

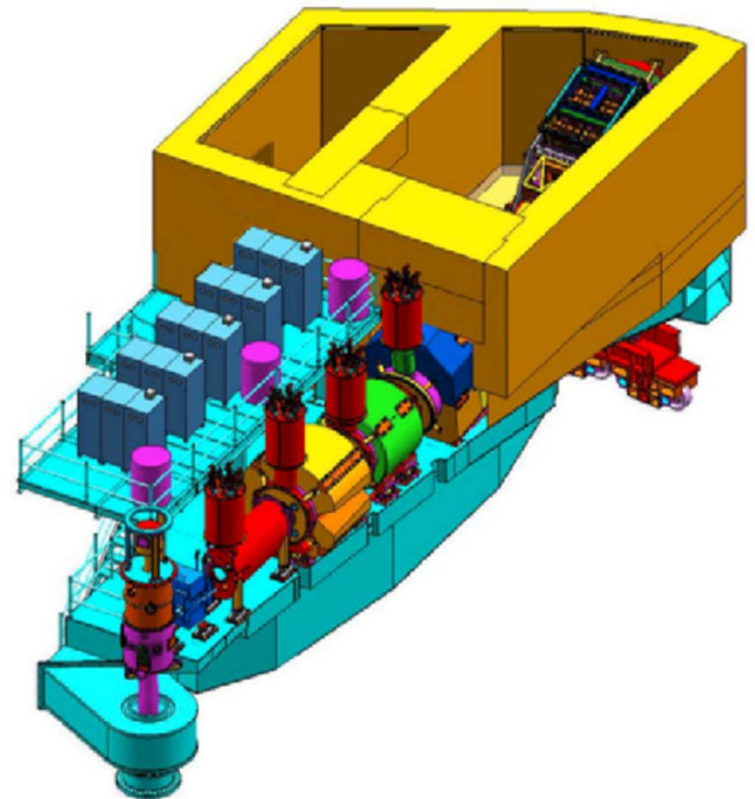


Halls A and C Deep Dive

*(Software Maturity and associated labor,
User Experiences,
Beam-to-publication considerations)*

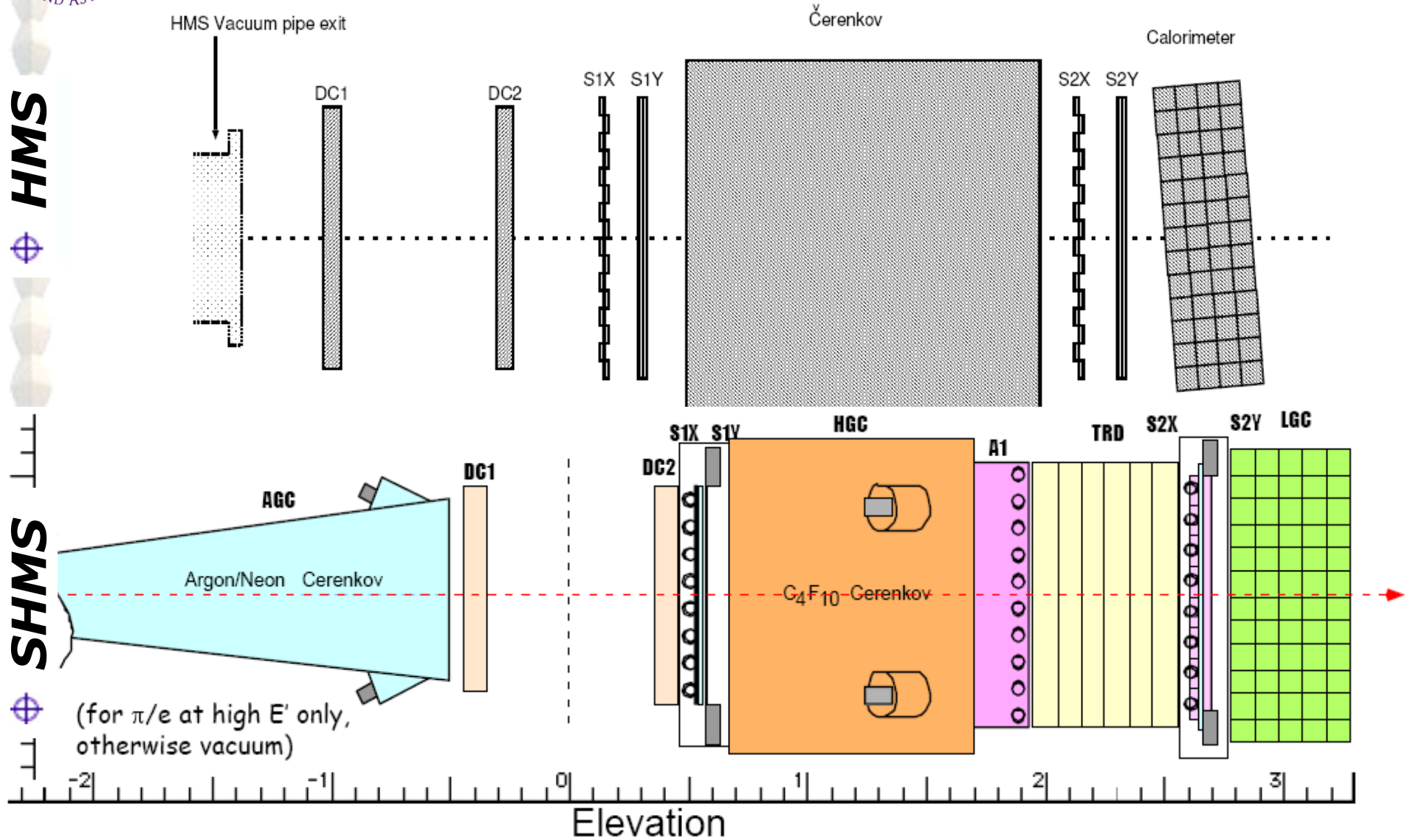
Gabriel Niculescu
James Madison University

- ⊕ **Introduction**
- ⊕ **Software Maturity**
- ⊕ **User experiences**
- ⊕ **beam-to-PRL journey**
- ⊕ **Conclusions**





Reminder





Reminder

HMS

SHMS

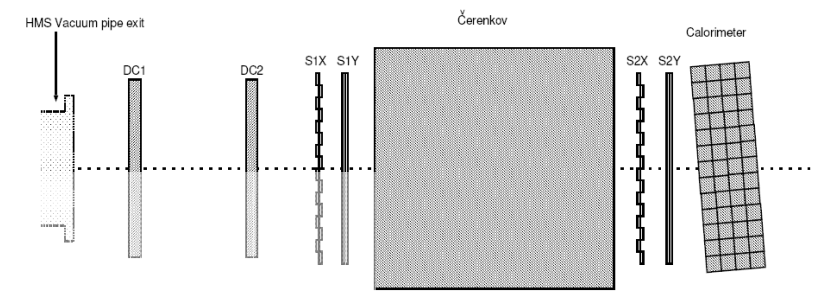
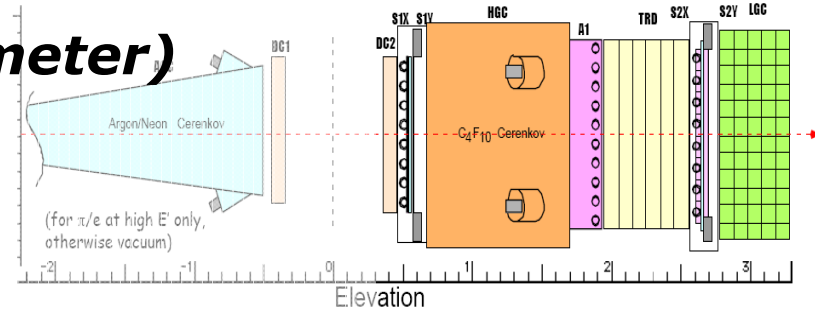


Figure 3.9: Schematic side view of the HMS detector package.



- ⊕ **Hall C:**
- ⊕ **Dual small aperture spectrometers**
- ⊕ **Low # of channels ($\sim 2k$ /spectrometer)**
- ⊕ **No tracking in magnetic field (fast reconstruction code)**
- ⊕ **High precision (p , angles, PID)**

Tasks:

- ⊕ **Complete rewrite of the Hall C analysis code (ROOT/C++) – *hcana***
- ⊕ **Built on top of Hall A's *PODD***
- ⊕ **Keep all* algorithms from *engine***
- ⊕ ***Document* analysis algorithms**

Statistics: Run # 50017	
run time:	234.5
event number:	20256
Q_BCM2(mC):	4.828
Analysis rate:	1590 Hz
dead time:	2.4 %
<hr/>	
htrig:	17642
htrack/trig:	91.4%
hfid effic:	94.6%
w/DC cuts:	95.2%
coin only:	95.2%



Software Maturity (& Labor)

hcana:

- ⊕ **Reconstruct single arm (HMS) events – 100% agreement with *engine* results** (N.B.: this subsumes a number of steps/milestones...)
- ⊕ **Handle (HMS) scalars (read, process, report)**
- ⊕ **Process coincidence events (HMS-SOS). NEW**
- ⊕ **Do single arm “physics analysis” (Q2, W2, x...). Coinc. reconstruction underway.**
- ⊕ **...while tightly integrated with Hall A’s *PODD***
- ⊕ **... and with a minimum of personnel**

- ⊕ **JLab (Steve, Mark, Brad...)**
- ⊕ **Regina (Ahmed), Yerevan (Simon, Vardan)**
- ⊕ **CNU (Ed), FIU (Pete), Miss. SU (DD), JMU (GN)**

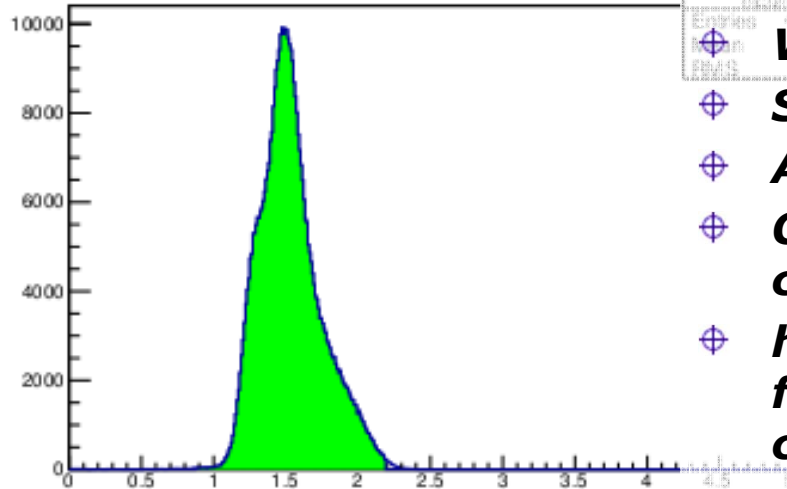
- ⊕ **Excellent value as most people listed have (many) other duties.**



HMS Calorimeter Calibration

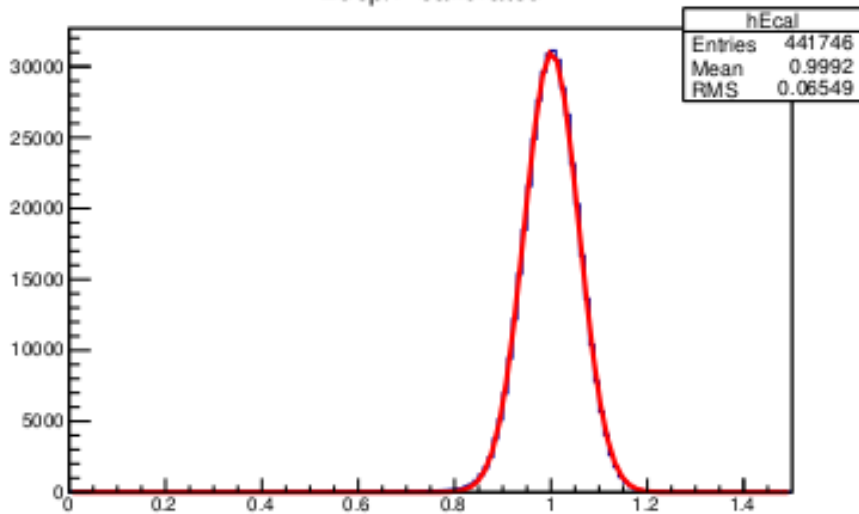
(Ts. Amatouni, Yerevan)

Edep/P uncalibrated

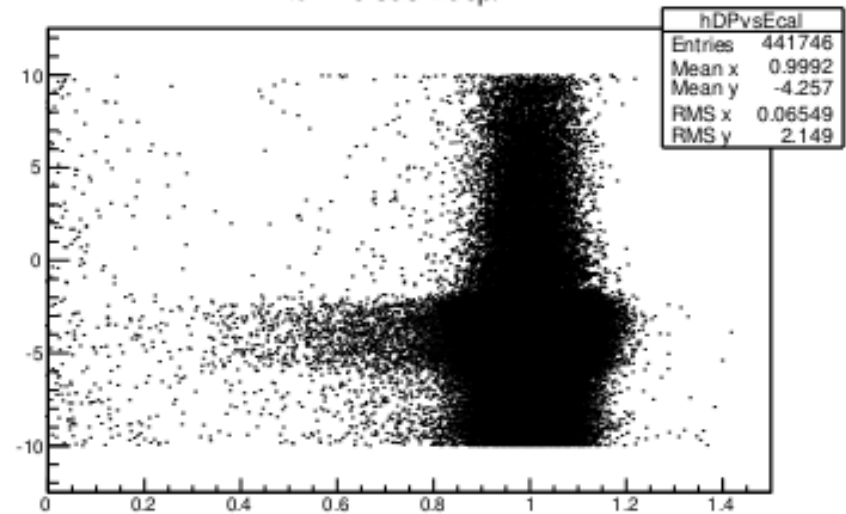


- ⊕ **Two step process: replay and calibration**
- ⊕ **Works on single track electron events**
- ⊕ **Selects electrons in Gas Cherenkov**
- ⊕ **Also makes use of β_{TOF} for e- selection**
- ⊕ **Calibration constants are saved in format compatible with Engine**
- ⊕ **hcal_calib.cpp was checked against engine, for the same cuts difference in calibration constants is 0.001 or less**

Edep/P calibrated



ØP versus Edep/P





Tracking Efficiency

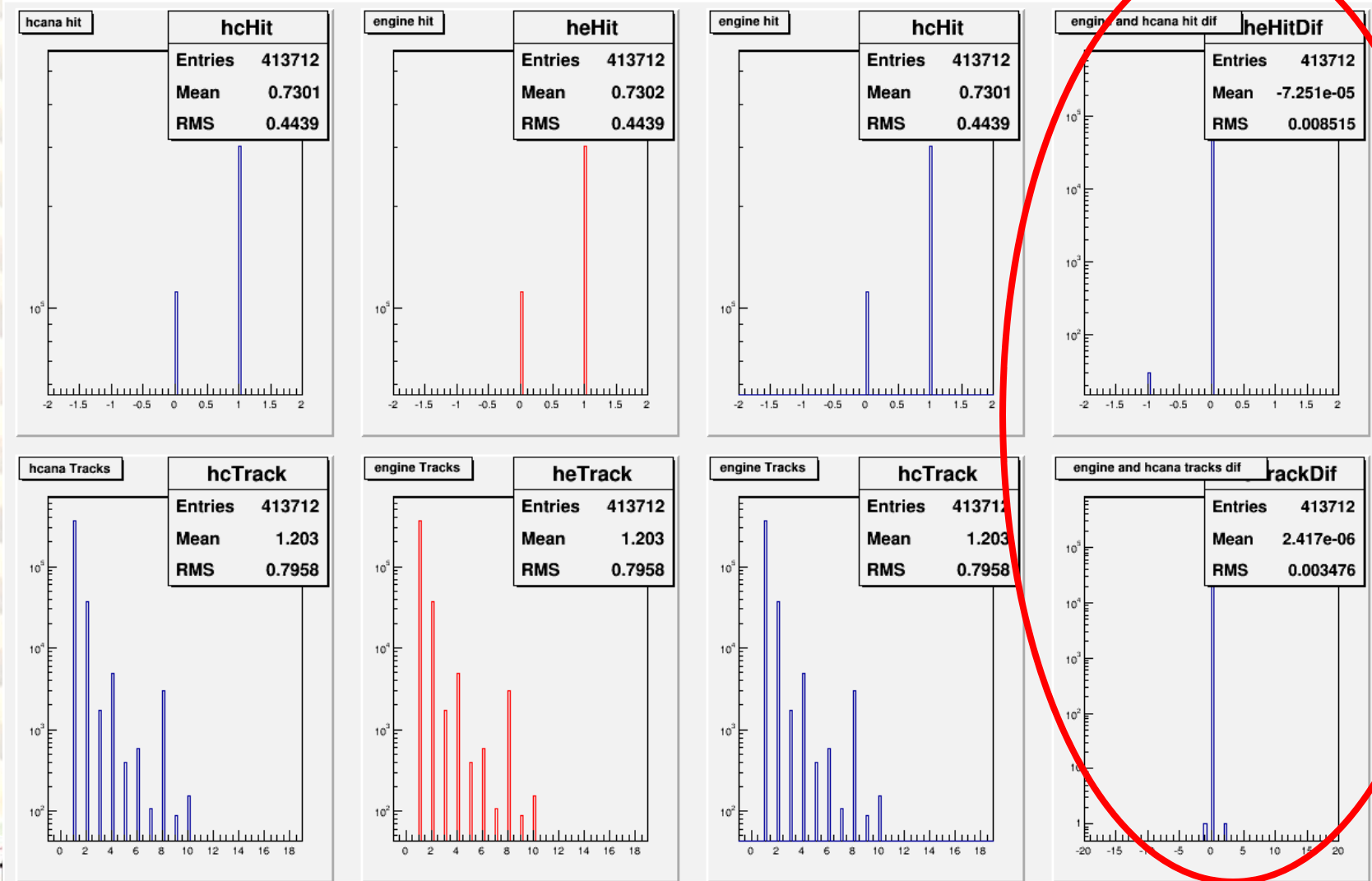
(A. Zafar, Regina)



4 quantities of interest:



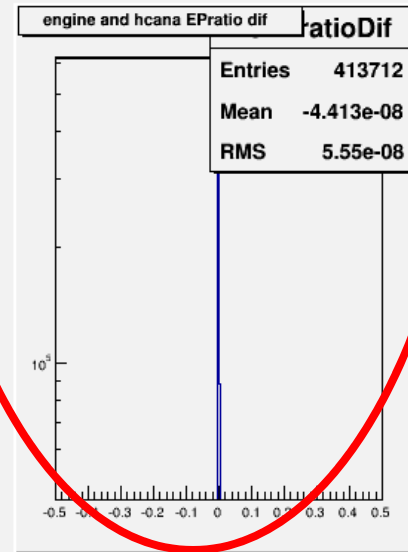
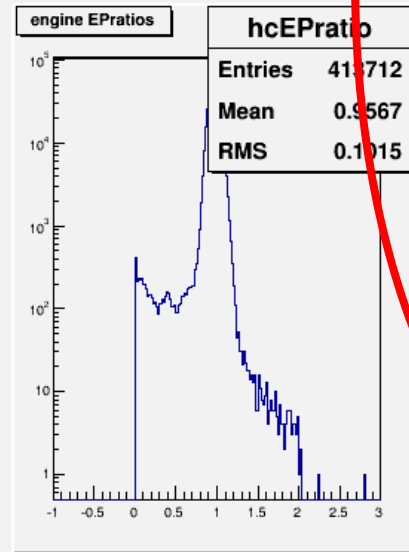
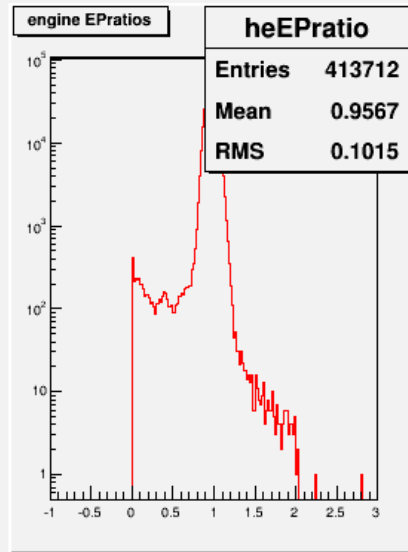
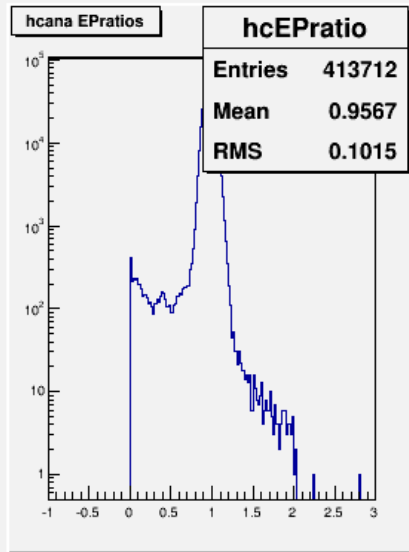
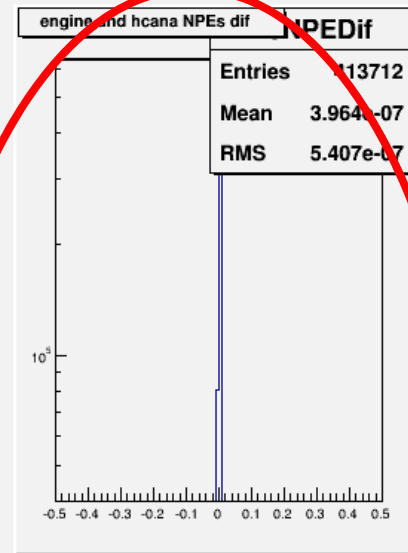
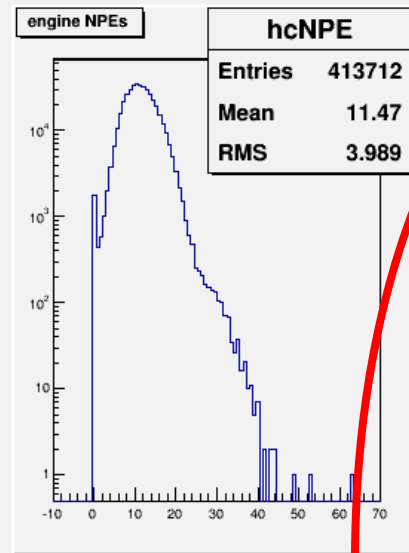
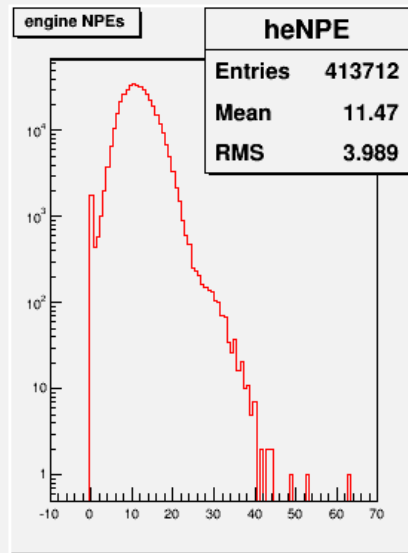
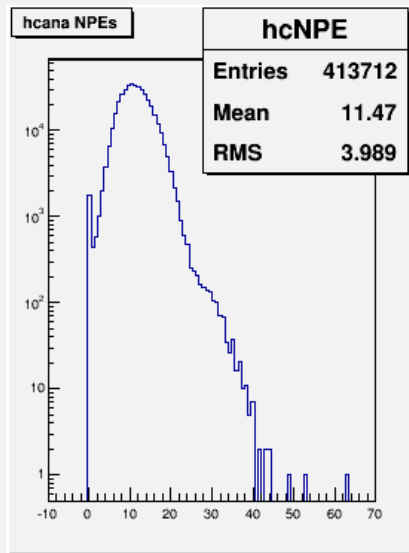
GoodScintHit, # of tracks, ecal, Cer npe





Tracking Efficiency

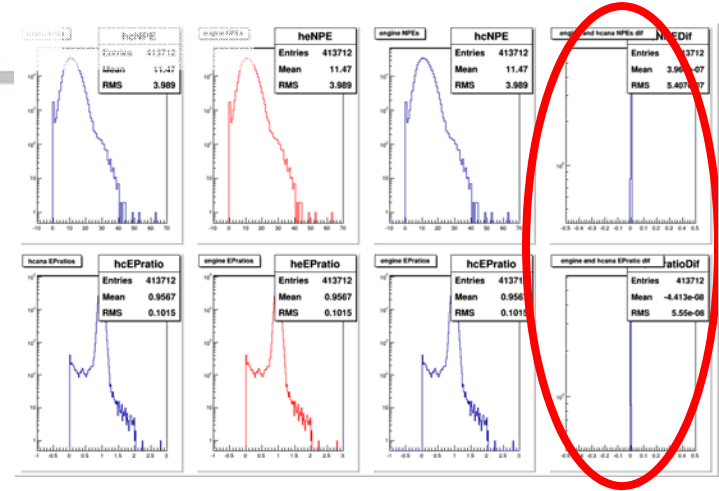
(A. Zafar, Regina)





Tracking Efficiency

(A. Zafar, Regina)



- ⊕ **hcana**
- ⊕ **hdid: 299928**
- ⊕ **hscinshould: 318101**
- ⊕ **SING FID TRACK EFFIC: 0.9429 +- 0.0004**

- ⊕ **engine**
- ⊕ *********

- ⊕ **HMS TRACKING EFFICIENCIES ***
- ⊕ *********

- ⊕ **hdid : 299947**
- ⊕ **hscinshould : 318123**
- ⊕ **SING FID TRACK EFFIC : 0.9429 +- 0.0004**

⊕ **It works!**





Online* Monitoring

(P. Markowitz & students, FIU)

- ⊕ **"Based" on Hall A's onlineGUI
(Bryan Moffit, MIT LNS)**
- ⊕ **Display (save, print) useful information detector
information**
- ⊕ **ROOT-based (highly portable, customizable)**
- ⊕ **Allows for direct comparison with a "Golden"
standard (useful for longer exp. – less kinematics
changes)**



Online* Monitoring

(P. Markowitz & students, FIU)

Radio Buttons

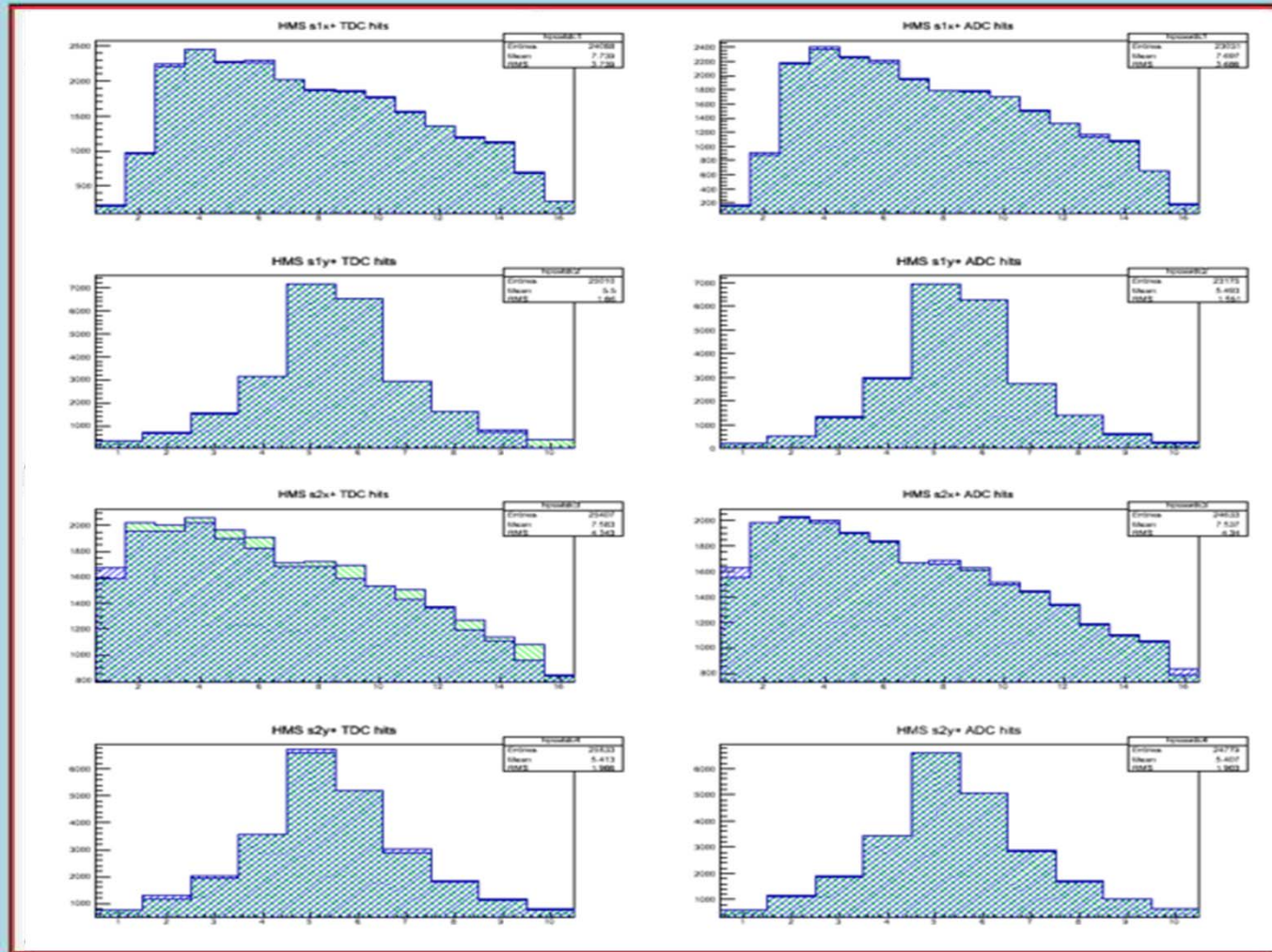
Canvas Title

- Blumi vs event number
- Norm Asym: Flumi
- Norm Asym: Flumi corr
- Asym: Flumi vs BCM1



Update Button

Current Canvas



Prev

Next

Exit GUI

Run #1500

Print To File

Navigation Buttons

EXIT Button

Run Number

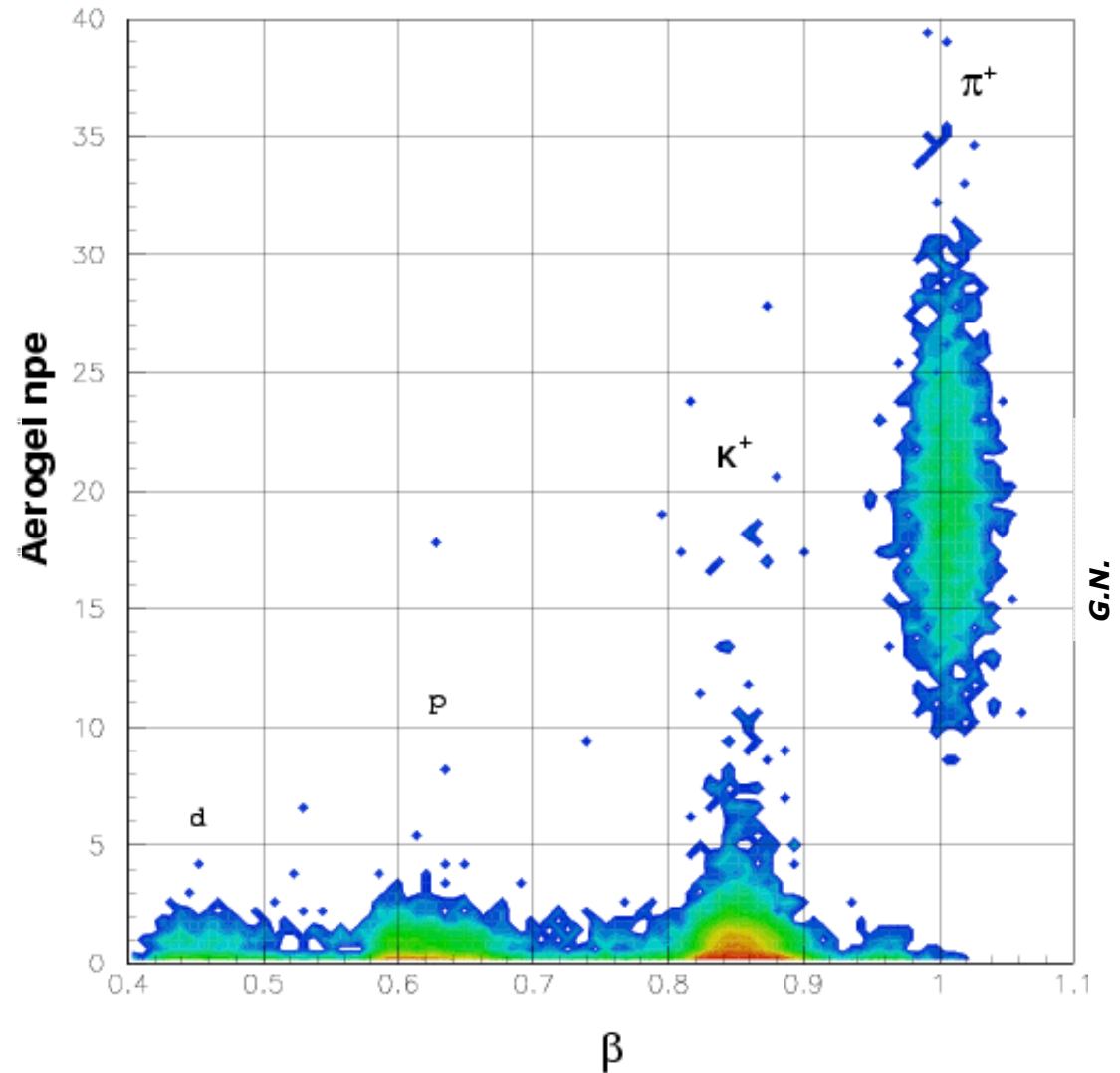
Print Button





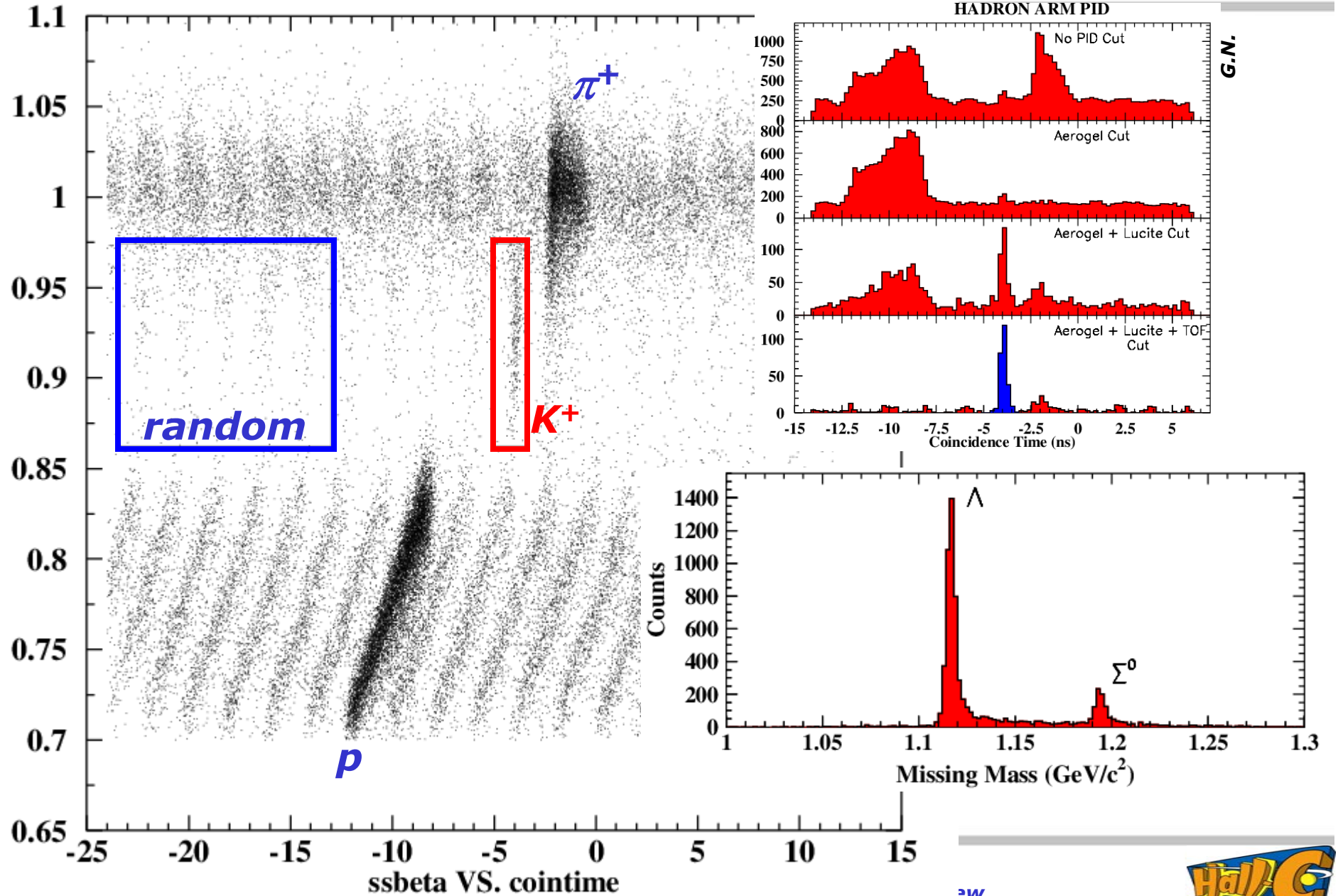
Coincidence-related calibrations

- ⊕ ***e-h coincidence time (separate $\pi/K/p...$)***
- ⊕ ***If present:***
- ⊕ ***Additional (aerogel, heavy gas, etc.) PID detector calibration***
- ⊕ ***PMT gain matching***
- ⊕ ***Beta vs npe***
- ⊕ ***Beta vs dE/dx***





Coincidence-related calibrations

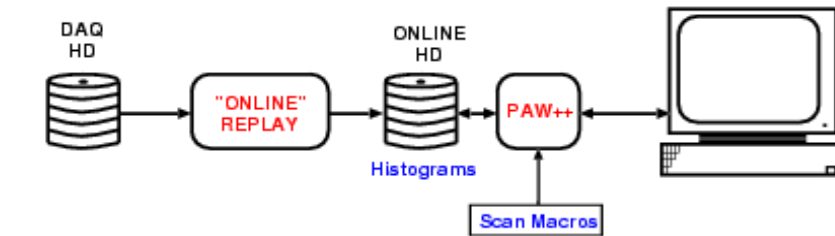


Beyond single event reconstruction

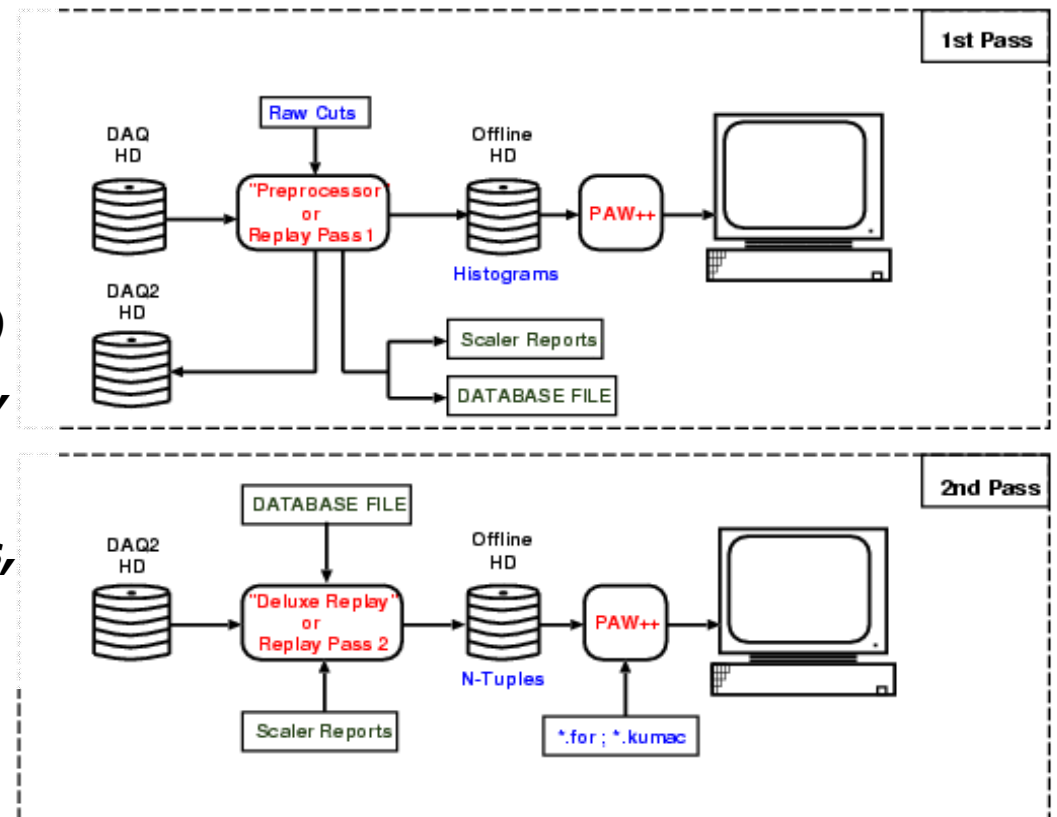
(beam-to-prl...)

- ⊕ **Sample workflow for a typical Hall C experiment (engine)**
- ⊕ **Programs & (customizable) scripts available to the user**
- ⊕ **3 Step process:**
 - ⊕ **Acquisition (Data Integrity)**
 - ⊕ **Processing (Reconstruction, Validation)**
 - ⊕ **Post-Processing (Normalization, Corrections, binning, etc.)**

"Online" Analysis



"Offline" Analysis





Beyond single event reconstruction (II)

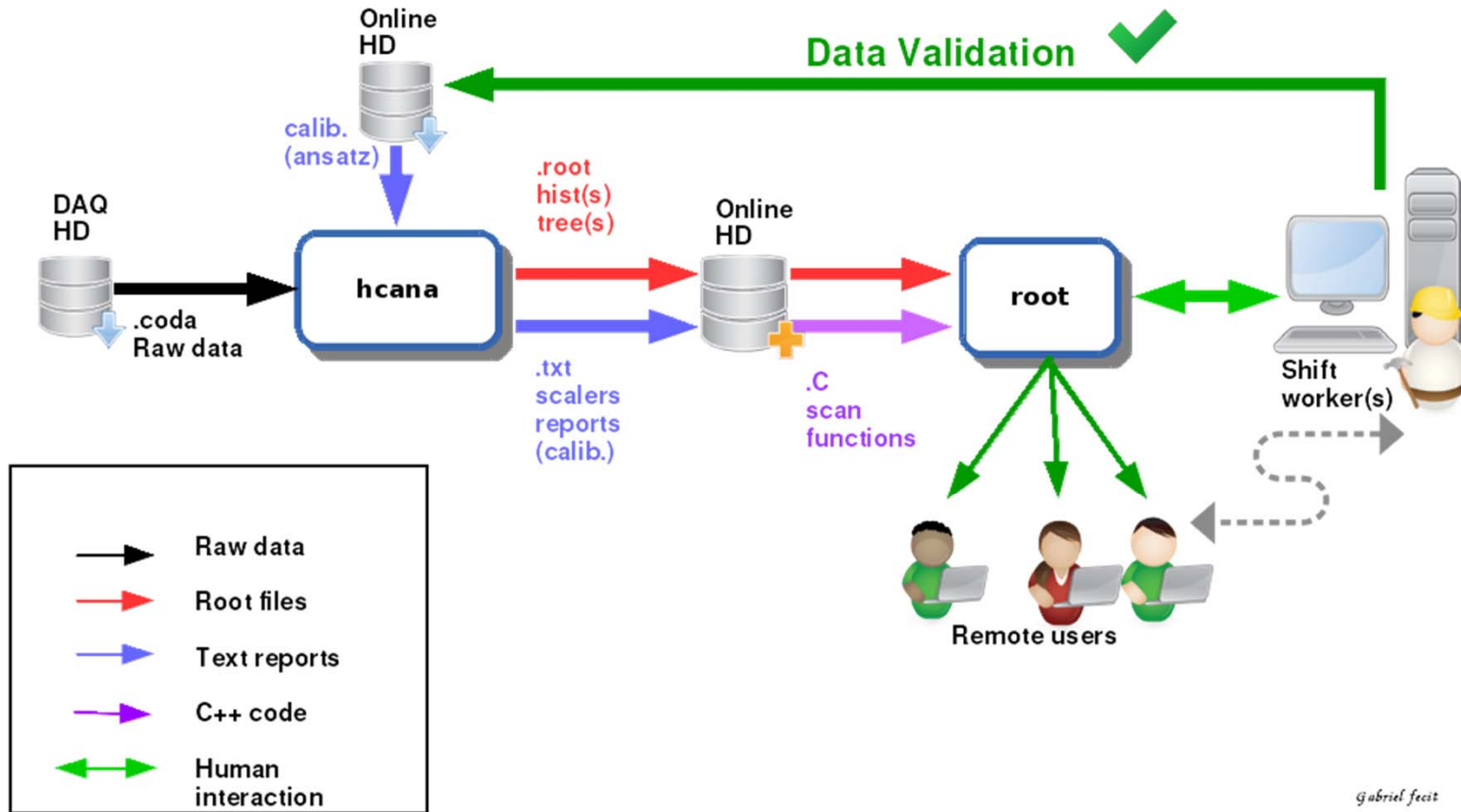
(beam-to-prl...)

- ⊕ **Retooling for the 12 GeV Hall C era (hcana):**
 - ⊕ **Workflow remains (largely) the same as the fundamentals of small angle spectrometers have not changed. However...**

- ⊕ **Substantial “toolkit” upgrade:**
 - ⊕ **C++/ROOT used throughout**
 - ⊕ **Integration of calibration procedures into hcana (using podd’s plug-and-play capabilities)**
 - ⊕ **Improved documentation, access to code (GIT/GITHUB, THtml, wiki, nightly builds)**
 - ⊕ **Tight, mutually beneficial cooperation with Hall A**

Hall C "from beam to PRL"

Step 0: "Online" ("just offline") Analysis

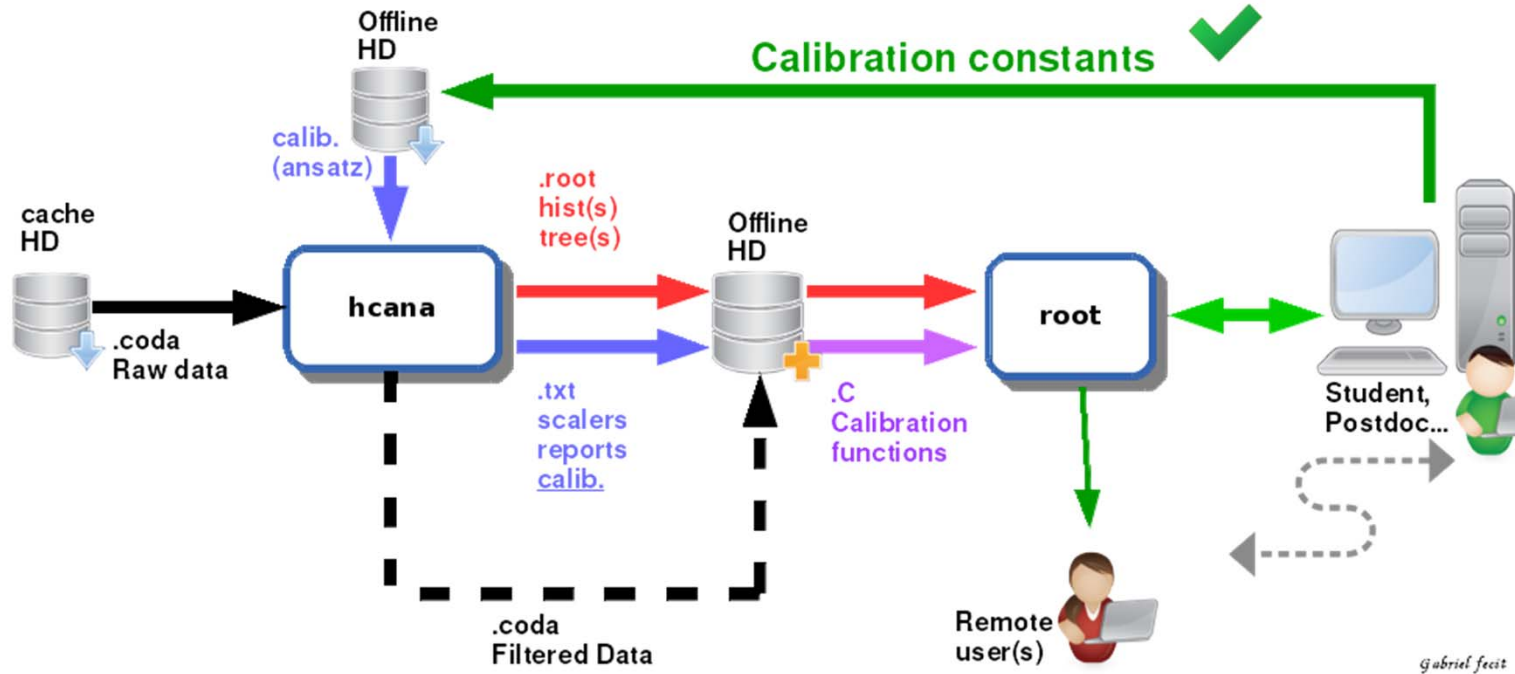


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Hall C "from beam to PRL"

Step 1: "Offline" Analysis (1st pass)



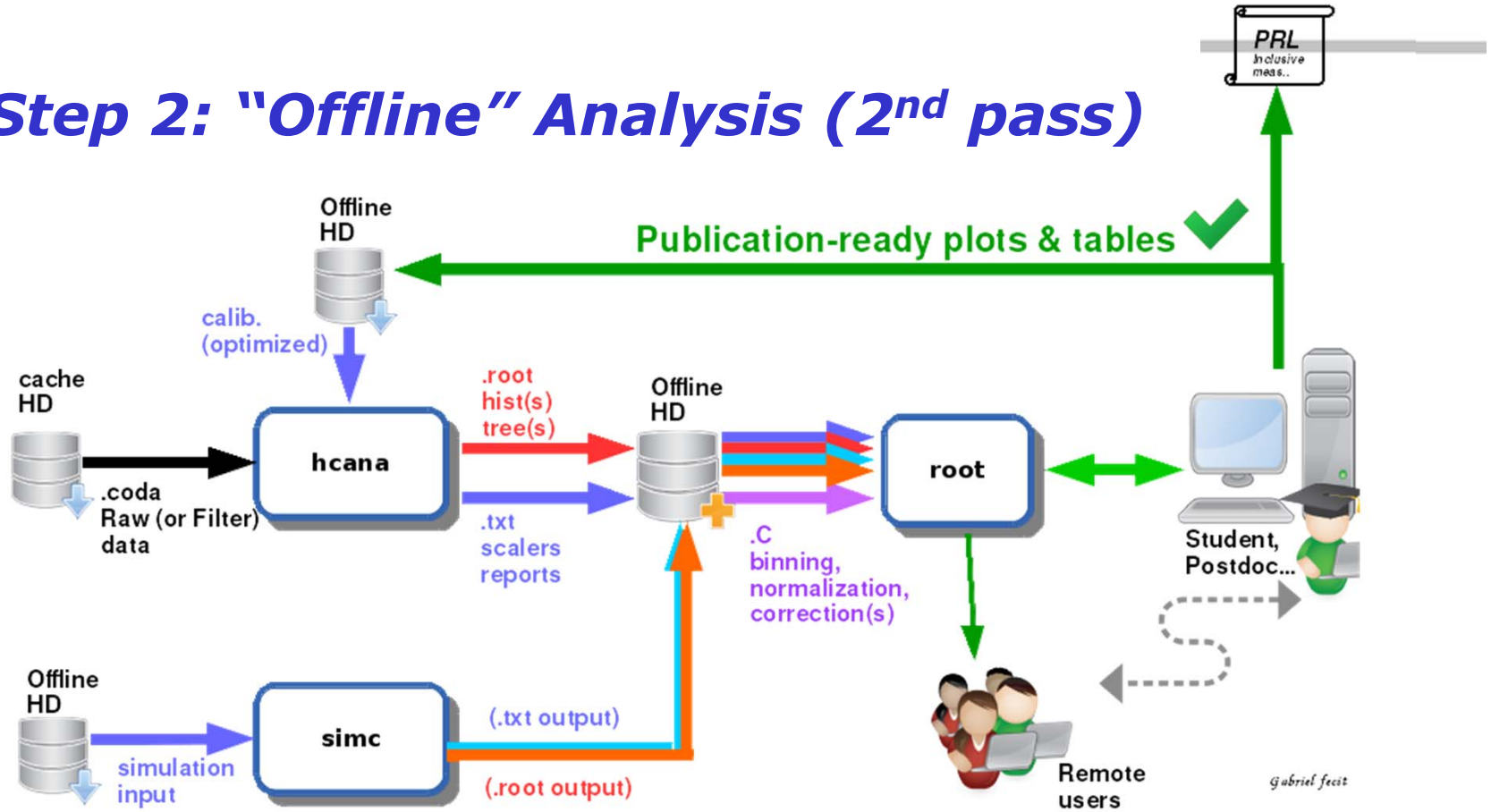
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Hall C "from beam to PRL"

Step 2: "Offline" Analysis (2nd pass)



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Summary

⊕ **Code:**

- ⊕ **Fully reconstructed hcana tracks match their engine counterparts.**
- ⊕ **Substantial progress on calibration & scalers**
- ⊕ **Can do double arm, will test with HMS-SOS coinc.**

⊕ **User Experience:**

- ⊕ **Documentation – continuously updating (wiki, github)**
- ⊕ **Excellent JLab staff support & communication.**
- ⊕ **Intensify effort to attract/educate more collaborators on hcana usage (tutorials, workshops?...)**

