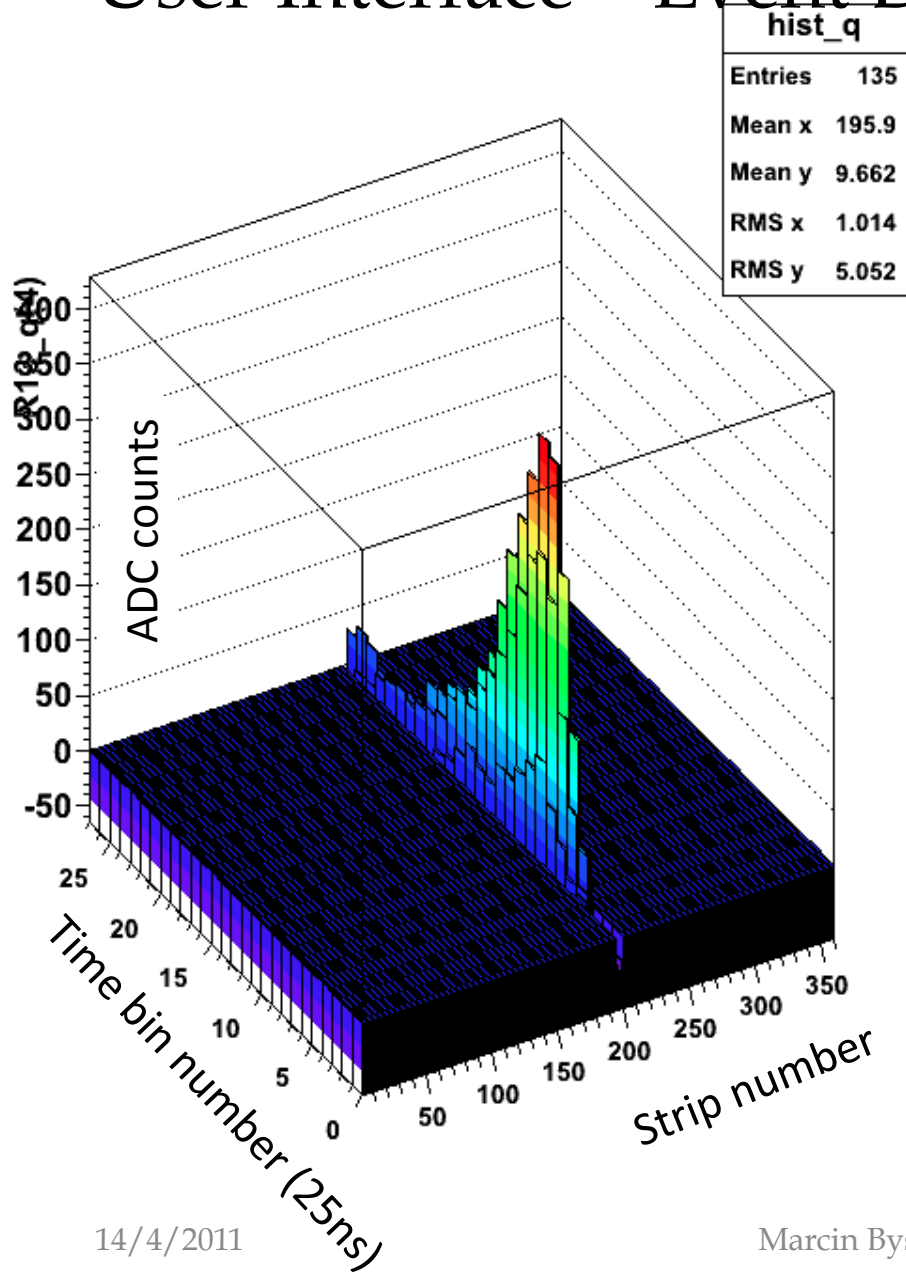


Current Configuration

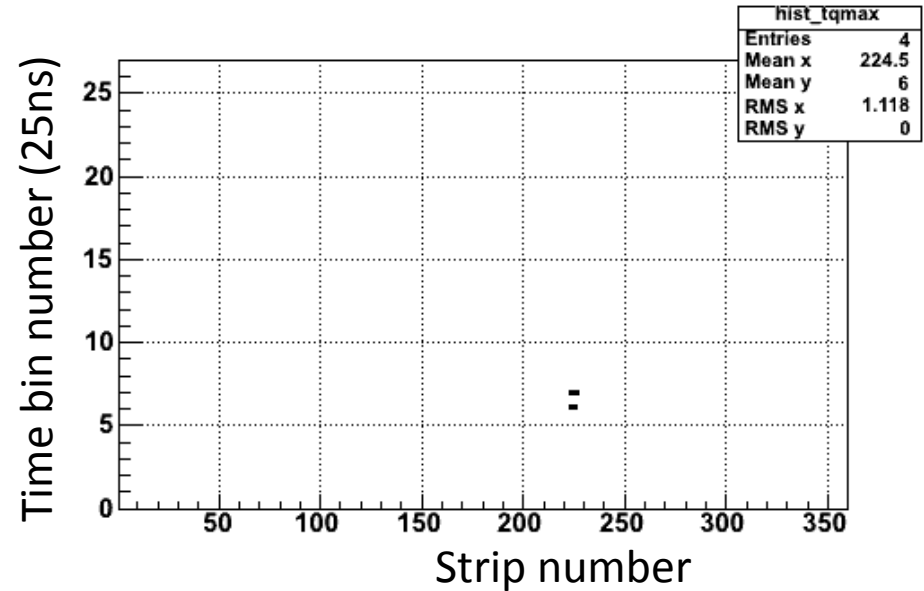
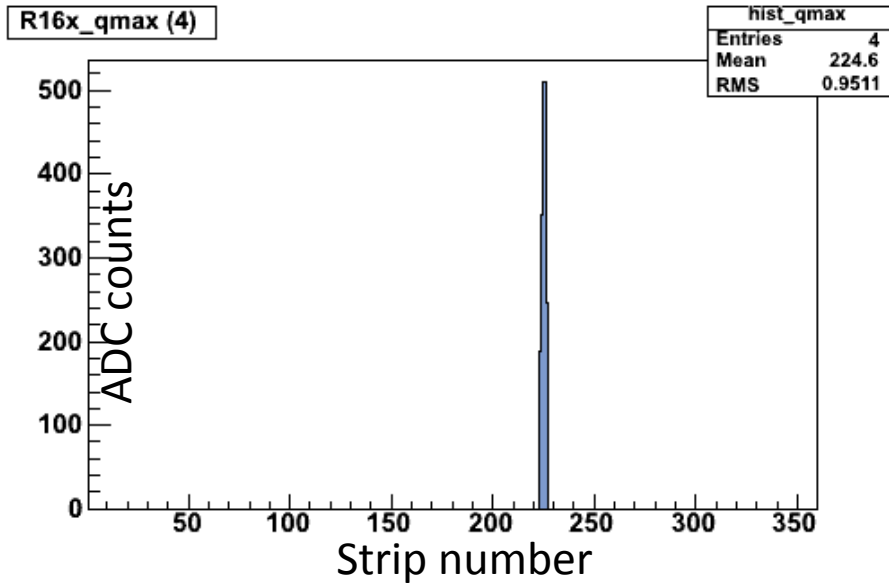
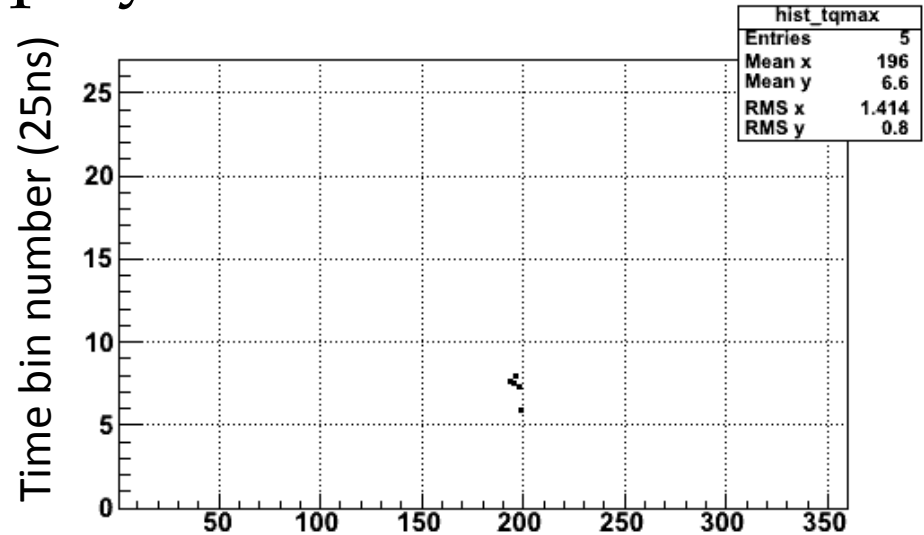
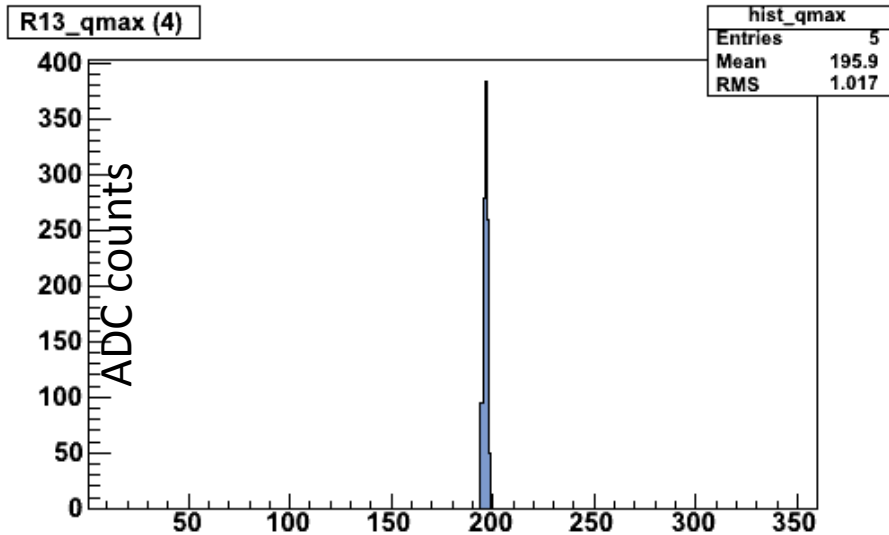
User Interface - Event Display - Raw UDP



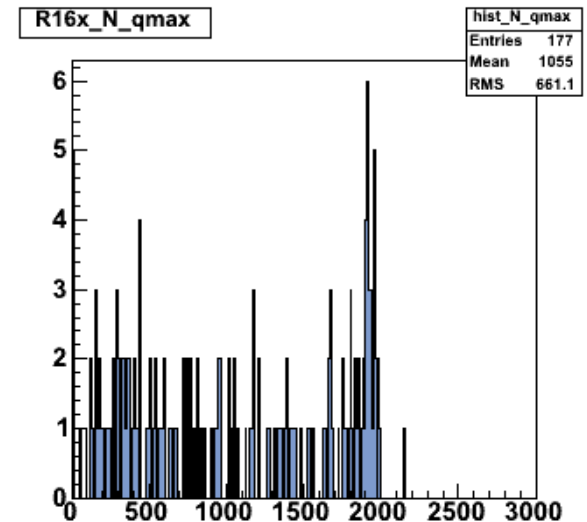
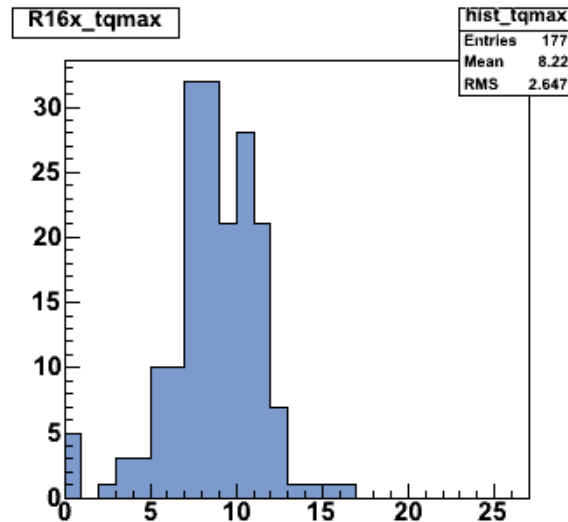
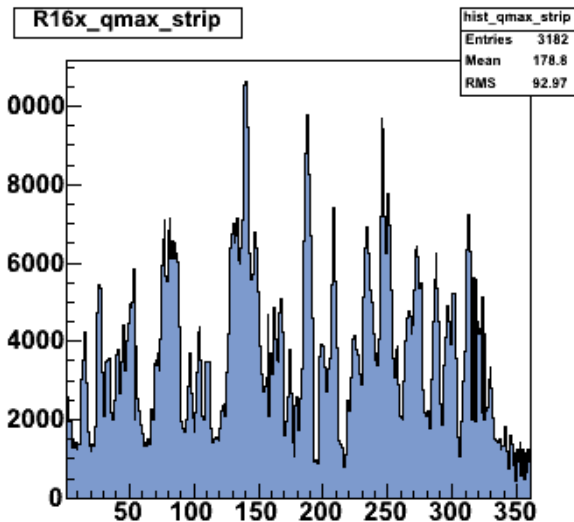
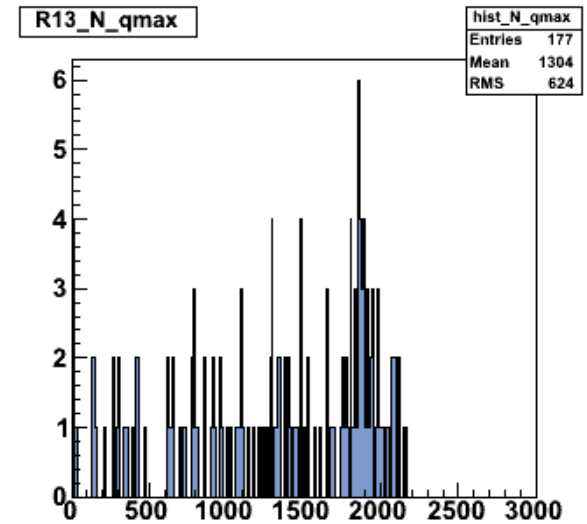
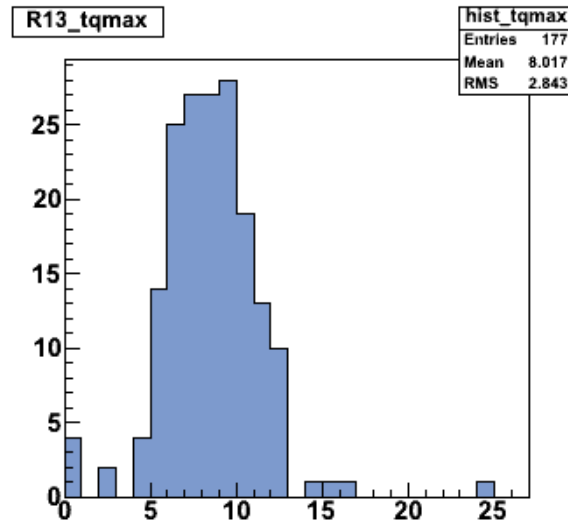
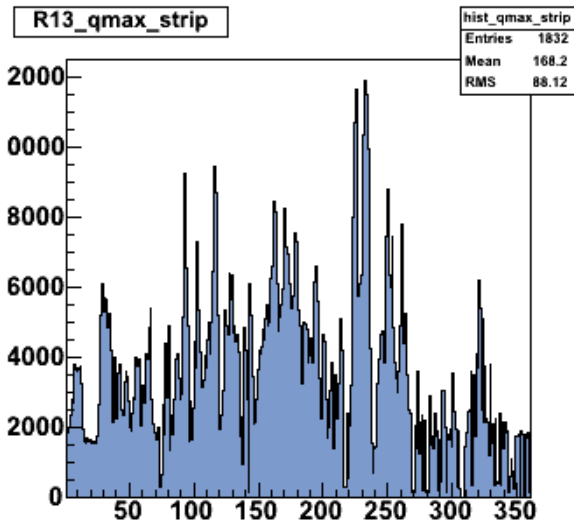
User Interface - Event Display - 2D



User Interface - Data Display - 1D



User Interface – Event Display – Run Statistics



Data Format – Pedestals Run

- Dedicated **Pedestal Run**
- Each event – 2 values/ch:
 - $\text{Mean}_{\text{Evt}}(\text{time bins})$
 - $\text{StdDev}_{\text{Evt}}(\text{time bins})$
- End Of Run – per Event
 - $\text{Mean}_{\text{Run}}(\text{Mean}_{\text{Evt}})$
 - $\text{Mean}_{\text{Run}}(\text{StdDev}_{\text{Evt}})$
 - $\text{StdDev}_{\text{Run}}(\text{Mean}_{\text{Evt}})$
- Saved in *pedestals* tree
- For *physics* runs – source file has to be specified

Data format – ROOT file

- ROOT files with TTrees
 - ‘pedestals’ - *physics & pedestal* run
 - ‘raw’ - *physics* run – measured values
 - ‘data’ - *physics* run – derived quantities (qmax, tqmax)
 - ‘run_info’ - *physics* run – run parameters
- Channel/Strip addressing:
 - Fec#, Chip#, Channel# - unique **chip channel** id
 - Mm_strip#, Chamber# - unique **chamber strip** id
- *Physics*
 - One TTree entry per event
 - Each hot strip has a vector <UInt16_t> of measured q_{tb}

Data Format – ROOT file

raw->Show(1)

=====> EVENT:1

apv_evt = 2
time_s = 1302008343
time_um = 294205
apv_presamples = 168

apv_fecNo = (vector<unsigned int>*)
apv_id = (vector<unsigned int>*)
apv_ch = (vector<unsigned int>*)
mm_id = (vector<string>*)
mm_strip = (vector<unsigned int>*)

apv_q = (vector<vector<short> >*)

run_info->Show(0)

=====> EVENT:0

comment = test DAQ comment
zero_factor = 10

pedestals->Show(0)

=====> EVENT:0

apv_evt = 0
time_s = 0
time_um = 0

apv_fecNo = (vector<unsigned int>*)
apv_id = (vector<unsigned int>*)
apv_ch = (vector<unsigned int>*)
mm_id = (vector<string>*)
mm_strip = (vector<unsigned int>*)

apv_pedmean = (vector<float>*)
apv_pedsigma = (vector<float>*)
apv_pedstd = (vector<float>*)

data->Show(1)

=====> EVENT:1

apv_qmax = (vector<short>*)
apv_tbqmax = (vector<short>*)

Log File

Text log file format

Run number, date, time, number of events, comments

"10452", "30-Mar-2011", "15:55 ", "1164", "pedestals", "test DAQ"

"10453", "30-Mar-2011", "15:56 ", "126340", "physics", "test DAQ"

"10454", "30-Mar-2011", "16:07 ", "143", "physics", "test DAQ"

Internal structure of the program

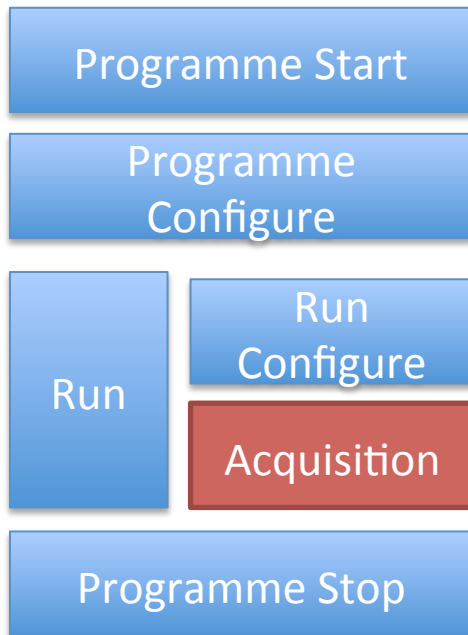
TECHNICALITIES

Technicalities

- Basics
- Data Flow
- Event Building
- Publishing (Online monitoring)

Technicalities – General Overview

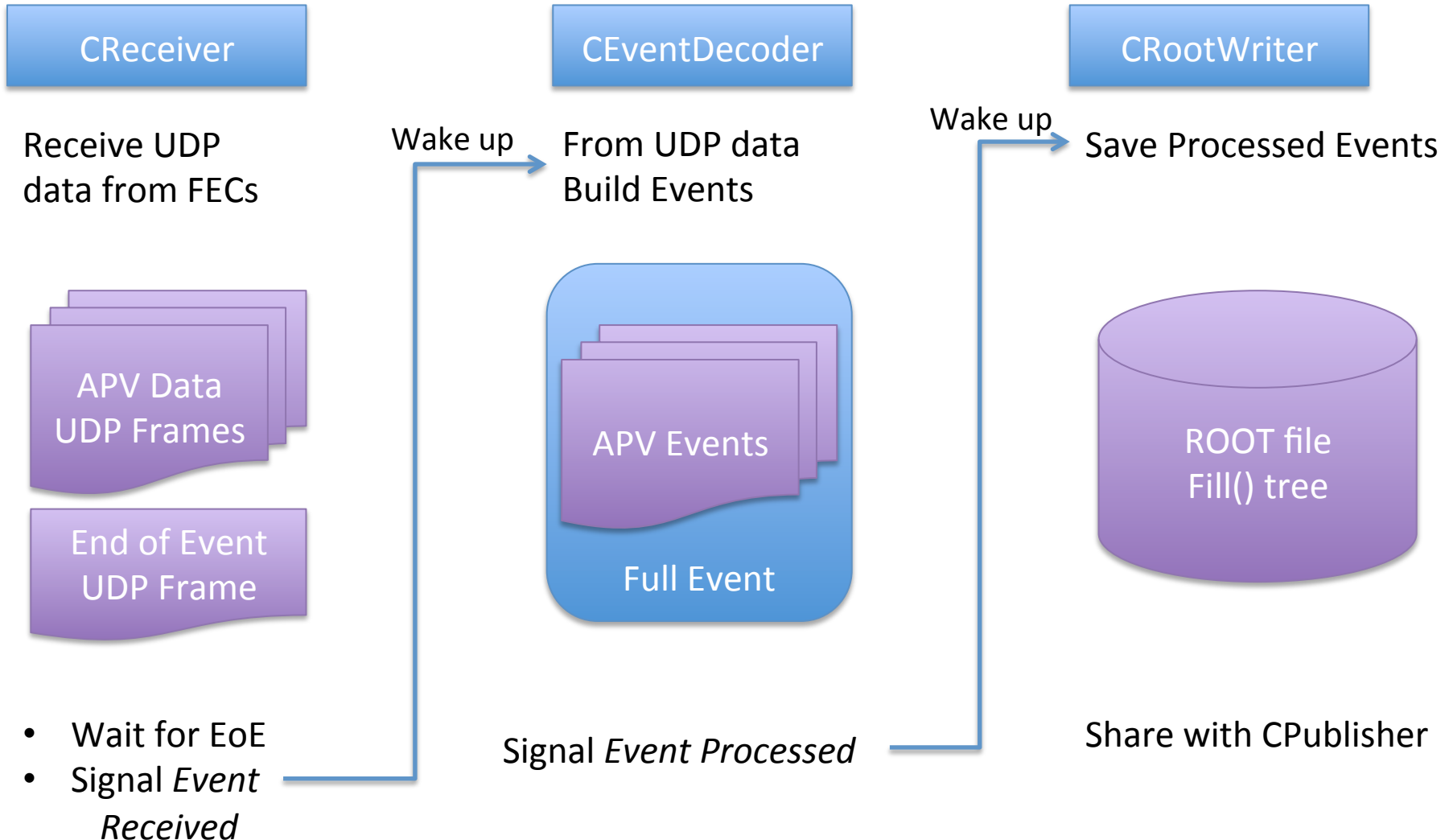
- C++
- POSIX Threads
(encapsulated in CThread)
- ROOT: GUI, TThread, file
- Classes in the programme:
 - CMMDaq
 - CConfiguration
 - CPublisher (T)
 - CGui



- On Start of Run – 4 Treads start
 - CReceiver
 - CEventDecoder
 - CRootWriter
 - CLogger
- On End Of Run
 - These 4 are deleted

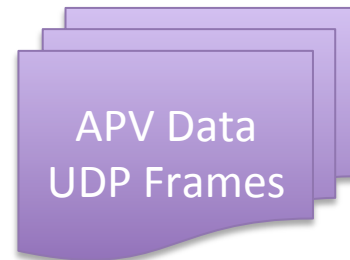
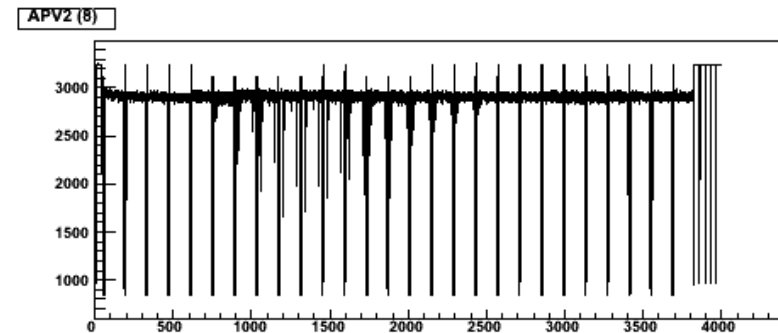
Technicalities – Data Flow

These classes have internal queues



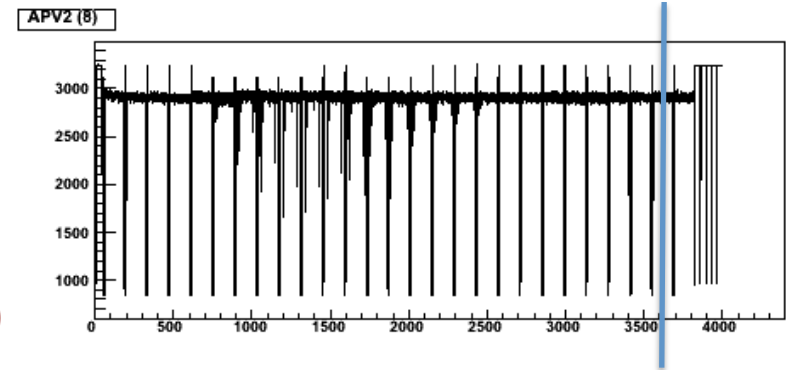
Technicalities – Event Building – APV Event

- Discard UDP data if # of UDP frames not equals # of declared chips
- From each UDP frame make an APV Event.
 - FEC# from IP declaration (←config file)
 - APVID# from frame data
 - Search for APV headers
(common error: bad hardware initialization -> no data !)
 - Get data for all APV channels (0-127)



Technicalities – Event Building – APV Event

- For *Physics* Events:
 - Remove unmapped channels (←map file)
 - Subtract pedestals (*mean* in *pedestals*)
 - Remove dark channels (sum of $q > \text{cut_user} * \text{pedestals_stddev}$)
 - Correct cross-talk
 - Remove dark channels
- Mark event as bad if
 - Bad number of time bins (<1 or >30)
 - Data truncated (UDP frame too small)
 - Bad APV ID (FEC or Chip number)

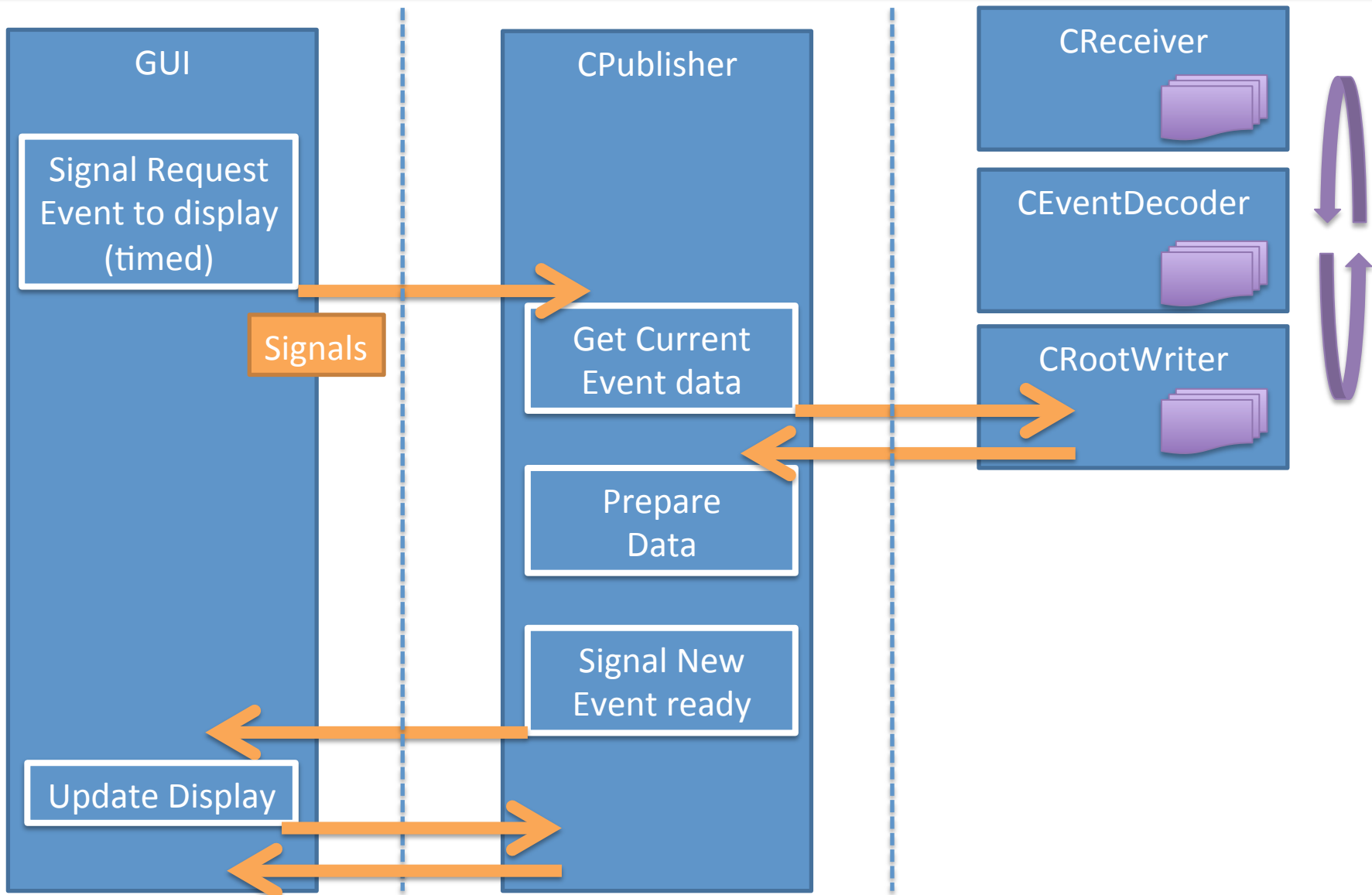


Technicalities – Event Building – Full Event

- For full events (collection of APV events)
- Discard as bad event if:
 - # of APV events not equals # of chips (Channel selection, network)
 - # of time bins not constant between APV events
 - All APV events empty
 - At least one APV event bad
- Collect all CAPVEvents into a full event CMMEEvent



Technicalities - Publishing



Usage – Configuration files

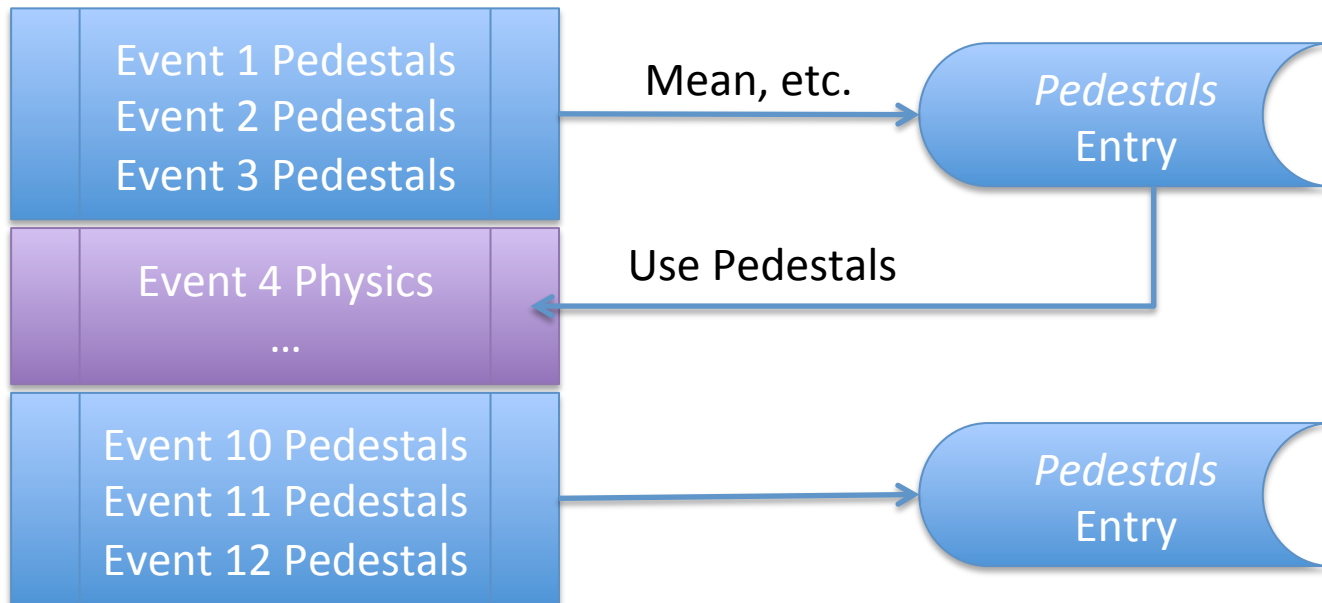
- Most of the files are Required
- Work in progress – currently **2 old versions** of configuration files coexist, both are used
 - repeated information (must be consistent).
- Misconfiguration may result in for example in
 - No data being saved to file
 - Reason: Channels not mapped, different chamber names
- See Reference Slides at the end for examples, with comments.
- **New GUI configuration tool in development**

Usage III – Pedestals in Physics Runs

- For **Physics runs** Pedestal data is copied into ROOT files' *pedestals* tree.
- When specified:
 - Pedestal subtraction
 - Identification of live channels
 - Zero suppression
 - Cross-talk correction

Usage IV – Pedestals in Physics Runs - **Plans**

- Plans to implement **base line correction** / pedestal identification during a physics run
- Option exists for automatic periodic pedestal events
 - Implemented in the code
 - Needs DCS interface (internal/ external trigger)
- **So, neither available yet**



Things to Do - Other plans

- Detach User Interface
 - Stability (2 existing problems are UI related)
 - Internal simplicity (single ROOT thread),
 - User benefit - connection over network to the DAQ
 - How? Use Inter Process Communication
- Communicate with DCS
 - Use IPC
 - Code DCS commands
 - Execute shell scripts
- Global run book (external DB)

Summary

- C++ multithreaded DAQ for micromegas using SRS
 - Zero suppression
 - ROOT ntuples
 - Online monitoring

 - Light, fast, designed to be scalable
 - Runs on any (reasonable) Linux PC (32/64bit)

Summary

- C++ multithreaded DAQ for micromegas using SRS
 - Zero suppression
 - ROOT ntuples
 - Online monitoring

 - Light, fast, designed to be scalable
 - Runs on any (reasonable) Linux PC (32/64bit)

Thank you

Backup Slides

Usage – Prerequisites & Compilation

- SLC 5
- gcc/g++ 4.4 (or 4.2)
- ROOT 2.28.00b
 - (last svn, with thread support enabled – default for Linux)
- Hardware SRS requirements
 - gigabit Ethernet with jumbo frames

Compilation (uses Makefile): `$> make`

Default paths :

`/sw/mmdaq/mmdaq` – executable

`/sw/mmdaq/config/` - configuration directory

Configuration Files I – the `--config:` switch

Command line parameter

`--config:/path/filename`

selects configuration file

```
./mmdaq --config:/sw/mmdaq/config/ATLAS.config
```

Configuration Files II – the main config file

```
# mmdaq configuration for ATLAS test
# Chambers R13, R16x; 6 APV25 chips all master
# last modified: M.Byszewski 28/03/2011 13:05
# comment lines starting with # are ignored

#####mmdaq.FECs: FEC1
# network parameters of the DAQ
#####mmdaq.FEC1.Chips: APV0, APV2, APV4, APV6, APV8, APV10
#####mmdaq.FEC1.IPAddress: 10.0.0.2

mmdaq.DAQIPAddress: 10.0.0.3
mmdaq.DAQIPPort: 6006

#####mmdaq.FEC1.Chips.APV0.Id: 0
#####mmdaq.FEC1.Chips.APV2.Id: 2
#####mmdaq.FEC1.Chips.APV4.Id: 4
#####mmdaq.FEC1.Chips.APV6.Id: 6
#####mmdaq.FEC1.Chips.APV8.Id: 8
#####mmdaq.FEC1.Chips.APV10.Id: 10

# following translate name eg. APV0 to id number 0
mmdaq.FEC1.Chips.APV0.Id: 0
mmdaq.FEC1.Chips.APV2.Id: 2
mmdaq.FEC1.Chips.APV4.Id: 4
mmdaq.FEC1.Chips.APV6.Id: 6
mmdaq.FEC1.Chips.APV8.Id: 8
mmdaq.FEC1.Chips.APV10.Id: 10

# each run numer, comments time, is saved to this file:
mmdaq.LogFile: /data/mmega2011/apv_data/mmdaq.log

# mapping between APV channels and Chamber strips:
mmdaq.ChannelMapFile: /sw/mmdaq/config/ATLAS_R13_R16.map

# crosstalk suppression identical for all APV chips
mmdaq.CrosstalkCorrectionFile: /sw/mmdaq/config/crosstalk.map

# default path to pedestal file, will be obsolete soon
mmdaq.PathToPedestalFile: /data/mmega2011/apv_data/root/
# data is saved to this directory:
mmdaq.WriteDataPath: /data/mmega2011/apv_data/root/

# factor for zero suppression – default start value
mmdaq.ZeroTresholdFactor: 20.0

# keep PedestalEventsPerSave = 0 for compatibility,
# will be used for automatic pedestal measurements
mmdaq.PedestalEventsPerSave: 0

#####
# FEC IP address, connection to APV Chips, and their id numbers (0-15)
#####
# define FECs and CHIPS connected to the FECs
#####
# CHAMBERS, list of names, their connection to APV chips
#####
#define chambers in the configuration
mmdaq.Chambers: R13, R16x

mmdaq.Chamber.R13.Strips: X
#Strips.AdapterType unused yet
mmdaq.Chamber.R13.Strips.AdapterType: 3to5
# list of connected chips to this chamber
mmdaq.Chamber.R13.Strips.X.Chips: APV0, APV2, APV4

mmdaq.Chamber.R16x.Strips: X
mmdaq.Chamber.R16x.Strips.AdapterType: 3to5
mmdaq.Chamber.R16x.Strips.X.Chips: APV6, APV8, APV10
```


Configuration Files III – the map file

```
# comments are ignored
# but the 2 lines with the APVid: and Chamber: keywords are obligatory
# they list APVid used in this configuration and the corresponding Chamber
# then follow 128 lines in format: apv_channel followed by strip_no for each declared APV
# bad/not connected channels marked -1 will be ignored
```

```
APVid: 0 2 4 6 8 10
```

```
Chamber: R13 R13 R13 R16x R16x R16x
```

```
0 -1 280 80 -1 280 80
```

```
1 -1 279 79 -1 279 79
```

```
2 -1 278 78 -1 278 78
```

```
3 -1 277 77 -1 277 77
```

```
4 -1 276 76 -1 276 76
```

```
5 -1 275 75 -1 275 75
```

```
6 -1 274 74 -1 274 74
```

```
7 -1 273 73 -1 273 73
```

```
8 -1 272 144 -1 272 144
```

```
9 -1 271 143 -1 271 143
```

```
10 -1 270 142 -1 270 142
```

```
11 -1 269 141 -1 269 141
```

```
12 324 268 140 324 268 140
```

```
...
```