Ecogas studies

comparison of efficiency and current density of 2023 vs 2024 Test beam results obtained with the CMS(RE1_1) chamber at GIF++

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- To investigate the aging effect of the CMS RPC chamber (RE1_1), the parameters for the 2023 and 2024 data have been compared
- As it is shown in the tables below, the data were analysed with source off and ABS_3.3 condition.
- These comparisons have been conducted for efficiency as a function of HV_eff.

STD : 95.2% R134a, 4.5% i-C_4H_{10} and 0.3% SF_6
ECO2: 60% CO_2, 35% HFO, 4% i-C_4H_{10} and 1% SF_6
ECO3: 69% CO_2, 25% HFO, 5% i-C_4H_{10} and 1% SF_6

2023

ABS	STD	ECO2	ECO3
Off	660	669	650
100	662	672	651
3.3	657	670	648

2024 (April)

ABS	STD	ECO2	ECO3
Off	750	781	813+836
100	764	790	826+844
3.3	762+765	783+807	816+837

2024 (June)

ABS	STD	ECO2	ECO3
Off	881	901	940
100		921	954
3.3	880	905	943+946

Working point voltage

	HV Knee(kV)				
	S_off_23	S_off_24_Apr	Diff(V)	S_off_24_Jun	Diff(V)
STD	9.83	9.71	120	9.87	40
ECO2	11.13	11.02	110	11.18	50
ECO3	10.25	10.25	0	10.23	20

Table 1: Working point voltages (source_off) for all the three gas mixtures

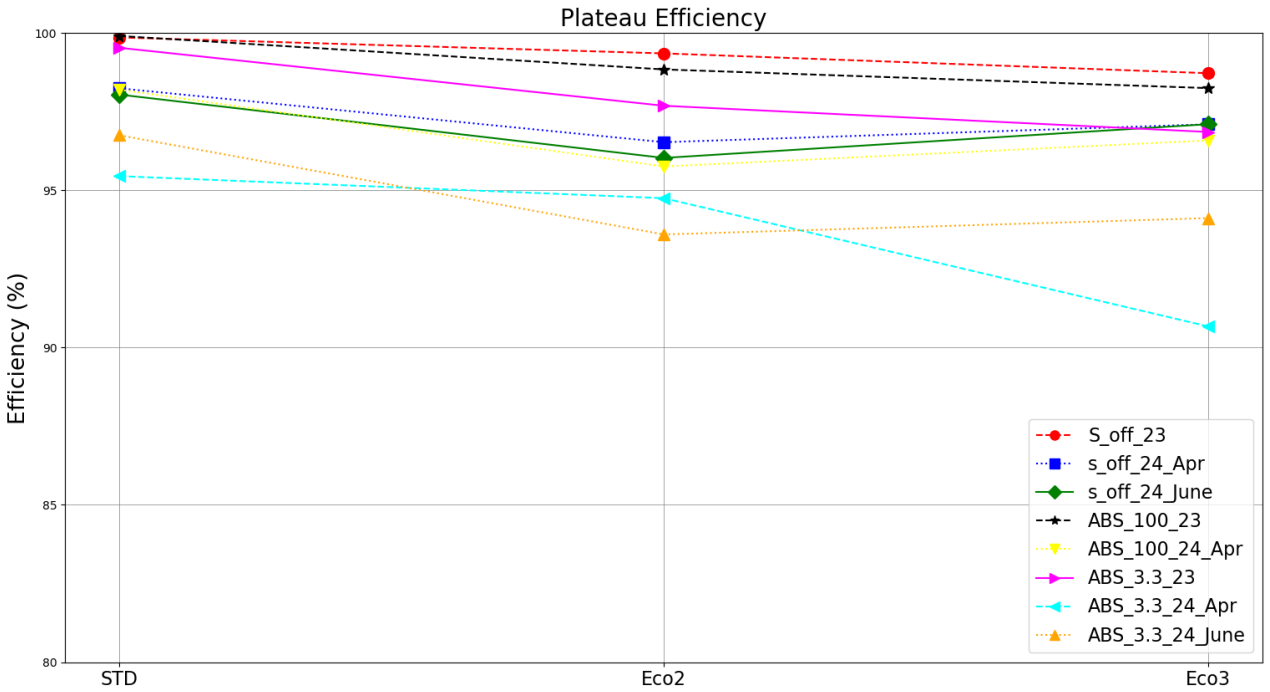
	HV Knee(kV)				
	ABS_100_23	ABS_100_24_Apr	Diff(V)	ABS_100__24_Jun	Diff(V)
STD	9.86	9.77	90		
ECO2	11.14	11.05	90	11.14	0
ECO3	10.28	10.30	20	10.26	20

Table 2: Working point voltages (ABS_100) for all the three gas mixtures

	HV Knee(kV)				
	ABS_3.3_23	ABS_3.3_24_Apr	Diff(V)	ABS_3.3_24_Jun	Diff(V)
STD	10.23	10.78	550	10.53	300
ECO2	11.61	12.17	560	12.18	570
ECO3	10.78	11.12	340	11.42	640

Table 2: Working point voltages (ABS_100) for all the three gas mixtures

Comparison of plateau efficiency of all data



- For 2023 data, plateau efficiency was decreasing from STD mixture to Eco3 for source_off, ABS_100. This trend can be also seen in 2024 april data with ABS_3.3.
- The higher the measured current recorded for 2023 data, the less the plateau efficiency will be.
- However, for 2024 april, when source_off and ABS_100 and for 2024 June data with source_off and ABS_3.3, Plateau efficiency decreases from STD to Eco2 and then experience an increases for Eco3.

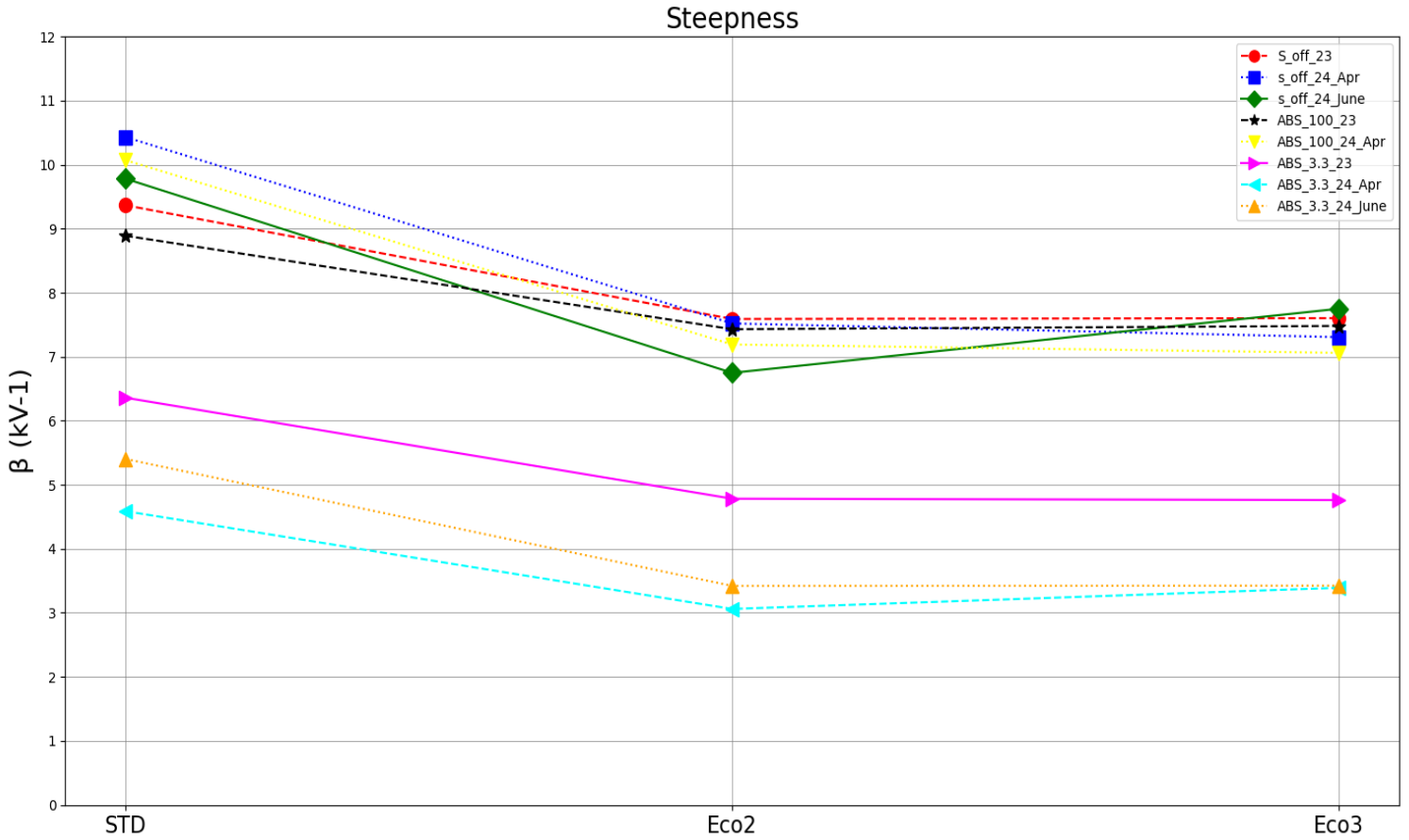
		2023	
ABS	STD	ECO2	ECO3
Off	99.869	99.353	98.723
100	99.907	98.843	98.249
3.3	99.531	97.688	96.855

	2024(April)		
ABS	STD	ECO2	ECO3
Off	98.242	96.53	97.099
100	98.2	95.757	96.586
3.3	95.451	94.75	90.674

	2024(June)	Max_efficiency	
ABS	STD	ECO2	ECO3
Off	98.042	96.03	97.102
3.3	96.75	93.597	94.116

$$\mathcal{E}(HV_{\text{eff}}) = \frac{\mathcal{E}_{\max}}{1 + e^{-\beta(HV_{\text{eff}} - HV_{50})}}$$

Comparison of slop of efficiency curve of all data



		2023	
ABS	STD	ECO2	ECO3
Off	9.365	7.59	7.603
100	8.889	7.43	7.481
3.3	6.359	4.782	4.761

	2024(April)		
ABS	STD	ECO2	ECO3
Off	10.43	7.52	7.306
100	10.07	7.191	7.061
3.3	4.587	3.06	3.39

	2024(June)		
ABS	STD	ECO2	ECO3
Off	9.78	6.748	7.749
100		6.692	7.176
3.3	5.402	3.42	3.424

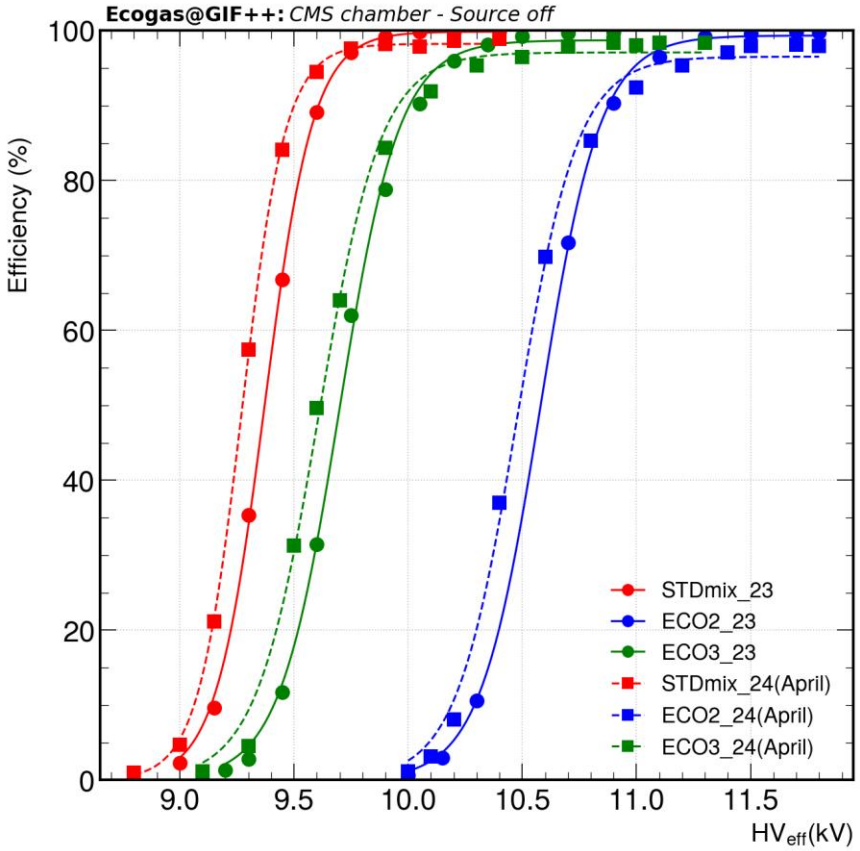
- For all data, the steepness becomes less from STD mixture to Eco2 and Eco3 data

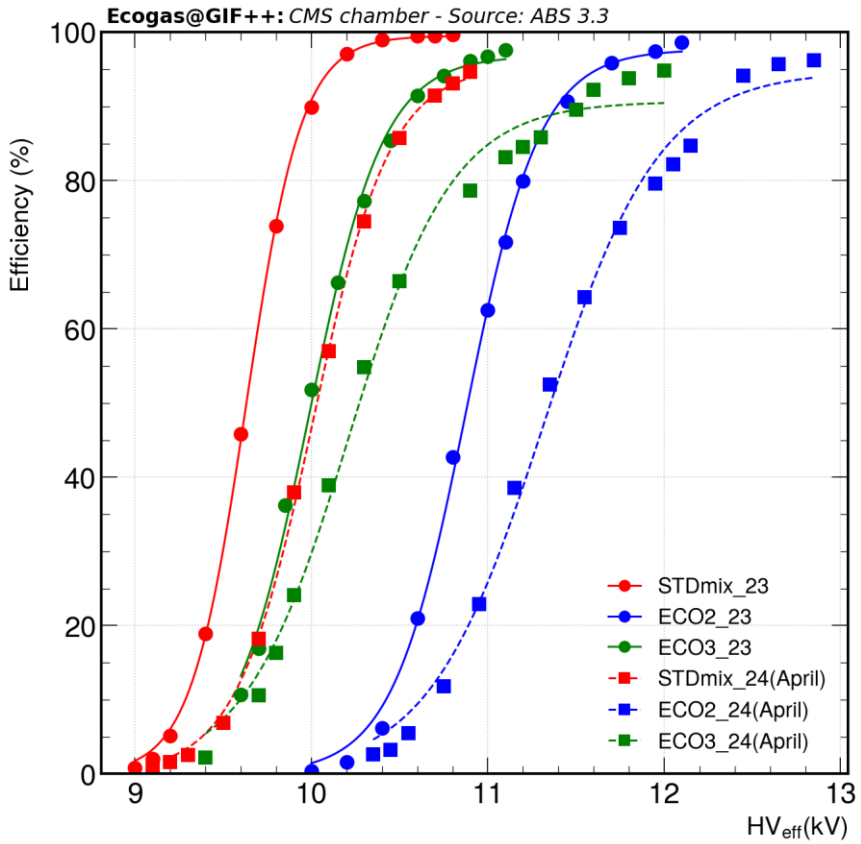
An increase is seen from Eco2 to Eco3 for June 24 (source_off) and slightly rise for April 24(ABS_3.3)

source_off

comparison of efficiency vs HVeff for 2023 and 2024 April data

ABS_3.3

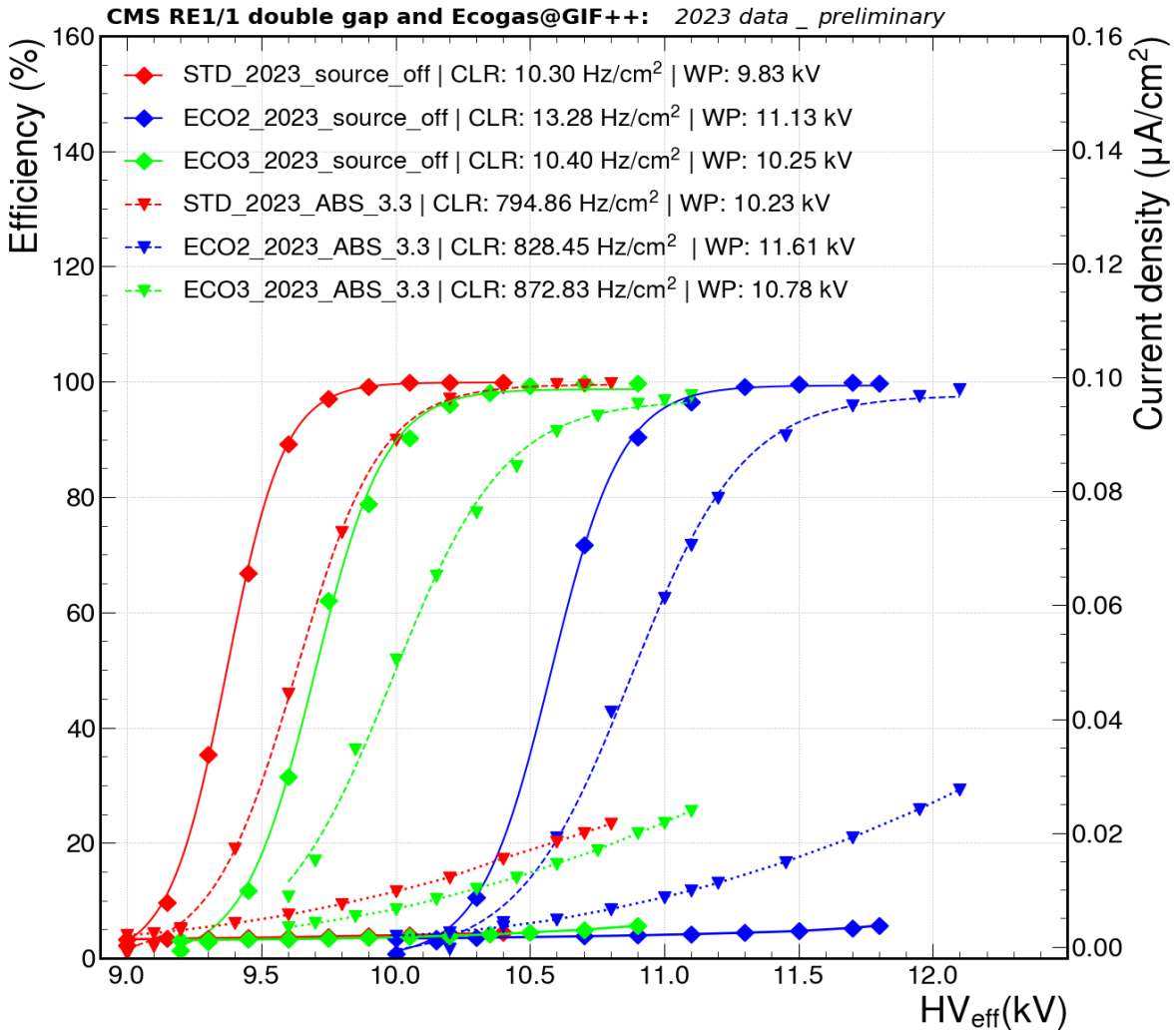




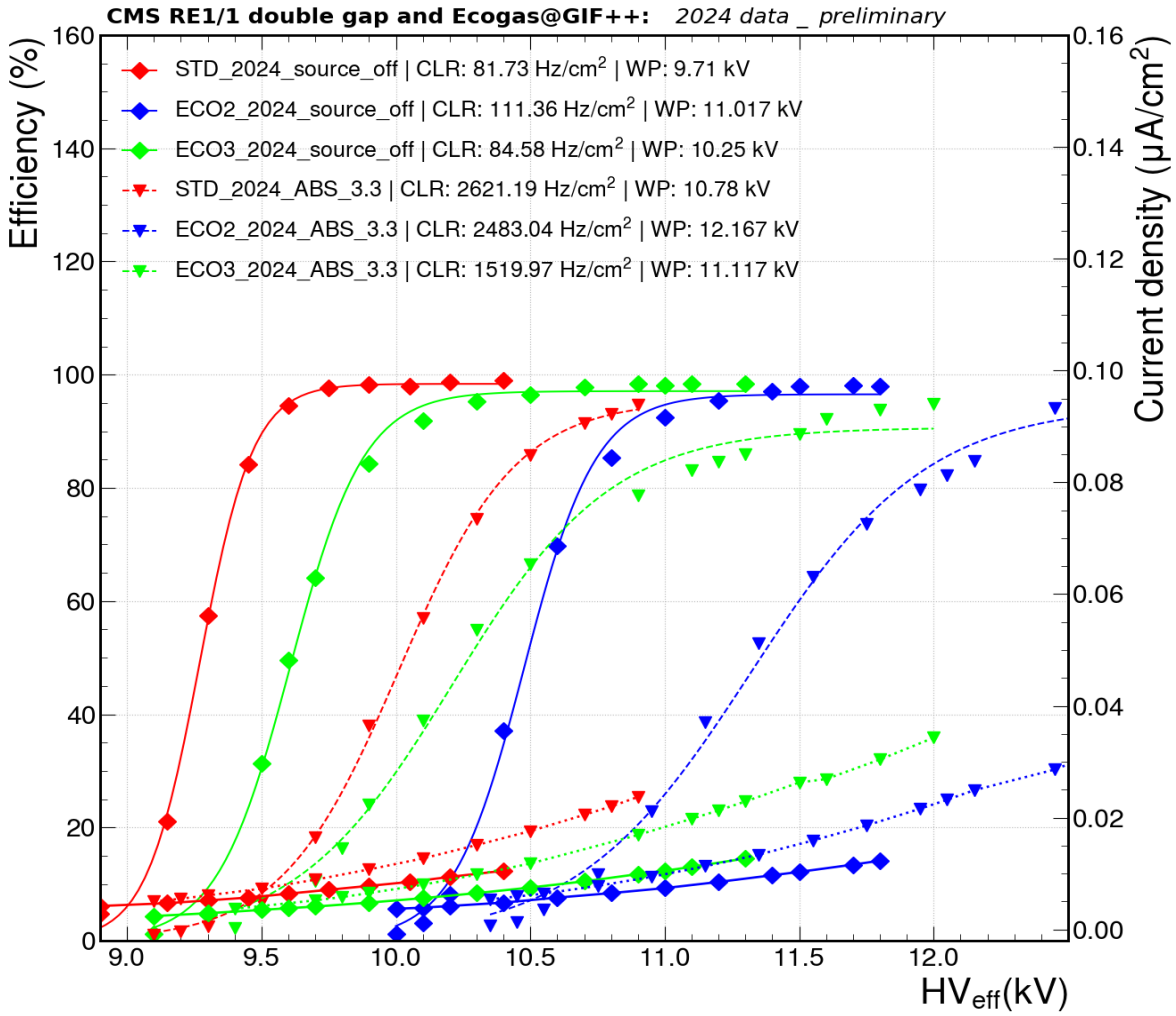
- For all gas mixtures, efficiency measured With source off and ABS_3.3
- A drop in the efficiency curves observed from 2023 to 2024
- A shift toward negative voltage for 2024 April data.

Efficiency and current density vs HVeff for 2023 and 2024 data_source_off and ABS_3.3

Source_off and ABS_3.3 for 2023 data

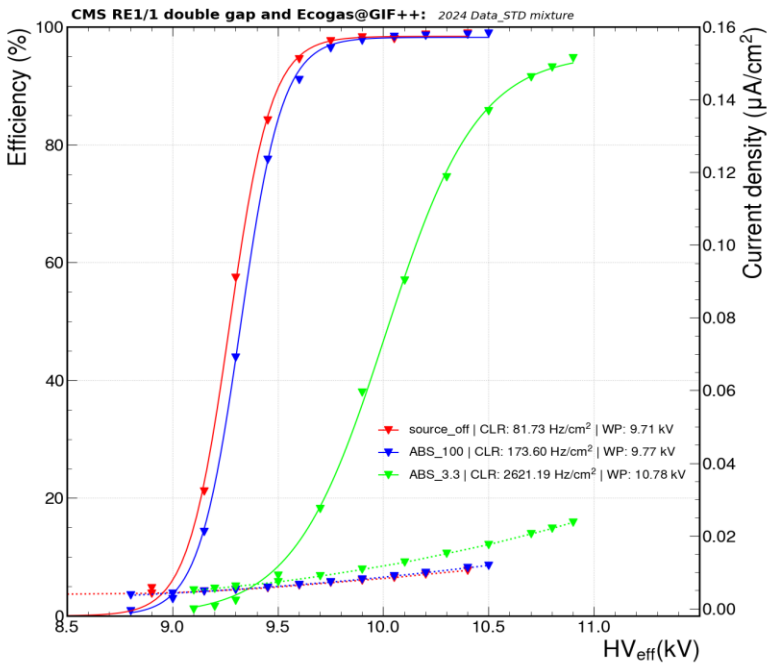


Source_off and ABS_3.3 for 2024 data

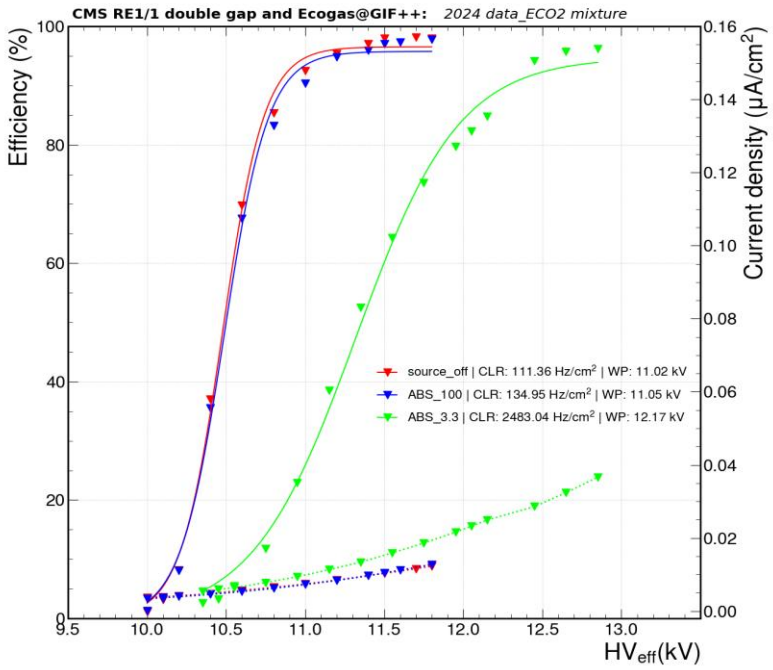


Efficiency and current density vs HVeff for 2024_STD_Eco2_Eco3

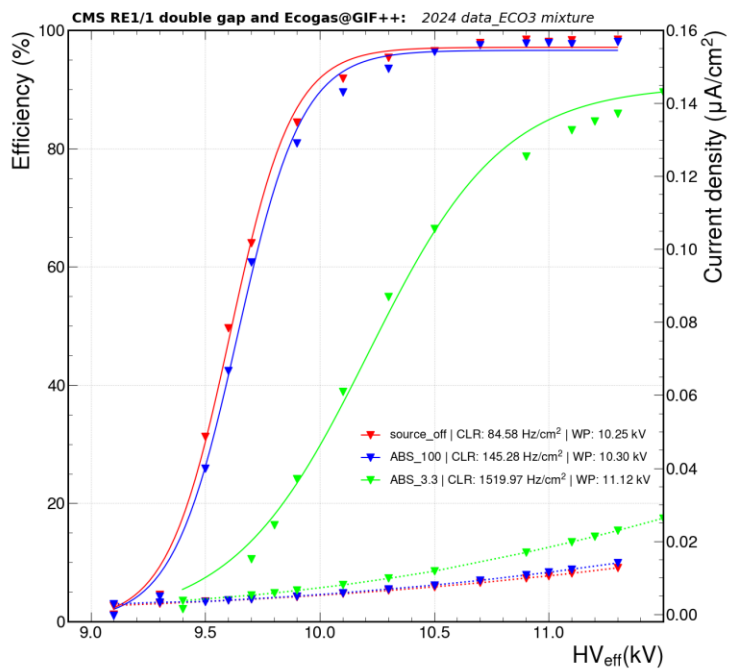
STD mixture



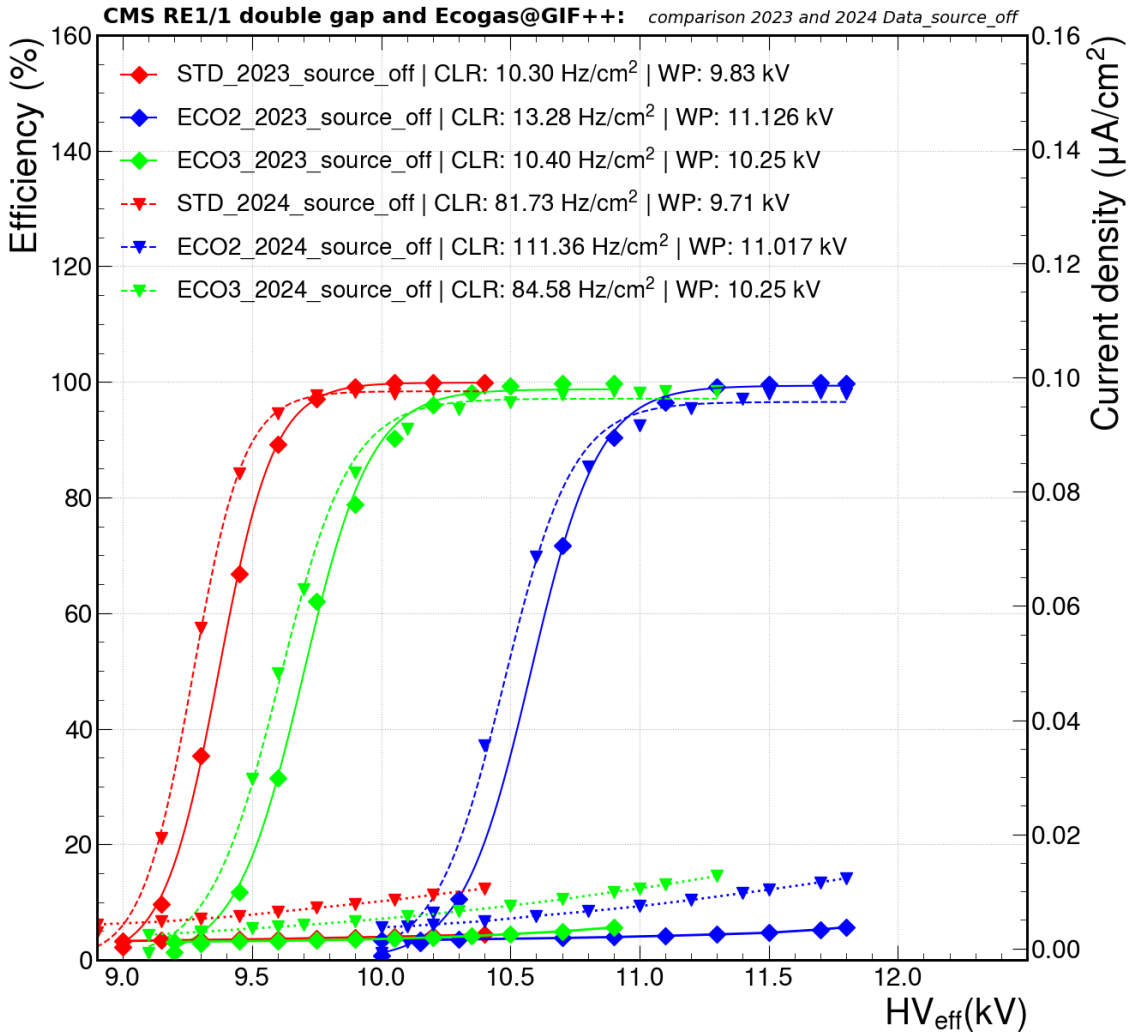
ECO2 mixture



ECO3 mixture

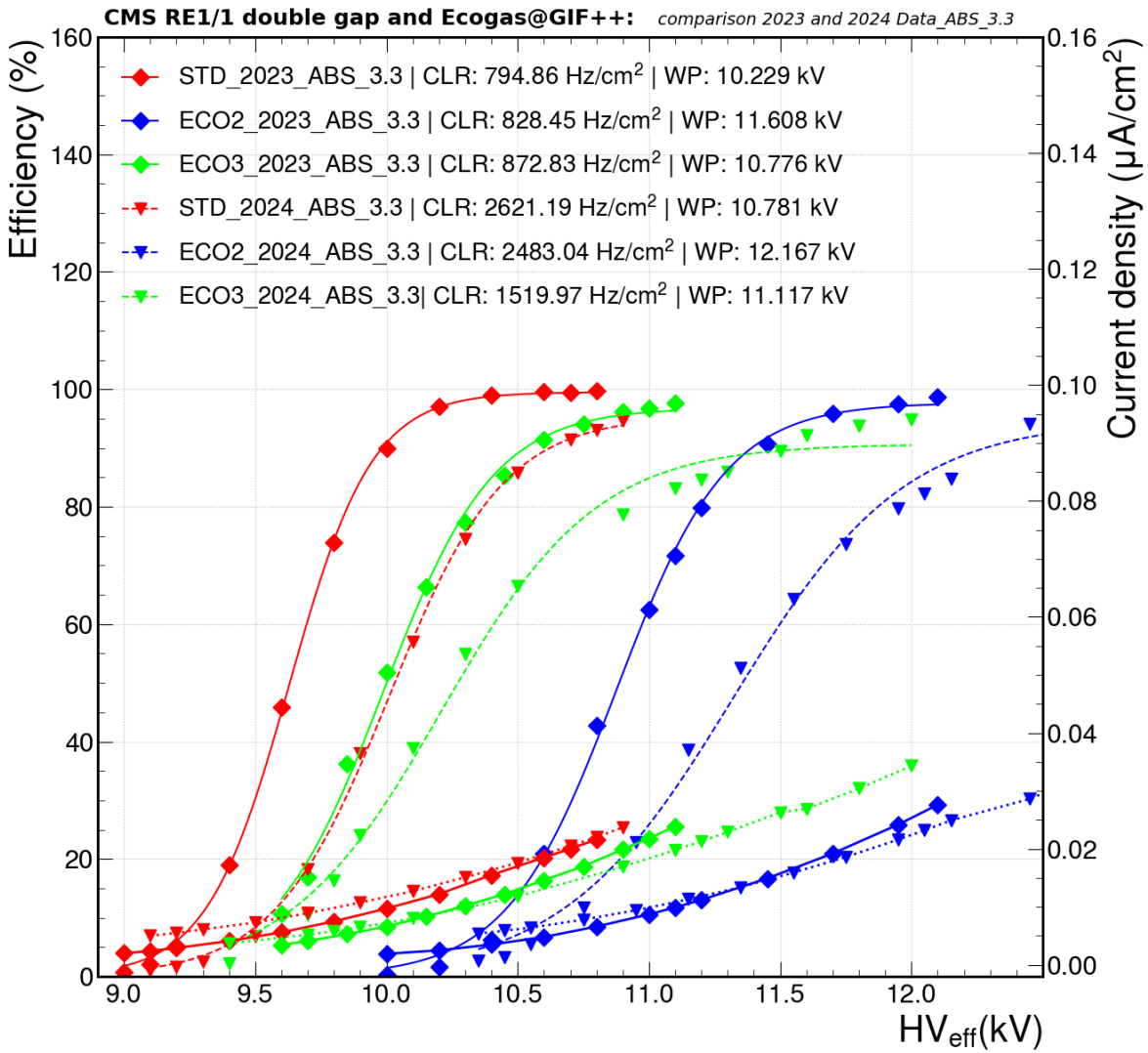


Comparison Efficiency and current density vs HVeff for 2023 and 2024 data_source_off



- Source off: In the 2023 data, the current density at WP for STD, ECO2, and ECO3 gas mixtures are approximately 2 nA/cm^2.
- In 2024, the current density rises to 6.4 to 8 nA/cm^2 for all gas mixtures representing a nearly 4 times increase in current density.

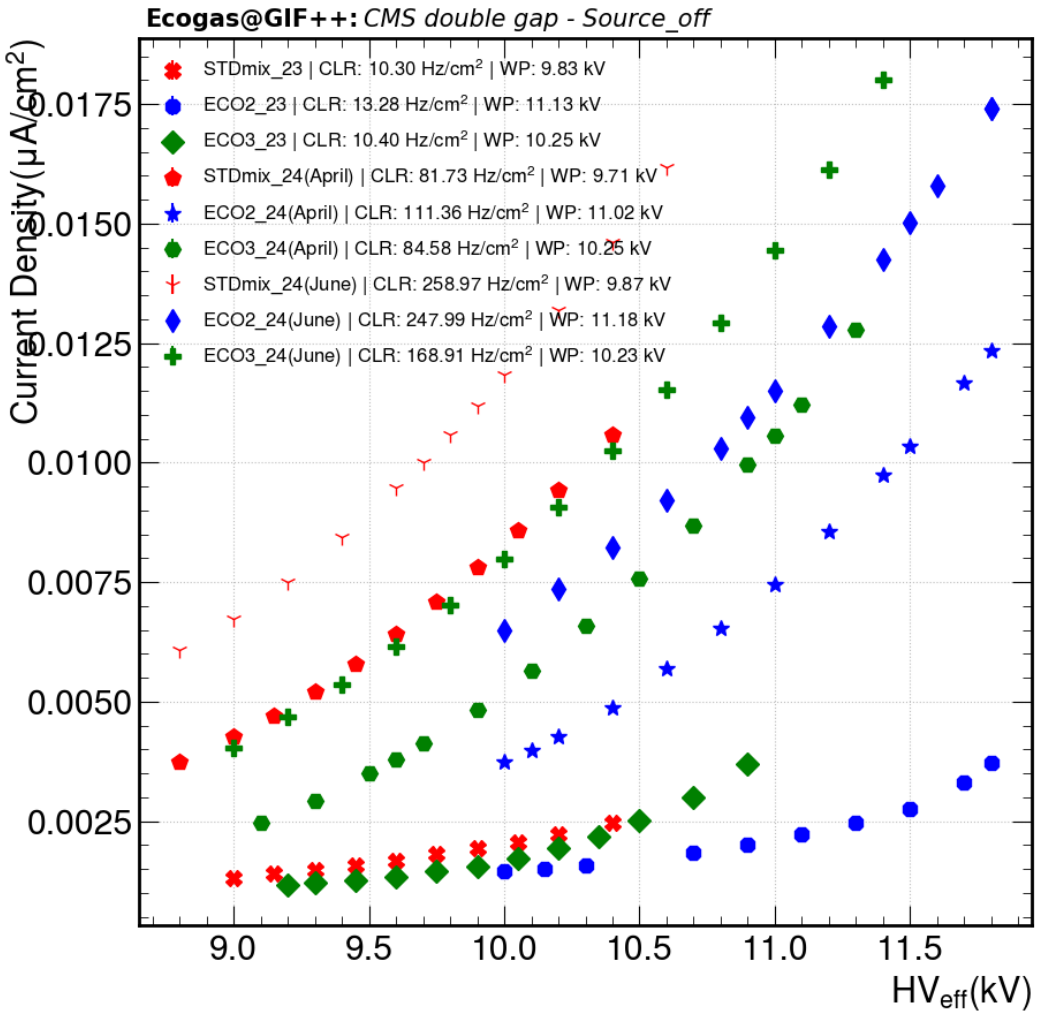
Comparison Efficiency and current density vs HVeff for 2023 and 2024 data_ABS_3.3



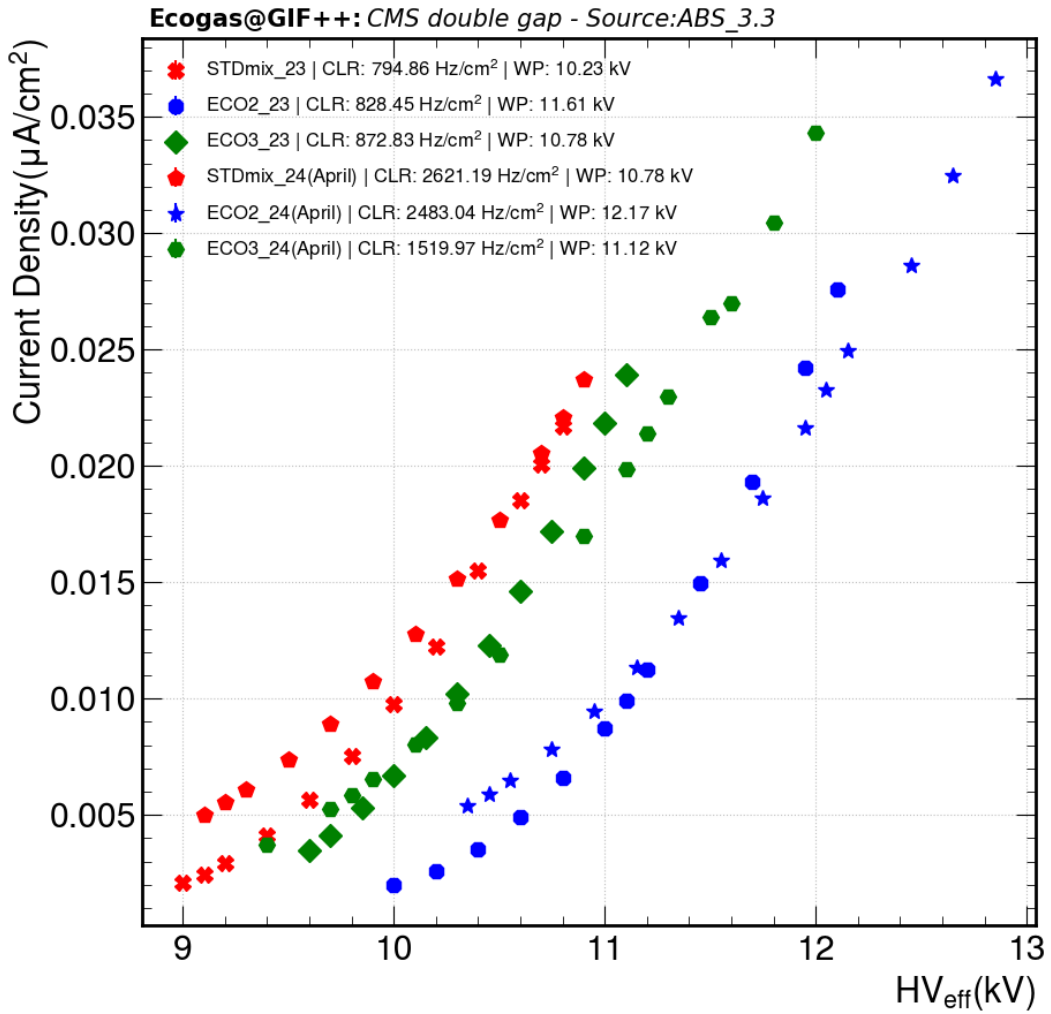
- ABS_3.3: 2023 data shows that the current density at WP for STD, ECO2, and ECO3 gas mixtures are around 12.3, 19, and 17 nA/cm^2.
- In the 2024 data, the current densities are 22, 25 and 20 nA/cm^2, respectively.

Comparison of current density vs HV_eff for 2023 and 2024 data

source_off



ABS_3.3



Question

For 2023, for each ABS and source off file, there was one file in data_all. Consequently, one file in data_wp.

for 2024 data, for some source_off, ABS_100 and 3.3, we have 2 files in data_all. Consequently for WP, we will have 2 files in data_wp.

For instance in 2024 for Eco3, for 813 (complete) file name, working point voltage is 10.25 KV. While for 836 (2 rows of data added), WP is 9.337 KV.

Is it fine to add data to a file which its WP is different?

2023

ABS	STD	ECO2	ECO3
Off	660	669	650
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2024
(April)

ABS	STD	ECO2	ECO3
Off	750	781	813+836
100	764	790	826+844
3.3	762+765	783+807	816+837

Conclusion

- There was a drop in plateau efficiency from 2023 to 2024.
- There is a decrease in the steepness of efficiency curves between 2023 and 2024.
- The shift in working point for 2024 april data(source_off) is higher than the shift in June 24.
- From 2023 to 2024, a negative shift in HV is seen for april 2024 data.
- From 2023 to 2024 when source is off, the current density increased nearly 4 times. However, for ABS_3.3, a slightly rise can be seen.