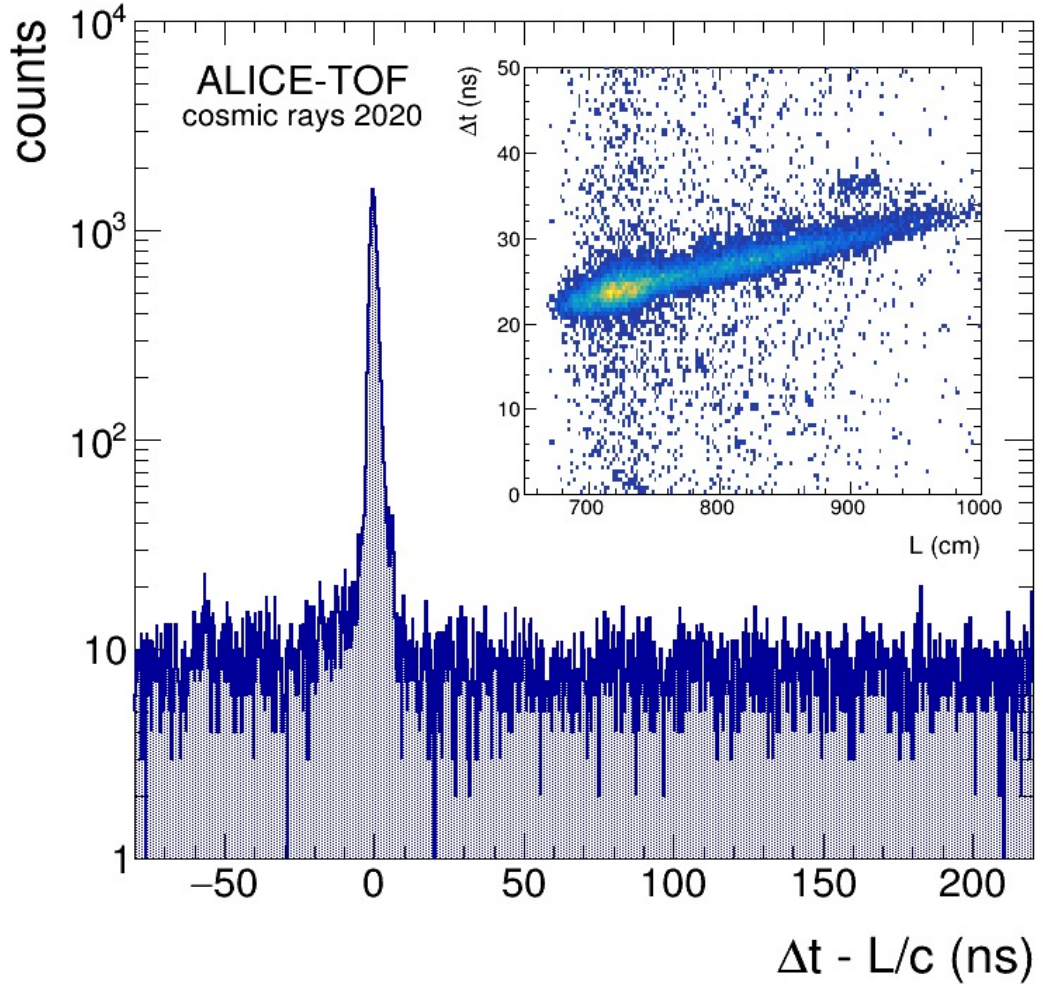
TOF status

- 2020-2021 a slow, difficult and challenging commissioning
- Hardware status after turning ON....
- Richieste specifiche



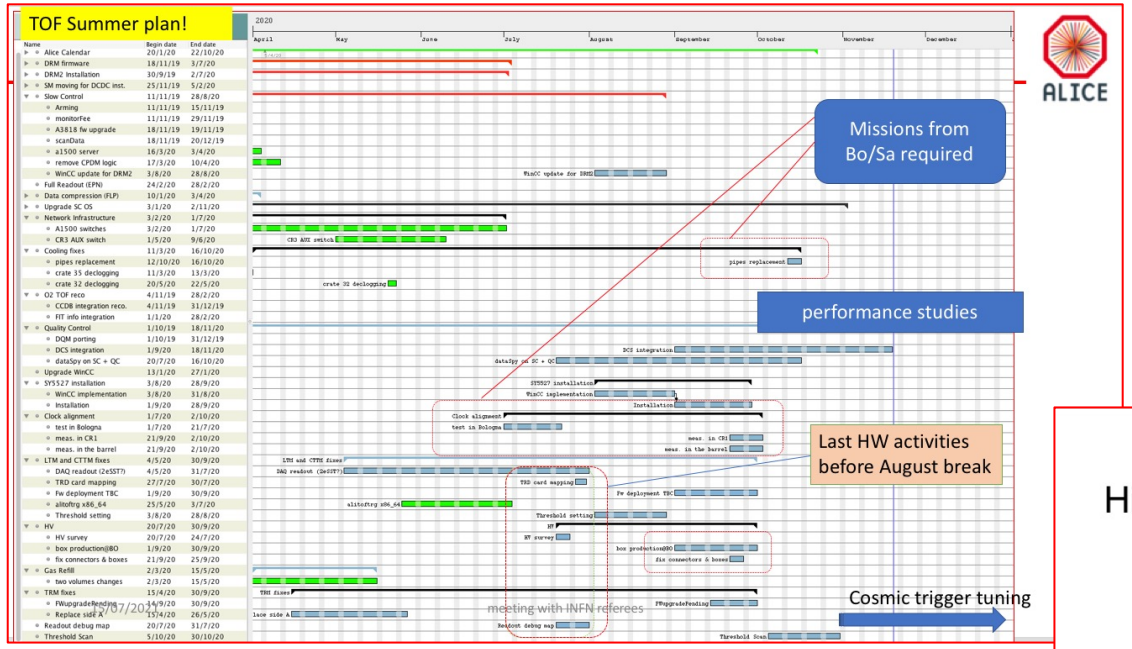
P. Antonioli / A. Alici

TOF	BO	SA
M&O-A	12	6
FTE	19.5	7.8

(uscita CF: agosto 2020)

Credits: many slides largely based on a recent presentation at ALICE Technical Board by F. Carnesecchi

Dove eravamo... (il 22 luglio 2020, riunione con i referee)



intenso programma di commissioning negli ultimi 12 mesi, per portare detector "up & running"

metodologie pre-RUN1
per commissioning con cosmici

Hit rates: threshold / HV scan

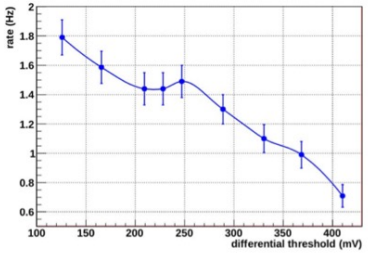


Figure 4.4: Single-channel noise rates as a function of the front-end discriminator circuit threshold. At a nominal threshold setting of 190 mV (November 2006 test beam) the noise rate is about 1.5 Hz.

1.5 Hz x 150,000 ch x 33 us = 7.4 hit/[window]

Cosmic rates: threshold / HV scan

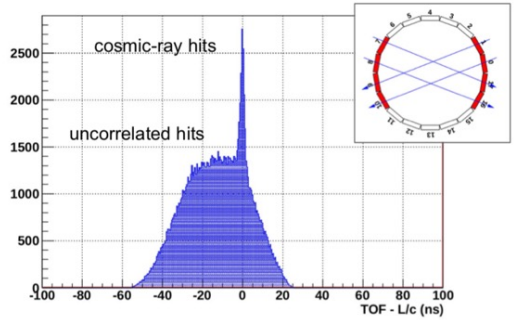


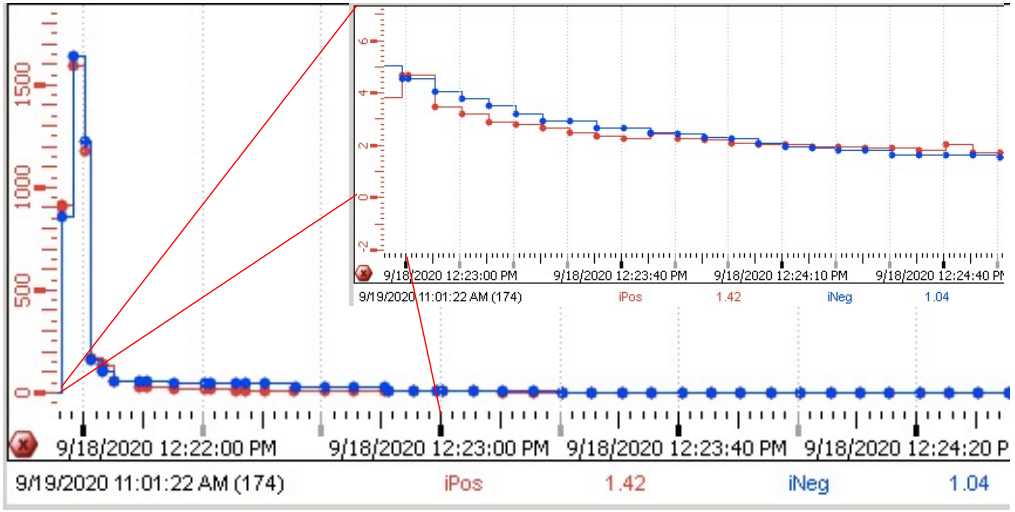
Figure 4.8: Measured time-of-flight with respect to the expected value in events triggered by the TOF. The peak at zero signals that muons have been triggered.

verify noise level all over the detector
optimize HV and threshodls
brutal "cosmic rate" rate (via coincidence in opposite sectors) allow to measure efficiency (varying HV/threshold)
then we setup trigger

Dove siamo: turning ON detector

Turned on at nominal value 09/2020 (first time since the end of Run 2)

- **Issues** (mainly trip) found (immediately or after some months) **on** a total of **15/174 HV:** **13/15** already **fixed**
  - 2 wrong order
  - 1 disconnected
  - 3 found broken (technician at CERN at the end of September)
  - 3 CAEN boards channel broken in CR4
  - 2 high current/current spikes → unipolar disconnected
  - 1 crate issue (used a spare)
  - 1 HV box issue
  - 1 cable broken in CR4 → **tbd**, technician from Bologna needed
  - 1 tripped 01/2021, further investigation needed, **ongoing**



finally planned for August 2021

NB each of these points required several interventions (and time…) for inspection+debugging

~40 HV boxes spares produced in Bologna

Bring home message

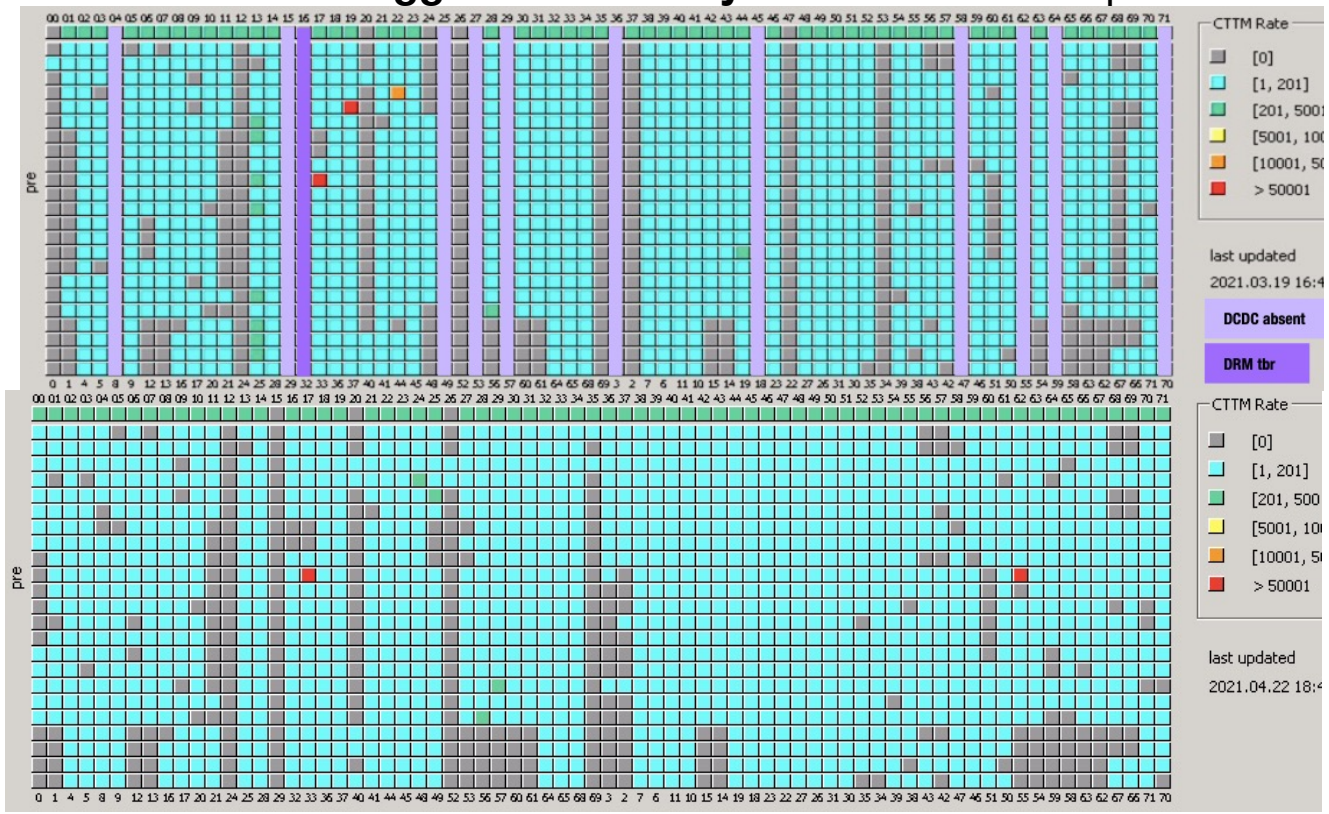
- 172/174 HV channels nowadays available
- For each HV recover several interventions needed
- Slowed down due to COVID restrictions

meeting with INFN referees

Cosmic trigger and CTTM

TOF cosmic trigger released **slowed down due to the restarting of CTTM:**

- **Key CTTM people not anymore in our team** → Difficulties on make the CTTM operational again
- **Finally fixed in March 2021** after deep debugging: **CTTM restarted! → threshold setting working again**
- Then important **debugging** (several channels unplugged, clock not transmitted in some crates, etc.)
- **TOF cosmic trigger made finally available** end of April

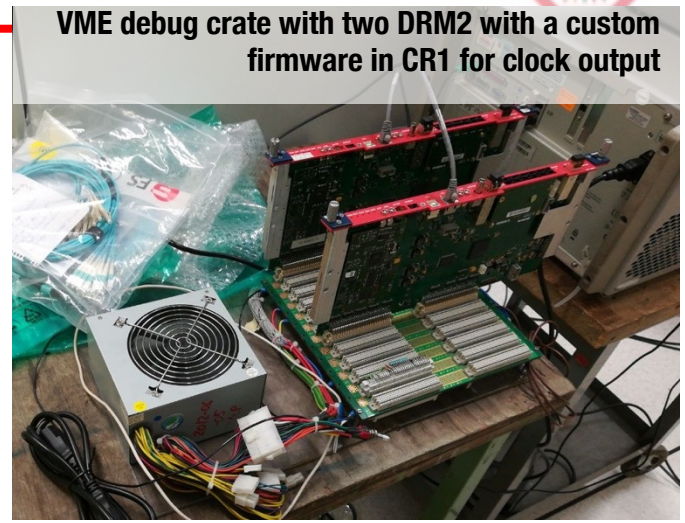


After all debug, we lost some connections (trigger cables) but stll delivered **~ 70 kHz** (instead of 80 kHz in RUN2)

Note: very difficult to recover some missing signal. Given TOF trigger in RUN3 will be used only for cosmics and only during commissioning we don't plan for the moment further interventions.

Clock alignment campaign

- Clock delay measurements **between CRUs** in **CR1 and** between **DRM2 boards** at **pit**
- **2 People from Bologna/Salerno in 2020/9**; the **only case for an ad hoc mission since 2020/03 in 2020**


VME debug crate with two DRM2 with a custom firmware in CR1 for clock output

CR1 :

- Internal delay test between different channels of the same CRU taking channel 1 of each slot as reference
- Delay test between different slots of the same CRU taking channel 1 of one slot as reference
- Delay test between 1 reference channel of one CRUs with all the other channels of the other CRUs

pit:

- Delay check on each DRM2 between GBTx clock and LHC clock + GBTx clock phase shifted until aligned
- Absolute time delay check between one reference DRM2 and all the others using the Bunch Reset signal → Signals shifted later after offline analysis of results and a new DRM2 firmware
- 2 DRM2 missing in Sep 2020 campaign, completed in May 2021

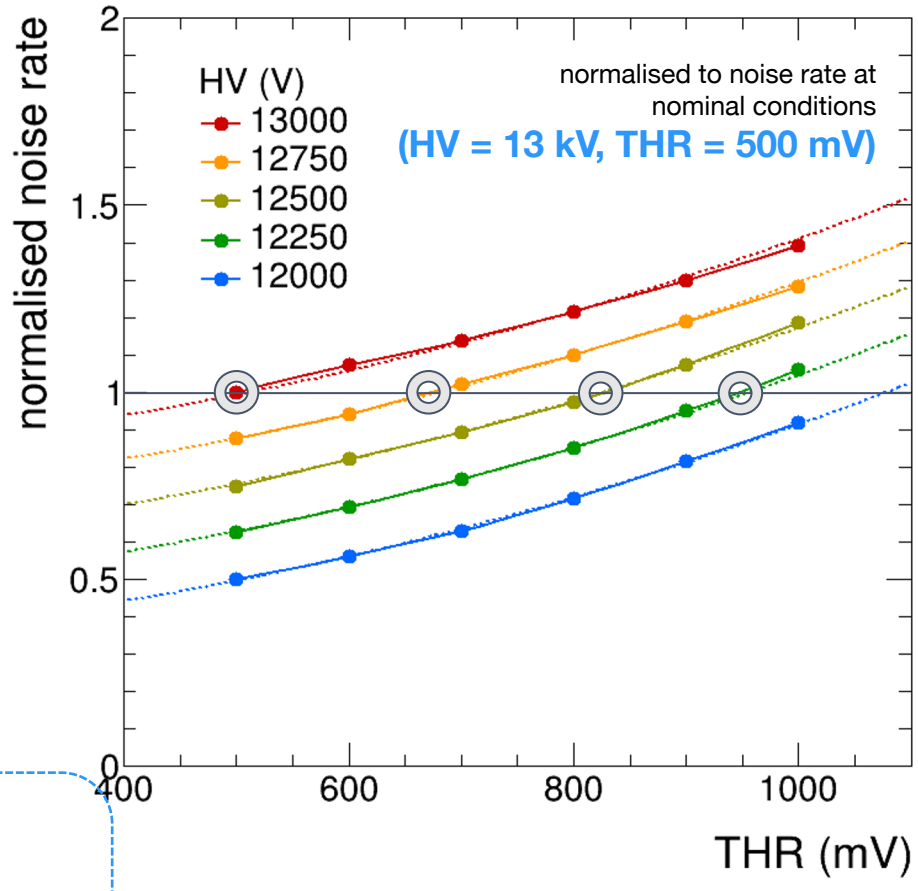
DRM # crate	Delay	Phase Adjust (coarse/fine)	Delay After	
57	10.02 ± 0.03 ns	D-0	-75 ± 26 ps	
58	- 8.00 ± 0.03 ns	15-F	77 ± 37 ps	
59	- 8.53 ± 0.03 ns	15-0	16 ± 35 ps	
60	-367 ± 30 ps	0-0		best delay value already obtained
61	147 ± 26 ps	0-4	-13 ± 27 ps	
62	6.82 ± 0.02 ns	8-F	36 ± 24 ps	can't ssh if trms are on
63				I/o 1 does not work
64	111 ± 29 ps	0-3	-7 ± 28 ps	can't ssh if trms are on
65	247 ± 48 ps	0-6	2 ± 50 ps	
66	6.08 ± 0.02 ns	7-F	57 ± 25 ps	
67	6.04 ± 0.02 ns	7-F	16 ± 25 ps	
68	-277 ± 29 ps	0-0		best delay value already obtained
69	357 ± 47 ps	0-9	18 ± 45 ps	
70	7.03 ± 0.03 ns	9-1	2 ± 25 ps	
71	6.54 ± 0.03 ns	8-9	15 ± 26 ps	

Bring home message

- CRUs channels show delays compatible with expectations
- 72/72 crates fully tested
- Shift coefficients database filled and already operational
- **Alignment** within crates (raw) is **at 1 ns** level as planned

Noise scan

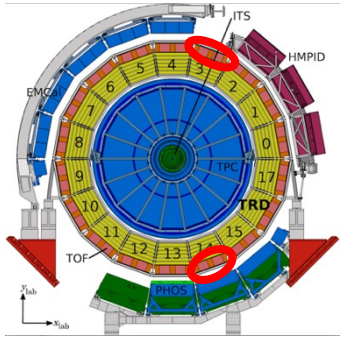
- **First noise scan with HV ON/OFF**
- **noise rate is not efficiency**
  - so it can **not** be a direct measurement of the efficiency
- **but we can possibly identify a few points**
  - to limit the number of measurements in future run with larger **statistics needs**
  - try to operate the detector in **conditions of constant noise** at 13, 12.75, 12.5, 12.15 kV
  - measure the **pseudo-efficiency** (variation of rate of cosmic rays)
  - measure better efficiency with first collisions (we must have better indication from cosmic rays)



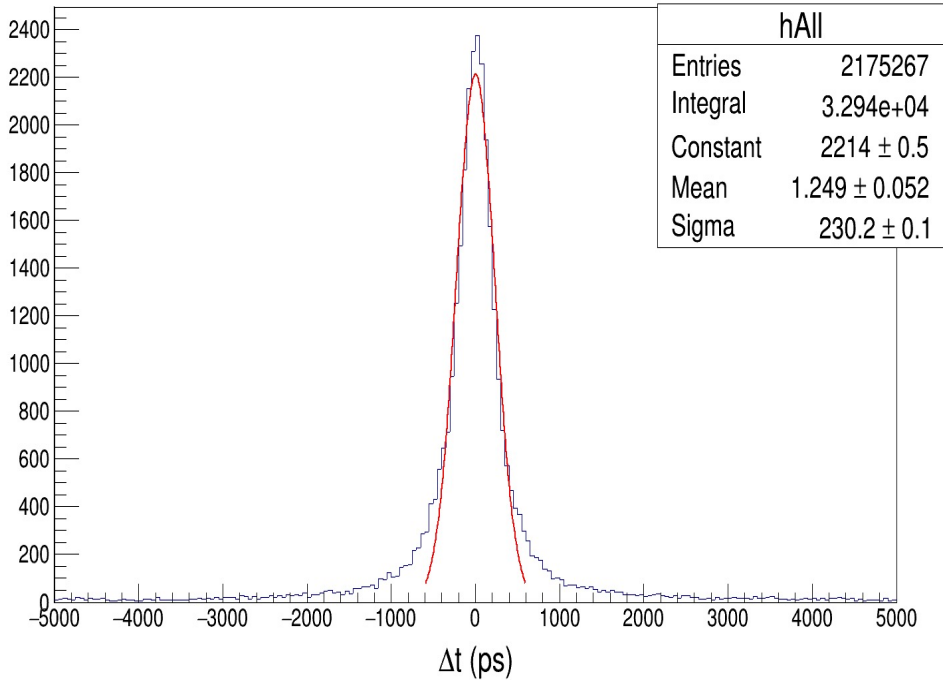
Bring home message

- Noise scan changing HV and threshold DONE. Four point selected.
- Aim: check the minimum HV needed (changing the threshold accordingly) in view of the future efficiency scan
- Main benefit: apply a lower HV and potentially saving HV channels

Cosmic rays

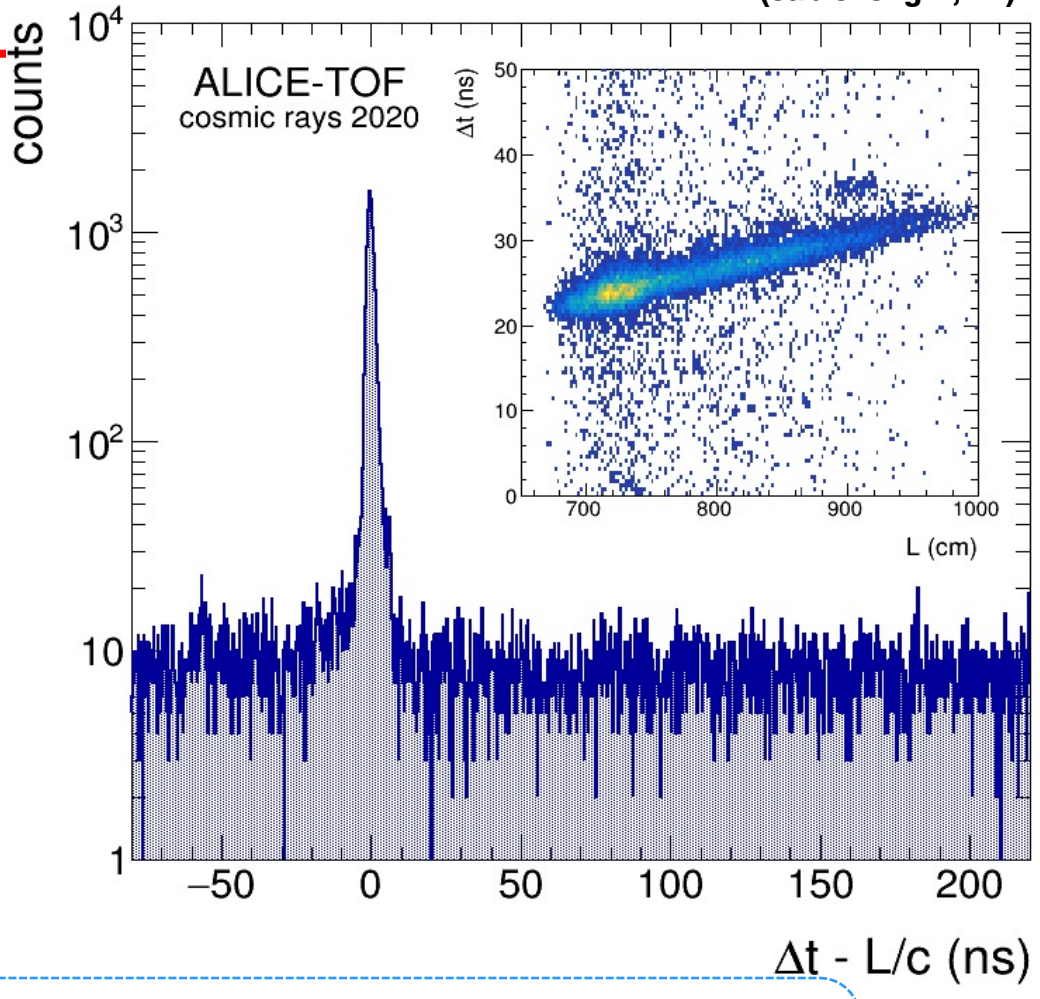


- No trigger, "**continuous**" mode
- Validation of **full chain up to FLP** (pre-processor "compressor", reconstruction, digitisation)
- First **QC** plots



Performance after further not yet optimized calibration (time slewing, …)

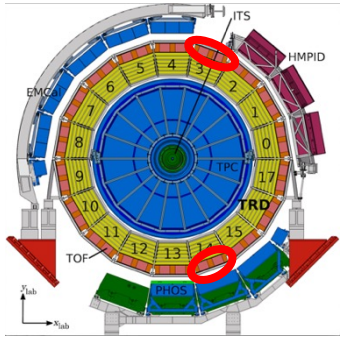
Performance after preliminary calibration (cable length, …)



Bring home message

- Very first ALICE cosmic rays after LS
- Continuous mode
- Very-good very-first detector performance

Cosmic rays



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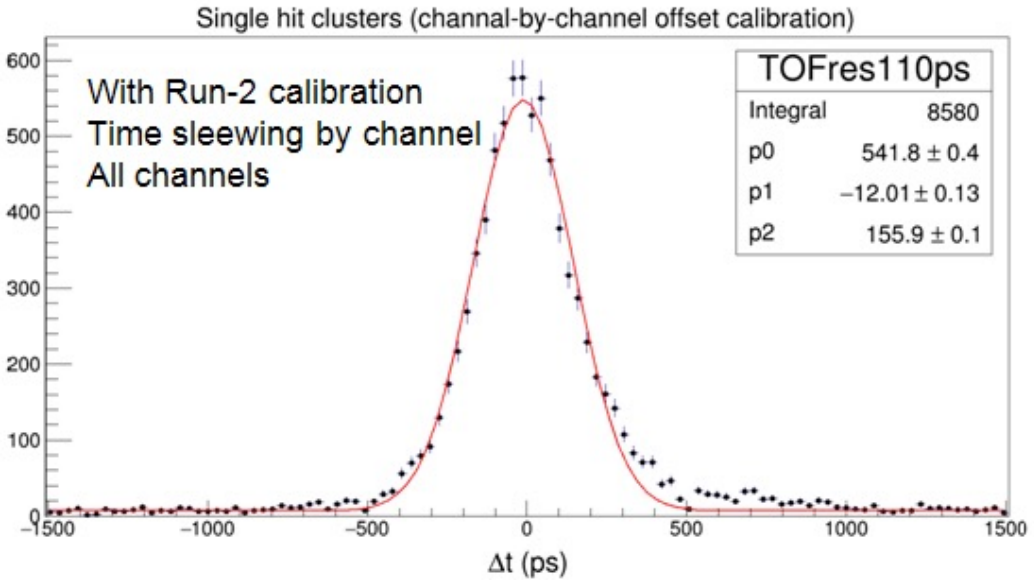
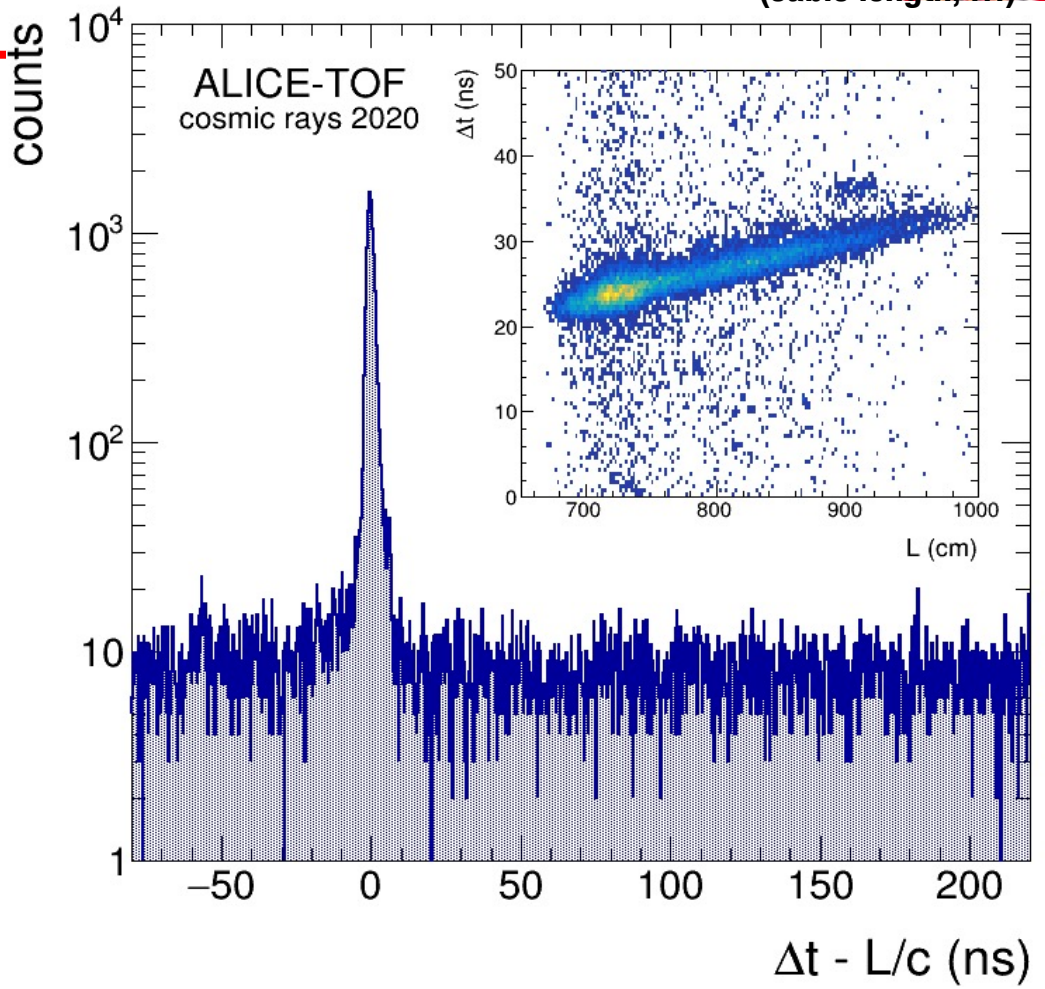


Performance after preliminary calibration (cable length, …)



Bring home message

- Very first ALICE cosmic rays after LS
- Continuous mode
- Very-good very-first detector performance

TOF Quality Control

- TOF Quality **Control in production**
- **Tested extensively during the MWs, up to EPN**

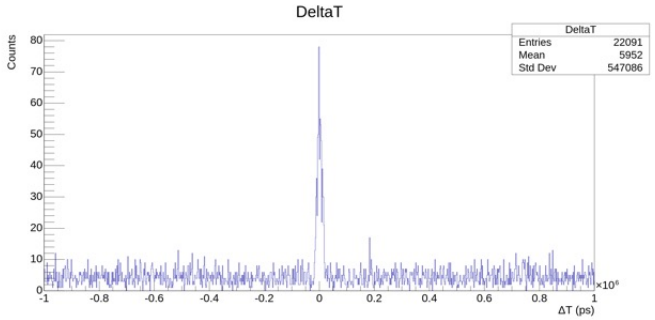
Monitoring:
- Diagnostics of electronics
- Hit rate
- Time distributions
- Rate of cosmics
- **Merging** output of several QC devices is supported and tested

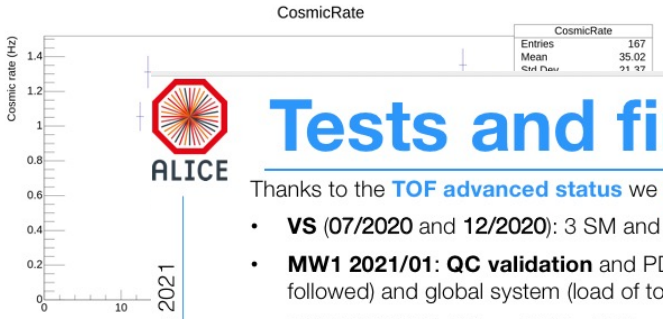
Next steps:
- QC with the O2 Analysis framework (e.g. efficiency monitoring)

https://indico.cern.ch/event/1014566/

	Definition of needs for commissioning and production	Test/Lab setup	Development started	Update requirements table *	Update progress table **	Software development progress ***
TOF						75%

Bring home message
- Tested extensively during the MWs monitoring the data
- Up to EPN and mergers





Cosmic ray

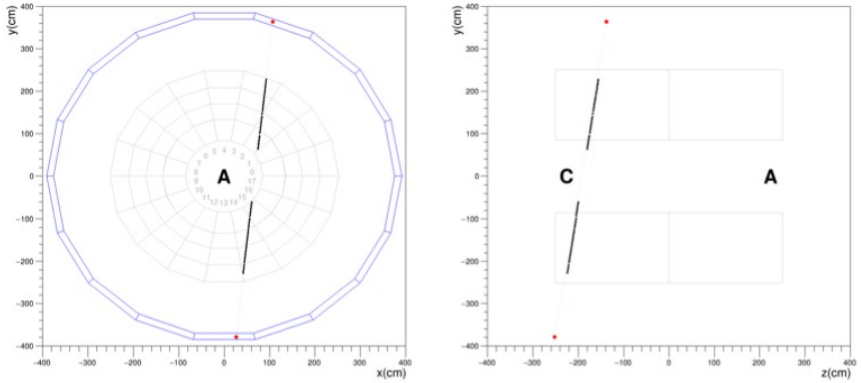
Continuous readout works!

Also a lot of other work on software!

Tests and first combined run

Thanks to the **TOF advanced status** we **participated since the beginning to global tests** (several global validation too):

- **VS** (**07/2020** and **12/2020**): 3 SM and 2 FLPs, Data collected landed on EPN**, first ALICE EPN synchronization**
- **MW1 2021/01**: **QC validation** and PDP verification by real data. Usefull also to **debug** some **issues** both for TOF (firmware update followed) and global system (load of too many links/crates)
- **MW2 2021/02**: **QC on EPN** e CTF creation
- **MW3 2021/03** extended to this week:
  - **QC merger on EPN**
  - stress test on FLP: full simulation of PbPb@50 kHz (+ 50% payload) in one FLP all links with O(10) multi-compressors TOF (pipeline) 1.7 GB/s compressed to 370 MB/s → stable run!
  - Working demonstration up **to 28 links on 1 FLP** (600 MB/s → compressor → 60 MB/s**) [yesterday!]**

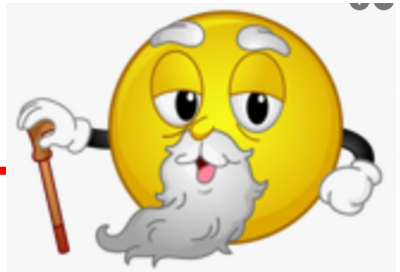


TPC + TOF combined runs
Thanks to Ruben, TOF, TPC experts
Clear correlation and associations of cosmic tracks

Bring home message
- Thanks to the advanced status, we validated several checkpoints up to EPN
- Since first VS up to all the MWs
- Very first successful combined run with TPC

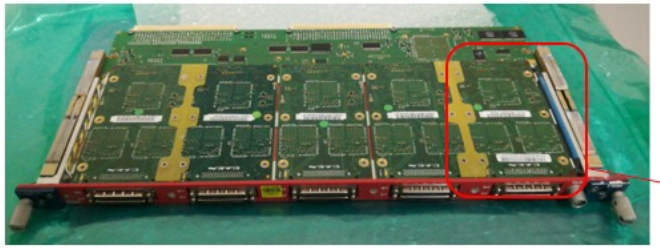
Caveat:: Aim: make sure TPC and TOF **data streams are in sync**
(standard code for TPC tracks to TOF matching does not find matches, probably due to calibration))

But... TOF is ageing (TRM)



TRM (TDC Readout Module)

custom card, based on HPTDC (30 chips on board): 240 channels
674 installed, only 631 operational



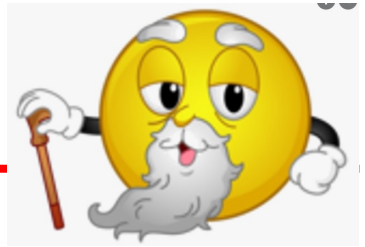
TRM:
- FPGA obsolete
- difficult to produce spares
- very custom form factor

3 HPTDC could be replaced by 1 picoTDC!

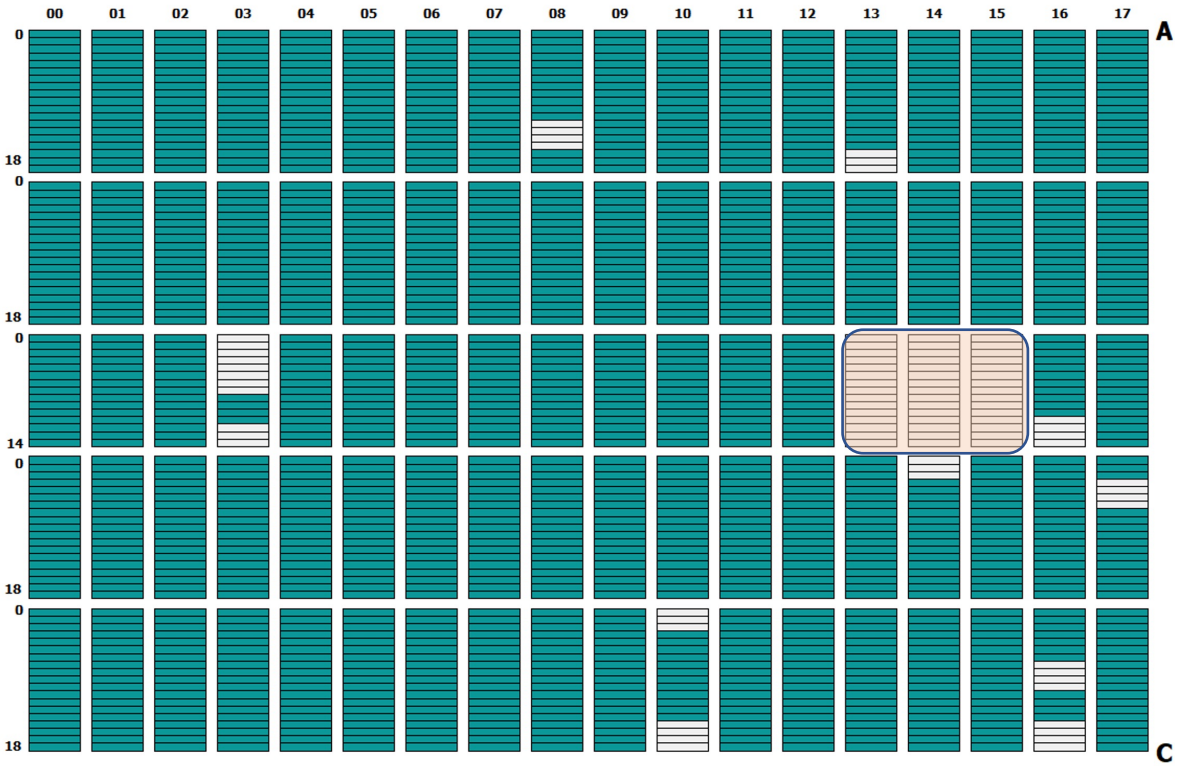
- **25 were already not working at end of RUN2**, big **increase** of failure at Sep2020 at "**re-powering**"
- **Now 43 TRMs** should be replaced (6.4% of TOF is off only due to TRM!)
- In addition 24 TRMs are no longer upgradable (FW upgrade fails: vulnerability of ACTEL FPGA, it seems linked to power glitches)
- In some crates replacement really difficult and it can do further damages (on backplane).
- **We are waiting for having more people at CERN to do some replacement, but it is clear this is already now the dominating inefficiency, on the long run we might consider turn off 1 SM (and use electronics as "spare") or... produce new card**

2022 request:
develop test picoTDC board

But… TOF is ageing (HV)

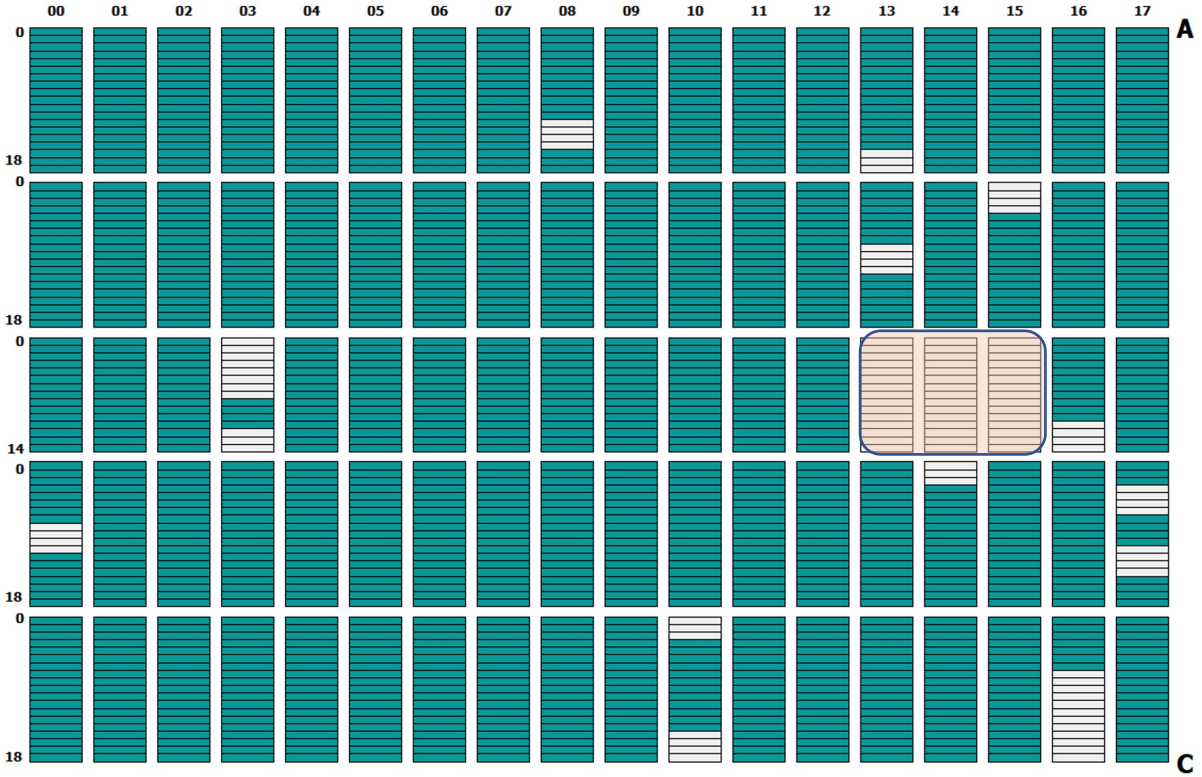


End of Run2: **3%** of TOF channel off due to HV issues (broken connectors that cannot be fixed or replaced)



Now: **4%** of TOF channel off due to HV issues

- additional 5 groups of MRPC switched off at the restart after LS2
- the connectors that are accessible will be fixed with dedicated interventions



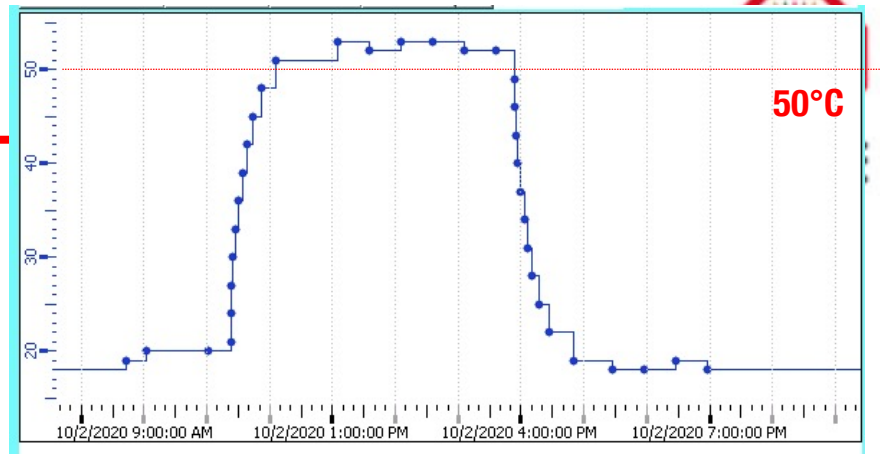
PHOS hole

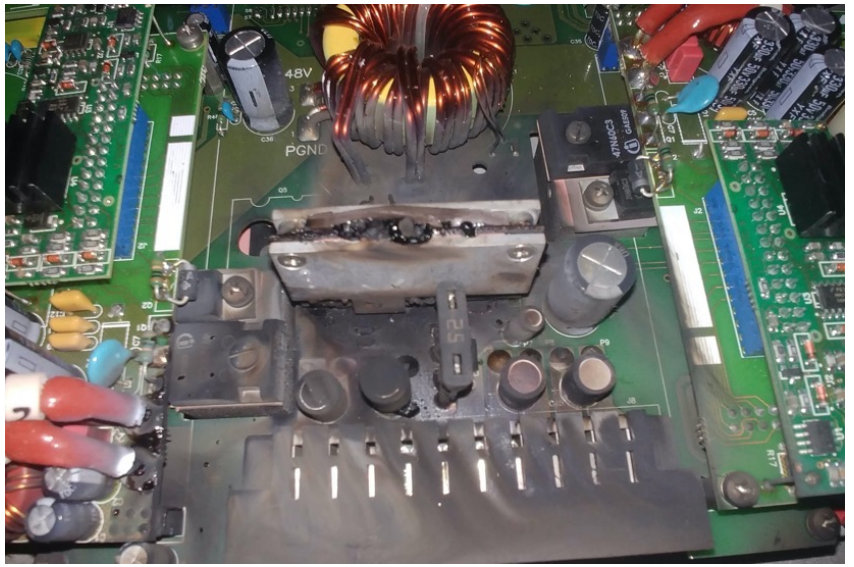
DC/DC accident

2020/10/09 (happened 2020/10/02 but it appeared as as a "simple" failure)

We found a **destructive damage on a reworked DC/DC**

- It was one of the 24 DC/DC (12 crates) **installed in Summer 2018**
- A **different fuse** has been found: 25 A instead of 15 A
- It stayed at a **temperature higher then 53°C** for about 5 hours (usually the hottest one are at around 40°)
- Usually the DCS system intervenes when the temperature is higher then 50°C → we found the alarm **deactivated** for that particular crate, now fixed.





Actions taken immediately after:

- Reported to TC
- Incident reported and discussed with CAEN, material sent to CAEN for full autopsy
- In the affected crate DC/DC replacement was enough (no other components damaged)

Actions taken for safety reason (after discussion with CAEN):

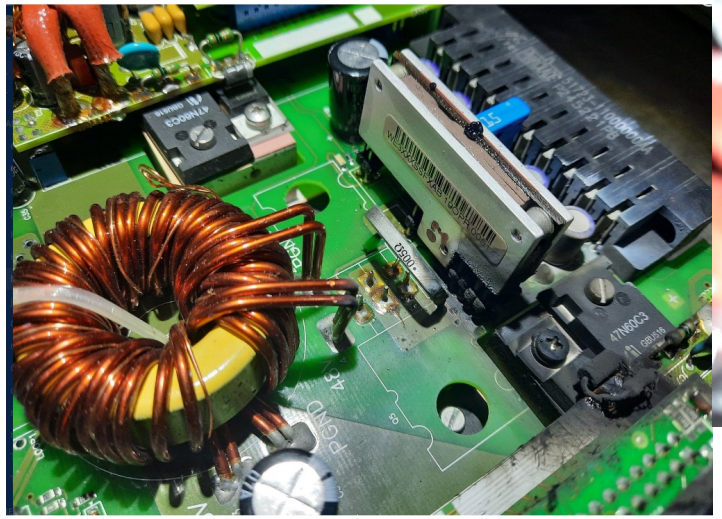
- **Send all the 2018 refurbished DC/DC to CAEN for a reworking**, in order to **change the fuse** (15 A everywhere) and later put a **fw threshold** around 50°C (nowadays ~70°C)
  - **22 DC/DC** (11 crates) **uninstalled** and **sent** to CAEN
  - **Back at CERN end of March/beginning of April**
  - **Installed back by end of April**

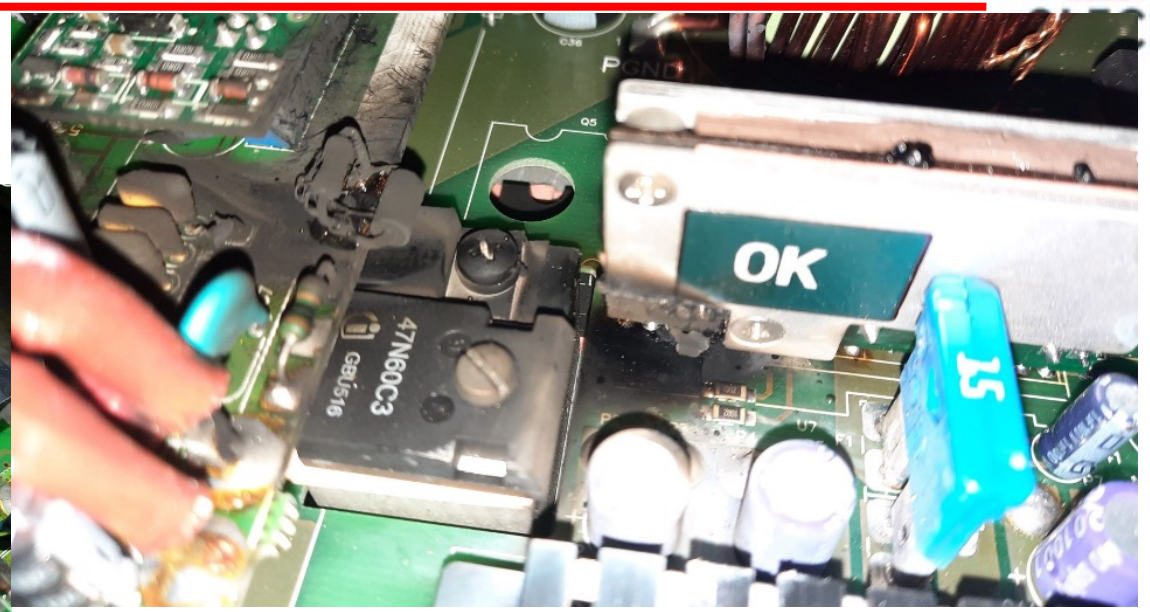
Bring home message

- Serious damage on 1 DC/DC
- Several actions taken
- Reworking of 22 DC/DC done

DC/DC accident [new]

4/7/2022 → perdita controllo DC/DC crate 37 (SM9)
12/7/2022 → intervento per sostituzione e...





- problema su componente rimpiazzato durante refurbishment 2018/2020 (SSF)
- **13/7 meeting with CAEN** , materiale spedito a Viareggio immediatamente
- questo DC/DC appartiene a altro lotto di lavorazione (giugno 2019)
- **14/7 meeting with ALICE TC and ALICE GLIMOS**
- probabile intervento "massiccio" in autunno 2021?
- per ora "no richieste per 2022" nei preventivi pero'....

shutdown 64/72 crates
8 crates operated half-power
waiting for inspection outcomes
report to TC 21/7
report to TB 22/7

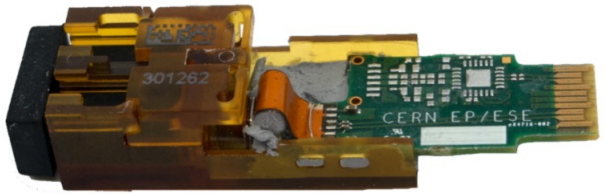
→ Teniamo aggiornato collegio referee tra qui e settembre

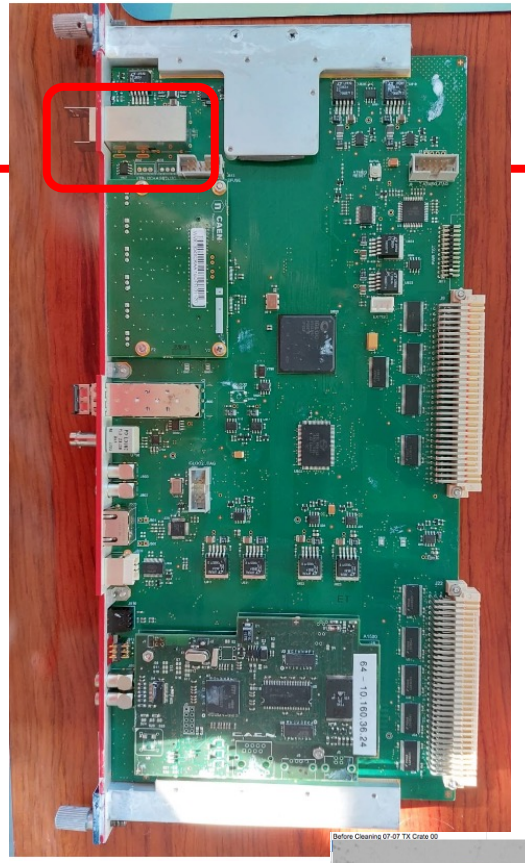
and... the VTRx saga

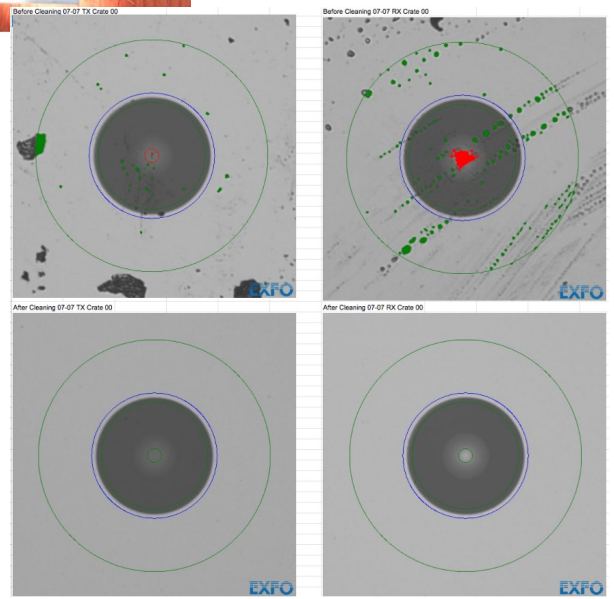
(see Stefania's presentation)

1. TOF has just 72 links. No possibility (no RSSI pin connected) to monitor RSSI
2. no links lost since Sep. 2020 (but not always on, now constantly on since 1/7/2021)

DRM have special cage for VTRx ("extractable") + VTRx is close to heat dissipator



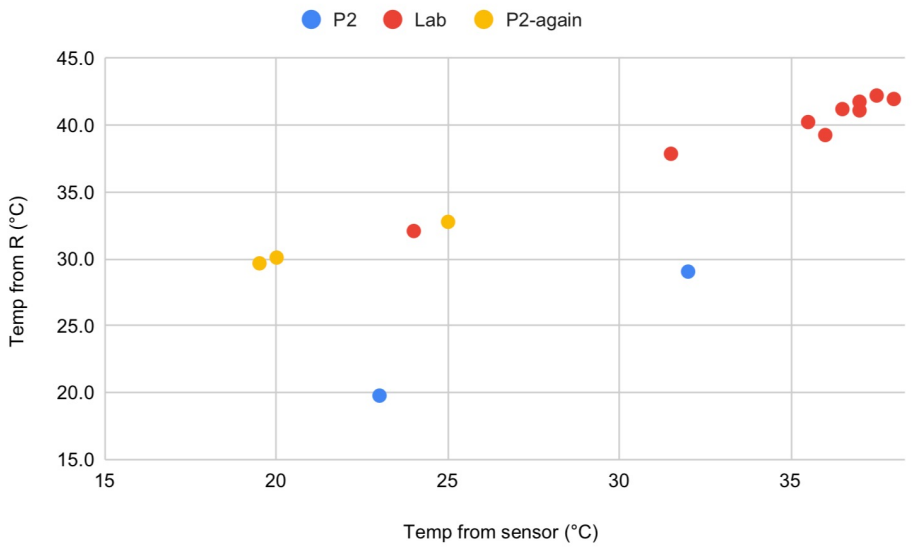




Actions taken

- monitored temperatures (with our on board sensors + special resistor)
- cleaned fibres on 8 crates and now we will observe if there is any deposit
- spares moved to baking procedure (start 12 July)
- VTRx replacement since 23 August (all 72 links). 3-week effort
- initial discussion with CAEN (and within TOF) about "cooling"

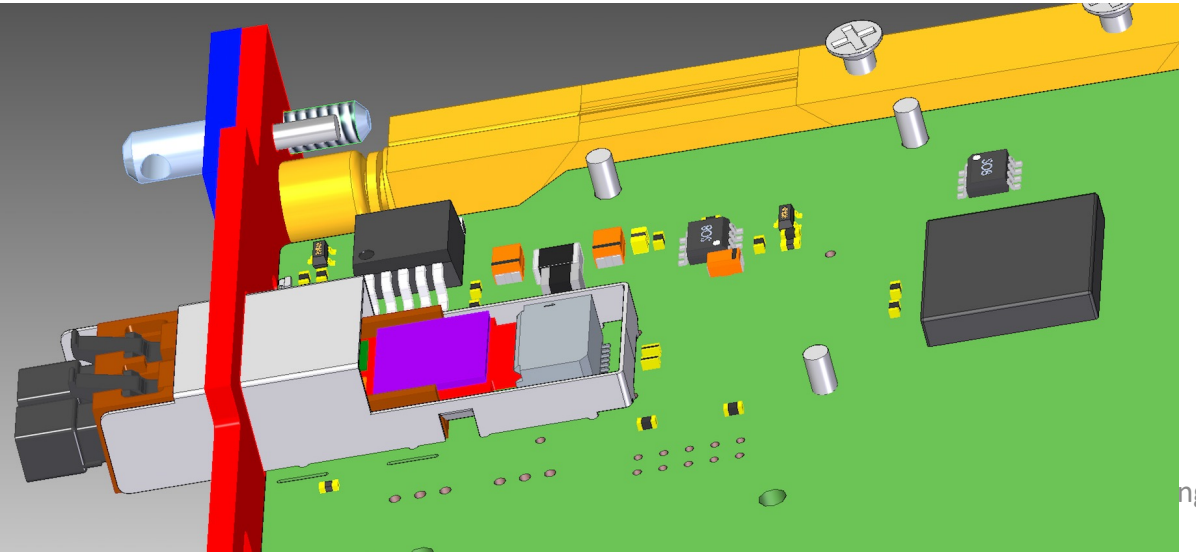
and… the VTRx saga (II)

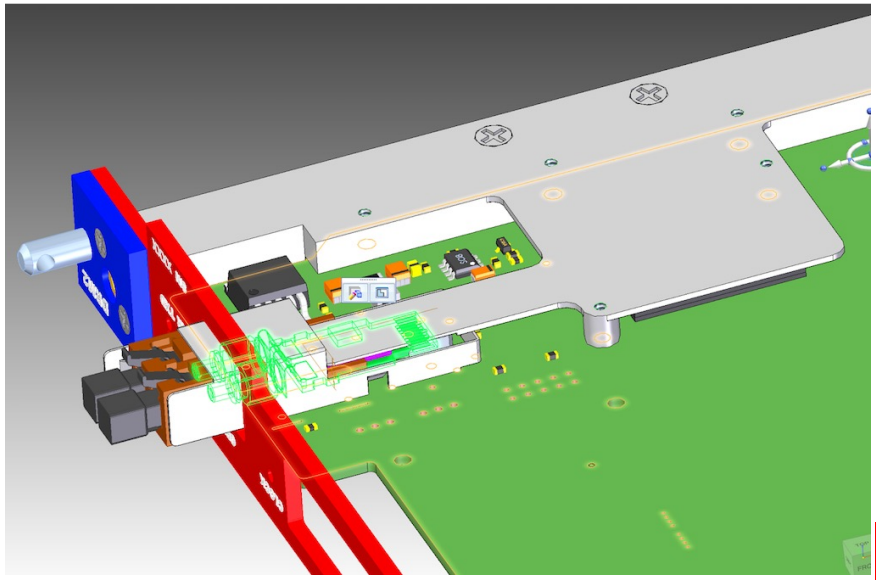


SM	0	1	2	3
00:	24.50	25.00	26.50	26.50
01:	25.00	25.50	26.50	26.00
02:	30.50	33.00	27.50	29.50
03:	27.50	26.50	26.00	
04:	27.50	32.50	29.00	33.00
05:	28.50	32.00	29.00	32.00
06:	34.00	35.00	29.00	30.00
07:	26.00	28.50	32.00	28.00
08:	43.50	26.50	25.50	
09:	27.50	26.50	25.50	
10:	25.50	27.00	25.00	25.50
11:	25.50	26.00	25.00	27.50
12:	25.00	27.00	26.00	26.50
13:	28.50	28.50	28.50	26.50
14:	28.50	26.50	26.50	30.00
15:	28.00	30.00	28.00	29.00
16:	25.50	27.00	26.00	27.50
17:	23.50	25.00	27.50	25.50

between on board T sensors (air close to component) and VTRx T found a systematic 5 C shift. → <u>Many VTRx above 30 C, few above 40 C</u>

<u>Potential cooling solution</u> (under discussion)



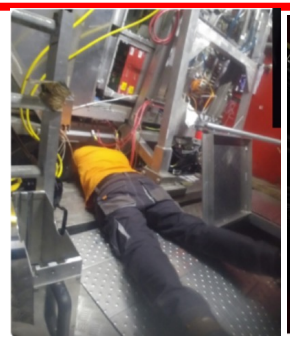


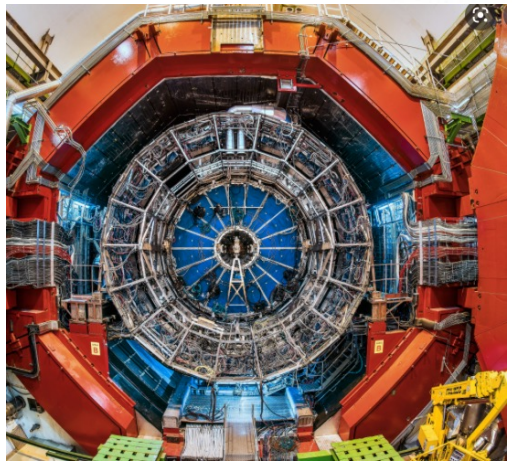
ng with INFN referees

and... the VTRx saga (III)

Current strategy:

- monitor if we have deposits (8 crates with "easy access")
- replace VTRx after baking
- continue to monitor
- develop and test a cooling solution
- **wait and see**





Notes:

- if forced to cooling solution (failure rate very high during Run3) this would be a **massive effort**
  - dismount all cards
  - immediate reworking
  - remount

  1 month minimum with 4 persons (4 mesi/persona sub judice)
  mechanical costs unknown (10 KEU as pure guess) during YETS 2022/2023
- main "sub judice" under Bologna/Salerno requests. We all hope never ask referees to use it.

Notare che per TOF costo implementazione cooling sarebbe molto piu' alto che 72 VTRx "nuovi"

TOF 2022 e richieste

- luglio - novembre (2020): global commissioning – fix instabilities (fw + sw) + hardware emergencies (DC/DC + VTRx)
- 2022: data taking, operatività detector

Proposed milestones TOF
31/12/2022 Presa dati pp e Pb-Pb
31/12/2022 Sviluppo procedure di automatic recovery durante data taking

Richieste

- 2022: missioni per data taking/mobilita' generale/responsabilita' (come da tabelle/librone)
- 2022:
  - missioni specifiche as usual: interventi di maintenance (tecnici da Bologna) [2 settimane + 2 settimane)
  - licenza Microchip (ex Microsemi)
  - + intervento per VTRx (s.j.) [**speriamo di no!**] (Bo/Sa) [10 KEU consumo + 4 mesi/persona]
  - sviluppo prima card con picoTDC (new TRM spares?) [Bo] 5 KEU (consegna chip gennaio 2022 speriamo! AIDAInnova pr.)
  - [altre richieste a Bologna come ITS3 o ALICE3 (poche) o RN calcolo (tante ;-))]

Caveat finale

- anno Covid "si è sentito molto"
- crew di poche persone "residente" ha retto enorme lavoro in questo anno e tre mesi. Riprese (poche) missioni solo di recente (+ 1 similfellow da 1/7). Il livello di preparazione del detector a Run3 è per il momento minore di quello che volevamo.