e-group
cms-tk-monitoring

Tracker monitoring

Jory Sonneveld

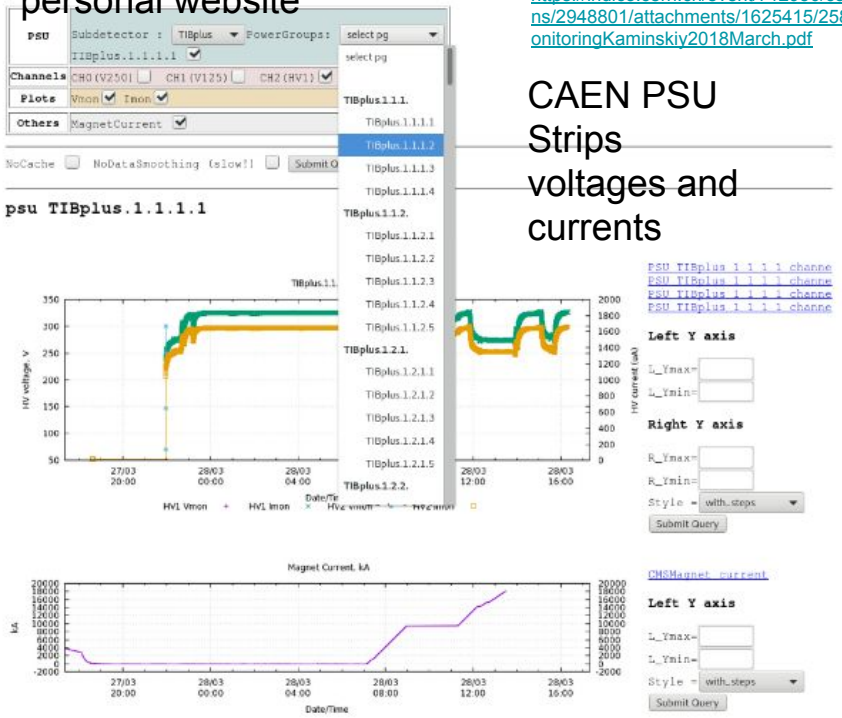
Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Weekly meetings Thursdays 15:00-17:00

Nothing new? There were tools already:

Existing tracker monitoring tools

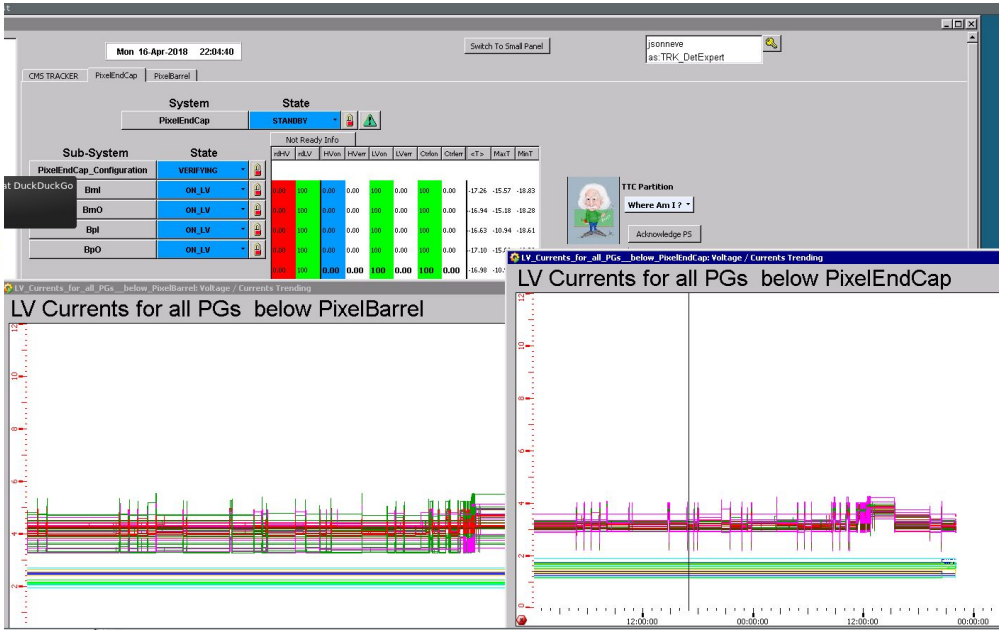
Personal tool on personal website



https://indico.cern.ch/event/712950/contributions/2948801/attachments/1625415/2588250/MonitoringKaminskiy2018March.pdf

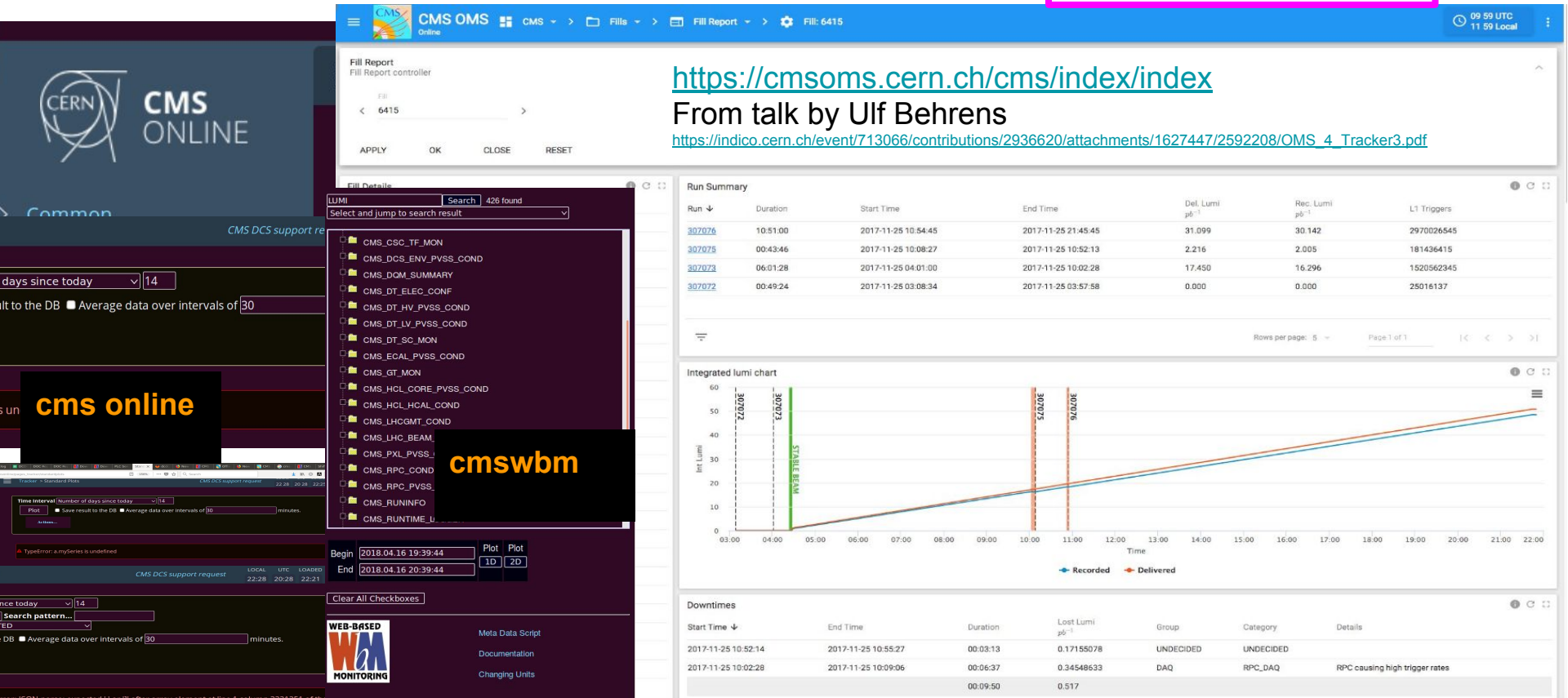
CAEN PSU Strips voltages and currents

Tracker DCS interface



Many tools available from CMS:

new CMS OMS



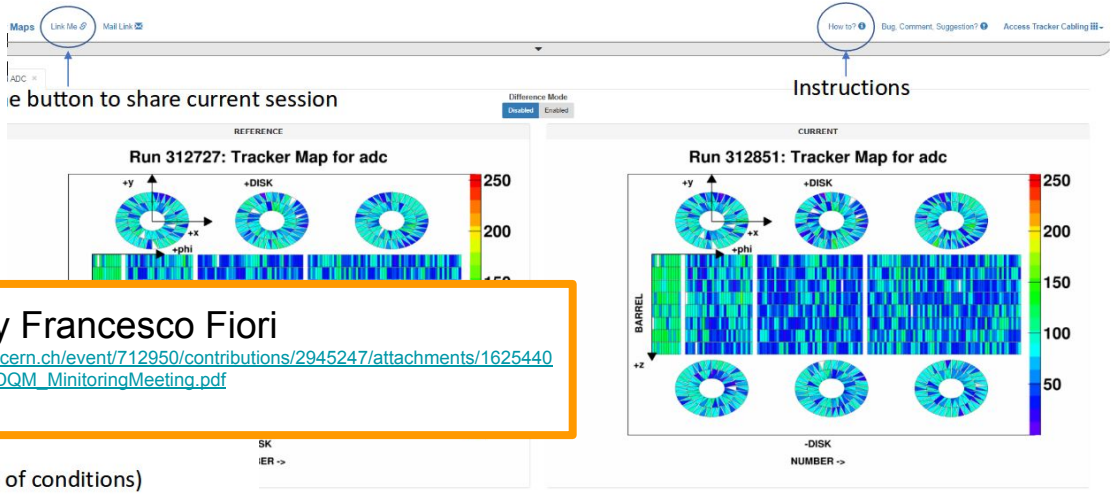
https://cmsoms.cern.ch/cms/index/index

From talk by Ulf Behrens

https://indico.cern.ch/event/713066/contributions/2936620/attachments/1627447/2592208/OMS_4_Tracker3.pdf

– http://vocms061.cern.ch/event_display/TrackerMapsReloaded/

Offline tools



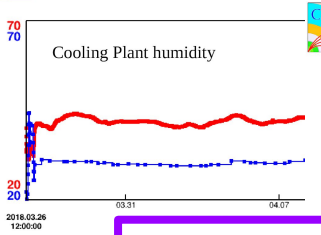
Historical DQM
vocms061.cern.ch/event_display/HDQM/v4/

Talk by Francesco Fiori
https://indico.cern.ch/event/712950/contributions/2945247/attachments/1625440/2588349/TkDQM_MinitoringMeeting.pdf

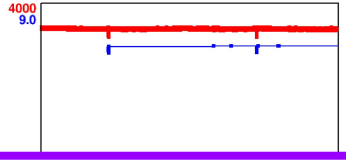
Hit efficiencies using express data by Vinicius Mikuni
https://indico.cern.ch/event/713066/contributions/2950236/attachments/1627718/2592764/PixMonitoring.pdf
http://vmikuni.web.cern.ch/vmikuni/

There was structure: weekly monitoring report

Cooling



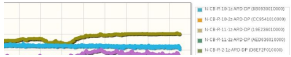
Membrane

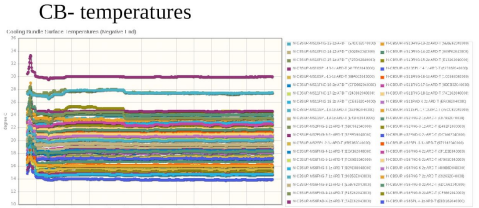


Flow and Pressure

Cooling Bundles

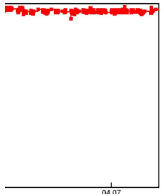
over the past week

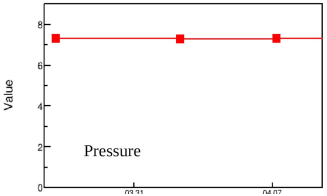


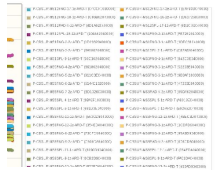


Doc report: daily monitoring and weekly tracker monitoring report by strips and pixel docs

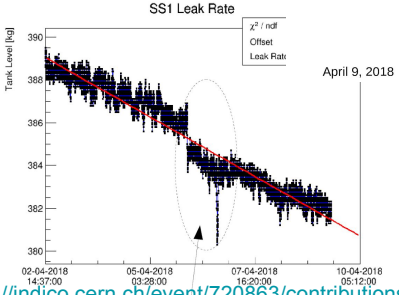
Dry Gas



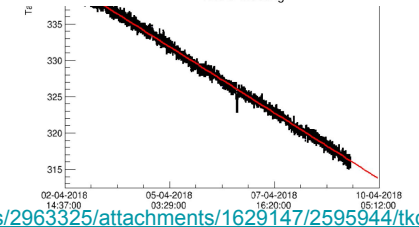




- Leak rate over the week

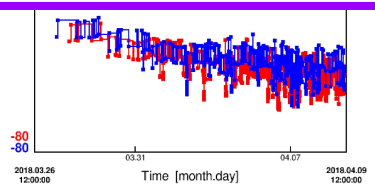


April 9, 2018

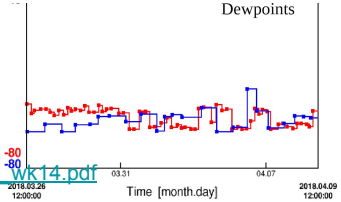


TKCO Meeting

Dewpoints



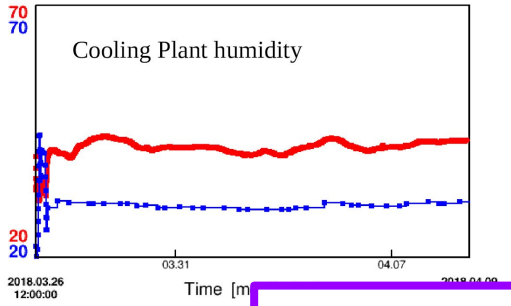
http://ebutz.web.cern.ch/ebutz/cgi-bin/docReport.pl

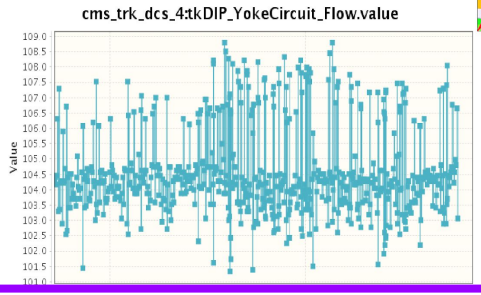


- Stable over the past week

https://indico.cern.ch/event/720863/contributions/2963325/attachments/1629147/2595944/tkdoc_wk14.pdf

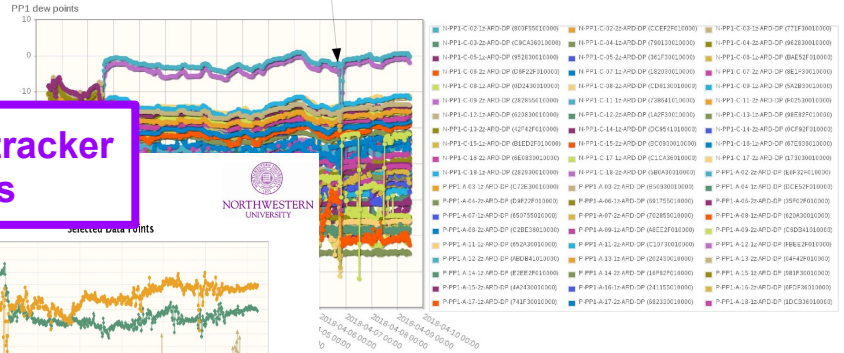
Tracker cooling and dew points: strips + pixel





PP1 Dew Points

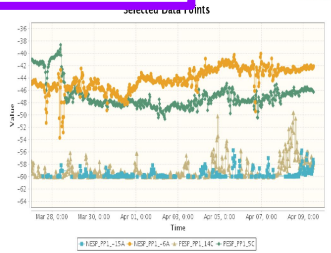
Around the time of off-lock incident, but most sensors don't show a sudden brief dip...

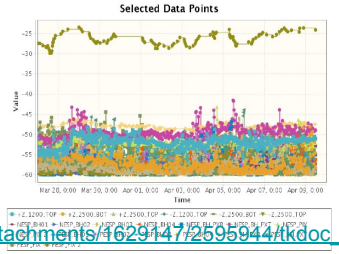


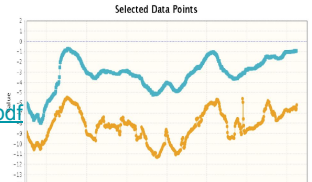
Doc report: daily monitoring and weekly tracker monitoring report by strips and pixel docs

CB dewpoints

- Stable over the past week

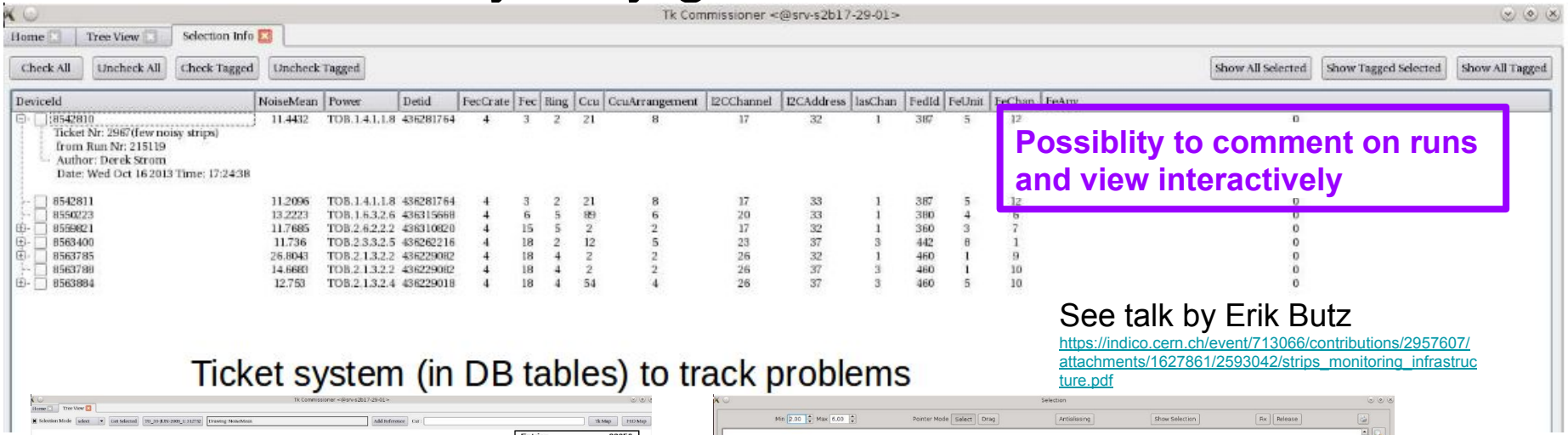






https://indico.cern.ch/event/720863/contributions/2963325/attachments/1629147/2595944/tkdoc_wk14.pdf

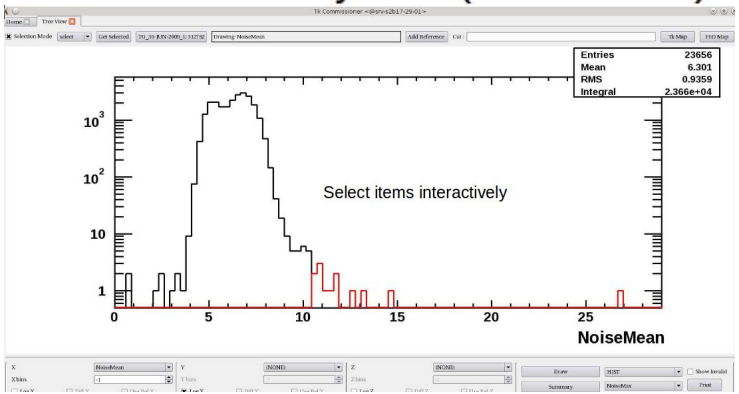
There are already very good tools: TK commissioner

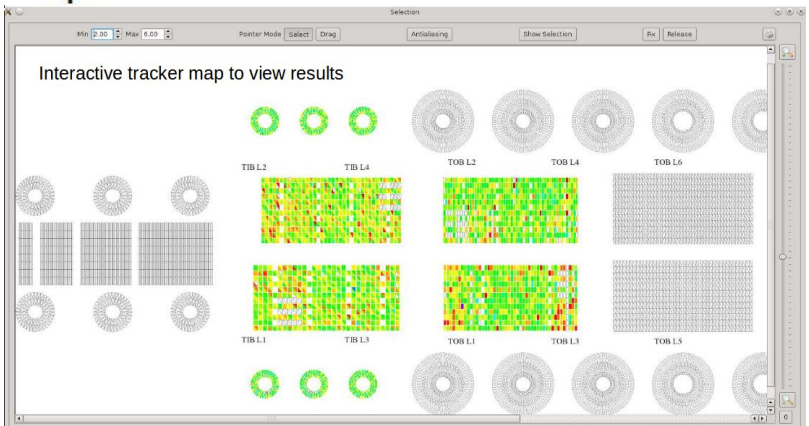


Possiblity to comment on runs and view interactively

See talk by Erik Butz
https://indico.cern.ch/event/713066/contributions/2957607/attachments/1627861/2593042/strips_monitoring_infrastructure.pdf

Ticket system (in DB tables) to track problems





Pixel: under construction

Many different tools are available and much monitoring infrastructure is in place for the strips detector --
and pixel where environmental variables like dew points overlap

Pixel may sometimes have different needs:

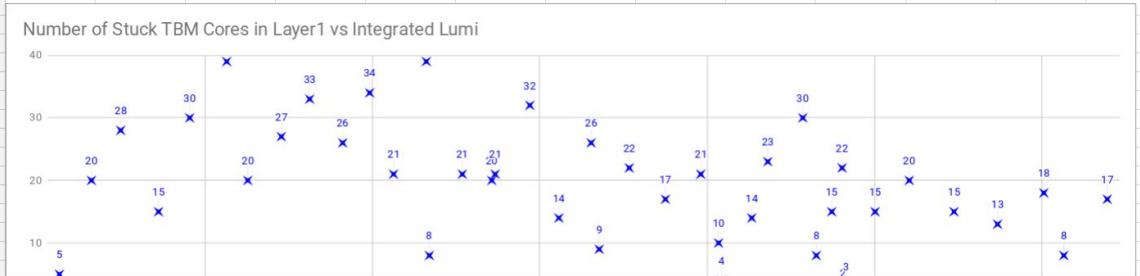
Pixel Detector Information

File Modifica Visualizza Inserisci Formato Dati Strumenti Componenti aggiuntivi Guida

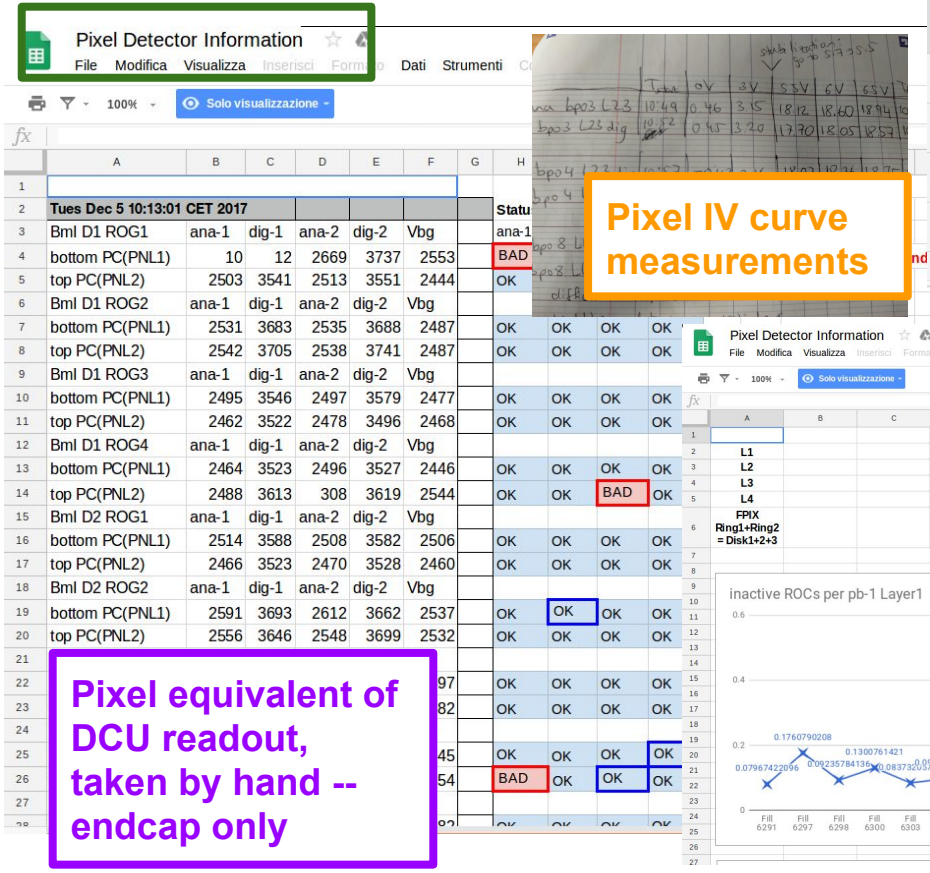
CONDIVIDI

Solo visualizzazione

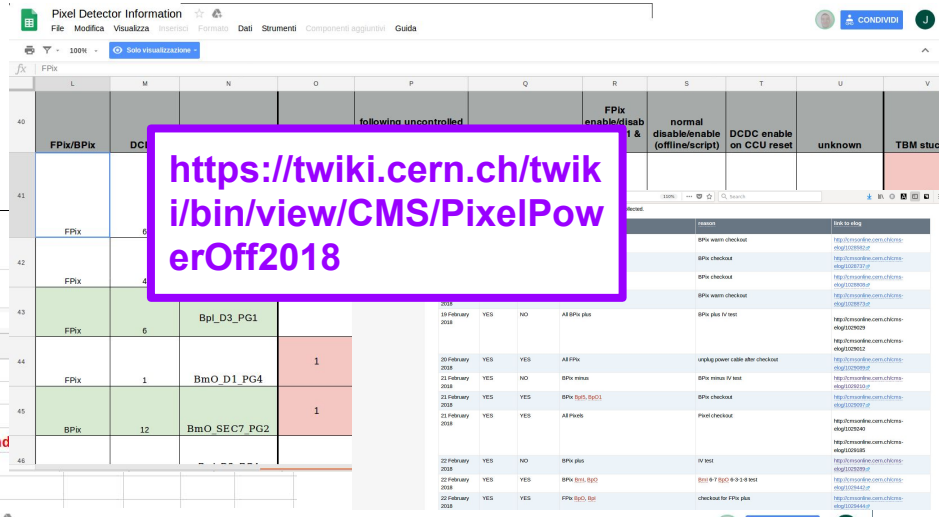
Fill	6285	6287	6288	6291	6297	6298	6300	6303	6304	6305	6306	6307	6308
Recorded Lumi (1/pb)	322.7	477.9	437.5	564.8	465.7	552.2	315.2	501.6	422.5	493.6	401.7	357.761	489.0
Integrated Lumi (1/pb)	322.7	800.6	1238.1	1802.9	2268.6	2820.8	3136	3637.6	4060.1	4553.7	4955.4	5313.161	5802.2
# Stuck TBM Cores													
Layer1	5	20	28	15	30	39	20	27	33	26	34	21	39
Layer2	2	4	13	9	4	4	5	9	14	14	16	20	23
Layer3	3	6	13	10	10	18	24	25	25	27	31	36	44
Layer4	1	10	15	7	3	11	14	21	26	30	30	34	33
Ring1	25	9	13	13	8	39	14	33	33	30	30	27	42
Ring2	16	10	13	15	3	41	13	23	39	22	31	27	33



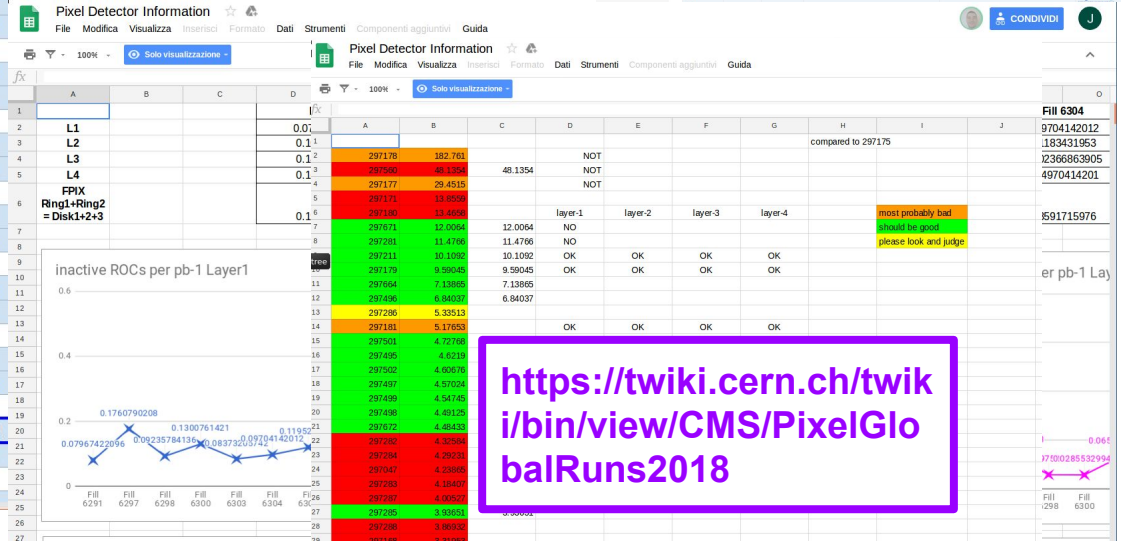
From spreadsheet to twiki



Pixel IV curve measurements



https://twiki.cern.ch/twiki/bin/view/CMS/PixelPowerOff2018



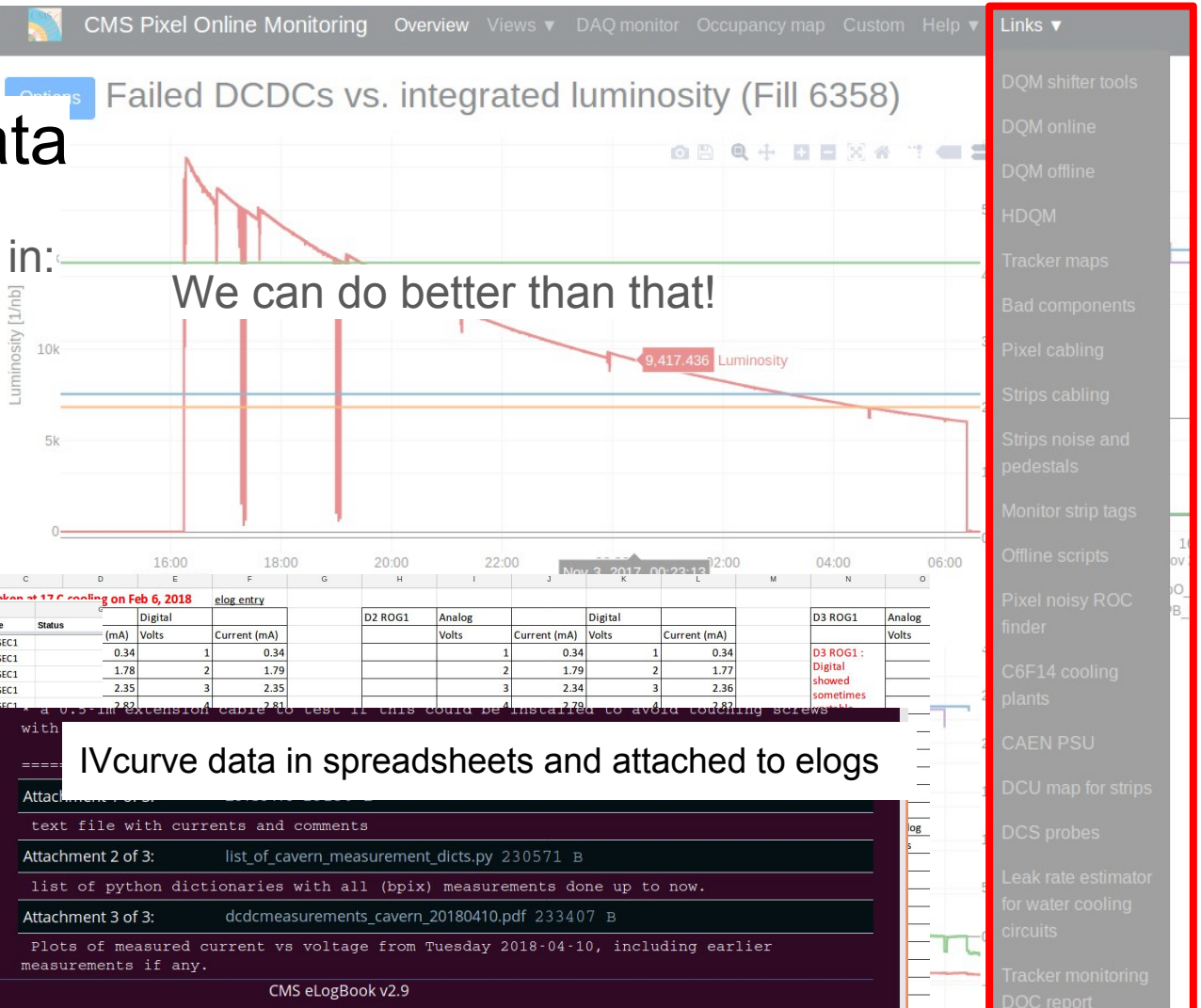
Pixel equivalent of DCU readout, taken by hand -- endcap only

https://twiki.cern.ch/twiki/bin/view/CMS/PixelGlobalRuns2018

Structuring data

Data can now be found in:

- Twikis
- Text files
- Google sheets
- Notebooks
- Root files
- Personal websites
- …



But most information is in the database...

… and if it is not there, perhaps it would be good to put it there =)

(like strips already does)

http://www.our-happy-cat.com/images/moo-moo-our-cats-name.jpg

Suited for database storage:

- Detector parts

- Global runs with comments
- Pixel off states with comments
- Masked ROCs with comments + elogs

- Any ROCs with comments + elogs
- Measurements (calibrations)
  Va, Vdig, Gains, …
- CASTOR DCDC monitoring
- IV curve measurements
- Masked channels
- …

Store all information in database and display in summaries

Current location:

- Detconfig,
  https://piberger.web.cern.ch/piberger/nametranslation/nametranslation_bpix.html
- twiki https://twiki.cern.ch/twiki/bin/viewauth/CMS/PixelGlobalRuns2018
- twiki https://twiki.cern.ch/twiki/bin/view/CMS/PixelPowerOff2018
- Twikis https://twiki.cern.ch/twiki/bin/viewauth/CMS/PixelKnownProblems
  https://twiki.cern.ch/twiki/bin/viewauth/CMS/BPixProblems

- Scattered elogs
- ROOT files on cmsusr

- Files on server
- elogs/notebooks
- Log files
- …

Tracker monitoring activities and goals

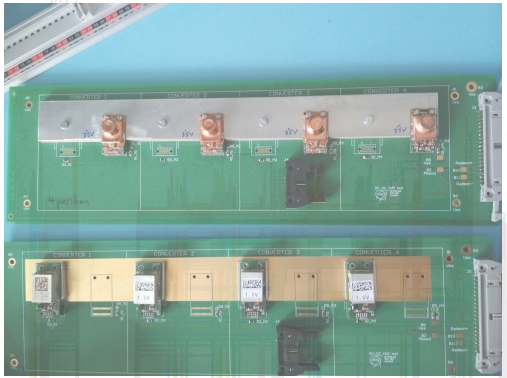
- Monitoring of silicon properties next week: https://indico.cern.ch/event/721478/
- Monitoring of environmental variables this week **in 42-3-032 from 16:00-18:00:** https://indico.cern.ch/event/720066/
- Gathering of information **(automatically)**, make analyses and predictions
- **(Automatically)** react to notable results (webpage, email)
- Online + offline report on Mondays 15:30-16:30 (between operations meetings) like yesterday: https://indico.cern.ch/event/721133/
- Regular working meetings Thursdays 15:00-17:00 at P5 in **3562-R-001**
- You can subscribe to the e-group at https://e-groups.cern.ch/e-groups/: cms-tk-monitoring

Improvement of tracker environmental monitoring

Note: a lot of this is work in progress on CMS pixel online monitoring!

Pixel

- Analog currents (over year vs lumi)
- Digital currents (compare PS trip limits)
- Analog and digital voltages (DCDC health indication) from ROC readback
- DCDC IV curve measurements (CASTOR, manual)



To be watched by DOCs
Weekly report Mondays 15:30-16:30

Default (adjustable!) two-week or year-long (leakage current) trend plots available online on tom.cms at p5

Mostly there for strips, could be improved for pixel + strips

- Temperatures (compare cooling set temperature, dew points)
- Occupancy plots with (compare known problems)
- Leakage currents (can be real time)
- FED error/ masked channel monitoring
- L1 trigger count
- Cooling plant leak rates
- Dew points (alarm before we reach critical temperature)
- Global runs, settings, and run info
- **Doc's comments**

POM: https://its.cern.ch/jira/projects/CMSPOM/issues/

New: pixel online monitoring development
https://gitlab.cern.ch/cmspops/pom

Online monitoring of environmental variables

Have all observables at hand without initial search or clicks (just open browser)

Default (adjustable!) two-week or year-long (leakage current) trend plots available online on tom.cms at p5

LV, also HV (not visible here)

Viktor Kutzner

Pixel online monitoring: correlations

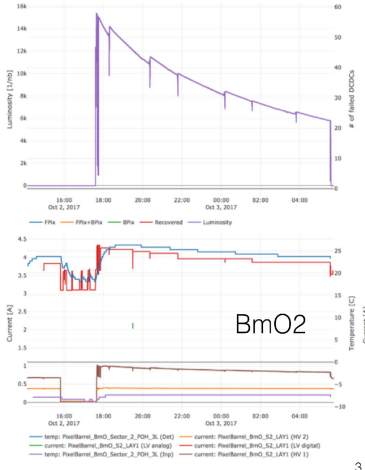
Study correlations between currents, temperatures luminosity, LHC states

Here: failed DCDCs and lumi levelling (No correlation found but note: low stats) Using database + own added information

V Kutzner and F Zhang

https://indico.cern.ch/event/1066654/contributions/2905358/attachments/1604492/2545148/Pixel_Online_Monitoring_II.pdf

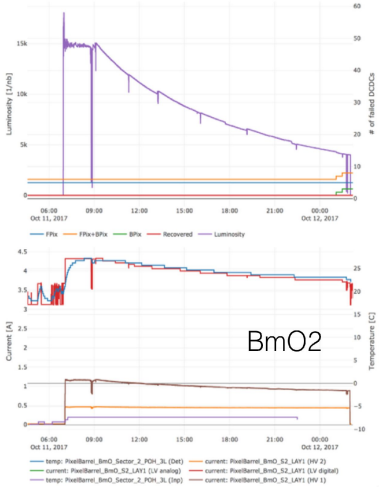
Luminosity levelling



- Fill 6266: **before** luminosity levelli
- luminosity vs. nu failed DCDCs
- current vs. tempe

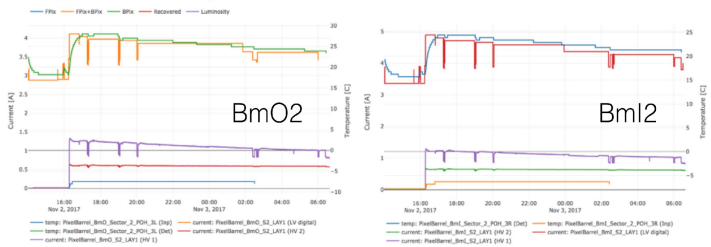
3

Luminosity levelling



- Fill 6291: **after** luminosity levelling
- luminosity vs. number of failed DCDCs
- current vs. temperature

4



5

(see backup for BpO2 & BpI2)

Pixel DAQ monitor

Use database information to monitor FEDs

→ choose logged information to write to database:

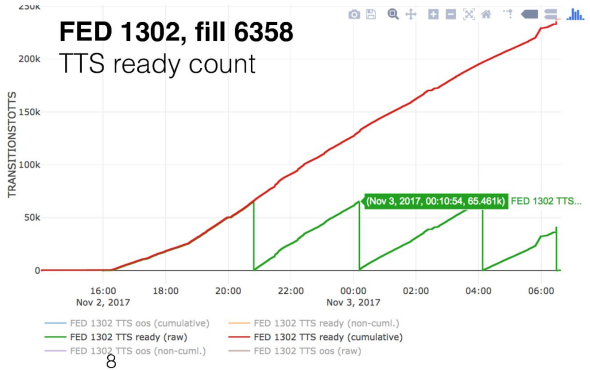
- Busy
- Ready
- Warning
- out of sync
- masked channels

DAQ monitor plugin

```
SQL> describe FEDMONITORPERSISTENT;
 Name
 -----------------------------------
 BOARDCODE
 CHANNELENABLESTATUS
 CHANNELMASK
 CNTEVTRSYTOT
 CNTTBMHIDTOT
 CNTTRLERRTOT
 CONNECTIONNAME
 CONTEXT
 EVTERRNUMTOT
 EVTTMONUMTOT
 FWIPHCDATE
 FWIPHCVERSION
 L1ACOUNT
 LID
 MACADDRESS
 NOTKNPSSTOT
 OVFNUMTOT
 PKAMRSTTOT
 PLL_200MHZ
 PLL_200MHZ_IDELAY
 PLL_400MHZ
 ROCERRNUMTOT
 SESSIONID
 STATENAME
 TBMATORSTTOT
 TBMMASK
 TIMEINTTSBUSY
 TIMEINTTSOOS
 TIMEINTTSREADY
 TIMEINTTSWARN
 TIMESTAMP
 TRANSITIONSTOTTSBUSY
 TRANSITIONSTOTTSOOS
 TRANSITIONSTOTTSREADY
 TRANSITIONSTOTTSWARN
 TTSSTATE
```

available information from DB

- get TTS information from **FED monitor** table
- busy, out-of-sync, ready, warn for
  - transitions to TTS
  - time in TTS
- individual information per channel being put into DB



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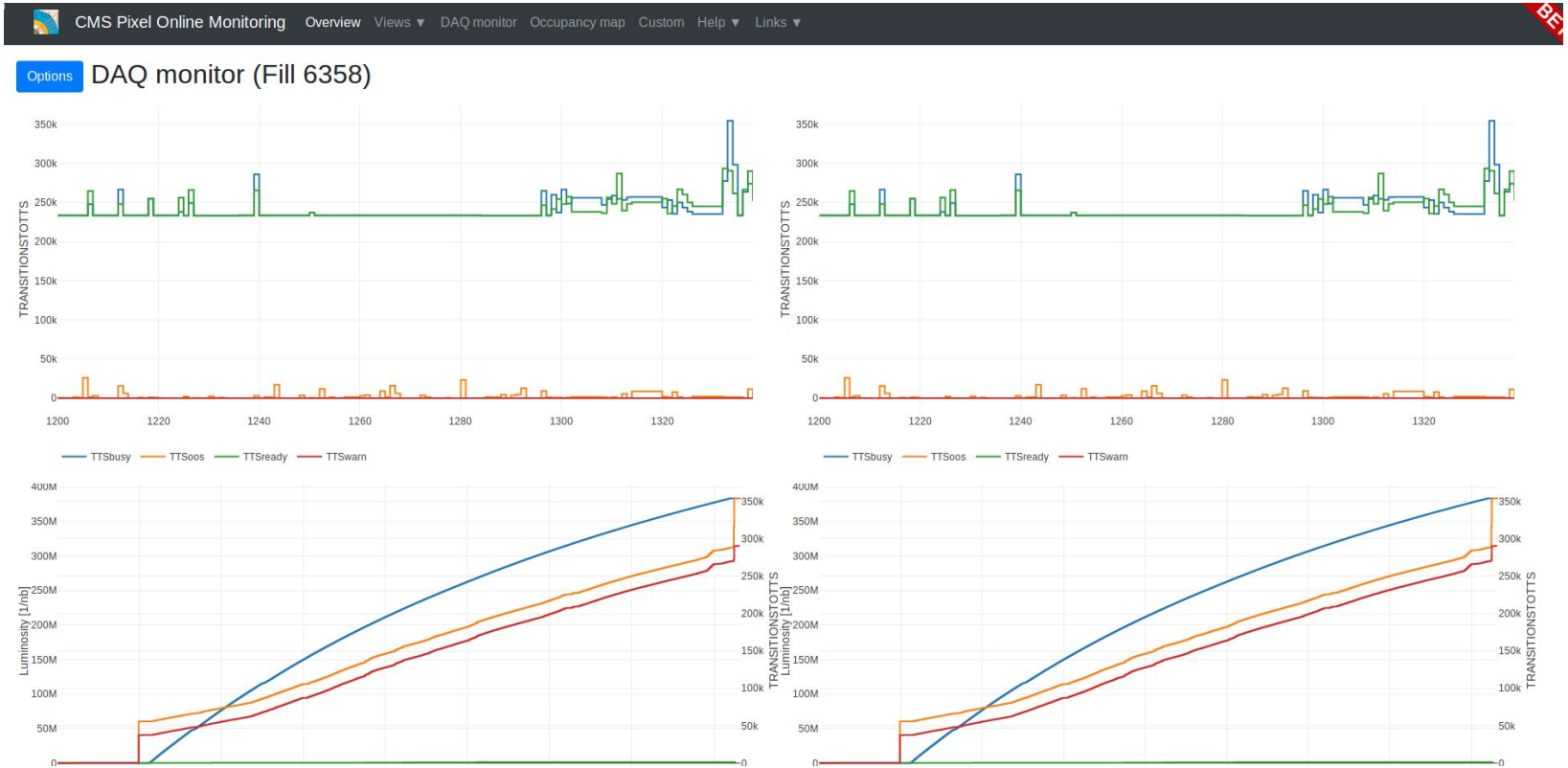
Weinan Si, Viktor Kutzner

https://indico.cern.ch/event/710755/contributions/2925481/attachments/1613083/2562217/pixel-monitoring-3.pdf

Pixel DAQ monitoring

See http://tom.cms

With cron: warnings in case of no phases, no portcard



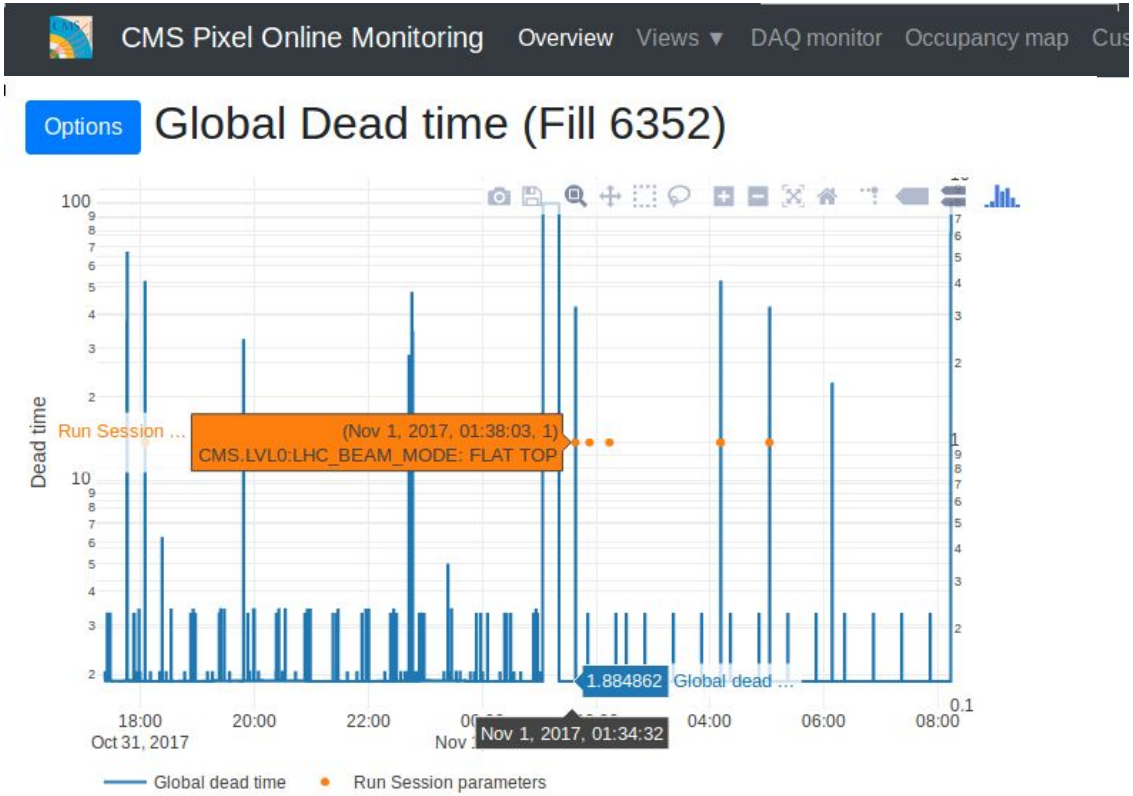
Weinan Si, Viktor Kutzner

https://indico.cern.ch/event/710755/contributions/2925481/attachments/1613083/2562217/pixel-monitoring-3.pdf

Online monitoring: dead time

Readily available information in the database

Dead time for pixel detector shown with LHC states using information from CMS from database

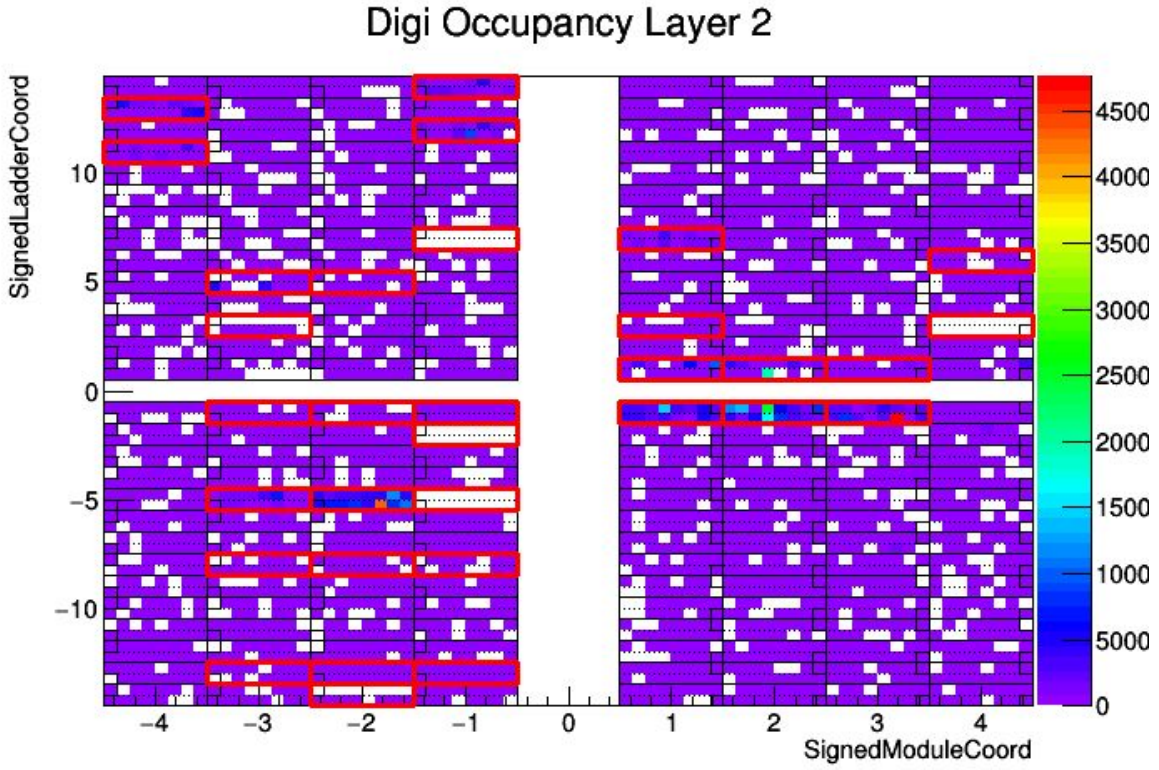


Viktor Kutzner

Adds information to database

Occupancy with masked ROCs/modules overlaid

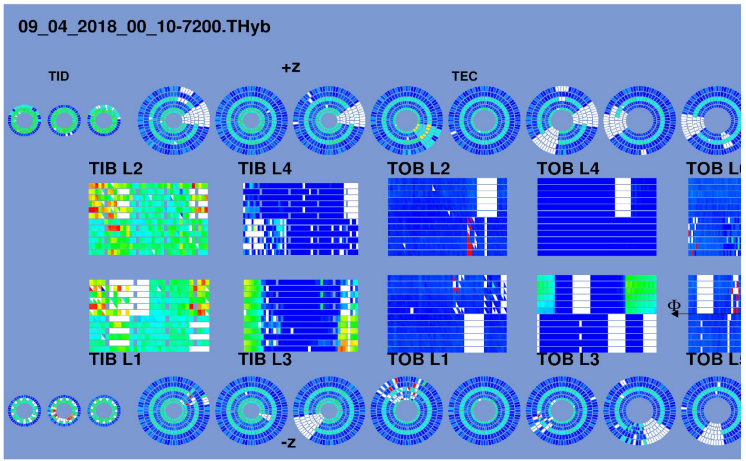
- Possible link to JIRA ticket or elog if any
- Reads known problems and config from database
- Works with (H)DQM (Alessandro Rossi) to display digi occupancies



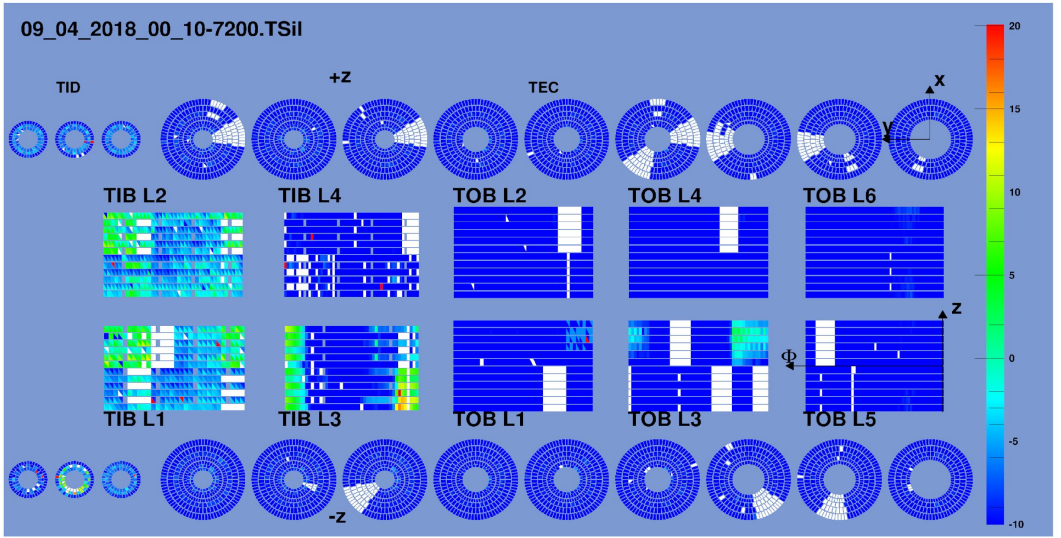
Run 313916 cosmics with 2018 known problems overlaid

There was already monitoring of radiation effects: Strips temperatures and leakage currents

Hybrid Temperatures



Silicon Temperatures



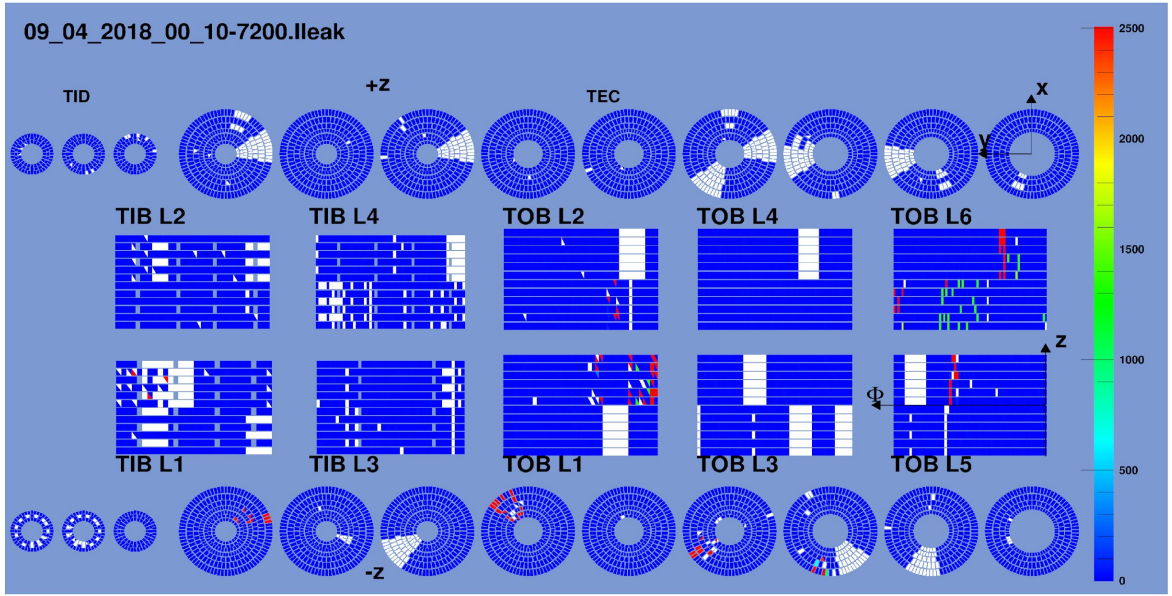
Strips doc report

https://indico.cern.ch/event/720863/contributions/2963325/attachments/1629147/2595944/tkdoc_wk14.pdf

Strips leakage currents

Leakage Currents

Strips leakage currents and temperatures displayed eye-friendly in cabling map



and Pixel?

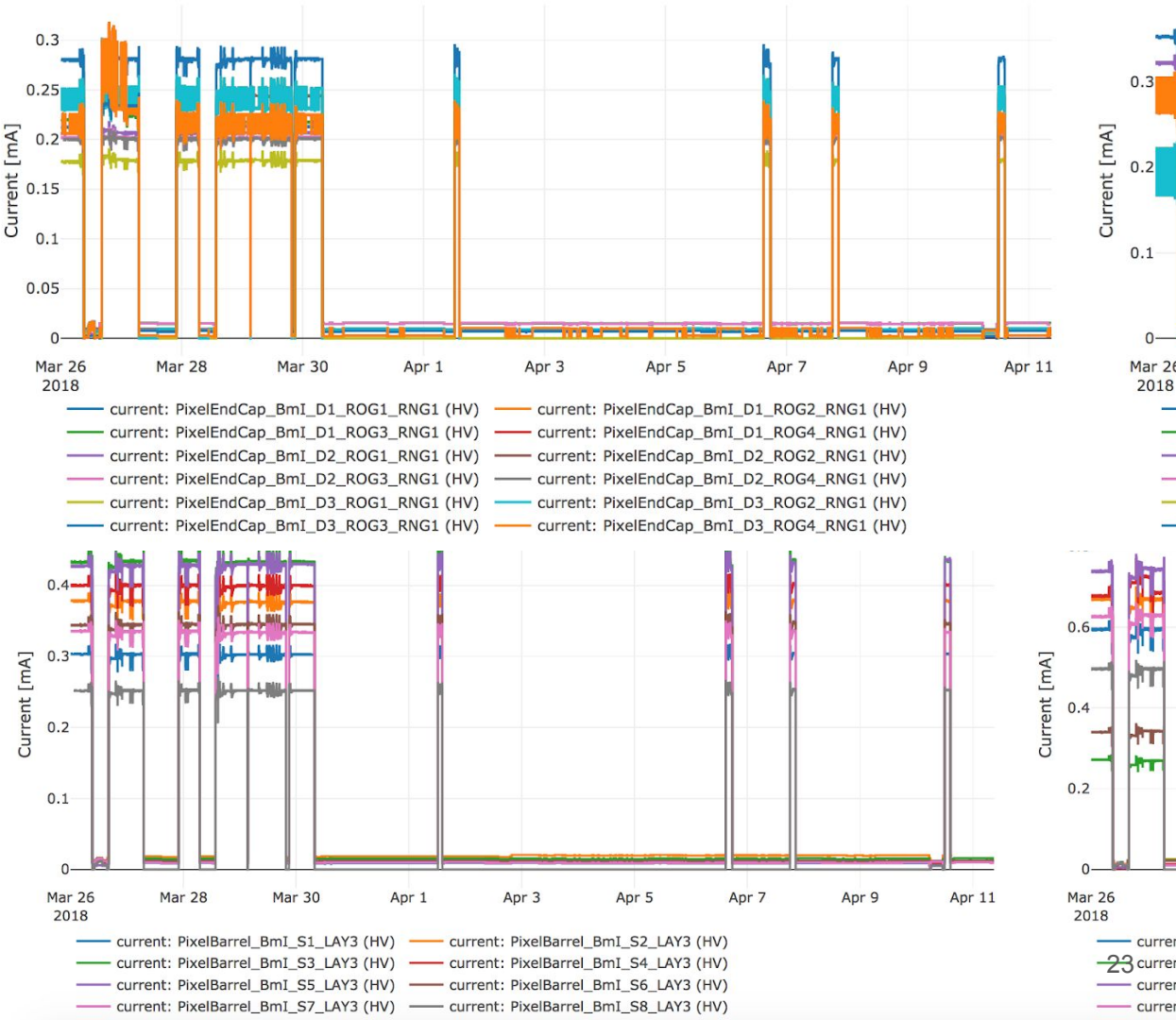
Pixel HV current

For radiation effects:

Work in progress on year-long overview with currents samples 10min into stable beam. Highly temperature dependent!

Shown in http://tom.cms, also vs temperature

Fengwangdong Zhang



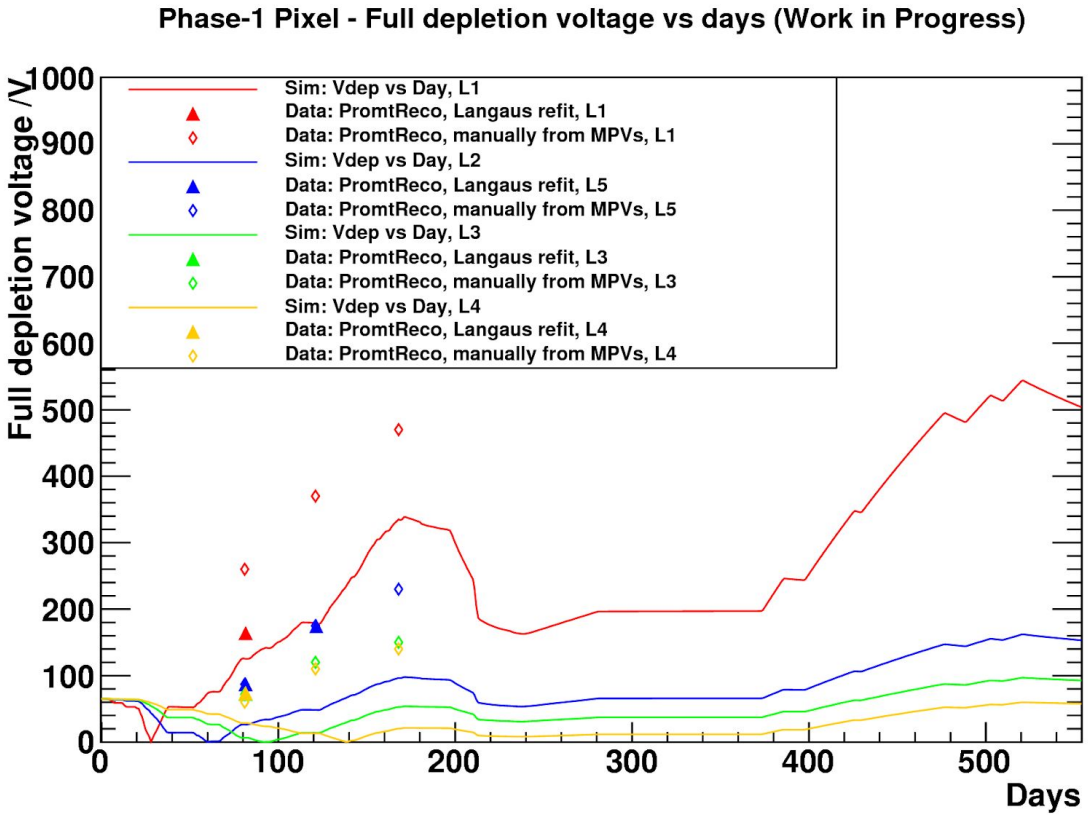
Radiation effects

Now available: pixel barrel phase 1 depletion voltage prediction

https://indico.cern.ch/event/719706/contributions/2959984/attachments/1632008/2602682/2018_04_12_Vdep_sim_LVonoffbandplots.pdf

Model and projection of pixel barrel depletion voltages

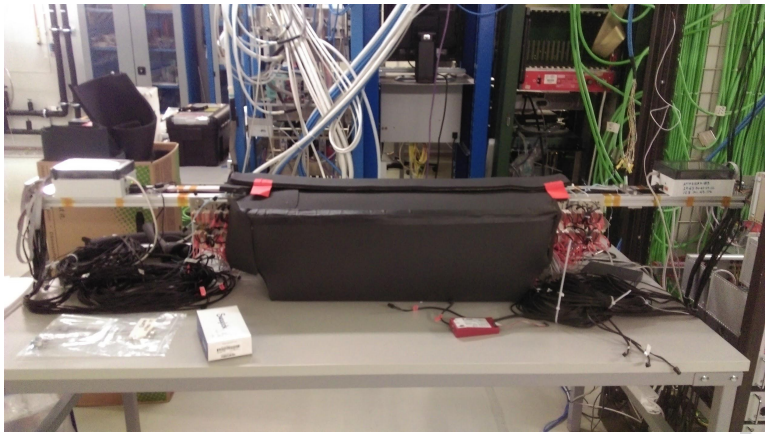
Uses HV bias scan results and pixel temperatures



Julia Hunt
Tilman Rohe

Temperatures and radiation effects

→ Get a better handle on sensor temperatures using a thermal mockup of the pixel barrel layer 2

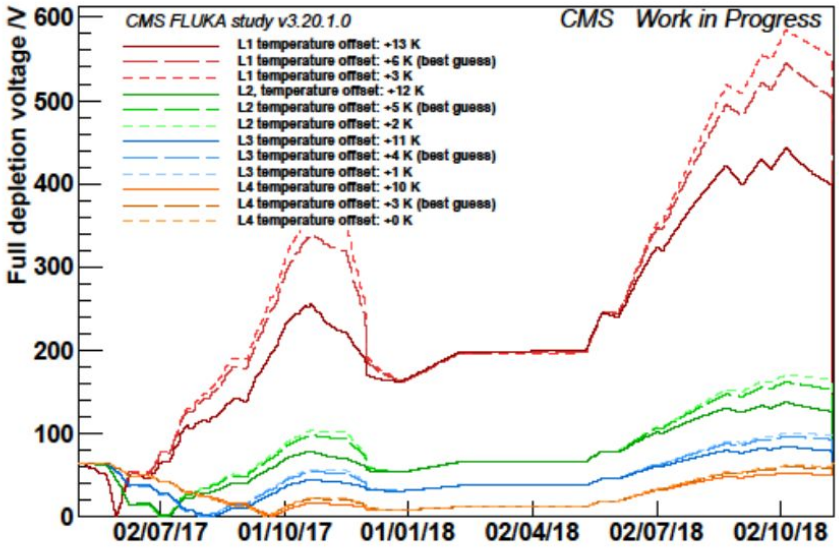


Max Rauch

Phase-1 "band plot": Temperature offset

Karlsruhe Institute of Technology

Full depletion voltage evolution, HH param set: RD48 oxy



lower temperature

higher temperature

Short-term (beneficial) annealing acts faster (is not "accumulated") for warm temp.

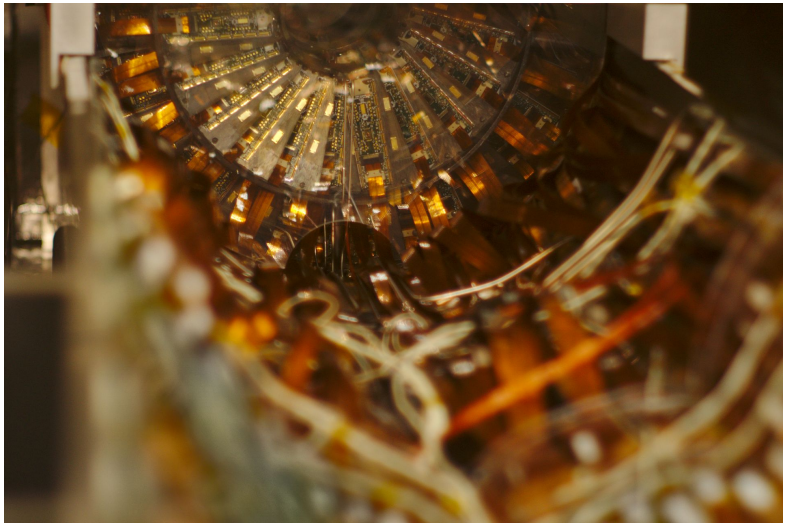
Julia Hunt

Projections of pixel endcap depletion voltages

…

We need your help!

=)

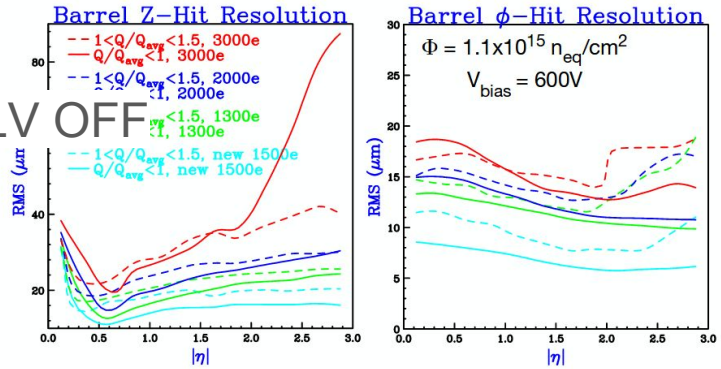


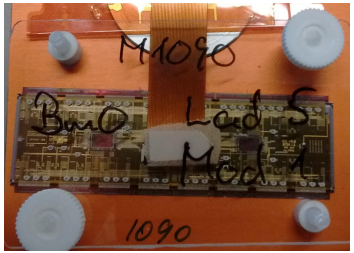
More modeling of radiation effects

Monthly report Mondays 15:30-16:30

- Monitoring, modeling, and prediction of **leakage currents**
- Monitoring, modeling, and prediction of **depletion voltages**
  --> need HV bias scans
- Pixel drifts in analog currents
- Pixel model for module damage with HV ON/LV OFF
- BPIX layer 1 lifetime after LS2
- Pixel threshold monitoring
- DCU readback and analog current readback

L1: end 2022, V_{bias} = 600V





- Detector still works [as expected]
- Resolution is ~50% worse in x and ~25% worse in y as compared with a new detector operated with low thresholds
- Cluster breakage is onsetting for 3000e at η > 2
  - y-resolution is most sensitive

BPix L1 projections for run 3 by Morris Swartz
https://indico.cern.ch/event/719706/contributions/2967656/attachments/1632211/2602675/BPix_L1_Performance_Run3.pdf

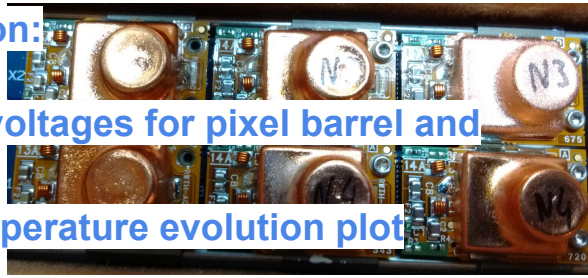
https://twiki.cern.ch/twiki/bin/view/CMS/TrackerMonitoringProjects

Growing list of monitoring projects

Still looking for people:

- Pixel endcap radiation damage projections
- DAQ monitoring summary
- Real time updated summary plot pages with comments and history
- Tracker radiation damage projections in Run 3
- Monitoring of thresholds
- Warn the DOC: create email and sms alarms where needed
- Estimate of beam spot location
- …

We already have but may want to have more people working on:

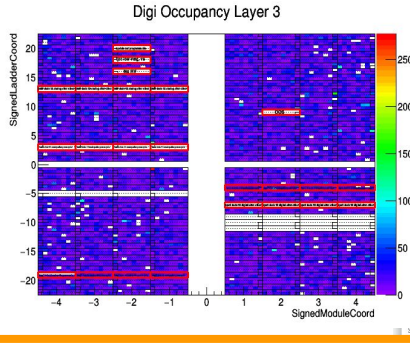


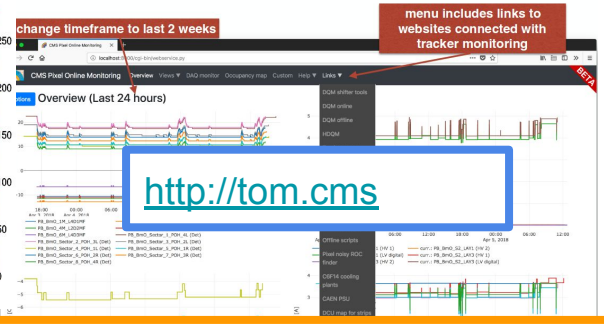
- Readback voltages for pixel barrel and endcap
- Sensor temperature evolution plot summary
- Sensor leakage current and analog current evolution plot summary
- Detector components in database
- Pixel offline data quality summary
- Pixel online data quality feedback with comments and archive

Your new ideas are welcome!

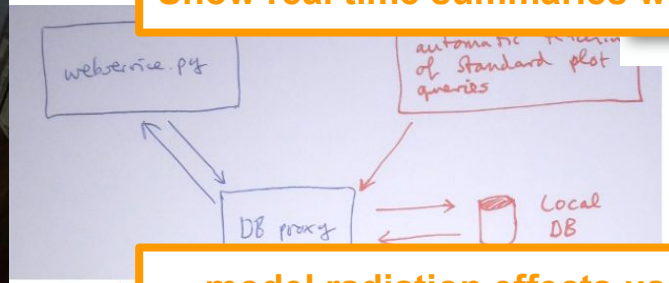
http://iruntheinternet.com/lulzdump/images/cat-filing-cabinet-draw-happy-1413757432c.jpg

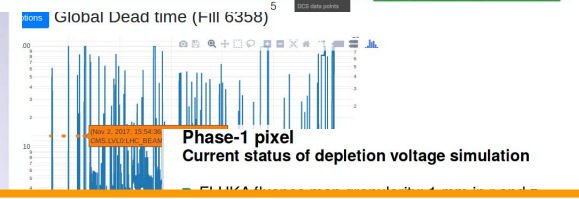
Goals





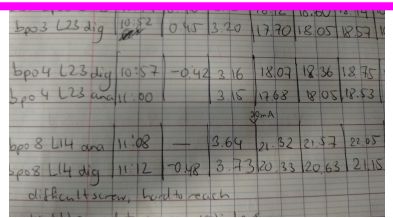
Show real time summaries with comments to aid our DOCs...





… model radiation effects using existing measurements …

Store information to accessible database



… and help us make decisions!

Summary: Goals of tracker monitoring

To help us understand **radiation effects** and and make projections for pixel and strips we aim to monitor and model:

- depletion voltages
- temperatures
- leakage currents
- analog currents
- thresholds

You are welcome to help:

https://twiki.cern.ch/twiki/bin/view/CMS/TrackerMonitoringProjects

jory.sonneveld@cern.ch

To summarize tracker **environmental observables**:

- status overview of the detectors
- weekly archive
- weekly online/offline discussion between operations meetings
- gather information **automatically** as much as possible
- update summaries automatically
- send alarms in case of **any** possible problems such as high temperatures, leak rates, missing phases, missing FEDs, missing