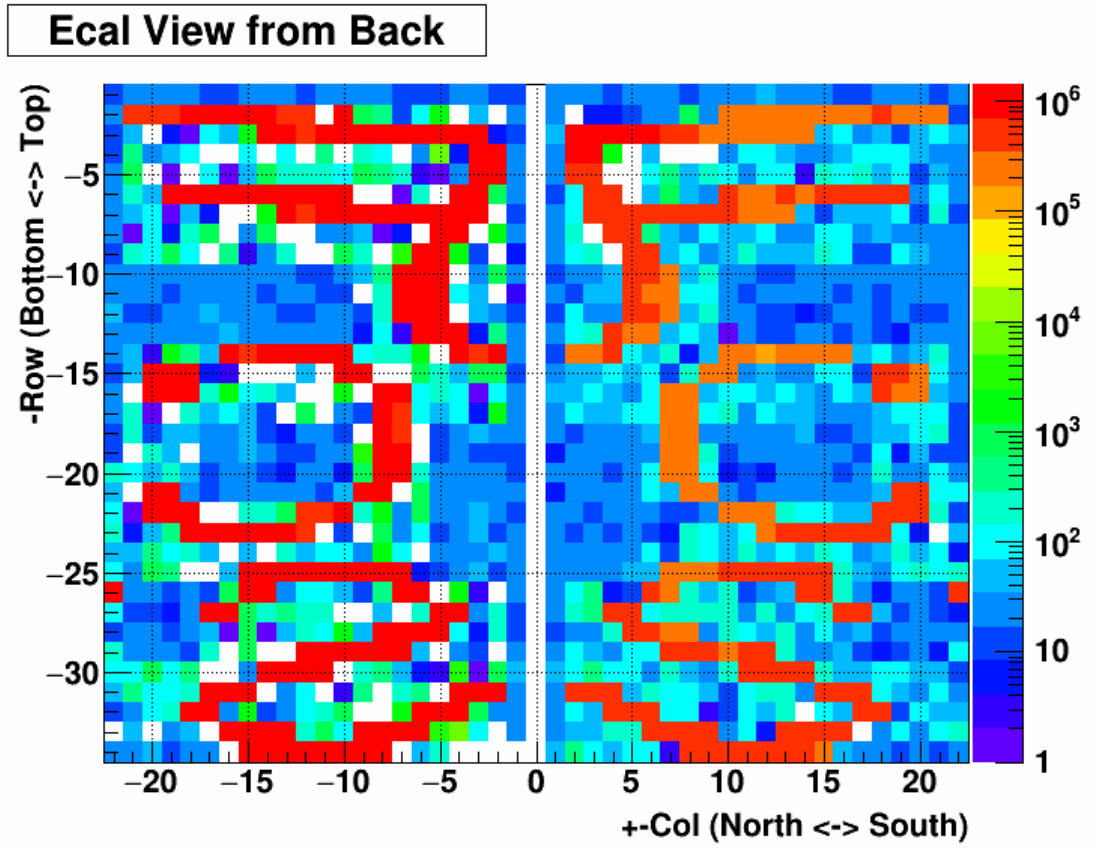
FCS commissioning before and during run

Construction Page:
https://www.star.bnl.gov/protected/spin/akio/fcs/construction/

Photos:
https://www.star.bnl.gov/protected/spin/akio/fcs/photo/index.html

LED Monitor
https://online.star.bnl.gov/fcs/led/

Code “How to”
https://www.star.bnl.gov/protected/spin/akio/fcs/index.html#howto
(Thanks to Raghav this is recently updated)



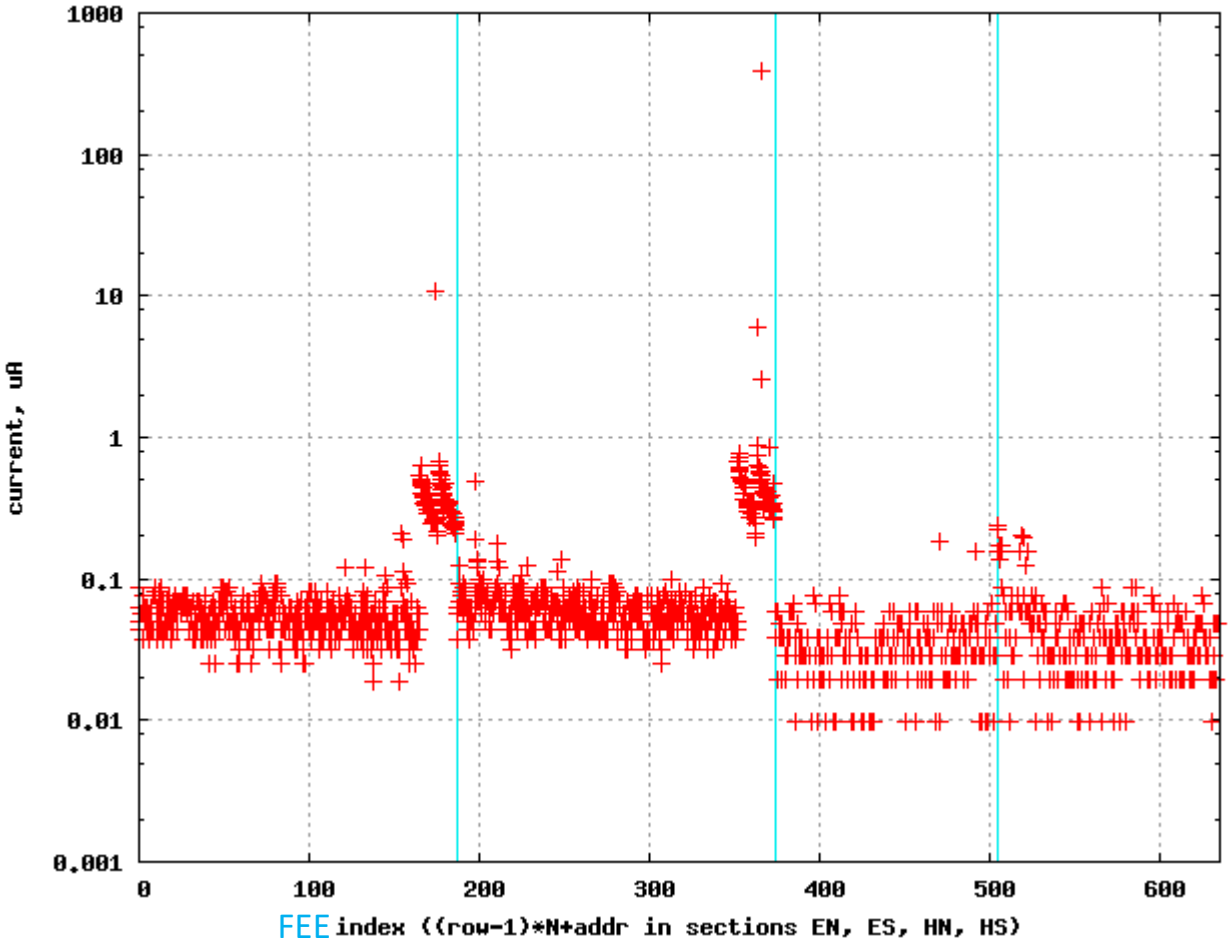
2021 Jan 20

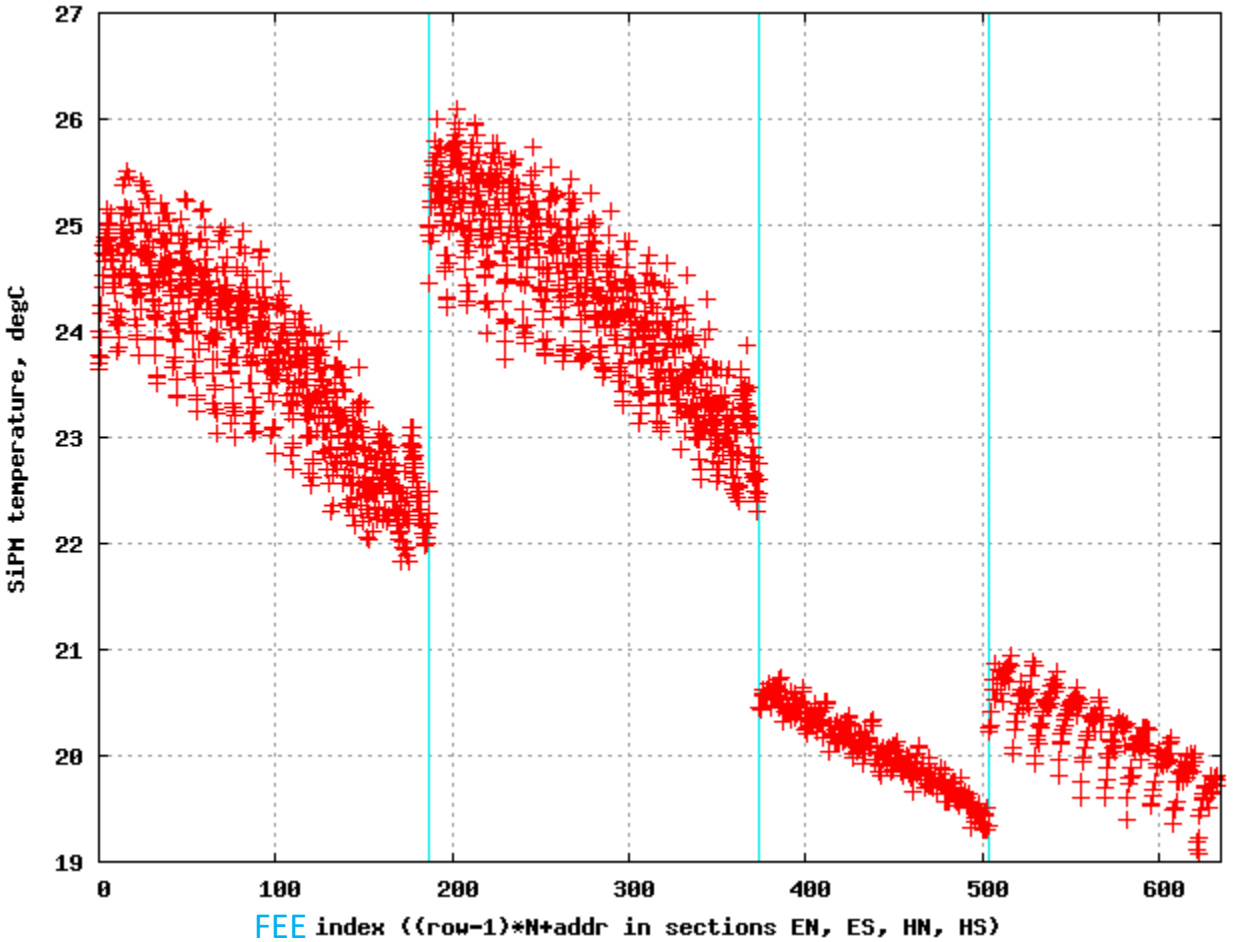
Akio

Slide by Gerard

- 634 FEE, 2016 channels commissioned
- 1 FEE non-responsive, replaced
- 2 FEE “recalled” to IU (problems discovered post test)
- SiPM board connectivity problems with 3, fixed
- 1 apparently failed ECAL SiPM board replaced
- after that – all working we believe

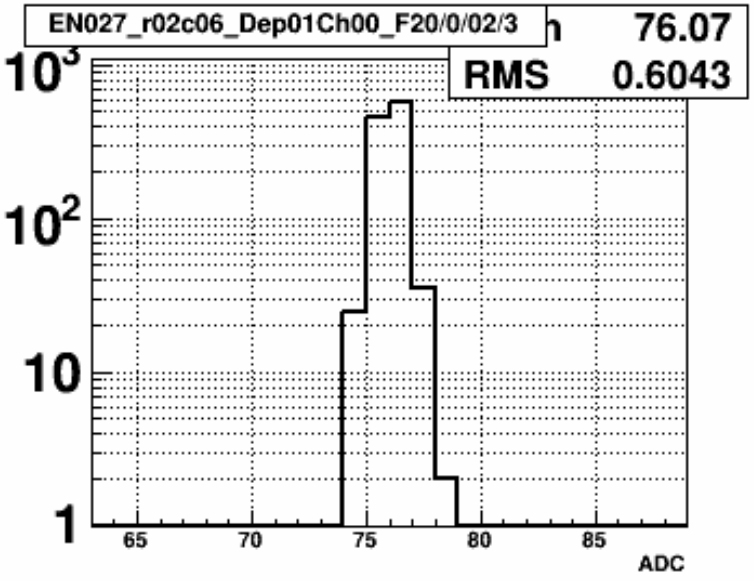
Example FEE monitoring plots below – SiPM currents and temperatures. All SiPM’s show nonzero, almost all reasonable dark currents.
This is after 10 hours warm-up.



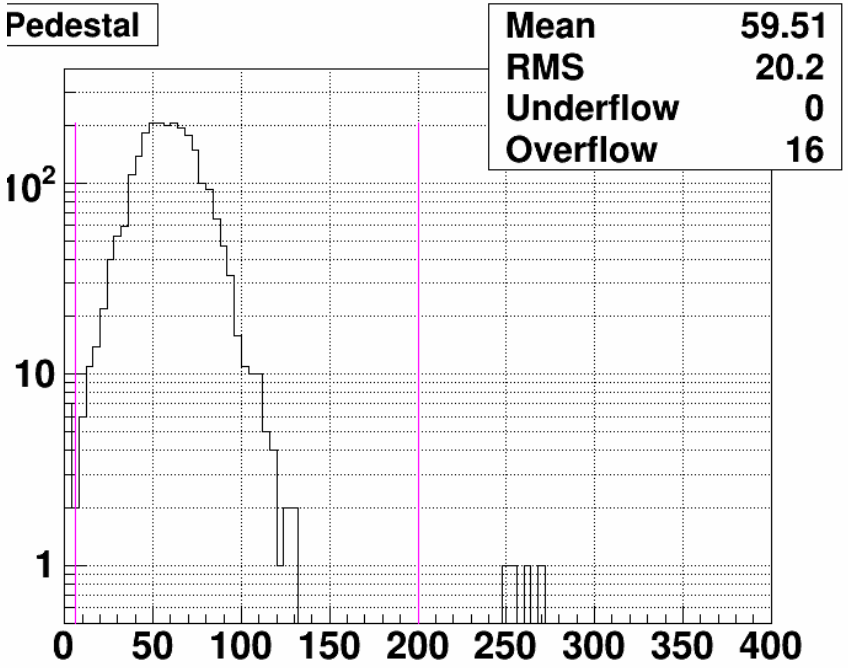


Commissioning : Pedestal

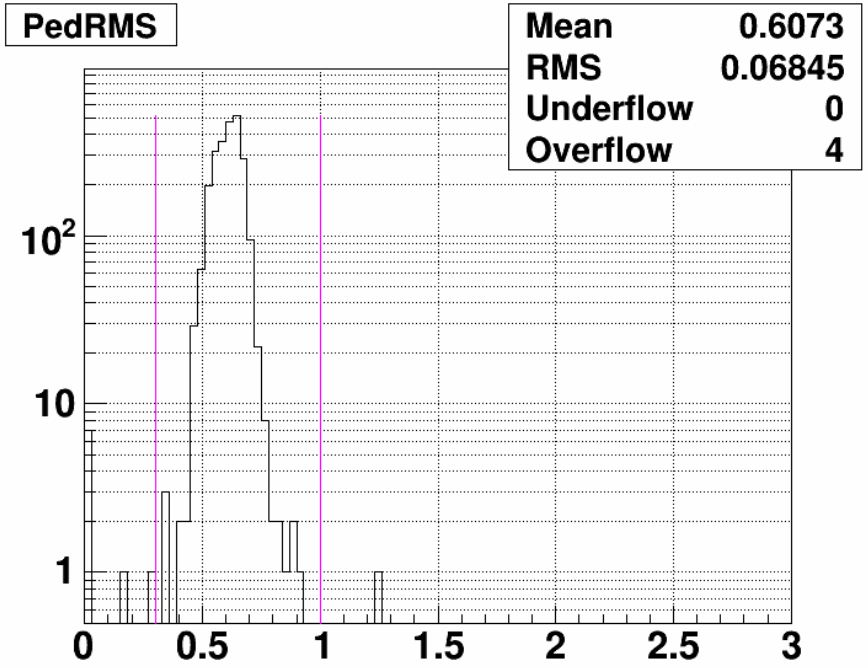
Pedestal for a channel



~20ch with too high/too low pedestals

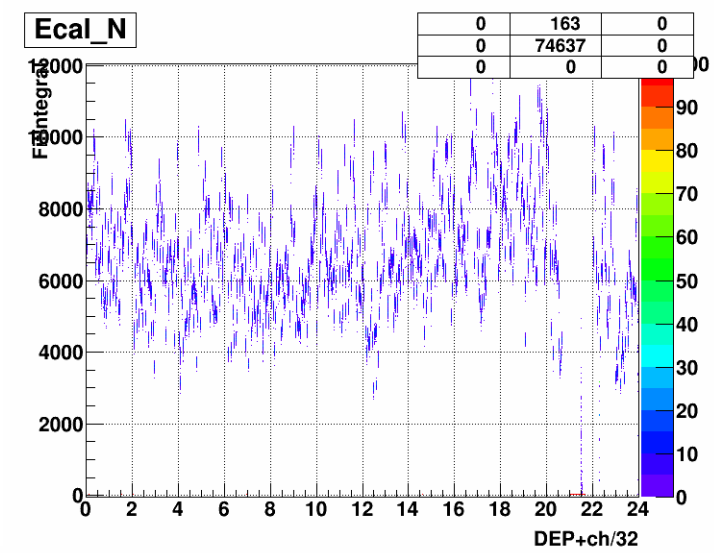


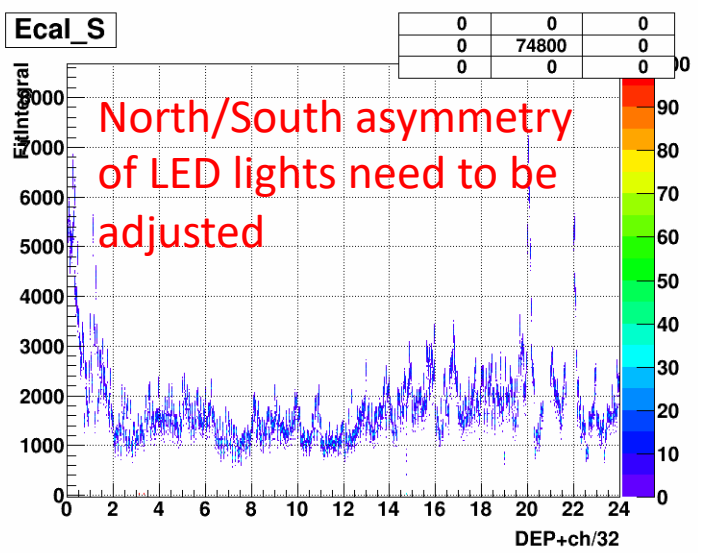
Pedestal RMS ~ 0.6



Commissioning ECAL : LED

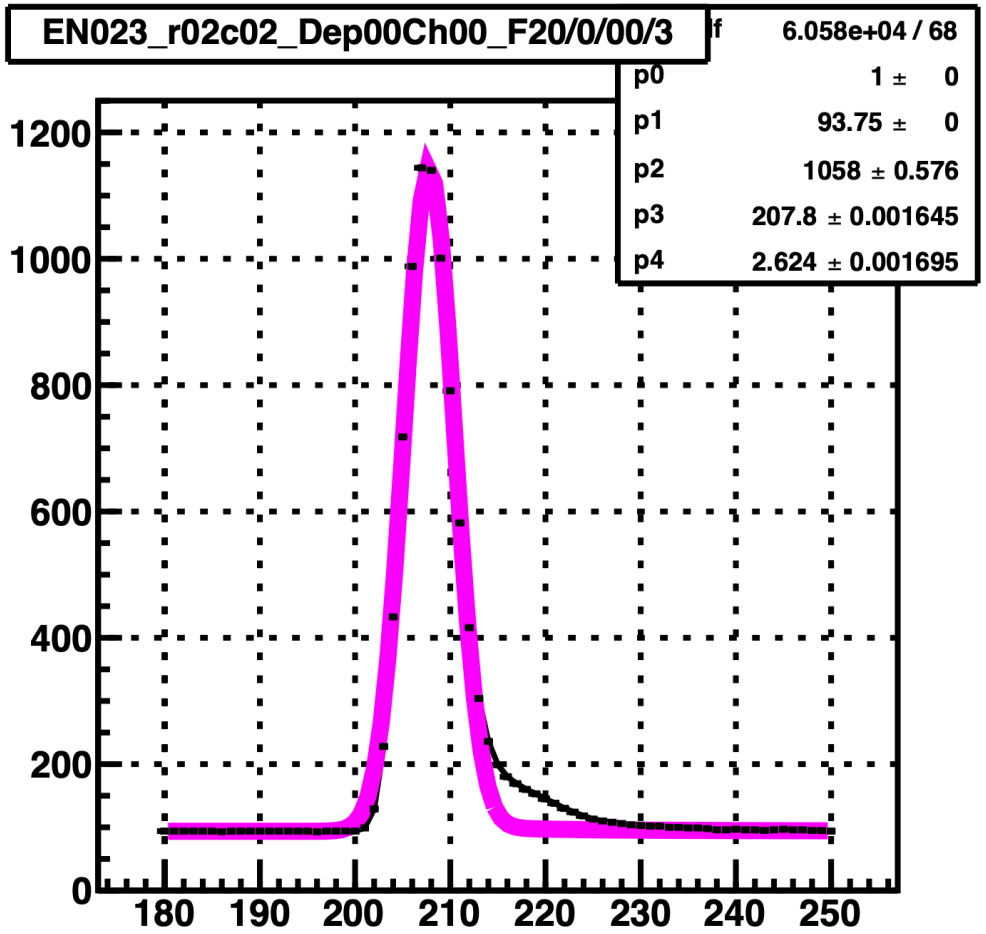
LED pulse integral vs channel



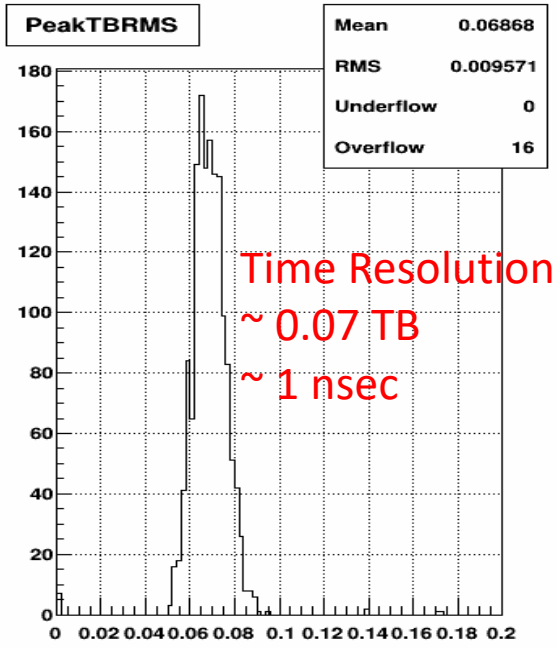


North/South asymmetry of LED lights need to be adjusted

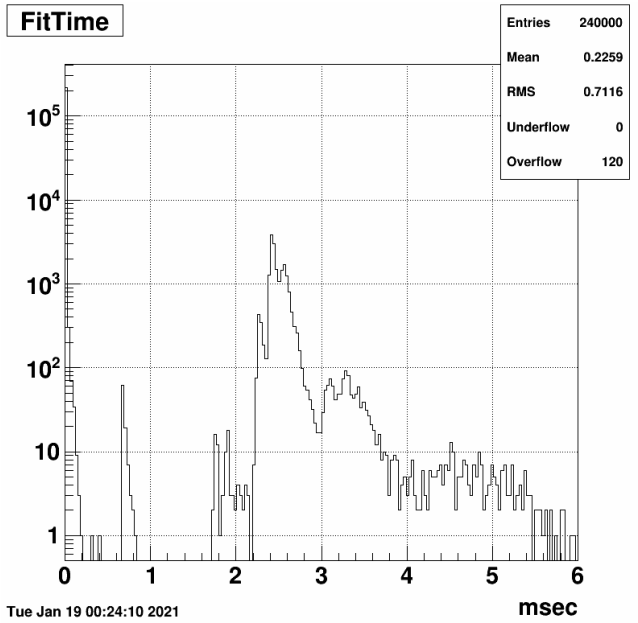
LED pulser vs Time-bin with a Fit



Tail shape is different from test bench data from last summer. Fitting function need to be adjusted



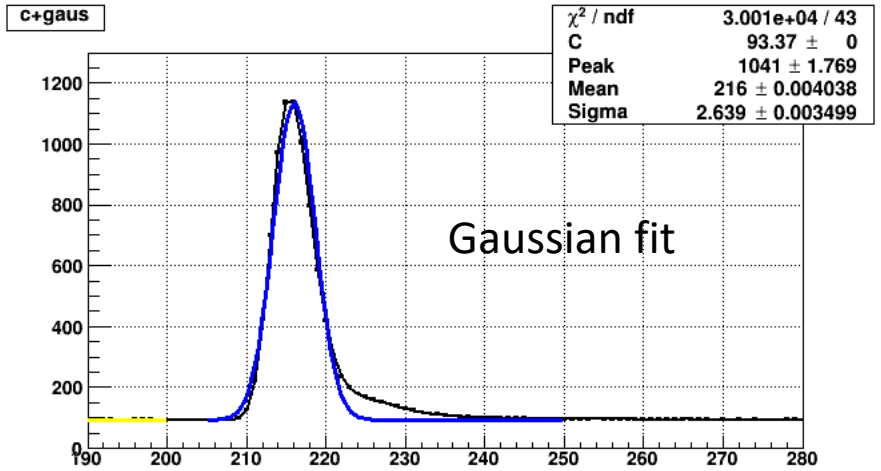
Time Resolution
~ 0.07 TB
~ 1 nsec

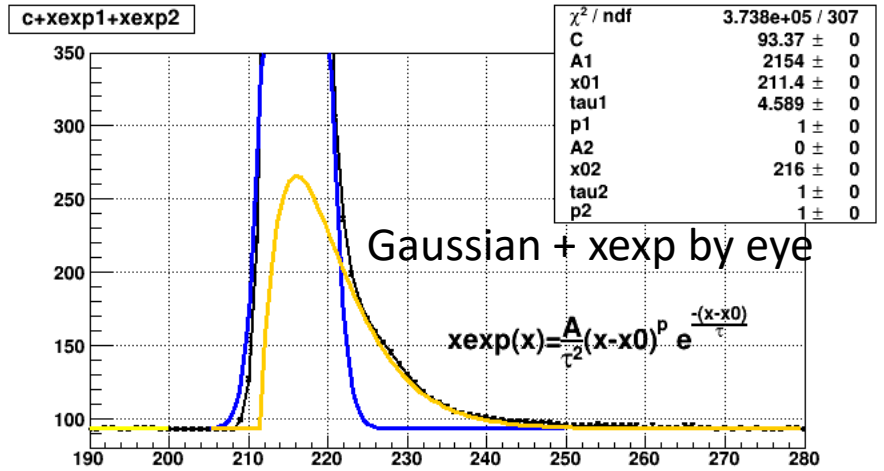


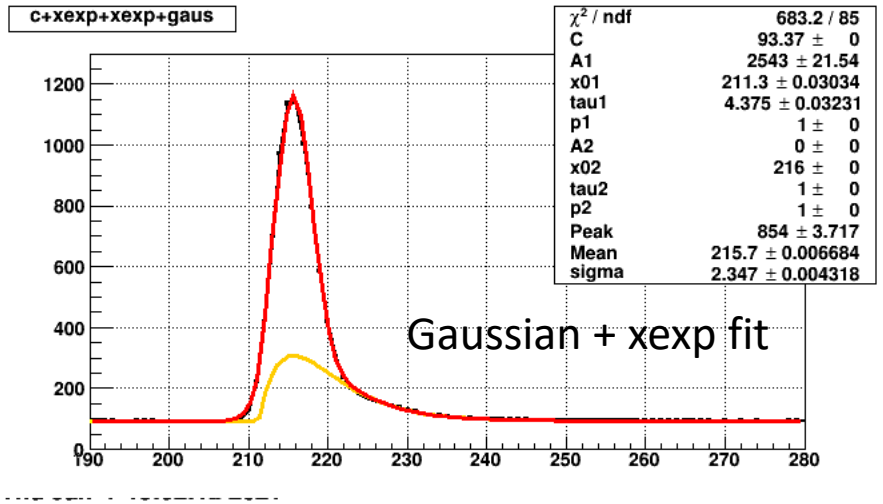
Fitting takes 2~3 msec

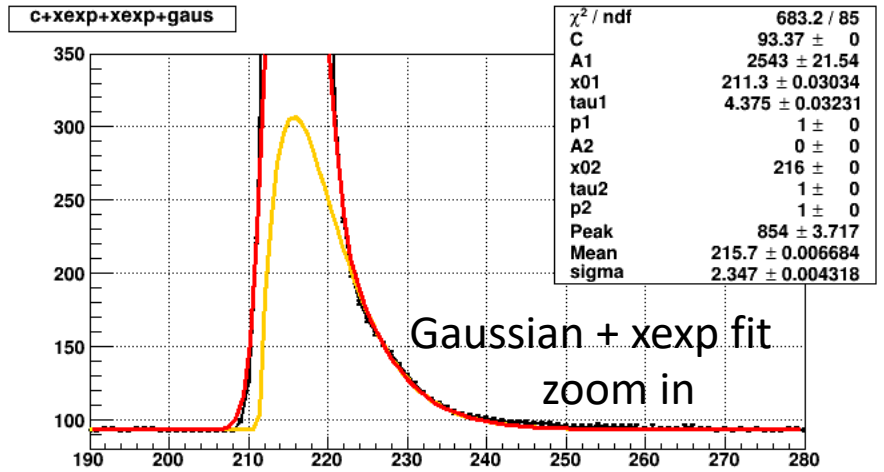
Commissioning ECAL : New tail function for LED (might differ for particle signals)

https://www.star.bnl.gov/protected/spin/akio/fcs/pulse_led/index.html





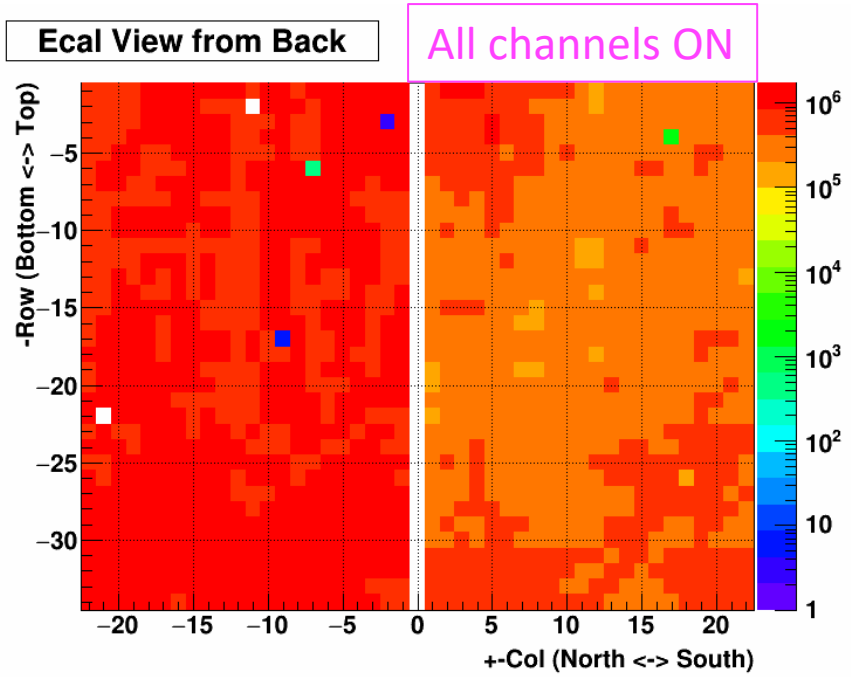


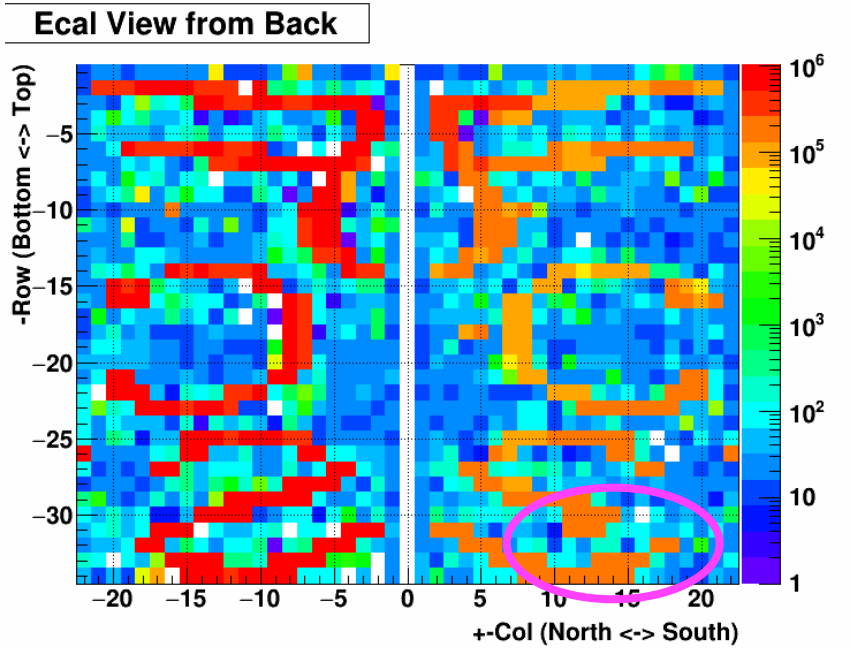


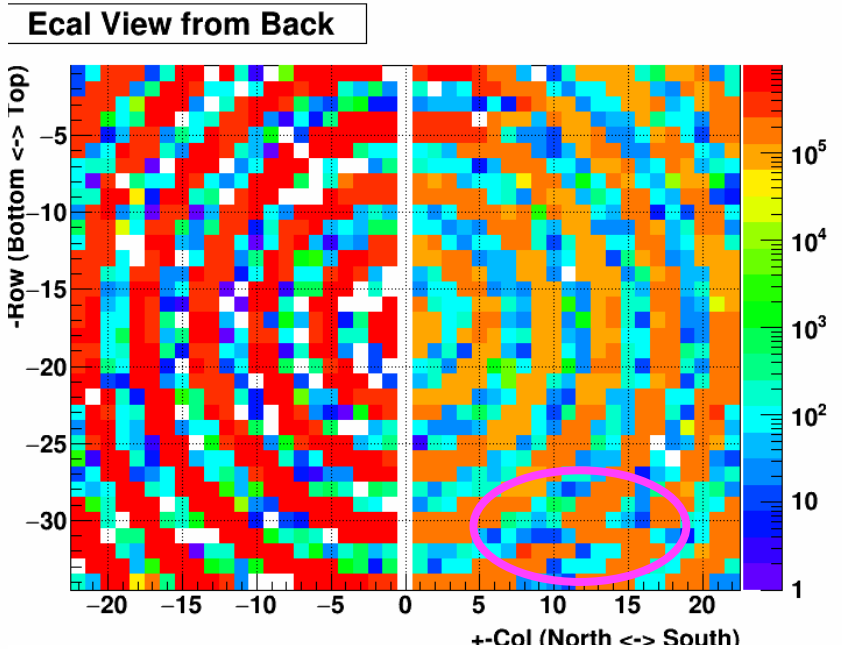
~30% of integral is from “xexp” tail function

In fitting code, tail shape is fixed & height scaled by gaussian integral → only 3 gaussian parameters for fit

Mapping Check with Voltage Patterns



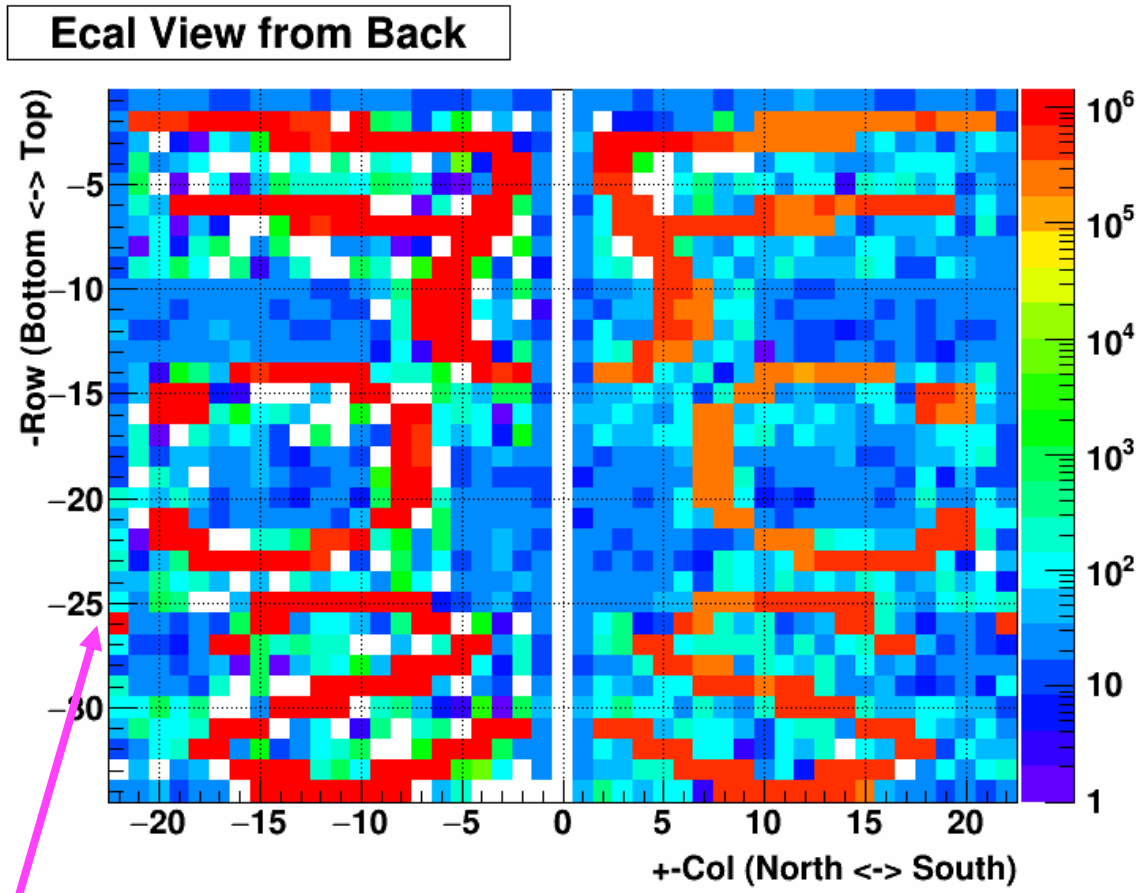




6 bad channels ~ all with DEP problem

Cable issue at South Row=31 Col=12~16

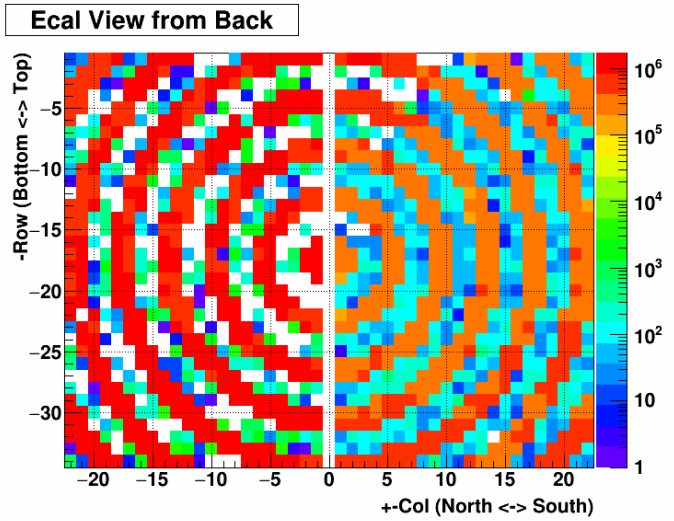
Mapping Check with More Voltage Patterns

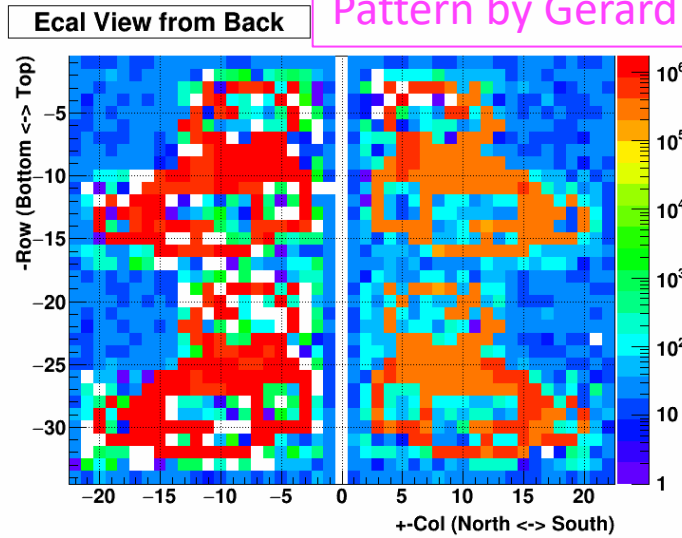


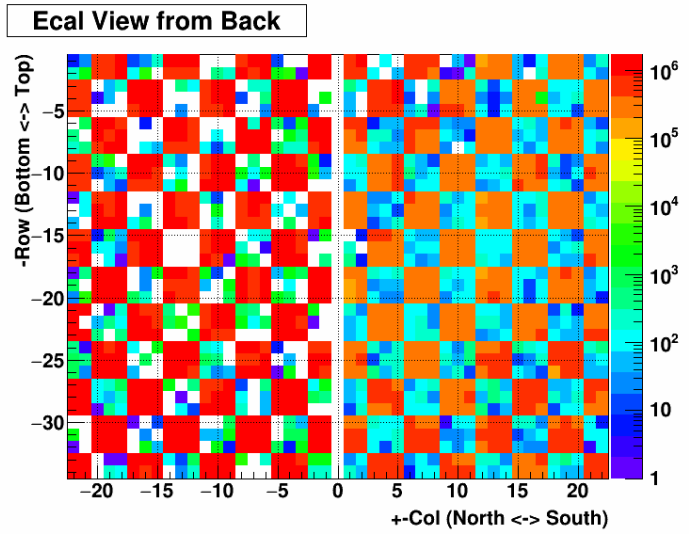
My typo in voltage pattern

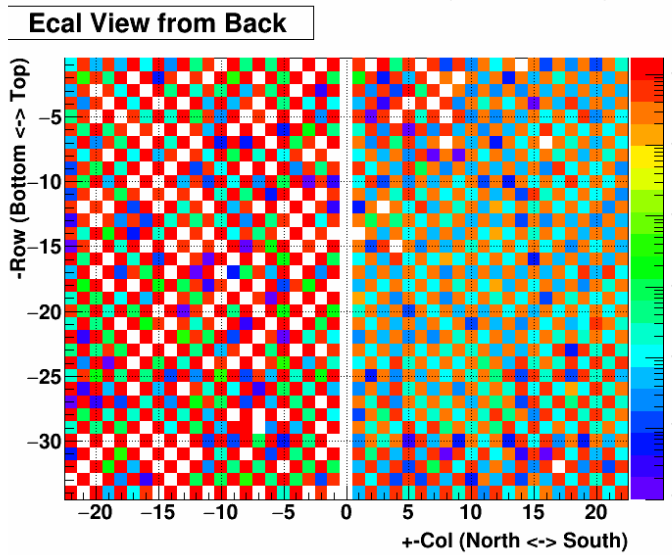
Cable issue at South Row=31 Col=12~16 → FIXED!

Pattern by Gerard





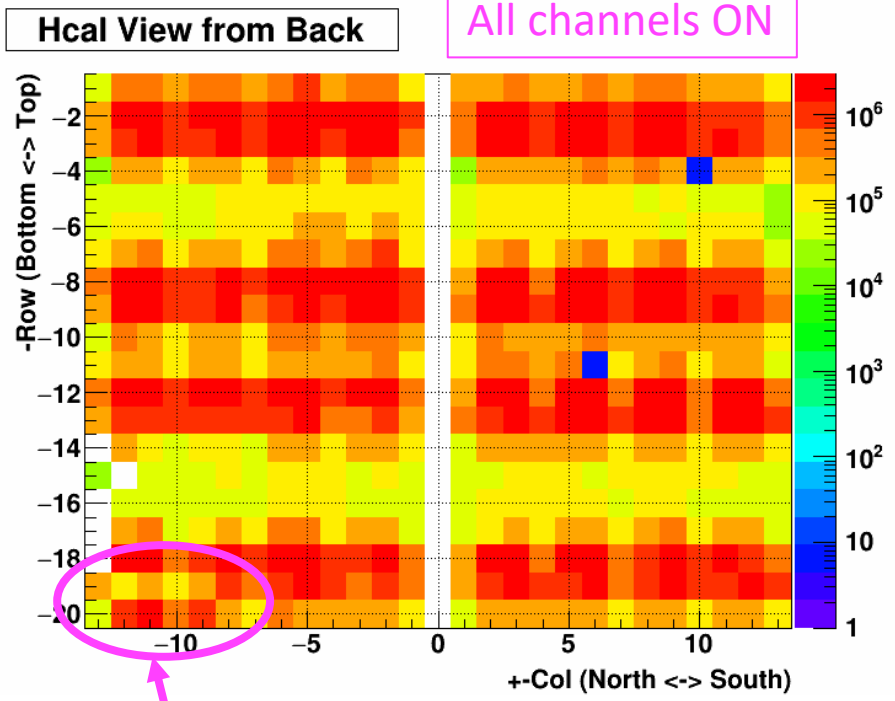




2 more cabling mistakes found and fixed with checkered patterns

Mapping Check with Voltage Patterns : Hcal

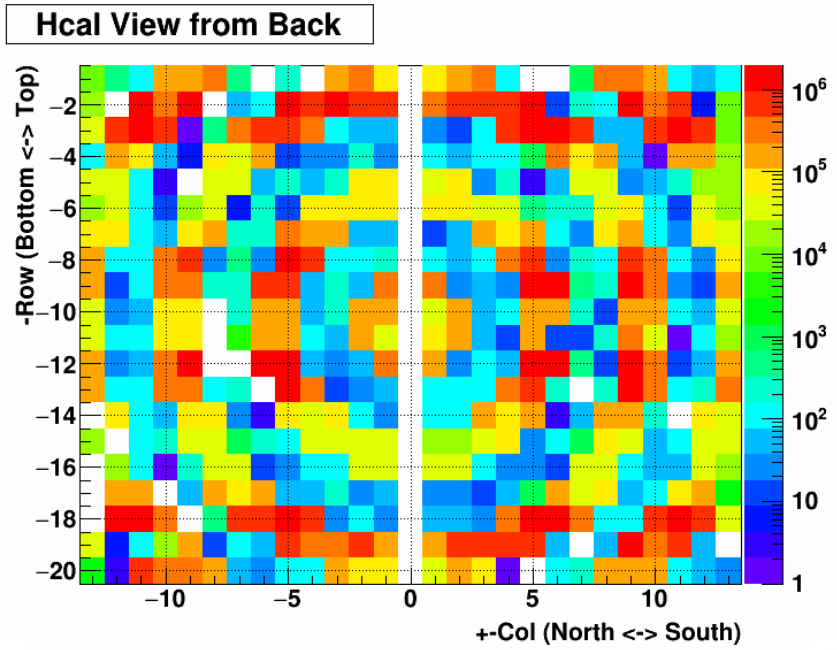
All channels ON



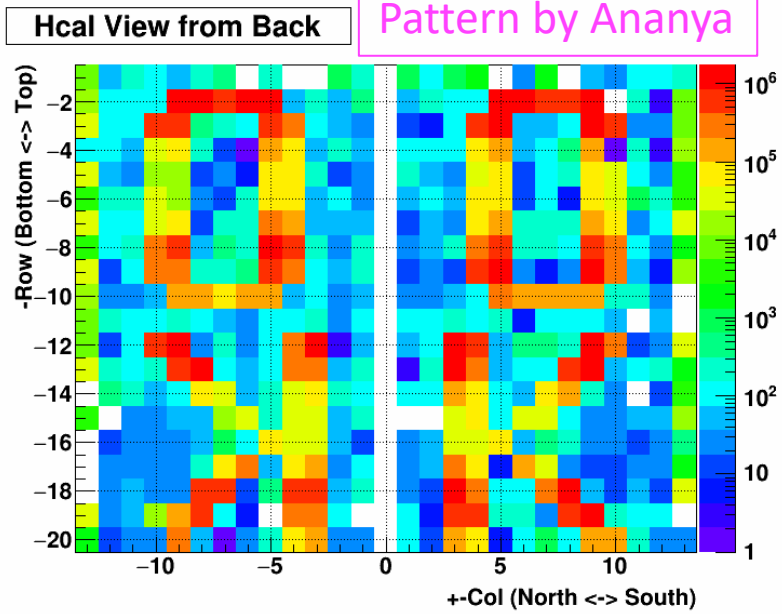
Much less uniform
LED lights at HCal

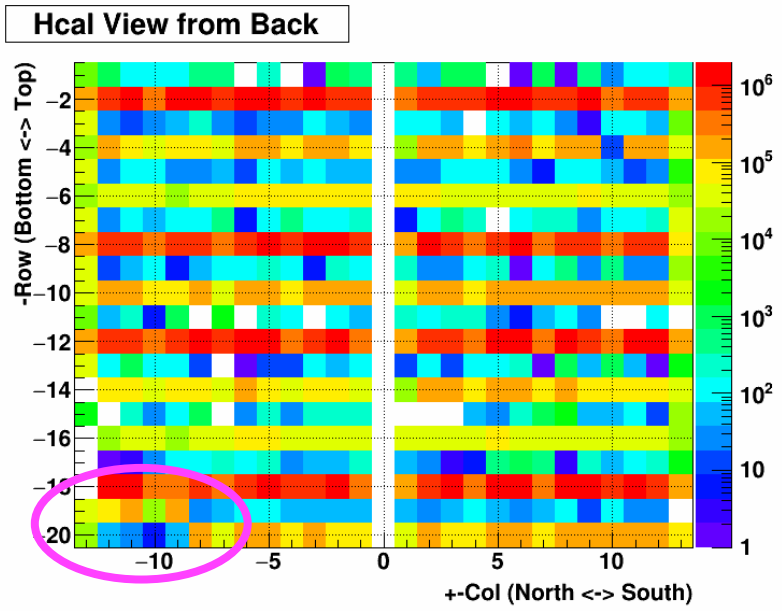
Oleg will work on better
uniformity of the LED lights

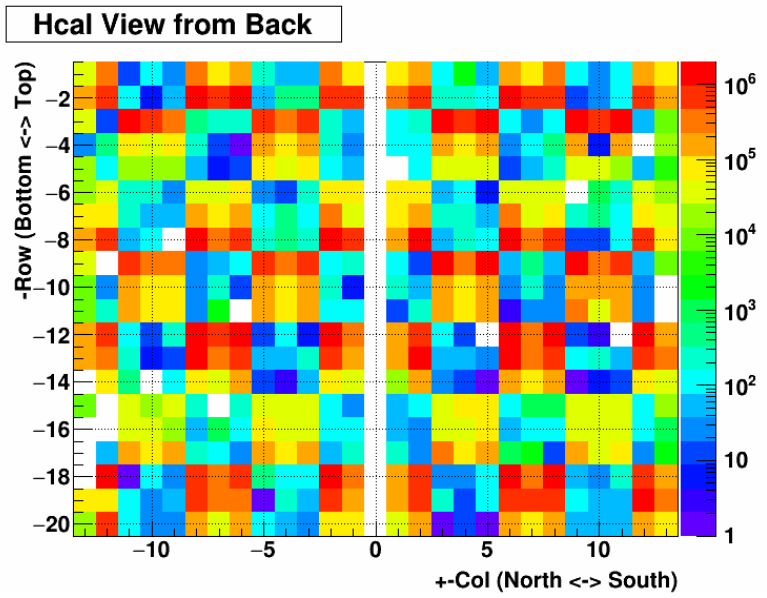
Cabling mistakes found and fixed



Pattern by Ananya







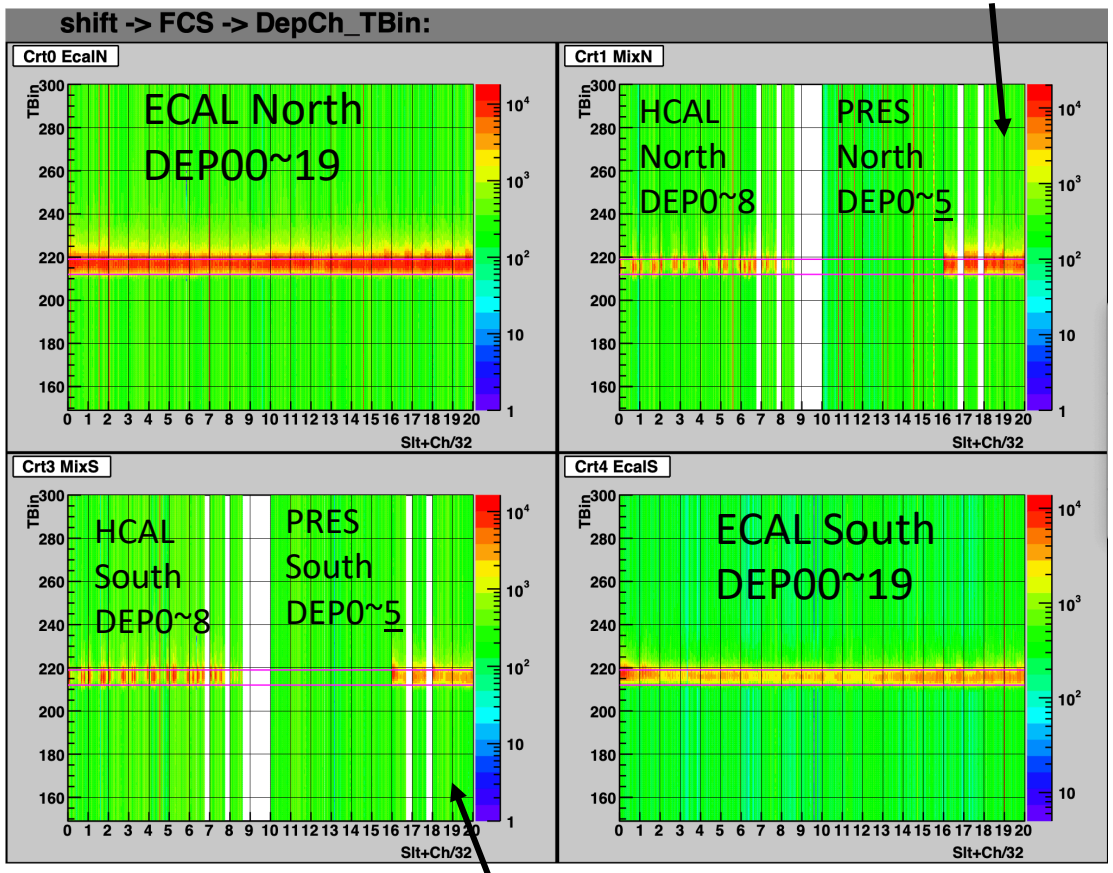
JEVP Plots – already in place and running

Example from STAR LED run : https://online.star.bnl.gov/runPlots/22015009.shift.pdf

Time bin

4 DEP crates views of ch vs time bin

ECAL North DEP20~23



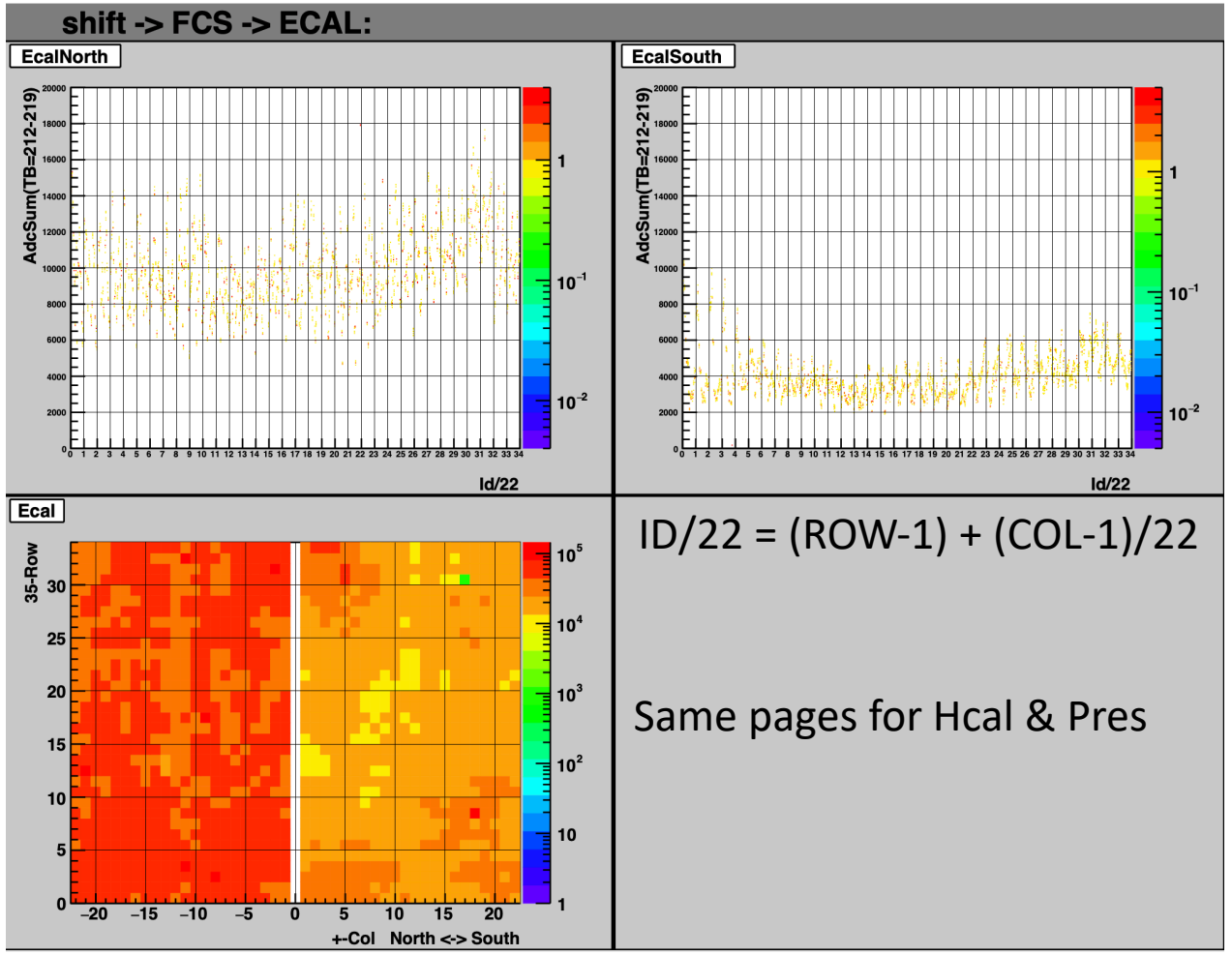
Z=Accumulated ADC

ECAL South DEP20~23

Slot + DEPCH/32

ADCSum

Triggered 8 time bin ADC sums



ID/22 = (ROW-1) + (COL-1)/22

Same pages for Hcal & Pres

Back view (from west side) of Ecal

What else do you want to see in JEVP (for shift crews)?

LED & PED (expert) monitor

https://online.star.bnl.gov/fcs/led/

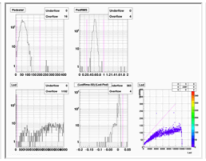
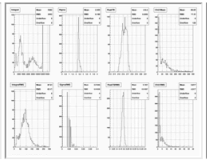
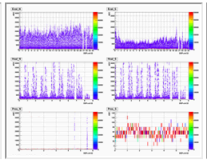
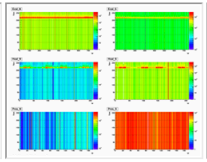
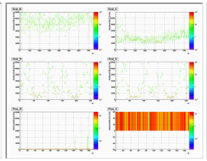
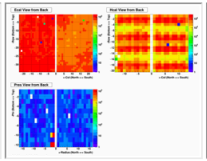
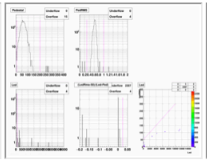
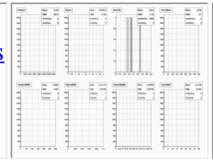
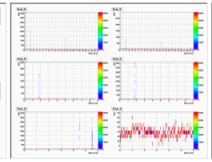
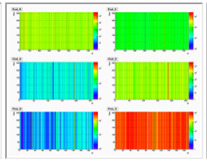
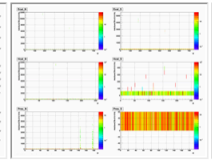
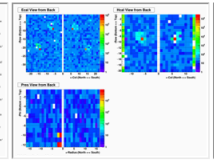
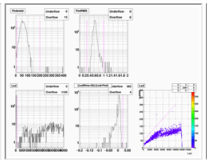
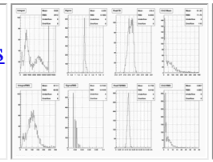
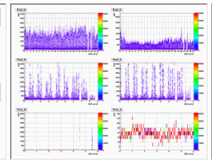
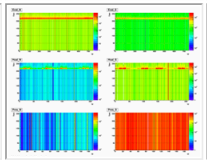
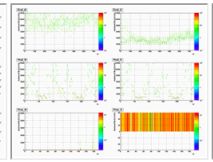
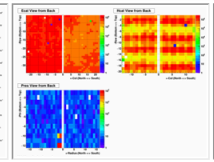
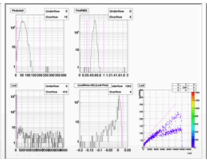
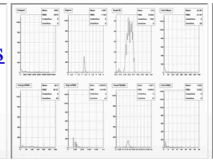
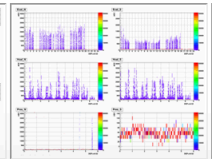
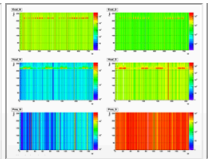
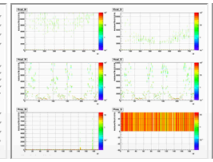
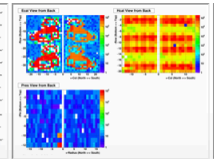
Search and History of a channel

Click any plots to see larger version

FCS LED Monitor

- Please add note by adding a line in onlxx.starp.bnl.gov:/onlineweb/www/fcs2021/led/note.txt
- Add "BADRUN" in the note to remove runs from this page
- Flag and its thresholds
- QA Log Search and Channel History

2364ch good, 36 ch bad (28/16ch with pedestal height/RMS problem, 12ch with LED)

Run	DateTime	S01 File Size[Mb]	QA text Bad ch	Bad reason	Plots	Ped/Led	Fit Plots	Fit Summary	Dep+ch/32 vs ADC All timebins	Id vs Tbin weighted by ADC	Id vs ADC Sum	View from Back/West	Note
1106840 ADC bank	2021/1/19 day19 Tue 00:17:02	30.294	QA text 2364 good 36 bad badch plots	Ped=28 Prms=16 Led=12 Lrat=1	No jEVP PED LED Browse		Samples FitTime FitPlots						
1106836 ADC bank	2021/1/16 day16 Sat 15:04:08	27.330	QA text 2373 good 27 bad badch plots	Ped=25 Prms=17 LED Off? FEE Off?	No jEVP PED LED Browse		Samples FitTime FitPlots						XTALK voltage to see crosstalks
1106835 ADC bank	2021/1/16 day16 Sat 14:47:05	31.147	QA text 2358 good 42 bad badch plots	Ped=26 Prms=26 Led=13 Lrat=1	No jEVP PED LED Browse		Samples FitTime FitPlots						Oleg fixed Hcal North COL9~12 ROW19<->ROW20 Attempt to give more uniform LED for Hcal North
22015012 ADC bank	2021/1/15 day15 Fri 15:15:29	28.424	QA text 2371 good 29 bad badch plots	Ped=27 Prms=17 LED Off? FEE Off?	jEVP PED LED Browse		Samples FitTime FitPlots						Pooh from Gerard

Both Local and STAR LED runs listed

Links to RunLog Browser and JEVP for STAR runs

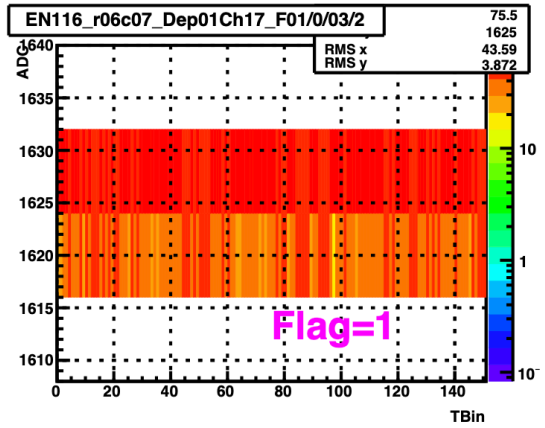
More detailed plots by following “PED” and “LED” and “FIT” links

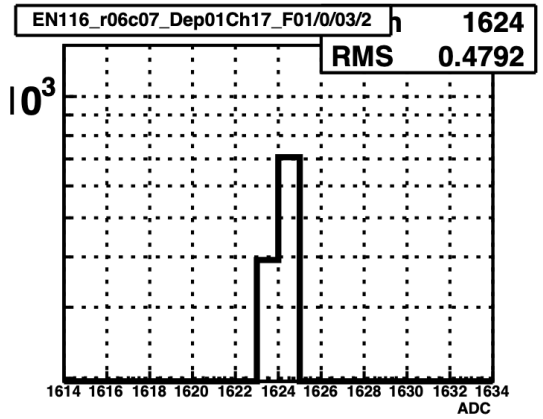
What else do you want to see in LED monitor (for us)?

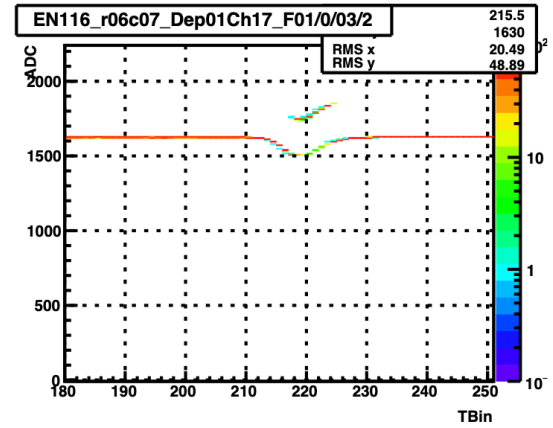
Bad Channel list
36 bad channels

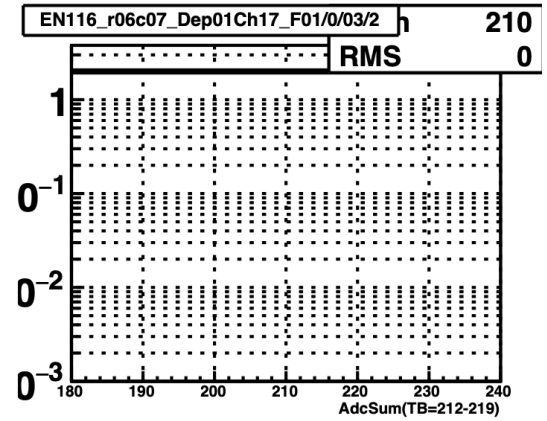
run	name	ped	pedrms	led	ledrms	rms/led	flags	
01106840	EN045_r03c02_Dep00Ch04_F00/0/00/1	3619.60	0.42	30.00	0.00	-1.6667	5	Ped Led
01106840	EN116_r06c07_Dep01Ch17_F01/0/03/2	1624.14	0.48	210.00	0.00	-0.2381	1	Ped
01106840	EN032_r02c11_Dep02Ch01_F20/0/05/2	3040.50	0.00	0.00	0.00	0.0000	7	Ped Prms Led
01106840	EN334_r16c05_Dep05Ch27_F08/0/02/2	0.50	0.00	9462.60	116.44	0.0070	3	Ped Prms
01106840	EN360_r17c09_Dep06Ch31_F09/0/04/0	3585.44	0.40	30.00	0.00	-1.6667	5	Ped Led
01106840	EN482_r22c21_Dep14Ch19_F11/0/10/2	2337.39	0.35	0.00	0.00	0.0000	5	Ped Led
01106840	EN220_r11c01_Dep22Ch09_F06/0/00/0	269.26	0.43	5371.80	68.12	0.0034	1	Ped
01106840	EN725_r33c22_Dep23Ch31_F19/0/10/1	263.50	0.05	9585.60	236.92	0.0195	3	Ped Prms
01106840	ES082_r04c17_Dep03Ch11_F00/0/08/3	18.70	0.94	30.00	0.00	-1.6667	4	Led
01106840	ES306_r14c21_Dep09Ch19_F07/0/10/3	1.73	0.67	2753.40	77.26	0.0099	1	Ped
01106840	ES348_r16c19_Dep09Ch25_F08/0/09/3	5.23	0.71	3358.20	79.80	0.0089	1	Ped
01106840	ES504_r23c21_Dep14Ch23_F12/0/10/1	253.50	0.07	4063.20	233.40	0.0451	11	Ped Prms Lrat
01106840	ES567_r26c18_Dep19Ch00_F13/0/08/2	2467.17	0.50	1726.80	39.87	-0.0059	1	Ped
01106840	ES733_r34c08_Dep21Ch07_F19/0/03/2	253.52	0.92	4948.80	114.15	0.0130	1	Ped
01106840	HN075_r06c11_Dep02Ch14_F02/0/10/1	50.63	1.87	643.80	35.85	-0.0220	2	Prms
01106840	HN193_r15c12_Dep05Ch19_F05/0/11/0	2527.50	0.00	0.00	0.00	0.0000	7	Ped Prms Led
01106840	HN181_r14c13_Dep08Ch13_F03/0/12/1	52.48	0.64	0.00	0.00	0.0000	4	Led
01106840	HN207_r16c13_Dep08Ch15_F05/0/12/1	59.02	1.73	37.50	19.84	-0.8042	6	Prms Led
01106840	HN220_r17c13_Dep08Ch16_F04/1/12/0	68.63	0.62	0.00	0.00	0.0000	4	Led
01106840	HN233_r18c13_Dep08Ch17_F04/1/12/1	61.05	0.64	0.00	0.00	0.0000	4	Led
01106840	HS029_r03c04_Dep00Ch03_F00/0/03/1	0.50	0.00	11344.80	119.45	0.0061	3	Ped Prms
01106840	HS048_r04c10_Dep02Ch05_F00/0/09/0	93.15	0.52	30.00	0.00	-1.6667	4	Led
01106840	HS135_r11c06_Dep04Ch01_F08/1/05/1	50.80	0.55	30.00	0.00	-1.6667	4	Led
01106840	HS187_r15c06_Dep04Ch17_F05/0/05/1	2451.26	0.83	570.00	18.97	-0.0544	1	Ped
01106840	HS007_r01c08_Dep06Ch11_F06/0/07/1	0.50	0.00	4391.40	77.63	0.0063	3	Ped Prms
01106840	PN026_r02c11_Dep00Ch26_F00/0/00/0	4095.50	0.00	0.00	0.00	0.0000	3	Ped Prms
01106840	PN031_r02c16_Dep00Ch31_F00/0/00/0	3597.51	0.50	30.00	0.00	-1.6667	1	Ped
01106840	PN051_r04c04_Dep01Ch19_F00/0/00/0	3606.38	0.43	30.00	0.00	-1.6667	1	Ped
01106840	PN095_r06c16_Dep02Ch31_F00/0/00/0	250.51	0.12	30.00	0.00	-1.6667	3	Ped Prms
01106840	PN104_r07c09_Dep03Ch08_F00/0/00/0	1822.15	0.48	0.00	0.00	0.0000	1	Ped
01106840	PN144_r10c01_Dep04Ch16_F00/0/00/0	1642.16	692.90	2128.70	1461.28	0.6630	3	Ped Prms
01106840	PN145_r10c02_Dep04Ch17_F00/0/00/0	4069.61	55.22	119.52	84.09	0.2852	3	Ped Prms
01106840	PN176_r12c01_Dep05Ch16_F00/0/00/0	633.39	887.70	2544.34	2602.33	1.0031	3	Ped Prms
01106840	PN177_r12c02_Dep05Ch17_F00/0/00/0	740.03	552.21	2027.65	1428.45	0.6798	3	Ped Prms
01106840	PS085_r06c06_Dep02Ch21_F00/0/00/0	0.50	0.00	0.00	0.00	0.0000	3	Ped Prms
01106840	PS101_r07c06_Dep03Ch05_F00/0/00/0	3.66	0.61	30.00	0.00	-1.6667	1	Ped

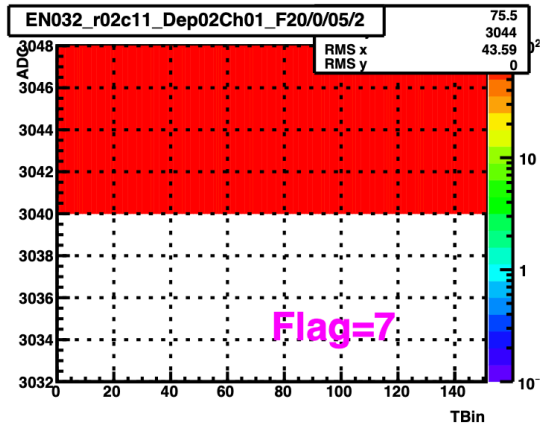
Bad Channel plots

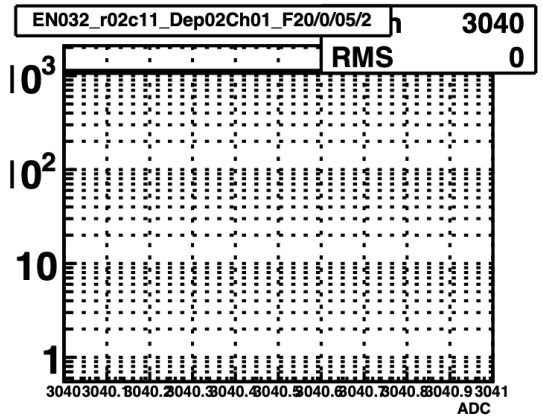


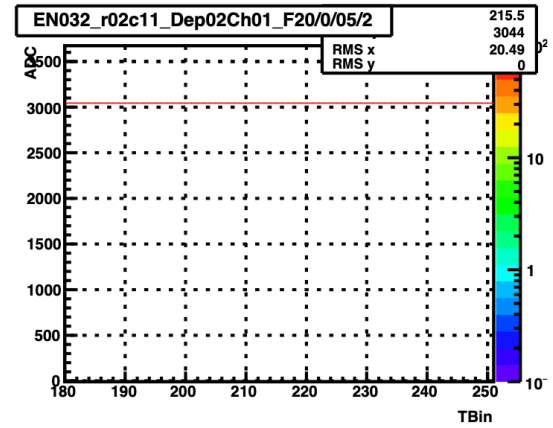


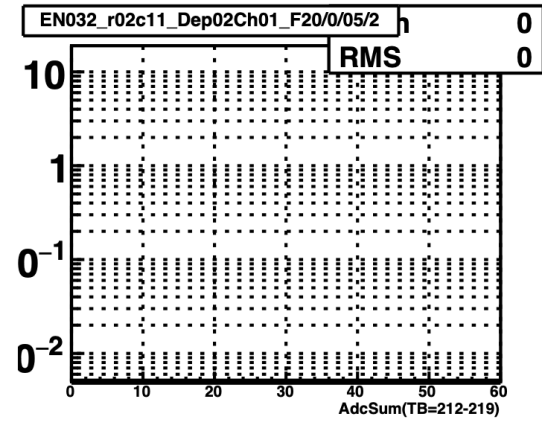


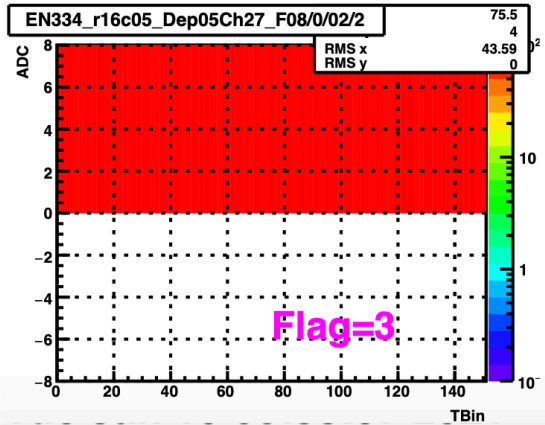


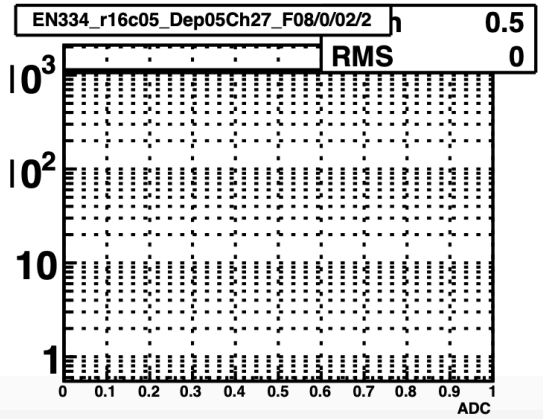


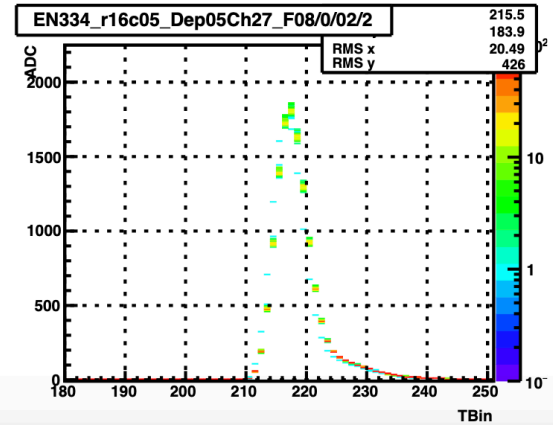


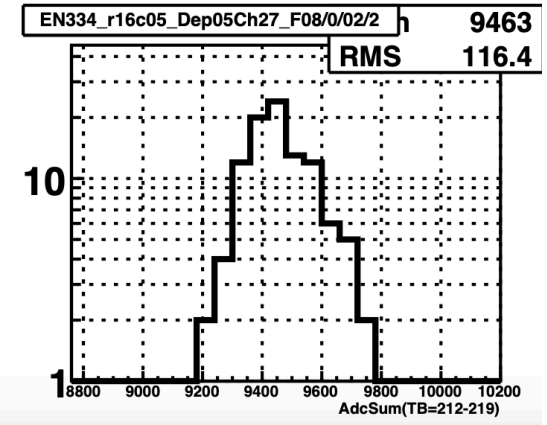












FCS Run21 QA Log Search

Ecal North Id= Search

Ecal North Row= Col= Search

Ecal North DEP= Ch= Search

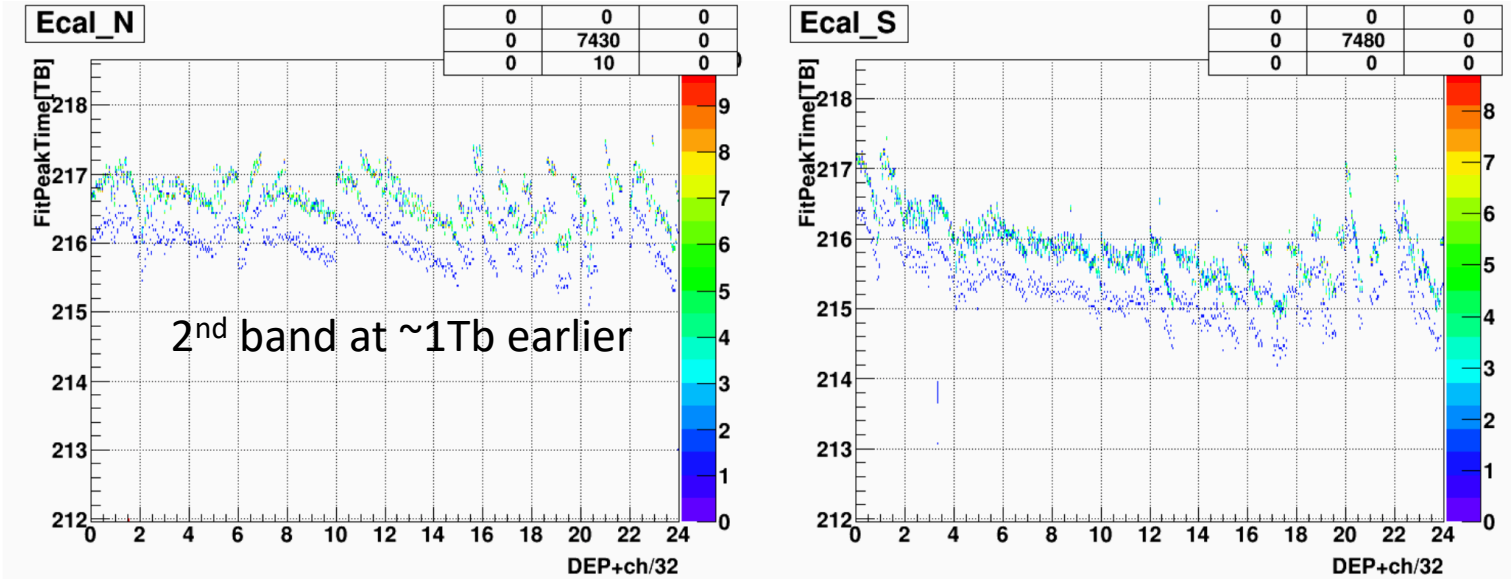
Any text 011068 EN033 Search

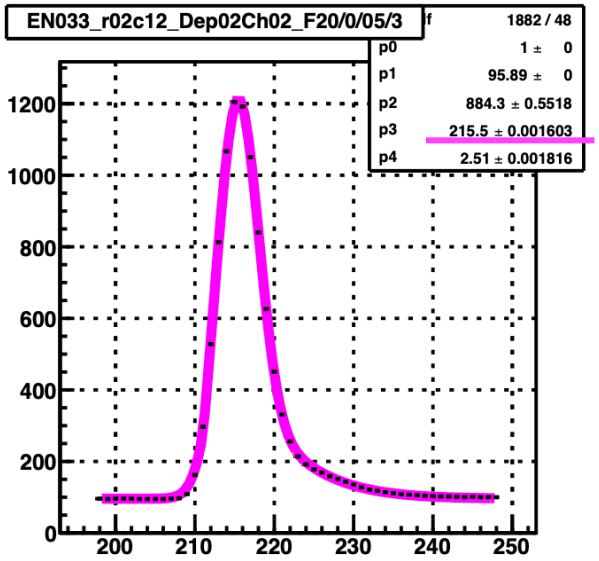
Searching: "011068" "EN033"

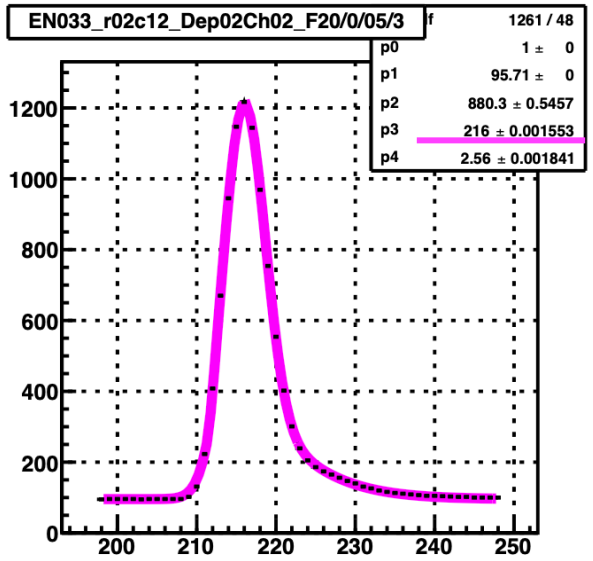
UnixTime	Run	Name	Ped	PedRms	Led	LedRms	Rms/Led	Flag	
1610561610	01106800	EN033_r02c12_Dep02Ch02_F20/0/05/3	95.72	0.56	6755.40	106.01	0.0083	0	Good LedOrFeeOff?
1610561680	01106801	EN033_r02c12_Dep02Ch02_F20/0/05/3	95.92	0.56	30.00	0.00	-1.6667	4	Led LedOrFeeOff?
1610561736	01106802	EN033_r02c12_Dep02Ch02_F20/0/05/3	96.35	0.56	6754.80	91.66	0.0062	0	Good LedOrFeeOff?
1610561795	01106803	EN033_r02c12_Dep02Ch02_F20/0/05/3	95.62	0.55	6736.20	93.67	0.0065	0	Good LedOrFeeOff?
1610561824	01106804	EN033_r02c12_Dep02Ch02_F20/0/05/3	95.60	0.58	30.00	0.00	-1.6667	4	Led LedOrFeeOff?
1610565459	01106805	EN033_r02c12_Dep02Ch02_F20/0/05/3	96.17	0.58	6775.20	92.24	0.0062	0	Good LedOrFeeOff?
1610724684	01106833	EN033_r02c12_Dep02Ch02_F20/0/05/3	95.65	0.56	6721.80	86.72	0.0055	0	Good LedOrFeeOff?
1610726521	01106834	EN033_r02c12_Dep02Ch02_F20/0/05/3	95.98	0.58	6702.00	96.00	0.0069	0	Good LedOrFeeOff?
1610826425	01106835	EN033_r02c12_Dep02Ch02_F20/0/05/3	95.57	0.53	6700.80	96.52	0.0069	0	Good
1610827448	01106836	EN033_r02c12_Dep02Ch02_F20/0/05/3	95.74	0.56	30.00	0.00	-1.6667	4	Led LedOrFeeOff?
1610987414	01106837	EN033_r02c12_Dep02Ch02_F20/0/05/3	96.02	0.59	6663.00	92.32	0.0064	0	Good
1611031166	01106838	EN033_r02c12_Dep02Ch02_F20/0/05/3	96.60	0.61	6684.60	92.99	0.0064	0	Good
1611033378	01106839	EN033_r02c12_Dep02Ch02_F20/0/05/3	96.19	0.59	6676.20	91.73	0.0062	0	Good
1611033422	01106840	EN033_r02c12_Dep02Ch02_F20/0/05/3	95.89	0.58	6686.40	104.55	0.0082	0	Good

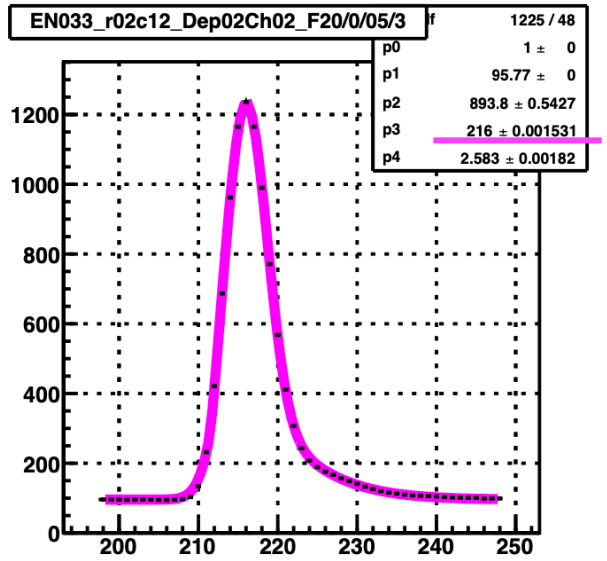
You can see pedestal and LED history/stability for a channel here (need to come up with a way to show this for all ch)

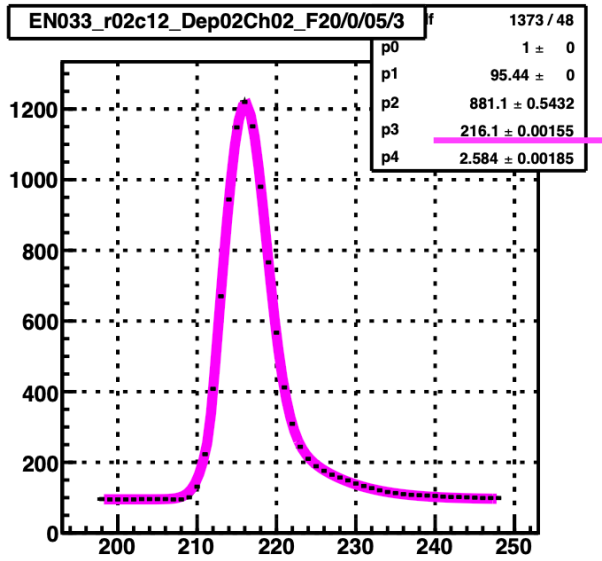
Time shift by 0.5~1 Time bin for 1st/2nd event





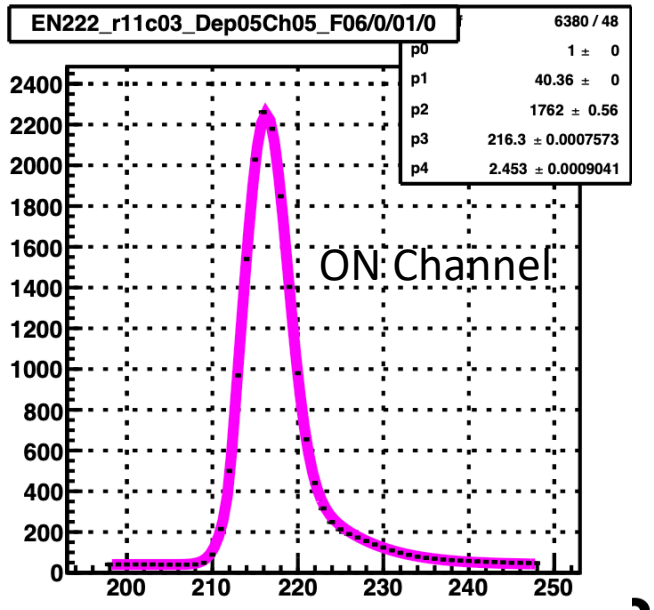


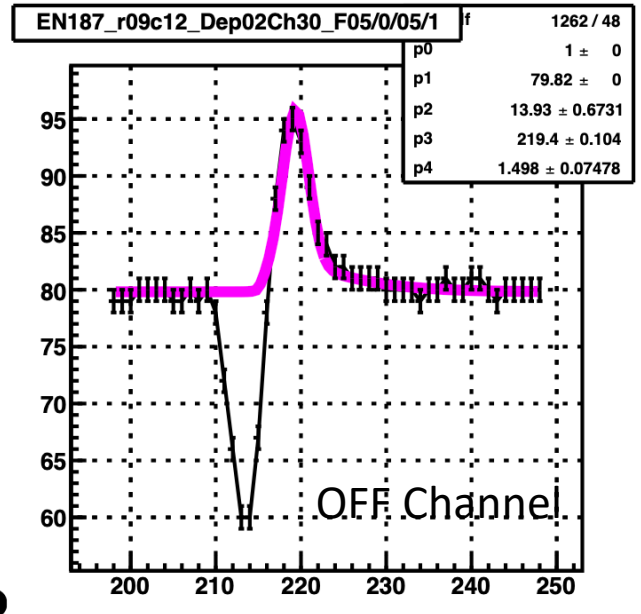


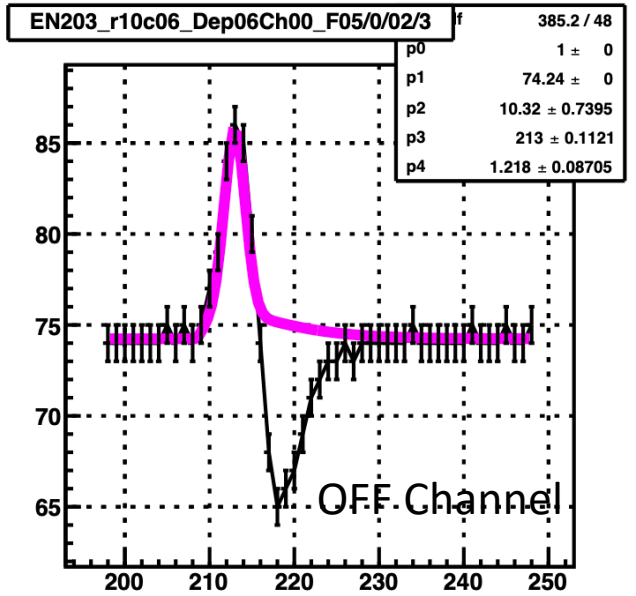



```
EN033_r02c12_Dep02Ch02_F20/0/05/3 mMinTB=206 mMaxTB=228 :   96   96   98  110  162  299  533  826 1084 1224 1210 1065  850  633  458  335  260  218  194  179  170  160  151
EN033_r02c12_Dep02Ch02_F20/0/05/3 mMinTB=206 mMaxTB=228 :   96   96   96  102  130  219  402  663  939 1147 1222 1156  985  769  569  413  308  245  208  188  175  166  157
EN033_r02c12_Dep02Ch02_F20/0/05/3 mMinTB=206 mMaxTB=228 :   97   96   97  102  133  228  415  681  958 1161 1228 1152  976  759  560  407  304  243  209  189  176  167  157
EN033_r02c12_Dep02Ch02_F20/0/05/3 mMinTB=206 mMaxTB=228 :   97   96   96  102  131  222  409  679  965 1175 1248 1174  994  772  567  410  305  244  209  189  177  167  159
EN033_r02c12_Dep02Ch02_F20/0/05/3 mMinTB=206 mMaxTB=228 :   96   96   97  102  131  226  415  681  958 1161 1231 1160  985  768  566  411  307  244  208  190  177  167  158
EN033_r02c12_Dep02Ch02_F20/0/05/3 mMinTB=206 mMaxTB=228 :   96   95   96  102  131  226  417  689  969 1172 1236 1157  977  757  556  403  301  241  207  188  176  166  157
EN033_r02c12_Dep02Ch02_F20/0/05/3 mMinTB=206 mMaxTB=228 :   96   96   97  102  132  225  414  679  957 1164 1240 1171  996  777  573  415  308  245  210  190  177  167  159
EN033_r02c12_Dep02Ch02_F20/0/05/3 mMinTB=206 mMaxTB=228 :   96   96   96  102  133  229  421  690  968 1174 1245 1172  995  773  568  411  306  244  209  189  177  167  158
```

Cross Talks





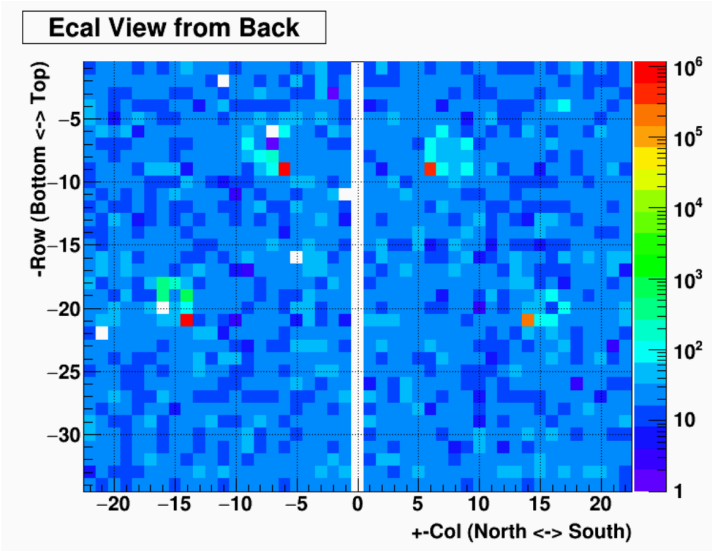


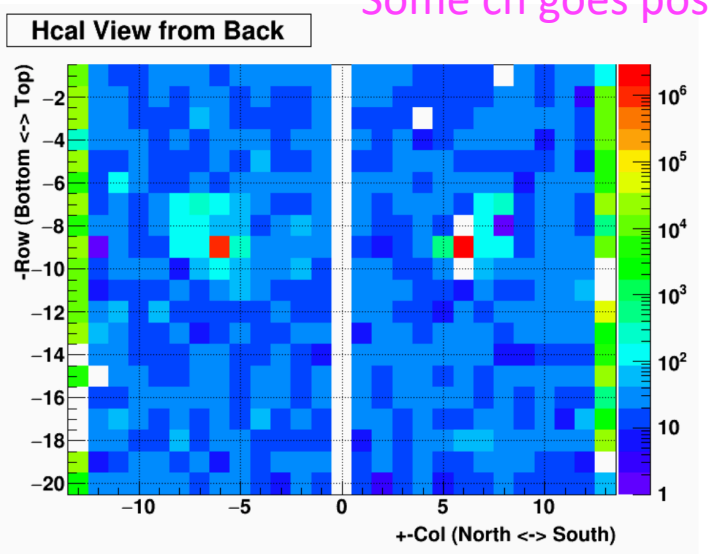
~20ch or ~1% cross talks in mapping check run
- ½ ch ON and very high
- ½ ch OFF

Much bigger cross talks than usual physics events

Some ch goes negative then positive
Some ch goes positive then negative

Current Fitting fails on those
Simple sum does better
PS/ZS?
Trigger and Offline separately





Run 1106836
Only 6ch are ON

We think we see cross talks in the long MDR cable (4x4=16ch) as expected

Too minor or need further look and quantify? Any taker?

Commissioning Plans

- Temperature gain compensation check & study
- FEEBd attenuator check & study

- FCS Trigger commissioning (see last slide / later talk by Tonko & Akio)
  - EPD to DEP Splitter, commissioning for timing & Trigger by ~April
- Pedestal and LED runs once a day by shift crew?
  - Pedestal stability
  - Long term LED stability
- Voltage control by expert only?
- Slow control – What do we ask shift crew to monitor?
- FCS operation manual for shift crews and for experts

- FCS data taking with Run21 STAR (main) physics triggers on AuAu 7.7GeV (3.85GeV Au beam) and others?
  - MIP from ~1/2 of charged hadrons at Ecal?
  - MIP from ~1% of charged hadrons at Hcal?
  - 3.85GeV proton/neutron, 7.7GeV deuteron or 16.4GeV Alpha?
    - https://www.star.bnl.gov/protected/spin/akio/fcs/auau7.7/index.html
    - DPMJET3 + Geant4STAR simulations
- Cosmic from sky when beam is off and trigger is ready
- Fix DEP channels when we have access & Tim is back

Commissioning tasks – Please participate!

1. Mapping check voltage pattern - Ananya
2. Temperature gain compensation study
3. FEEBd attenuator study
4. Cross talk study (maybe minor)
5. Time-bin shift study (maybe minor)
6. Short & long term stability/history for PED & LED
7. Slow control for LED box
8. FCS operation manuals for shift crew & expert
9. Expanding jEVP (as needed)
10. Expanding LED expert monitor (as needed)
11. Physics run expert monitor (On local file? On EVP? Or just Offline?)
12. Trigger commissioning
    - Making “PHYSICS” (like DY event, Jet event) gain file from MC
    - Running and understanding Bit-Checker, maybe making online QA out of this?
13. Analysis
    - Cosmic (from sky)
    - MIP from charged hadrons on Ecal
    - MIP from charged hadrons on Hcal
    - Beam fragments (P,N,D,Alpha)?
      - DPMJET3 + Geant4STAR simulations
    - Speeding up pulse shape fit (2msec maybe too slow)
14. 510A LAB test of HCAL with cosmic (tower on vertical orientation)

See Construction Page for more details:
https://www.star.bnl.gov/protected/spin/akio/fcs/construction/

Trigger Commissioning

Baseline Trigger Algo specified :

https://www.star.bnl.gov/protected/spin/akio/fcs/trigger.html (Akio's webpage)
https://www.star.bnl.gov/protected/spin/akio/fcs/fcs_stage2_2020.pdf (by Eleanor)
https://www.star.bnl.gov/cgi-bin/protected/viewvc.cgi/cvsroot/StRoot/RTS/src/TRG_FCS/ (C++)

Past : Stage 0 and stage 1 was done by Tonko

This week : Christian is finishing the first pass of "Full 2022 algo" VHDL code for Stage 2
Tonko "test fit" Christian's VHDL code to his project to see if it fits
Eleanor cross checks Christian's code
Wiggle test for 1 FCS trigger bit in TCU and Triggering STAR

~January : Tonko finishes his "Bit checker" framework with simplest HT trigger
Akio (and someone else?) will actually run the bit checker

~February : Christian finishes stage 3 VHDL
More FCS bits on TCU
Internal and external (to STAR trigger) timing commissioning

~April : Akio (or someone else) will generate "physics pattern" gain file
and run with LED & full algorithm
Cosmic (from sky) trigger when beam is OFF?
EPD splitter and timing commissioning