Examples of functionality of STAR FCS LED monitoring system.
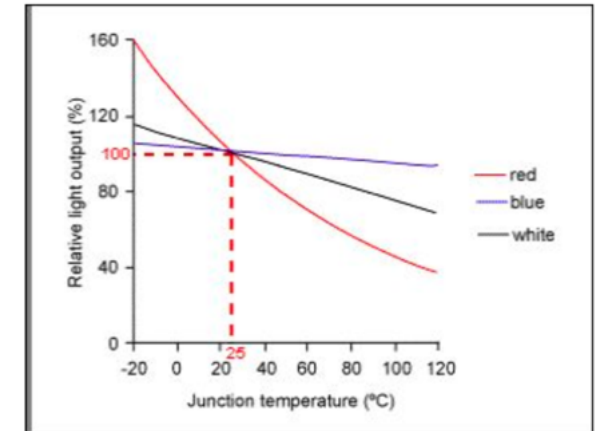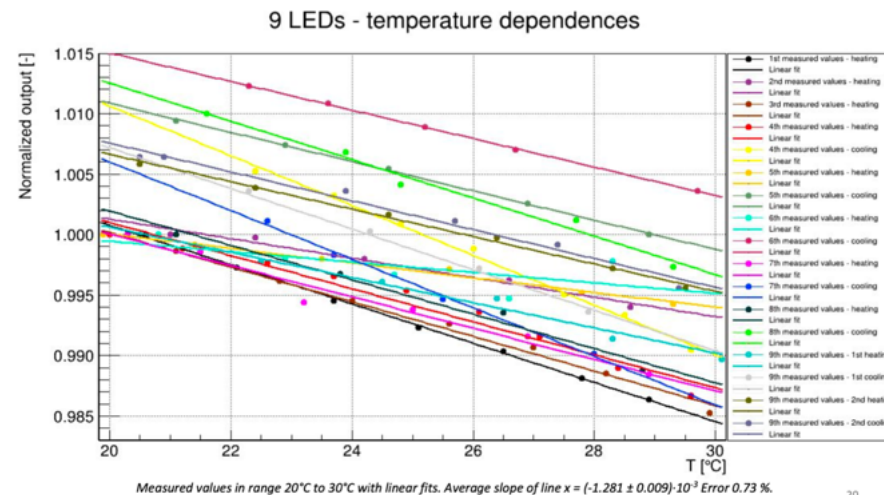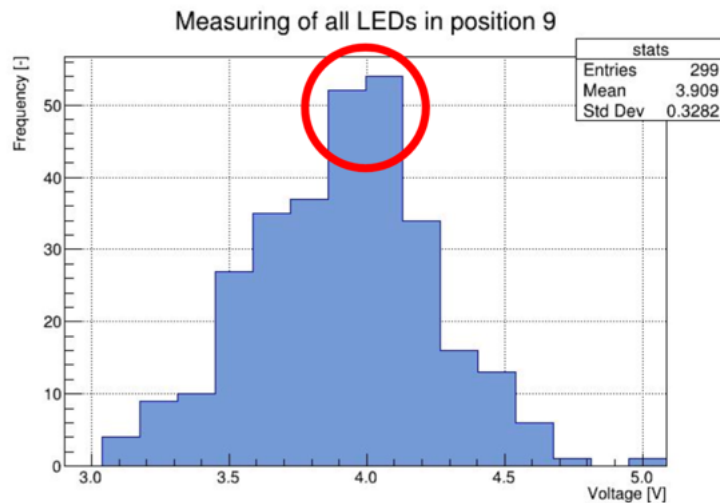
(Most slide were borrowed from Akio Ogawa's presentations)

O.Tsai. ePIC Calo meeting 12/13/2023

LEDs for FCS monitoring system
OVL-5523 (InGaN/Sapphire) (used for upgrade of LHCb ECAl LED monitoring system ~ 2014)

Summer students at BNL O. Lomicky and M. Svoboda from CTU, Prague.

Selected LEDs with similar characteristics, confirmed that at expected FCS conditions variations of light yield due to T will be within 1%. That lead to a very simple implementation of monitoring system for FCS.
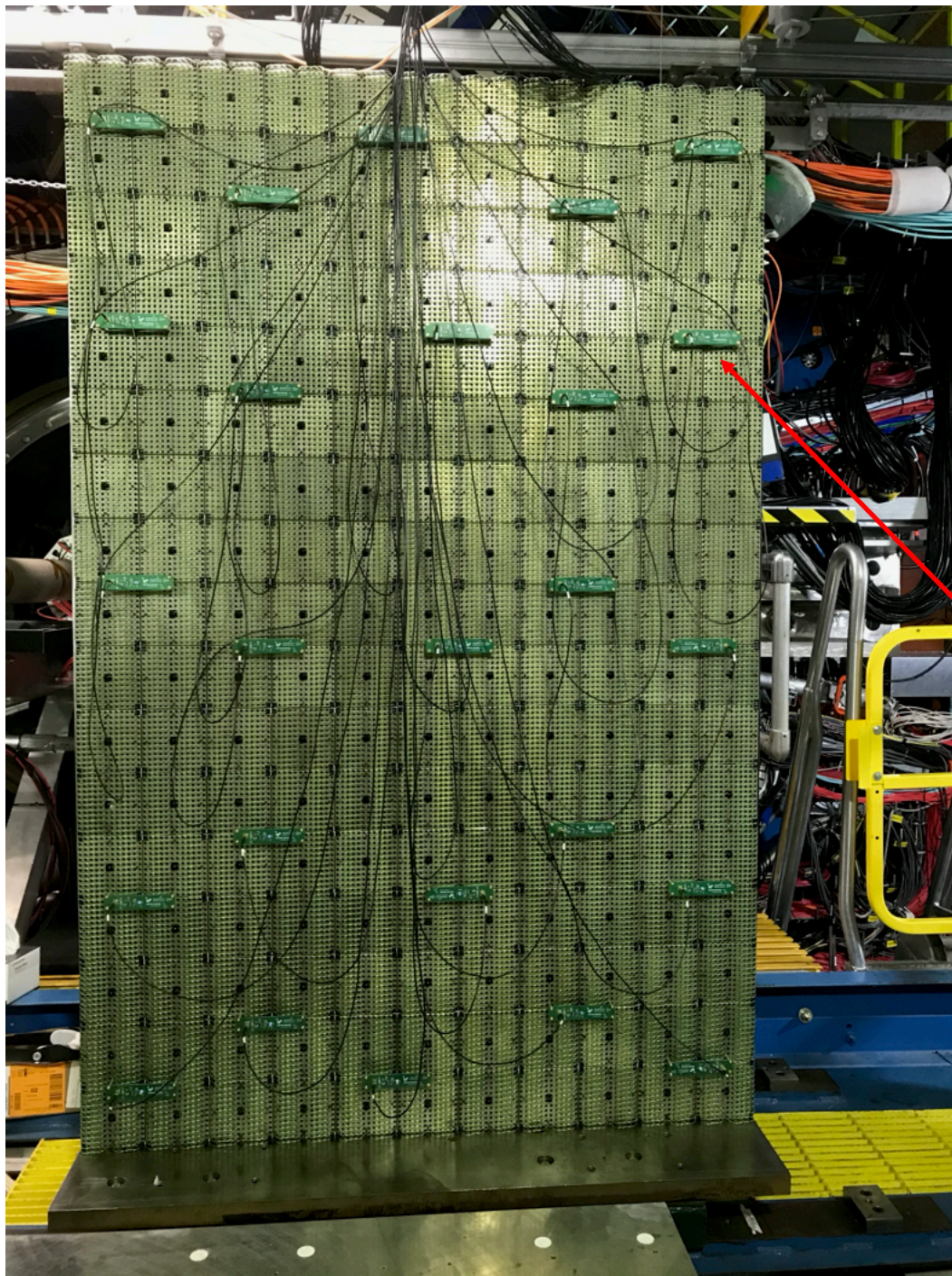
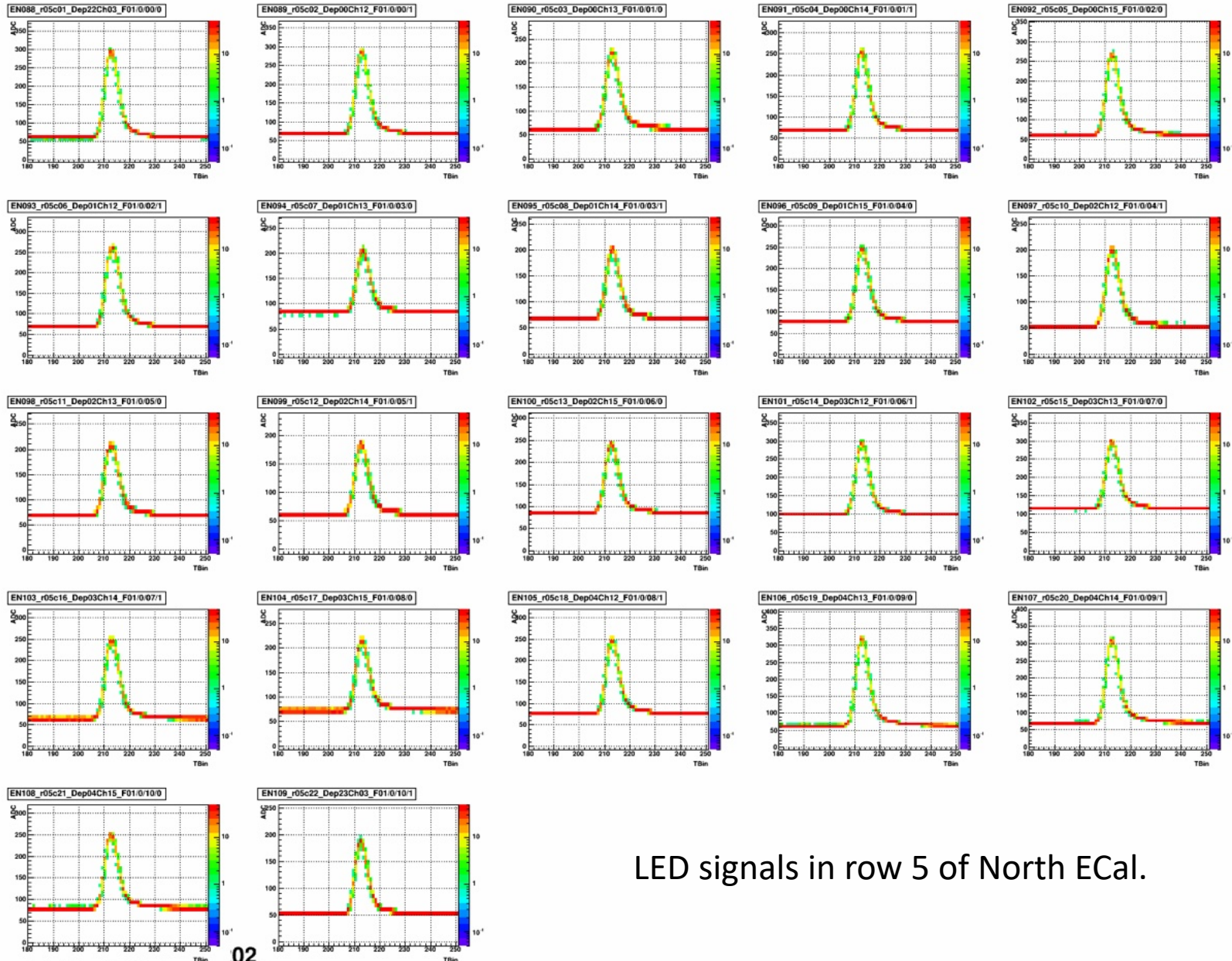A half of FCS ECal back side, before Al enclosure was put in place.
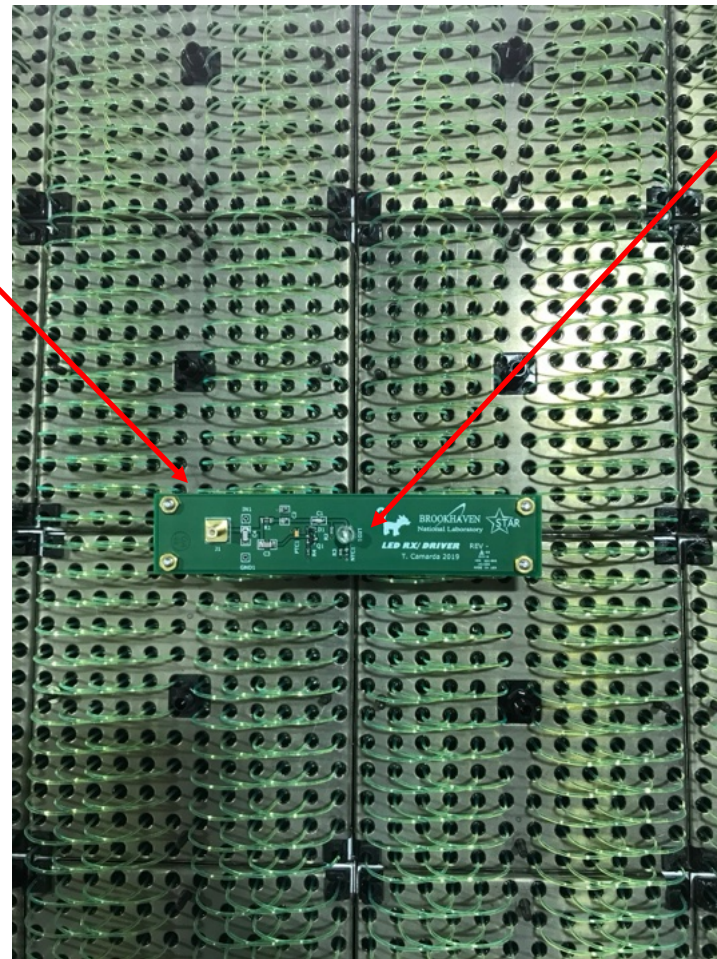
LED shines toward aluminum cover.

Light bounces and reaches WLS fiber loops at the back side of SHASHLYK blocks.

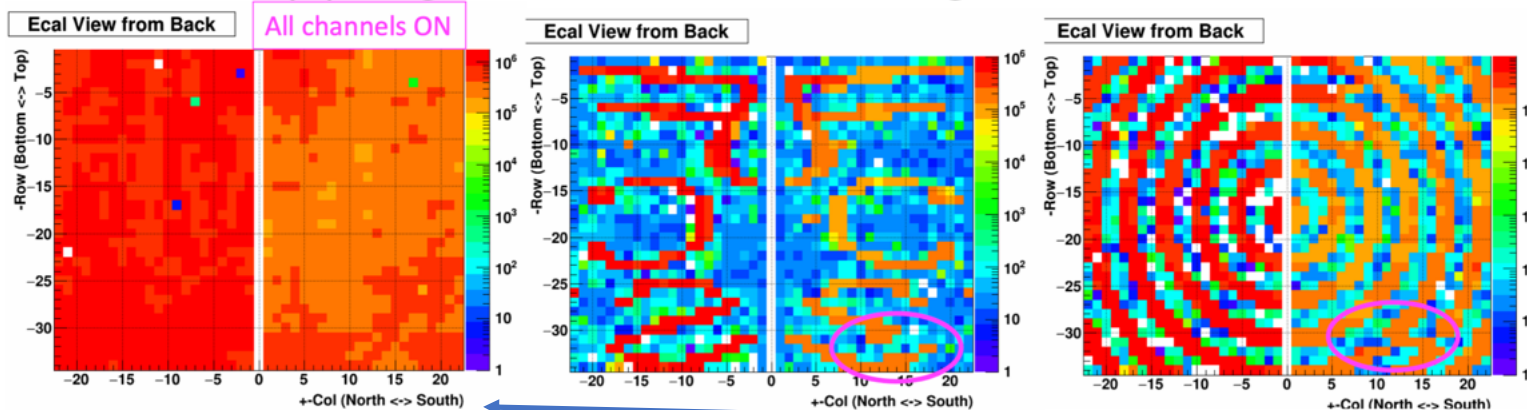External LED driver, allows to pulse different LEDs independently, but it was never used.

It was much easier to configure SiPM bias patterns.

Turned out, such simple LED system provides quite uniform illumination!

LED signals in row 5 of North ECal.

Mapping Check with Voltage Patterns

Ecal View from Back — All channels ON

6 bad channels ~ all with DEP problem

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

My typo in voltage pattern

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

2 more cabling mistakes found and fixed with checkered patterns

Pattern by Gerard

LED system was critical for initial commissioning:

- Well.., sometimes there is no signal !

- Or, signal is nice but it is in a wrong place!

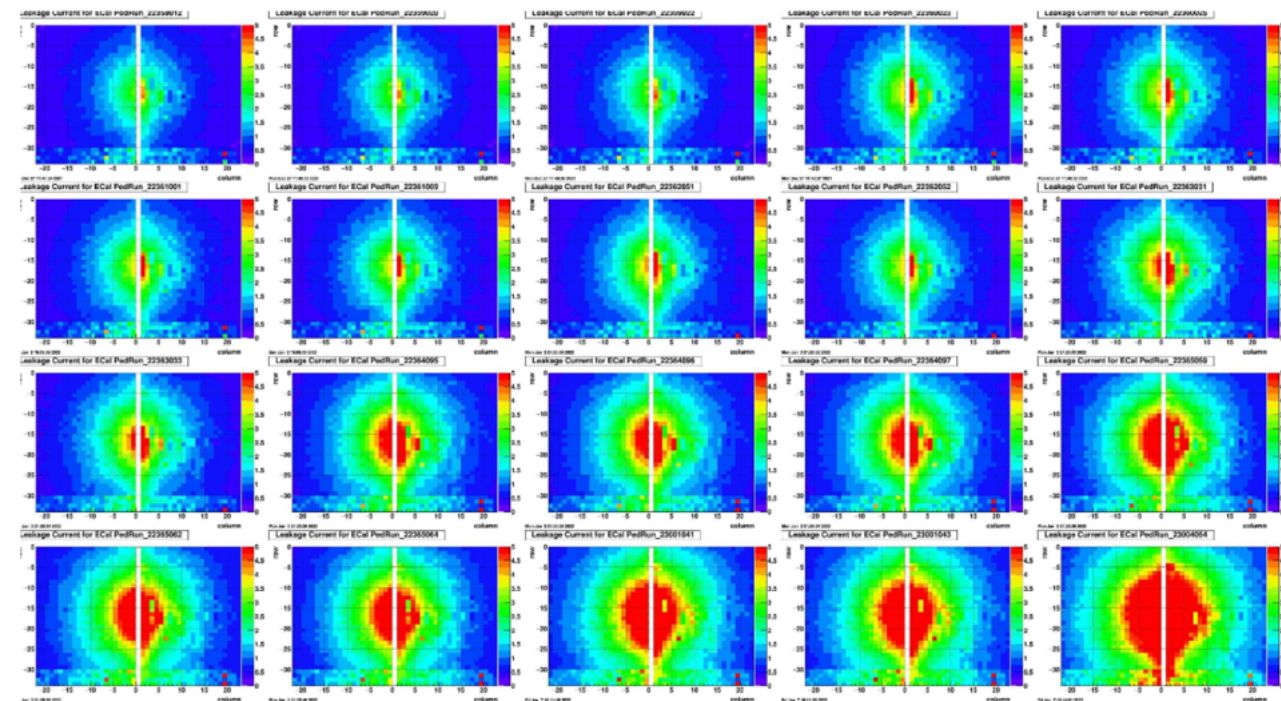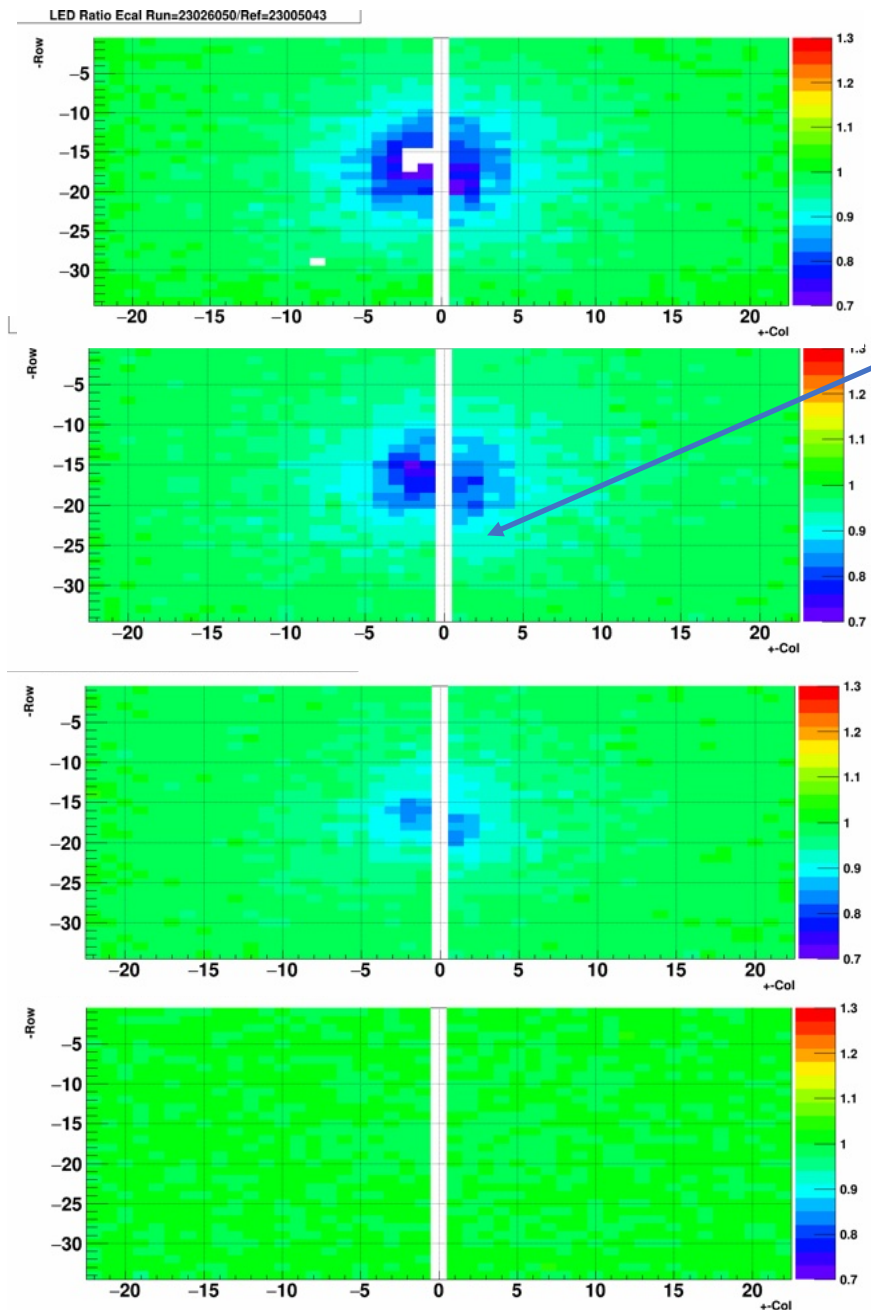At the end all was fixed and collaborators had some fun making patterns.
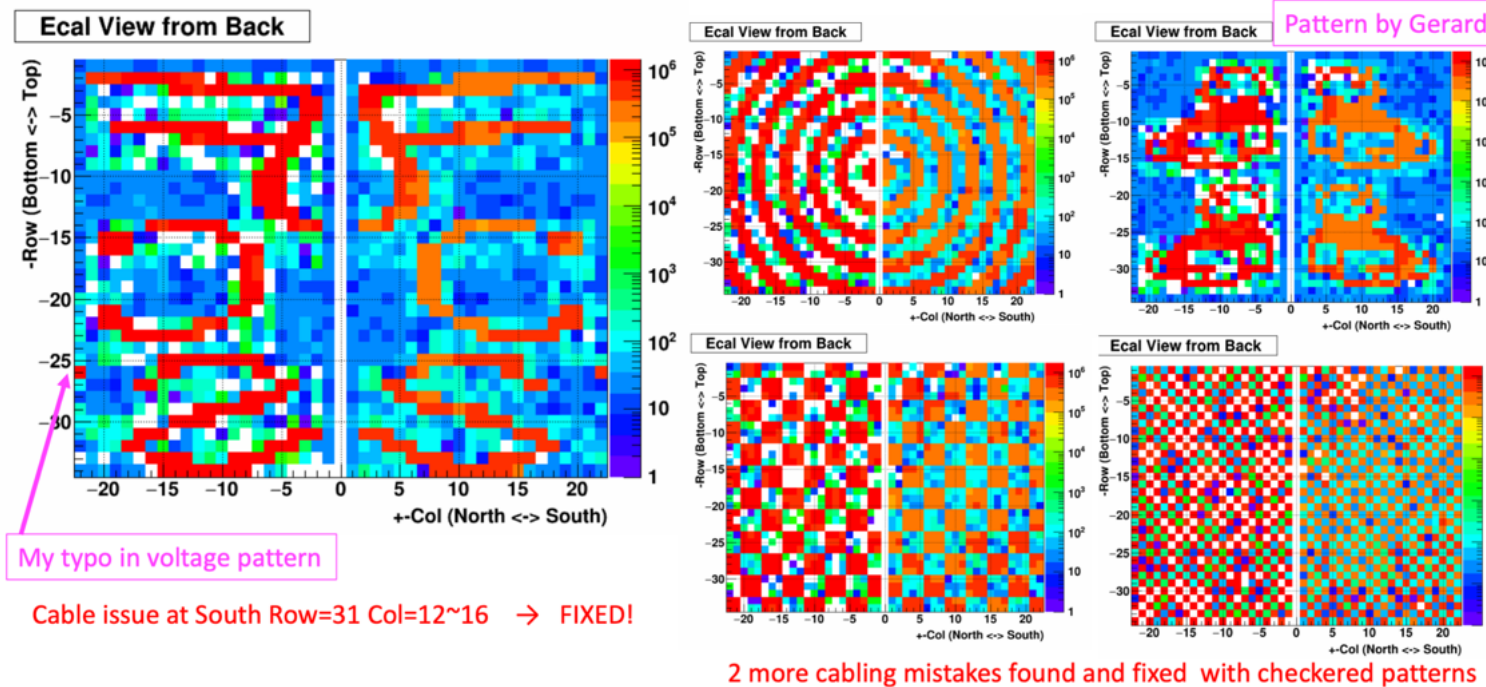
Example of on-line monitoring with LED system during data taking. Unexpected problem.

LED Ratio Ecal Run=23026050/Ref=23005043

Monitoring health of the system during Run 22, 500 GeV pp.

LED ratio (signal at given day/ signal at the start of the run)
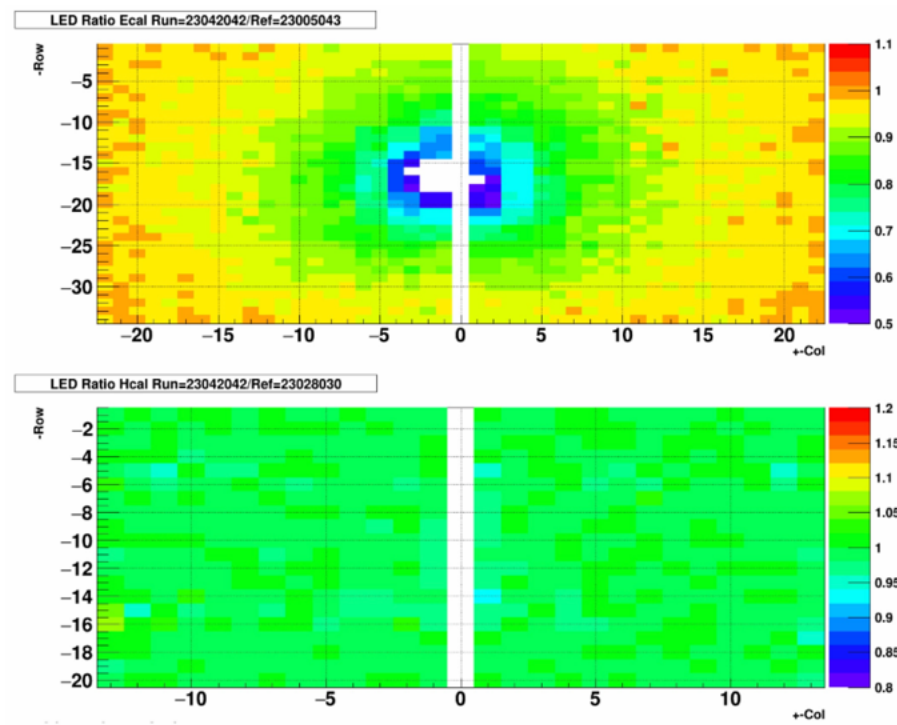Hmm, it was dropping near the beam pipe.

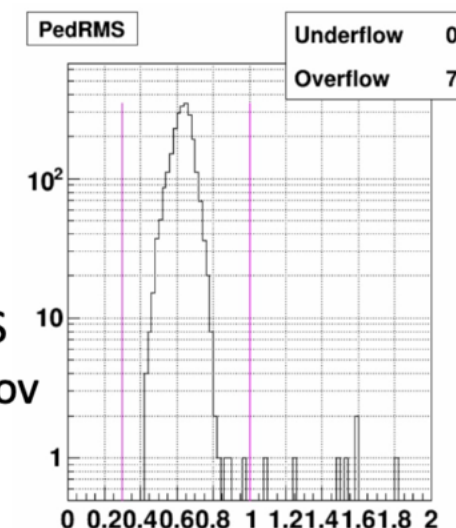Ecal Dark Currents from Ananya's Radiation Monitor

Online Plots : LED & Pedestal Monitor

https://online.star.bnl.gov/fcs2022/led/
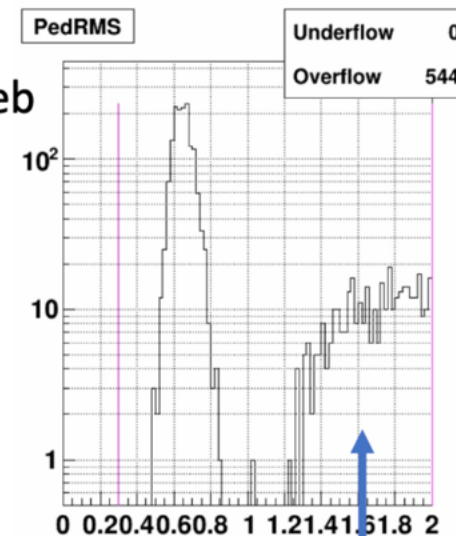https://online.star.bnl.gov/fcs2022/led/search.php

LED Ratio plot 2/11 over 1/05

Pedestal RMS
2021 Nov

2002 Feb

EPD

- Ecal loosing lights as much as ~50% near beam over a month
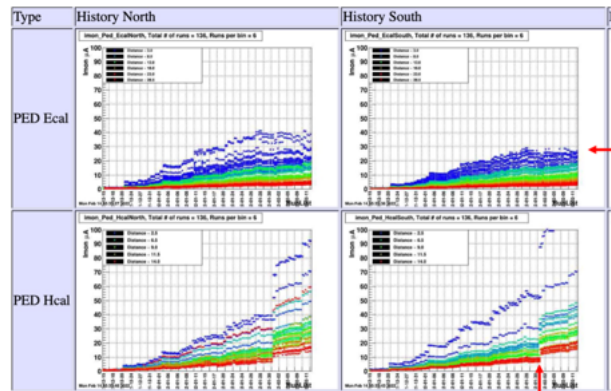- Hcal is stable
- Pedestal RMS is still < 1ch, even near beam

That was very puzzling at that time !

1/23

1/17

Online Plots : Radiation Monitor (Ananya)
https://online.star.bnl.gov/fcs2022/radmon/

There were other telltale signs something was not right. Data from LED monitoring system catched the problem immediately!

Type	History North	History South
PED Ecal		
PED Hcal		

Ecal current flattened? (see Oleg's talk)

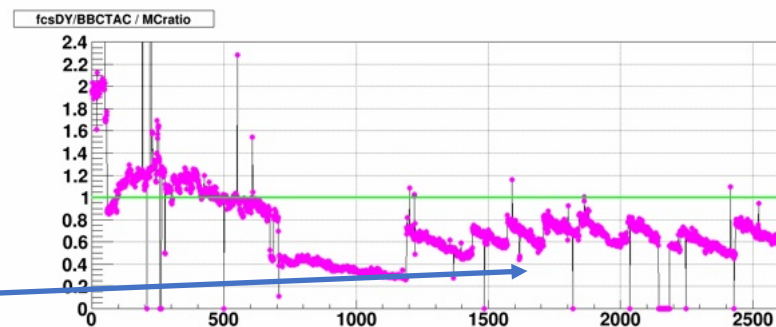Hcal Voltage Change 2022/01/27

Limits are 400uA (Ecal) and 600uA(Hcal)
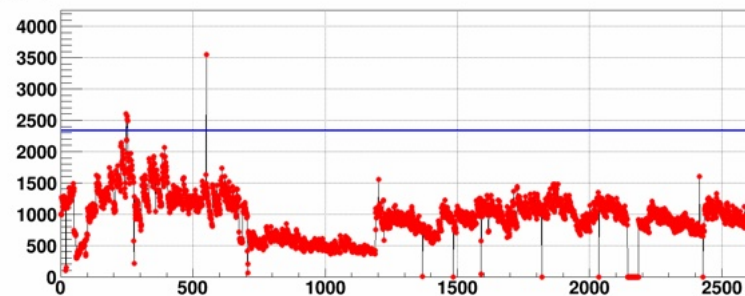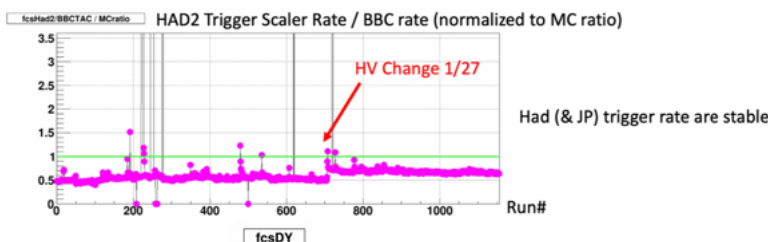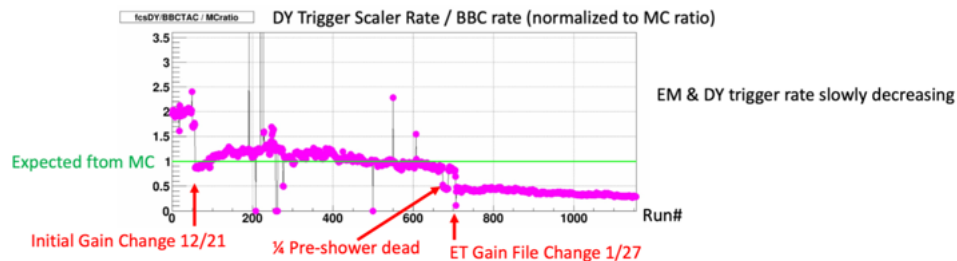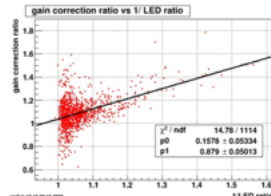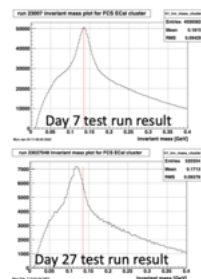At this rate, they will reach 120 (Ecal) and 300 (Hcal) at near beam by end of run22

Online Plots : Rate Monitor
https://online.star.bnl.gov/fcs2022/trg/rate/

DY Trigger Scaler Rate / BBC rate (normalized to MC ratio)

fcsDY/BBCTAC / MCratio

Expected ftom MC 1

EM & DY trigger rate slowly decreasing

Initial Gain Change 12/21   ¼ Pre-shower dead   ET Gain File Change 1/27

HAD2 Trigger Scaler Rate / BBC rate (normalized to MC ratio)

fcsHad2/BBCTAC / MCratio

HV Change 1/27

Had (& JP) trigger rate are stable

fcsDY

fcsDY/BBCTAC / MCratio

Future Calibration run needs

gain correction ratio vs 1/ LED ratio

Day 7 test run result

Day 27 test run result

Between day7 and day27:

1/LED ratio
vs
GainCorrectoon factor ratio
(Xilin)

- Light loss seen in LED is also confirmed by Pi0 analysis
- LED and EM shower (pi0) see similar amount of light loss (not trivial)
- But variation is large (cannot use LED ratio for tower by tower gain)
- ASAP, we need to install tower by tower gain (electronics gain file) for DEP (trigger)

- More low-luminosity MB trigger calibration runs?
- Or physics data taking is enough?

Reasonably quickly we figured out that reference voltage chip on FEE board is not rad hard, which was a surprise! Same chip was fine in Run 17 (prototyping for FCS FEEs Run 17, pp 500 GeV)!

N.B. irradiation tests should be done with production components.

Based on data from LED systems, new bias settings were calculated and uploaded ~every week. Zig-zag pattern in trigger rate for DY

Summary:

- A very simple LED monitoring system was built for STAR FCS.

  1. blue stable LEDs,

  2. enough space to arrange uniform light distribution

  3. design of SHASHLYK blocks with exposed WLS fiber loops at the back)

- It was critical for:

  1. commissioning of the detector

  2. monitoring and correcting unexpected issues during data taking.

- A similar functionality will be needed for ePIC fECal, however implementation will be quite different due to space limitation and design of the fECal towers.