

NA62 Italia, Laboratori Nazionali di Frascati



LAV, IRC & SAC performance in 2021 and future improvements

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2-3 December 2021

Outline

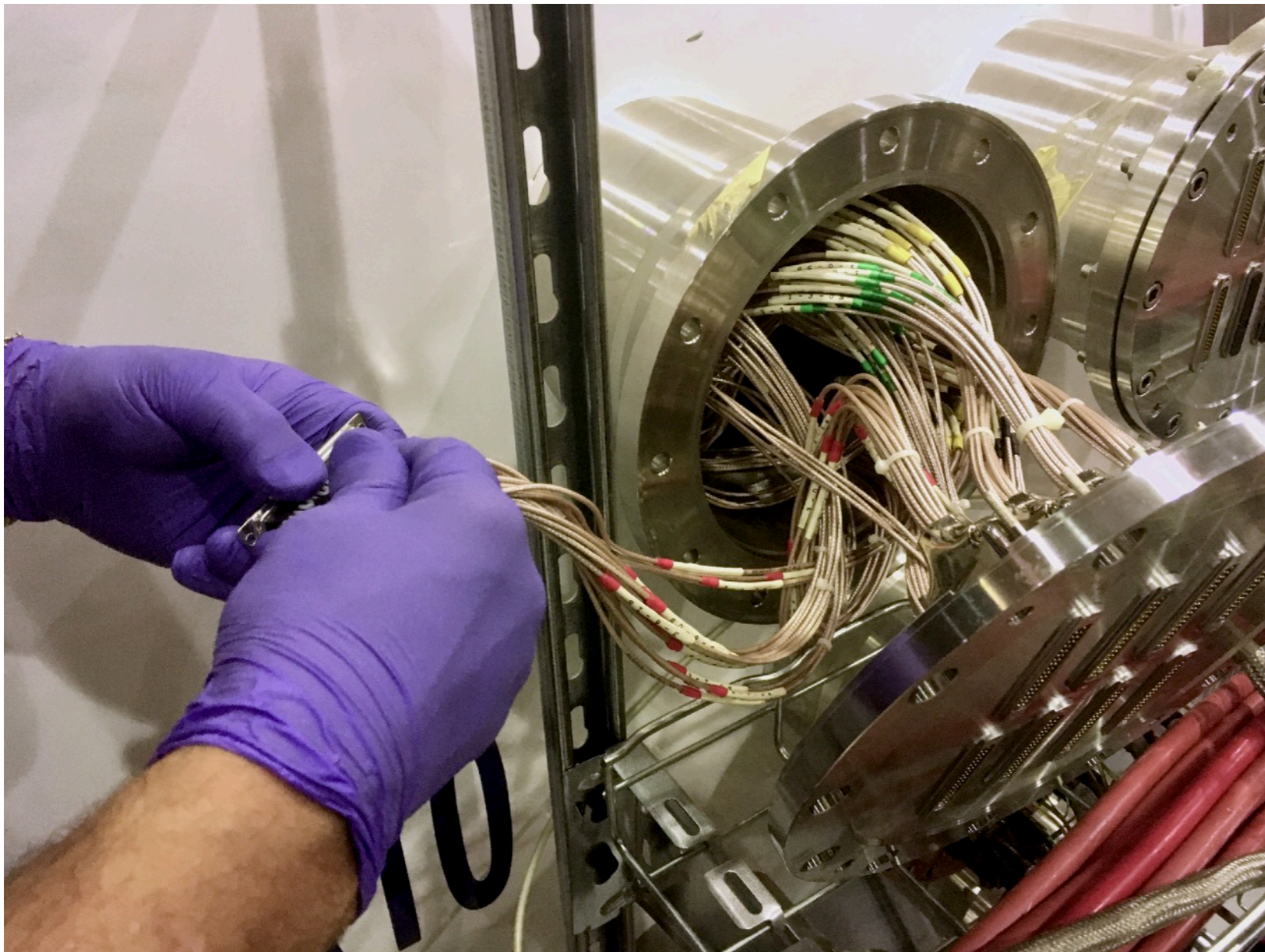
LAV, IRC & SAC:

- ▶ Hardware intervention before 2021 run
- ▶ Hardware performance during data taking
- ▶ Detectors efficiency and data quality
- ▶ Possible improvement for the future

Actions on LAV before 2021 data taking

Before the 2021 Run a thorough maintenance has been done on all the LAVs channels

Pulser + cosmic run → check of the signal quality → cable contacts check and fixing...



First intervention and survey

- Track down and solve some of the problematic channels
- PMTs response studies

Technical work

- Opening of specific flanges to check connections
- Reinforce of grounding for a couple of LAVs
- Deep diagnosis of channel problem sources

New HV recipe

13 new PMT HV values in 2021:

- HV **decreased** to reduce excessive pulsing (PMTs getting noisy)
- HV **increased** to restore signal (PMTs getting less reactive)

Detector ch	Old HV	New HV	Δ
1.2.2.2	1268	1198	-70
4.0.7.0	1483	1308	-175
5.1.5.1	1357	1307	-50
5.4.2.1	1143	1393	+250
6.0.4.2	1230	1160	-70
6.4.1.0	1163	1113	-50
7.3.6.1	1393	1323	-70
9.3.1.0	1476	1376	-100
10.1.2.3	1466	1266	-200
11.0.7.2	1203	1303	+100
12.1.8.1	1169	1044	-125
12.3.12.1	1223	1123	-100

LAVs few problematic channels

Dead channels:

- LAV 3 **D03.0.02.2** dead PMT
- LAV 7 **D07.3.09.3** dead from 2018 , trips($V = 0V$)
- LAV 10 **D10.3.11.3** suspect breakdown of capacitor divider ($V = 0V$)

Extremely noisy (2MHz of noise, not real signal):

- LAV 9 **D09.0.08.3** —-> masked in the xml file
- LAV 12 **D12.3.08.3** —-> masked in the xml file

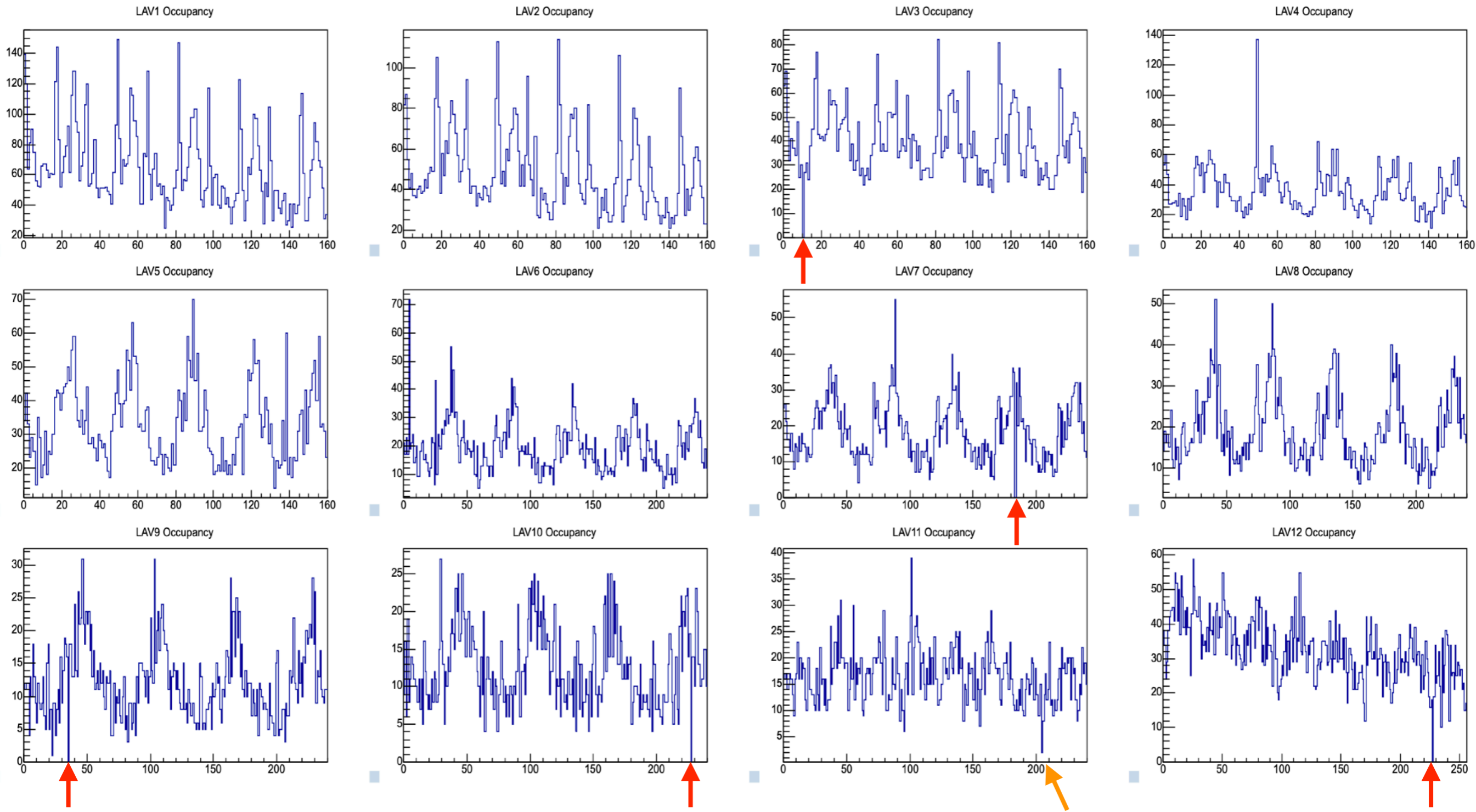
No significant deterioration for the moment (known issues)

Hot channels all under control: tolerable noise

5 dead
channels
over 2496

▶ TDCb cables are loosening up, contact in the last channels (31, 176) should be periodically fixed with hand manipulation

LAV occupancy plot

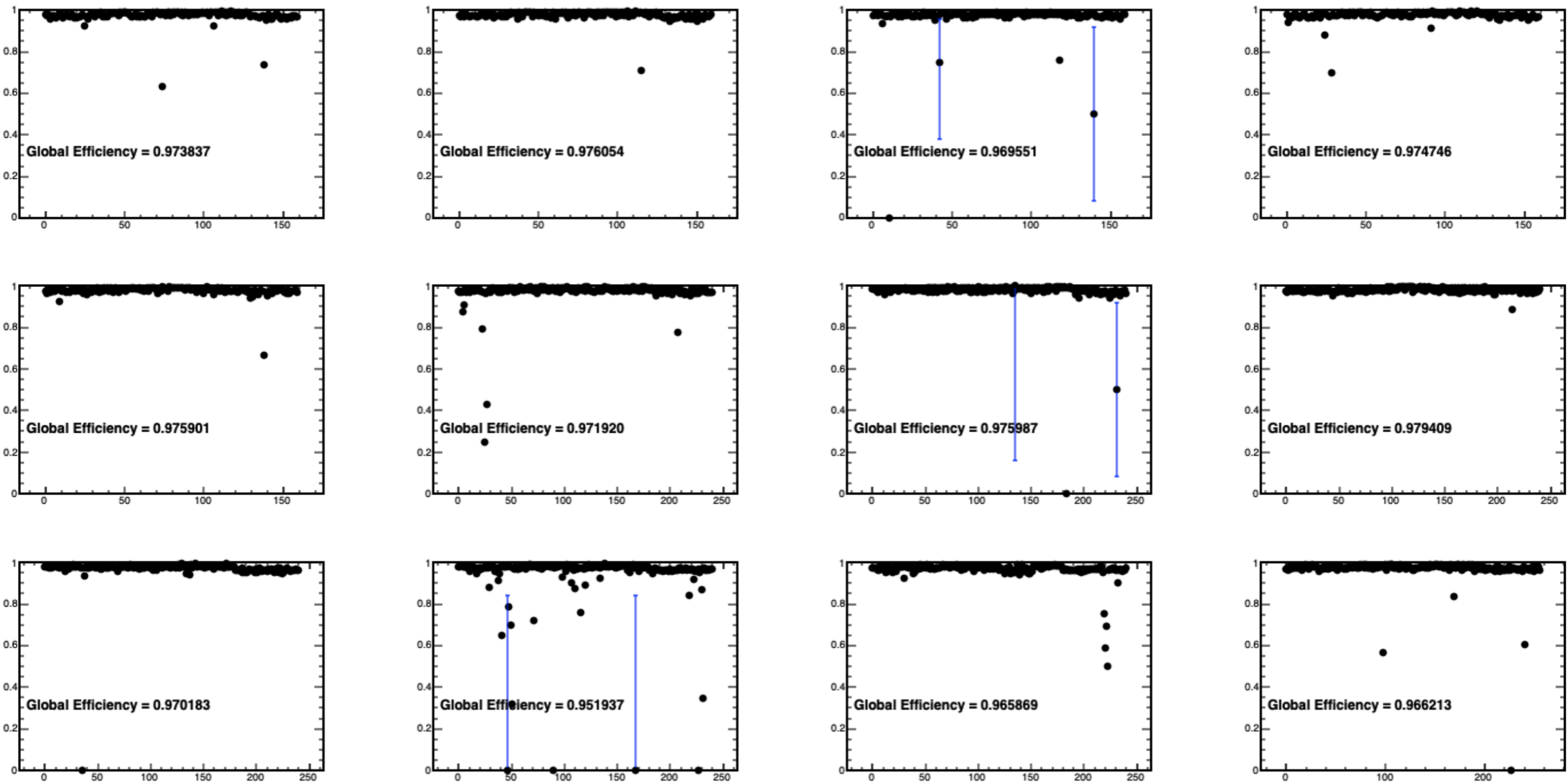


NA62 Monitor - Run 010640 - burst 159

LAV Efficiency with muon Run 10475

- LAV blocks efficiency obtained with a Muon Run (July 23rd)
- Threshold scan: 5 mV - 5 mV

Muon efficiency ~ 97%



Post Processing analyzer for LAV DQ

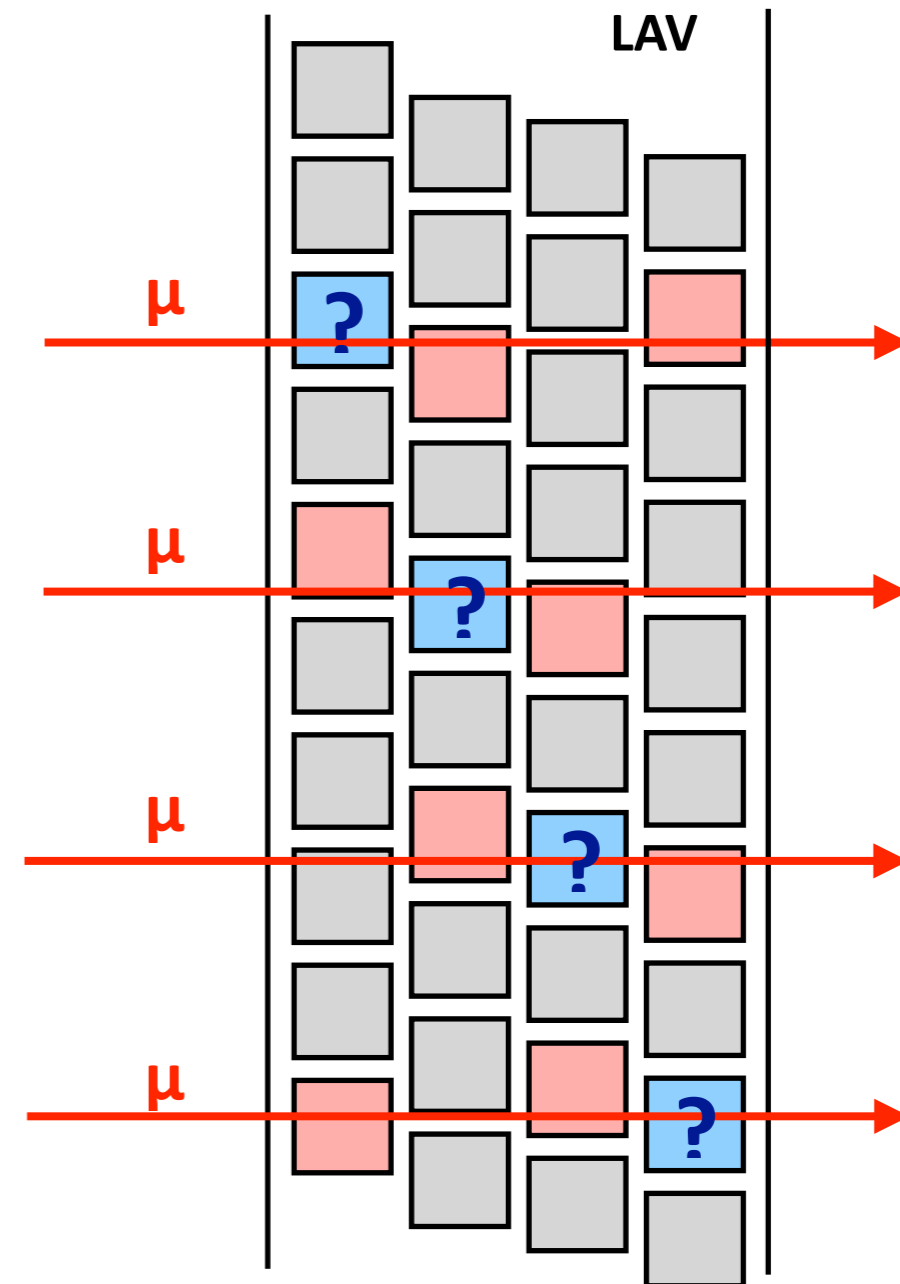
- Is there a hit between (before, for the first layer or after, for the last layer) 2 hited blocks?

Matt's algorithm, that used the Digi information:

2 hits in column, L + T edges on the control threshold - **5 mV**, clusterized in time

Search for 1 hit, L + T edges on the tested threshold (variable)

Now the code is able to run over the RecoHit and will be added to the post processing analyzers as LAV data quality check



LAV HV system during run

Channels			Status		Values		
Channel	State		Actual	Req	VSet,V	VMon,V	IMon,uA
Block-07-4-06-0	ON	✓	ON	ON	1298.0	1299.0	382.40
Block-07-4-06-1	ON	✓	ON	ON	1140.0	1140.4	335.95
Block-07-4-06-2	ON	✓	ON	ON	1306.0	1306.0	384.55
Block-07-4-06-3	ON	✓	ON	ON	1421.0	1421.2	417.80
Block-07-4-07-0	ON	✓	ON	ON	1264.0	1263.9	372.55
Block-07-4-07-1	ON	✓	ON	ON	1427.0	1426.6	417.15
Block-07-4-07-2	ON	✓	ON	ON	1284.0	1283.7	377.95
Block-07-4-07-3	ON	✓	ON	ON	1342.0	1341.4	395.30
Block-07-4-08-0	ON	✓	ON	ON	1200.0	1242.3	367.60
Block-07-4-08-1	ON	✓	ON	ON	1158.0	1193.4	353.10
Block-07-4-08-2	ON	✓	ON	ON	1240.0	1281.1	376.30
Block-07-4-08-3	ON	✓	ON	ON	1358.0	1404.5	416.70
Block-07-4-09-0	ON	✓	ON	ON	1329.0	1375.7	408.90
Block-07-4-09-1	ON	✓	ON	ON	1151.0	1191.9	352.75
Block-07-4-09-2	ON	✓	ON	ON	1261.0	1306.2	386.80
Block-07-4-09-3	ON	✓	ON	ON	1121.0	1161.0	344.85
Block-07-4-10-0	ON	✓	ON	ON	1117.0	1144.6	339.80
Block-07-4-10-1	ON	✓	ON	ON	1100.0	1122.2	331.60
Block-07-4-10-2	ON	✓	ON	ON	1021.0	1043.0	308.60
Block-07-4-10-3	ON	✓	ON	ON	1194.0	1222.4	361.25
Block-07-4-11-0	ON	✓	ON	ON	1112.0	1139.2	336.75
Block-07-4-11-1	ON	✓	ON	ON	1117.0	1144.7	338.45
Block-07-4-11-2	ON	✓	ON	ON	1332.0	1366.1	401.05
Block-07-4-11-3	ON	✓	ON	ON	1174.0	1203.4	355.85

- **HV boards** common problem: **drift of V_{mon} values** till over 50 V (blocks of 8 channels): during the run **6** HV boards have been replaced for this reason.
 —> Is it a real problem?
- **2** HV boards have been replaced due to real problem on 1 single channel: oscillation of V_{mon} and trips
- **2** HV boards have been replaced because apparently dead after a power cycle/lost connection but afterwards alive on LAV 13 (test stand for HV board)
- **1 dead HV crate CPU**: replaced
- No Power Supply replacement

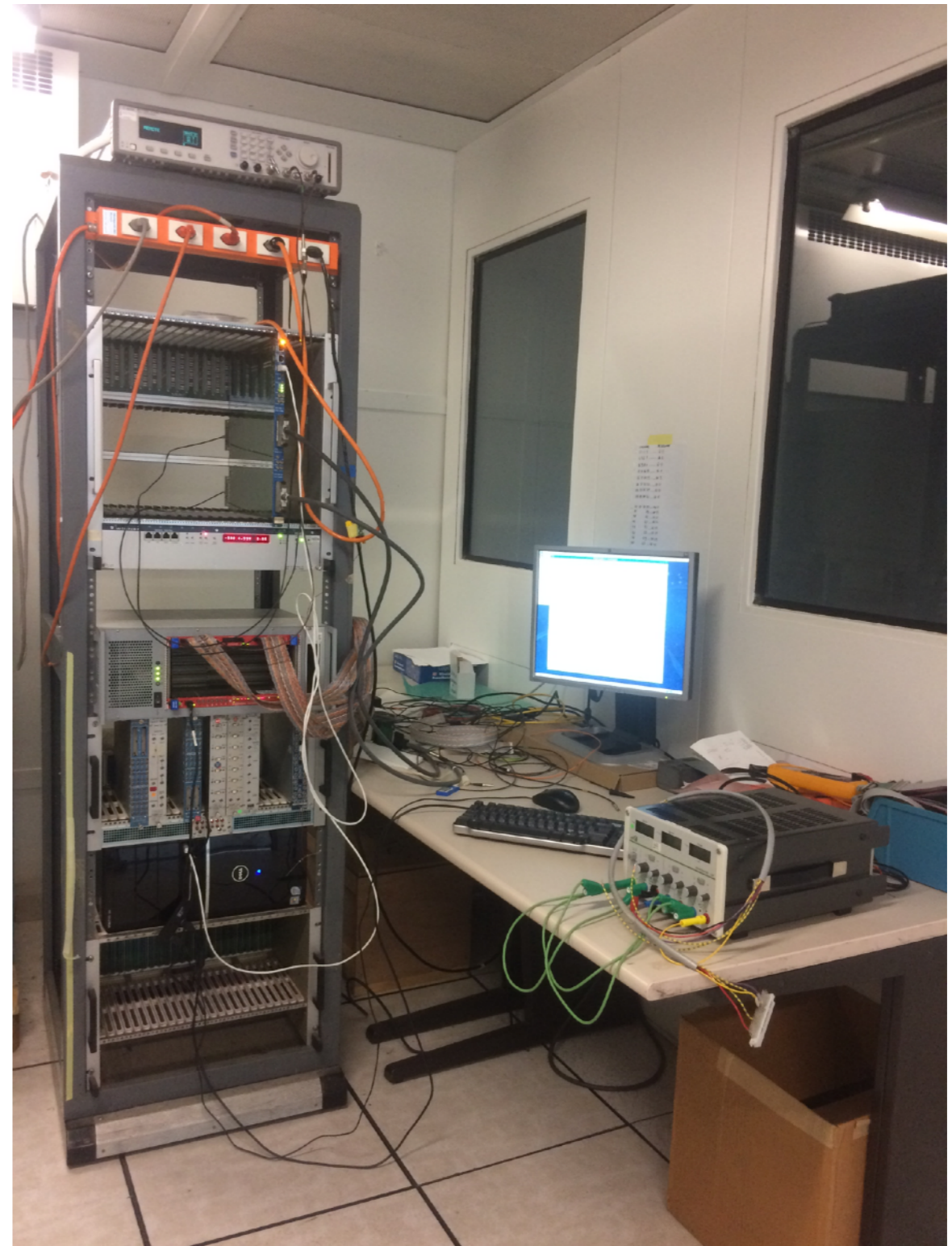
FEE-Boards and PDU

LAV front-end electronic test stand
back to life

**We have been able to test and
calibrate some FEE-Boards spares**

- 3 good spares (after broken fuse fixing intervention and mezzanines change)
- 1 “second best” spare with low hysteresis but fine (used for the SAC during data taking)
- 1 with 2 HV fuses broken
- 2 still to be tested (first attempt of characterization failed)

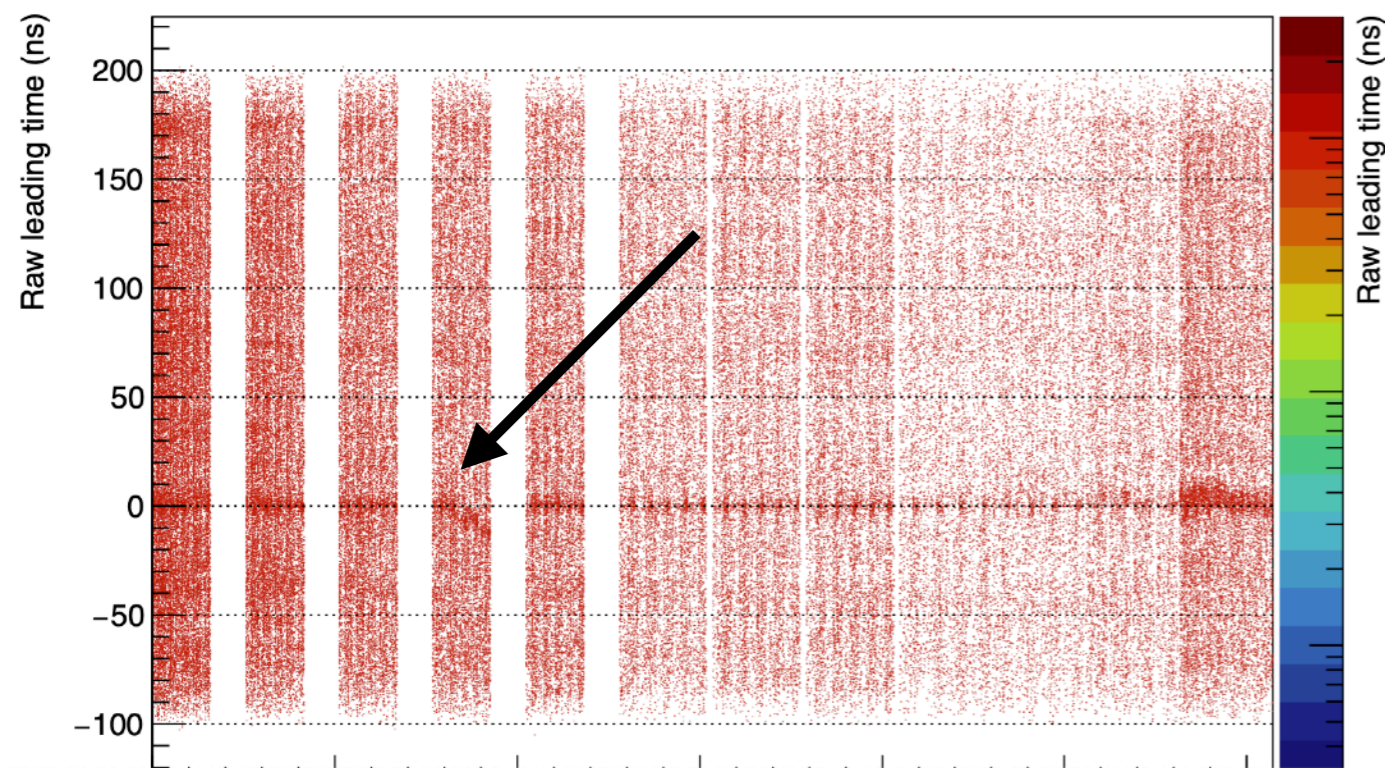
A new PDU system has been installed in 2021 to manage the power cycle the switches of LAV from 1 to 11 from the Control Room



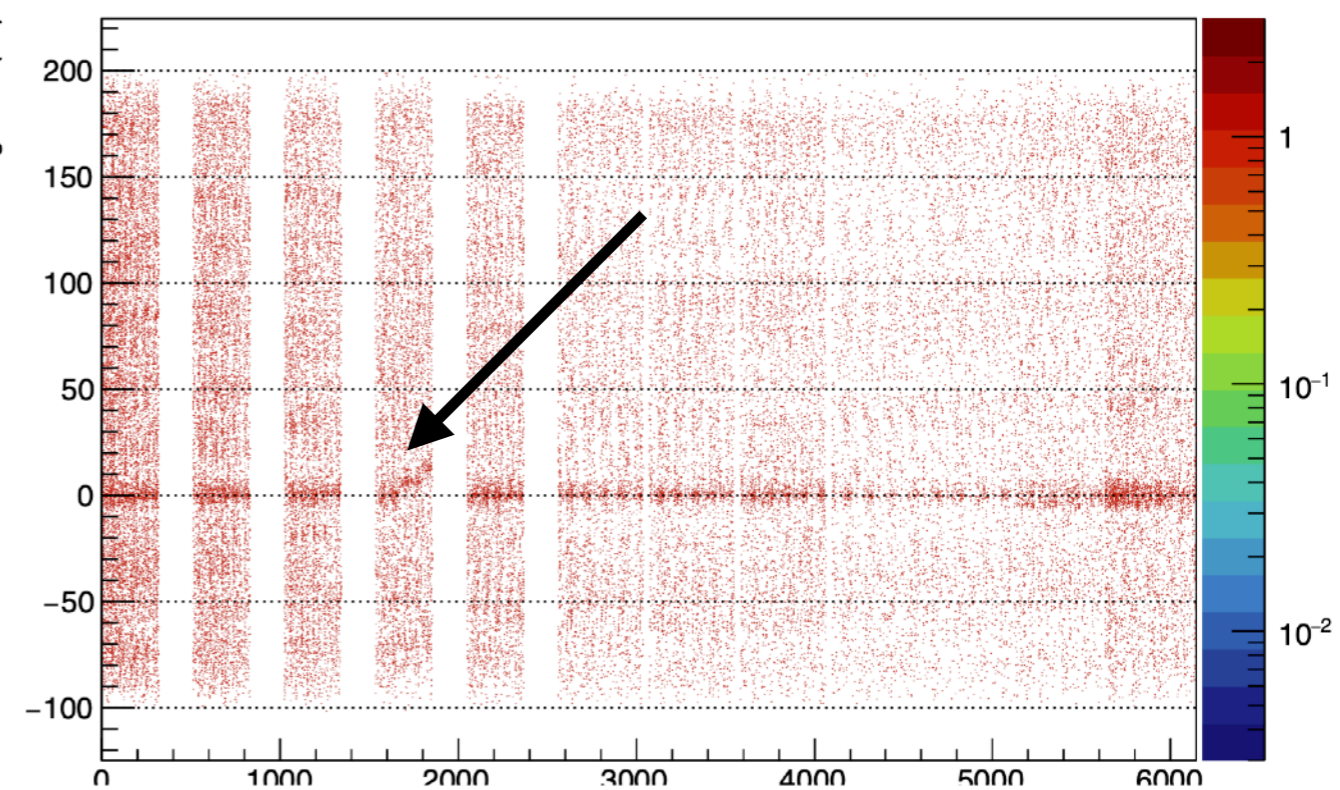
TEL62 readout

- **LAV 8 TEL62** has been change on July 2021 (before physics data) due to instability (unable to manage the new fw version)
- **LAV 4 TEL62** also presented some instabilities: several t0 update during data taking has been required. October 8: MUV3 fw has been loaded in the LAV 4 TEL62

LAV DigiTimeRawFine Vs ROChannel



LAV DigiTimeRawFine Vs ROChannel



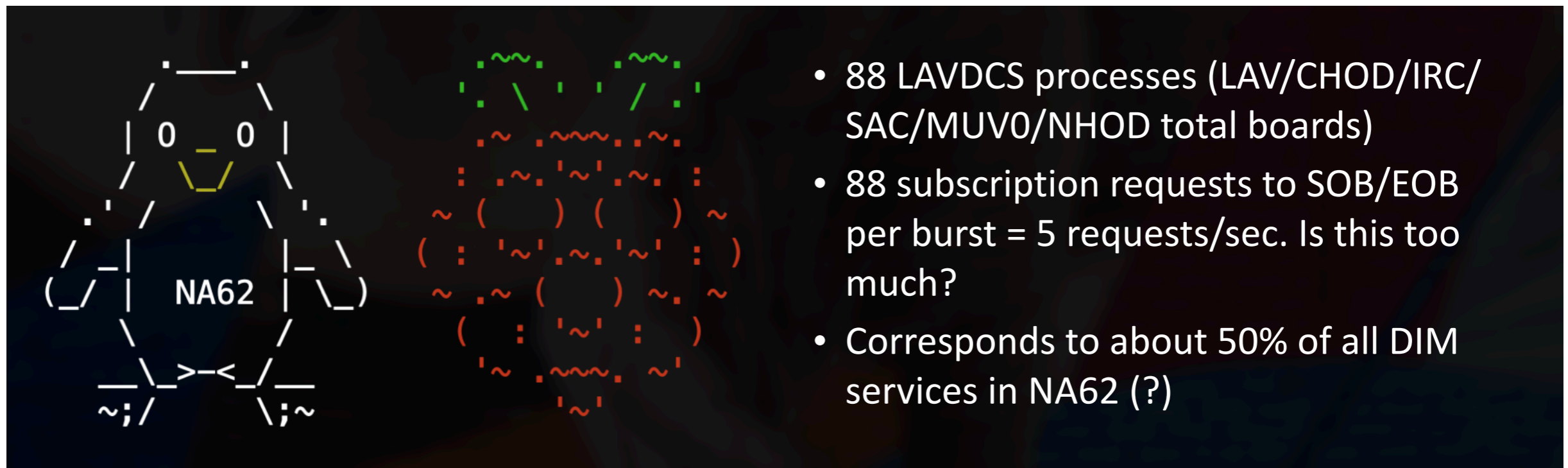
Raspberry Pi

Problems:

- **1 RPI stops responding**. Temporary loss of threshold monitoring/control for 1 FEE-Board
- **DIM DNS server stalls** (stops responding, 100% CPU). Potential problems for other subsystems that use DIM, e.g. mergers

Possible causes(?):

- Loss of sync with SOB/EOB cycle because of delays executing commands
- Single-event upsets
- Bugs in RC-RPi-DIM interface software (LAVDCS)
- DIM server overload/Bugs in DIM



We need a dedicated machine for DIM services related to threshold management!
—> DIM DNS traffic problems should not be allowed to disrupt data taking

L1 LAV veto algorithm

Present algorithm:

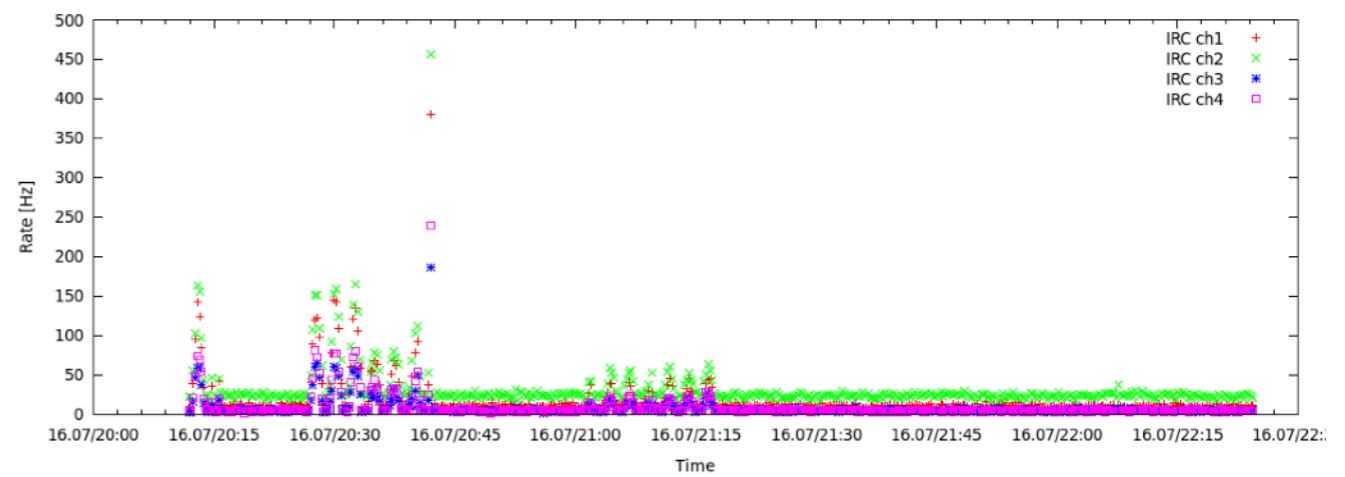
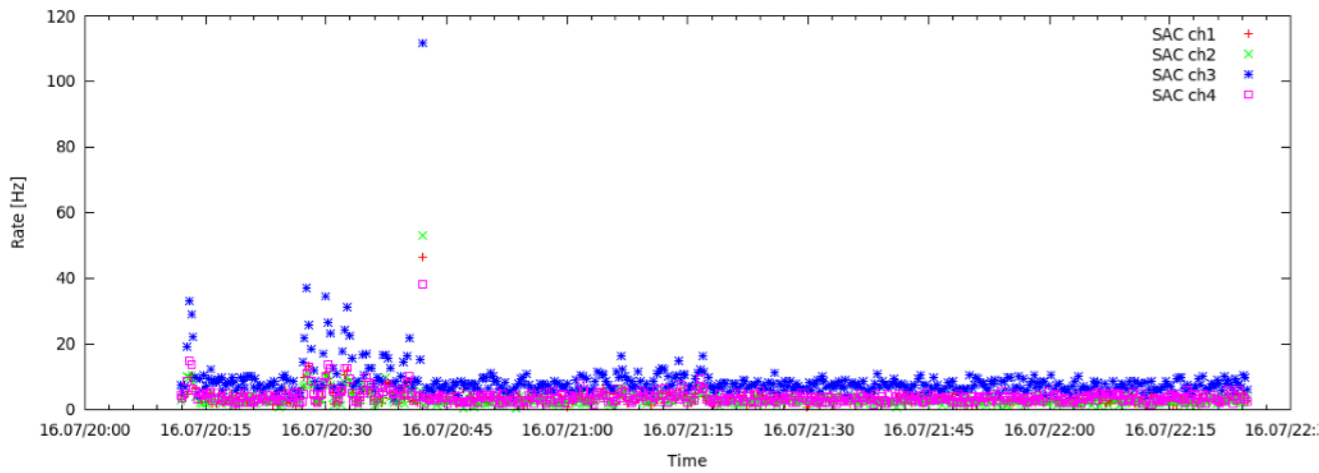
- < 3 hits on LAV 2 - 11 with at least leading and trailing low edge within ± 6 ns from RICH primitive

Possible improvements:

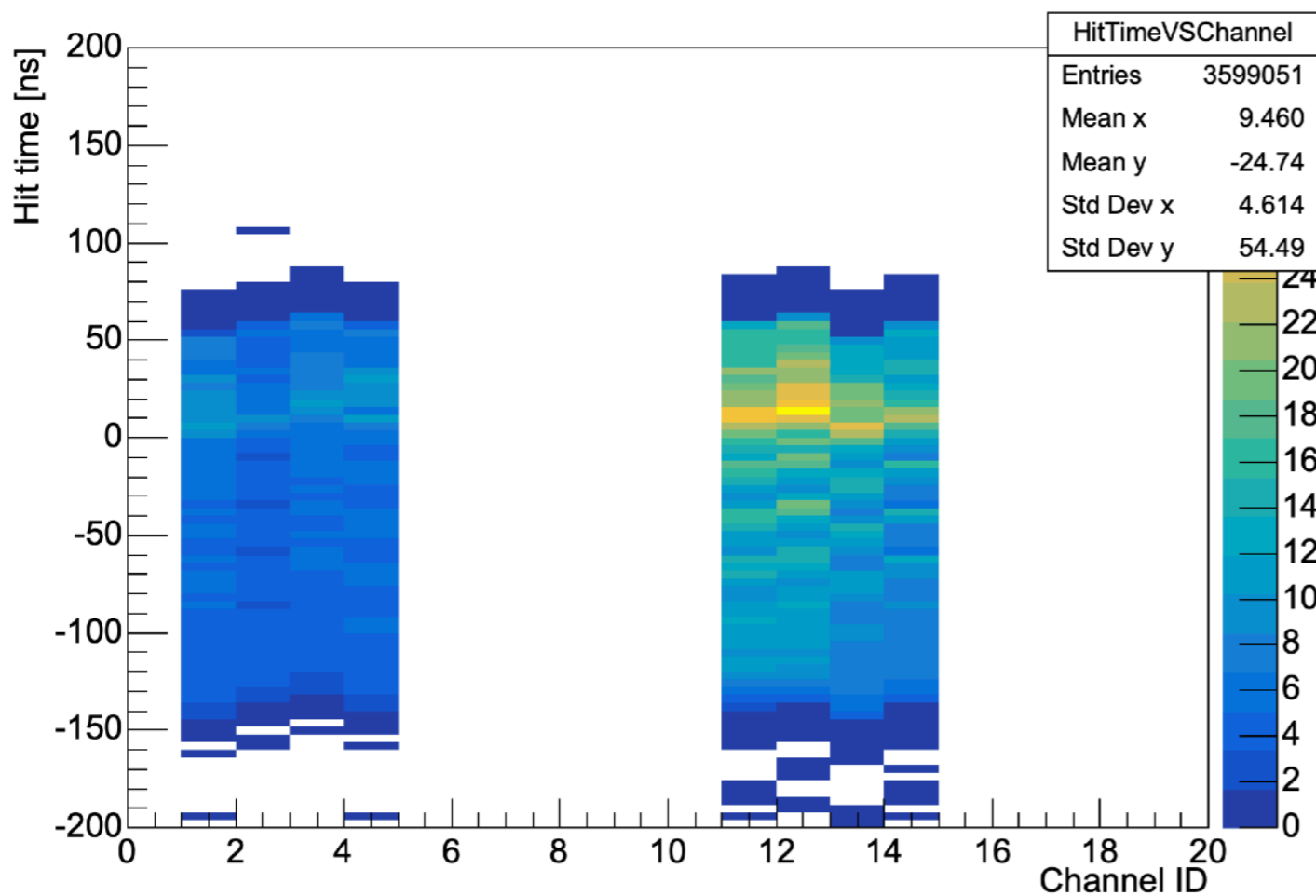
- Applying **slewing correction**: to use the corrected hit time and reduce the time window width (and random veto as a consequence)
- **Vertex reconstruction**: to neglect LAV hits upstream with respect to the decay vertex, as in the offline LAVMatching veto algorithm: pure random veto contribution. Already studied offline from Angela
- Or may be totally removed?!: a multivariate analysis would be more powerful in characterize random veto without the L1 cut

IRC/SAC performance

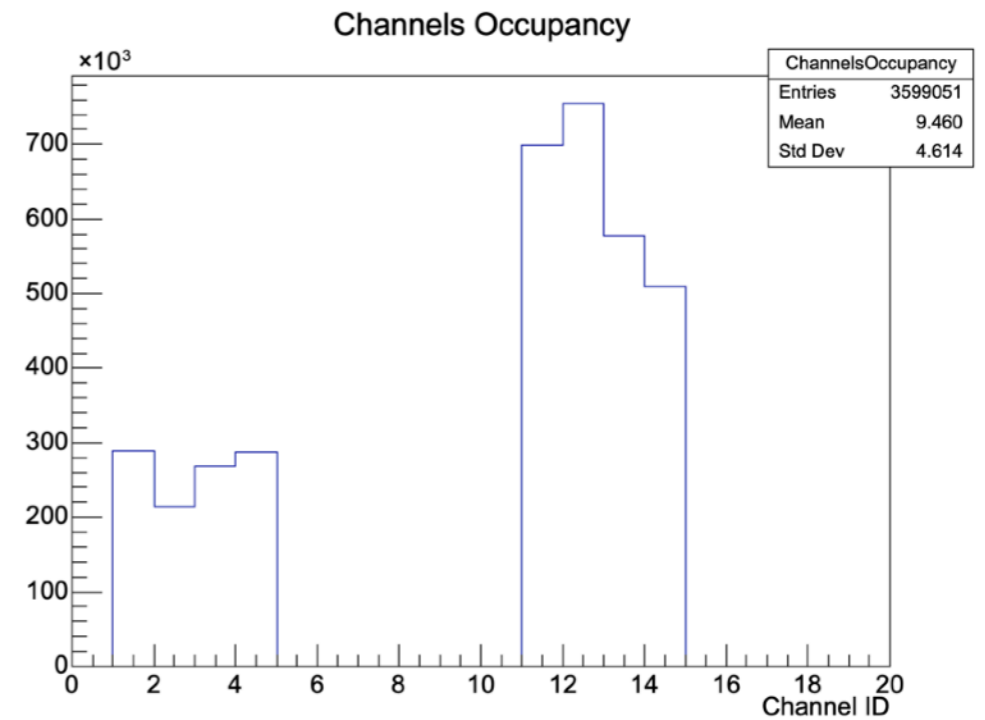
- First beam observation with SAC and IRC at the start of the run (July 2021):



Hit time vs Channel

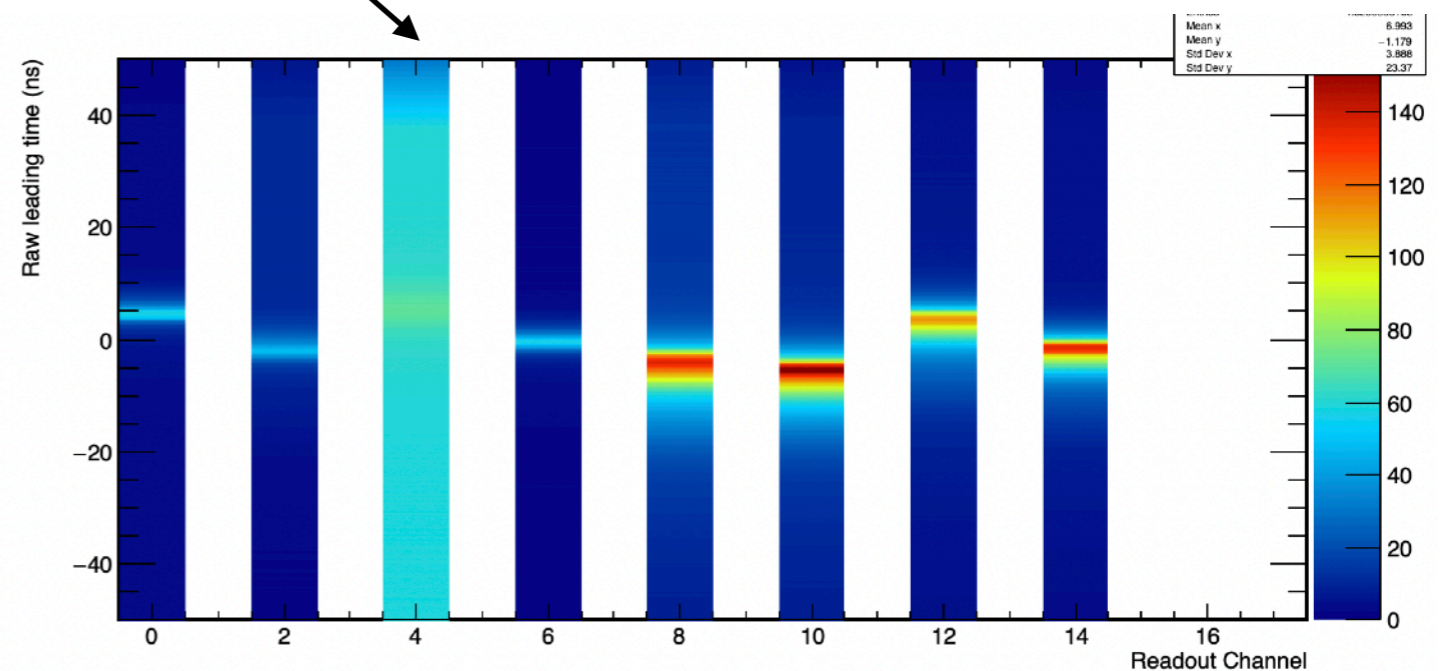
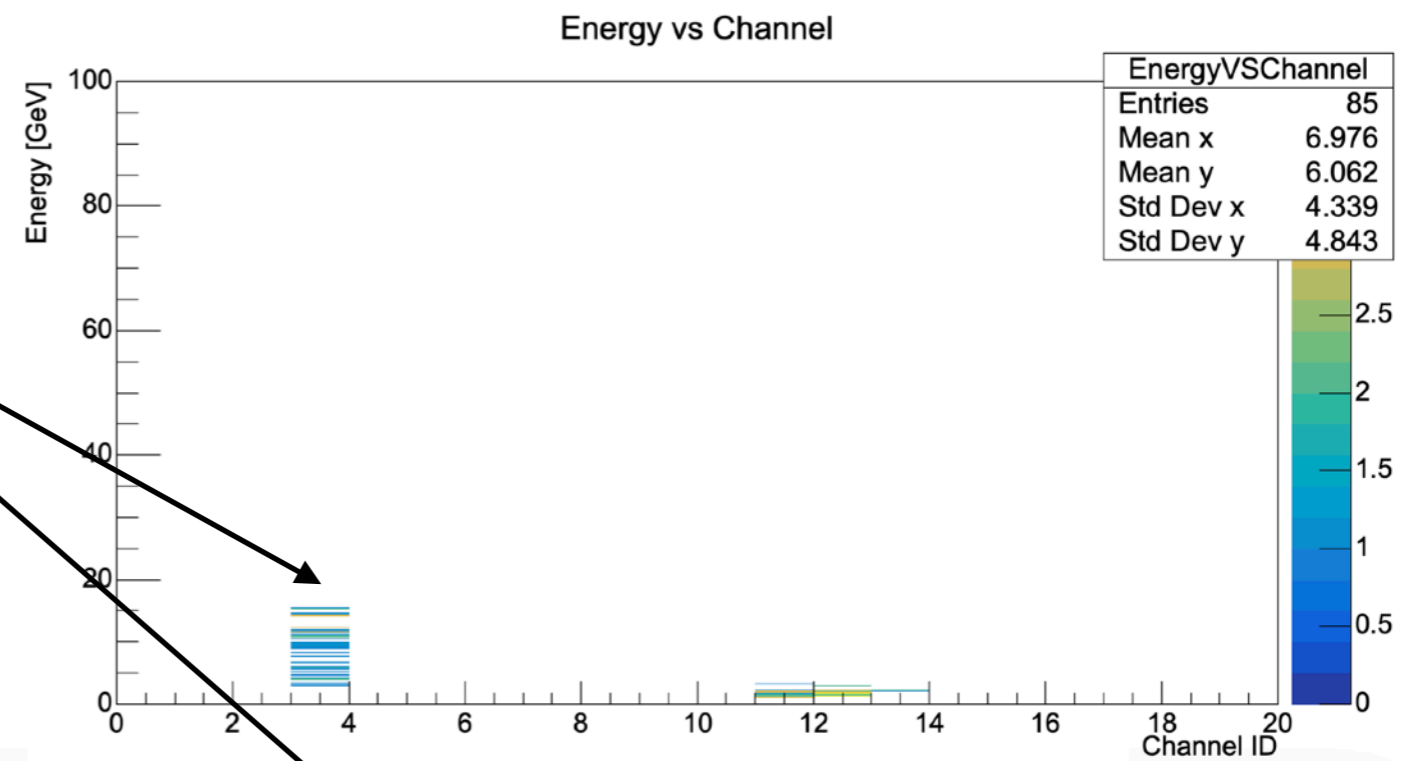
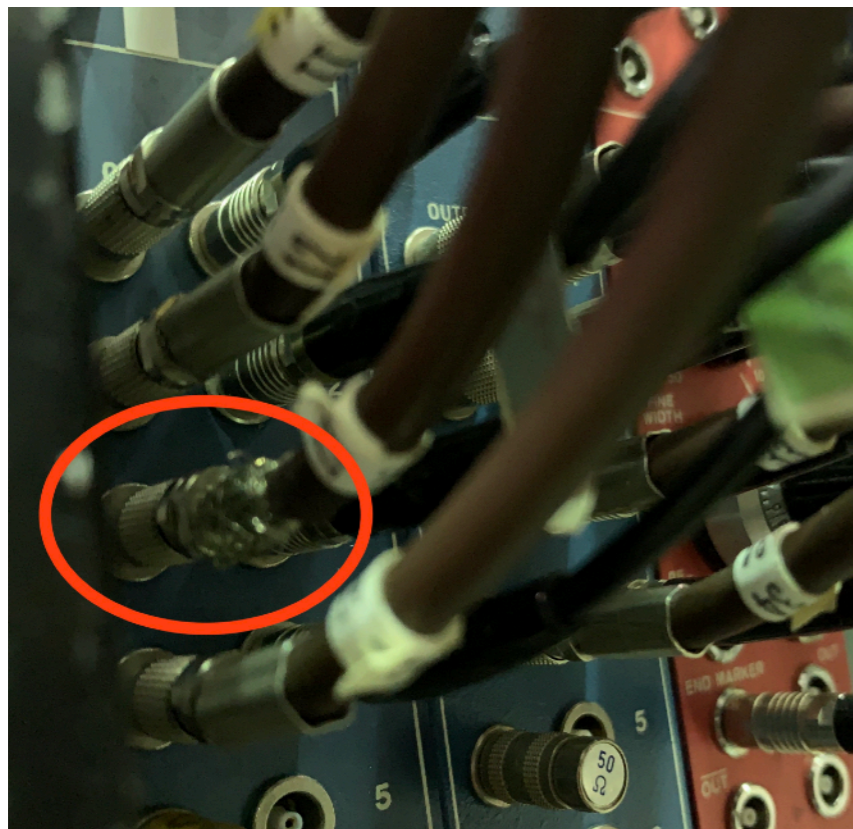


- New online monitor plot



SAV hardware interventions during run

- August 3: IRC/SAC FEE-board replaced due to the loss of channel ST on SAC
- **Noise problem** on SAV channel 3 responsible for a Cream RawDecoder fatal error. August 25: Replaced 4 lemo cable headers of the BNC cables going from SAC signal amplifier to the shaper in the electronic barracks



Conclusion

- ▶ LAVs are still in a very good shape
- ▶ IRC/SAC properly working
- ▶ Improvements have been done for the data quality and online monitoring
- ▶ Improvements for the next data taking have been mentioned

Backup

Raspberry Pi problems

Sporadic: One RPi (LAV FEE board) stops responding

Frequency: 1 RPi per day?

Consequences: Temporary loss of threshold monitoring/control for board; expert must restart LAVDCS process

Possible causes:

- Loss of sync with SOB/EOB cycle because of delays executing commands
- Single-event upsets

Systematic: DIM DNS server stalls (stops responding, 100% CPU)

Frequency: 1 failure per week?

Consequences: Disruption of data taking

- Loss of threshold monitoring/control for all boards
- Potential problems for other subsystems that use DIM, e.g. mergers

Possible causes:

- Bugs in RC-RPi-DIM interface software (LAVDCS)
- DIM server overload
- Bugs in DIM

Raspberry Pi/DIM DNS problems

In total LAVDCS uses 176 DIM commands and 11440 DIM services

- 88 LAVDCS processes:
 - 81 LAV boards + 4 CHOD boards + IRC/SAC + MUV0 + NHOD
- Each process registers 2 commands (set threshold, restart) and 130 services (64 thresholds, 64 ADC values, board ID, update flag)
- Corresponds to about 50% of all DIM services in NA62 (?)

Services are updated for even and odd numbered boards, every two bursts

- However, DIM DNS shouldn't have to do much once services are running

Each time a process issues a command to an FEE board, the command subprocess has to subscribe to SOB and EOB

- 88 subscription requests/burst = 5 requests/sec. Is this too much?

DIM DNS seems to have no problem running interactively

- Jams up only when running in the background → Bug in DIM DNS itself?

In any case: we need a dedicated machine for DIM services related to threshold management (i.e., LAVDCS/LAVFEES and NewCHOD CFDs)

- DIM DNS traffic problems should not be allowed to disrupt data taking