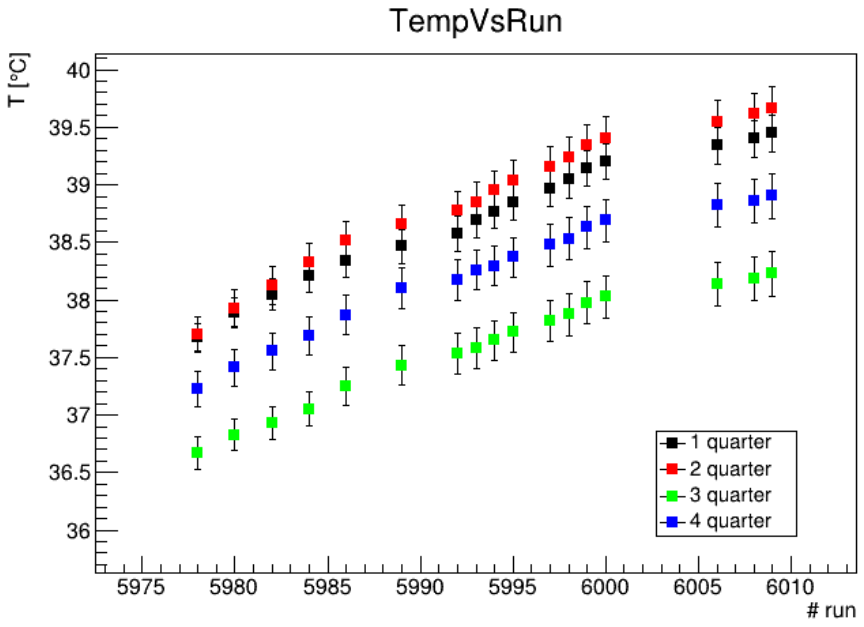
Istituto Nazionale di Fisica Nucleare
SEZIONE DI TORINO

Calo status for CNAO 2023

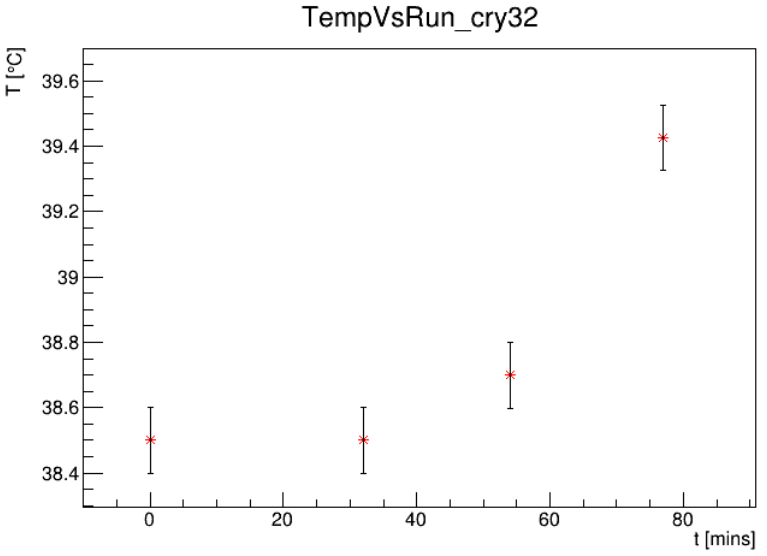
Benedetto Spadavecchia

FOOT Physics Monthly Meeting, 06/02/2024



Where we stopped: no evidence of T stabilization for any quarter was found → for next data taking: better turn on the CALO earlier.

However, for every crystal, the variation in T_{mean} was within 1°C along the 4 calibration runs → 0.5% variation in ADC response.



By mediating T_{mean} values among the 4 calibration runs a crystal-specific T_{ave} value was obtained and chosen as reference temperature.

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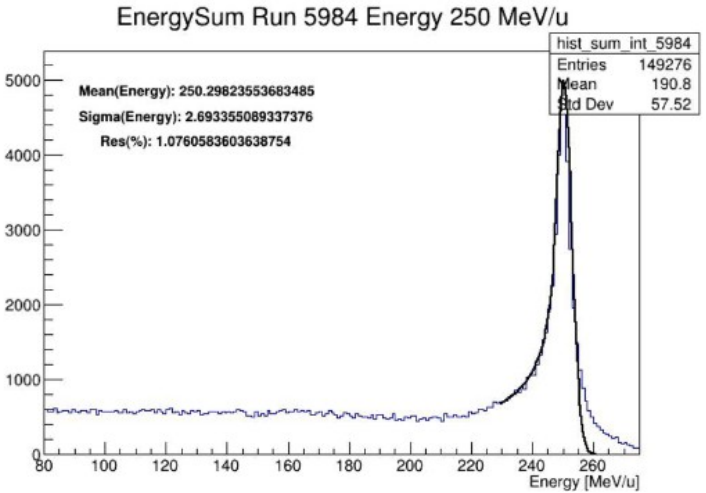
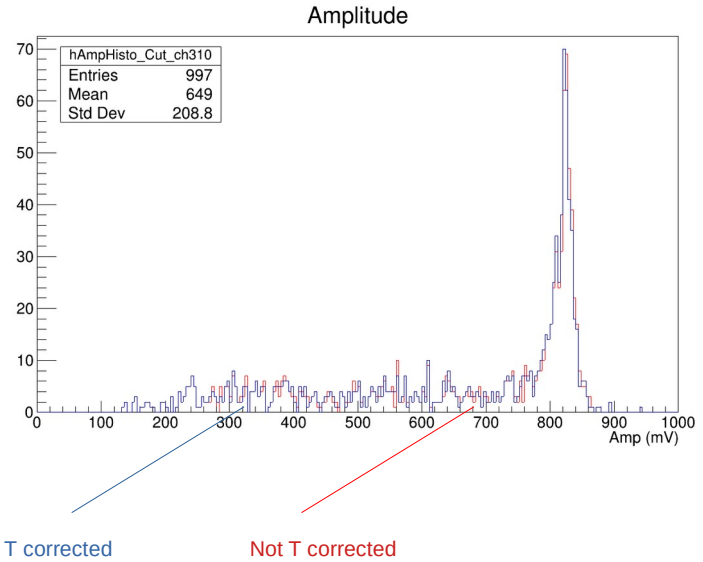
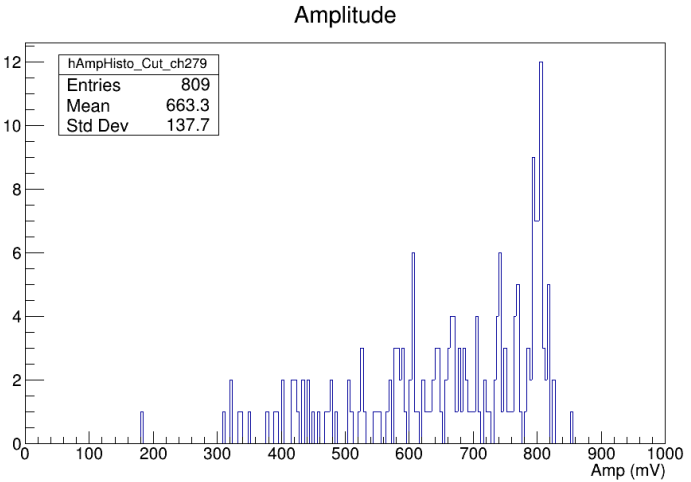
$$m_{meas} = m_1 + \frac{m_2 - m_1}{T_2 - T_1} \cdot (T_{meas} - T_1)$$

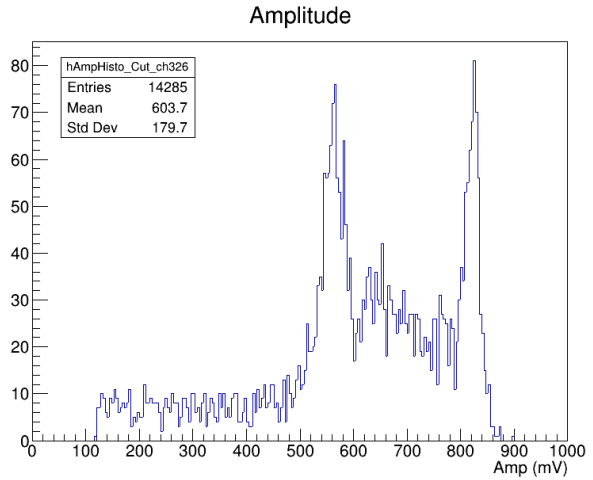
$$A'_{meas} = A_{meas} + m_{meas} \cdot (T_{ref} - T_{meas})$$

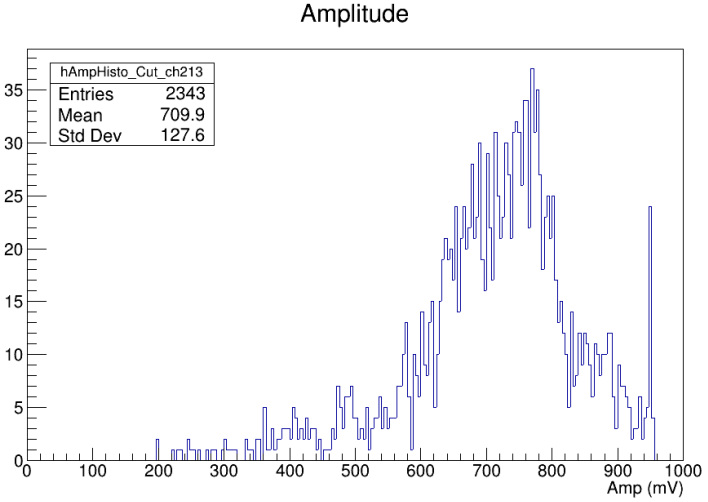




Spectra were fitted with a crystal ball function → peak values were extracted: differently from other times, a new script was developed to perform the process automatically → to be uploaded on *shoe*.



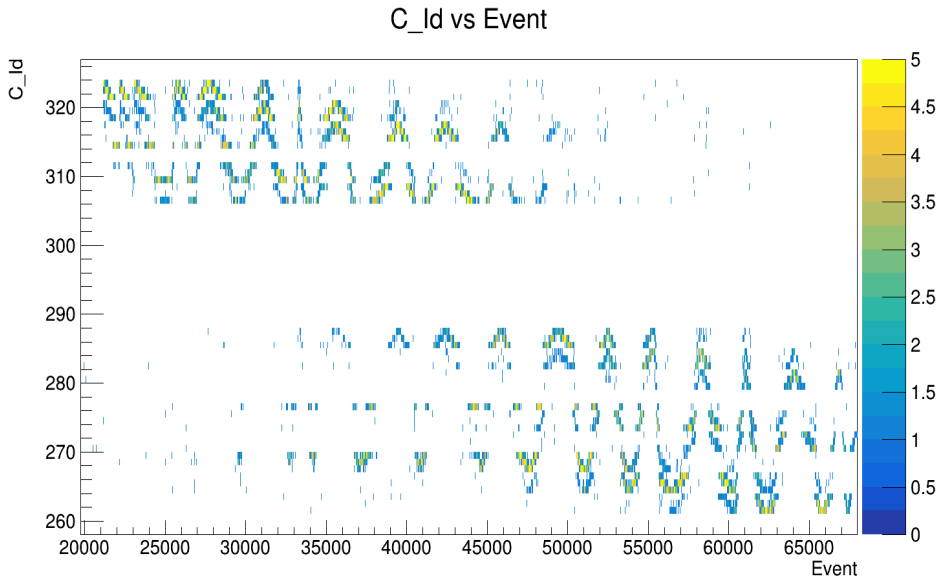


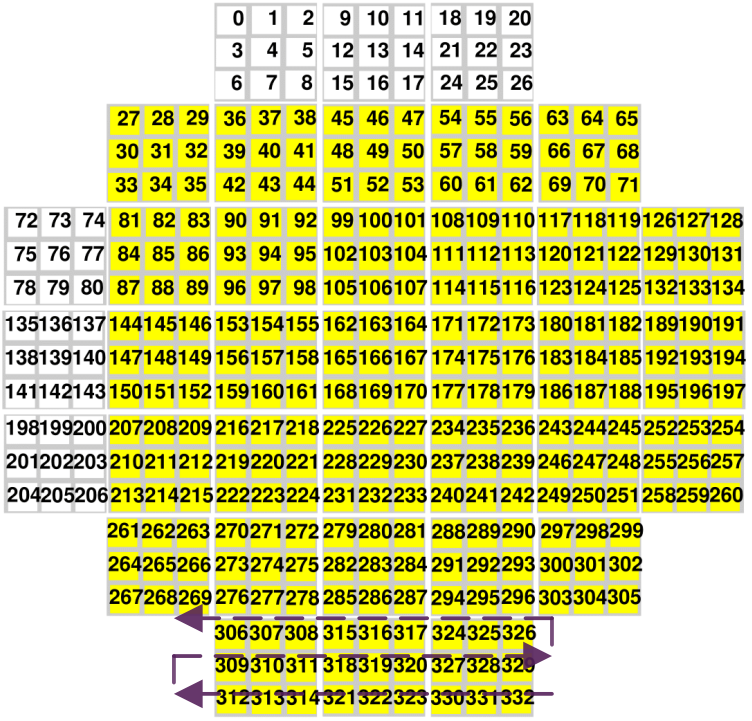


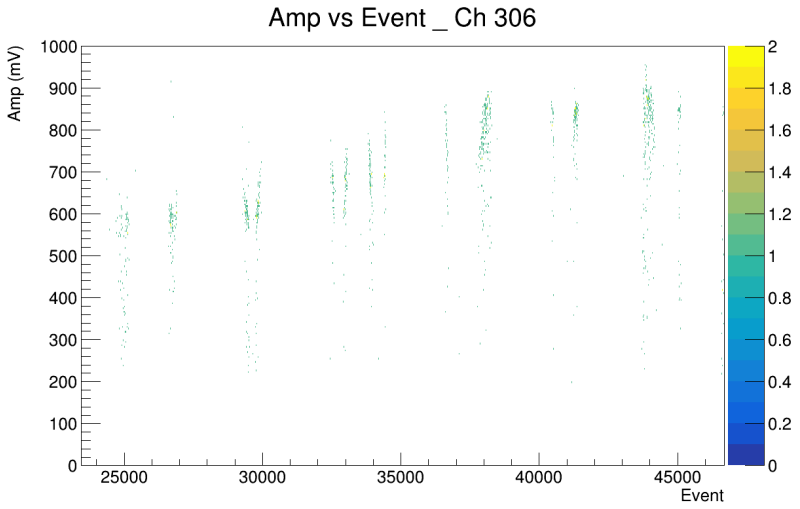
For some runs and crystals, energy spectra show:
1) scarcely populated distributions (i.e. 279)
2) largely distributed peaks (i.e. 213)
3) multiple peaks (i.e. 326).

Cases (2) and (3) mainly involve crystals on border, for which discarding events with multiplicity > 1 is less efficient.

A plot of the activated channels per event was created, to obtain information upon beam scanning.







In border crystals, sometimes energy is not fully deposited and multiplicity cut cannot be applied. In order to investigate on this issue, also a 2D plot of amplitude (mV) vs event number was created.

We already knew that if particles hit crystals closer to the SiPM, the formed signal has lower amplitude

→ hypothesis: this is more likely to happen when the beam is not perfectly centered on the crystal and at higher energies (higher particle range)

→ peaks at lower gain show up.

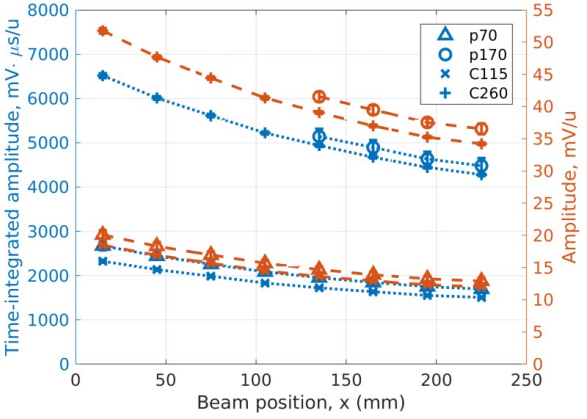
$$A(x) = A[Re^{\alpha(L-x)} + (1-R)e^{-\alpha(L+x)}]$$

A is the normalization factor

α is the attenuation coefficient

R is the fraction of reflected photons

L is the crystal length.



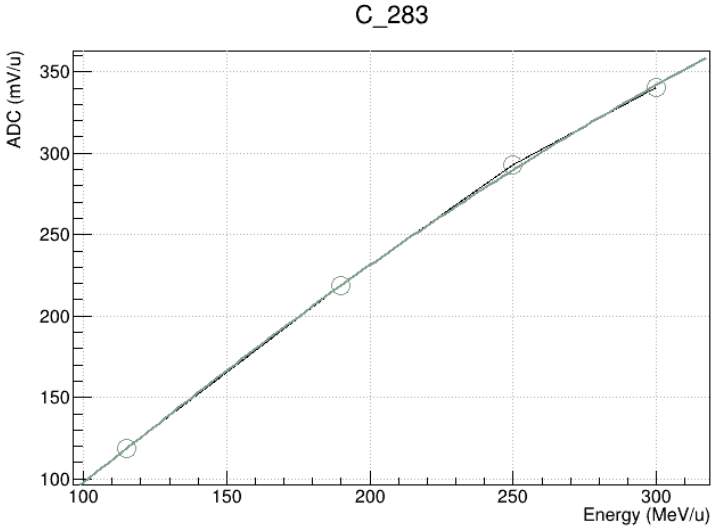
For each crystal → fit with modified Birks function on:
a) not T corrected peak values;
b) T corrected peak values

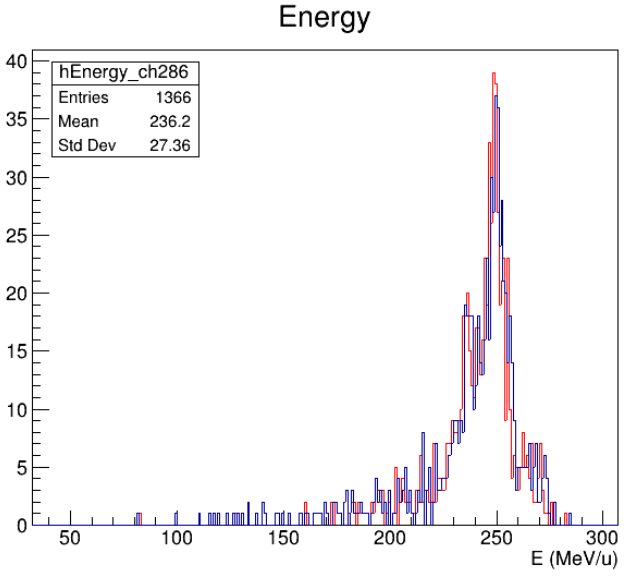
$$ADC(E) = \frac{p_0 x^2}{1 + p_1 x + p_2 x^2}$$

→ two sets of p_0, p_1 and p_2 parameters
→ two hEnergy plots per crystal, one corrected for T, one not:
how much do integral resolutions differ

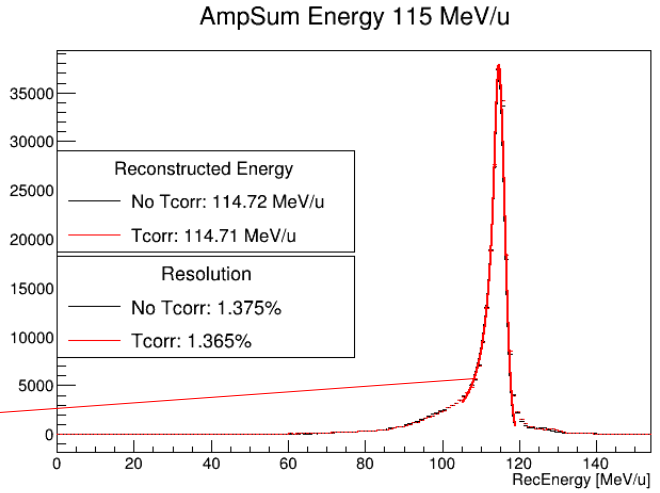
$$E(ADC) = \frac{-p_1 ADC - \sqrt{(p_1 ADC)^2 - 4ADC(p_2 ADC - p_0)}}{2(p_2 ADC - p_0)}$$

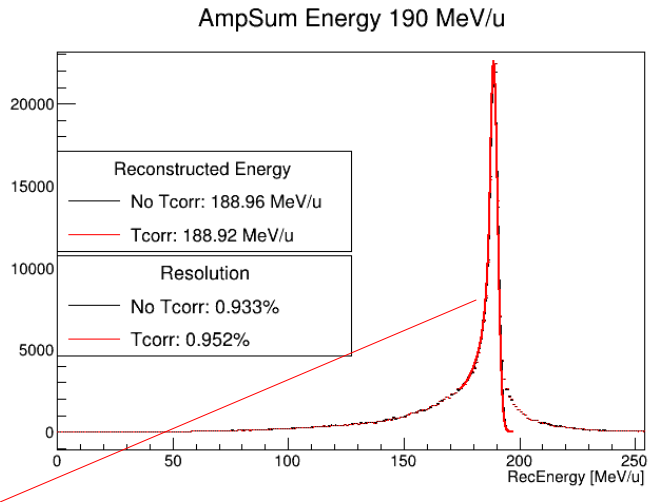
Not all the fits with Birks function lead to a correct minimization: the following results were obtained by excluding “bad Birks-fitting” crystals (37, 44, 64, 68, 71, 95, 213, 302, 304, 305, 306, 326)



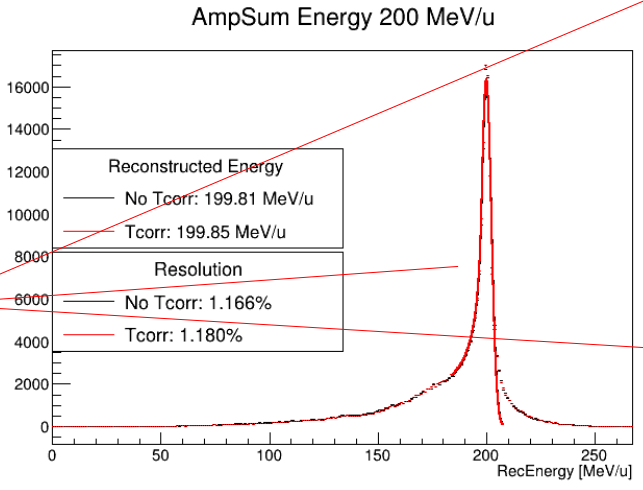


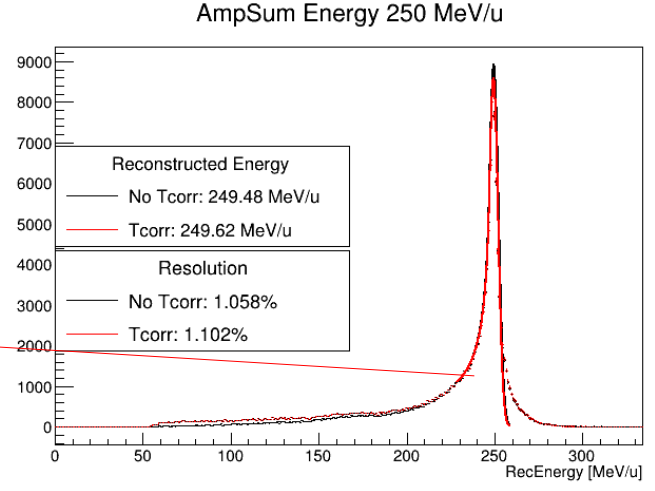
Improvement





Worsening





Upcoming tasks

Software: data analysis on HIT2022; to interpret CALO energy response, proper Z identification is required
a) issues in reading TW tree from decode-glb output must be fixed;
b) TW and CALO closest hits must be coupled;
c) mass reconstruction capability from CALO to be studied.

E [MeV/u]	1	2	3	4
115		55, 68, 71, 128	248, 295, 299, 327	312
190		55, 64, 68, 71, 127, 128	248, 295, 299, 302 304, 305, 326	312
200		55, 56, 64, 68, 71, 127	248, 295, 299, 302 304, 305, 326	306, 309, 312, 314, 321, 322
250	28, 46, 47, 82, 87, 151, 167	55, 63, 64, 126, 127	248, 295, 299, 302 304, 305, 326	207, 215, 223, 264, 269, 274, 306, 311, 312
300	X	X	X	207, 215, 223, 263, 264, 265, 267, 268, 269, 271, 273, 279, 287, 306 308, 309, 311, 312, 315 319, 322, 323
		55	248, 295, 299	312
No data taking	27, 38, 39		303	225, 277, 278
Unplugged		131		313

	dirty/multiple peaks
	(almost) no signals
	overflow
	problems in all runs
	border crystals

Hardware: last spare crystals (about ten) will be glued @CERN on february-march 2024; to check whether excluded crystals need replacement or not.