Comparison between 2022 and 2023 TB - ALICE

Luca Quaglia

ECOgas weekly meeting



Overview

- Brief reminder of the ALICE GIF++ RPC history
- TB July 2022 vs TB July 2023
 Source OFF (STD-ECO2-ECO3)
 - Source ON
- Studies in October 2023
- Conclusions, what to do next?



Current at July 2022 vs 2023 TB - 1a

- Reminder: how is current measured with beam?
- For each high voltage value we measure the current evey 2 seconds
 - \rightarrow Measurement can be done in the spill or out of it
 - \rightarrow Current distribution @ fixed HV shows two populations
- Statistically most of the time the current is measured out of spill
 → More counts in the first peak
- To take out beam contribution and study only dark/souce current at source OFF/ON
 - \rightarrow Gaussian fit to the peak with highest counts
 - \rightarrow Calculate the avearge in the interval: mean of the Gaussian ± 5σ
 - \rightarrow N.B. for the STD gas mixture the difference is not so great, higher for eco-friendly mixtures



Distribution of current measurements @ fixed HV with STD gas mixture

Current at July 2022 vs 2023 TB - 1b

• Situation is a bit different (in the case of the ALICE detector) in 2023



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Noise at July 2022 vs 2023 TB - 2a

- Reminder: how is the noise/gamma cluster rate calculated?
- In-spill signal to tag muon events, out of spill signal to tag noise/gamma-induced events
- Clustering of the out of spill events
 - \rightarrow Count the total number of clusters and divide it by the total data-taking time and the total strip area



N.B. In 2023 we have 24 strips, in 2022 we had 16

Noise at July 2022 vs 2023 TB - 2b



Gamma rate July 2022 vs 2023 TB - 2C



Gamma rate July 2022 vs 2023 TB - 2d



Efficiency at July 2022 vs 2023 TB - 3a source OFF

- Reminder: how is efficiency computed?
- Starting from the TDC time profile (distribution of the time of all the registered hits) we fit the muon peak and tag an event as muon if its time lays in the range mean $\pm 3\sigma$
- If in a given trigger we have an event on the X(Y)(both planes) we increase a counterX(Y)(XY) and we evaluate the efficiency as the ratio between the counter and the total number of triggers



Efficiency at July 2022 vs 2023 TB - 3b source OFF



Efficiency at July 2022 vs 2023 TB - 3c source OFF

MIXTURE	ε MAX 2022 [%]	ε MAX 2023 [%]	HV ₅₀ 2022 [V]	HV ₅₀ 2023 [V]	λ 2022	λ 2023	WP 2022 [V]	WP 2023 [V]
STD	98.2	97.8	9019.9	9027.2	0.00863	0.00674	9510.9	9613.7
ECO2	97.3	95.4	10115	10292	0.00674	0.00557	10701.7	10971.2
ECO3	95.53	93.7	9330.7	9422.3	0.00703	0.00605	9899.3	10058.7

Summary table of all parameters at source OFF

Efficiency at July 2022 vs 2023 TB - 3d source OFF

- Maybe the increase of working point is due to increase of current, leading to an Ohmic voltage drop
- This has been calculated. Two resistance measurement carried out before the start of the test beam in July 2023



STD: +102 V (from eff curves) / +249 V (calculated with resistance method) ECO2: +269 V (from eff curves) / 418 V (calculated with resistance method) ECO3: +159 V (from eff curves) / 289 V (calculated with resistance method)

Few observations on resistance

• Resistance measured with Ar method is subject to fluctuations, depending on how many points are used in the fit

HV	l	Delta I	R
500	0.08	/	//
1000	0.160833	0.080833	6.18559251791E+09
1500	0.276833	0.116	4.31034482759E+09
1900	0.44075	0.163917	2.44025939957E+09
1925	0.45025	0.0095	2.63157894737E+09
1950	0.45925	0.009	2.77777777778E+09
1975	0.47325	0.014	1.78571428571E+09
2000	0.532083	0.058833	4.24931586015E+08
2025	0.618583	0.0865	2.89017341040E+08
2050	0.78625	0.167667	1.49105071362E+08
2075	1.14042	0.35417	7.05875709405E+07
2100	1.79708	0.65666	3.80714525021E+07
2125	2.604	0.80692	3.09820056511E+07
2150	3.54825	0.94425	2.64760391845E+07
2175	4.583	1.03475	2.41604252235E+07
2200	5.68408	1.10108	2.27049805645E+07
2225	6.83433	1.15025	2.17344055640E+07
2250	8.05333	1.219	2.05086136177E+07
2275	9.29783	1.2445	2.00883889112E+07
2300	10.5494	1.25157	1.99749115111E+07
2325	11.8794	1.33	1.87969924812E+07
2350	13.1947	1.3153	1.90070706303E+07
2375	14.592	1.3973	1.78916481786E+07

- R calculated as $\Delta V/\Delta I$ (between two subsequents points)
- R should be constant but the values vary, I tried to calculate it as the average of more values

• R increases if more points are added

AVG 1 value	AVG 2 values	AVG 3 Values	AVG 4 Values	AVG 5 Values
1.7892E+07	1.8449E+07	1.8565E+07	1.8918E+07	1.9152E+07

Anyhow the different values do not justify the difference between observed increase in WP and measured (ex for STD) 1 Value: 219 V (vs 102 V from efficiency curve) 2 Values: 226 V (vs 102 V from efficiency curve) 3 Values: 227 V (vs 102 V from efficiency curve) 4 Values: 232 V (vs 102 V from efficiency curve) 5 Values: 235 V (vs 102 V from efficiency curve)

Efficiency at July 2022 vs 2023 TB - 3e **ABS 22** 100 - July 2022 100 - July 2022 - July 2023 80 -- July 2023 100 80 - July 2022 60 <mark>г [%]</mark> з - July 2023 80 60 [%] 40 STD ω WP July 2022: 9503.8 V 40 60 ECO2 WP July 2023: 9612.5 V 20 [%] WP July 2022: 10722.8 V WP July 2023: 10972.6 V ω 20 40 0 ECO3 9500 HV_{Eff} [V] 9000 10000 8500 WP July 2022: 9935.7 V 0 WP July 2023: 10087.7 V 20 10500 11000 HV_{Eff} [V] 11500 10000 Increase of the detector working point for all mixtures STD: +109 V 9500 10000 HV_{Eff} [V] 9000 10500 ECO2: +250 V ECO3: +152 V

Efficiency at July 2022 vs 2023 TB - 3C source ON

MIXTURE	ε MAX 2022 [%]	ε MAX 2023 [%]	HV ₅₀ 2022 [V]	HV ₅₀ 2023 [V]	λ 2022	λ 2023	WP 2022 [V]	WP 2023 [V]
STD	98.3	98.1	9025.7	9013.7	0.00897	0.00656	9503.8	9612.5
ECO2	96.5	94.9	10133.5	10291.3	0.00670	0.00554	10722.8	10972.6
ECO3	94.7	93.1	9355.1	9432.2	0.00683	0.00582	9935.7	10087.7

Summary table of all parameters at source ON – ABS 22

Efficiency at July 2022 vs 2023 TB - 3e ABS 2.2



Efficiency at July 2022 vs 2023 TB - 3C source ON

MIXTURE	ε MAX 2022 [%]	ε MAX 2023 [%]	HV ₅₀ 2022 [V]	HV ₅₀ 2023 [V]	λ 2022	λ 2023	WP 2022 [V]	WP 2023 [V]
STD	97.2	96.9	9137.1	9130.7	0.00756	0.00582	9676.8	9785.9
ECO2	92.2	91.7	10273.3	10368	0.00617	0.00455	10900	11164.4
ECO3	92.6	89.9	9509.8	9558.8	0.00524	0.00462	102222	10346.2

Summary table of all parameters at source ON – ABS 2.2

Measurements in October

Tests on the ALICE detector

- Gas flow was checked both at input and output of the RPC \rightarrow Gas present at input () and output of the detector \checkmark
- HV cable ramped up in air to measure if any current leak is present in the cable \rightarrow 0 $\mu A @$ 11 kV \checkmark
- Measure of leakage current with multimeter \rightarrow Result of this measurement in the next slide



Measurement of leakage current



Outlook – future + aging conference

<u>Aging conference</u>

- Description of the issues with F-gases and RPCs (EU regulations + CERN request)
- Use of HFO + CO₂ in place of R134a and RPC ECOgas@GIF++ collaboration
 - HFO used by industries (available + cheaper in the long term)
 - Comment on possible more negative impact of HFO for the environment

 \rightarrow Two sources cited by Marcello, one positive and one negtive, both points of view will be taken into account and we would say that for the moment it's not clear if HFO is harmful, hence we use it

- Description of experimental setup (aging + beam test)
- Results on current stability vs int. charge (similar to EPJ plus paper)
- Comparison of 2022 vs 2023 test beam data (available for ALICE, CMS(?), SHiP(?))
- In the outlook
 - \rightarrow So far so good, current increase observed, more in some RPCs than others
 - \rightarrow Origin of the increase not yet understood, new campaign to be launched next year to measure :
 - 1) Leakage currents
 - 2) Gas humidity at input of each chamber
 - 3) Periodic ISE measurements