

Comparison between 2022 and 2023 TB SHiP/LHCb

Giuliana Galati on behalf of the SHiP/LHCb Bari Group

Introduction

Details about SHiP/LHCb chamber:

- Area: 70x100 cm²
- 1.6 mm thick bakelite electrodes
- 1.6 mm single gas gap
- 2D readout, 32 strips per plane
- Strip pitch ~1 cm
- TDC readout

T3 trolley (3m from the source)

Gas Mixtures:

Std: 95.2% R134a-4.5% iC₄H₁₀-0.3%SF₆

eco2: 35% HFO-60% CO₂-4 % iC₄H₁₀-1% SF₆

eco3: 25% HFO- 69% CO₂- 5% iC₄H₁₀- 1% SF₆

NEW → Efficiency:

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

where \mathcal{E}_{max} is the asymptotic value of the logistic function fitted; β describes the steepness of the curve; HV_{50} sets the voltage at which the chamber efficiency reaches 50%.

WP is defined as the HV_{eff} value at which the 2D efficiency reaches 95% of the asymptotic value approached by the logistic function

Integrated charge at TB 7/2023: 110 mC/cm²

ABS used in this analysis:

OFF	Used for 2023 plots and 2023-2022 comparison
100	available
69	
22	
10	
6.9	
4.6	
3.3	
2.2	
1	

Comparison 2022-2023: WP, Eff2D, Current STD

	WP (V)		Delta WP (V) (23-22)	Efficiency 2D al WP (%)		Delta Eff 2D (23-22)	Current al WP (uA)		Delta Current (23-22)
ABS	2022	2023		2022	2023		2022	2023	
OFF	7968.43	8207.50	239.07	92.18	93.61	1.43	0.31	26.07	25.76
22	8017.37	8322.60	305.23	92.28	93.45	1.17	42.47	69.72	27.25
6.9	8180.57	8503.73	323.16	91.66	92.58	0.92	118.59	130.25	11.66
3.3	8313.16	8689.65	376.49	90.71	92.16	1.45	209.87	215.90	6.03
2.2	8364.66	8816.28	451.62	89.45	91.84	2.39	250.72	264.79	14.07
1	8637.85	9139.48	501.63	86.56	88.15	1.59	445.49	449.83	4.34

Comparison 2022-2023: WP, Eff2D, Current ECO2

ABS	WP (V)		Delta WP (V) (23-22)	Efficiency 2D al WP (%)		Delta Eff 2D (23-22)	Current al WP (uA)		Delta Current (23-22)
	2022	2023		2022	2023		2022	2023	
OFF	9029.76	9352.67	322.91	91.93	91.71	-0.22	1.47	46.30	44.83
22	9199.31	9573.97	374.66	91.02	90.40	-0.62	101.08	128.88	27.8
6.9	9443.14	9859.34	416.20	88.24	87.80	-0.44	221.25	236.41	15.16
3.3	9659.12	10259.85	600.73	85.27	87.83	2.56	375.25	433.76	58.51
2.2	9586.01	10252.56	666.55	82.26	85.52	3.26	424.22	466.38	42.16
1	9975.93	10517.47	541.54	74.86	76.38	1.52	690.33	663.41	-26.92

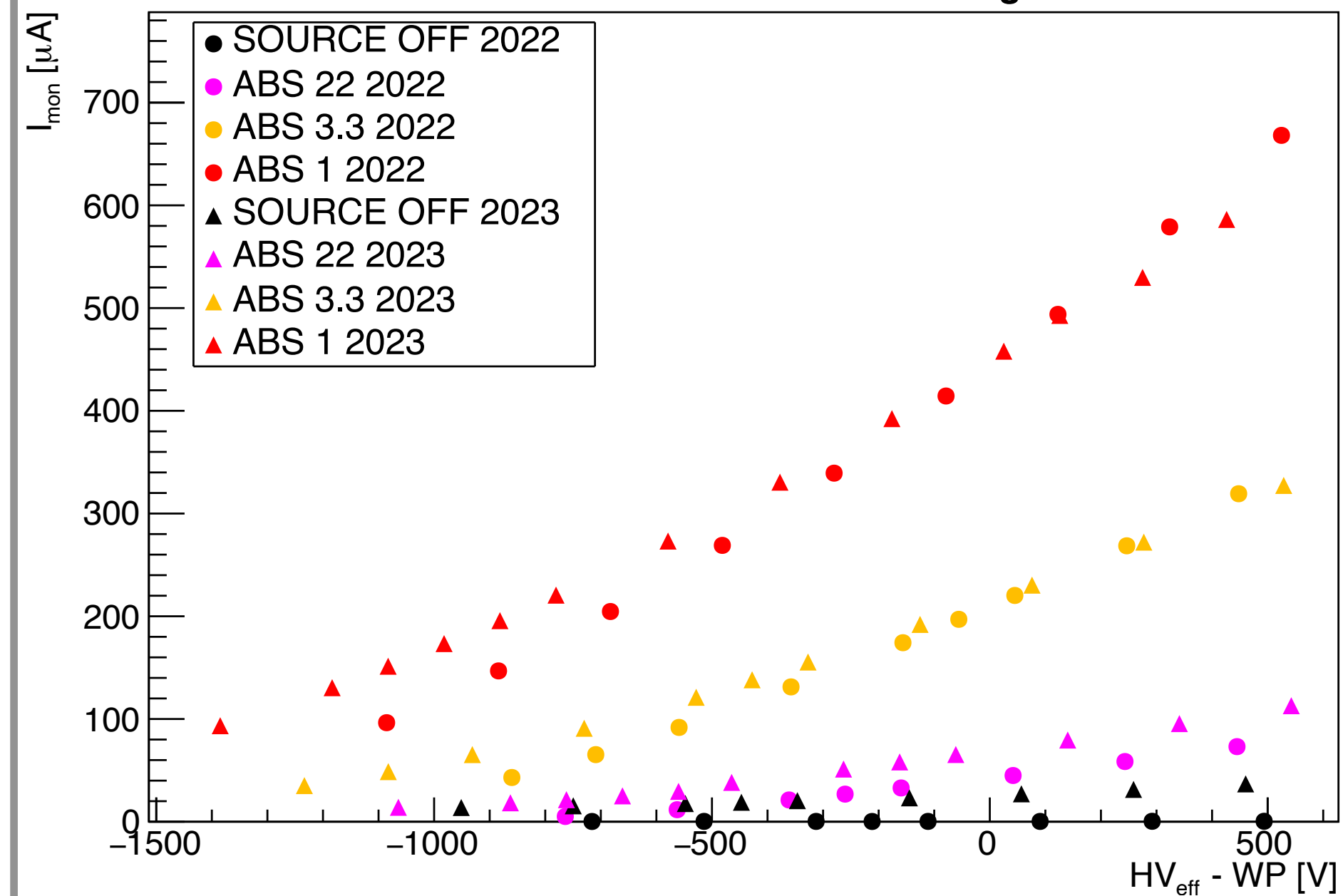
Comparison 2022-2023: WP, Eff2D, Current ECO3

ABS	WP (V)		Delta WP (V) (23-22)	Efficiency 2D al WP (%)		Delta Eff 2D (23-22)	Current al WP (uA)		Delta Current (23-22)
	2022	2023		2022	2023		2022	2023	
OFF	8368.24	8819.21	450.97	91.29	92.18	0.89	12.98	50.82	37.84
22	8432.12	8981.98	549.86	88.54	88.87	0.33	82.79	140.83	58.04
6.9	8628.02	9298.09	670.07	85.39	86.70	1.31	191.09	278.02	86.93
3.3	8805.28	9557.66	752.38	84.11	83.36	-0.75	322.42	428.00	105.58
2.2	8884.31	9444.67	560.36	83.01	78.06	-4.95	391.71	420.16	28.45
1	9155.44	10001.26	845.82	77.64	72.15	-5.49	630.64	750.47	119.83

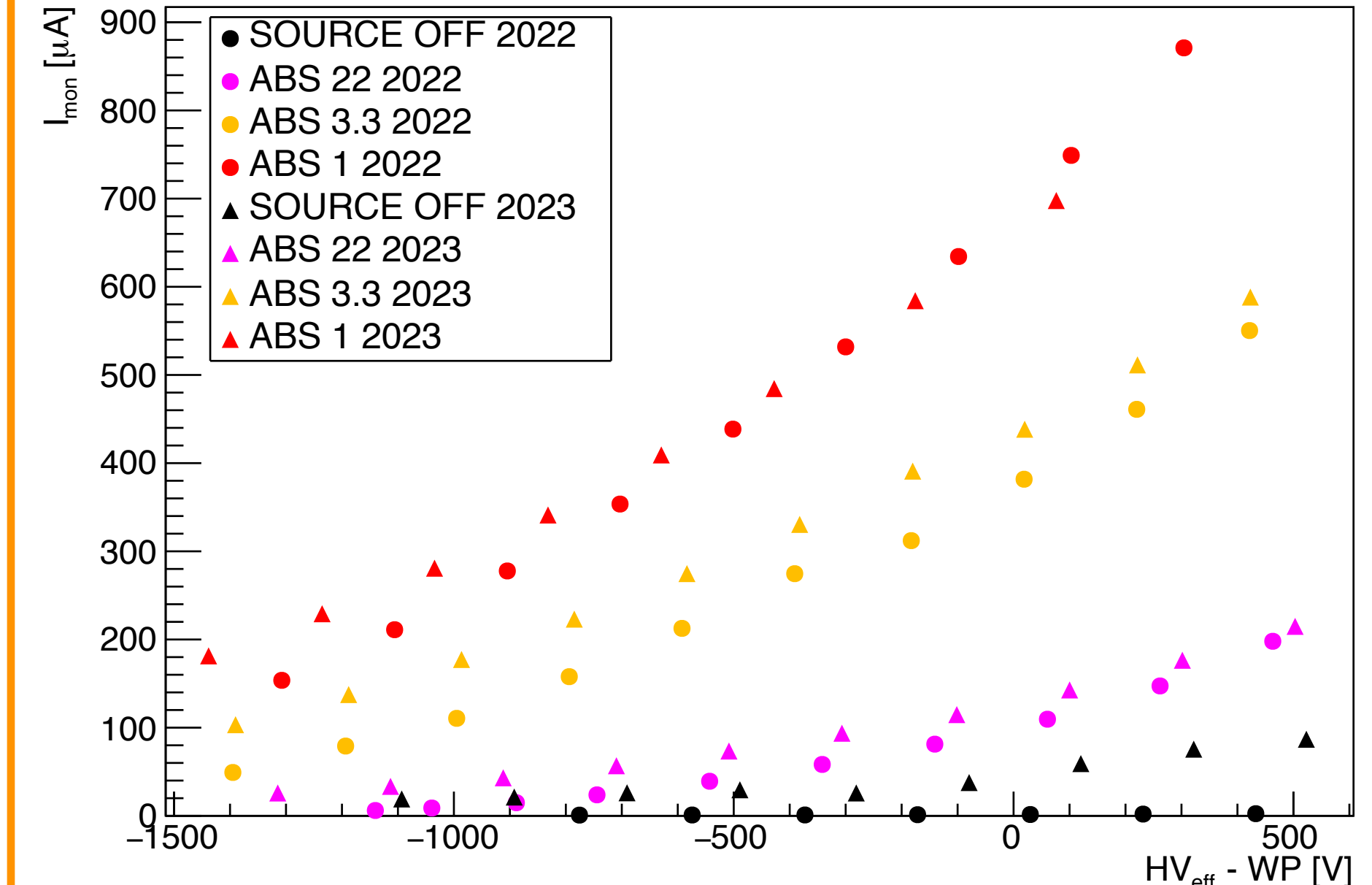
*NB: Values for ABS 1 at WP are extrapolated for the fit

Current - Comparison 2022-2023

ECOGas@GIF++ std mix



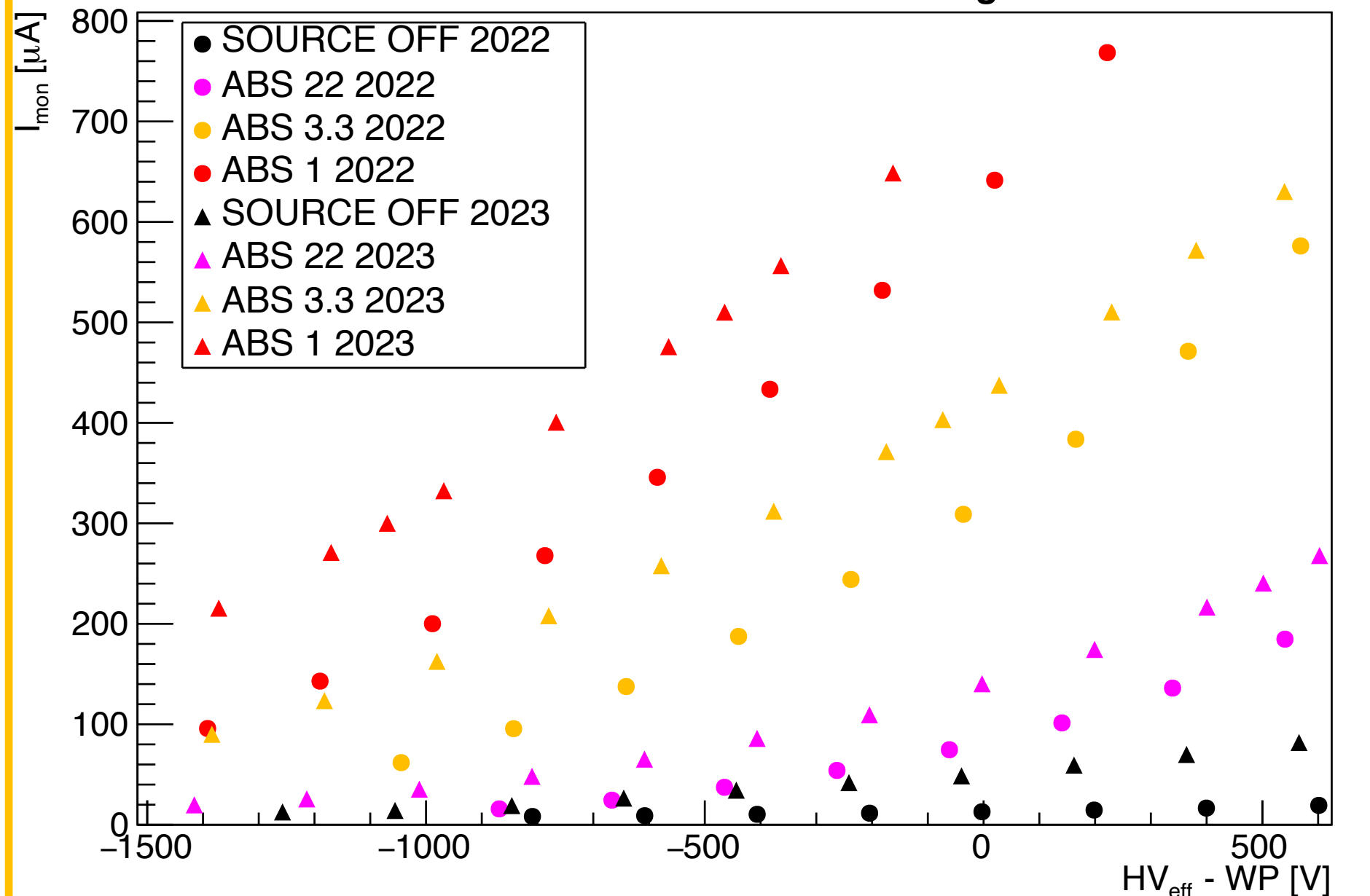
ECOGas@GIF++ eco2 mix



ABS	WP (V) 2022	Current at WP	WP (V) 2023	Current at WP
OFF	9030	1.47	9353	46.30
22	9199	101.08	9574	128.88
6.9	9443	221.25	9859	236.41
3.3	9659	375.25	10260	433.76
2.2	9586	424.22	10253	466.38
1	9976	690.33	10517	663.41

ABS	WP (V) 2022	Current at WP	WP (V) 2023	Current at WP
OFF	7968	0.31	8208	26.07
22	8017	42.47	8323	69.72
6.9	8181	118.59	8504	130.25
3.3	8313	209.87	8690	215.90
2.2	8365	250.72	8816	264.79
1	8638	445.49	9139	449.83

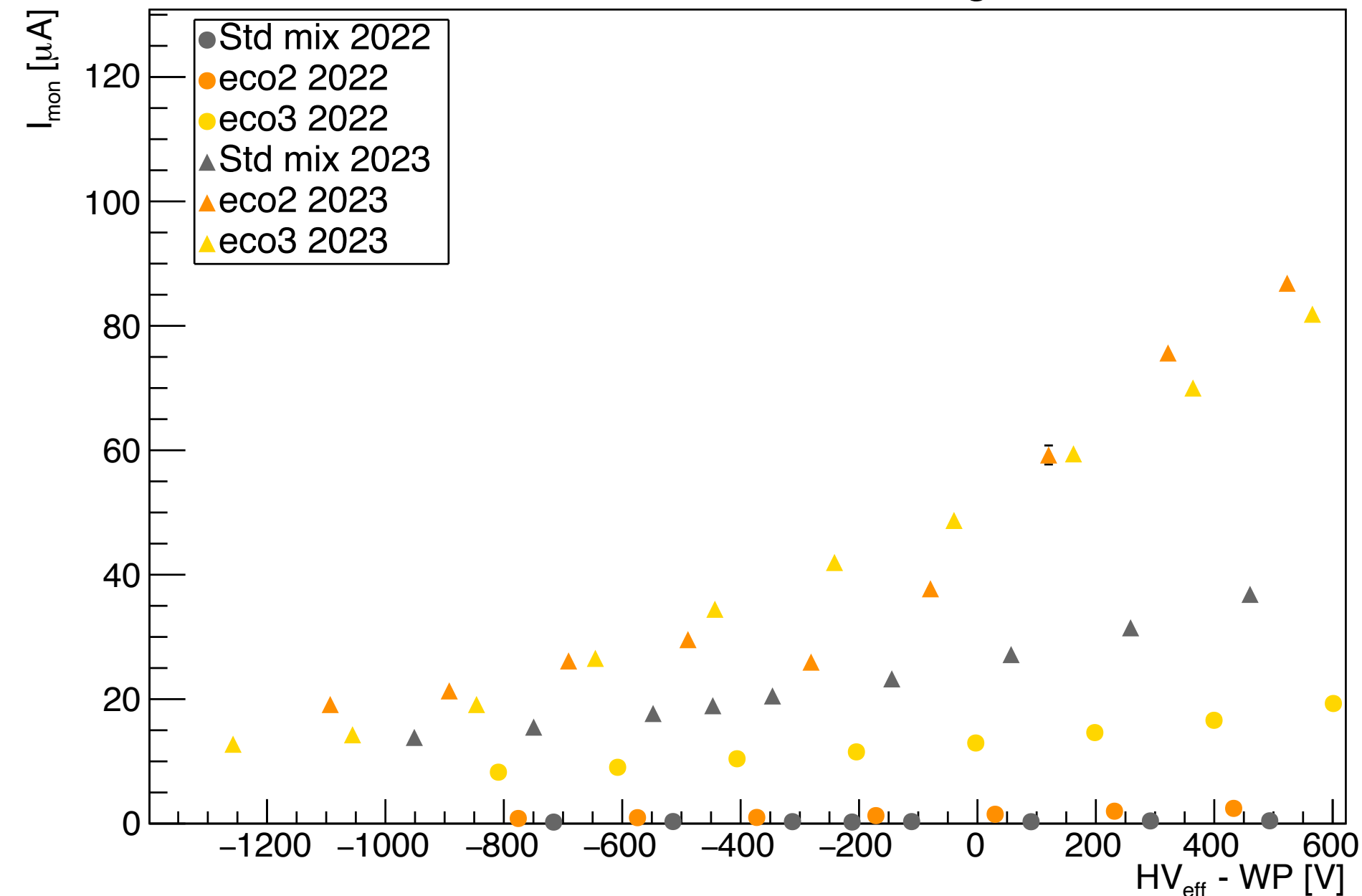
ECOGas@GIF++ eco3 mix



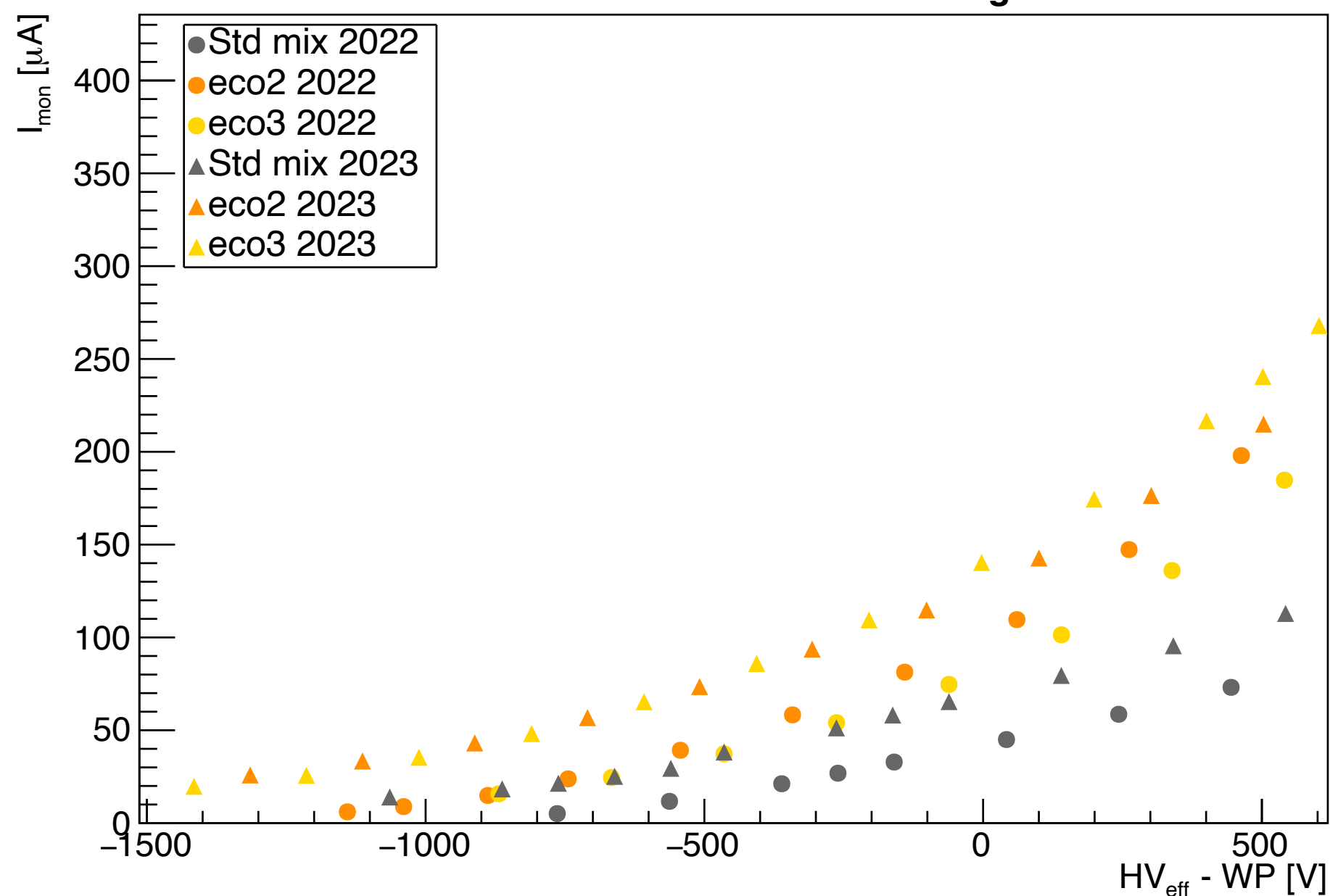
ABS	WP (V) 2022	Current at WP	WP (V) 2023	Current at WP
OFF	8368	12.98	8819	50.82
22	8432	82.79	8982	140.83
6.9	8628	191.09	9298	278.02
3.3	8805	322.42	9558	428.00
2.2	8884	391.71	9445	420.16
1	9155	630.64	10001	750.47

Current - Comparison 2022-2023

ECOgas@GIF++ Source OFF



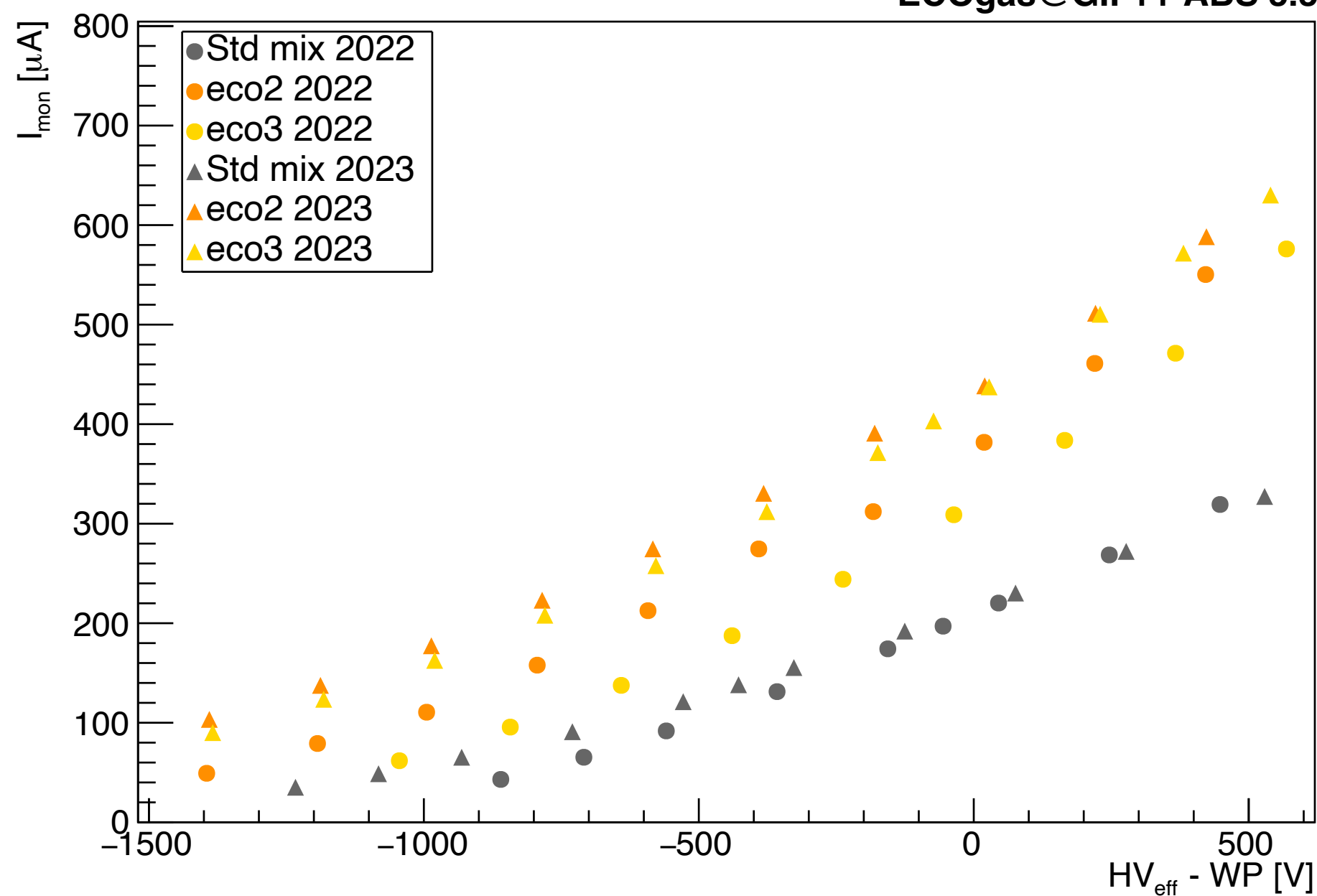
ECOgas@GIF++ ABS 22



ABS	WP (V) 2022	Current at WP	WP (V) 2023	Current at WP
OFF	9030	1.47	9353	46.30
22	9199	101.08	9574	128.88
6.9	9443	221.25	9859	236.41
3.3	9659	375.25	10260	433.76
2.2	9586	424.22	10253	466.38
1	9976	690.33	10517	663.41

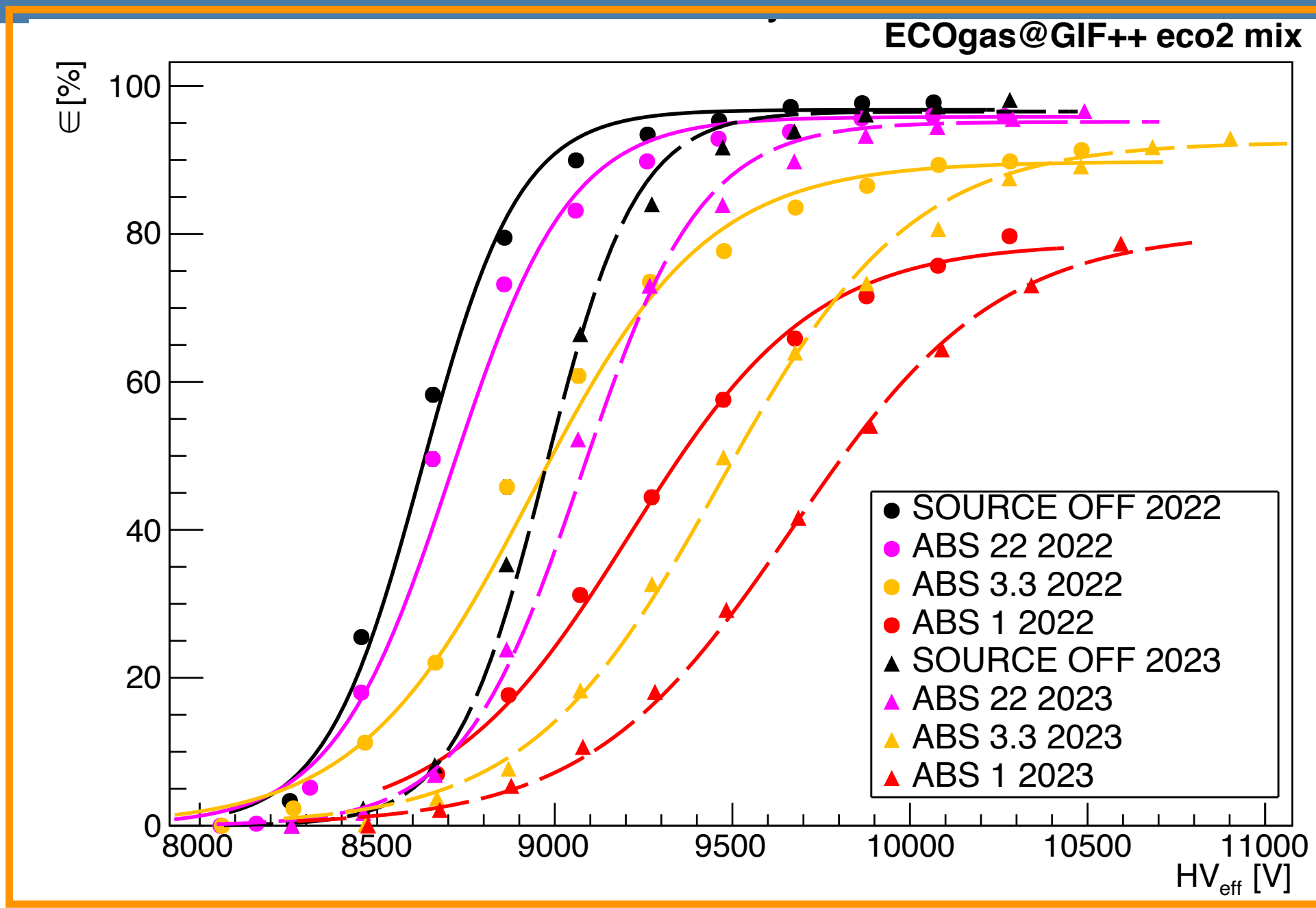
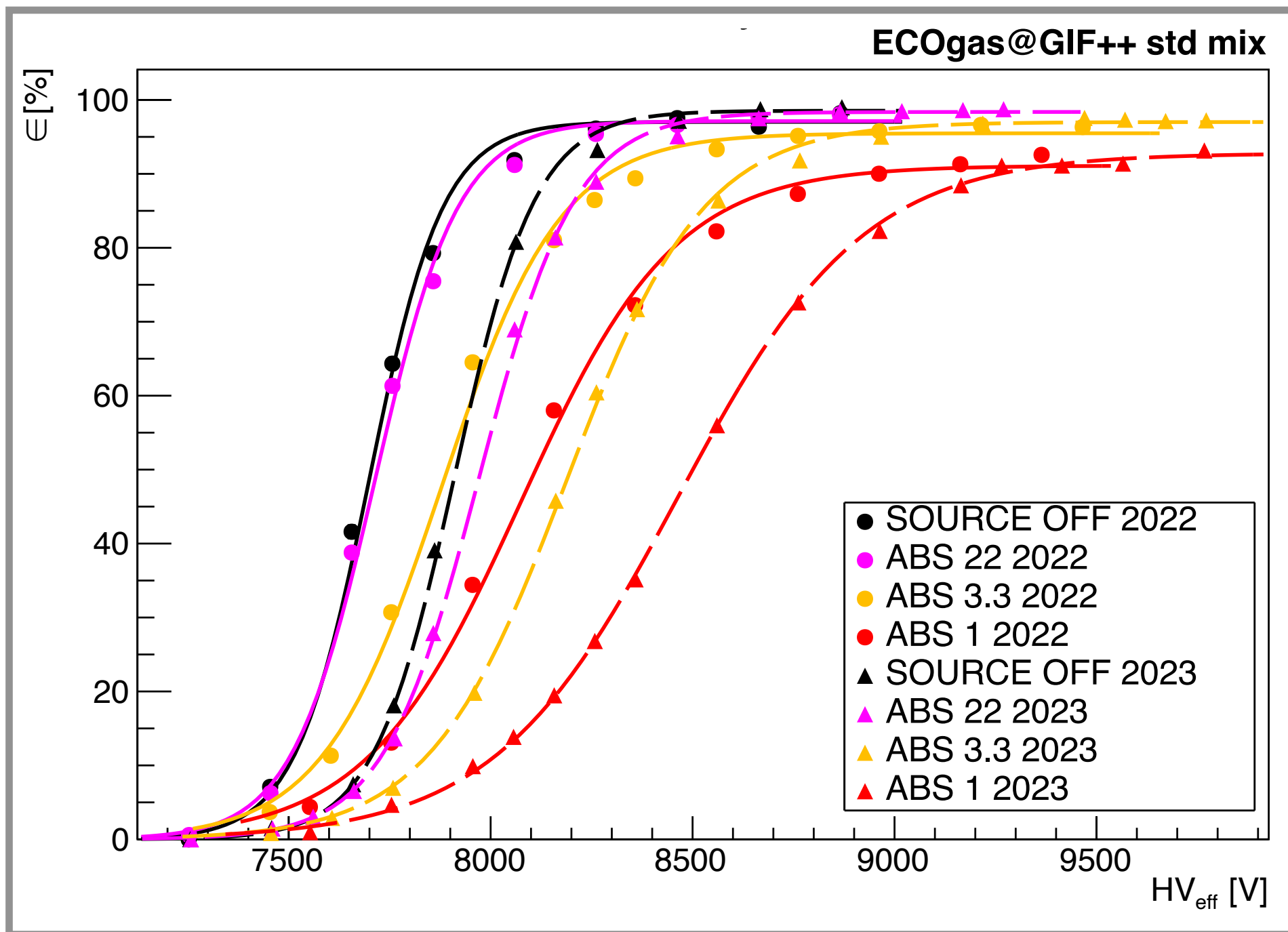
ABS	WP (V) 2022	Current at WP	WP (V) 2023	Current at WP
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22	8017	42.47	8323	69.72
6.9	8181	118.59	8504	130.25
3.3	8313	209.87	8690	215.90
2.2	8365	250.72	8816	264.79
1	8638	445.49	9139	449.83

ECOgas@GIF++ ABS 3.3



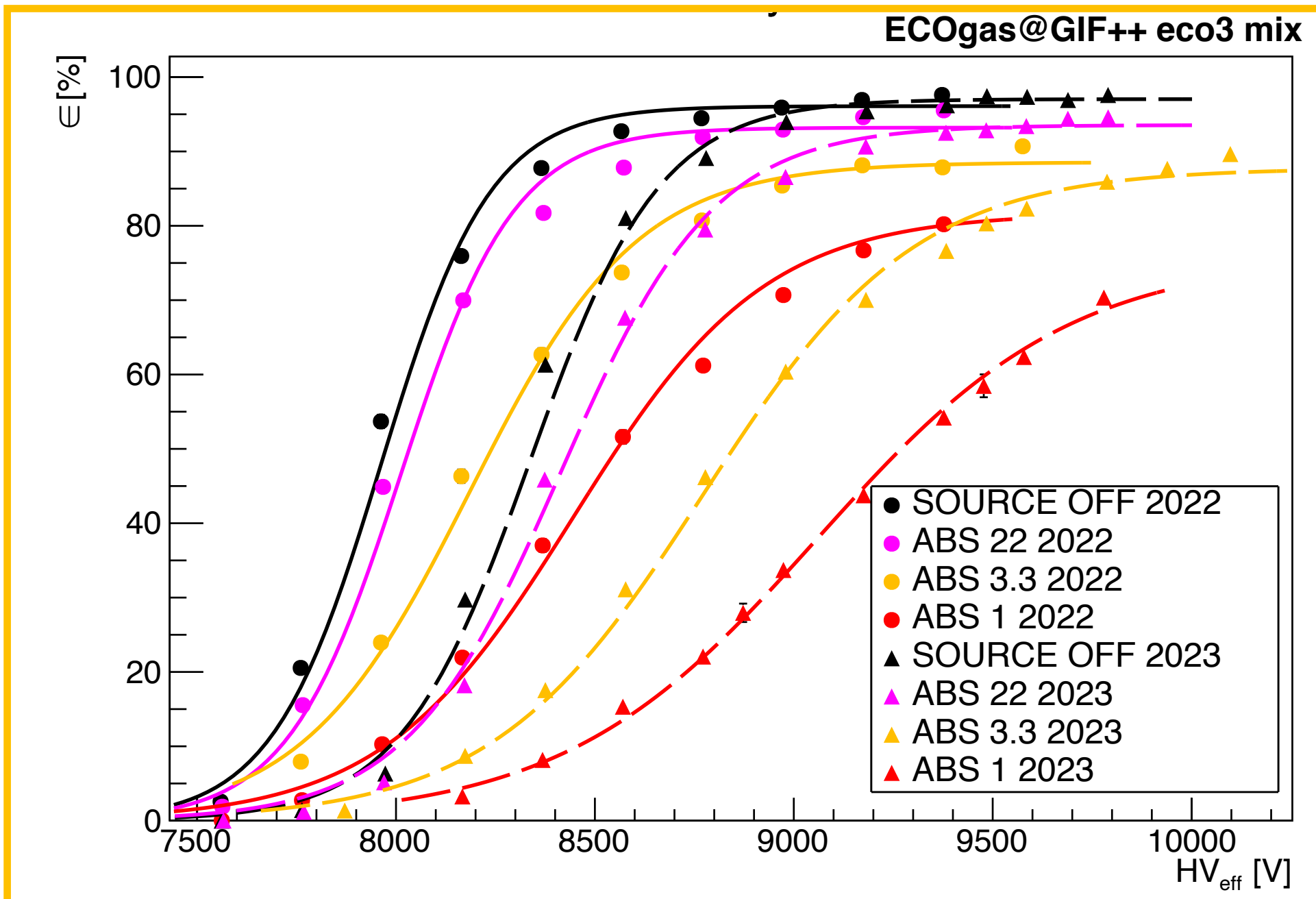
ABS	WP (V) 2022	Current at WP	WP (V) 2023	Current at WP
OFF	8368	12.98	8819	50.82
22	8432	82.79	8982	140.83
6.9	8628	191.09	9298	278.02
3.3	8805	322.42	9558	428.00
2.2	8884	391.71	9445	420.16
1	9155	630.64	10001	750.47

2D efficiency - Comparison 2022-2023 (Detailed table in slides 6-8)



ABS	WP (V) 2022	Eff 2D %	WP (V) 2023	Eff 2D %
OFF	9030	91.93	9353	91.71
22	9199	91.02	9574	90.40
6.9	9443	88.24	9859	87.80
3.3	9659	85.27	10260	87.83
2.2	9586	82.26	10253	85.52
1	9976	74.86	10517	76.38

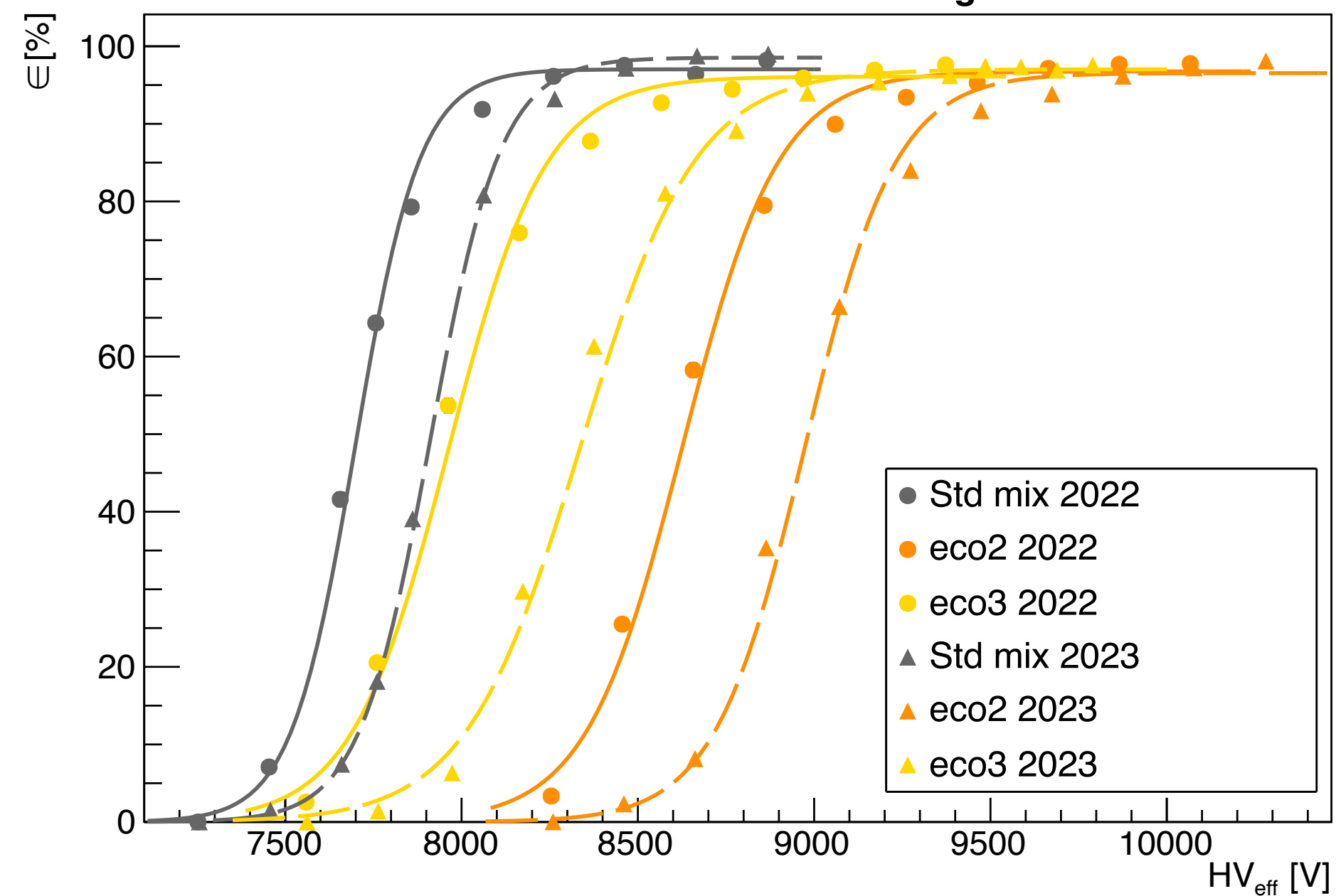
ABS	WP (V) 2022	Eff 2D %	WP (V) 2023	Eff 2D %
OFF	7968	92.18	8208	93.61
22	8017	92.28	8323	93.45
6.9	8181	91.66	8504	92.58
3.3	8313	90.71	8690	92.16
2.2	8365	89.45	8816	91.84
1	8638	86.56	9139	88.15



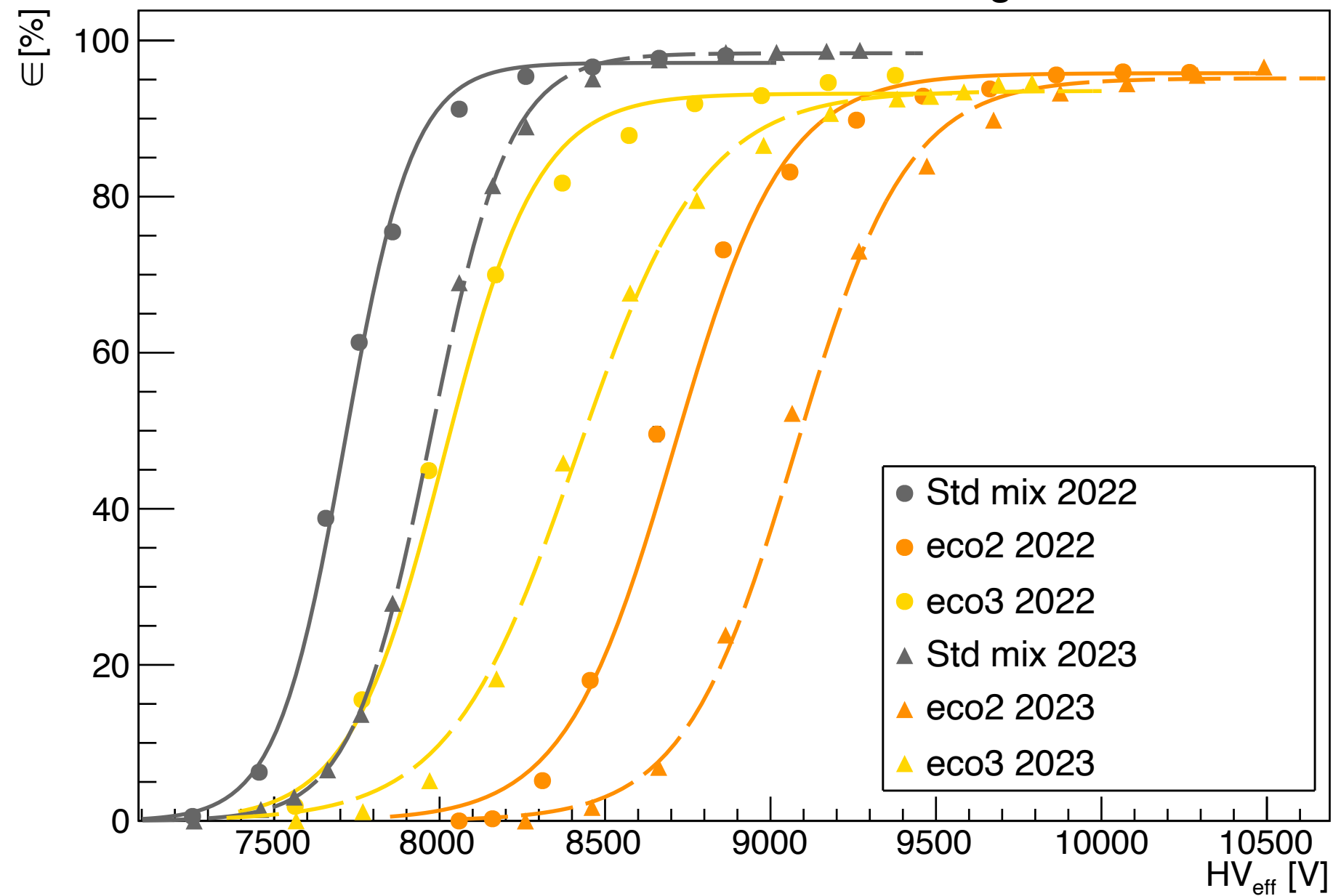
ABS	WP (V) 2022	Eff 2D %	WP (V) 2023	Eff 2D %
OFF	8368	91.29	8819	92.18
22	8432	88.54	8982	88.87
6.9	8628	85.39	9298	86.70
3.3	8805	84.11	9558	83.36
2.2	8884	83.01	9445	78.06
1	9155	77.64	10001	72.15

2D efficiency - Comparison 2022-2023 (Detailed table in slides 6-8)

ECOgas@GIF++ Source OFF



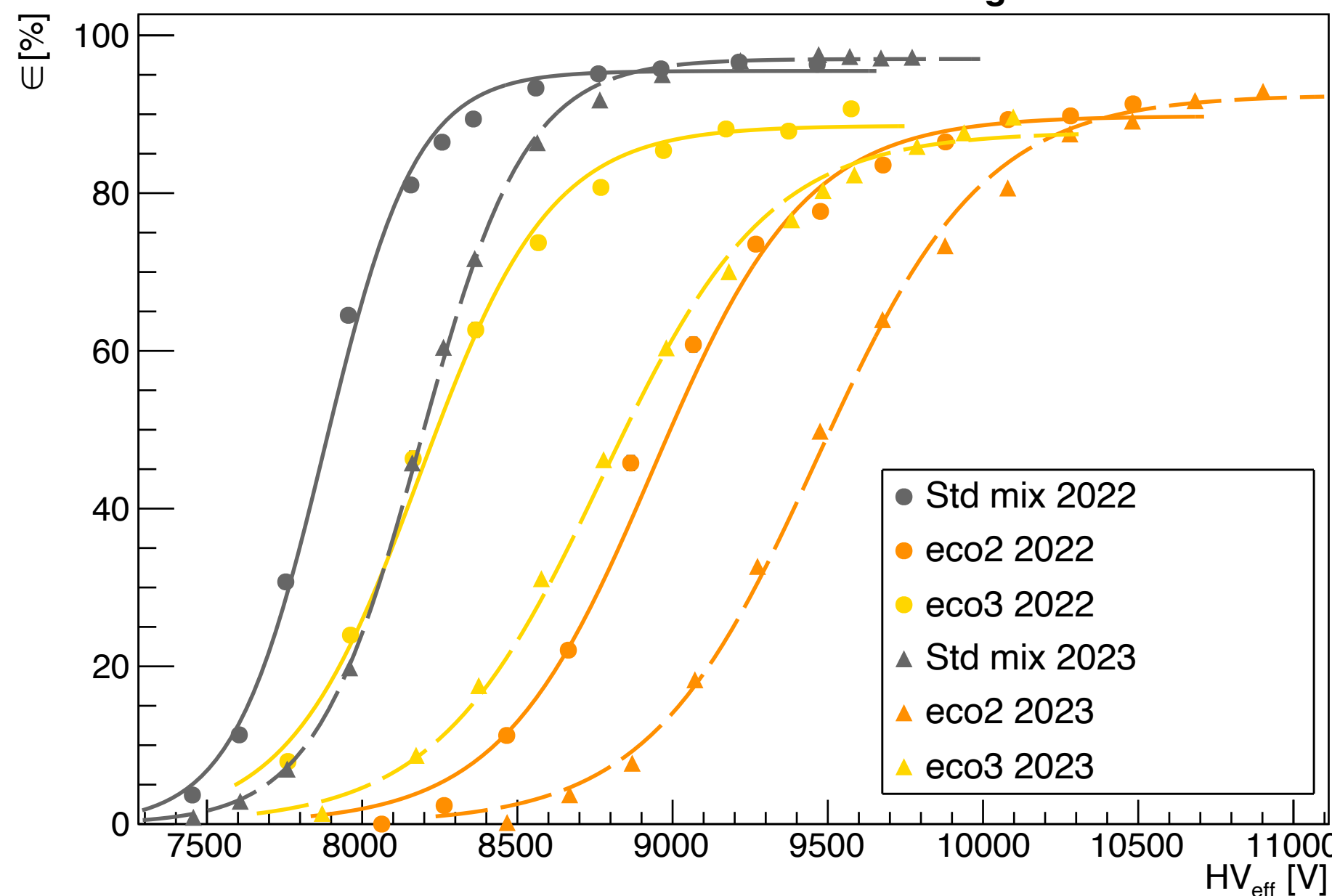
ECOgas@GIF++ ABS 22



ABS	WP (V) 2022	Eff 2D %	WP (V) 2023	Eff 2D %
OFF	9030	91.93	9353	91.71
22	9199	91.02	9574	90.40
6.9	9443	88.24	9859	87.80
3.3	9659	85.27	10260	87.83
2.2	9586	82.26	10253	85.52
1	9976	74.86	10517	76.38

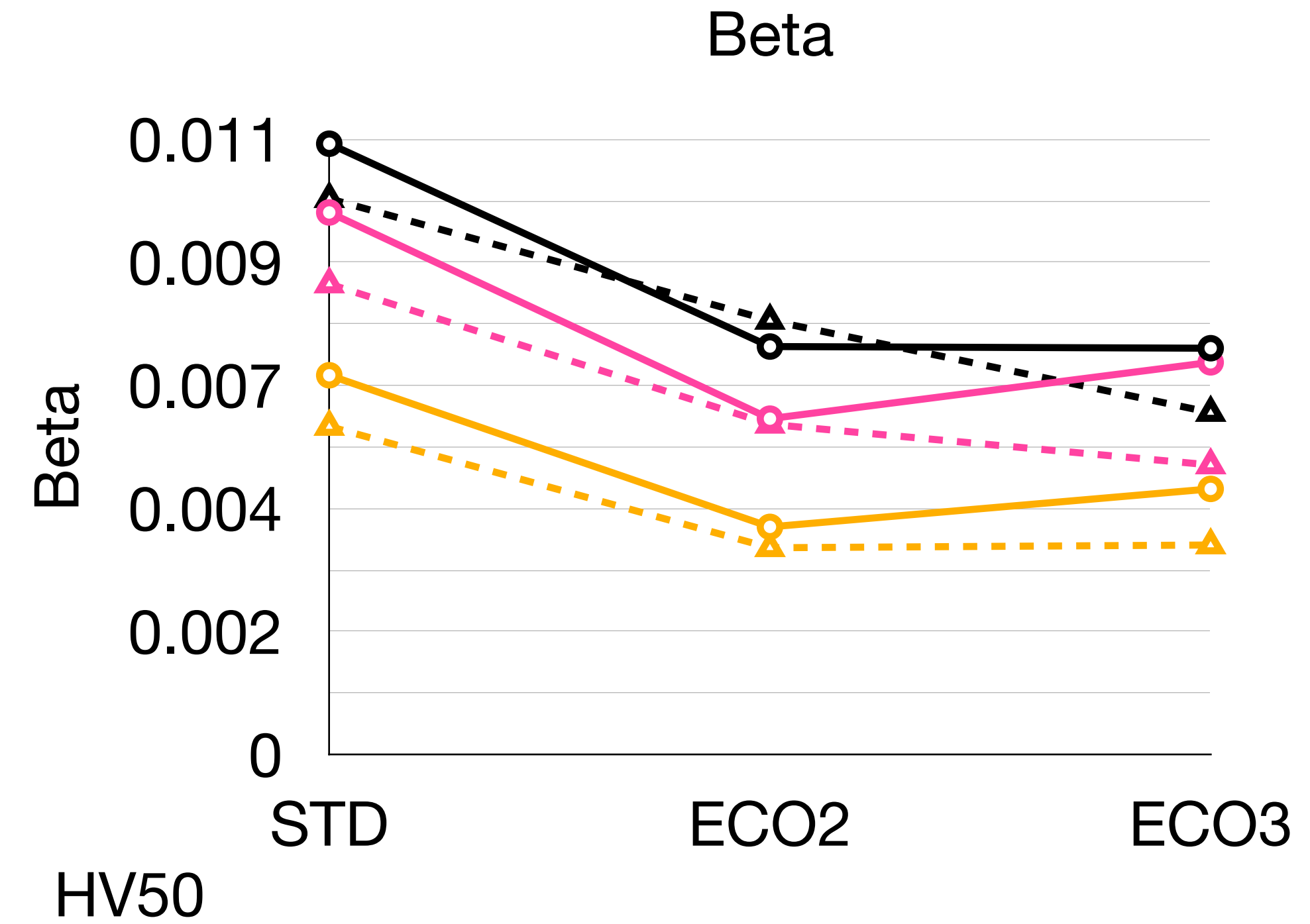
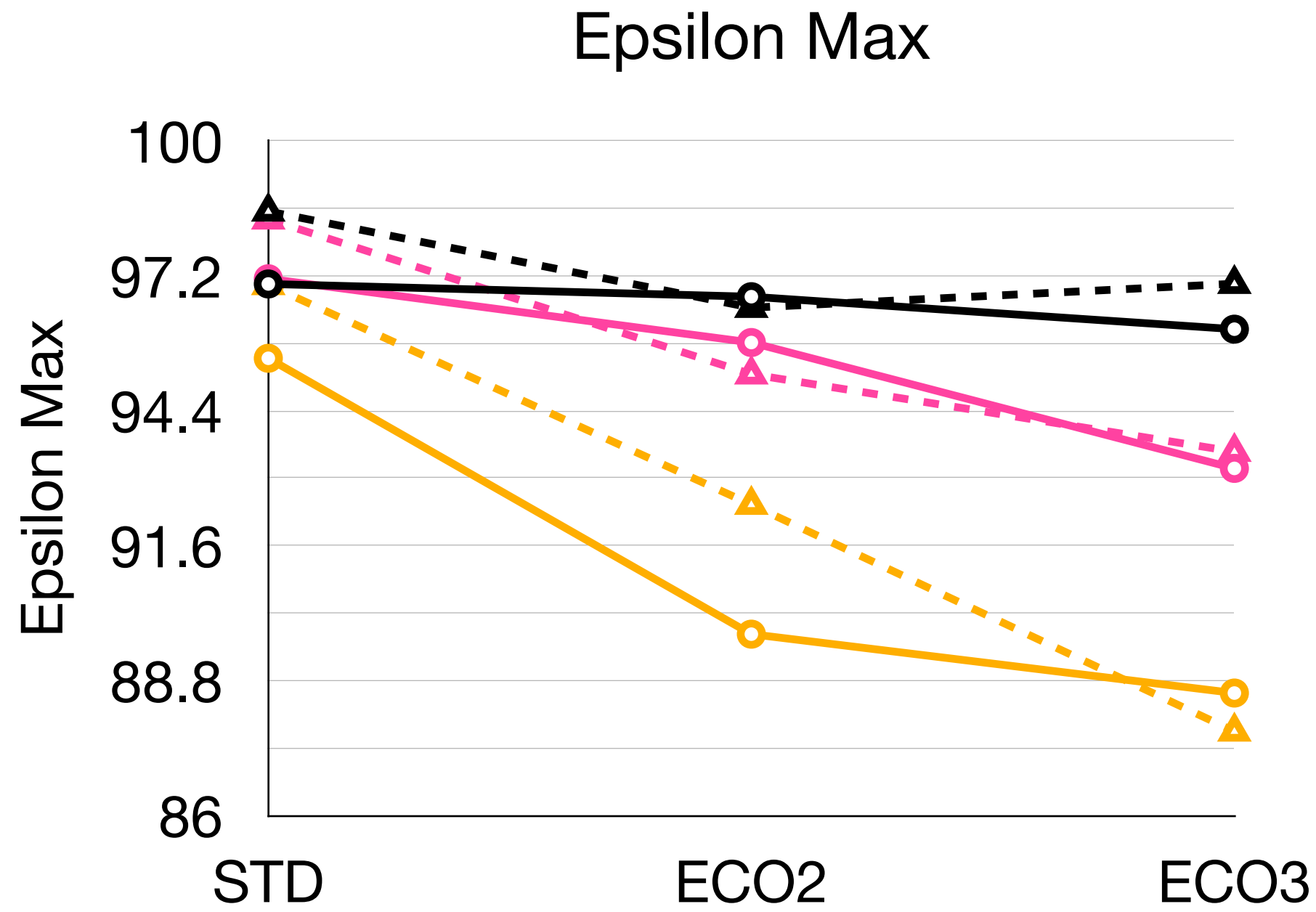
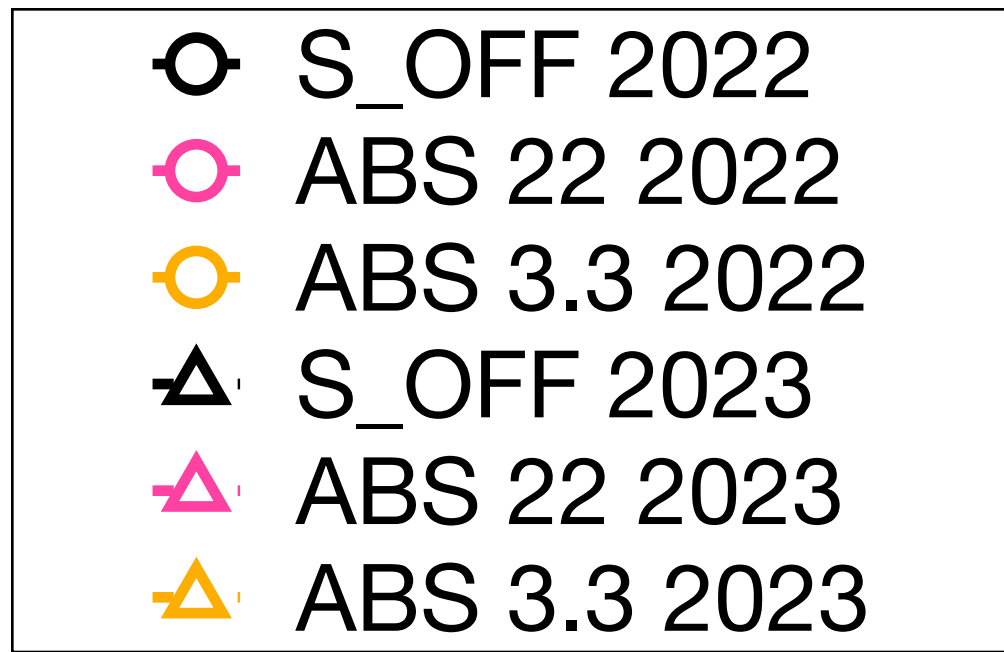
ABS	WP (V) 2022	Eff 2D %	WP (V) 2023	Eff 2D %
OFF	7968	92.18	8208	93.61
22	8017	92.28	8323	93.45
6.9	8181	91.66	8504	92.58
3.3	8313	90.71	8690	92.16
2.2	8365	89.45	8816	91.84
1	8638	86.56	9139	88.15

ECOgas@GIF++ ABS 3.3

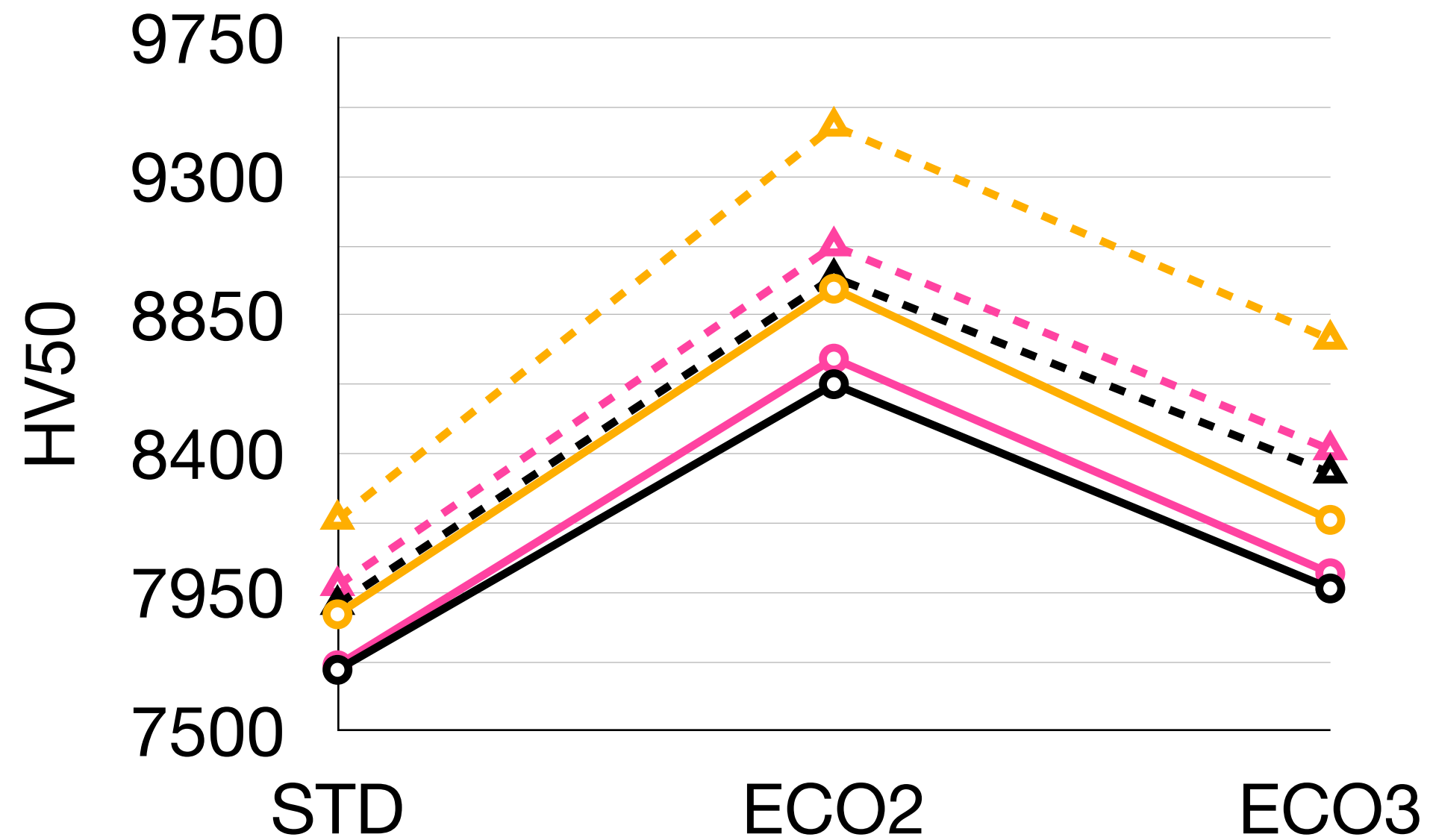


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OFF	8368	91.29	8819	92.18
22	8432	88.54	8982	88.87
6.9	8628	85.39	9298	86.70
3.3	8805	84.11	9558	83.36
2.2	8884	83.01	9445	78.06
1	9155	77.64	10001	72.15

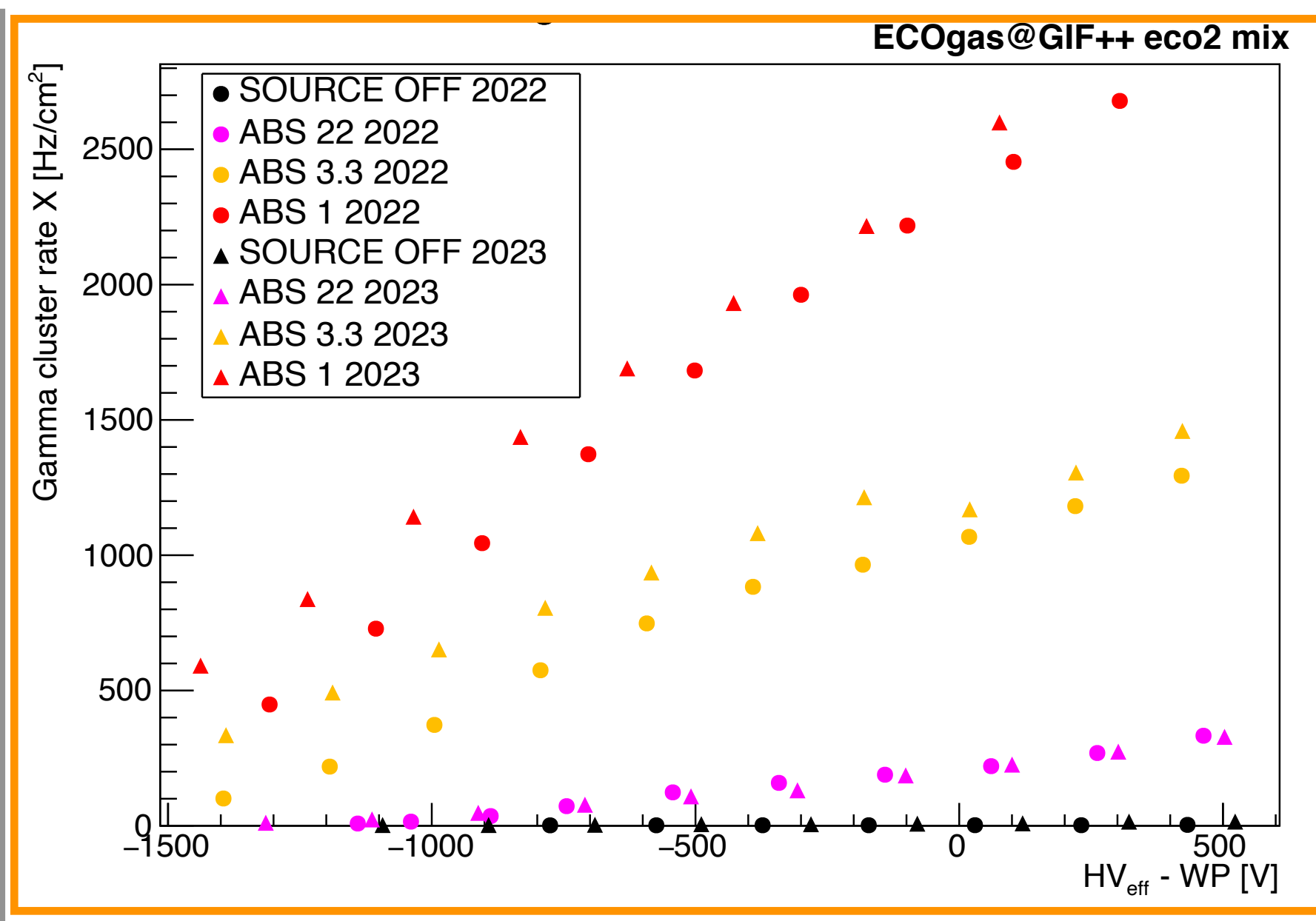
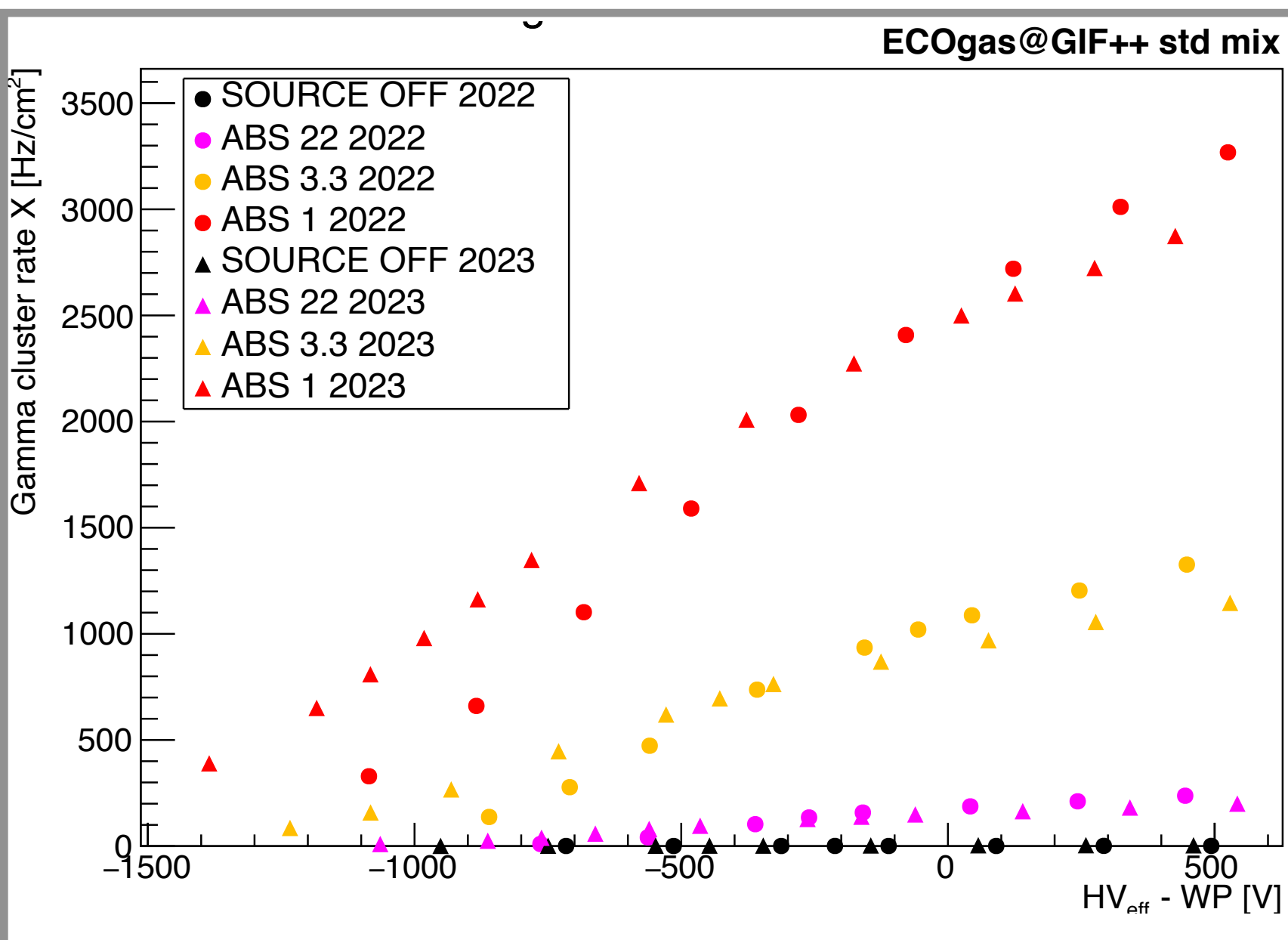
Comparison Eff 2D fit parameters



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

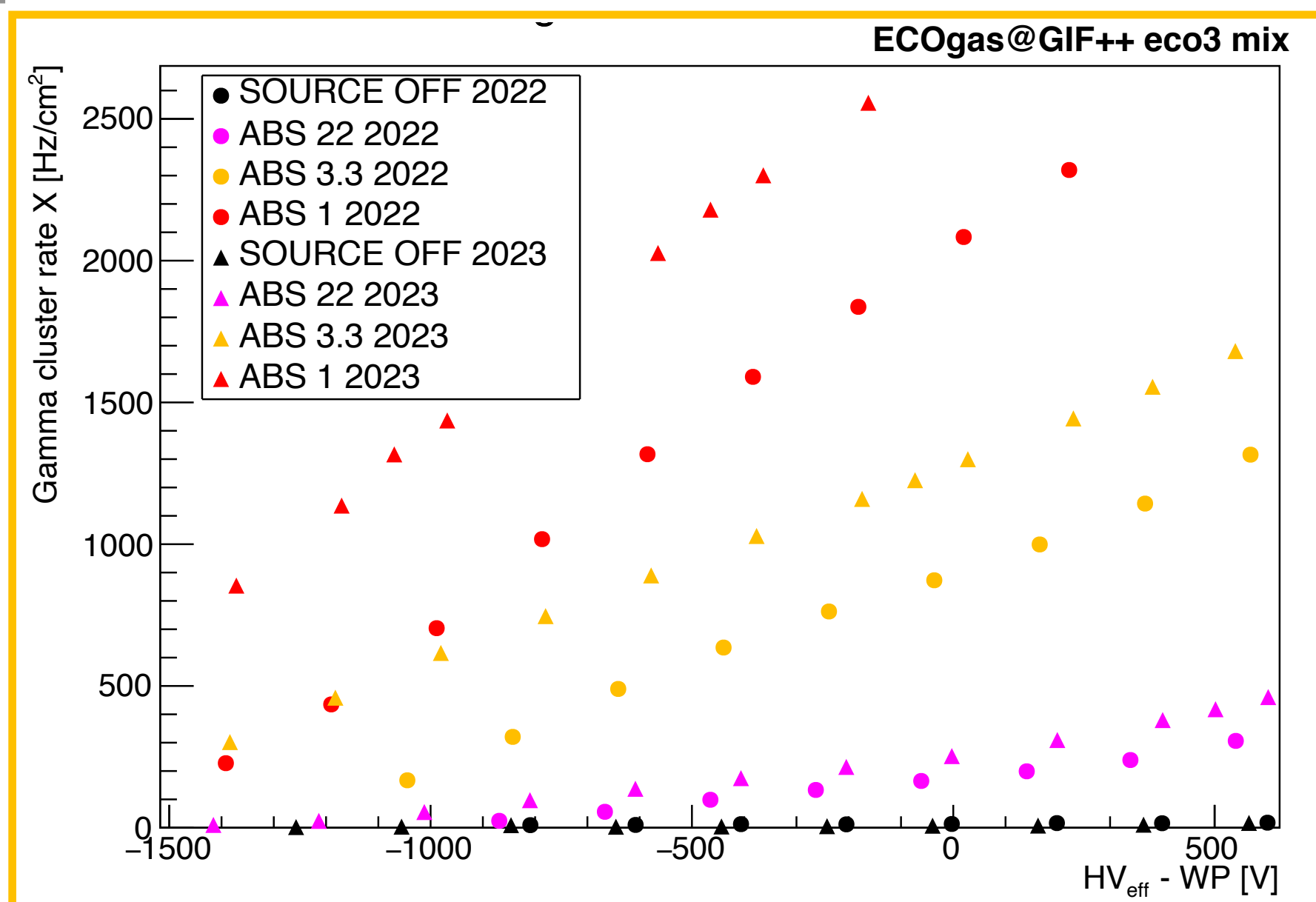


Gamma cluster rate X (2023)



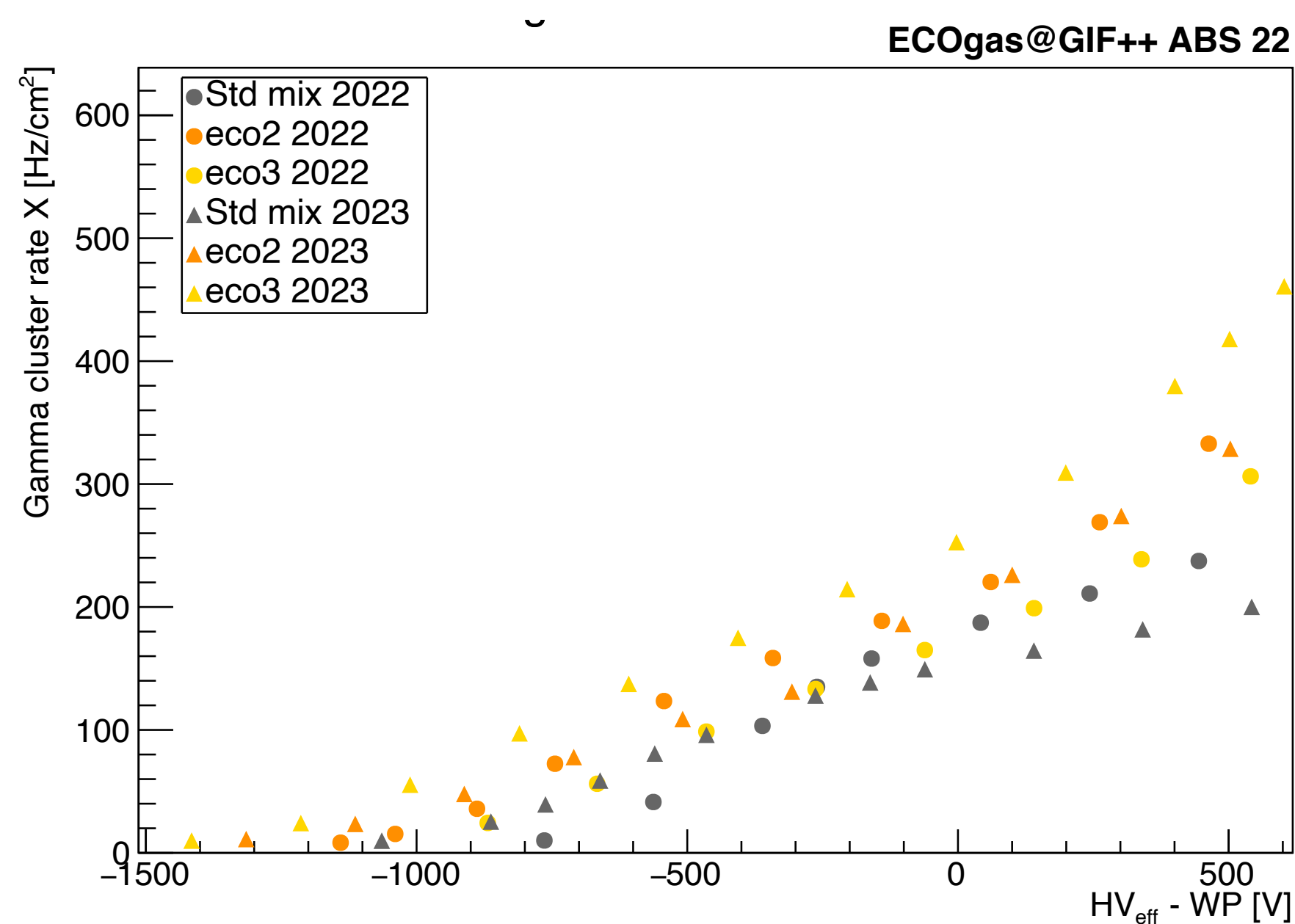
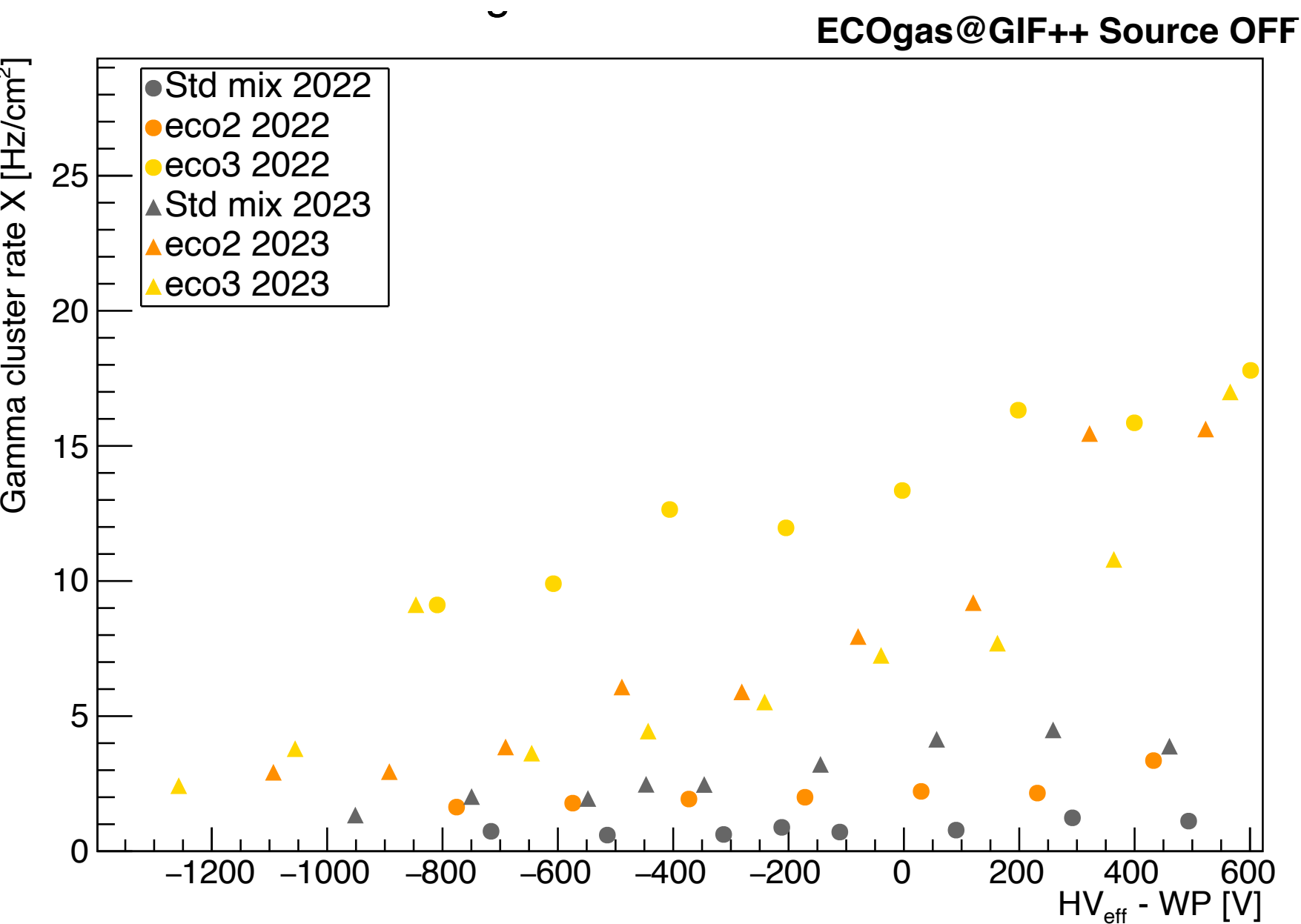
ABS	2022	2023	Delta
OFF	2.18	8.45	6.27
22	210.83	206.35	-4.48
6.9	549.38	624.05	74.67
3.3	1058.29	1174.12	115.83
2.2	1296.46	1369.69	73.23
1	2333.31	2483.63	150.32

ABS	2022	2023	Delta
OFF	0.75	3.88	3.13
22	181.15	153.98	-27.17
6.9	541.11	539.00	-2.11
3.3	1057.40	931.76	-125.64
2.2	1325.82	1227.01	-98.81
1	2529.85	2471.64	-58.21



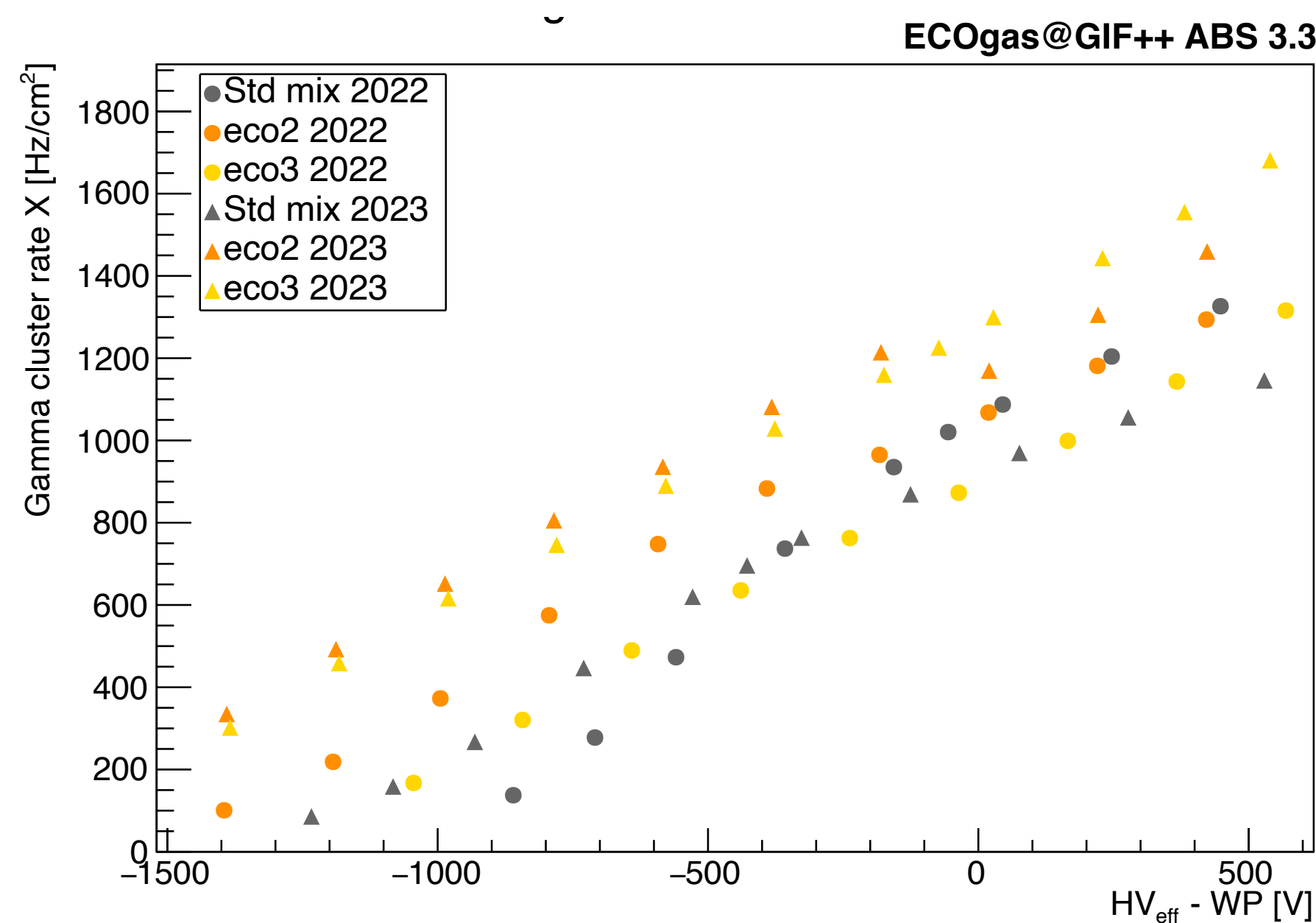
ABS	2022	2023	Delta
OFF	13.39	7.34	-6.05
22	175.30	253.49	78.19
6.9	474.81	681.09	206.28
3.3	895.51	1279.31	383.8
2.2	1129.17	1588.08	458.91
1	2059.00	2763.56	704.56

Gamma cluster rate X (2023)



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OFF	2.18	8.45	6.27
22	210.83	206.35	-4.48
6.9	549.38	624.05	74.67
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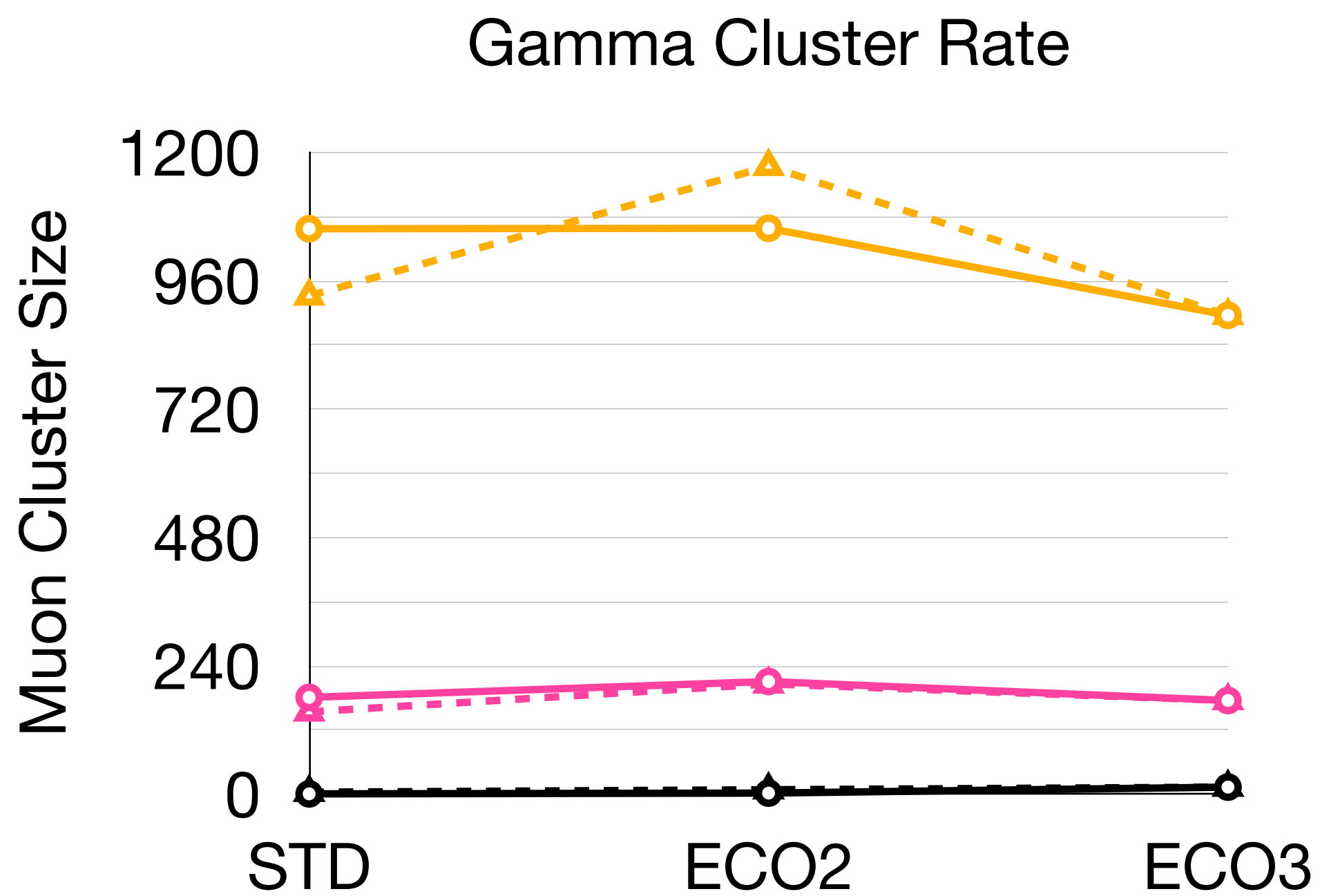
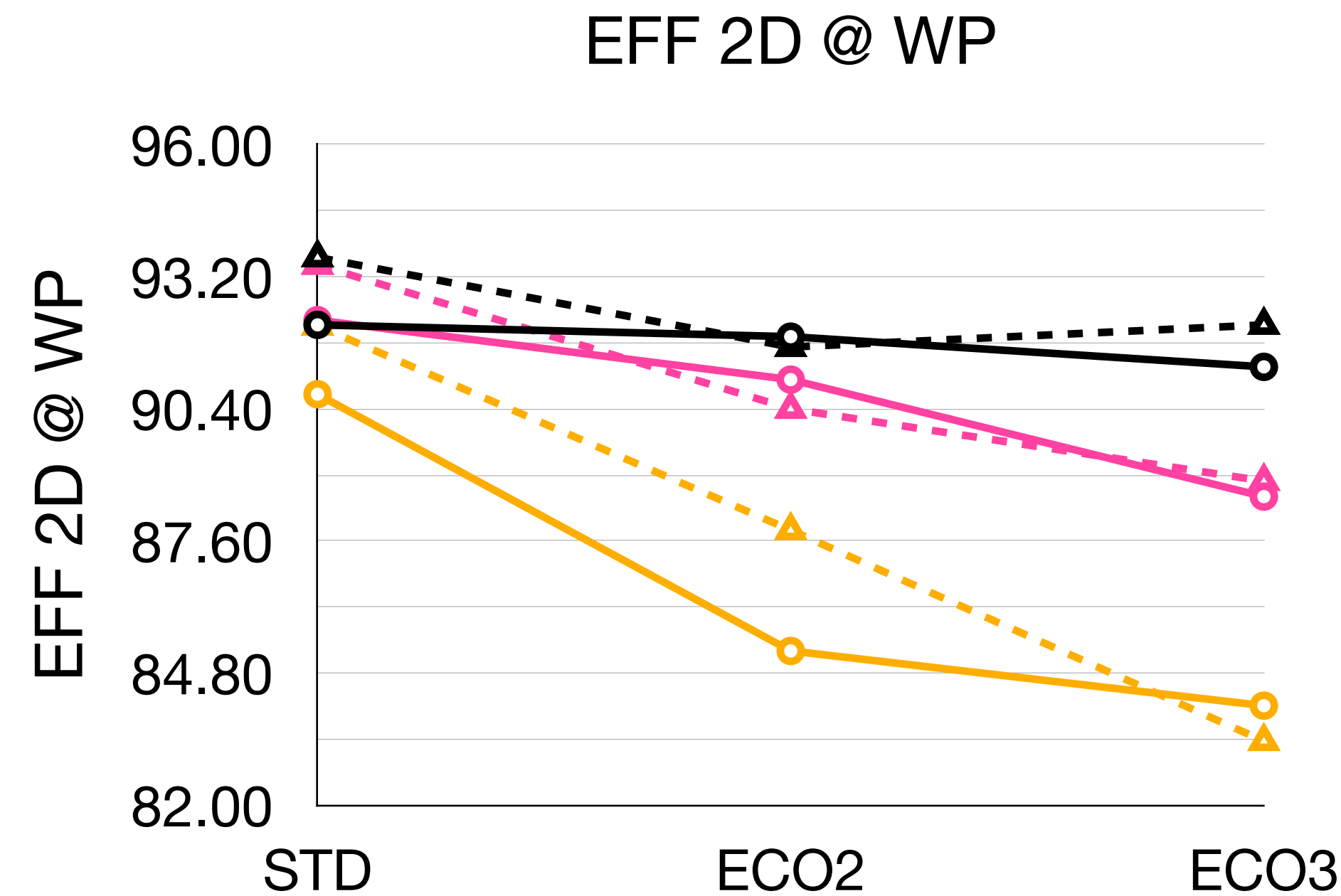
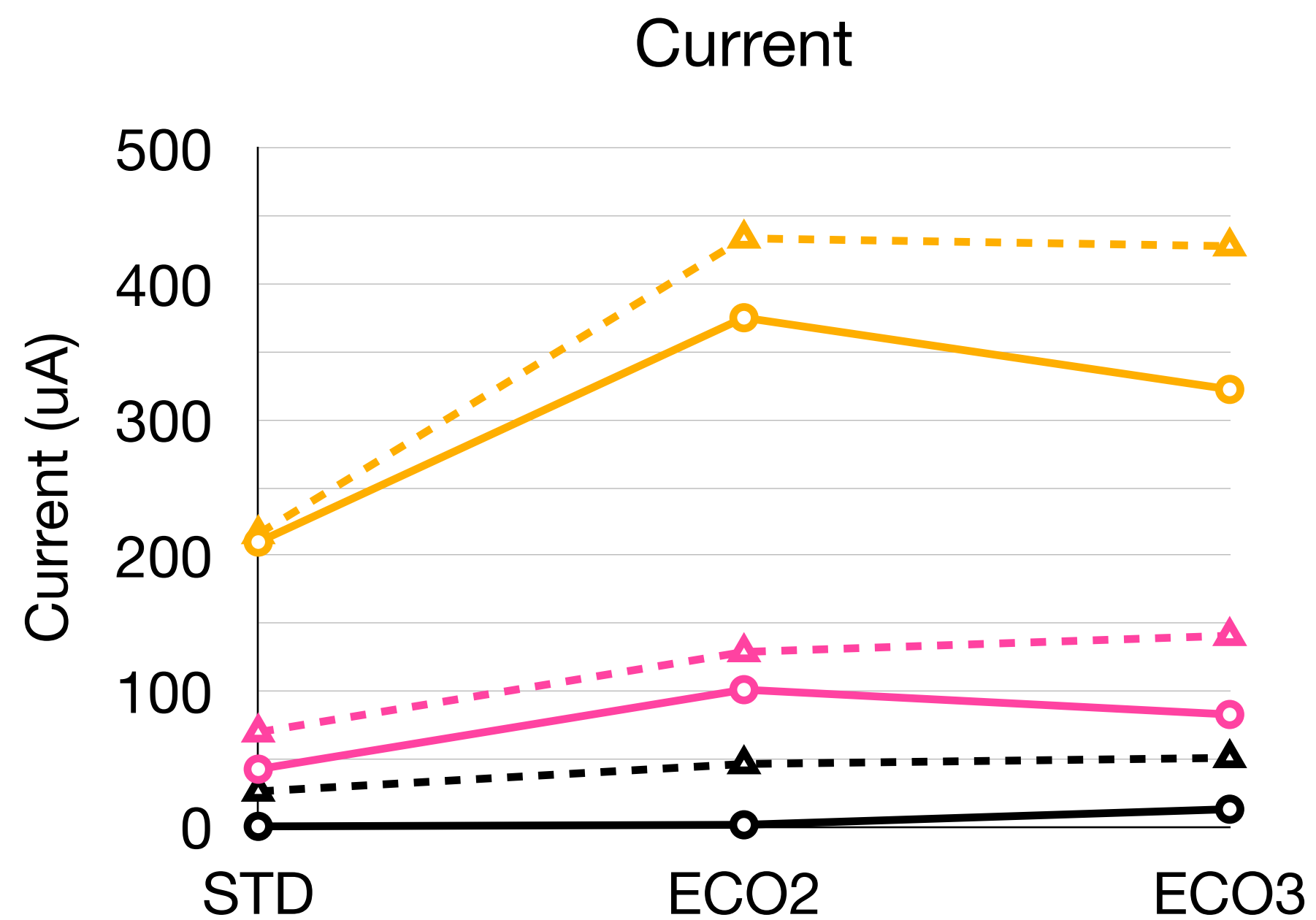
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2.2	1325.82	1227.01	-98.81
1	2529.85	2471.64	-58.21



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OFF	13.39	7.34	-6.05
22	175.30	253.49	78.19
6.9	474.81	681.09	206.28
3.3	895.51	1279.31	383.8
2.2	1129.17	1588.08	458.91
1	2059.00	2763.56	704.56

Comparison Current, Eff 2D, Gamma cl rate, Muon Cluster Size

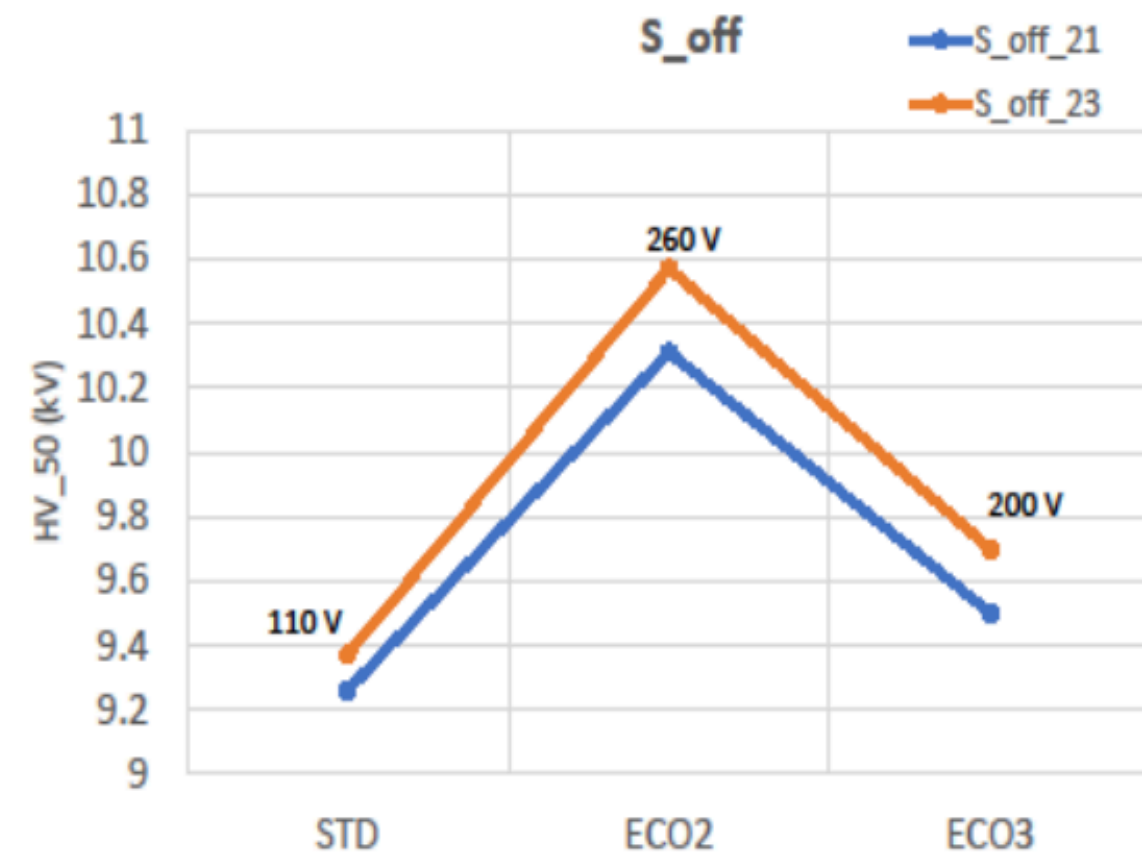
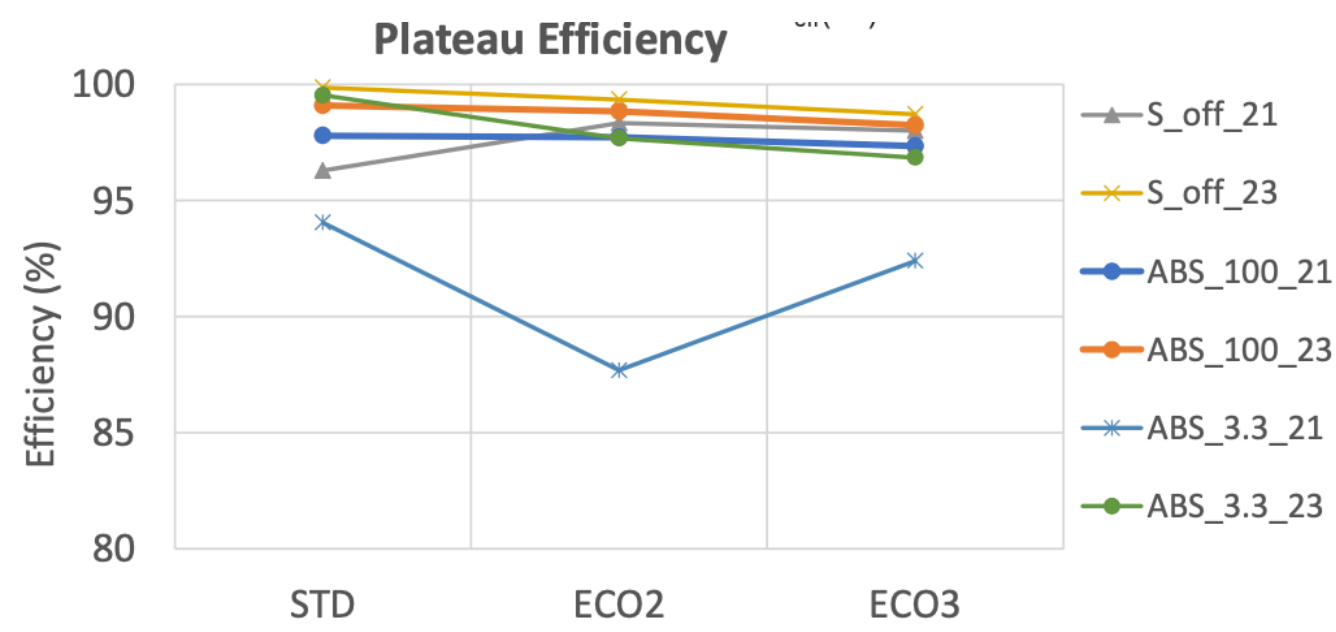
- S_OFF 2022
- ABS 22 2022
- ABS 3.3 2022
- △ S_OFF 2023
- △ ABS 22 2023
- △ ABS 3.3 2023



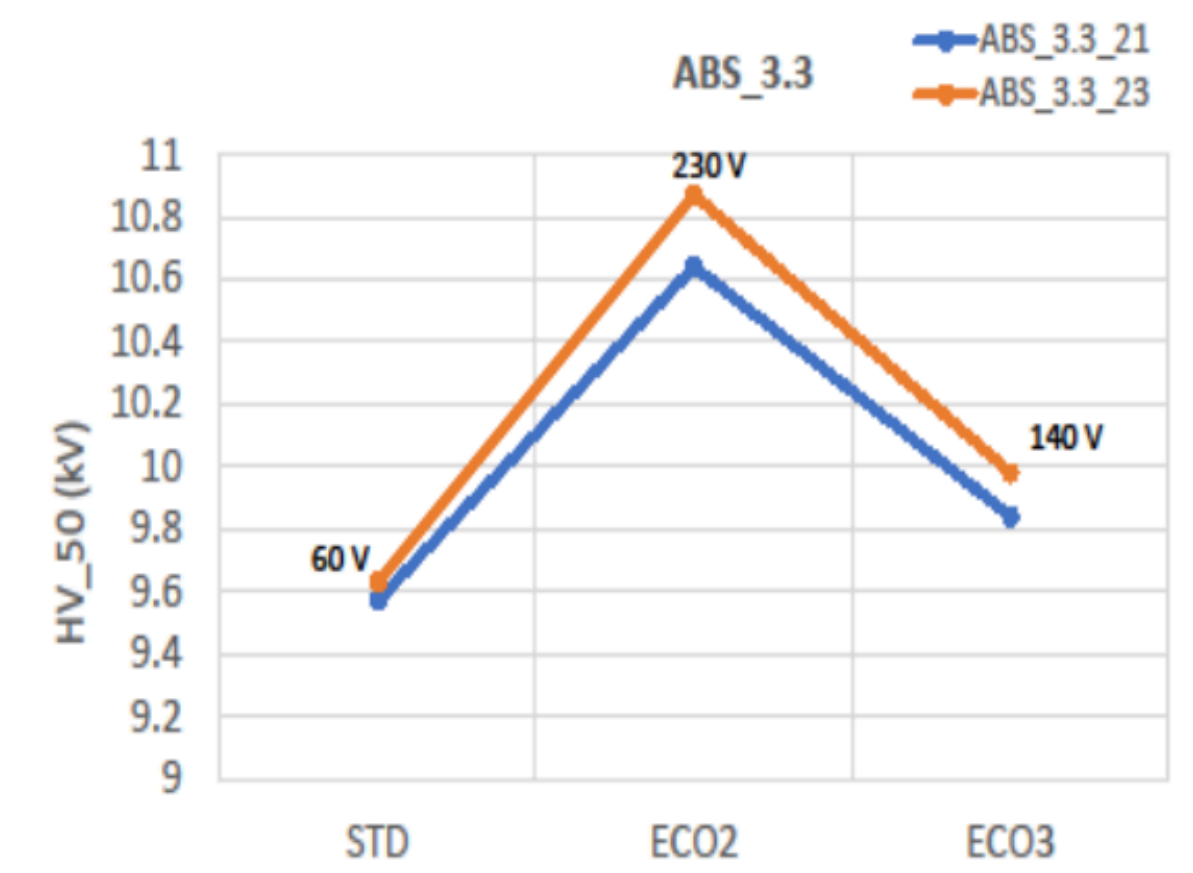
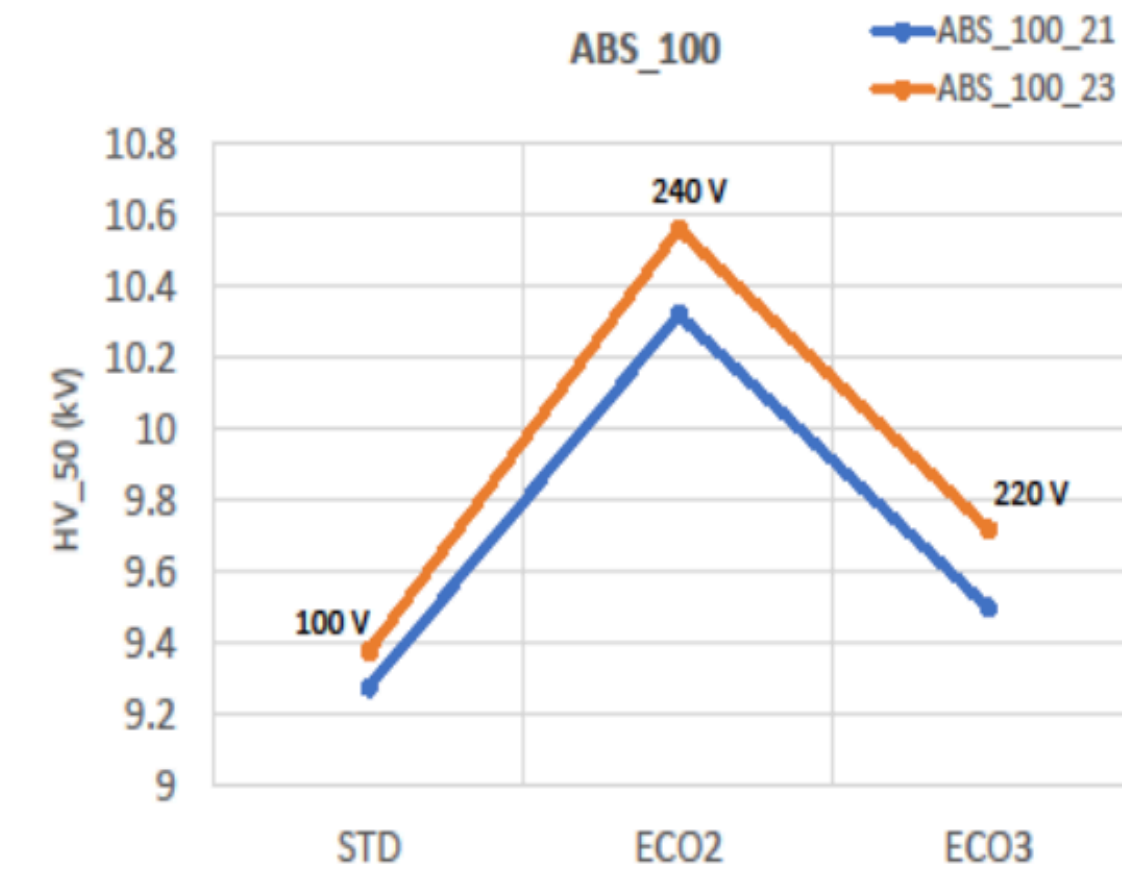
- NEW: Efficiency fit with logistic function and WP evaluation at 95% of the asymptotic value
- WP reached at ABS 1 2023 for std mix and eco2
- Efficiency values at WP comparable between 2022 and 2023, but different slope
- Gamma cluster rate decreases for std mix and increases for eco2 and eco3 (to be investigated)
- Muon Cluster Size and $P(C_s > 4)$: to do

Background

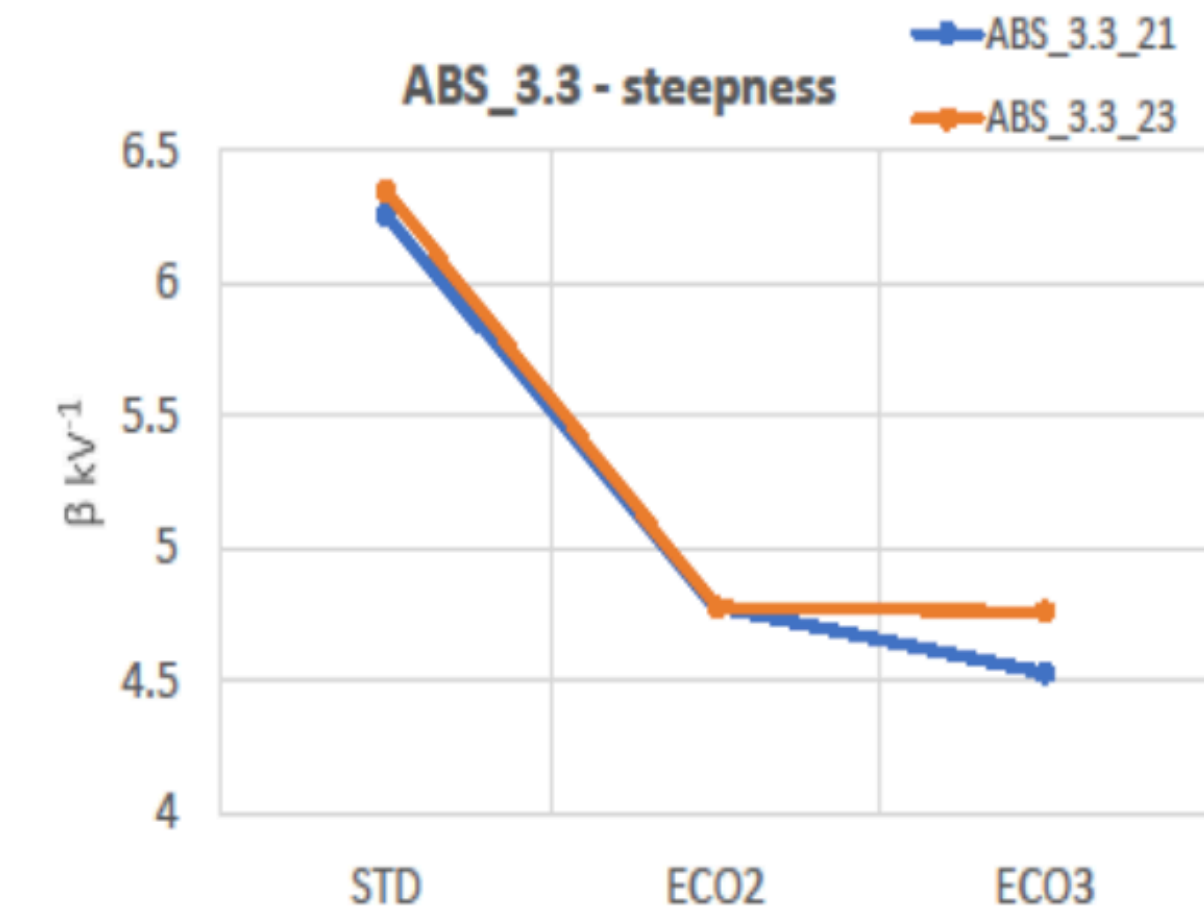
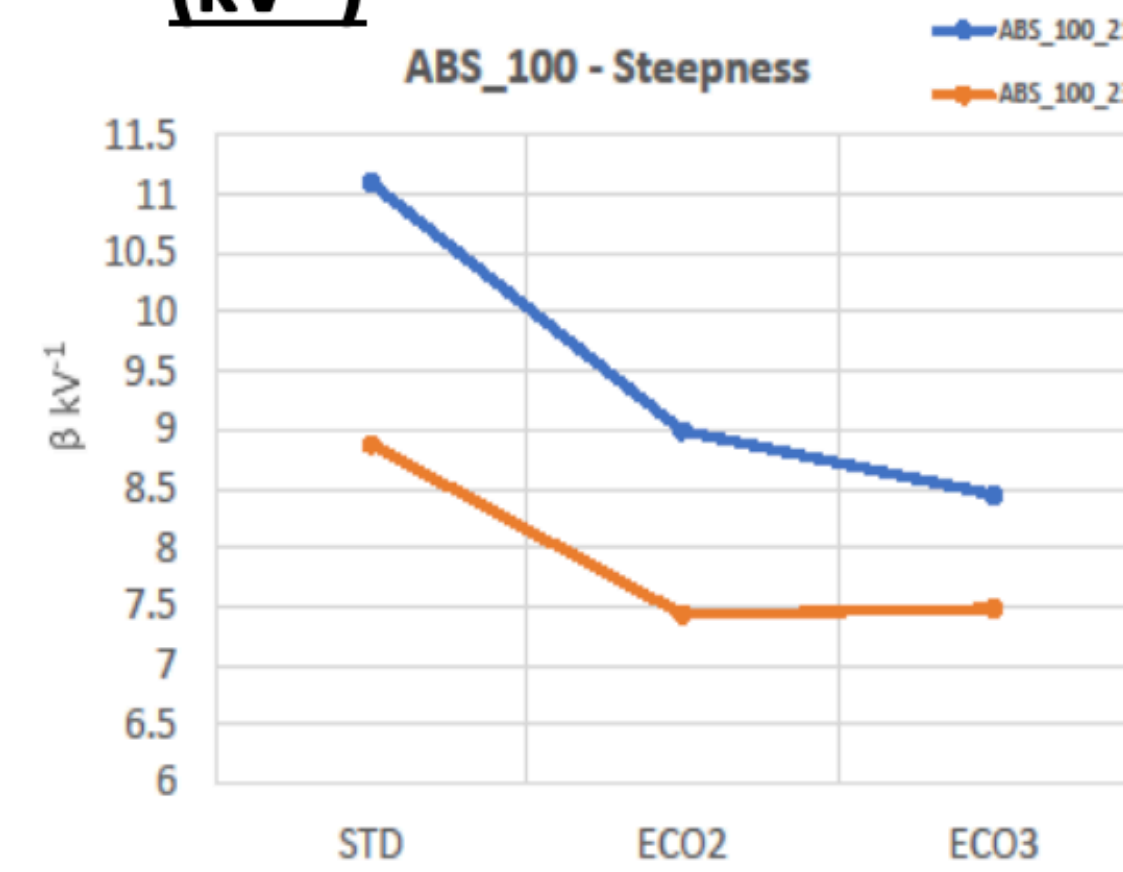
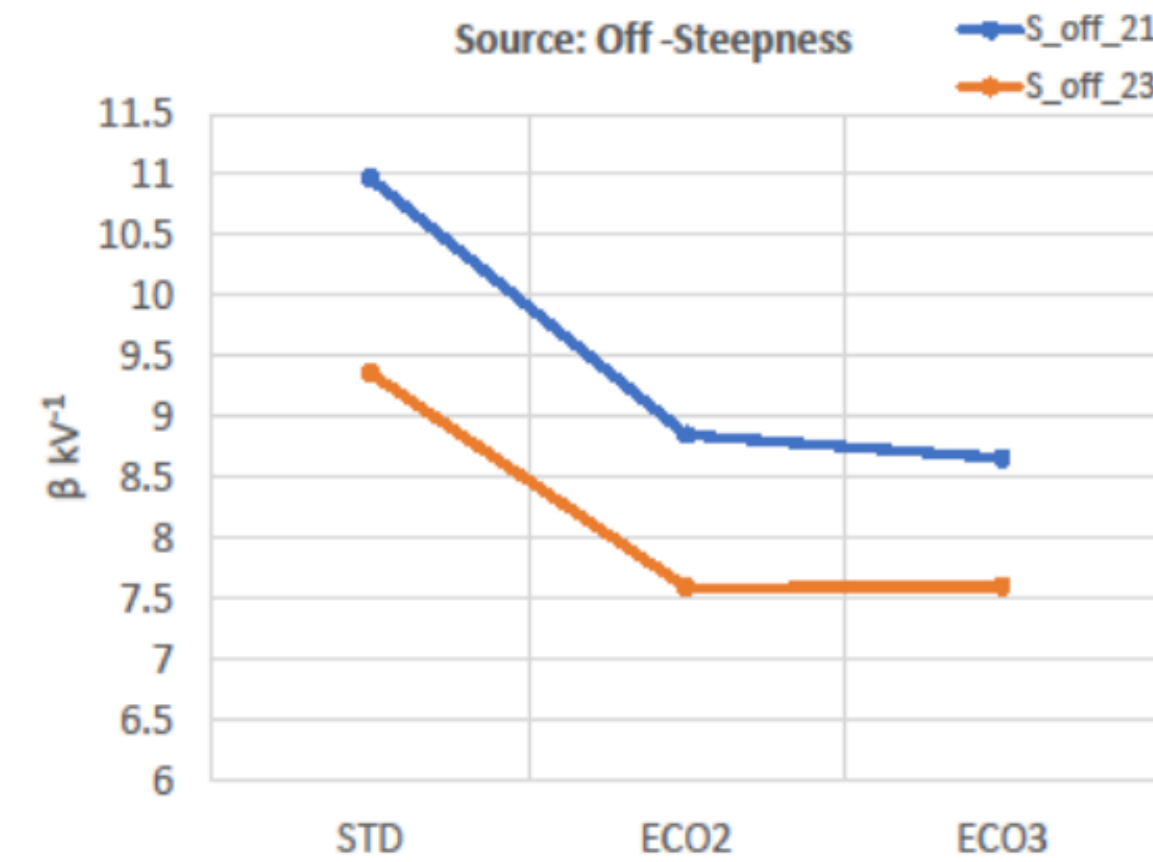
Umesh's talk - CMS chamber



HV 50 plots (chamber efficiency reaches 50%)



Slope of the efficiency curve β (kV⁻¹)



<https://agenda.infn.it/event/39901/contributions/222583/attachments/115989/167111/eco-gas.pdf>