FCAL Status Report

IU FCAL Team

GlueX Collaboration Meeting
May 12, 2015

Outline

- Detector configuration for spring run

- Calibration

  - first look at spring data

- CW bases

  - overall health

  - control and monitoring

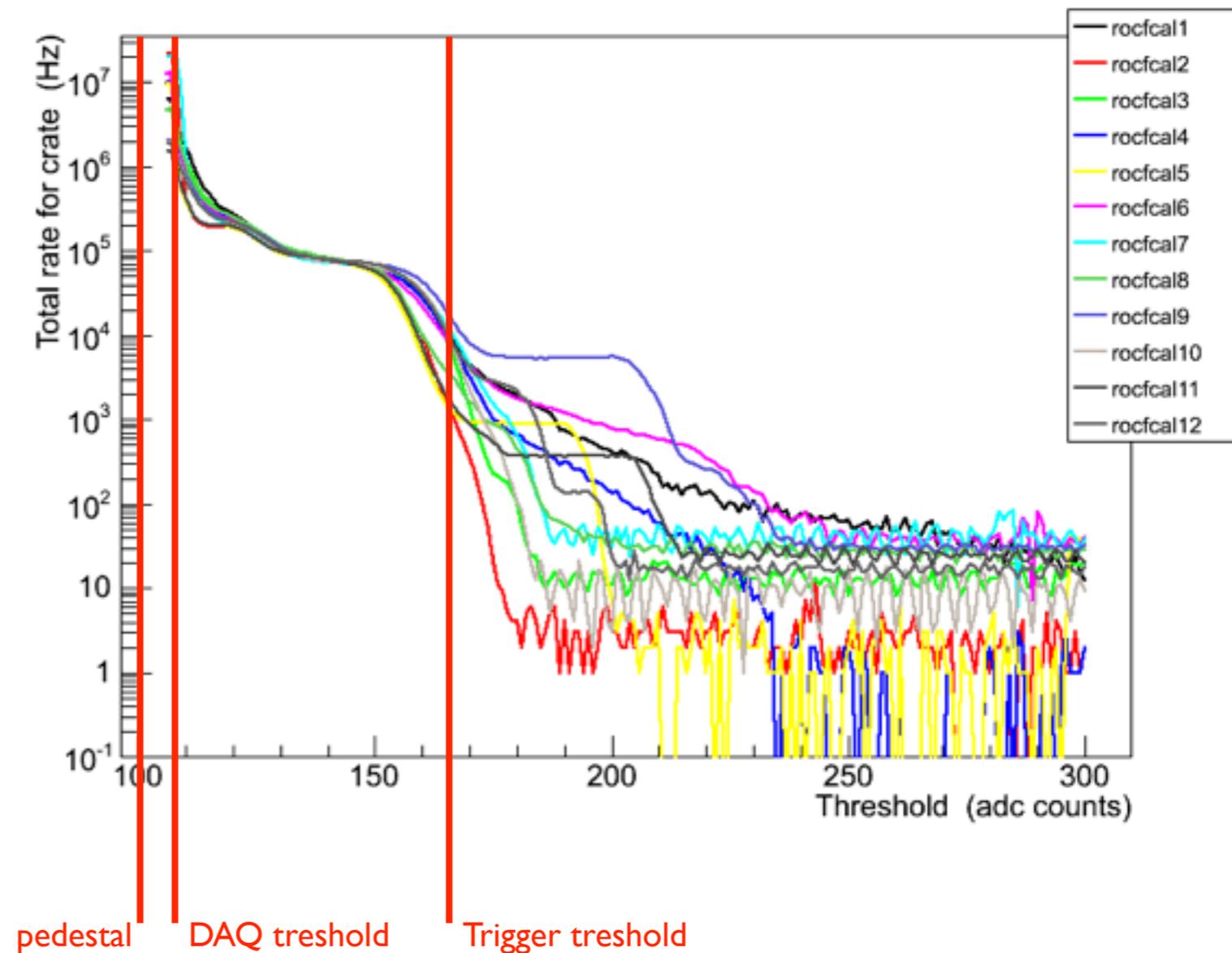- Summer action items for the FCAL group

FCAL Detector Configuration
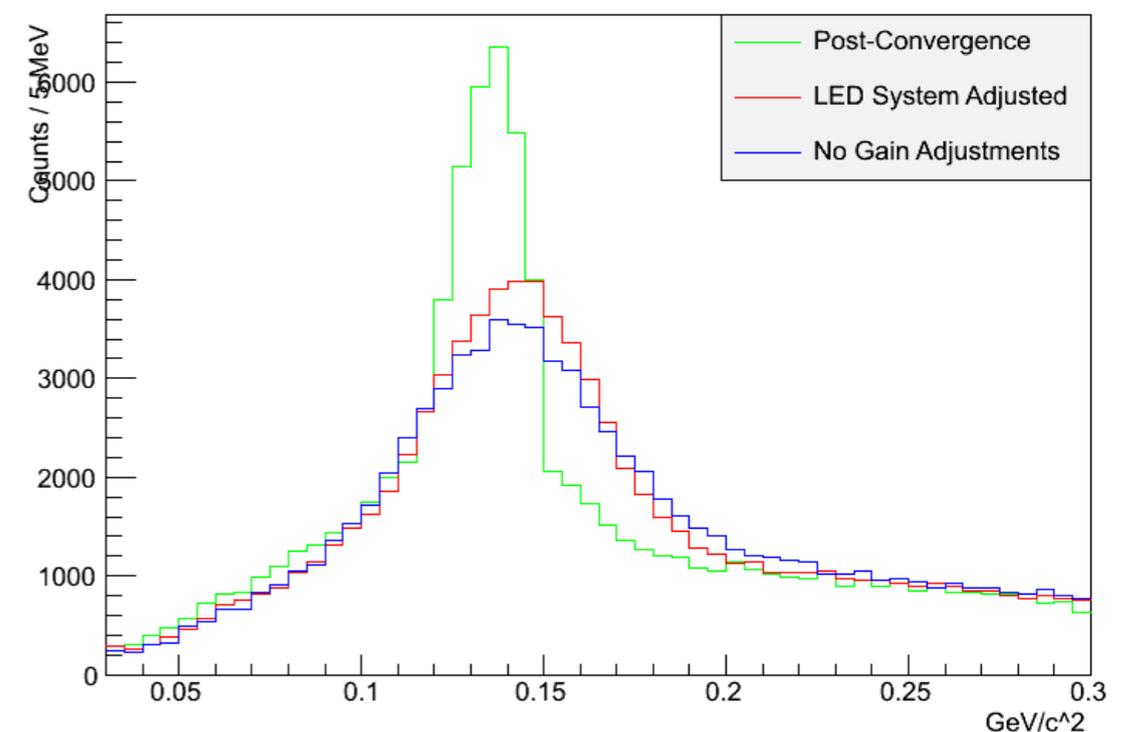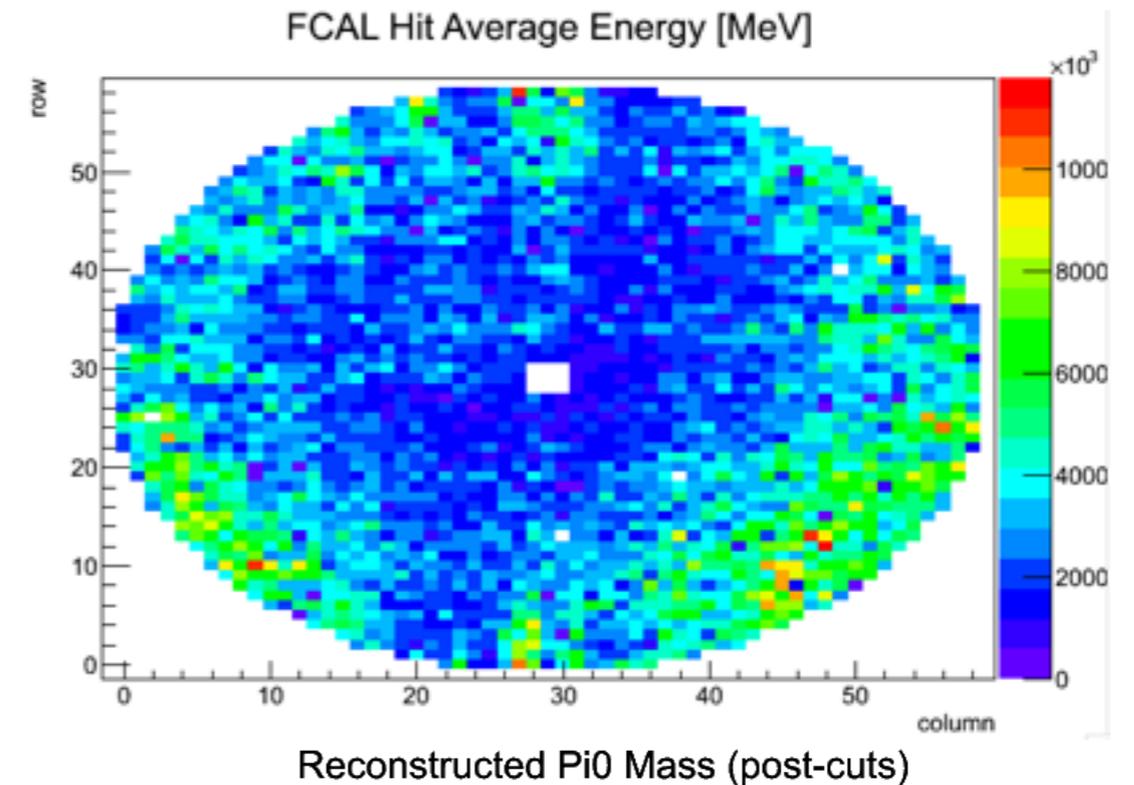
(from Mark Dalton in the Fall)

- Maintain gain at setting of 600 units that was used in the fall (still dead reckoned)

  - 0.27 MeV/FADC integral unit

- Raise trigger threshold to 165 to reduce triggers on switching noise

- DAQ threshold at 108 or about 16 MeV/block

  - about double what it was for the fall run

FCAL FADC rates versus threshold (no beam)

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Calibration Strategy

- No complete calibration available for fall run

- Best strategy so far:

  - use constant to smooth detector response to LED monitoring system

  - iterate from there to minimize π^0 mass resolution

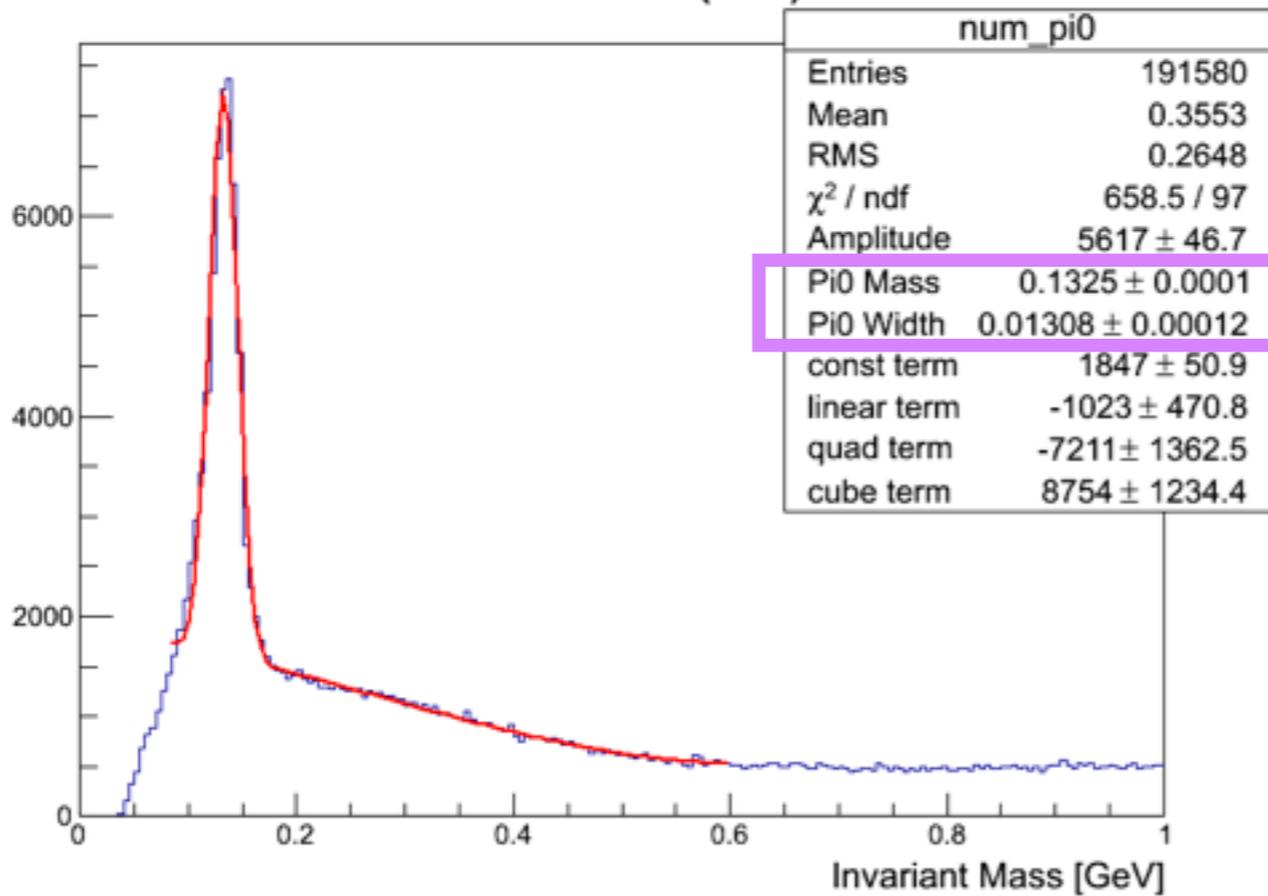- Use those constants in DB for spring run to modify same dead-reckoned HV settings

FCAL Hit Average Energy [MeV]

Reconstructed Pi0 Mass (post-cuts)

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First Fall/Spring Comparison

Fall 2014
2-track skim
run > 1770

Spring 2015
all events
all field ON runs

eL > 1 GeV (Fall)

num_pi0	
Entries	191580
Mean	0.3553
RMS	0.2648
χ^2 / ndf	658.5 / 97
Amplitude	5617 ± 46.7
Pi0 Mass	0.1325 ± 0.0001
Pi0 Width	0.01308 ± 0.00012
const term	1847 ± 50.9
linear term	-1023 ± 470.8
quad term	-7211 ± 1362.5
cube term	8754 ± 1234.4

eL > 1 GeV

num_pi0	
Entries	48213
Mean	0.1917
RMS	0.1591
χ^2 / ndf	385.4 / 97
Amplitude	2906 ± 33.3
Pi0 Mass	0.1167 ± 0.0001
Pi0 Width	0.01253 ± 0.00016
const term	1124 ± 36.1
linear term	-6045 ± 301.8
quad term	1.245e+04 ± 7.935e+02
cube term	-9061 ± 661.8

Invariant Mass [GeV]

Invariant Mass [GeV]

$\approx 36{,}000 \ \pi^0$

$\approx 18{,}000 \ \pi^0$

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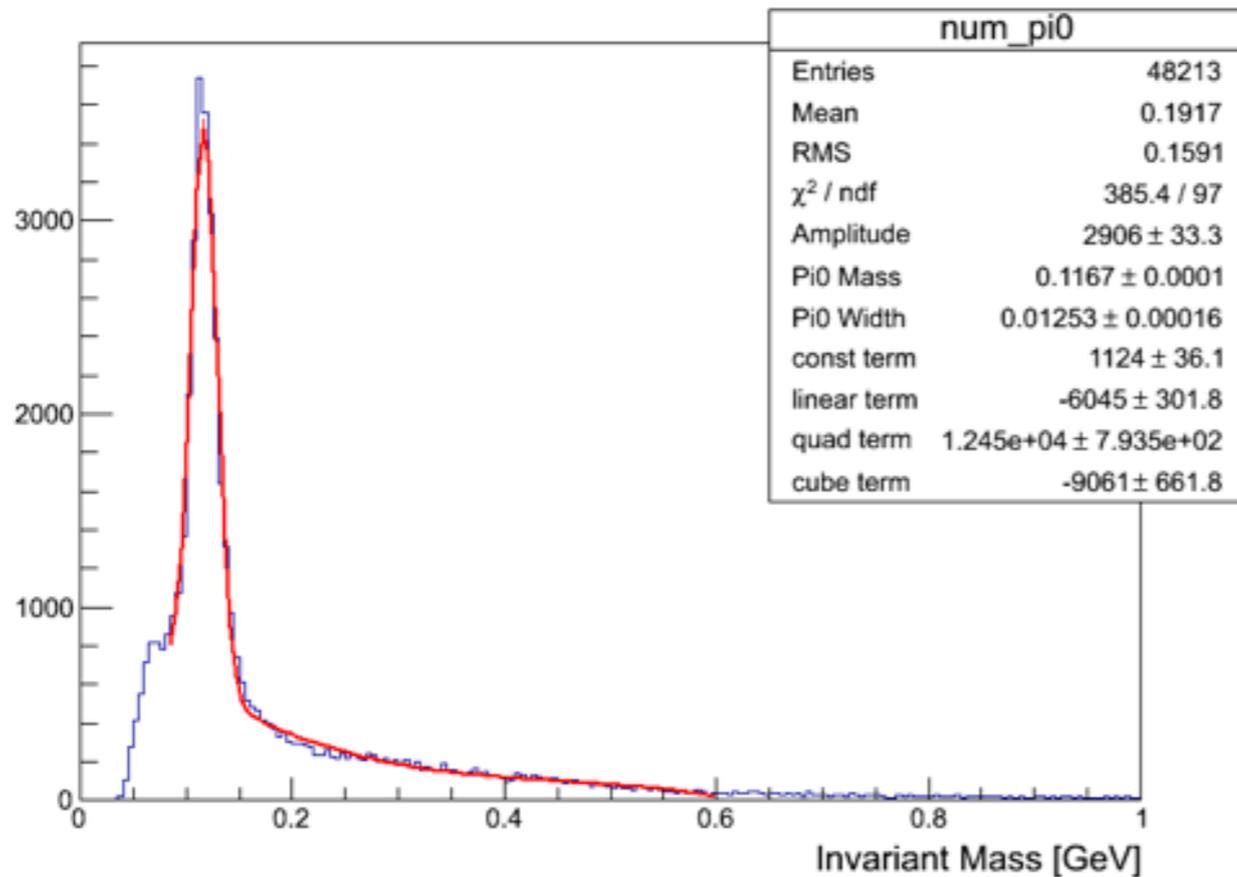INDIANA UNIVERSITY
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Energy Dependence

E$_\gamma$ cut [GeV]	Mass [MeV]	Width [MeV]	Yield [10^3]
0.5	111	13.4	96
1.0	117	12.5	18
1.5	123	11.1	2

eL > 0.5 GeV

num_pi0	
Entries	367064
Mean	0.129
RMS	0.09057
χ^2 / ndf	2187 / 97
Amplitude	1.546e+04 ± 8.373e+01
Pi0 Mass	0.1111± 0.0001
Pi0 Width	0.0134 ± 0.0001
const term	1.36e+04 ± 8.61e+01
linear term	-8.405e+04 ± 6.573e+02
quad term	1.742e+05 ± 1.609e+03
cube term	-1.199e+05 ± 1.267e+03

eL > 1 GeV

num_pi0	
Entries	48213
Mean	0.1917
RMS	0.1591
χ^2 / ndf	385.4 / 97
Amplitude	2906 ± 33.3
Pi0 Mass	0.1167 ± 0.0001
Pi0 Width	0.01253 ± 0.00016
const term	1124 ± 36.1
linear term	-6045 ± 301.8
quad term	1.245e+04 ± 7.935e+02
cube term	-9061 ± 661.8

eL > 1.5 GeV

num_pi0	
Entries	8893
Mean	0.3076
RMS	0.239
χ^2 / ndf	213.5 / 95
Amplitude	332.8 ± 12.6
Pi0 Mass	0.1231± 0.0004
Pi0 Width	0.01116 ± 0.00046
const term	218.8 ± 16.1
linear term	-1192 ± 139.8
quad term	2592 ± 382.2
cube term	-1925 ± 331.1

Preliminary Conclusions

- Fall calibration provides similar results for spring data

  - statistically independent check

  - gain stability

- For comparable cuts, spring data appear cleaner

- Yield of π^0's:

  - same order of magnitude: 1/2 of fall for similar cuts

  - likely peaked at lower energies where backgrounds are larger

- Much more analysis and calibration work to do

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(A slide from the last meeting)

CW Base Health and Control

- Most alarming concern is bases that develop a high-current condition

  - consistent with short developing on the HV generating board

  - suspect: conducting grime underneath of components and conformal coating

  - examination/test/repair ongoing at IU by Paul Smith

    - need database to log repairs

  - need to monitor failure rate: are we getting rid of the bad bases now?

- Variety of other issues — suspect some issues with control but also some an artifact of EPICS

  - HV randomly turning off

  - pulser randomly turning on

  - "jam bits" (diagnostic, tool for unregulated HV) randomly set

  - some bases with anomalous temperatures

- Some improvements made by Hovanes and Manuel to control framework

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CW Base Health

- O(40) bases with high current
  - some still have satisfactory HV performance
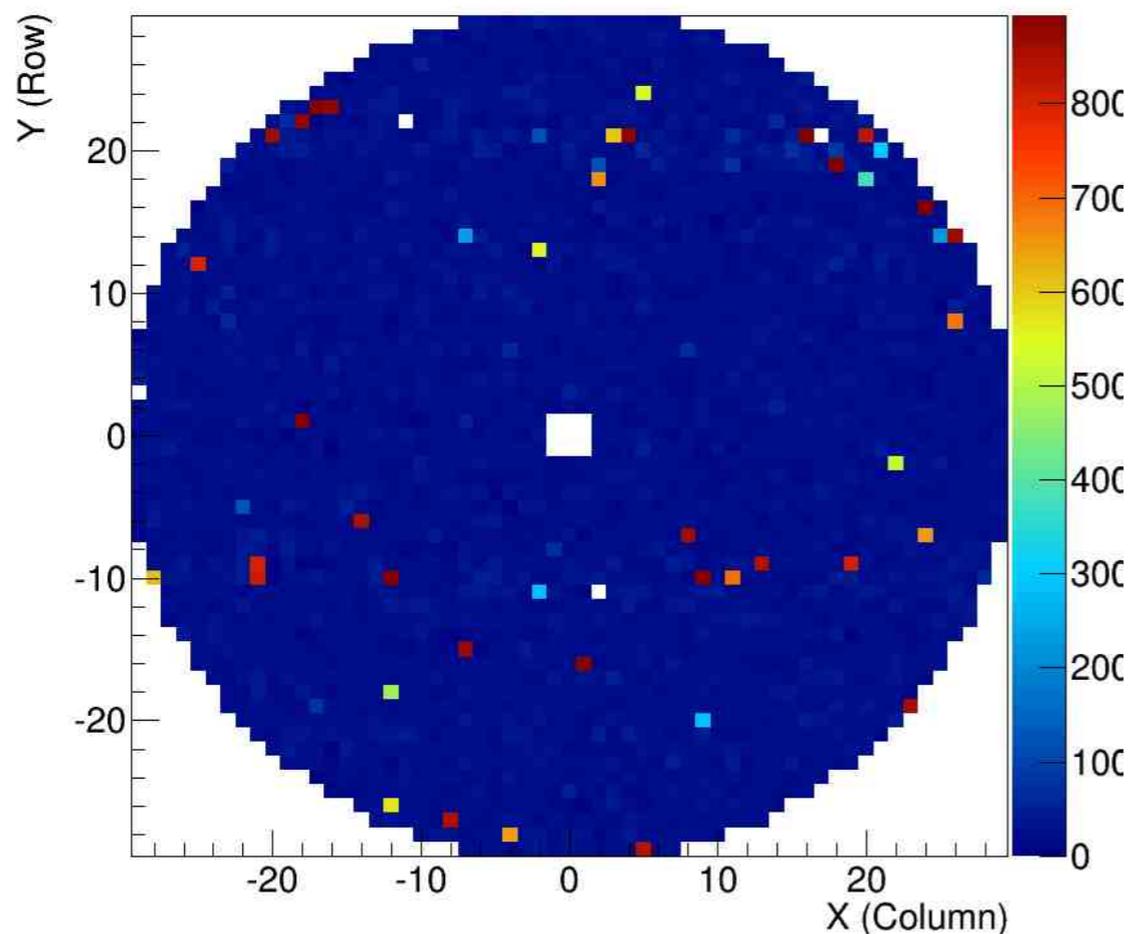- Replaced 21 bases last week, most with fluctuating HV

Number of times Current > 14.5 mA

Cathode
1st Dynode
HV drops
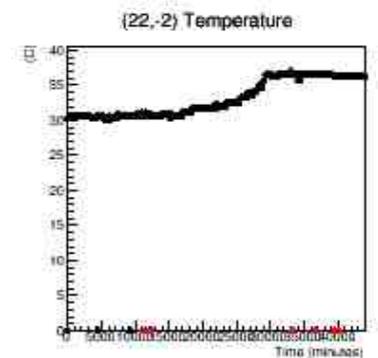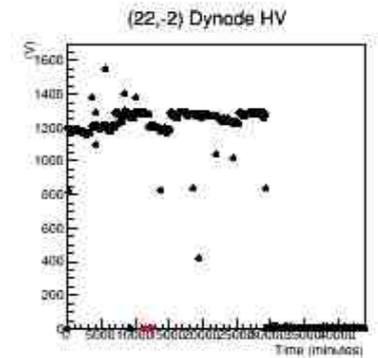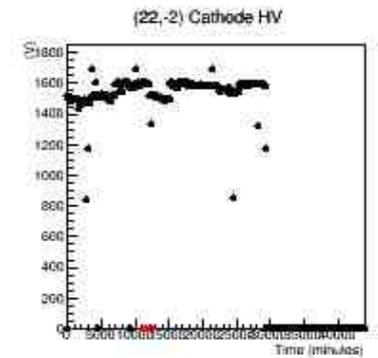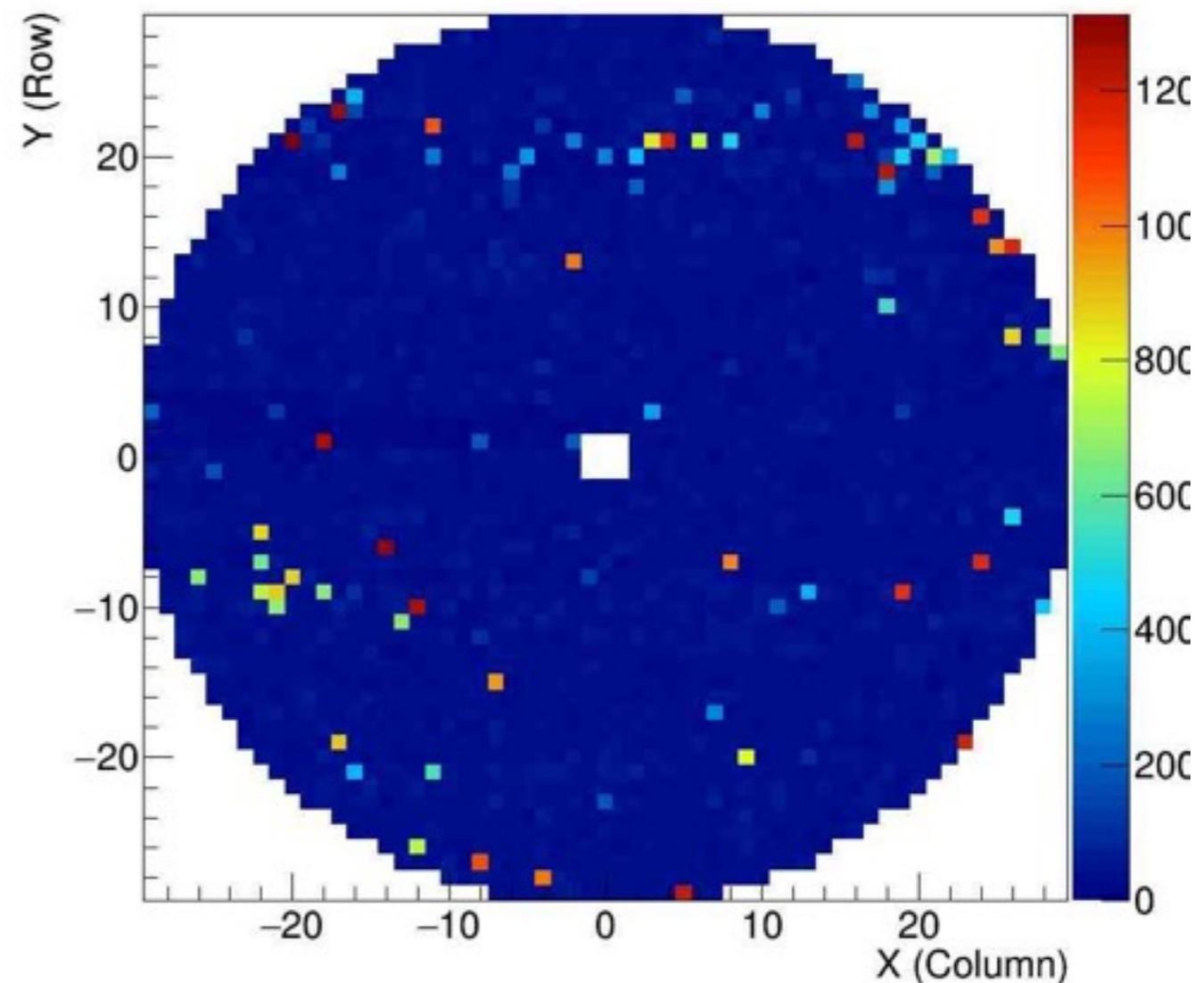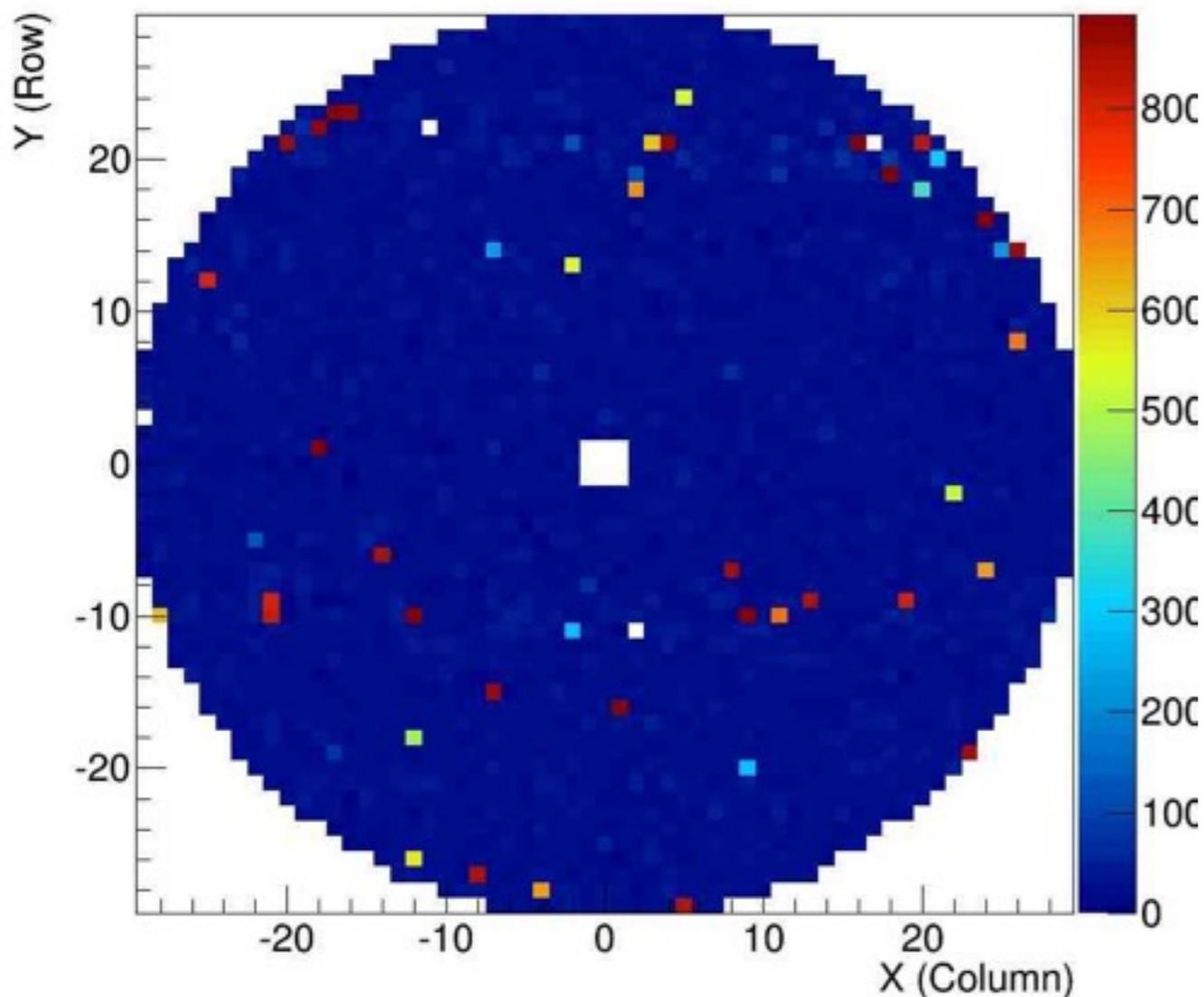
Temperature
Rises
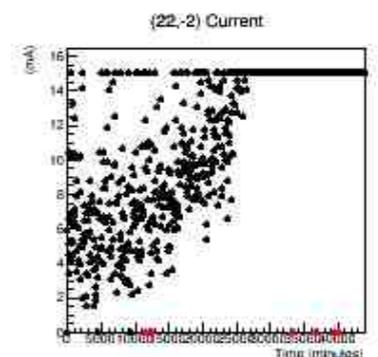
Current
Hits
Limit

Time

Fall and Spring High Current Comparison

Fall 2014

Number of times Current > 14.5 mA

Spring 2015

Number of times Current > 14.5 mA

Most high current bases still function properly.
Not an accelerating problem?

Typical (?) High Current Failure
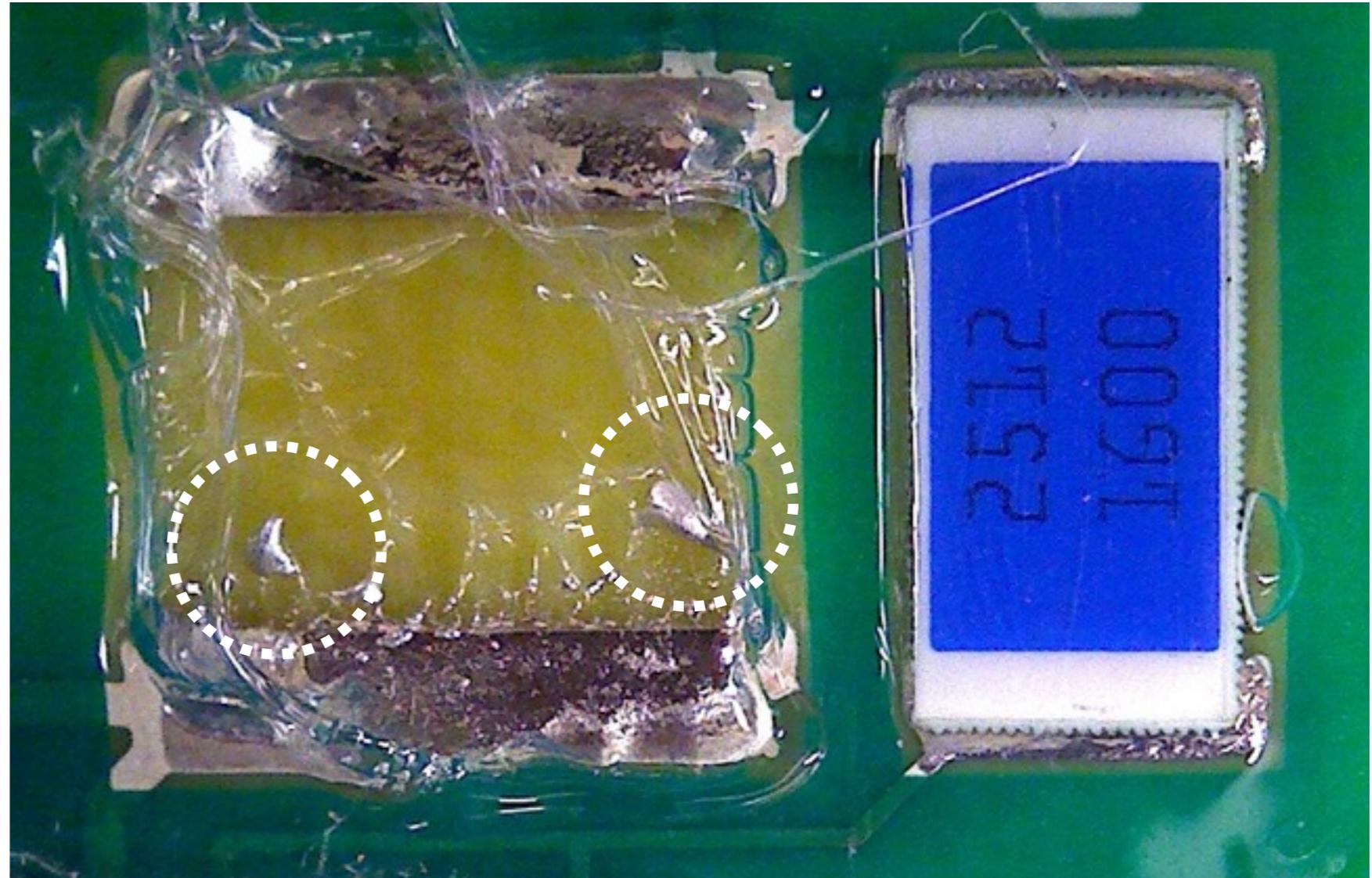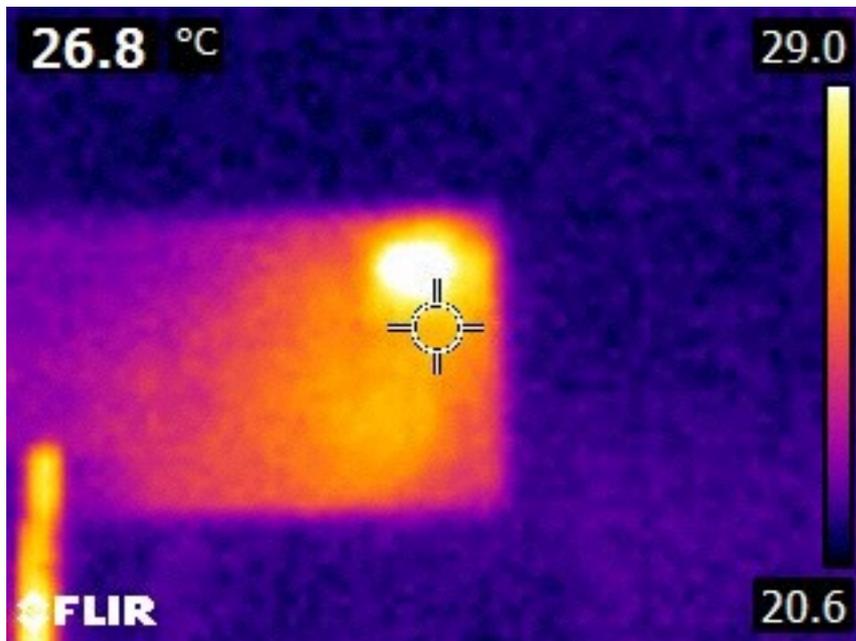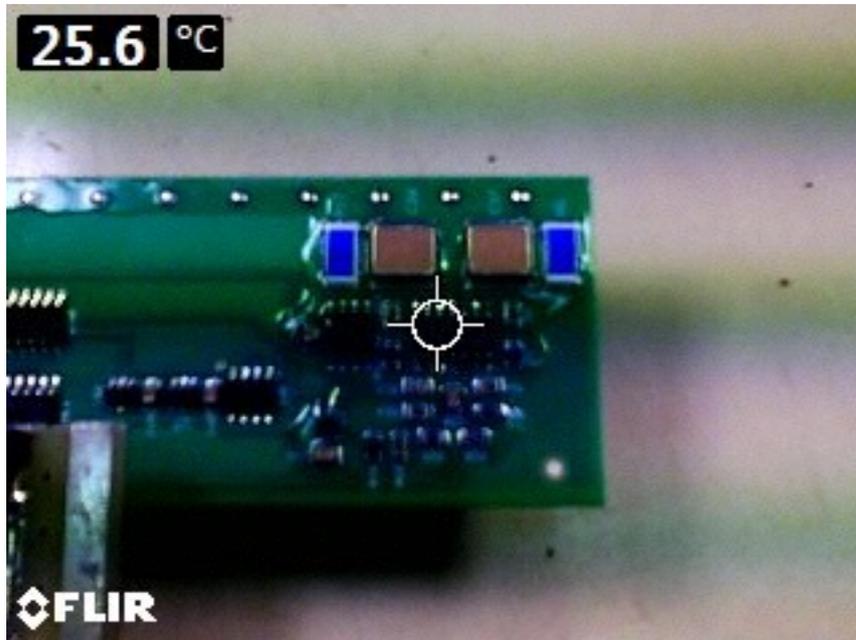
Solder "antennae" under 2 kV capacitor
encourage conduction — a repairable failure.

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CW Base Repair/Spare Pool

- Current status of FCAL

  - 20 channels with unstable HV (not necessarily high current)

  - 6 channels with communication problems

- Repairs

  - 68 bases considered failed during the fall run

  - those plus 60 others (uncertain status) returned to IU for testing

  - some tested OK; about 30 repaired by Paul and tested

  - 49 sent back to Jefferson Lab

- Spare pool: 121 total

  - 25 in counting house; 47 in EEL for base testing; 49 in box from IU on Adesh's desk

Base Tracking with JInventory

- Track individual components in detector at JLab and at IU

- Log failures and repairs

- Remotely accessible via web

- Minimal assembly/testing QA data imported: DB for future maintenance

- Thanks to Serguei Pozdniakov for help

JInventory database in use by CUE user 'manlara' with 'read/write' access

New Item   Items List   Items Small List   People   Companies   Brands   Advanced Search...   Delisa's DB   Paginate   One Page

Edit Item (step 1/2)
Fields marked with * are required.

< Back   Save As New   Save

General information

* Property Tag	F_23373
Short name	FCAL Base 23373
Description	The BaseID is a bar code label on the end panel of the base. This is the only ID visible when a
* Brand-Format-Model Select or enter brand-format-model	IU - FCAL Base - N/A or **Enter new brand-format-model:**
Part num. - Serial num.	
* Location Select or enter a new location	1 IU Physics DEPT 2 IU Base Testing Room 3 n/a
GeomLoc	
Purchase date - Location - Price	--- --- --- - - PR #
MAC_Address	
IP Name	
Telecom	
Comment	"No entry in logbook" 4.6 mA @ 2000V. ReTest.
Lent to	date: --- --- ---

Maintenance

Status	⦿ Normal ◯ Action Needed Operational Status Notes:

Maintenance History

```
----- Original Information -----
> Property Tag: F_23373
> Short Name: FCAL Base 23373
> Description: The BaseID is a bar code label on the end panel of the base. This is the only ID visible when a base is installed in the wall.
> Brand-Format-Model: IU-FCAL Base-N/A
> Housing Parent: IU Physics DEPT (1679) | IU Paul Worshop (1680)
> Comment: "No entry in logbook" 4.6 mA @ 2000V. ReTest.
> Custodian: Paul Smith
> Replacer: Manuel Lara
> OnSite Eval: Adesh Subedi
> OffSite Repair: IU
> State: Normal
> Status: Operational
===== 2015-04-28 16:34:17 modified by ptsmith =====
> Housing Parent: IU Physics DEPT (1679) | IU Base Testing Room (1681)
```

```
===== 2015-04-28 16:34:17 modified by ptsmith =====
> Housing Parent: IU Physics DEPT (1679) | IU Base Testing Room (1681)
```

Pictures

Edit Pictures >

Add Picture	Add picture to item's picture list. Click on 'Edit Pictures' to edit existing pictures. Note: You should save this page before entering additional pictures. Choose File No file chosen

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JInvetory
Web Interface

- perform DB consistency/integrity checks

  - search for duplicates

  - missing data

  - incomplete records

- graphical access to an element in the DB

FCAL Looking Upstream

Legend:
- 🟨 - There are too many or too few boards associated with the base in this cell
- 🟦 - The can id is missing
- 🟪 - The board ids are missing
- 🟥 - This cell is missing a base or pmt
- ⬛ - The base id, can id, or pmt id in this cell does not match with the IU db
- 🟩 - The cell has a base, with the correct number of boards, and a pmt
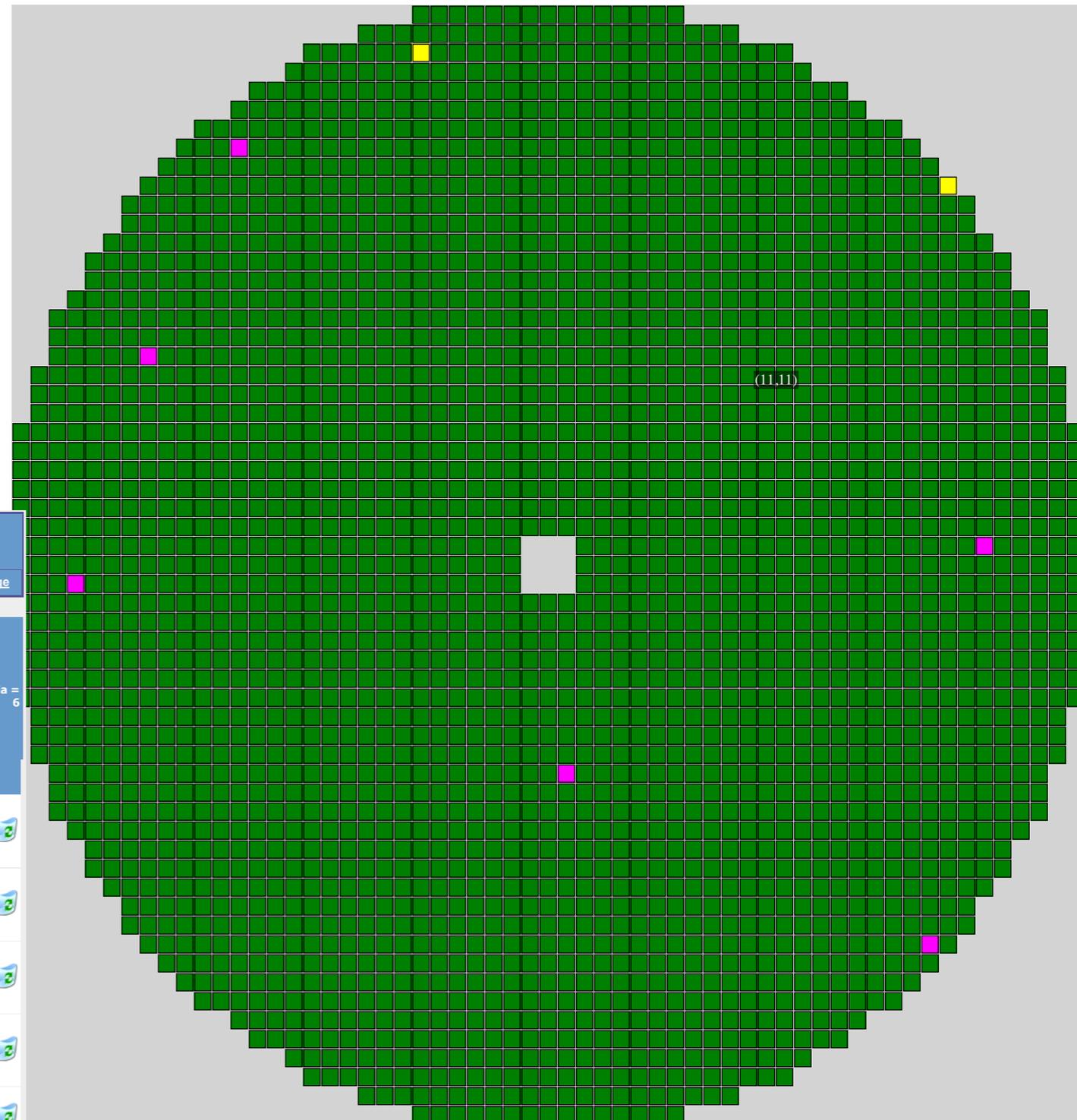
JInventory database in use by CUE user 'manlara' with 'read/write' access

New Item | Items List | Items Small List | People | Companies | Brands | Advanced Search... | Delisa's DB | Paginate | One Page

Items

Item ID:
Housing Parent | Ancestor: FCAL_18_23
Property Tag:
Short name and description:
Brand-Format-Model: -- all --   Reset >>   Search >>

Total Items meet Search Criteria = 6

New item | Delete selected | Toggle All | Show selected | Edit selected

Check	Property Tag (Serial number)	ID	Short name	Description	Housing	Custodian	Insert Date	Action
☐	F_52672	20161	FCAL TranBoard 52672	TRAN board connects the MULT board to the SOCK board	Hall D (1) D2 (576) FCAL (1688) FCAL Cell (18,23) (20155) FCAL Base 21434 (20157)	Adesh Subedi	2015-04-09 14:59:46	
☐	F_61434	20160	FCAL SockBoard 61434	SOCK board has the PMT socket and the test pulser.	Hall D (1) D2 (576) FCAL (1688) FCAL Cell (18,23) (20155) FCAL Base 21434 (20157)	Adesh Subedi	2015-04-09 14:59:46	
☐	F_42788	20159	FCAL MultBoard 42788	MULT board produces the high voltage with a Greinacher multiplier.	Hall D (1) D2 (576) FCAL (1688) FCAL Cell (18,23) (20155) FCAL Base 21434 (20157)	Adesh Subedi	2015-04-09 14:59:46	
☐	F_31745 (7565715)	20158	FCAL CommBoard 31745	COMM board contains the STM8 processor which handles the CAN communication and also contains the CAN ID.	Hall D (1) D2 (576) FCAL (1688) FCAL Cell (18,23) (20155) FCAL Base 21434 (20157)	Adesh Subedi	2015-04-09 14:59:46	
☐	F_21434	20157	FCAL Base 21434	The BaseID is a bar code label on the end panel of the base. This is the only ID visible when a base is installed in...	Hall D (1) D2 (576) FCAL (1688) FCAL Cell (18,23) (20155)	Adesh Subedi	2015-04-09 14:59:46	
☐	F_1548	20156	FCAL Pmt 1548	FCAL PMT	Hall D (1) D2 (576) FCAL (1688) FCAL Cell (18,23) (20155)	Adesh Subedi	2015-04-09 14:59:46	

New item | Delete selected | Toggle All | Show selected | Edit selected | For more information send mail to Serguei Pozdniakov

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Base Control: EPICS

- Run multiple EPICS I/O controllers in parallel

  - order of magnitude longer time between reboots

  - order of magnitude faster reboot time

- Enable EPICS broadcast HV on/off: speedup (half hour → seconds)

- Some remaining issues:

  - random rare activation of unregulated HV mode: > 2000 V affected 10 bases this spring — DANGER!

  - need alarms

  - mesh EPICS operational theory with design/vision for firmware

Counting Room Interface

shift taker screen
(physical layout)

expert screen
(electronics layout)

FCAL Detector Health

- No alarming signs of accelerating failure with age; still needs careful monitoring

- EPICS control/monitoring needs improvement

  - coupled with compatible firmware changes

- Infrastructure for monitoring, documented failure modes of bases has been developed and is being exercised

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FCAL Summary and Action Items

- Complete analysis of spring data to calibrate energy

- EPICS and base firmware improvements

- Examine F250 signal processing

  - best pedestal determination

  - peak or integral?

- Evaluate clusterizer performance using electrons

- Study F250 timing algorithm

- Improve FCAL hit model and noise simulation on MC