Simulations for CalCom

Introduction to GEMC
Rates, Scalers studies
Possible studies for different experiments/configurations/fields
Trigger Studies

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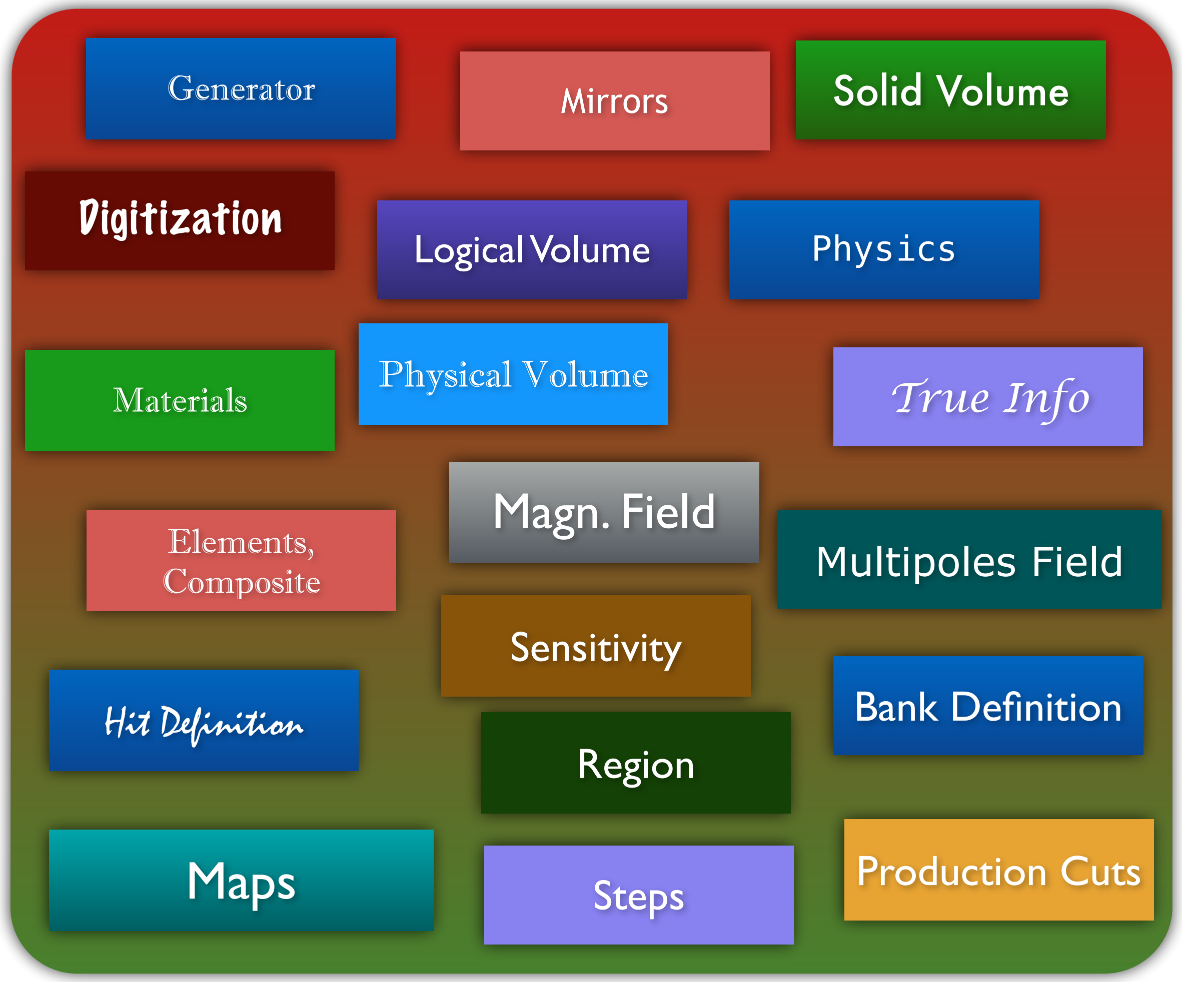
CLAS12 CWB Review
January 15, 2015

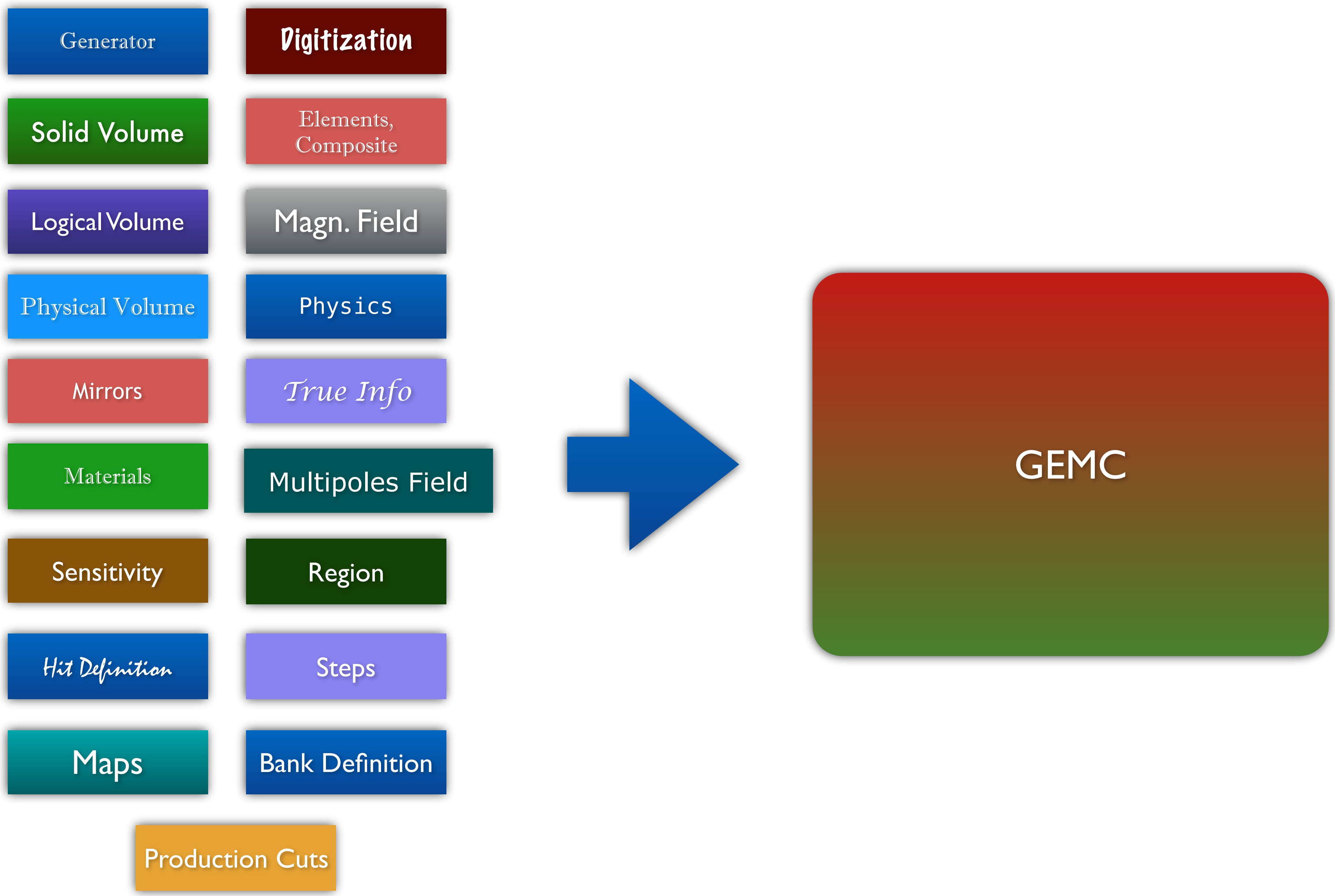
What is GEMC

Typical Geant4 simulation



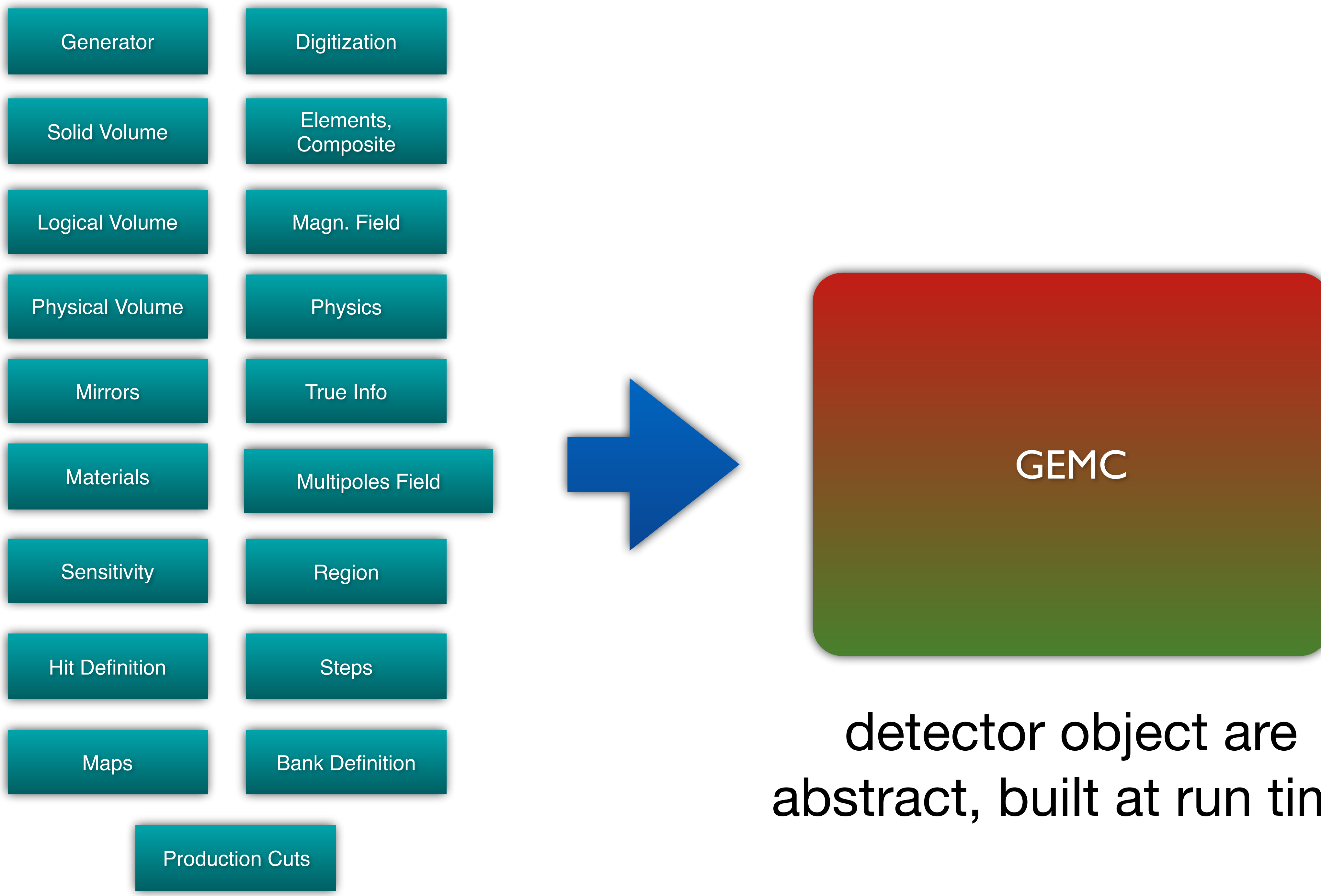
What is GEMC

GEMC: all parameters are external



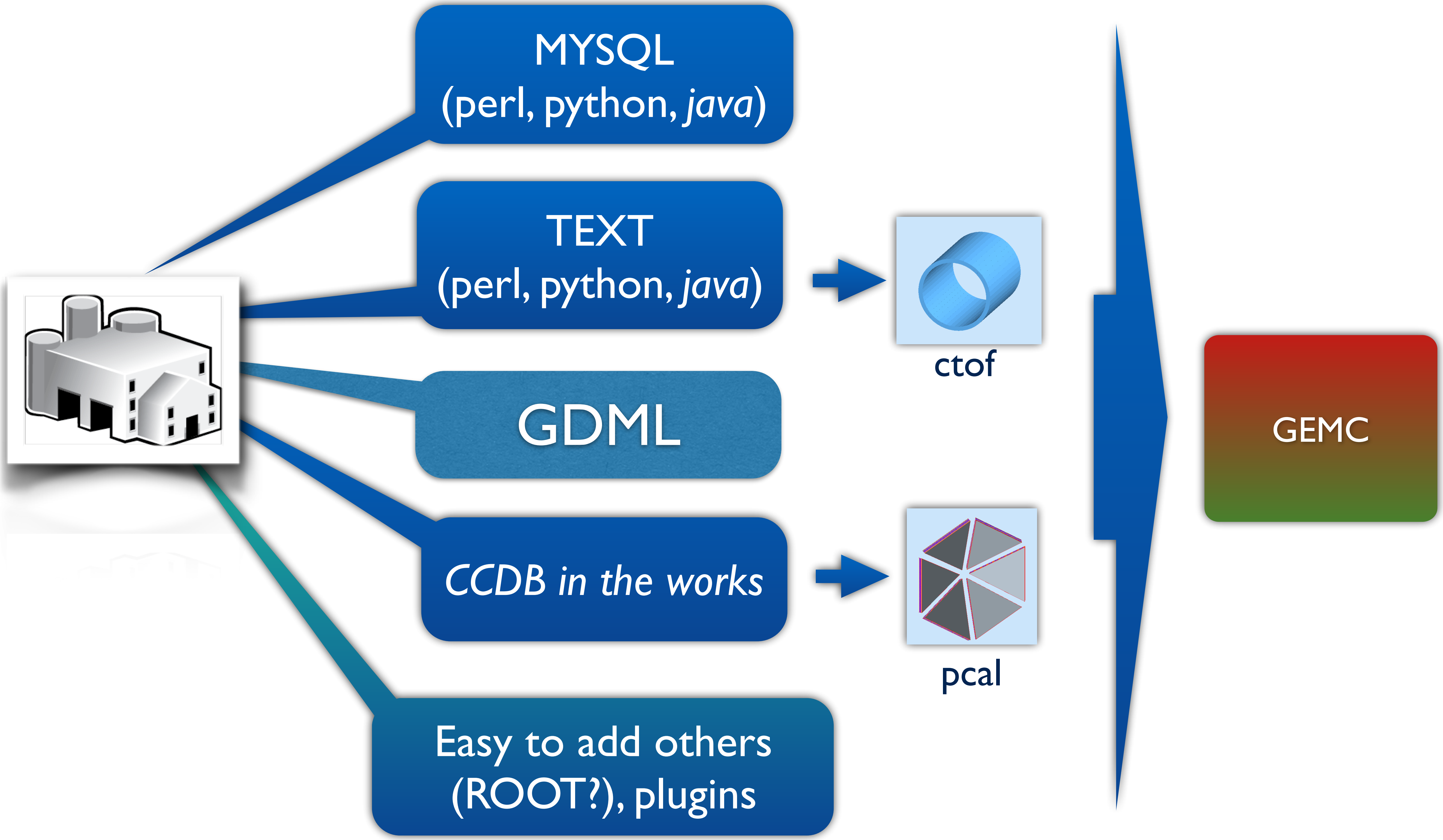
What is GEMC

GEMC: all parameters are external, formalized



detector object are abstract, built at run time

GEMC Factories



MYSQL, TEXT, CCDB: run number, variation, id, date

Generators

Internal: up to 3 particles
One primary two "beam"
(will change to arbitrary number)

Lund Format (text)

SLAC Formats
(StdHep, lXDR)

General text format in the works

GEMC

Easy to add others,
plugins

Beam on Target

- Number of electrons / event: 10^{35} luminosity is 130K e- / event in 250s window

- Can be bunched (i.e. 2 ns bunch for CLAS12)

- Vertex smeared, rastered

Output, bank structure

Same output as data calibration/commissioning

```
> BST  100, 0

 > True Step by Step infos   (101, 0)
    - Edep                   (101, 1)
    - Pid                    (101, 2)
    - positions              (101, 3)

 > Dgtz Step by Step infos   (102, 0)
    - ADCL                   (102, 1)
    - ADCR                   (102, 2)

 > True Integrated infos     (103, 0)
    - Edep                   (103, 1)
    - Pid                    (103, 2)
    - positions              (103, 3)

 > Dgtz Integrated infos     (104, 0)
    - ADCL                   (104, 1)
    - ADCR                   (104, 2)

 > Voltage as a function of time (105, 0)
    - Identifier                 (105, 1)
    - Time                       (105, 2)
    - Voltage                    (105, 3)

> Trigger Bank               (106, 0)
    - Identifier             (106, 1)
    - Time                   (106, 2)
    - Voltage                (106, 3)
```

Automatic

```
 pid",     "Ri", "ID of the first particle entering the sensitive volume");
"mpid",    "Ri", "ID of the mother of the first particle entering the sensitive volume");
"tid",     "Ri", "Track ID of the first particle entering the sensitive volume");
"mtid",    "Ri", "Track ID of the mother of the first particle entering the sensitive volume");
"otid",    "Ri", "Track ID of the original track that generated the first particle entering the sensitive volume");
"trackE",  "Rd", "Energy of the track");
"totEdep", "Rd", "Total Energy Deposited");
"avg_x",   "Rd", "Average X position in global reference system");
"avg_y",   "Rd", "Average Y position in global reference system");
"avg_z",   "Rd", "Average Z position in global reference system");
"avg_lx",  "Rd", "Average X position in local reference system");
"avg_ly",  "Rd", "Average Y position in local reference system");
"avg_lz",  "Rd", "Average Z position in local reference system");
"px",      "Rd", "x component of momentum of the particle entering the sensitive volume");
"py",      "Rd", "y component of momentum of the particle entering the sensitive volume");
"pz",      "Rd", "z component of momentum of the particle entering the sensitive volume");
“vx",      "Rd", "x component of primary vertex of the particle entering the sensitive volume");
"vy",      "Rd", "y component of primary vertex of the particle entering the sensitive volume");
"vz",      "Rd", "z component of primary vertex of the particle entering the sensitive volume");
"mvx",     "Rd", "x component of primary vertex of the mother of the particle entering the sensitive volume");
"mvy",     "Rd", "y component of primary vertex of the mother of the particle entering the sensitive volume");
"mvz",     "Rd", "z component of primary vertex of the mother of the particle entering the sensitive volume");
"avg_t",   "Rd", "Average time");
"hitn",    "Ri", "Hit Number");
```

Detector Time Window (DTW)

Individual geant4 steps are integrated over DTW

sector
SuperLayer
Layer
wire
LR
Doca
SDoca
time
Stime

user-defined

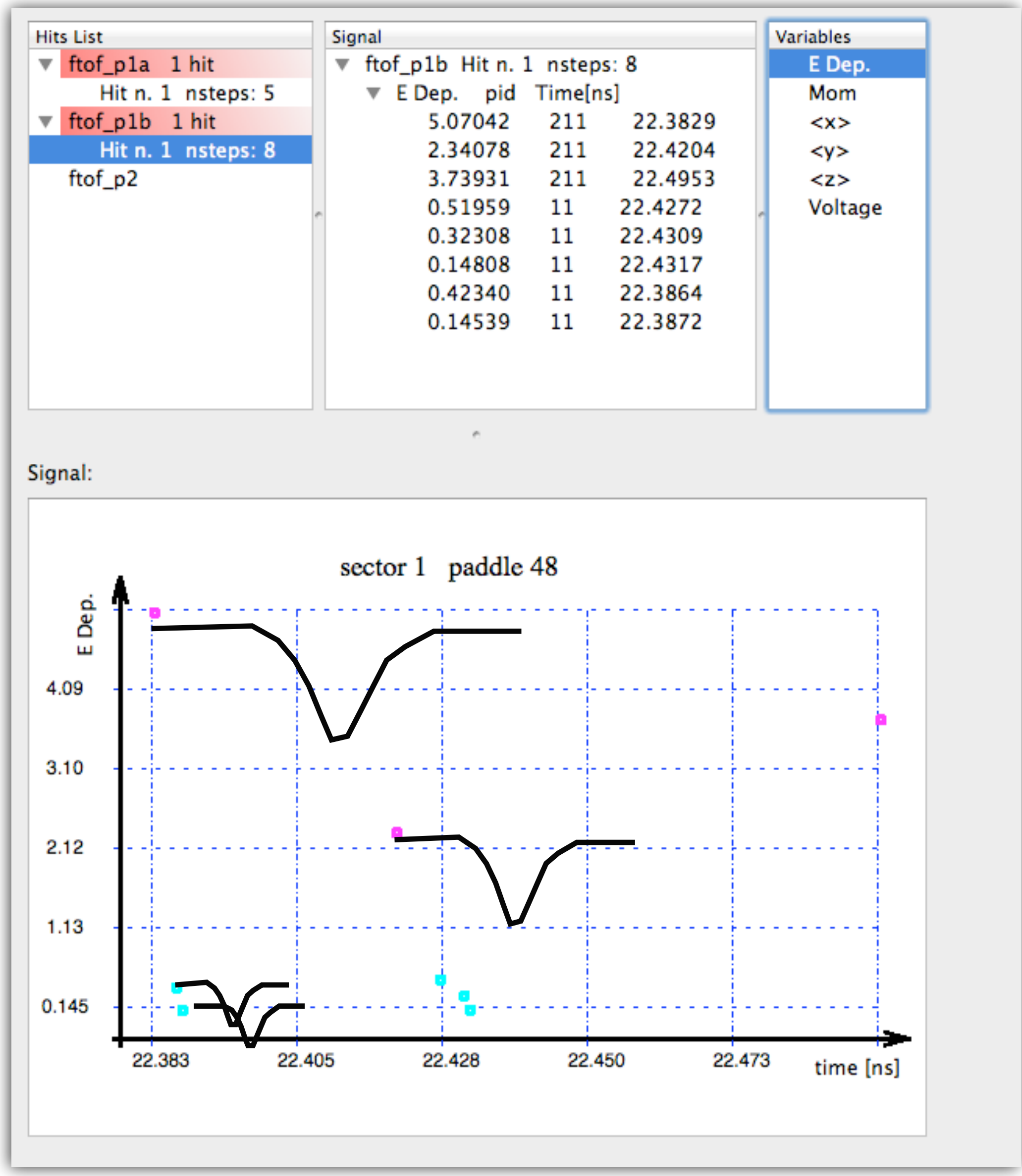
Automatic

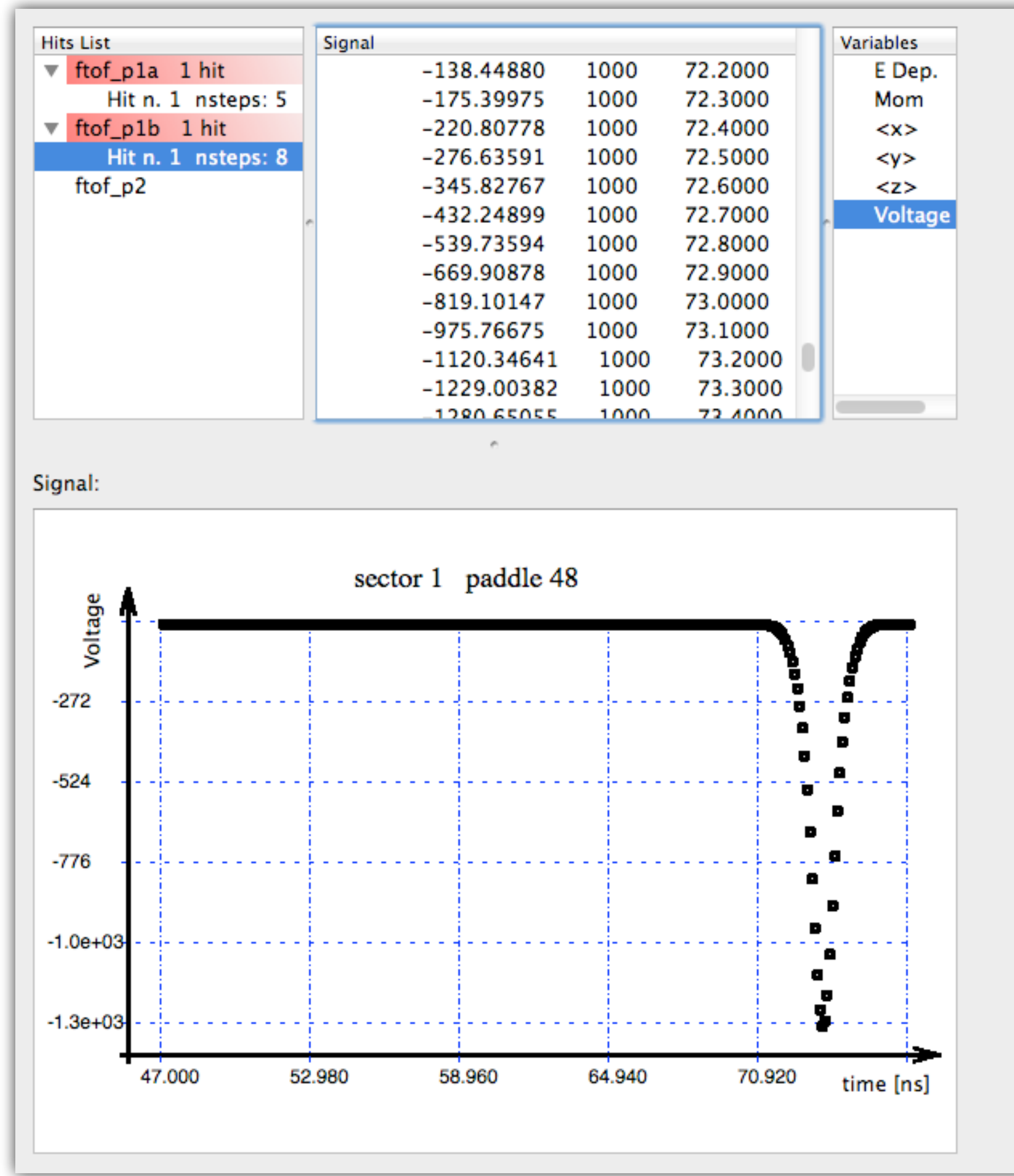
```
> Generated Particles

   - pid
   - p
   - v
   - vector<Det. Summary>
      ‣ EC,   22 hits, 3 GeV
      ‣ DC,   29 hits, 0.6 MeV
      ‣ HTCC, 2 hits, 23 nphe
```

Voltage Signal

Rise time: 1ns
Fall time: 2ns
Delay: 50ns
1 MeV = 100 mV

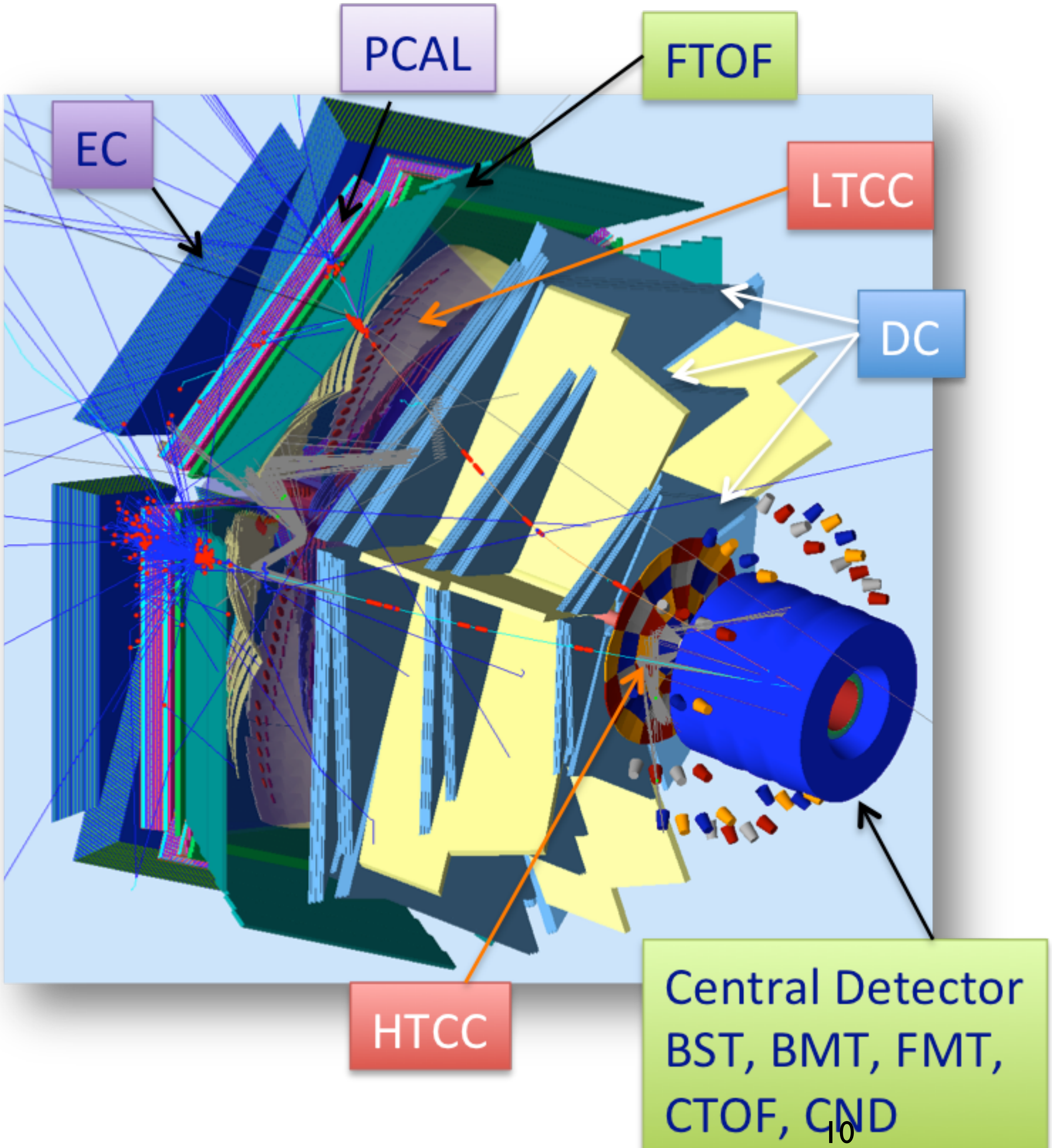
User-defined

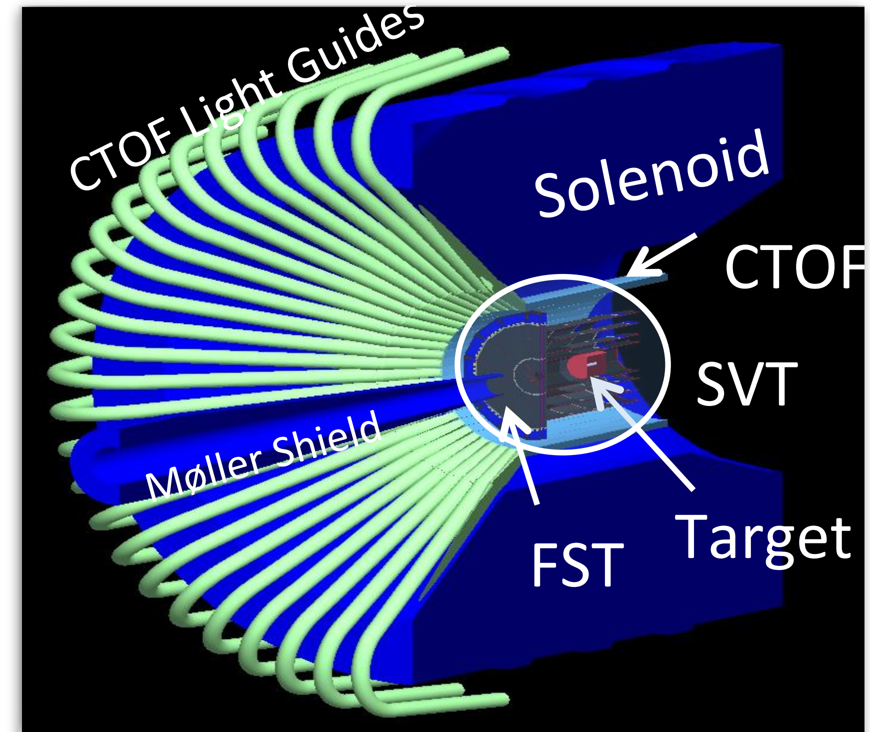


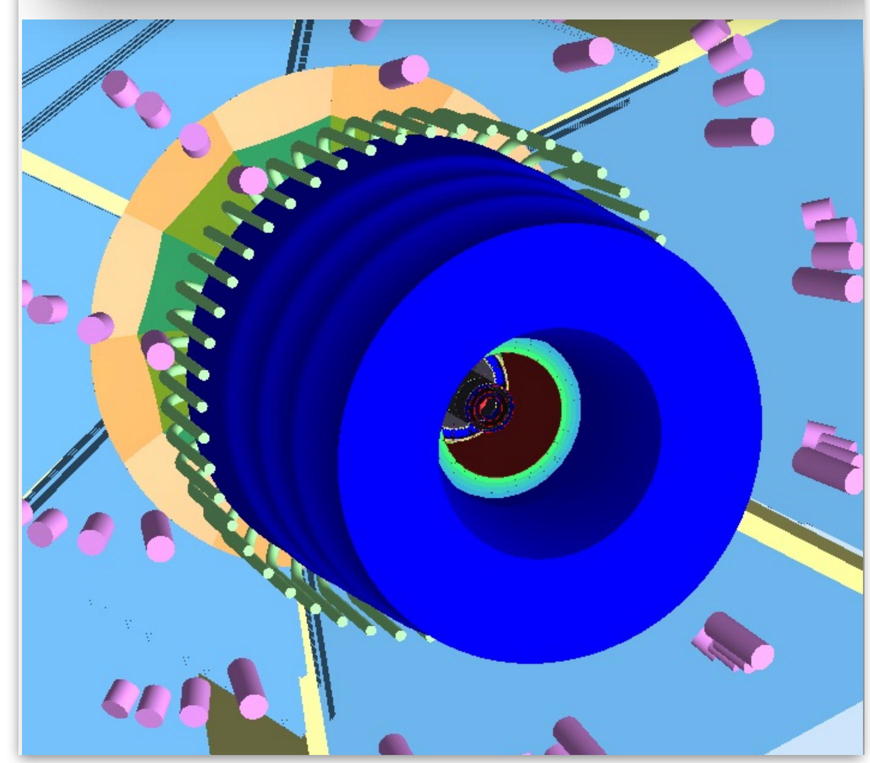


Total Signal is integral of all the step-signals.
Amazingly enough signal processing time is small.

CLAS12 simulations





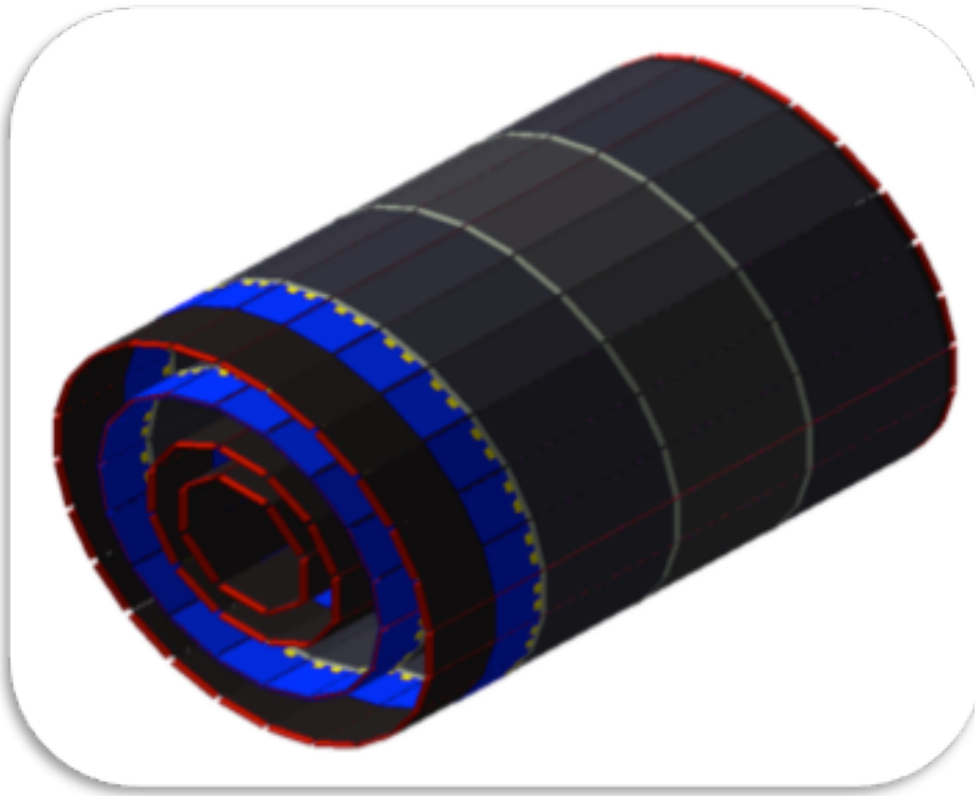


CLAS12 simulations

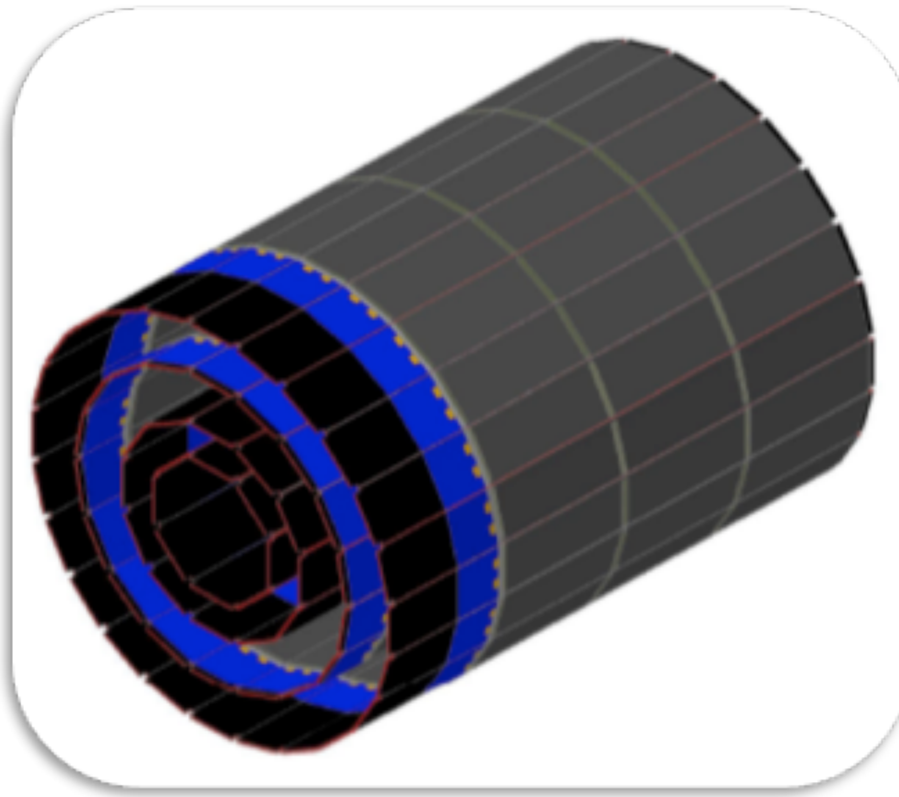
Detector	Sensitivity	Digitization
BST	3/4 regions, 2 layers/region, 3 modules/layer, 256 variable angle strips. Charge sharing. electronic noise.	3 bit ADC, region/layer/strip
Micromegas	3/4 regions, 2 layers/region, 3 tiles/layer, 1000 strips/tile. Charge sharing. Lorentz angle.	12 bit ADC, region/layer/tile/strip
CTOF	58 scintillators, PMT q.e., attenuation length, effective velocity	region/paddle ADC TDC
CND	3/4 layers, 48 scintillators each, PMT q.e., attenuation length, effective velocity, birks effect, paddle resolution	region/layer/paddle ADC TDC
HTCC	12 sectors, 4 layers. Wavelength-dependent PMT q.e., gas and mirror refraction indexes	sector/layer, PMT, nphe
DC	3 region, 2 superlayers/region, 6 layers/SL. DOCA, drift velocity, cell resolution	sector/region/SL/layer/wire, TDC
LTCC	6 sectors, 2 regions, 18 PMT / region. Wavelength-dependent PMT q.e., gas and mirror refraction indexes	sector/region, PMT, nphe
FTOF	6 sectors, 3 panels, 5/23/62 paddles/panel, left right PMT	sector, panel, ADC TDC
PCAL	15 layers, u,v,w views, 24 scintillator/view, attenuation length, effective velocity, PMT gain, nphe/charge	sector/stack/view/PMT ADC TDC
EC	39 layers, u,v,w views, 36 scintillator/view, attenuation length, effective velocity, PMT gain, nphe/charge	sector/stack/view/PMT ADC TDC
RICH	Wavelength-dependent PMT q.e., gas and mirror refraction indexes, multi-channel PMT	PMT, ADC, TDC
FT	Light Yield for PbW04, APD q.e, gain, noise	PMT, ADC, TDC

Background Rates, Scalers - example 1 (SVT)

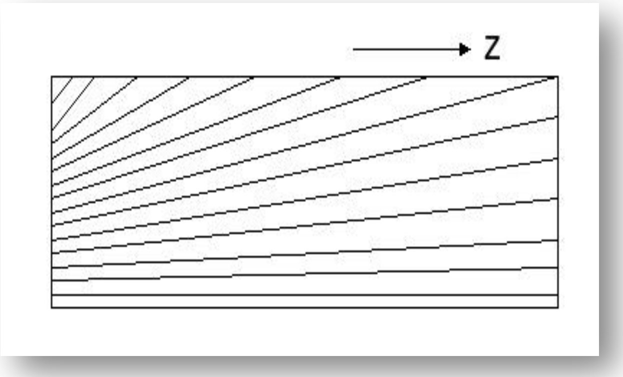
Geant4



Eng. Design



Exaggerated Strips Layout



SVT:

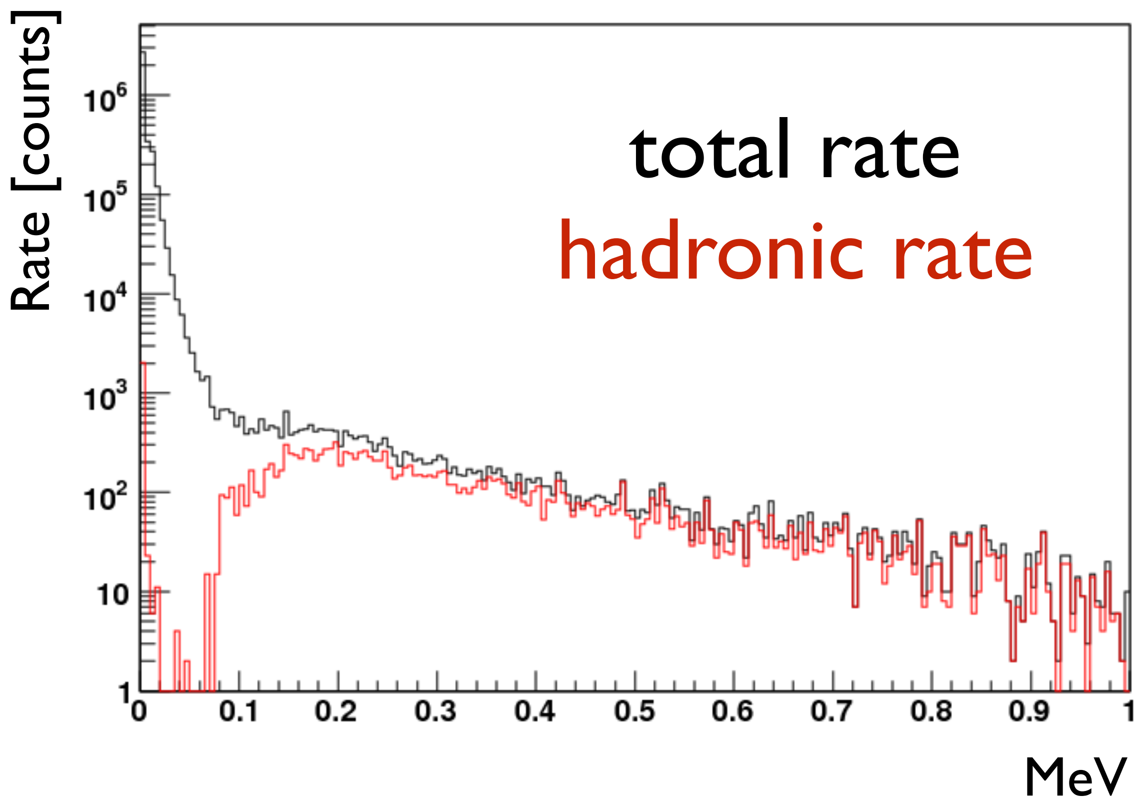
Geometry: complete.

Sensitivity: 3/4 regions, 2 layers/region, 3 modules/layer, 256 variable angle strips. Charge sharing. electronic noise.

Digitization: 3 bit ADC, region/layer/strip

Background Rates, Scalers - example 1 (SVT)

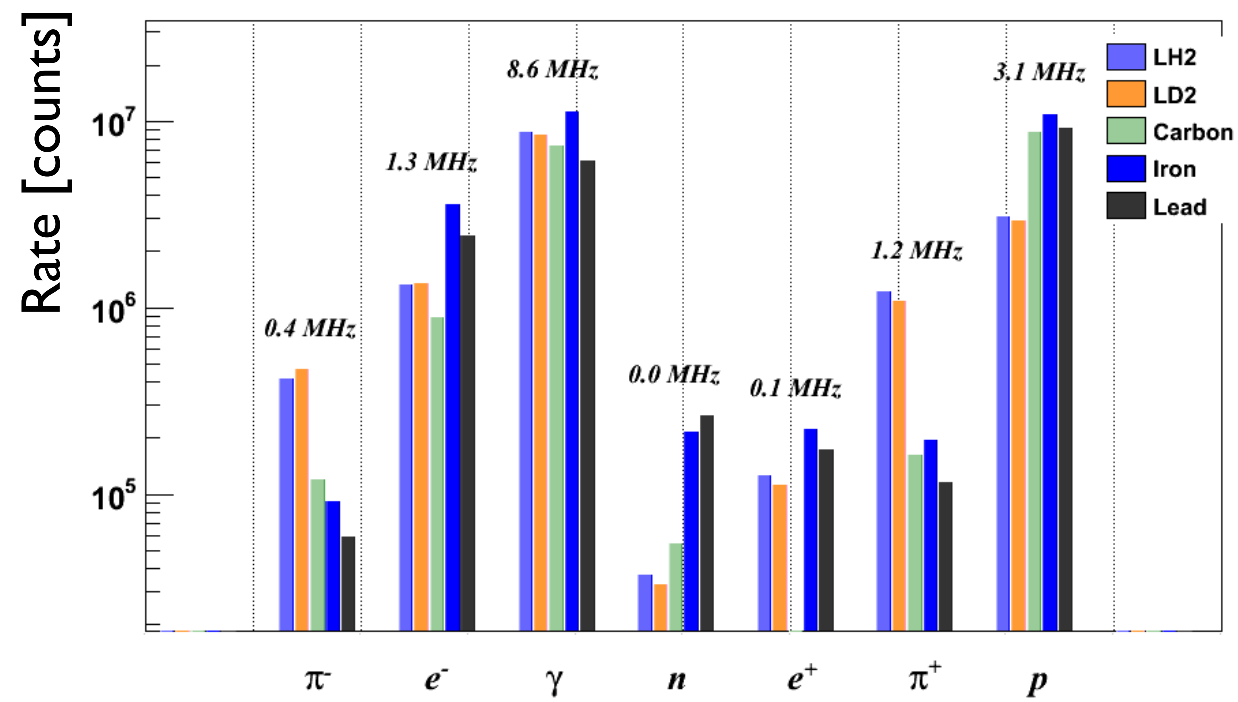
Energy Deposited (Threshold Study)



	EM	Hadronic	Total
1a	57.68	2.588	60.27
1b	43.29	2.124	45.41
2a	50.82	3.685	54.51
2b	41.91	3.162	45.07
3a	44.59	4.813	49.4
3b	38.04	4.354	42.4
4a	32.74	3.383	36.12
4b	28.83	3.862	32.69

Edep > 20 KeV, Rate in MHz

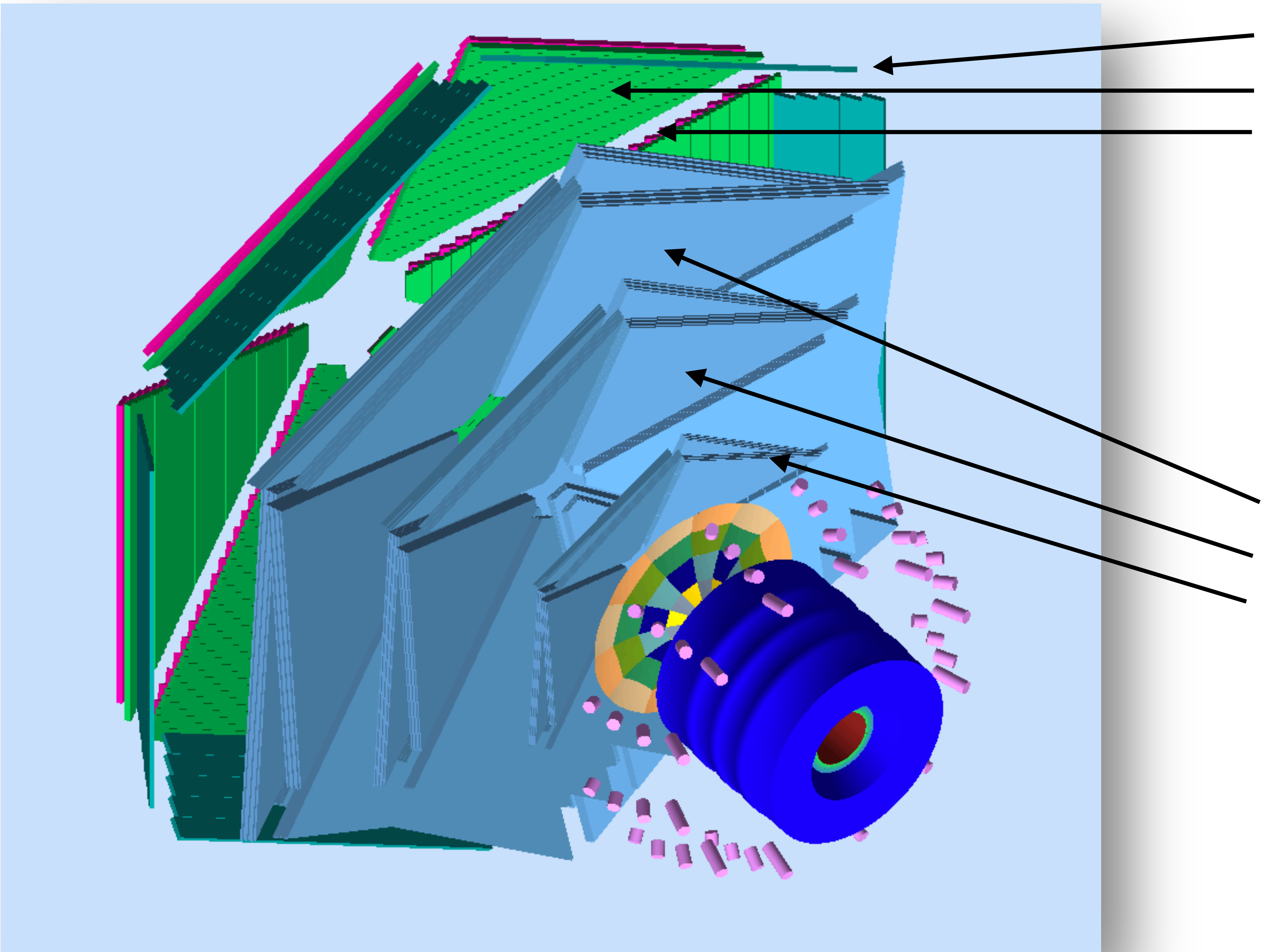
Rates / particles / energy deposited / target



target	GeV/s	GeV/(s cm2)	mrad/s	mrad/(scm2)	rad/year	rad/(year cm2)
lh2	20325	15.054	6.244	0.00462	196939	145
ld2	20332	15.060	6.247	0.00462	197013	145
C	32220	23.865	9.899	0.00733	312193	231
Fe	52182	38.650	16.032	0.01187	505612	374
Pb	66000	48.885	20.278	0.01501	639498	473

(what's shown here would correspond to random trigger in clas12)

Background Rates, Scalers - example II (FTOF)



FTOF:

Geometry: complete.

Sensitivity: 6 sectors, 3 panels, 5/23/62 paddles/panel, left right PMT

Digitization: sector, panel, ADC TDC

DC:

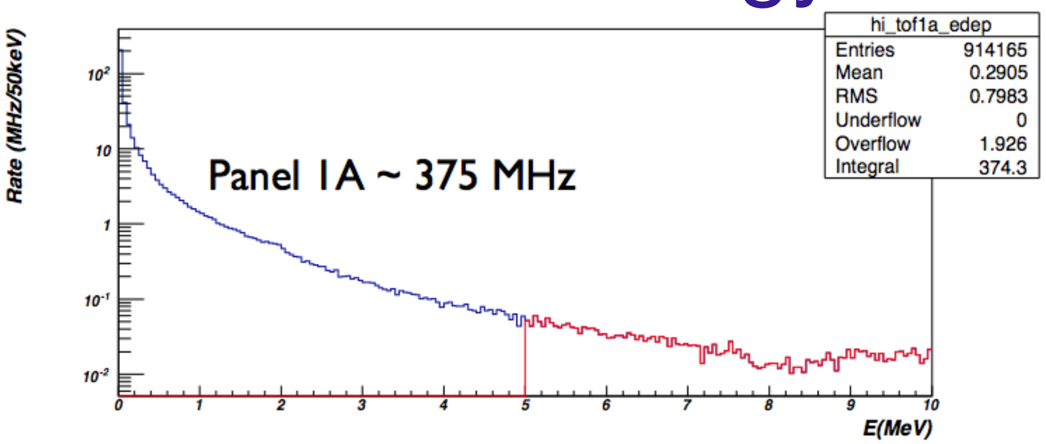
Geometry: complete.

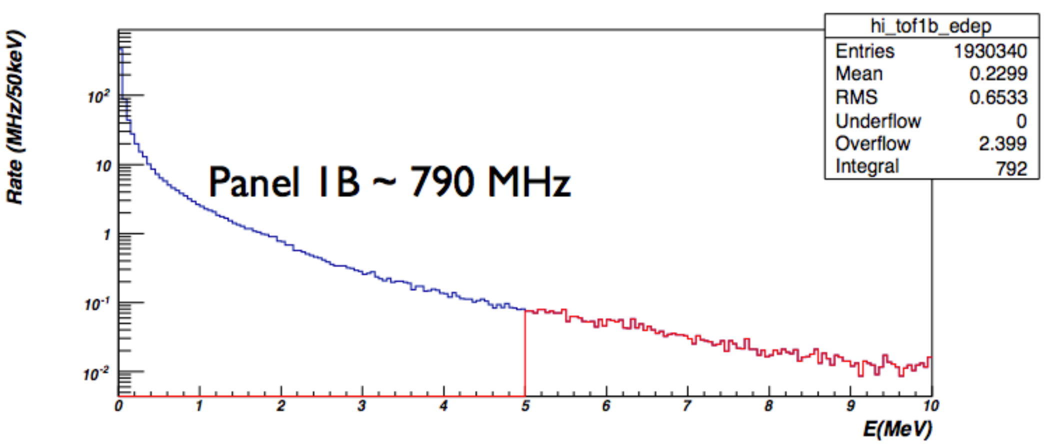
Sensitivity: 3 region, 2 superlayers/region, 6 layers/SL. DOCA, drift velocity, cell resolution

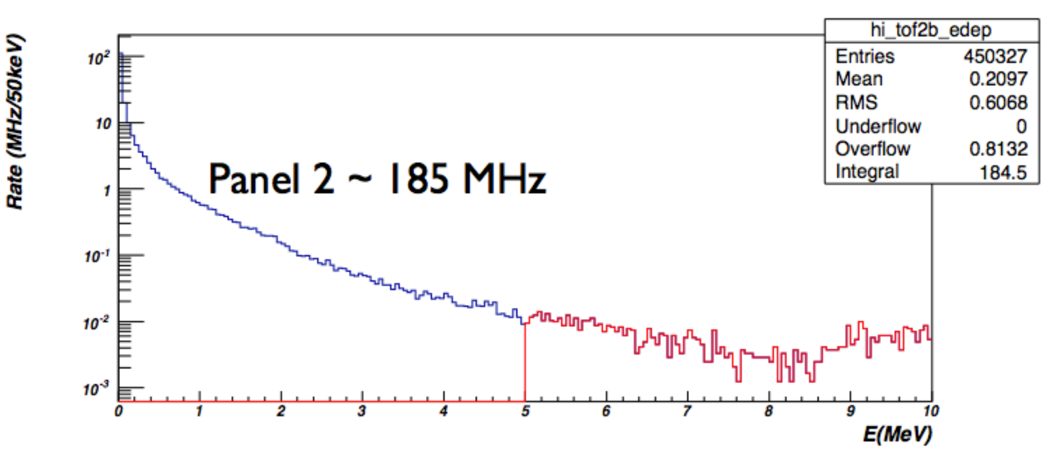
Digitization: sector/region/SL/layer/wire, TDC

Background Rates, Scalers - example II (FTOF)

Rates vs Energy





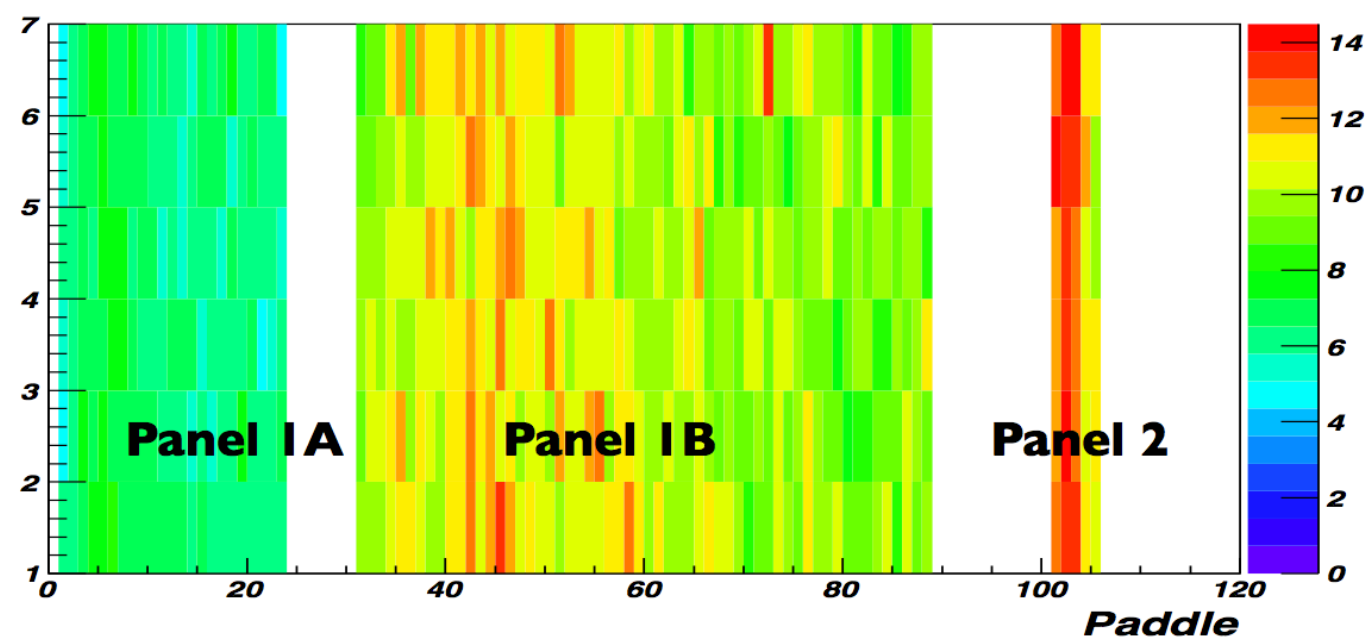


Most very low energy.

Energy/μs converted into current.

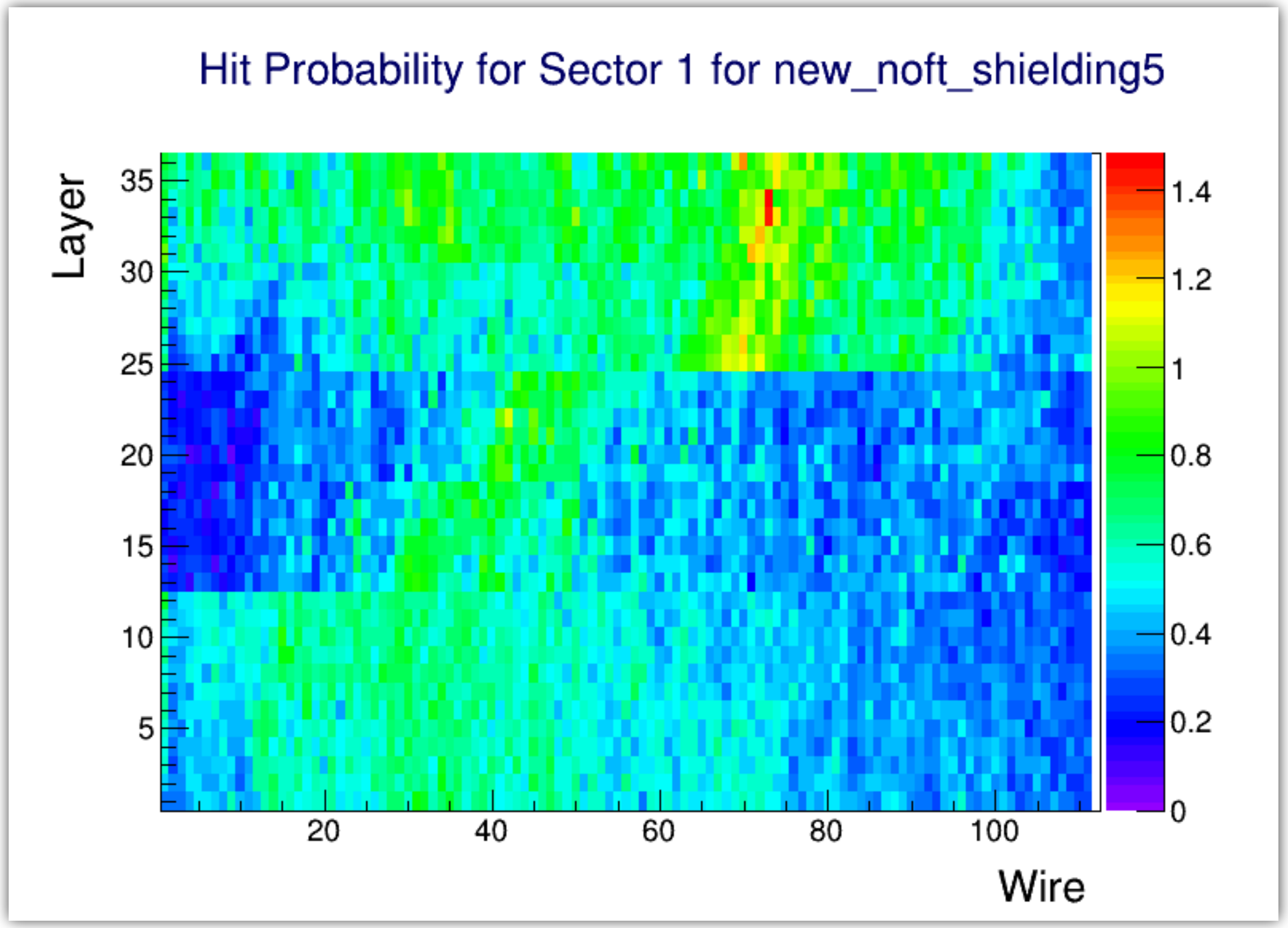
Safety margin for FTOF: 100 μA

Current vs Sector / Paddle

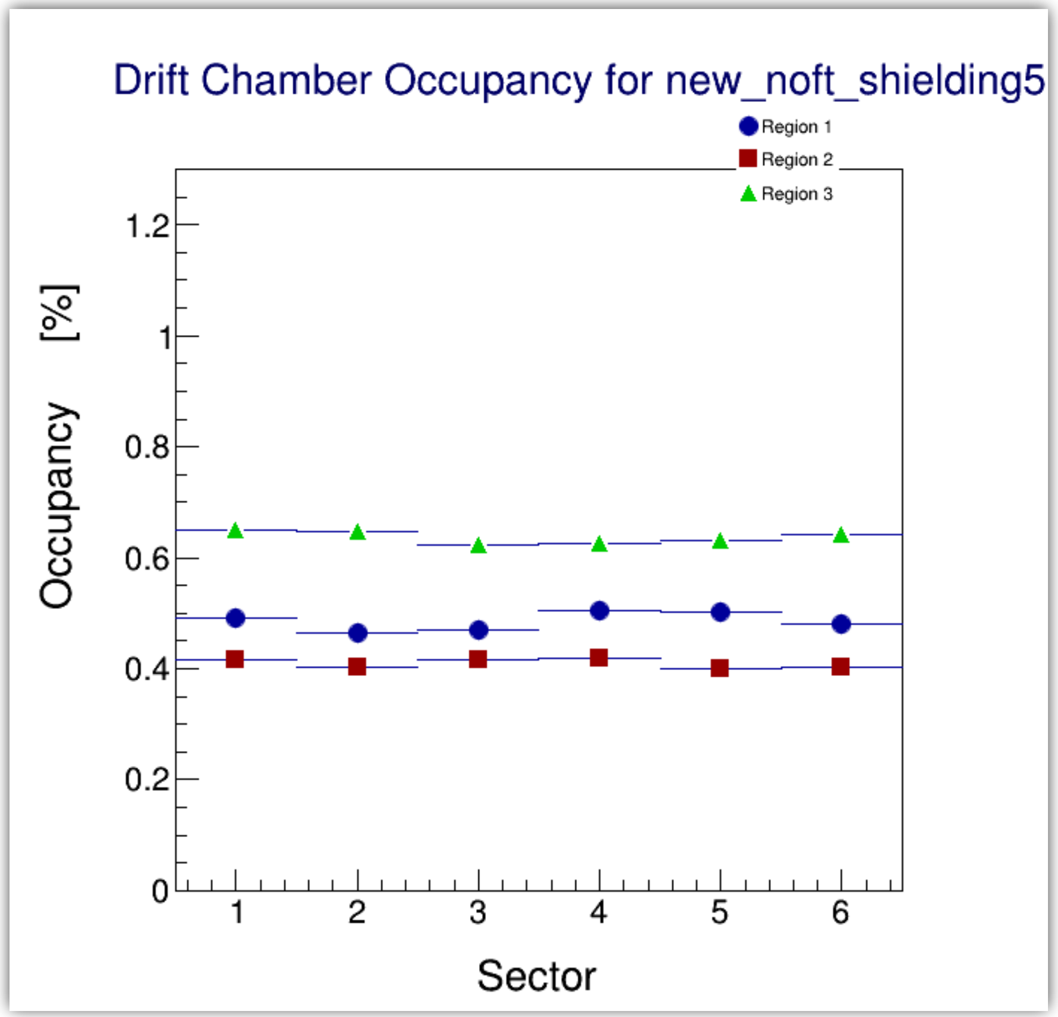


Background Rates, Scalers - example III (DC)

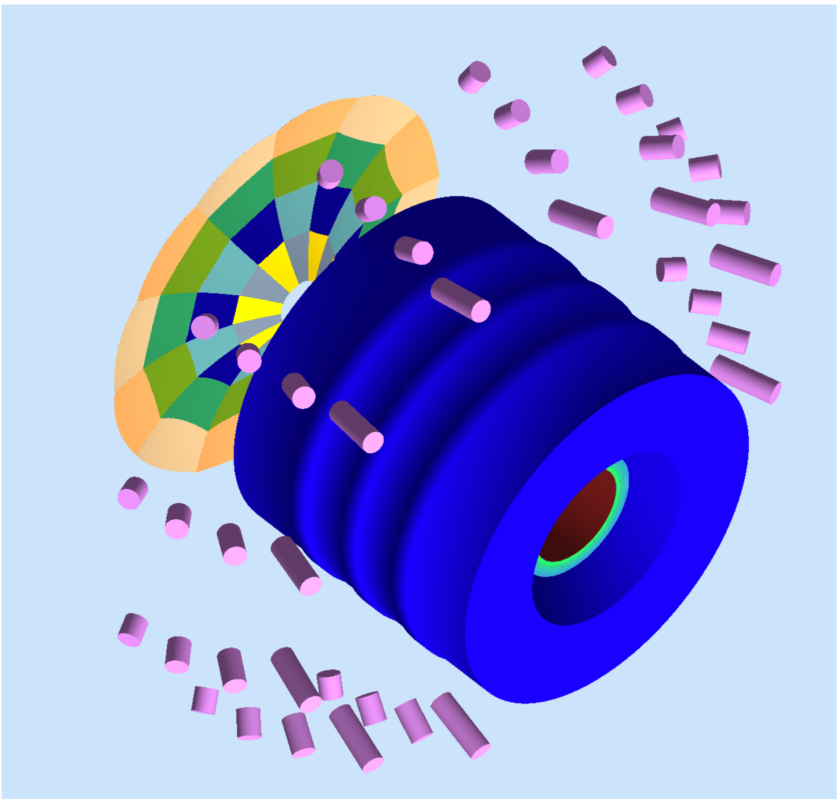
Drift Chambers Occupancy vs Layer vs Wire

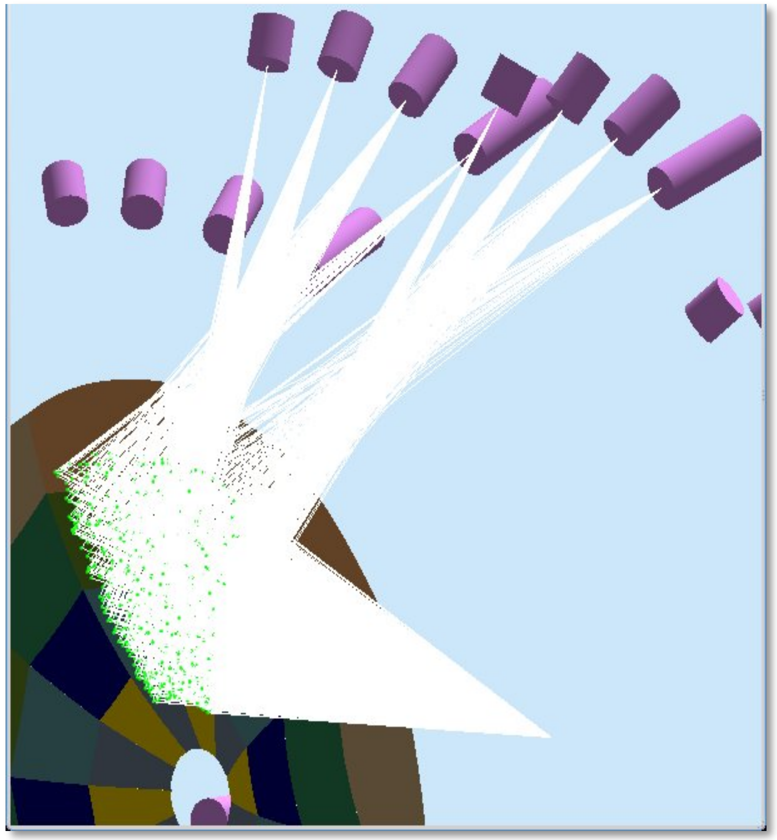


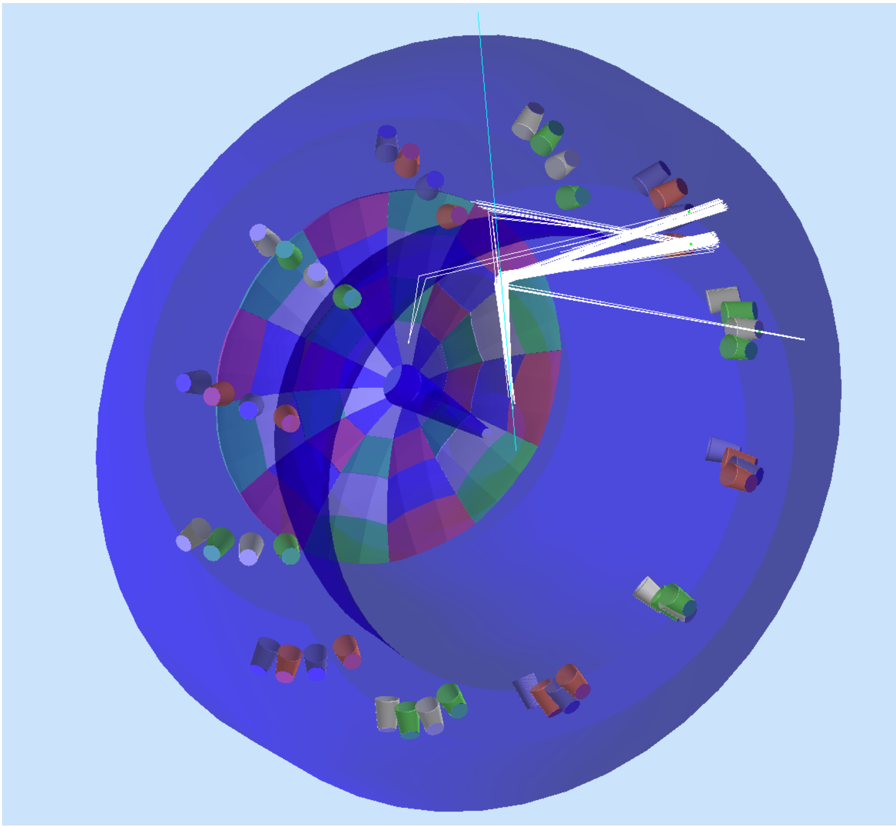
Drift Chambers Occupancy



Background Rates, Scalers - example IV (HTCC)







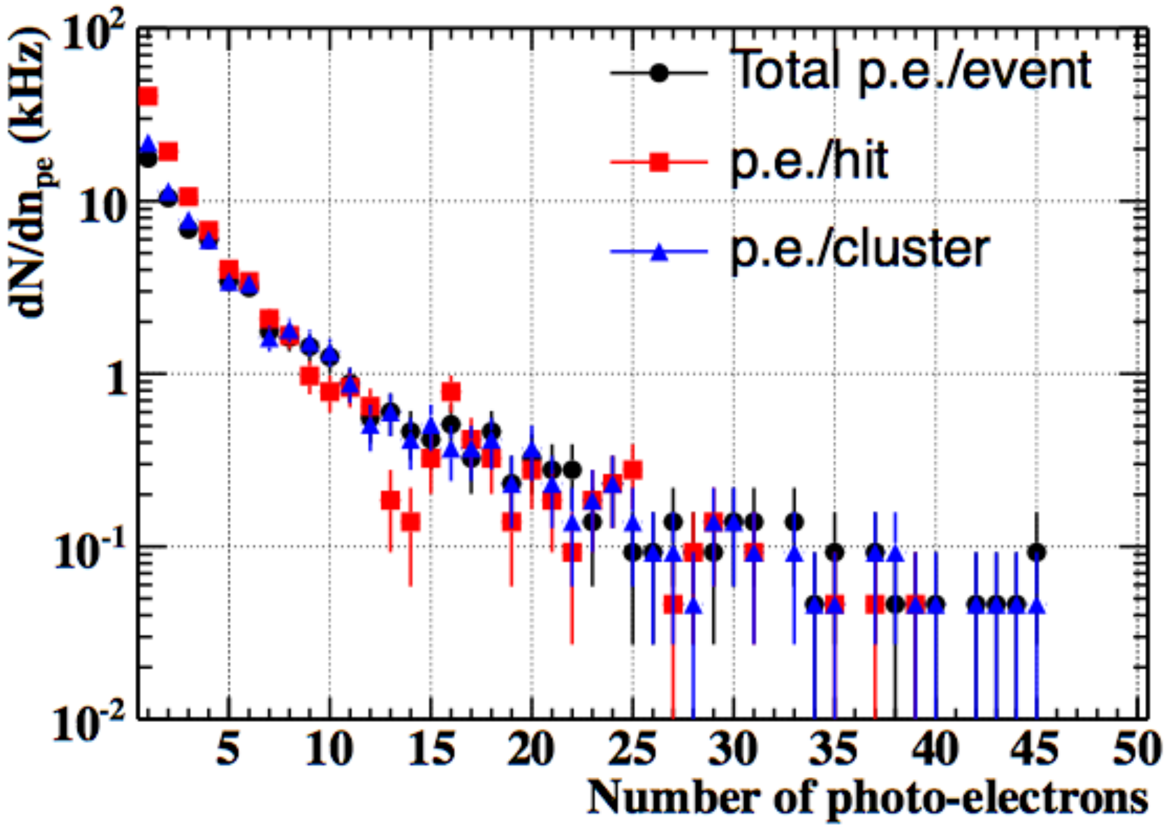
HTCC:

Geometry: complete.

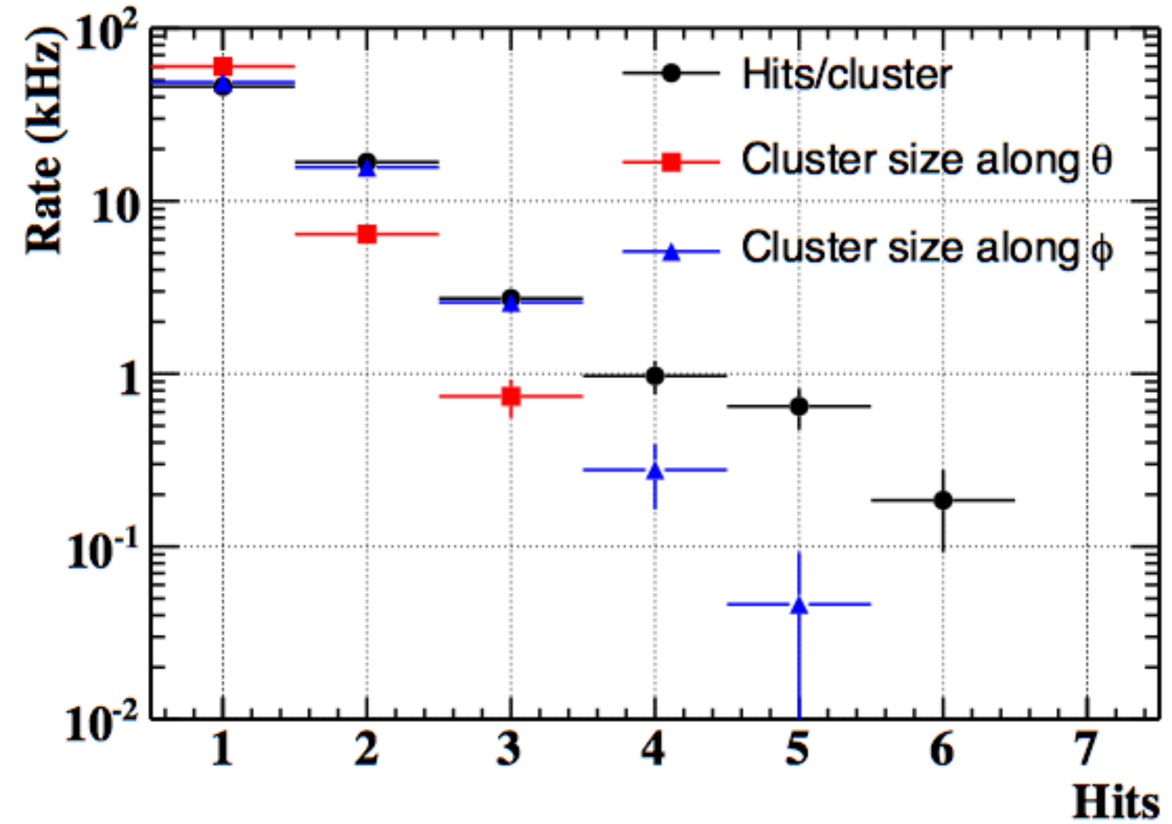
Sensitivity: 12 sectors, 4 layers. Wavelength-dependent PMT q.e., gas and mirror refraction indexes

Digitization: 3 bit ADC, region/layer/strip

Background Rates, Scalers - example IV (HTCC)



Rates vs n. photoelectrons
20 ns window



Rates vs cluster size
(max cluster = 2x2)

Beamtime for different running configurations

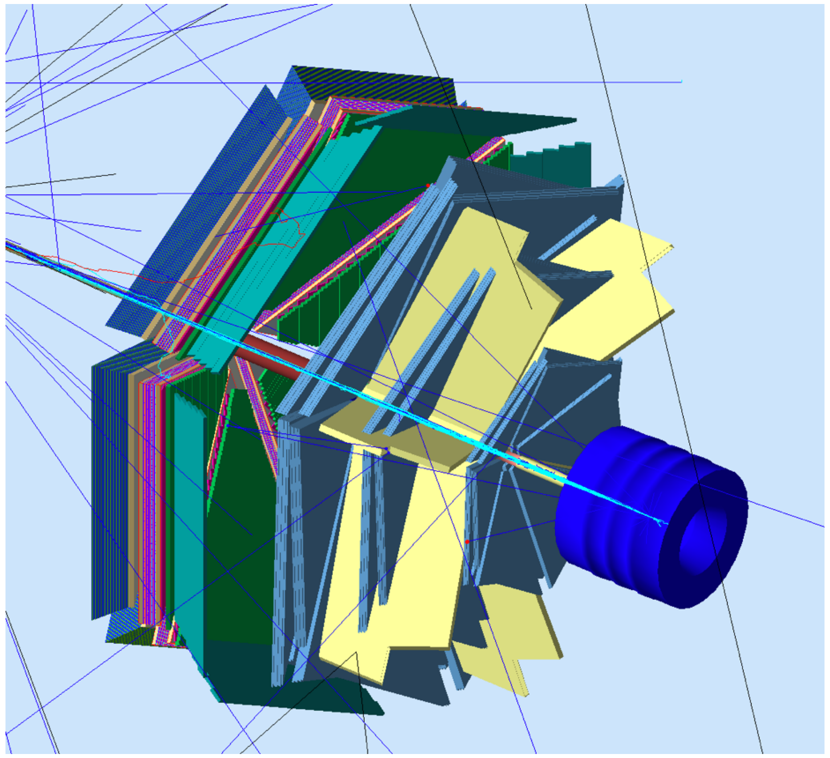
Generator (SIDIS, DVCS, resonances, etc)
Different detectors/shielding configurations
Polarity and strength of fields
Target configurations

- Scaler (Detector and Beamline Monitors), as a function of angles
- Trigger rates
- Missing and invariant masses positions, width
- Yield of different particles / different angles / field
- Energy dependent background overlaps with CLAS6 (EC)
- FT: elastic scattering studies for calibration
- Multiple thin targets

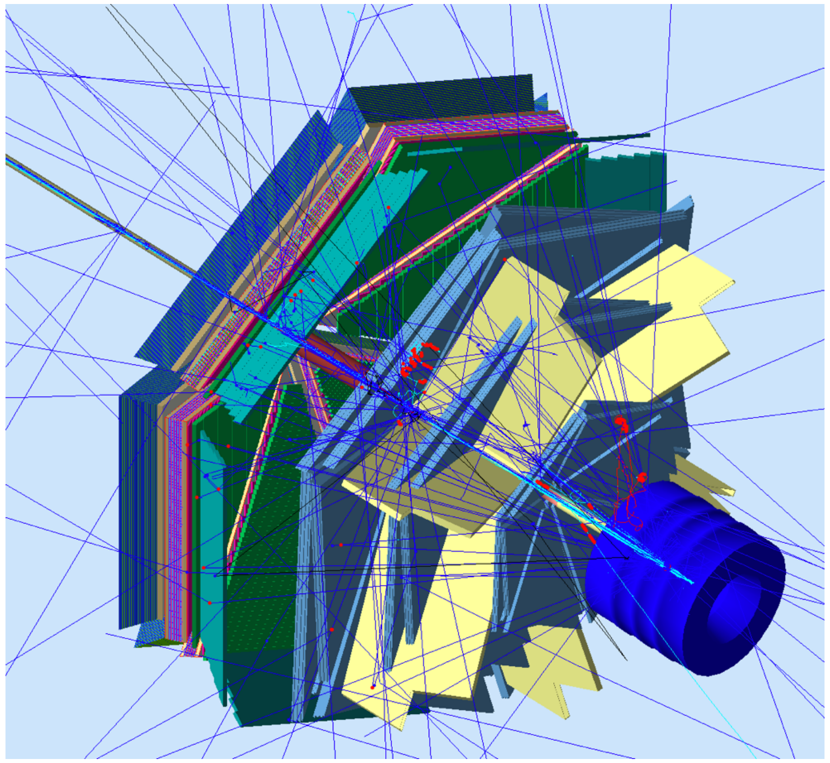
What if some scalers do not agree with data? Can compare scalers from all detectors and beam line as clues as sources of background, etc

Background for different solenoid / torus field

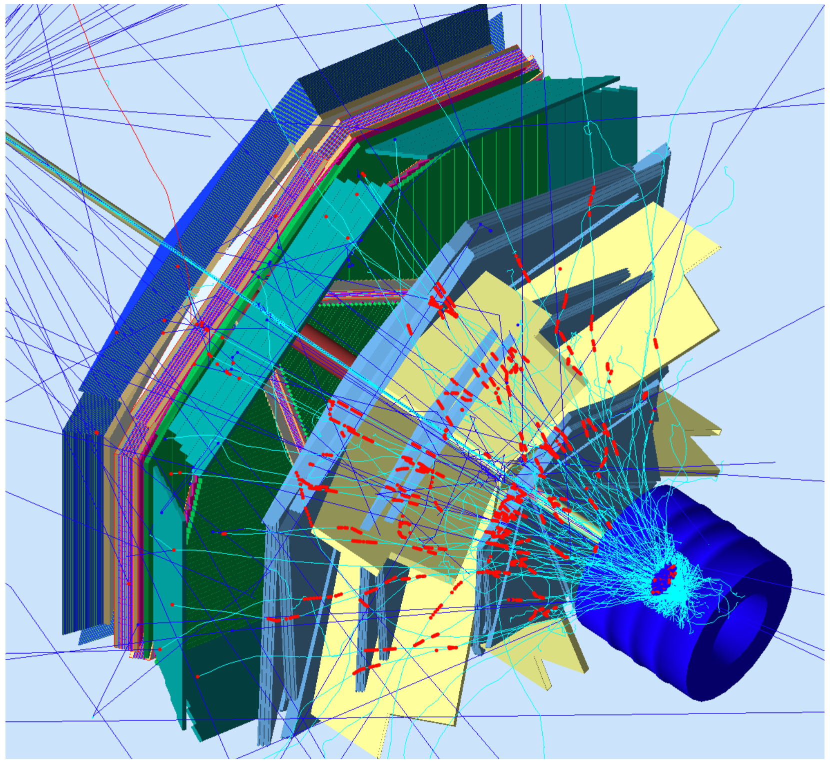
3000 e-, 11 GeV, LH2 target (1/40 luminosity for 250 ns)



Full Solenoid



20% Solenoid (1T)

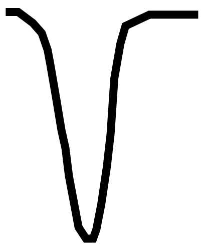


No Solenoid

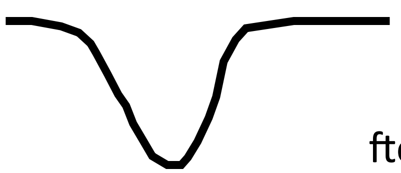
Polarity and zero field studies (straight tracks)

Trigger Studies

FADC pulse mode (signal is integrated)



ftof p1b paddle 18



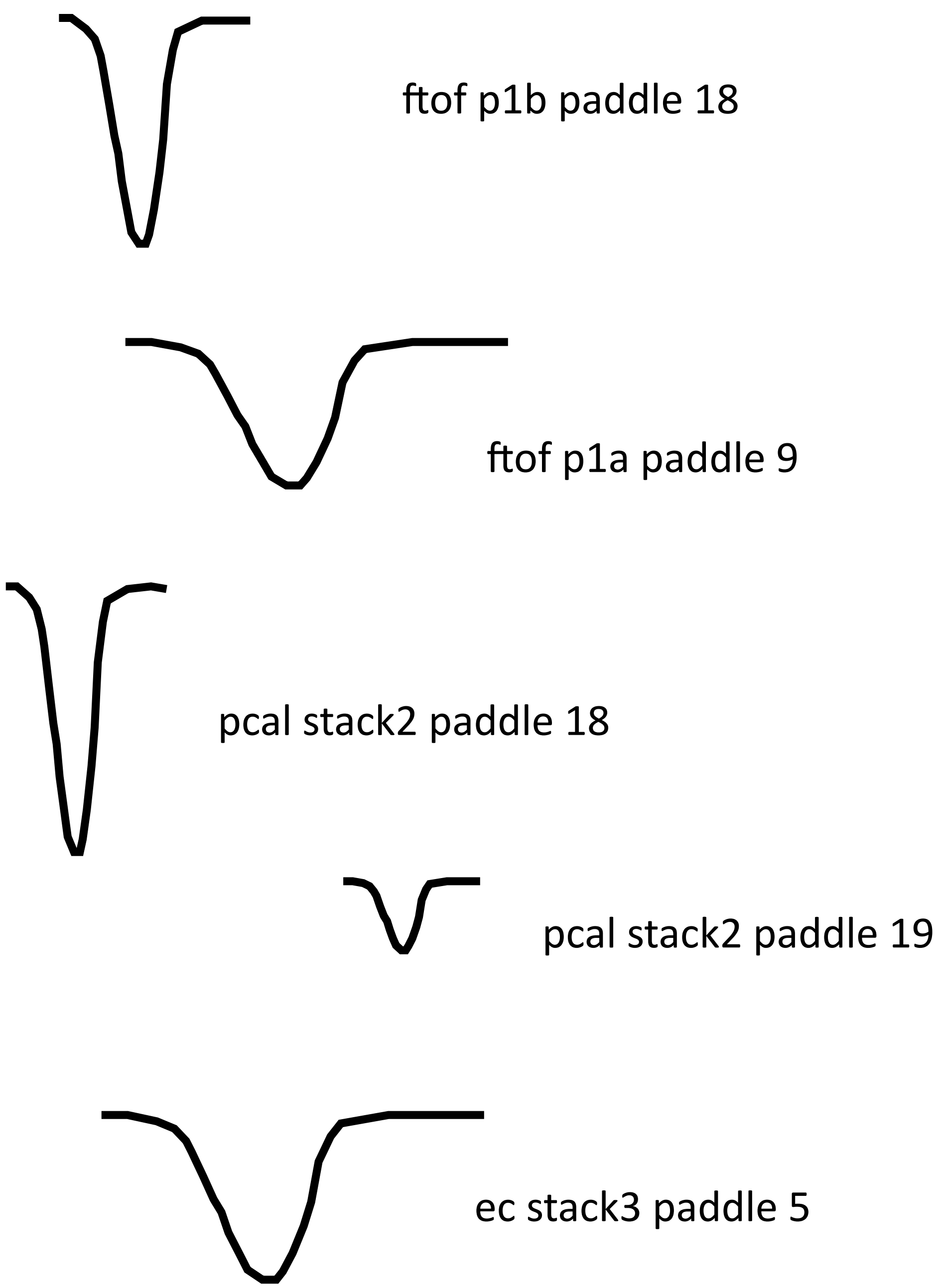
ftof p1b paddle 18

slot, channel,
n(timestamp, integrated ADC)

This part can be done by GEMC

Trigger Studies

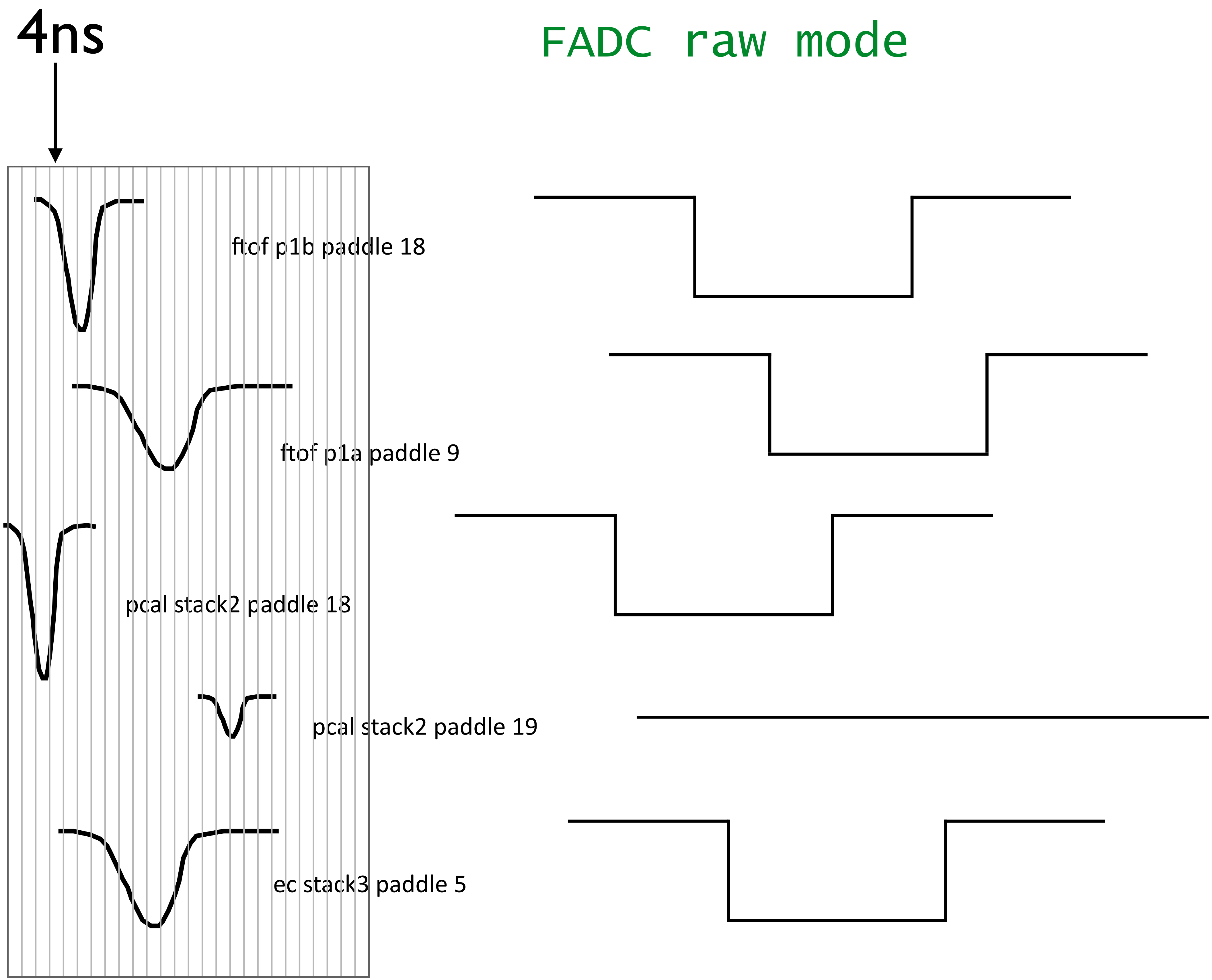
FADC raw mode (4ns-steps signal shape)



Signal as function of time
(already existing)

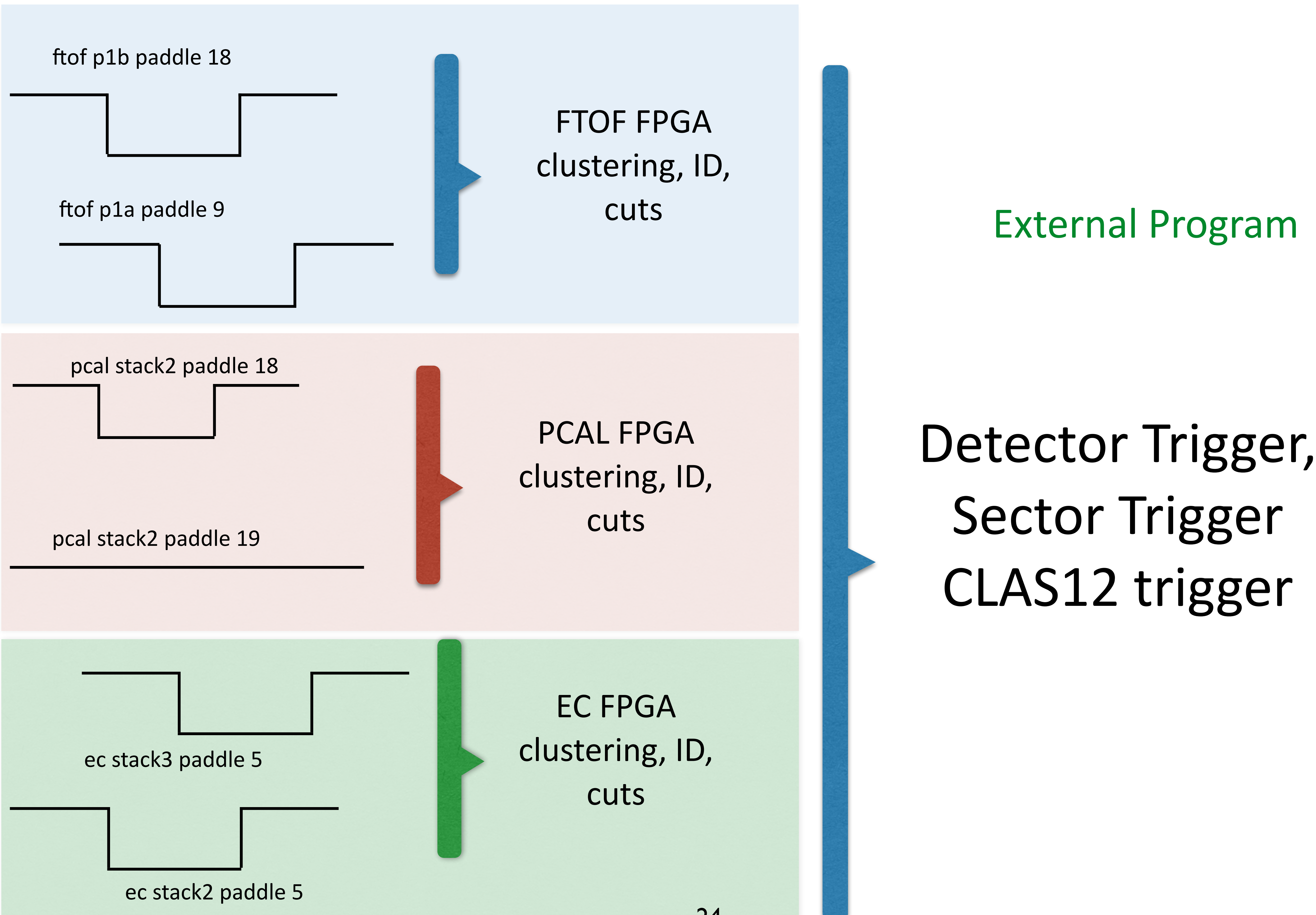
Trigger Studies

FADC raw mode



This part can be done by GEMC

Trigger Studies



GEMC Digitization

As close as possible to DATA

- Digitization should be AGARA:
  As Good As Reasonably Achievable

- Calibration Constant, mechanism should not slow down or complicate GEMC. Same DB (CCDB)

- CASE by CASE Study by simulation and detector experts

Summary

- GEMC used for rates/background. More studies needed.
- Commissioning: rates/scalers, missing/invariant masses, particles yields comparison GEMC/data
- Study of beam time for all planned running configurations during commissioning.
- Trigger Studies