

Comparison between
2022 and 2023 TB
SHiP/LHCb

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

Richards generalised logistic function for efficiency evaluation:

$$\epsilon = \frac{\epsilon_{\max}}{\left[1 + \psi \cdot e^{-\beta(HV_{\text{eff}} - HV_0)}\right]^{1/\psi}}$$

where ϵ_{\max} represents the asymptotic efficiency; β describes the steepness of the curve; ψ ranges between 0 and 1 and is introduced, with respect to the standard logistic function, to parameterise the slower growth of the curve observed for eco-gas mixtures; HV_0 sets the displacement of the curve along the x-axis for fixed ψ and β .

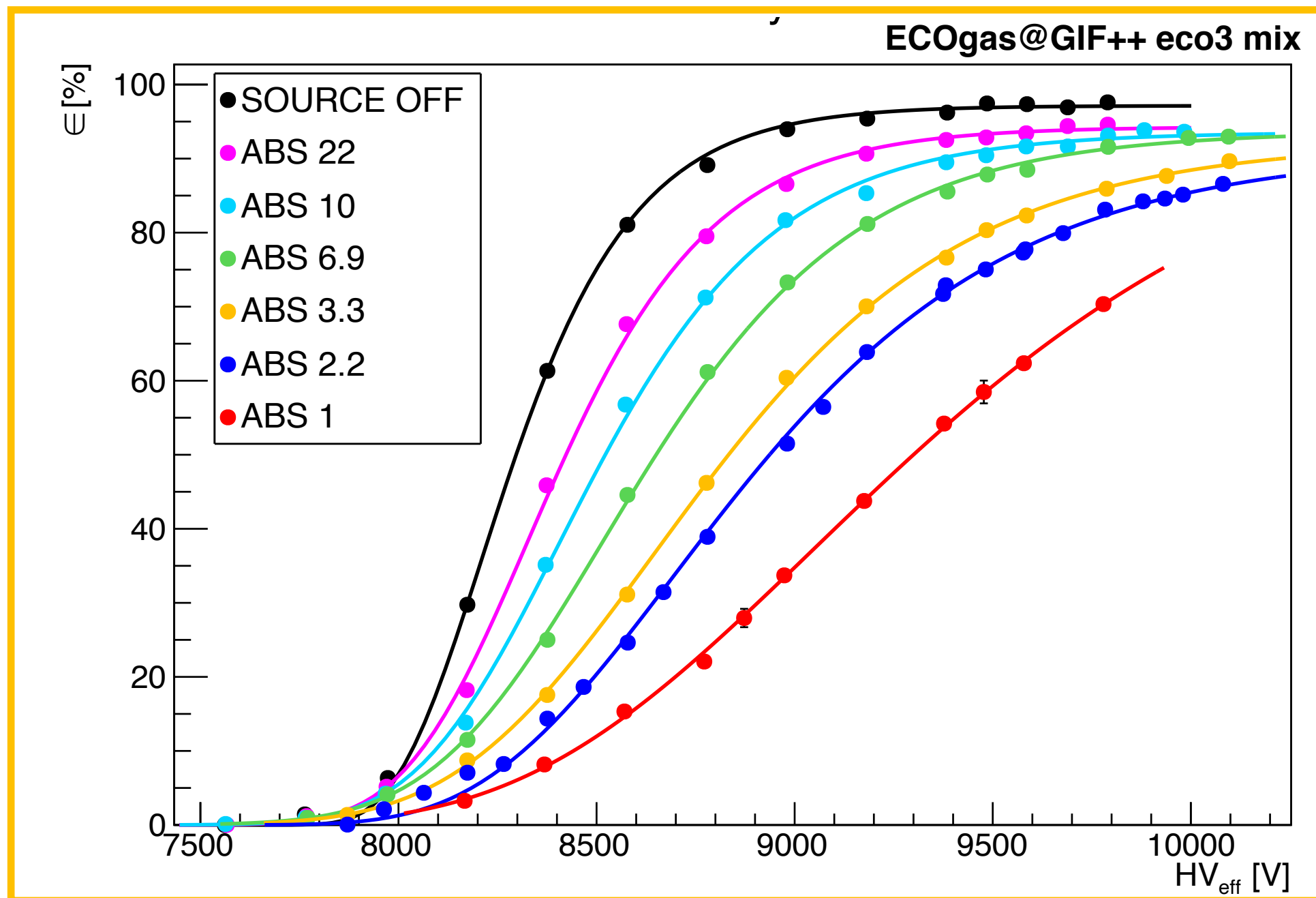
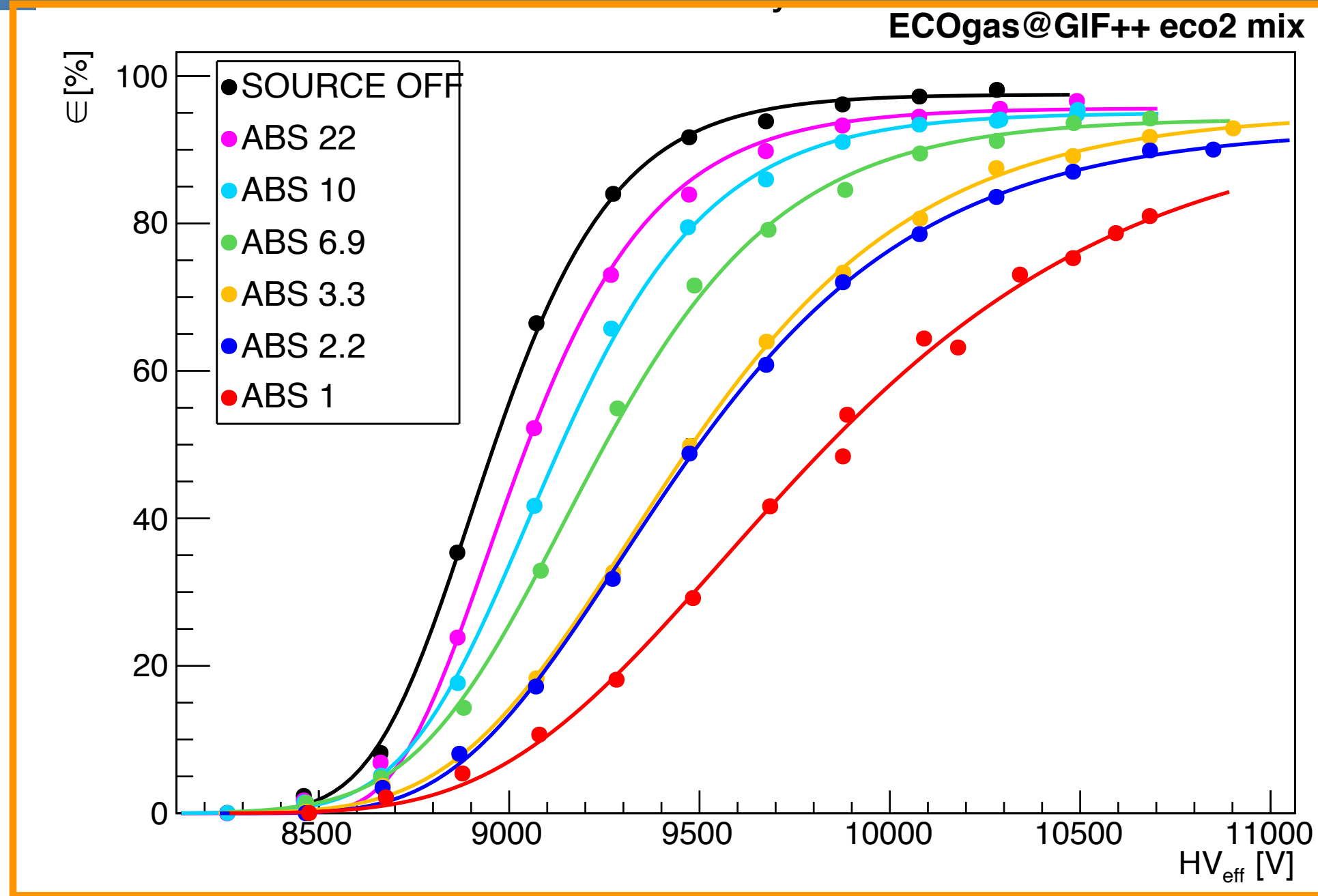
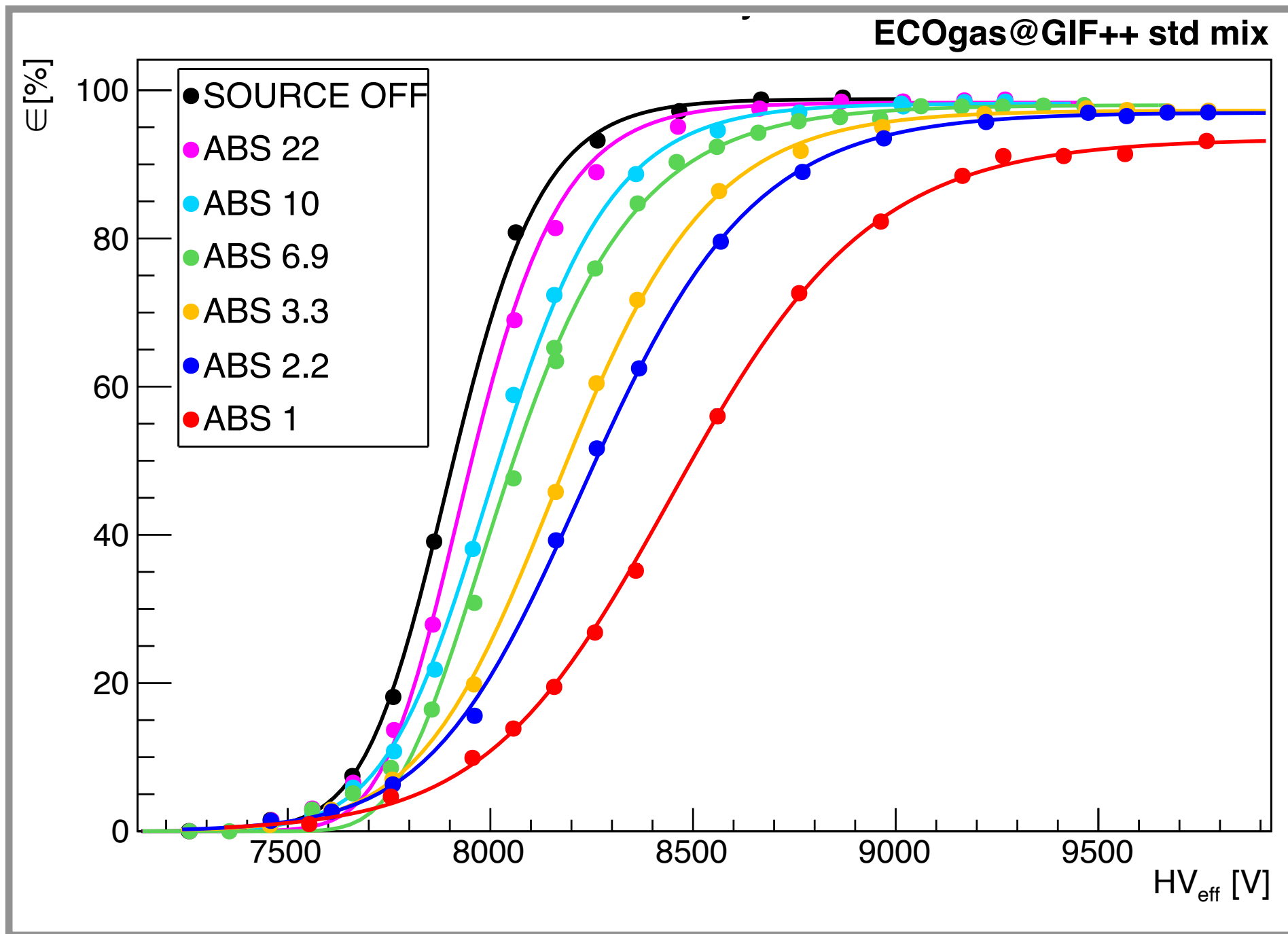
WP is defined as the HV_{eff} value at which the 2D efficiency reaches 99% of the asymptotic value approached by the Richard function

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	Used for 2023 plots
10	
6.9	
4.6	
3.3	
2.2	
1	

2D efficiency (2023)



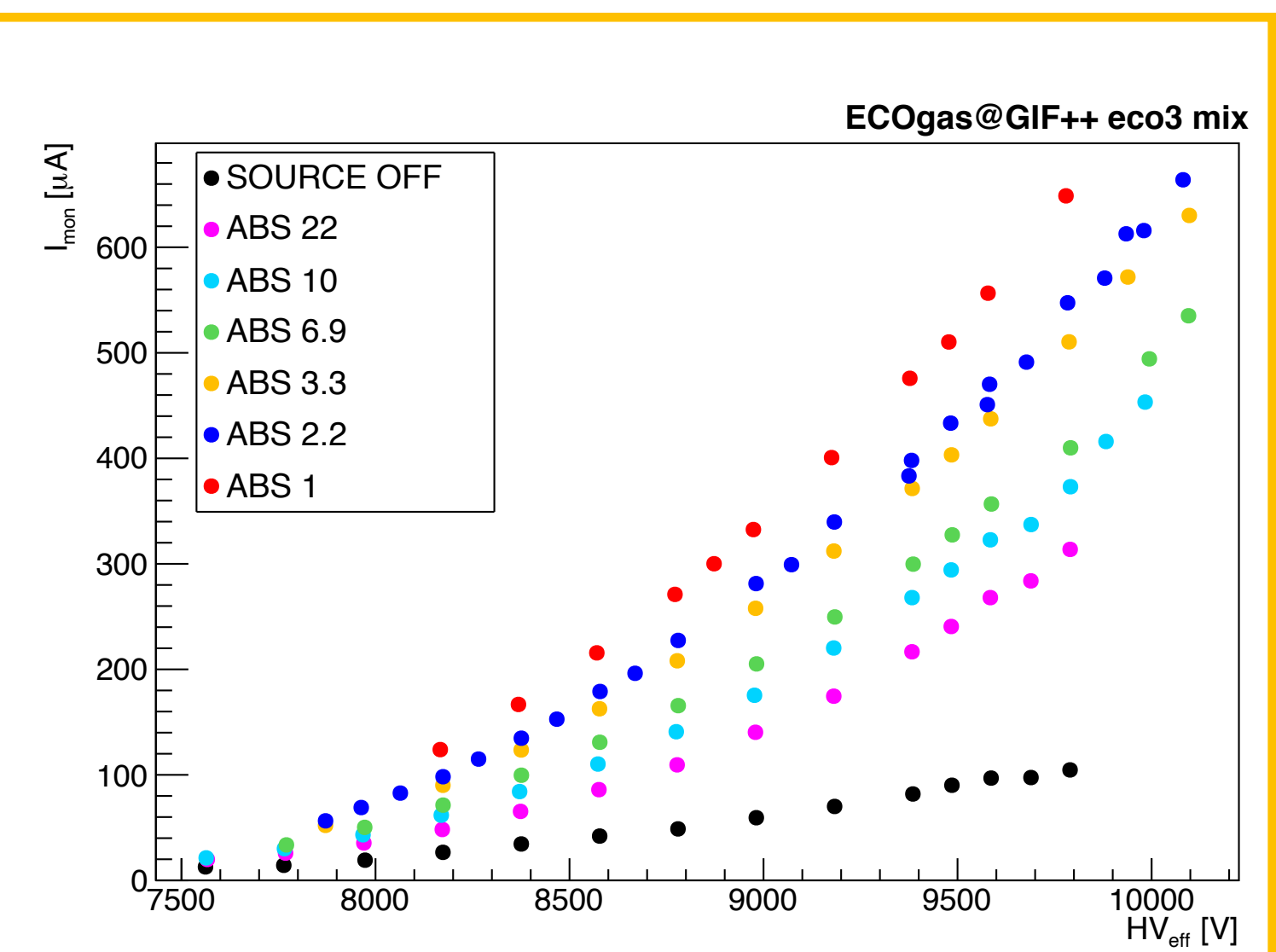
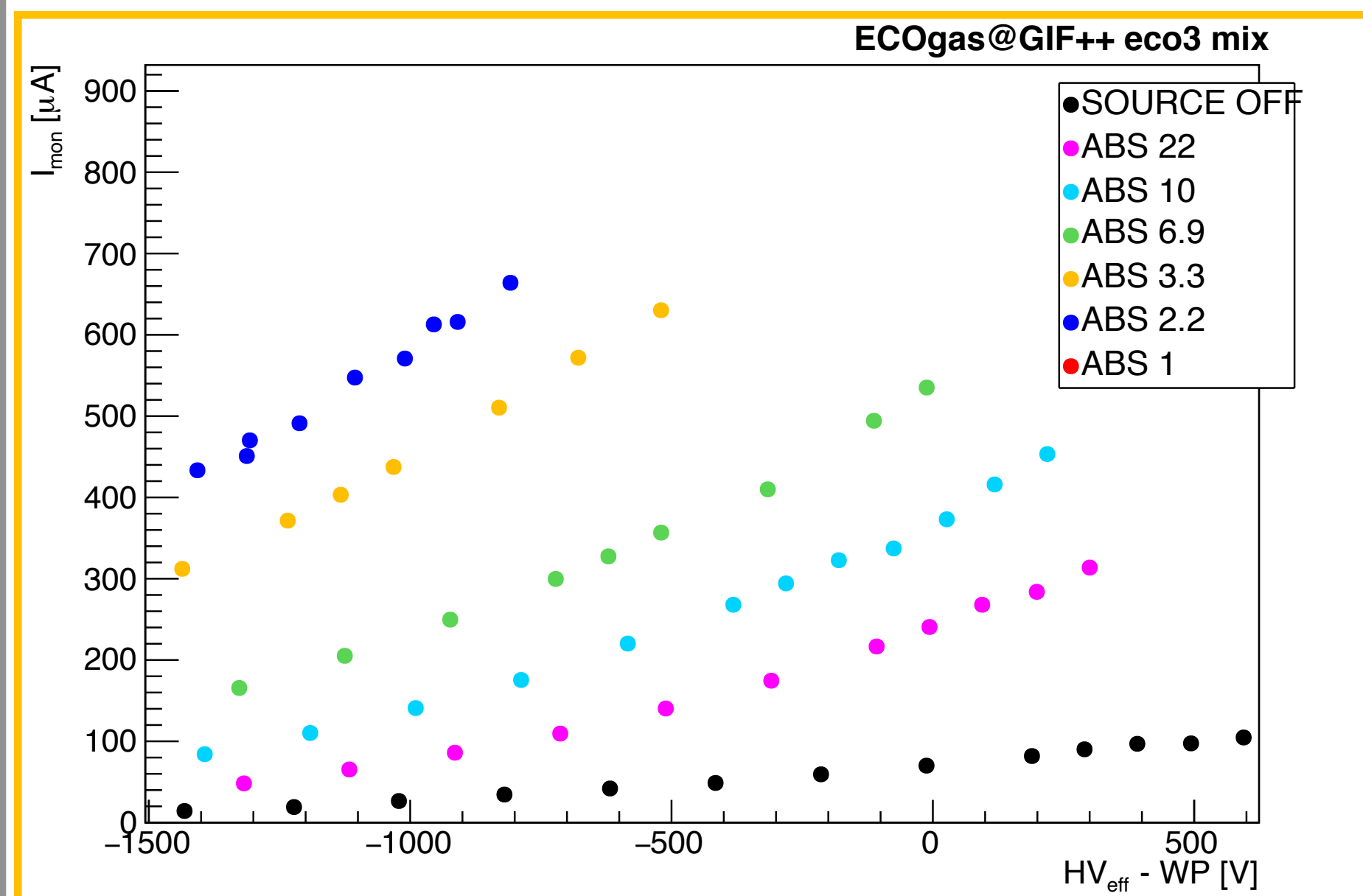
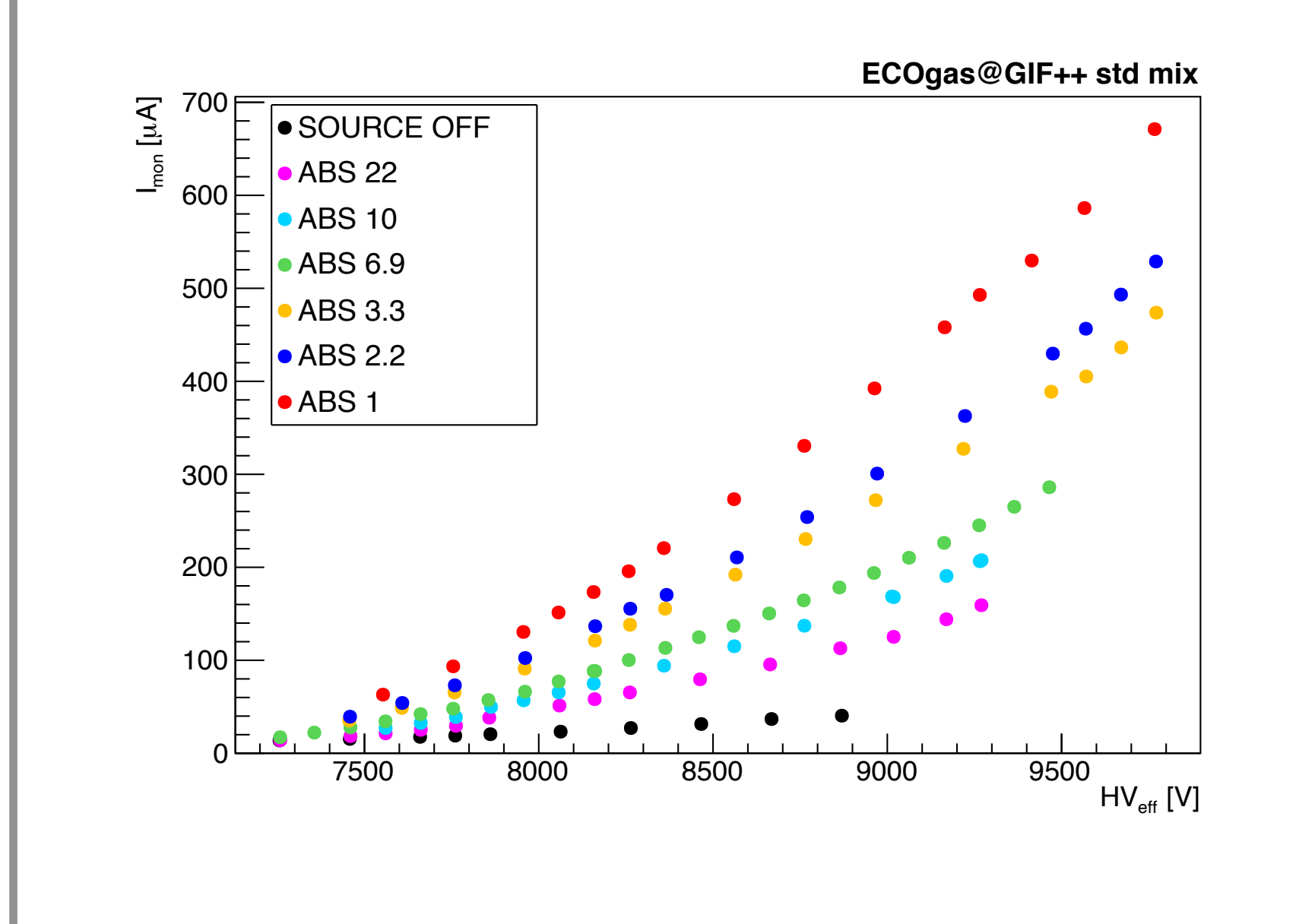
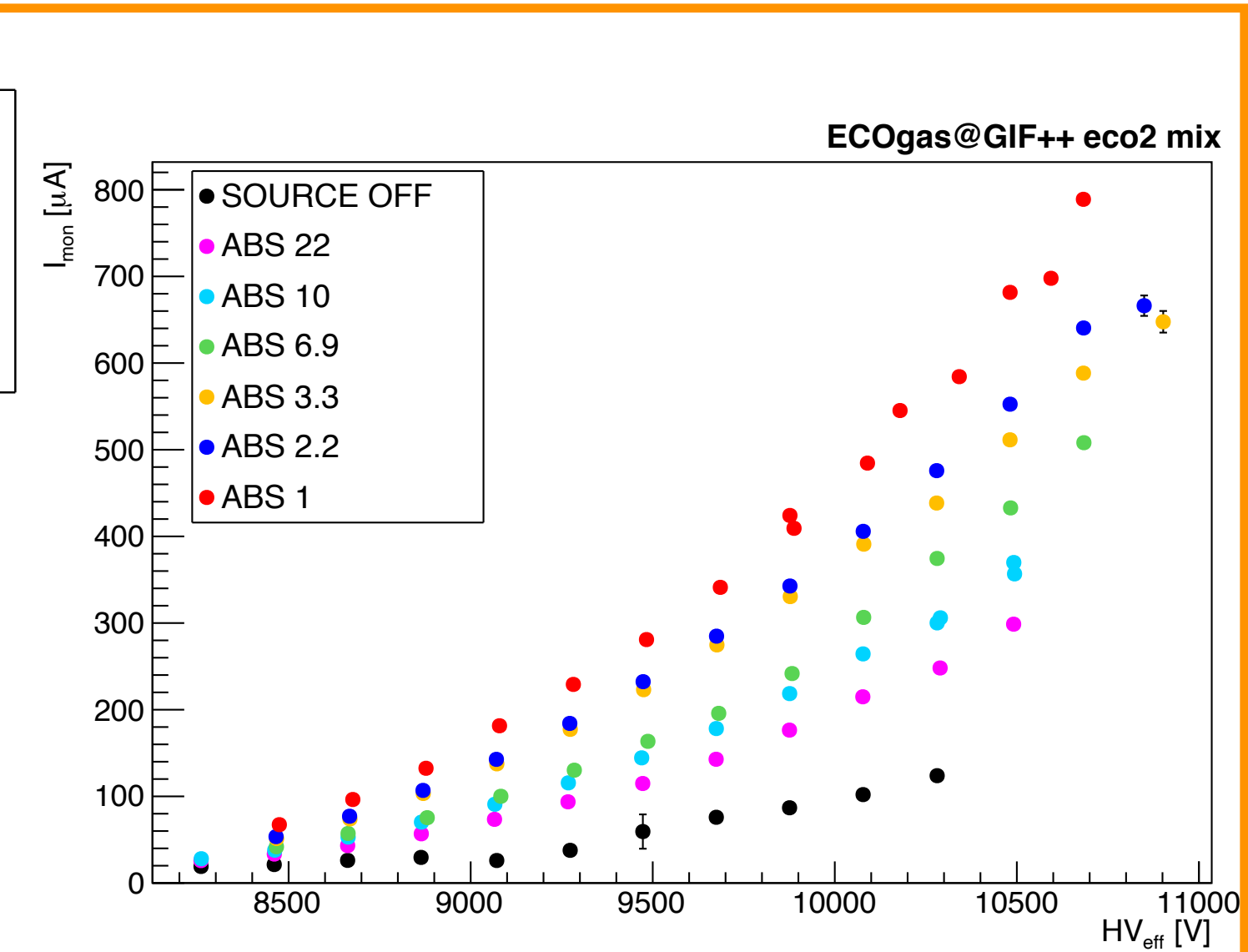
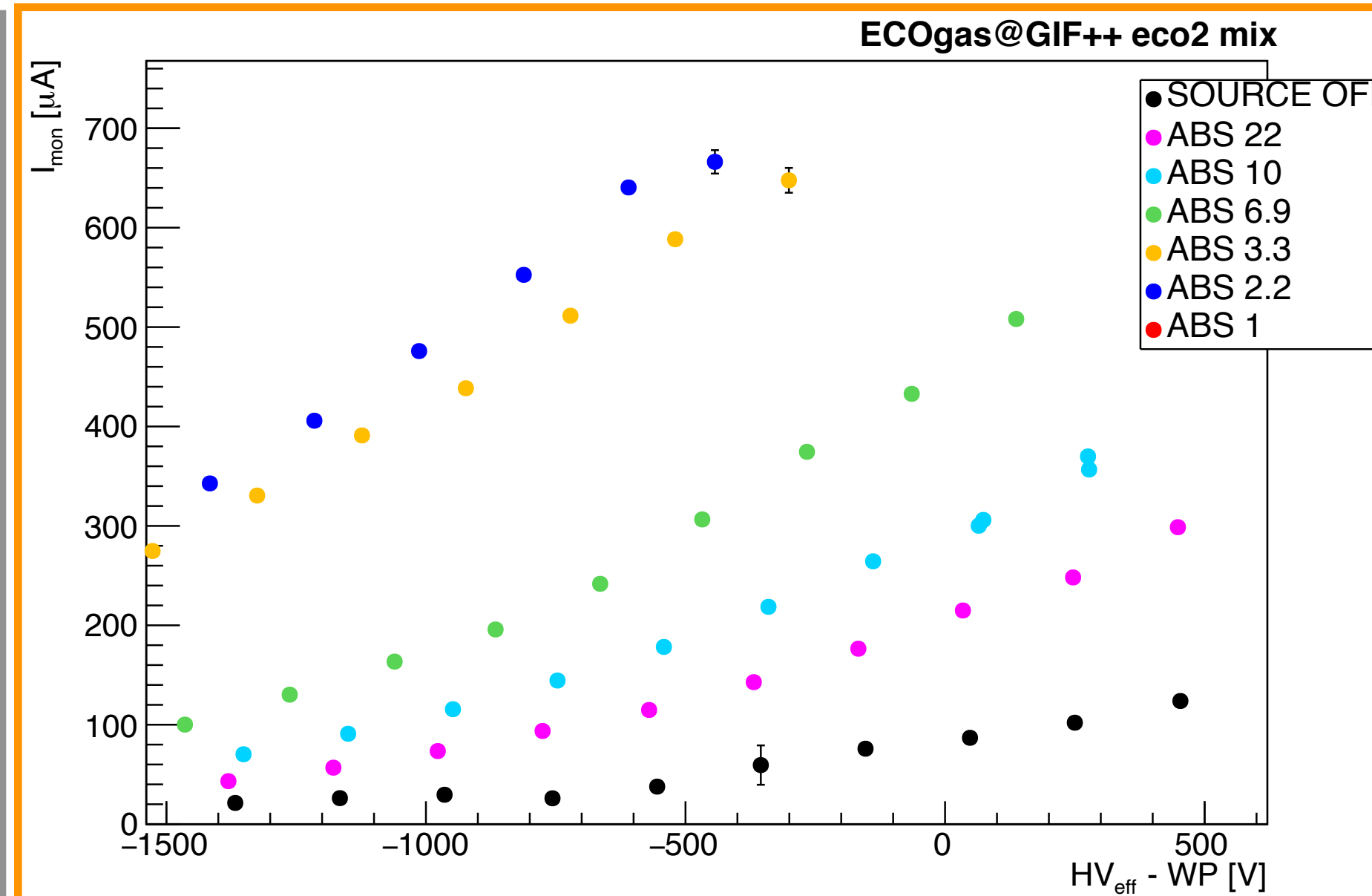
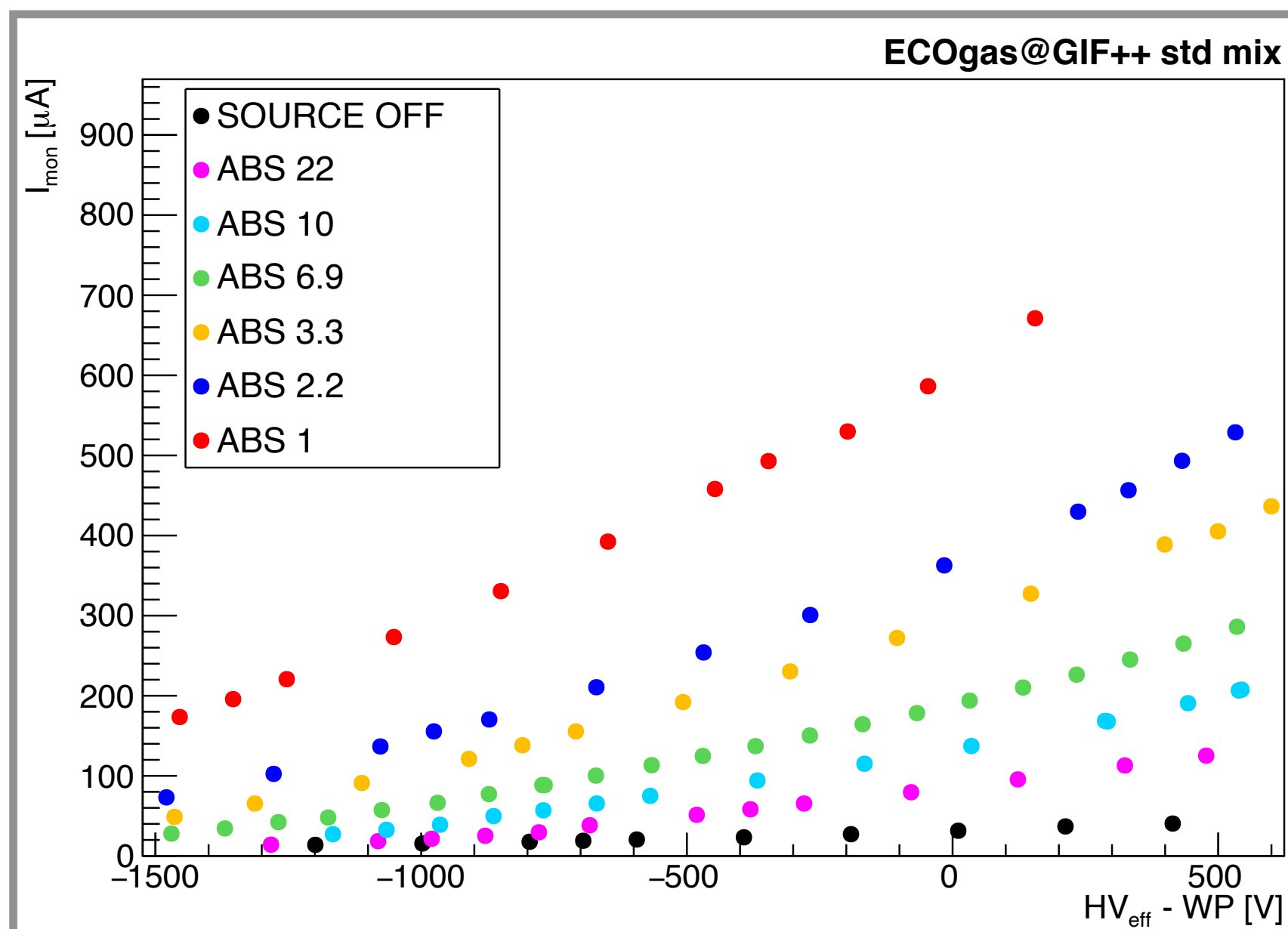
ABS	WP (V)	Eff 2D %
OFF	9827.78	96.52
22	10042.60	94.66
6.9	10547.05	93.27
3.3	11202.81	94.05
2.2	11293.00	91.98
1*	12286.86	92.77

ABS	WP (V)	Eff 2D %
OFF	8455.49	97.82
22	8540.88	97.35
6.9	8929.60	97.02
3.3	9071.31	96.29
2.2	9238.67	96.01
1*	9611.82	92.51

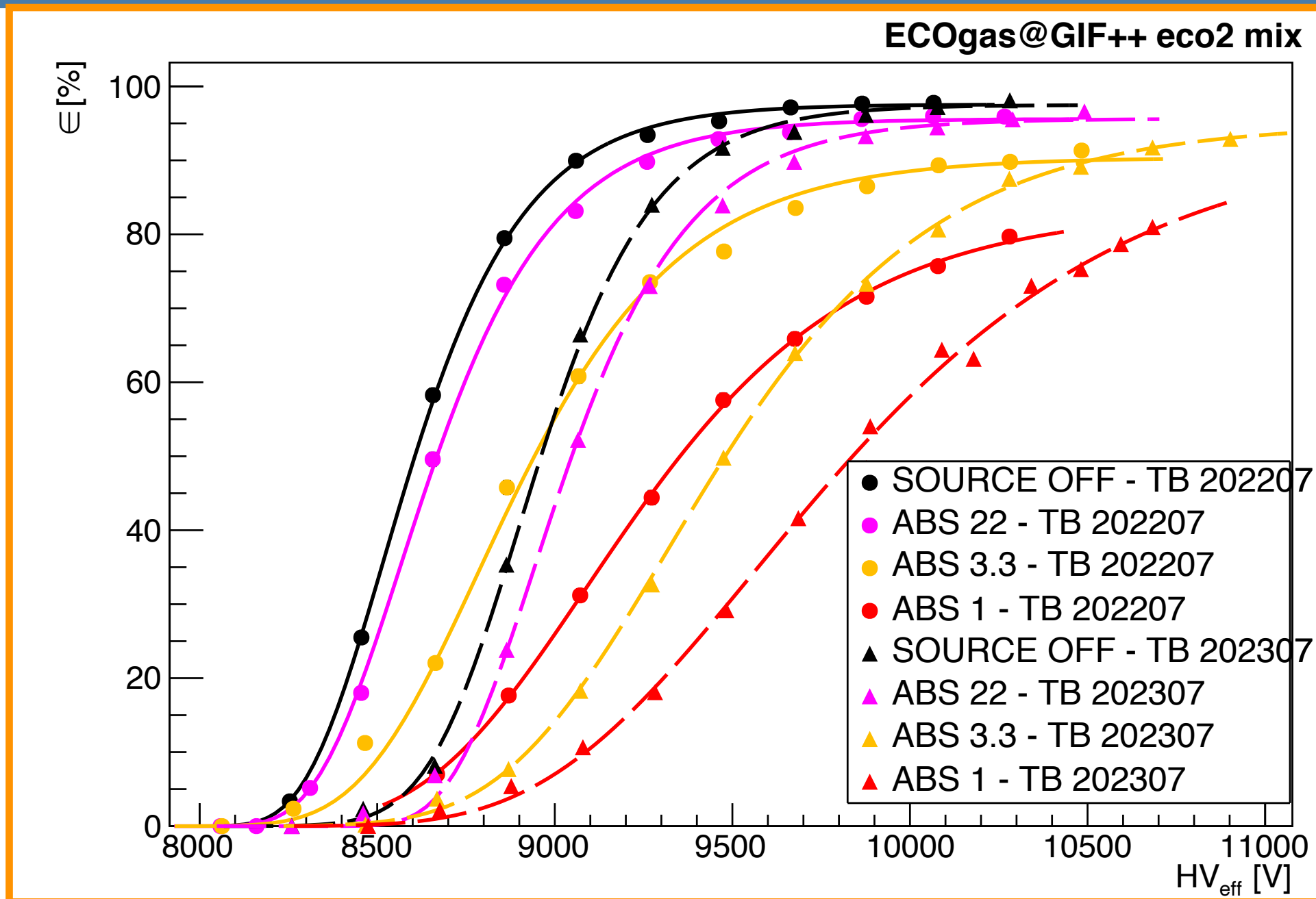
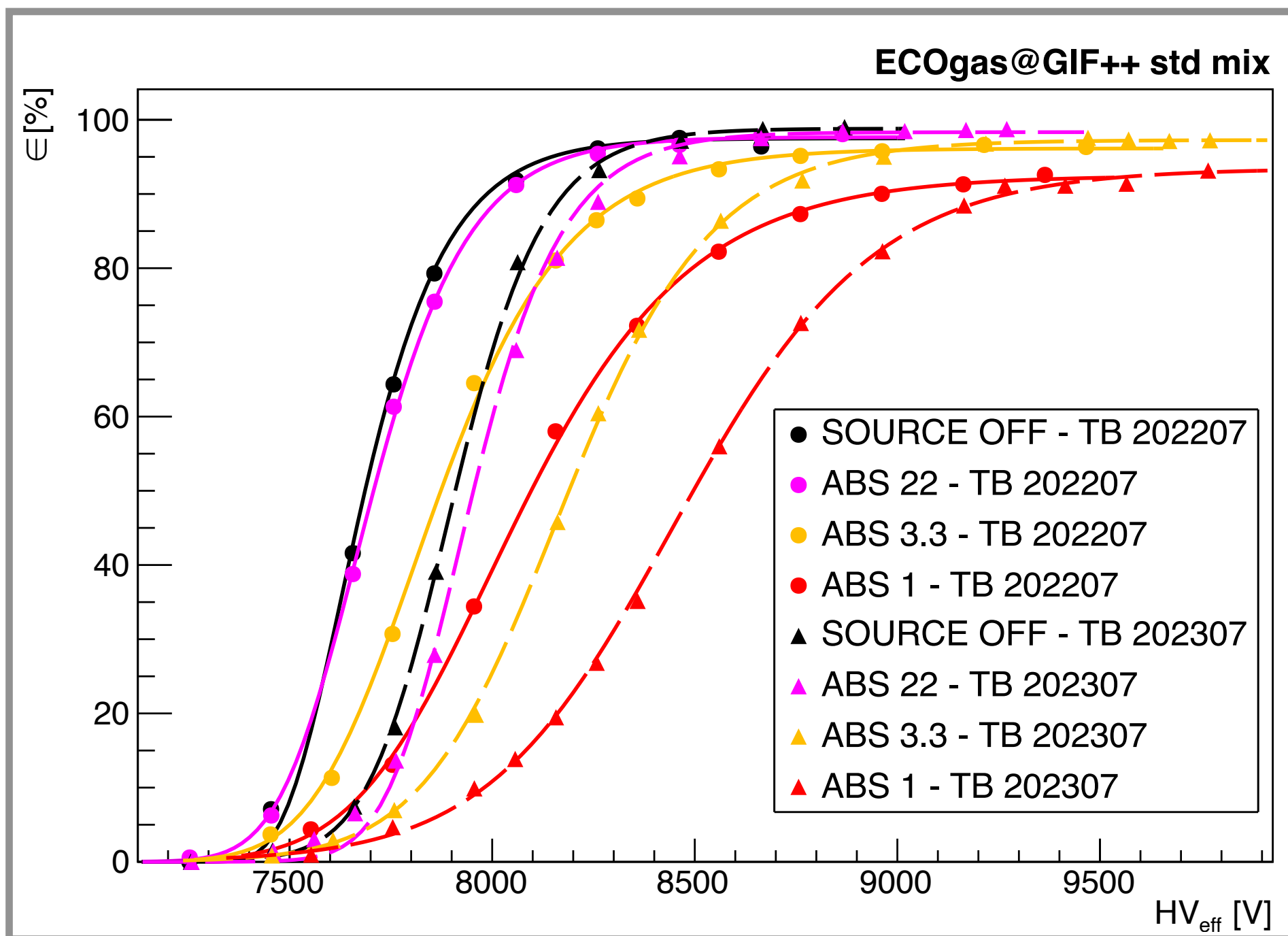
ABS	WP (V)	Eff 2D %
OFF	9195.35	96.17
22	9490.17	93.34
6.9	10107.12	92.70
3.3	10617.36	91.34
2.2	10889.39	90.25
1*	12294.67	99.00

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

Current (2023)



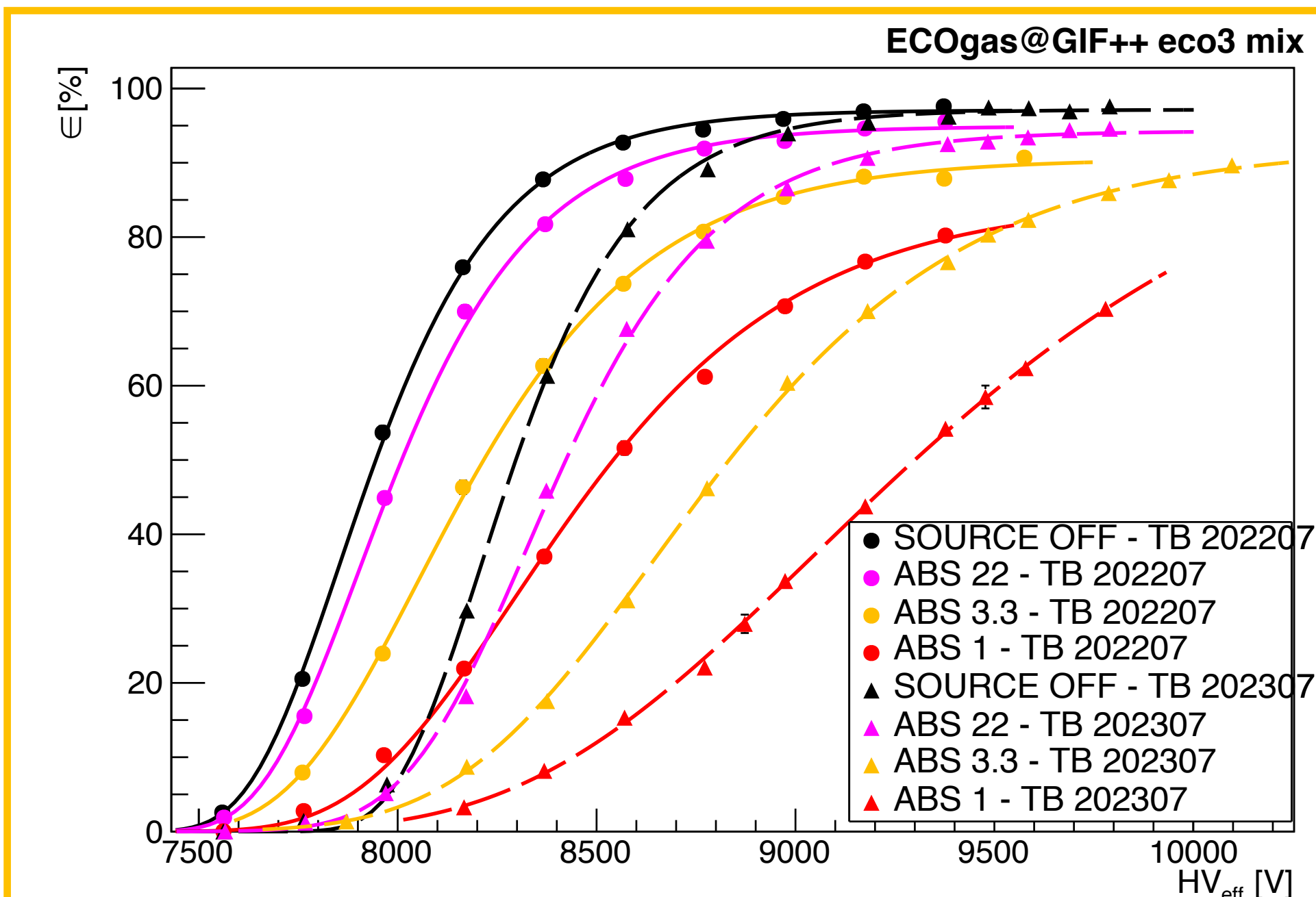
2D efficiency - Comparison 2022-2023 (Detailed table in slides 6-8)



ABS	WP (V) 2022	Eff 2D %	WP (V) 2023	Eff 2D %
OFF	9524	96.59	9828	84.23
22	9652	94.63	10043	208.34
6.9	9950	91.98	10547	456.86
3.3	10226	89.47	11203	728.97
2.2	10365	87.42	11293	734.84
1*	10980	82.61	12287	2431.22

ABS	WP (V) 2022	Eff 2D %	WP (V) 2023	Eff 2D %
OFF	8281	96.52	8455	97.82
22	8341	96.68	8541	97.35
6.9	8541	95.95	8930	97.02
3.3	8724	95.18	9071	96.29
2.2	8805	93.94	9239	96.01
1*	9199	91.55	9612	92.51

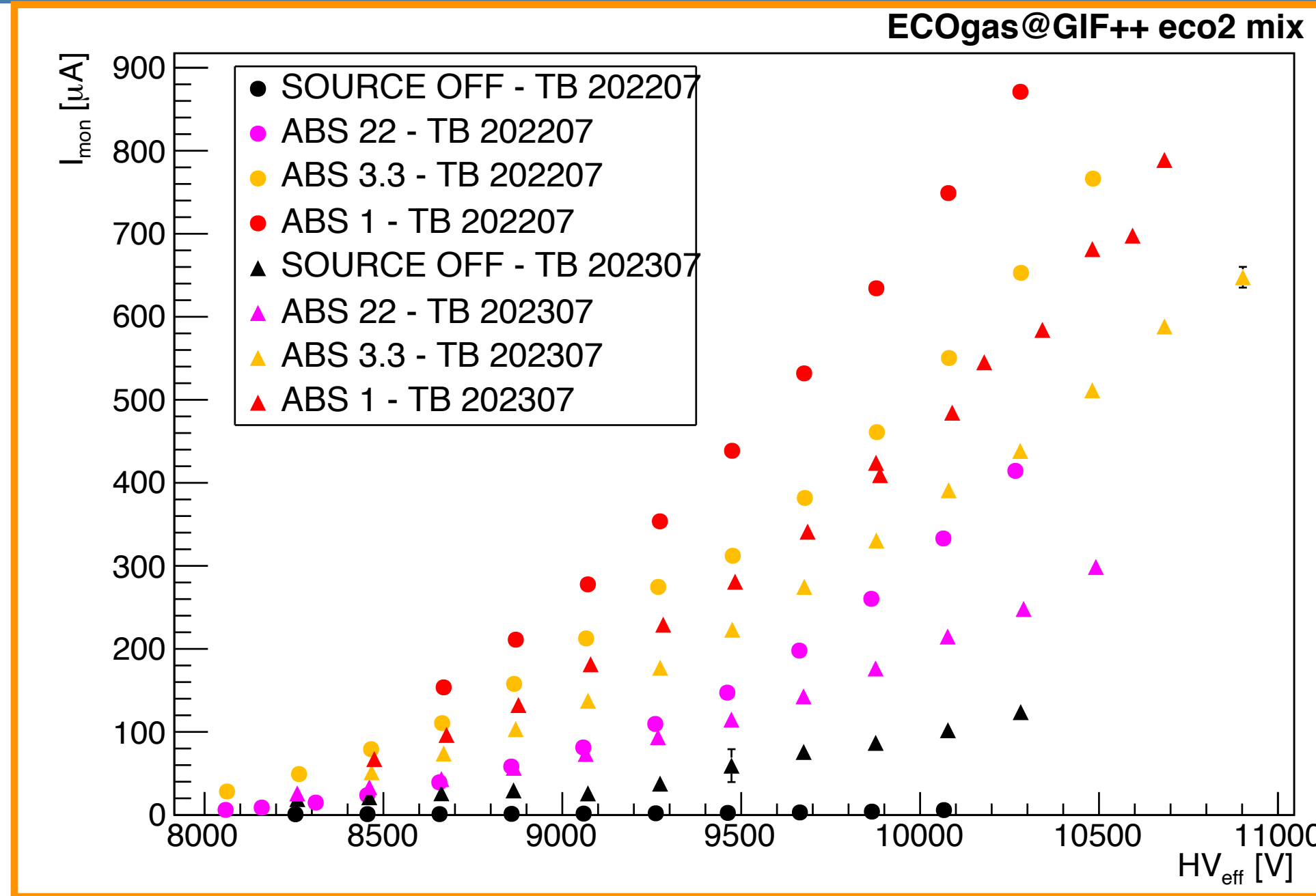
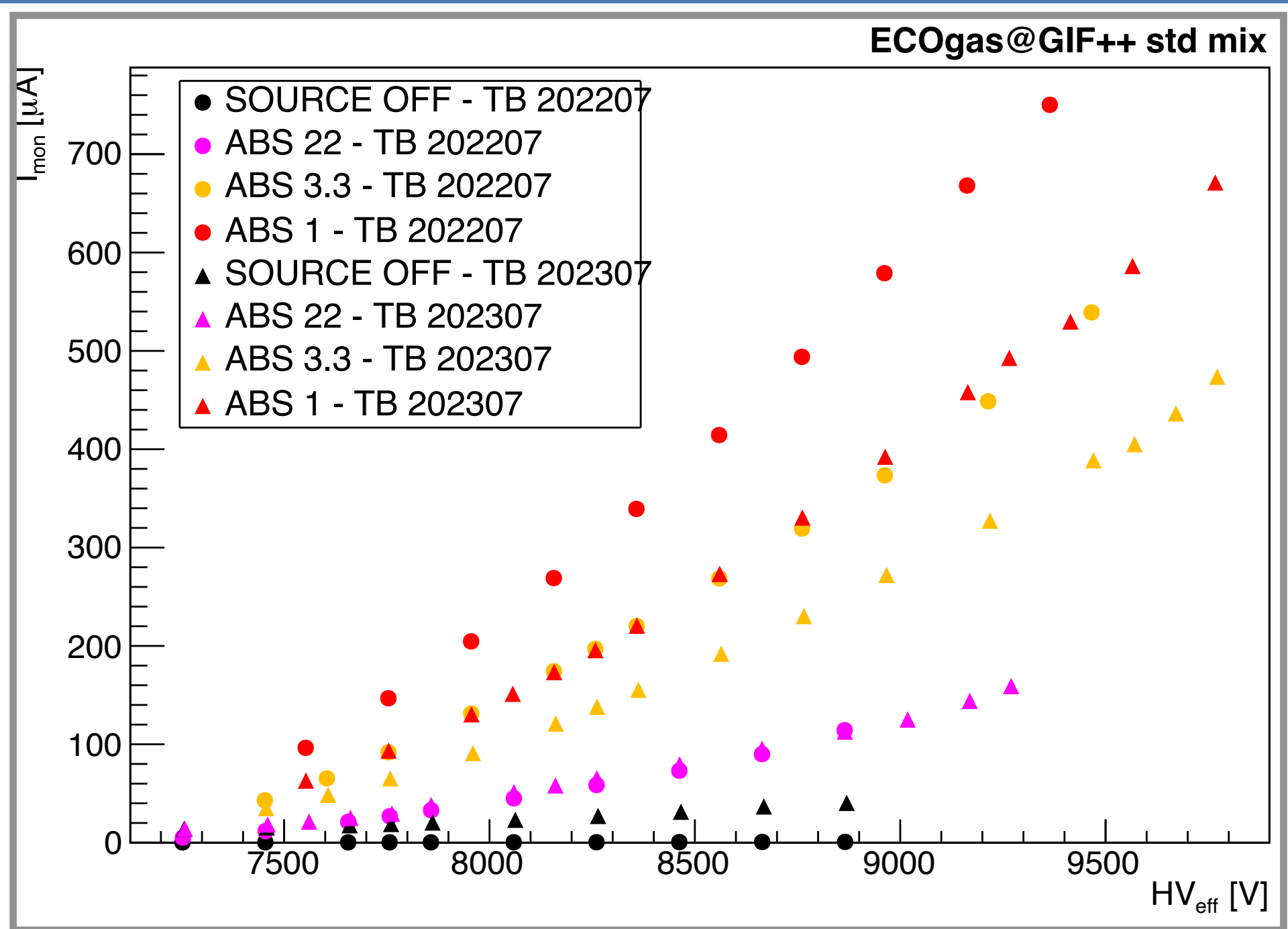
*NB: Values for ABS 1 at WP are extrapolated for the fit



ABS	WP (V) 2022	Eff 2D %	WP (V) 2023	Eff 2D %
OFF	8889	96.11	9195	96.17
22	9024	93.95	9490	93.34
6.9	9192	91.14	10107	92.70
3.3	9534	89.63	10617	91.34
2.2	9693	89.20	10889	90.25
1*	10104	84.15	12295	99.00

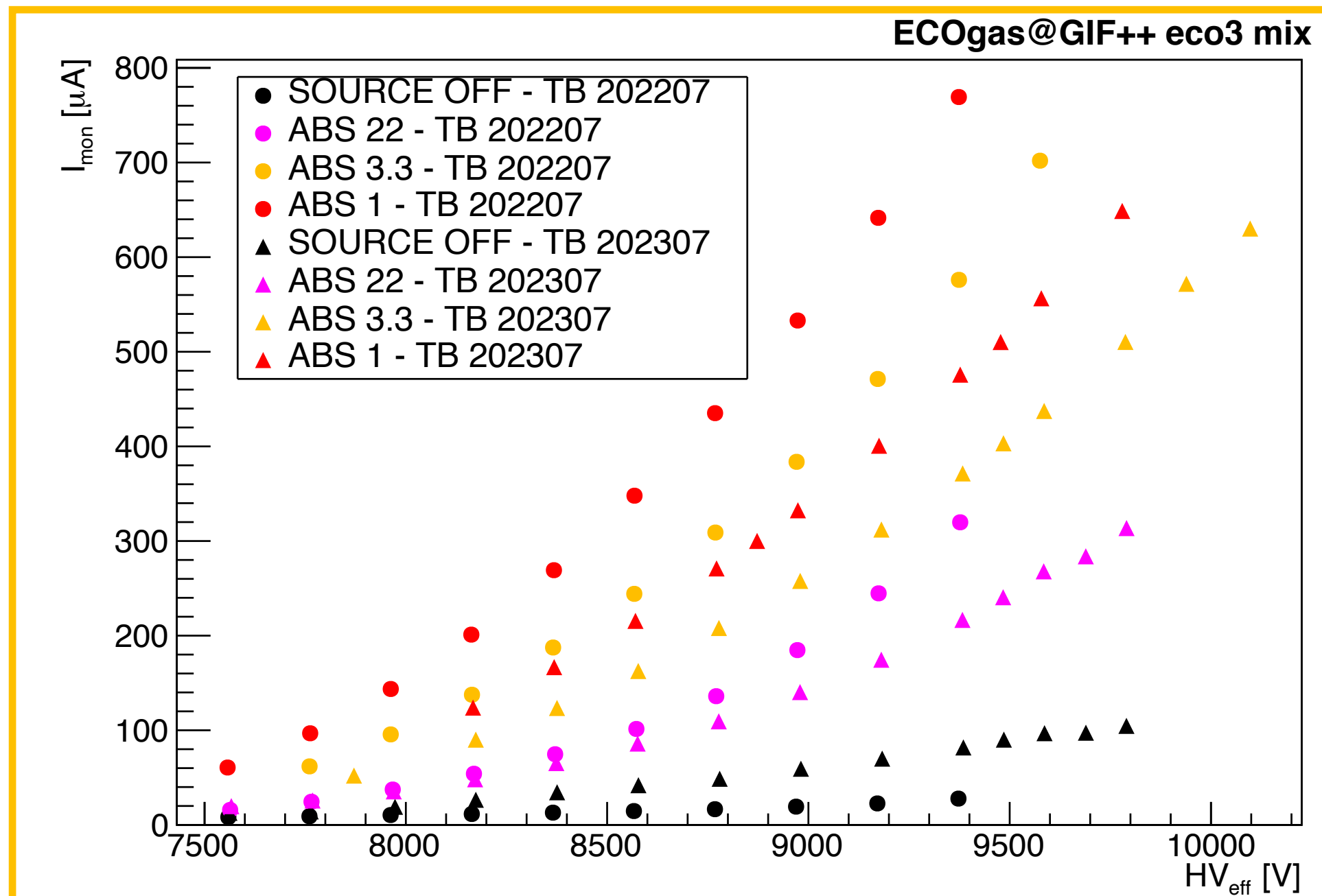
Current - Comparison 2022-2023

(Detailed table in slides 6-8)



ABS	WP (V) 2022	Current at WP	WP (V) 2023	Current at WP
OFF	9524	2.61	9828	84.23
22	9652	195.24	10043	208.34
6.9	9950	382.88	10547	456.86
3.3	10226	624.29	11203	728.97
2.2	10365	722.12	11293	734.84
1*	10980	1294.97	12287	2431.22

ABS	WP (V) 2022	Current at WP	WP (V) 2023	Current at WP
OFF	8281	0.44	8455	31.24
22	8341	64.36	8541	85.74
6.9	8541	175.14	8930	188.84
3.3	8724	309.90	9071	295.08
2.2	8805	376.51	9239	366.87
1*	9199	682.77	9612	605.76



ABS	WP (V) 2022	Current at WP	WP (V) 2023	Current at WP
OFF	8889	18.23	9195	70.76
22	9024	200.13	9490	242.35
6.9	9192	383.34	10107	539.90
3.3	9534	676.01	10617	821.91
2.2	9693	810.74	10889	1049.11
1*	10104	1225.93	12295	1803.30

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

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	8281.14	8455.49	174.35	96.52	97.82	1.30	0.44	31.24	30.8
22	8340.58	8540.88	200.30	96.68	97.35	0.67	64.36	85.74	21.38
6.9	8541.18	8929.60	388.42	95.95	97.02	1.07	175.14	188.84	13.7
3.3	8723.56	9071.31	347.75	95.18	96.29	1.11	309.90	295.08	-14.82
2.2	8805.49	9238.67	433.18	93.94	96.01	2.07	376.51	366.87	-9.64
1*	9198.74	9611.82	413.08	91.55	92.51	0.96	682.77	605.76	-77.01

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

Comparison 2022-2023: WP, Eff2D, Current ECO2

	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	9523.98	9827.78	303.80	96.59	96.52	-0.07	2.61	84.23	81.62
22	9651.60	10042.60	391.00	94.63	94.66	0.03	195.24	208.34	13.1
6.9	9949.75	10547.05	597.30	91.98	93.27	1.29	382.88	456.86	73.98
3.3	10225.81	11202.81	977.00	89.47	94.05	4.58	624.29	728.97	104.68
2.2	10364.86	11293.00	928.14	87.42	91.98	4.56	722.12	734.84	12.72
1*	10980.23	nd	nd	82.61	nd	nd	1294.97	nd	nd

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

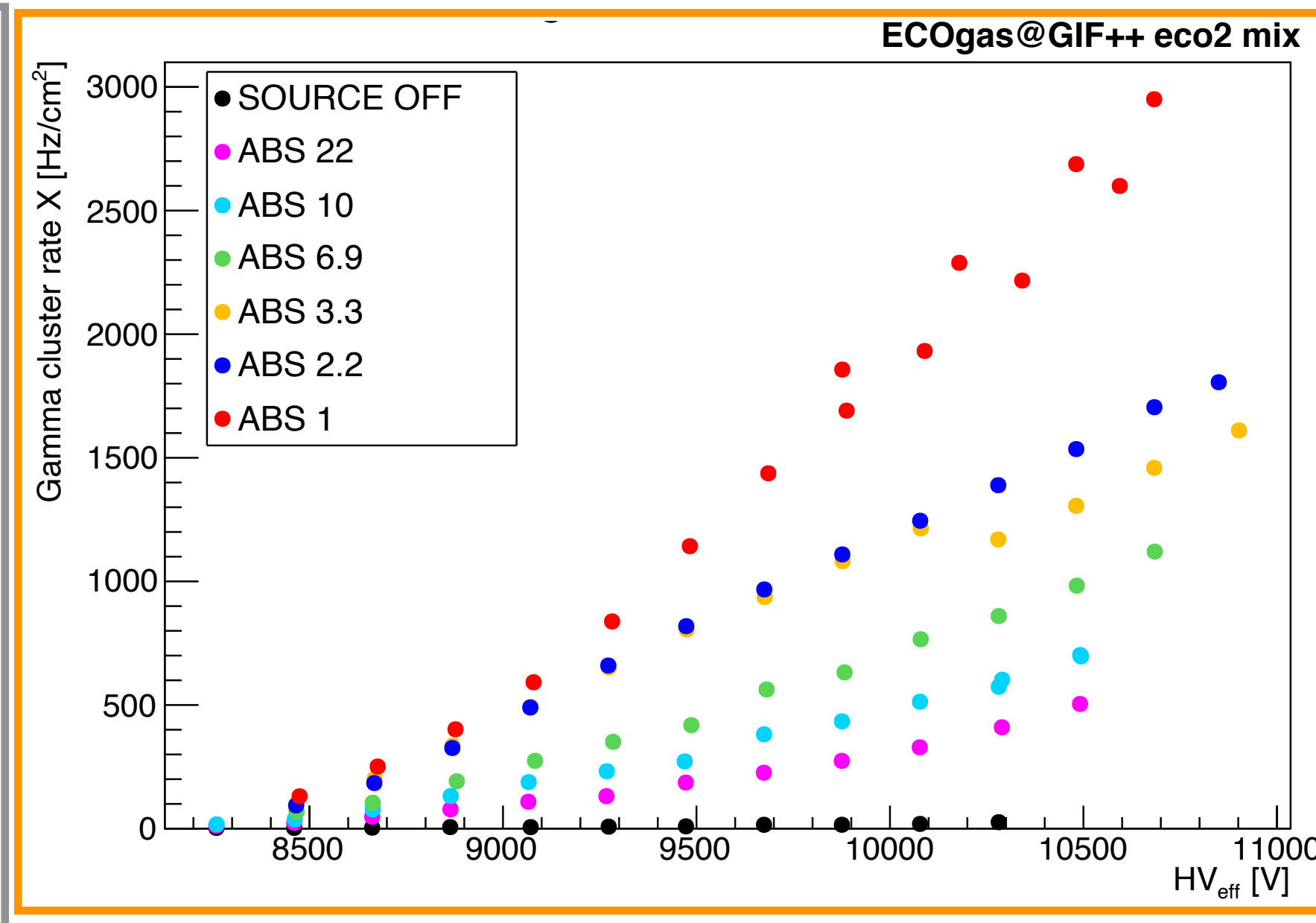
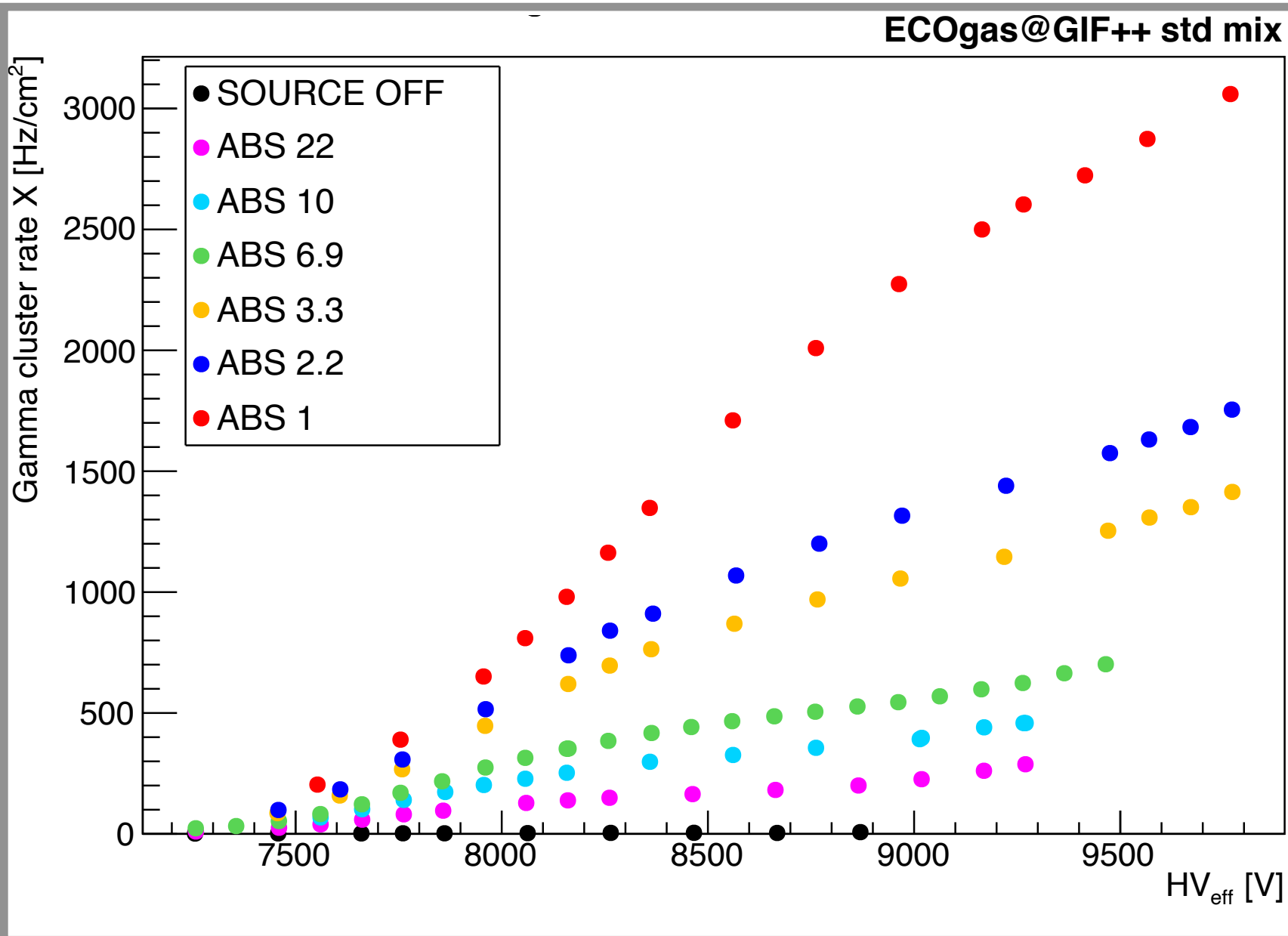
Comparison 2022-2023: WP, Eff2D, Current ECO3

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	8889.31	9195.35	306.04	96.11	96.17	0.06	18.23	70.76	52.53
22	9024.47	9490.17	465.70	93.95	93.34	-0.61	200.13	242.35	42.22
6.9	9192.35	10107.12	914.77	91.14	92.70	1.56	383.34	539.90	156.56
3.3	9533.89	10617.36	1083.47	89.63	91.34	1.71	676.01	821.91	145.9
2.2	9693.42	10889.39	1195.97	89.20	90.25	1.05	810.74	1049.11	238.37
1*	10104.23	nd	nd	84.15	nd	nd	1225.93	nd	nd

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

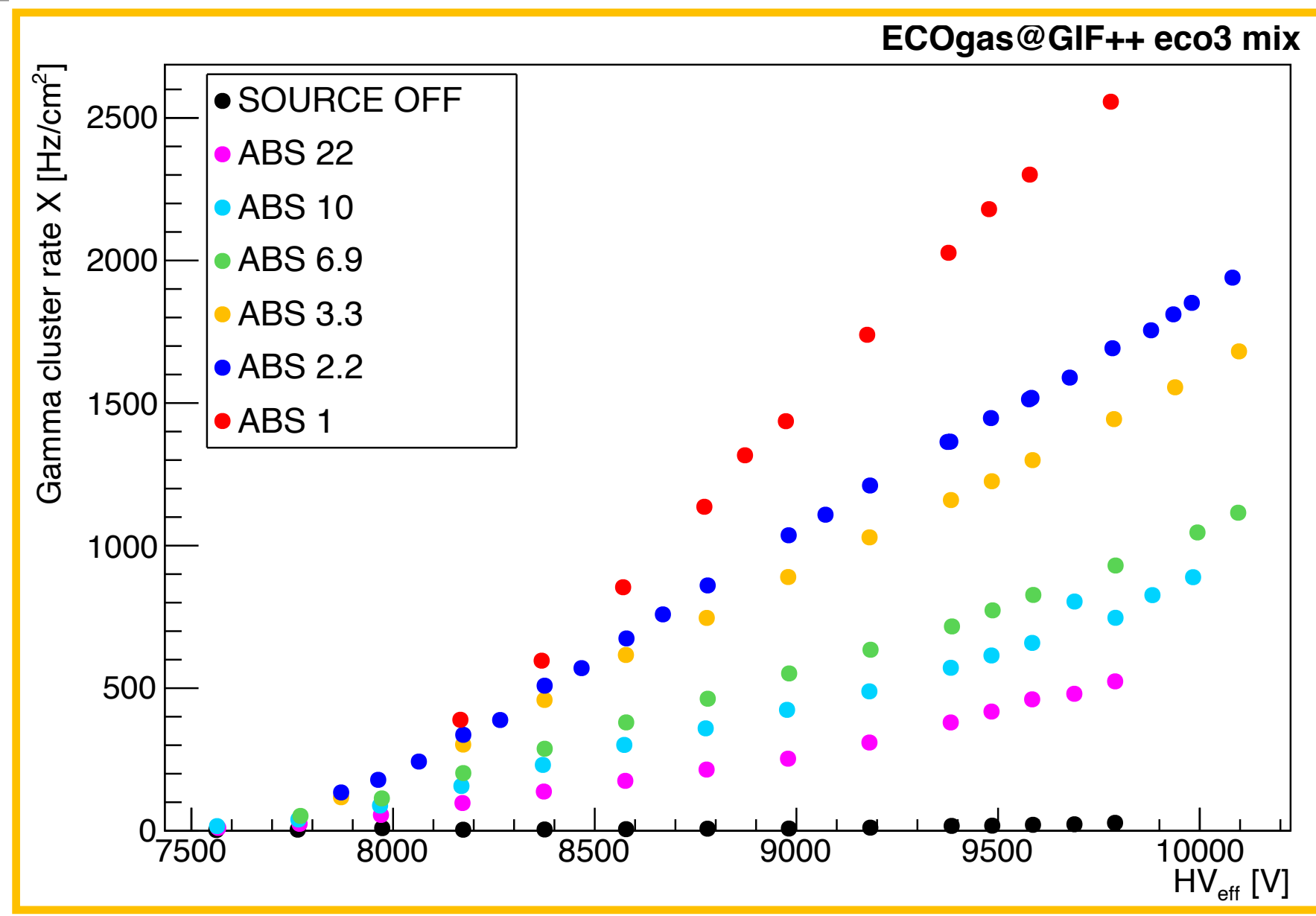
Gamma cluster rate X (2023)

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



ABS	2022	2023	Delta
OFF	3.34	15.59	12.25
22	329.41	319.41	-10
6.9	756.38	1026.72	270.34
3.3	1397.81	1817.85	420.04
2.2	1715.37	2074.83	359.46
1*	3461.48	nd	nd

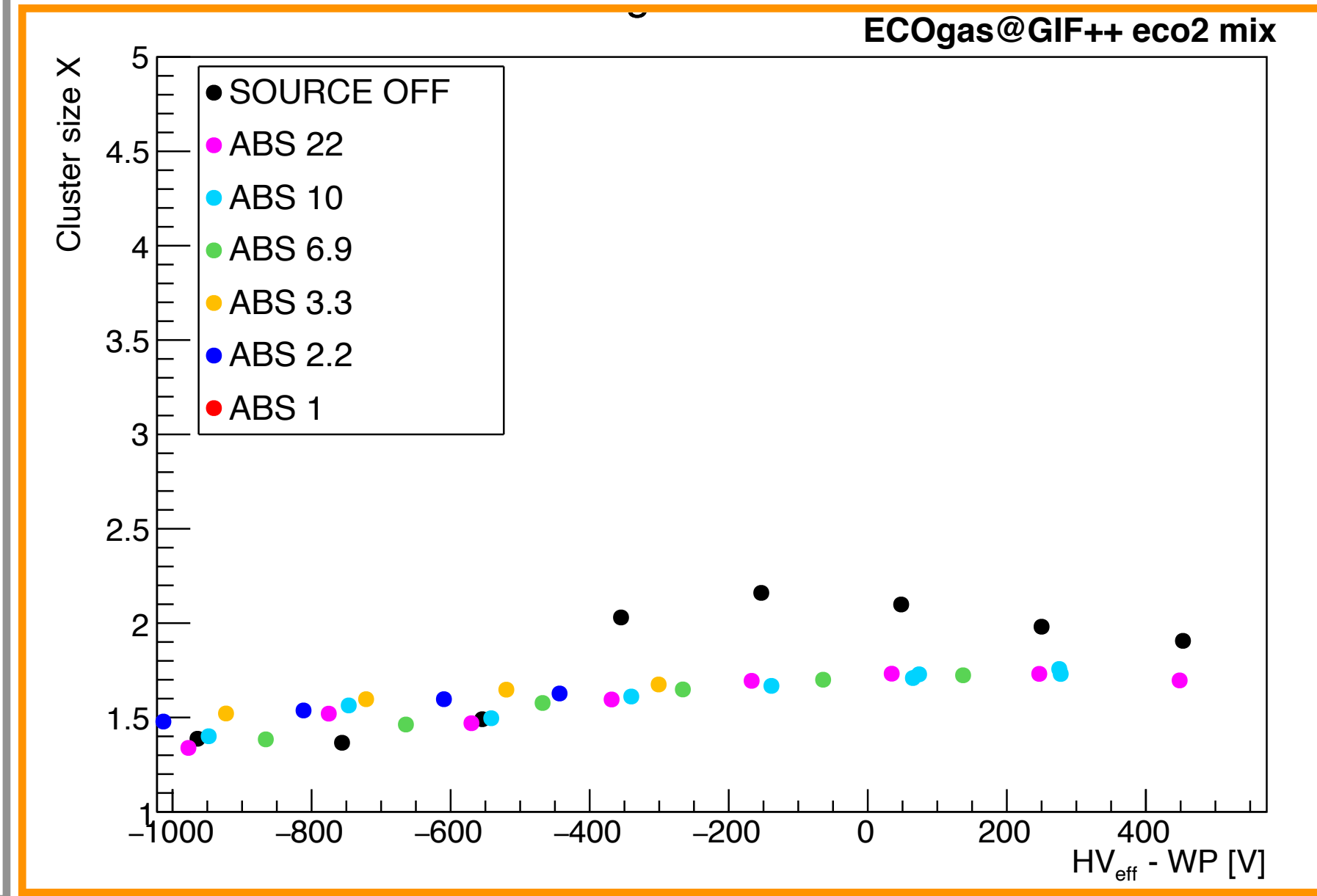
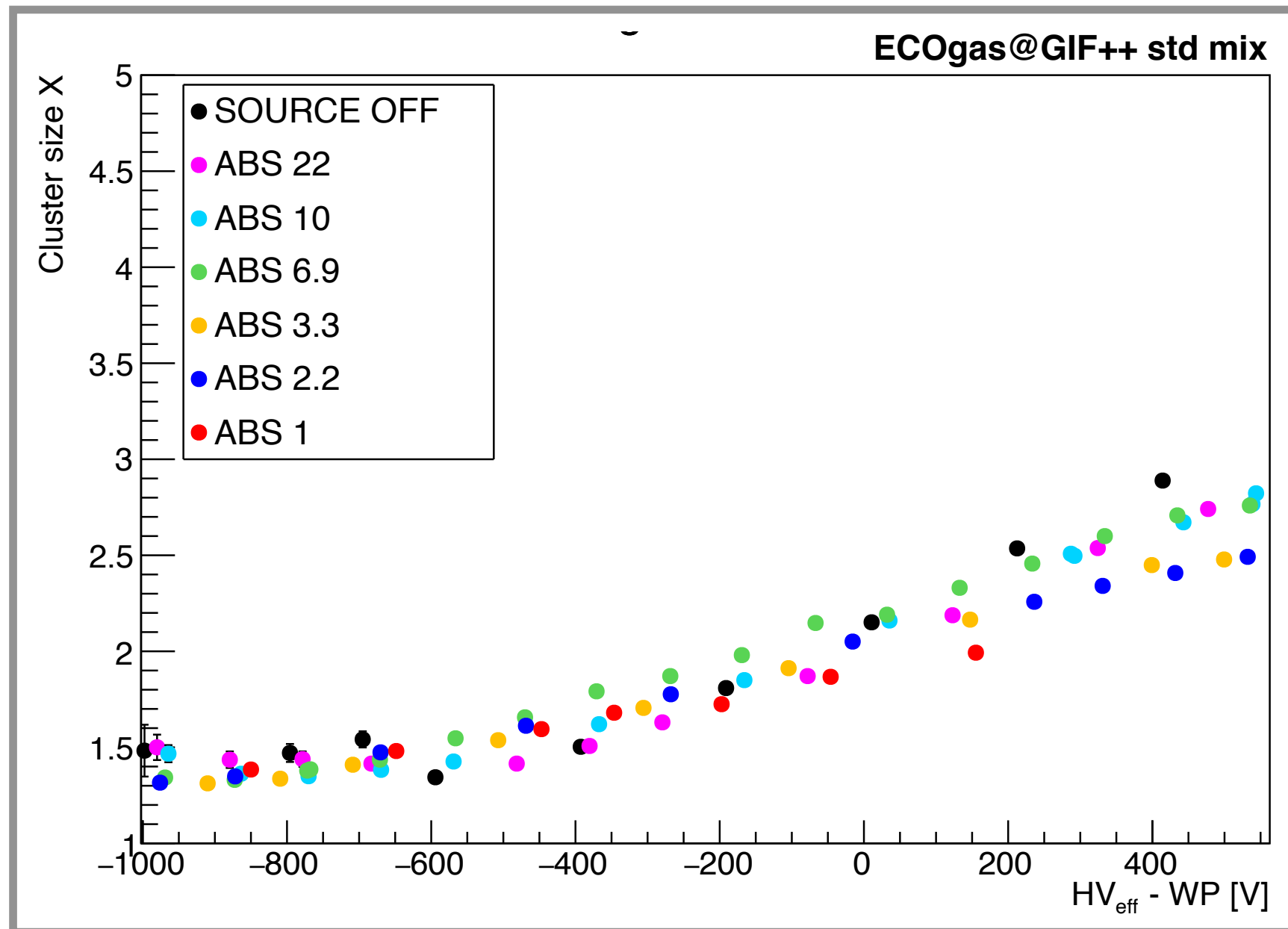
ABS	2022	2023	Delta
OFF	1.20	4.47	3.27
22	221.48	171.24	-50.24
6.9	659.34	539.00	-120.34
3.3	1303.58	1093.38	-210.2
2.2	1670.13	1448.26	-221.87
1*	3306.88	2916.77	-390.11



ABS	2022	2023	Delta
OFF	17.02	11.17	-5.85
22	326.63	420.74	94.11
6.9	761.78	1123.44	361.66
3.3	1469.61	2094.84	625.23
2.2	1829.13	2647.95	818.82
1*	3171.25	nd	nd

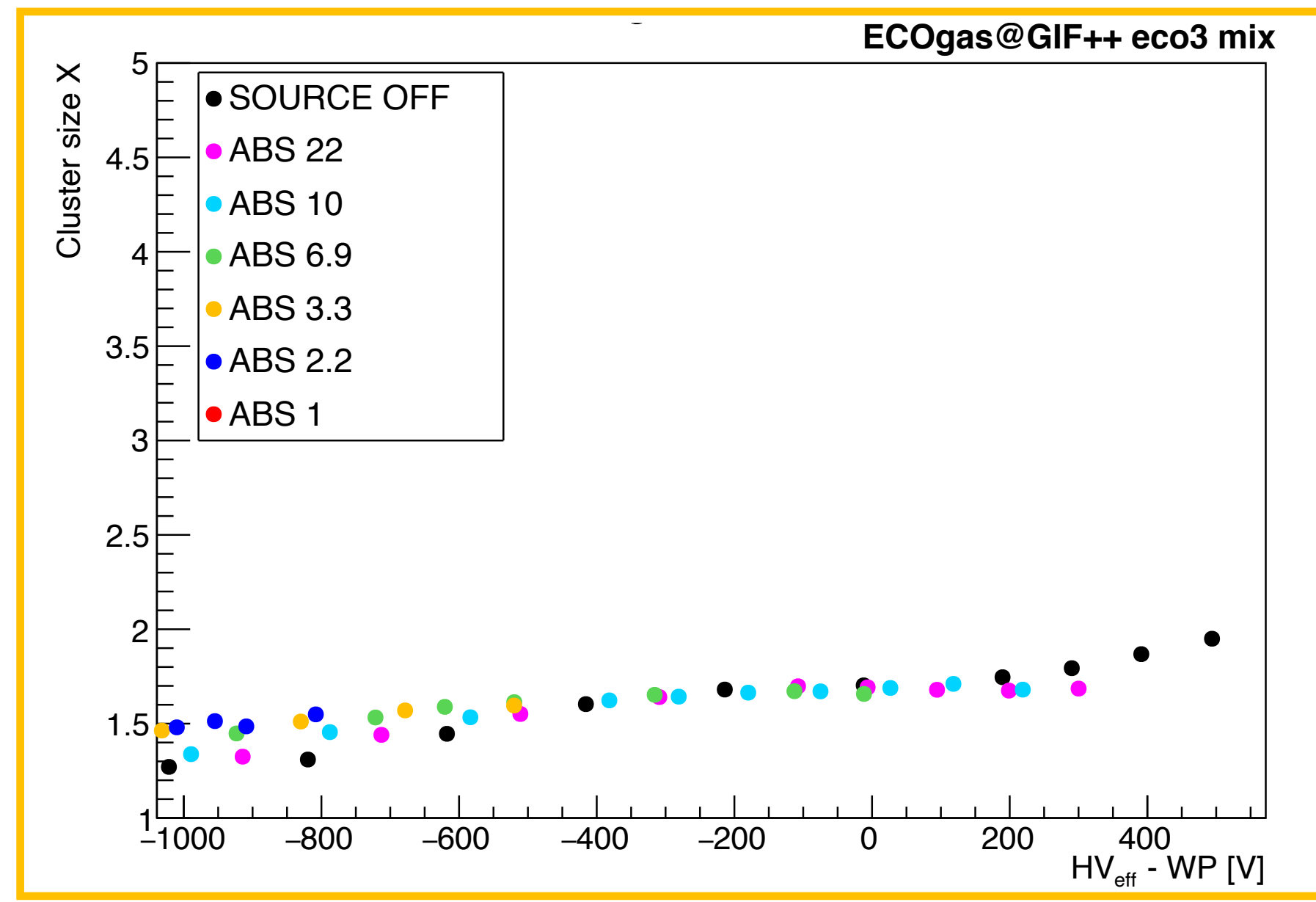
Muon Cluster size X (2023)

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



ABS	2022	2023	Delta
OFF	2.23	2.11	-0.12
22	2.28	1.73	-0.55
6.9	2.22	1.71	-0.51
3.3	2.09	1.71	-0.38
2.2	2.03	1.71	-0.32
1*	2.08	nd	nd

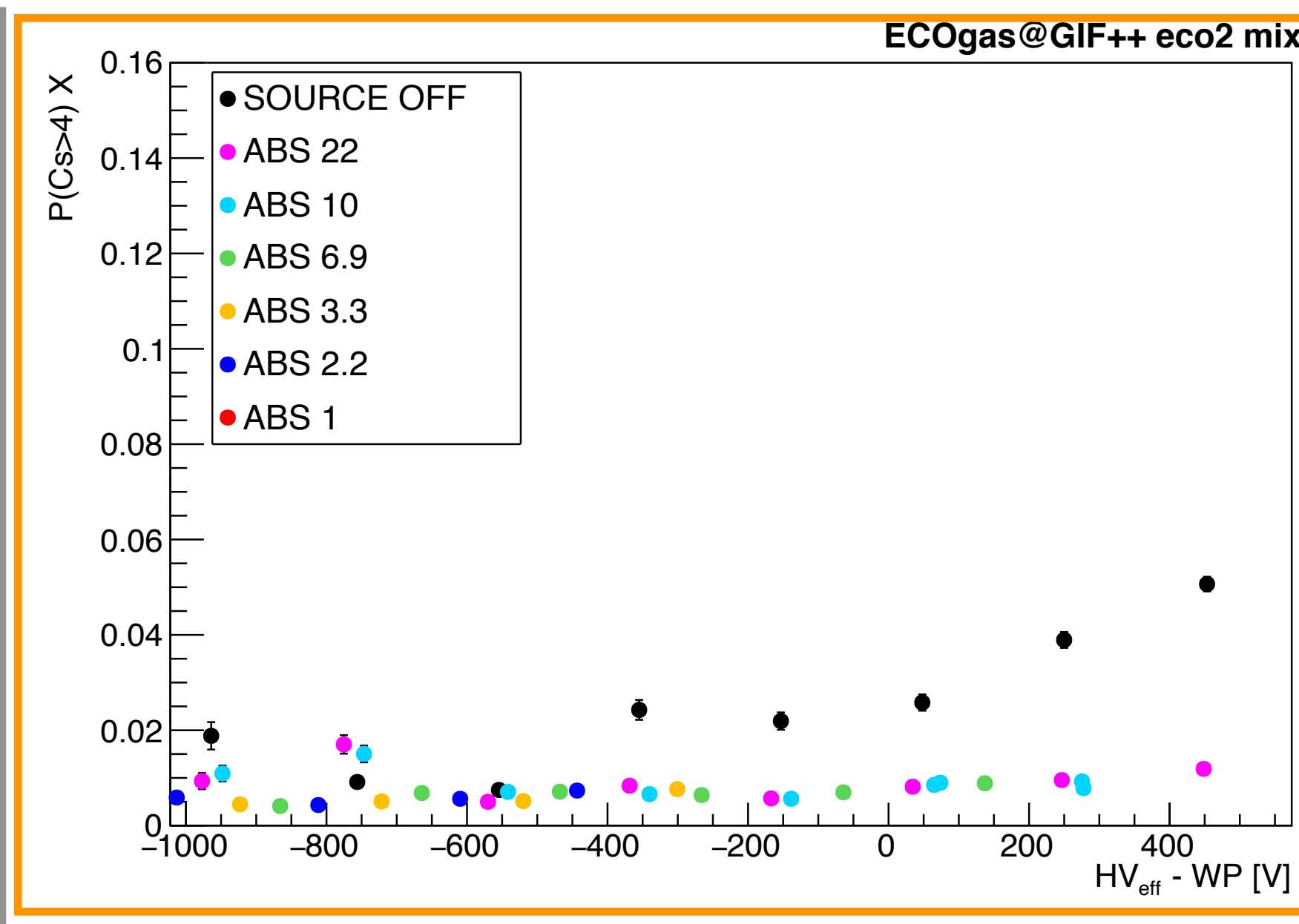
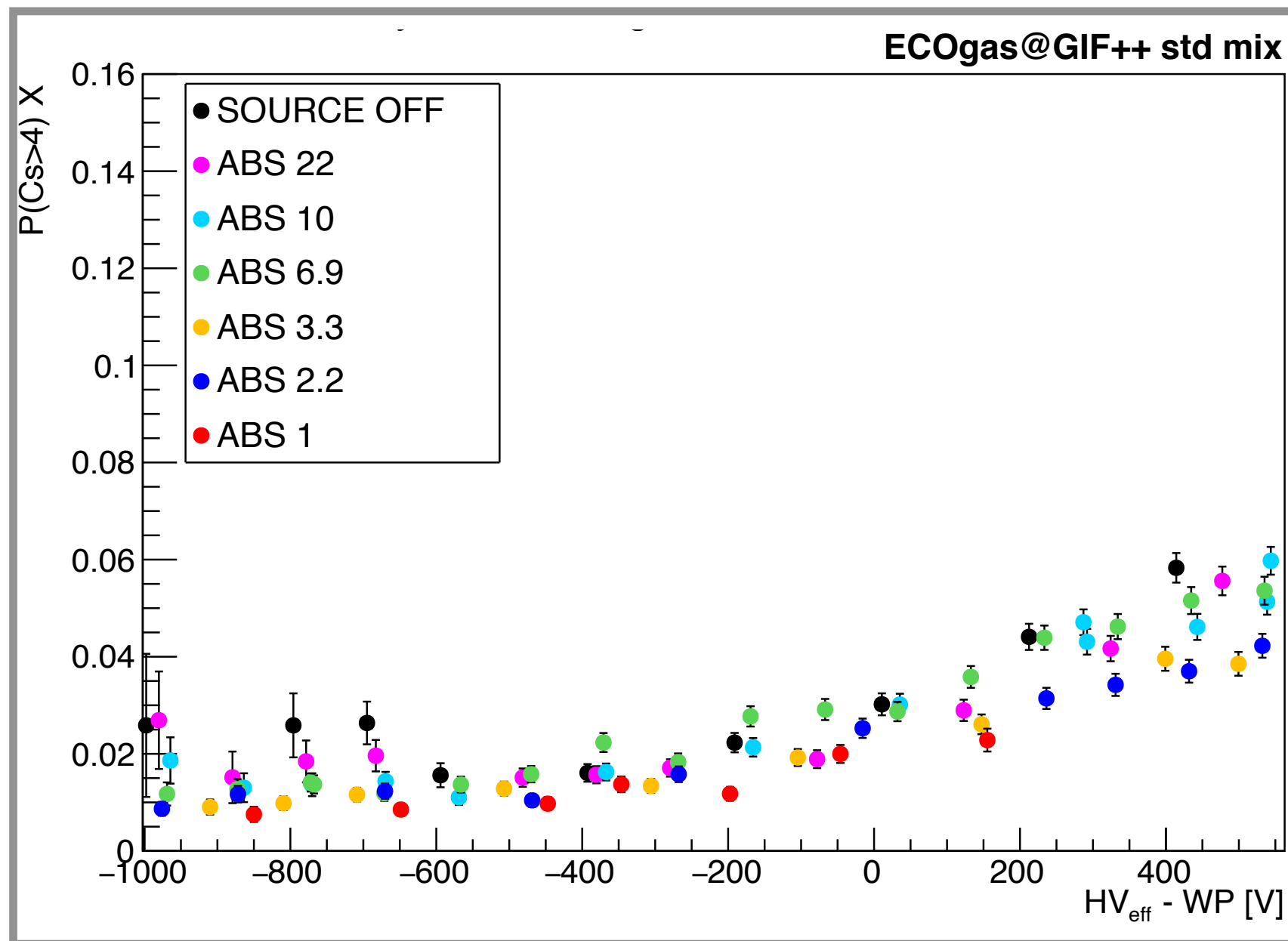
ABS	2022	2023	Delta
OFF	2.32	2.13	-0.19
22	2.27	1.99	-0.28
6.9	2.26	2.18	-0.08
3.3	2.09	2.02	-0.07
2.2	2.06	2.06	0
1*	1.92	1.90	-0.02



ABS	2022	2023	Delta
OFF	2.18	1.71	-0.47
22	2.18	1.69	-0.49
6.9	2.17	1.66	-0.51
3.3	2.08	1.68	-0.4
2.2	2.10	2.06	-0.04
1*	2.04	nd	nd

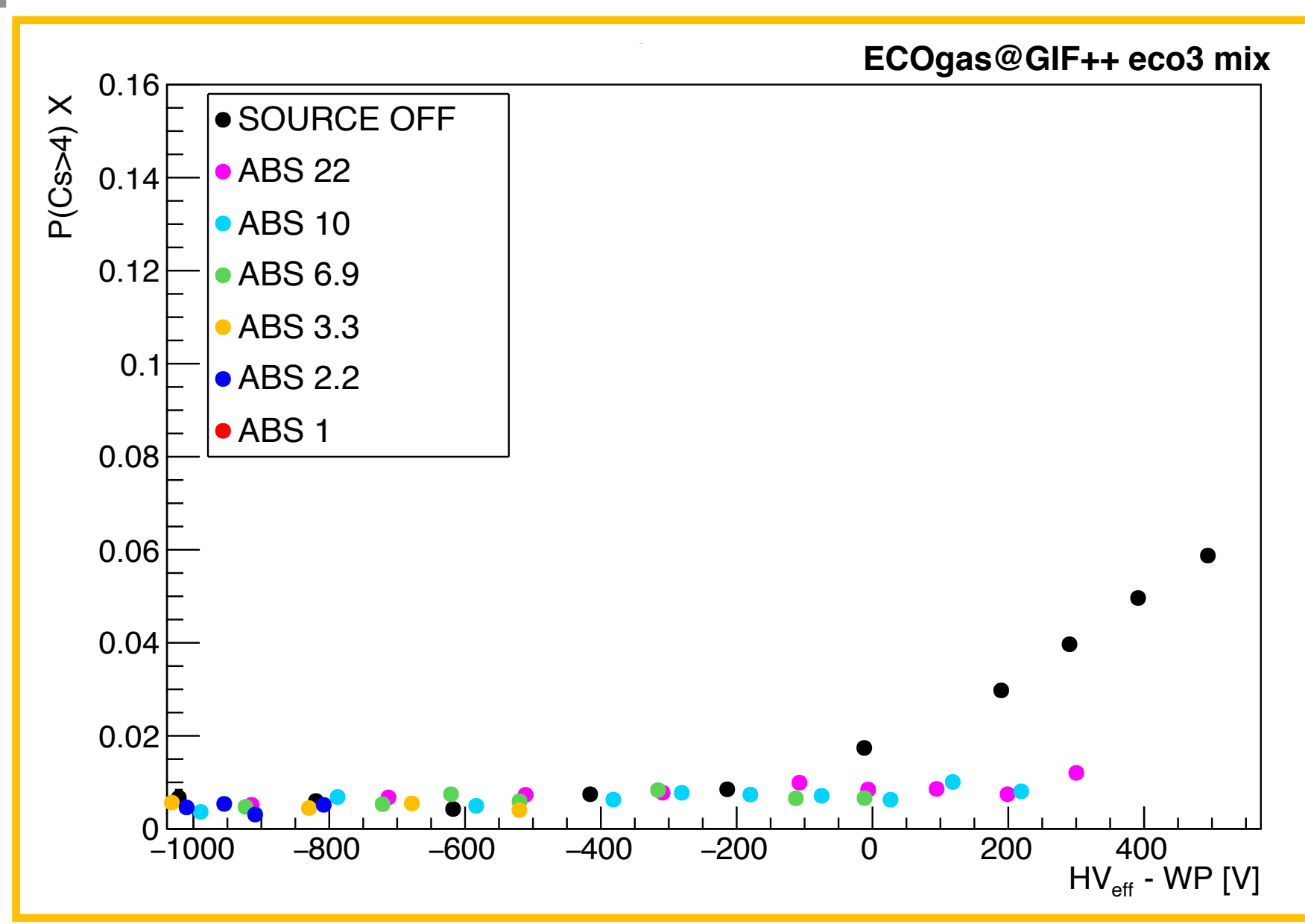
Probability of observing clusters with size >4 X (2023)

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



ABS	2022	2023	Delta
OFF	0.0381	0.0249	-0.0132
22	0.0206	0.0077	-0.0129
6.9	0.0215	0.0076	-0.0139
3.3	0.0163	0.0111	-0.0052
2.2	0.0162	0.0119	-0.0043
1*	0.0146	nd	nd

ABS	2022	2023	Delta
OFF	0.0361	0.0298	-0.0063
22	0.0420	0.0228	-0.0192
6.9	0.0377	0.0288	-0.0089
3.3	0.0210	0.0221	0.0011
2.2	0.0216	0.0256	0.004
1*	0.0147	0.0206	0.0059



ABS	2022	2023	Delta
OFF	0.0622	0.0182	-0.044
22	0.0292	0.0085	-0.0207
6.9	0.0290	0.0066	-0.0224
3.3	0.0230	0.0066	-0.0164
2.2	0.0229	0.0219	-0.001
1*	nd	nd	nd

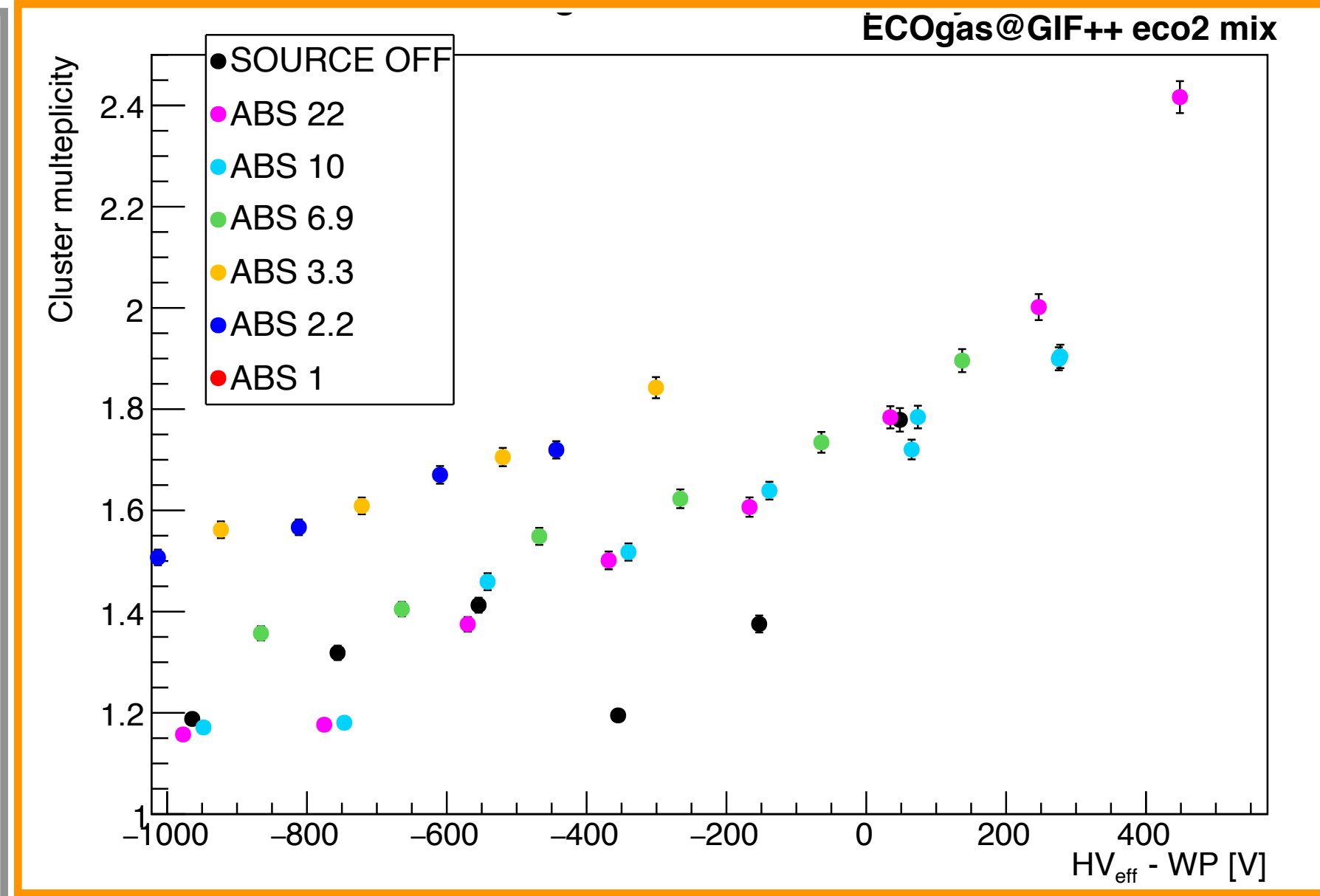
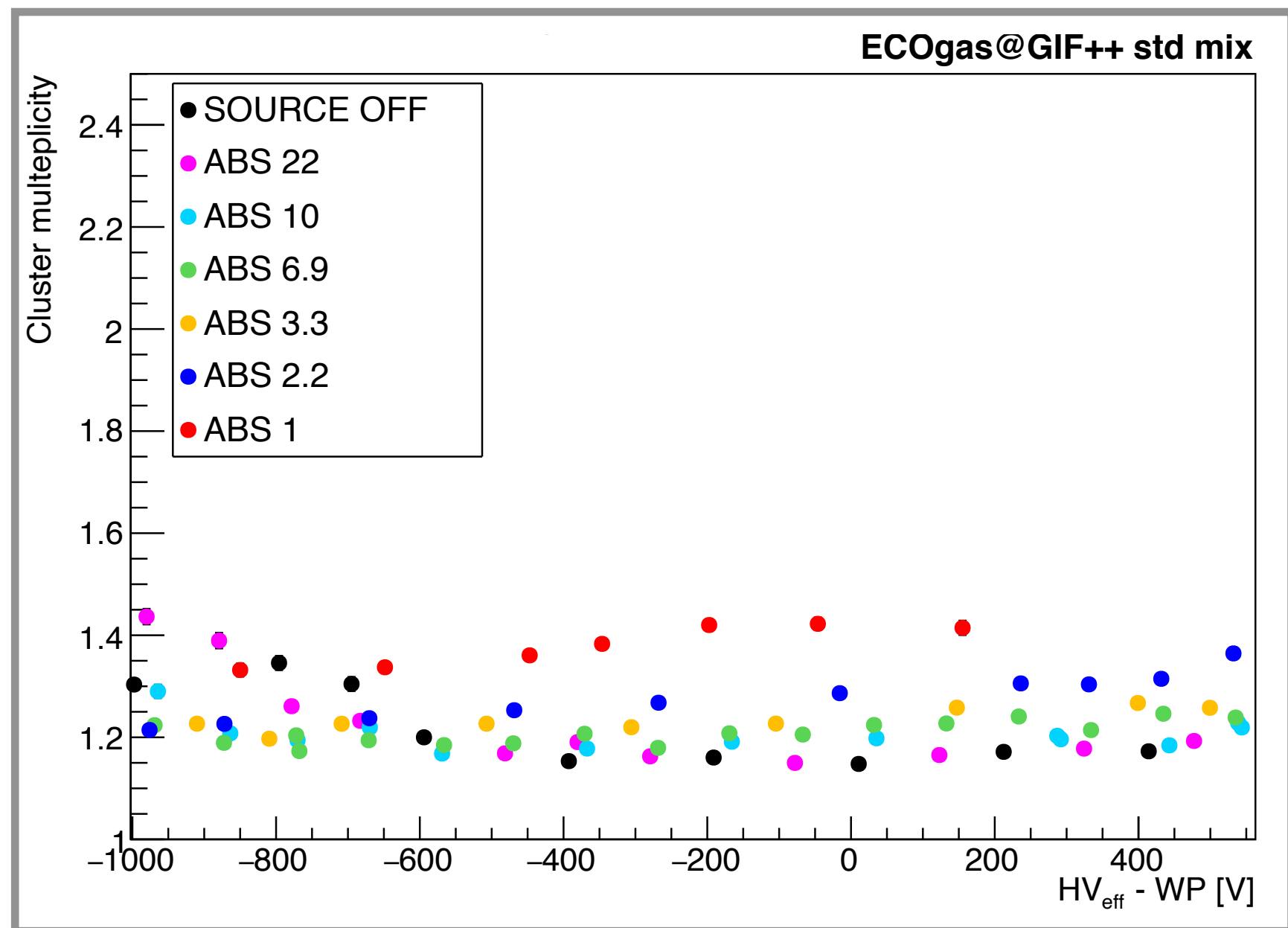
Conclusions

- Efficiency values at WP comparable between 2022 and 2023, but different slope
- Shift in WP at source off: 170V for stdmix, 300V for eco2 and eco3
- Current at WP comparable between 2022 and 2023 for STD mix, higher differences for eco3.
At source off it increases of 31uA for stdmix, 82uA at eco2, 53uA at eco3.
- Gamma cluster rate decreases for std mix and increases for eco2 and eco3 (to be investigated)
- Muon Cluster Size and $P(C_s > 4)$: STD distributions seem to be comparable, while for eco2 and eco3 values are much lower (about 22%)

backup

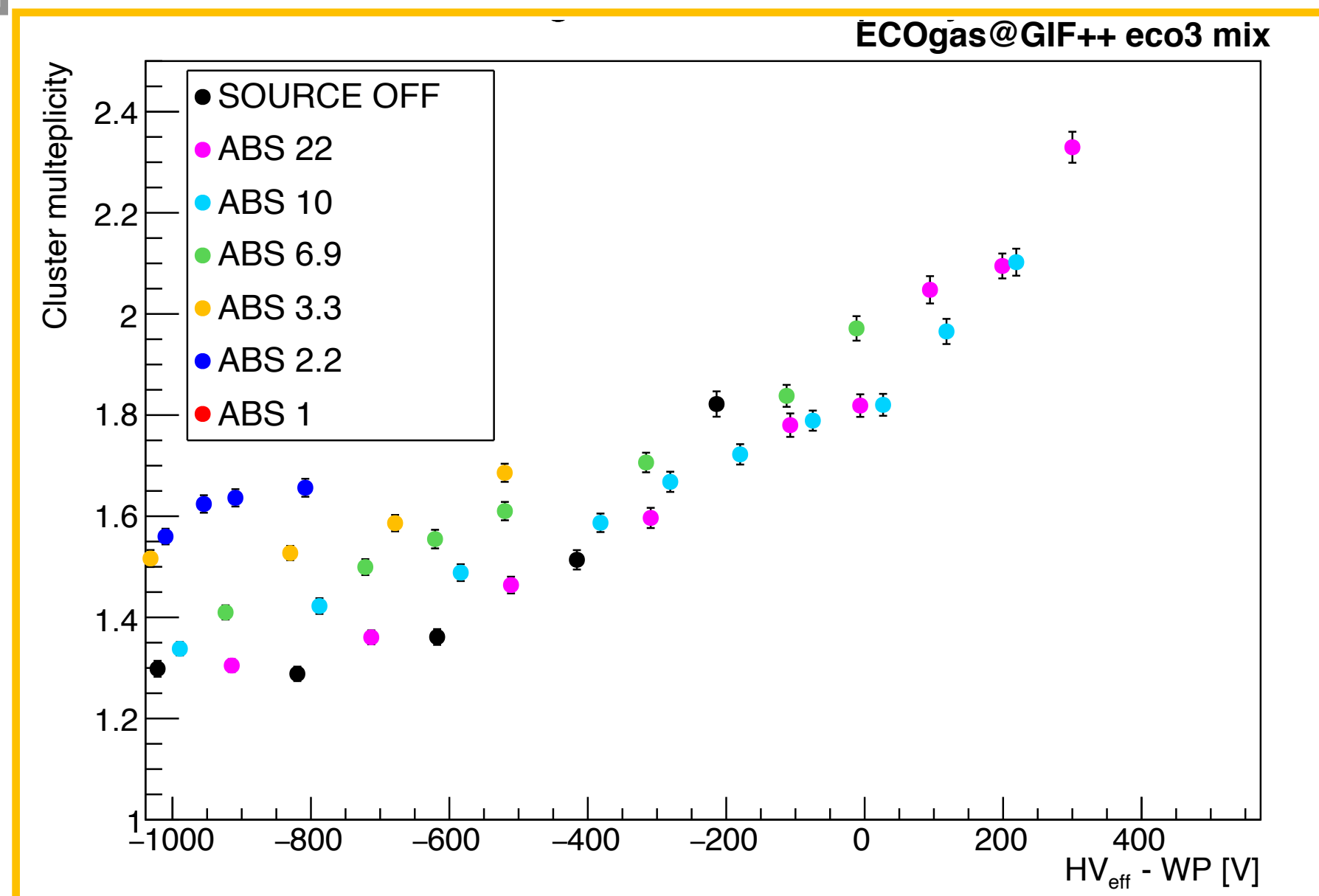
Muon Cluster multiplicity X (2023)

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



ABS	2022	2023	Delta
OFF	1.98	1.68	-0.3
22	1.41	1.75	0.34
6.9	1.36	1.79	0.43
3.3	1.34	2.03	0.69
2.2	1.37	1.85	0.48
1*	1.47	3.13	1.66

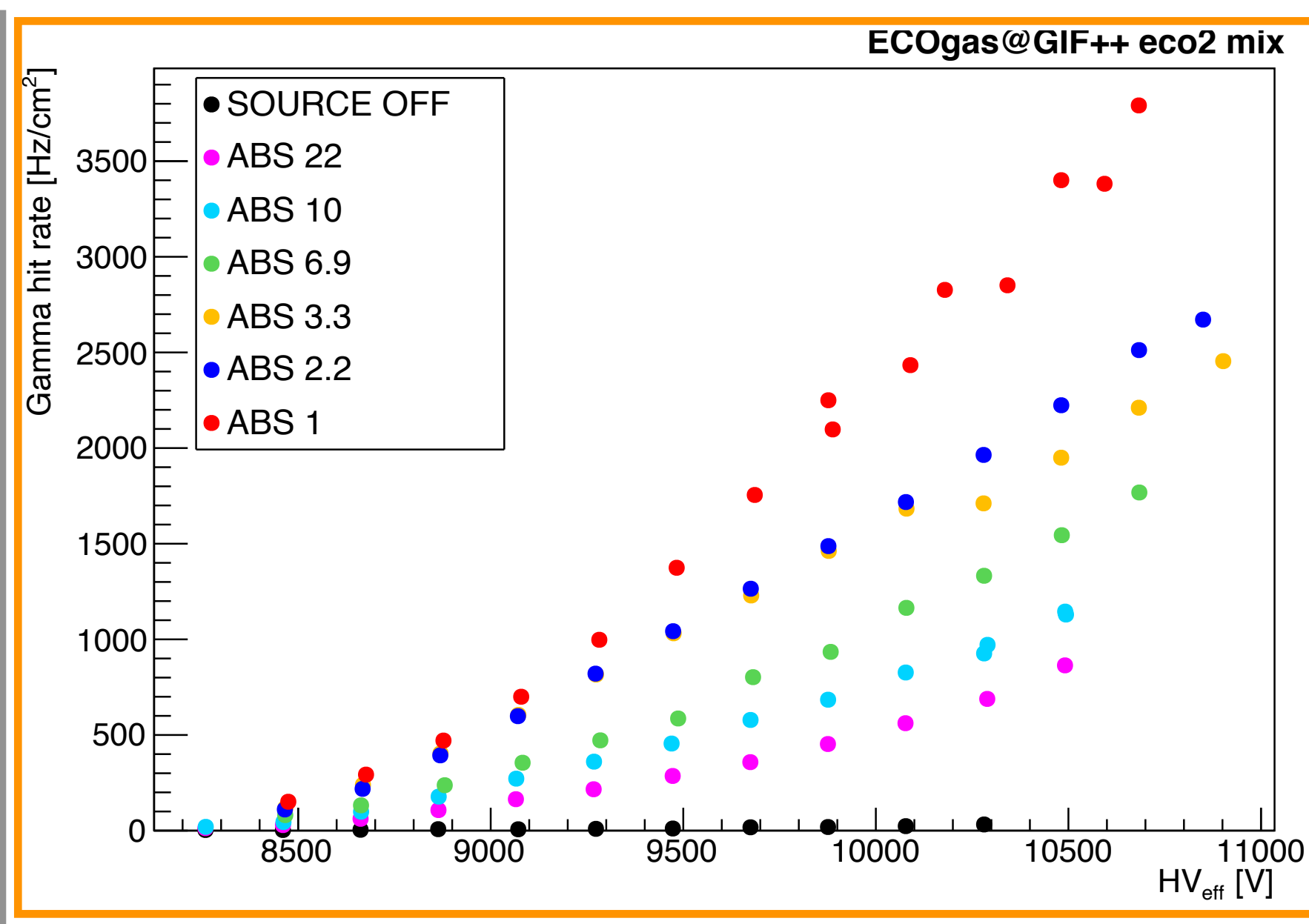
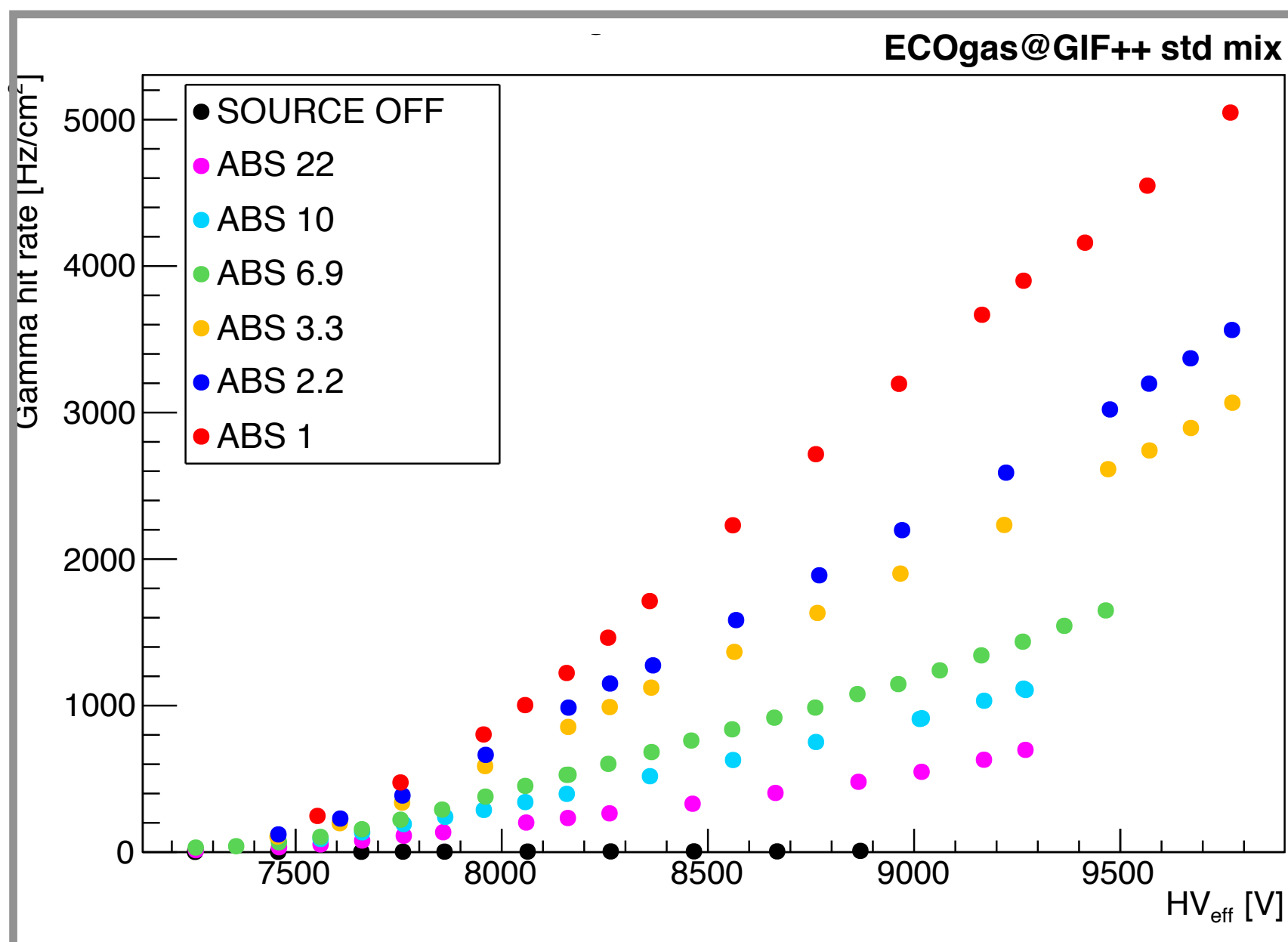
ABS	2022	2023	Delta
OFF	1.15	1.15	0
22	1.21	1.16	-0.05
6.9	1.23	1.22	-0.01
3.3	1.27	1.24	-0.03
2.2	1.28	1.29	0.01
1*	1.47	1.42	-0.05



ABS	2022	2023	Delta
OFF	2.86	2.58	-0.28
22	1.76	1.83	0.07
6.9	1.58	1.99	0.41
3.3	1.61	2.01	0.4
2.2	1.57	1.82	0.25
1*	1.57	1.52	-0.05

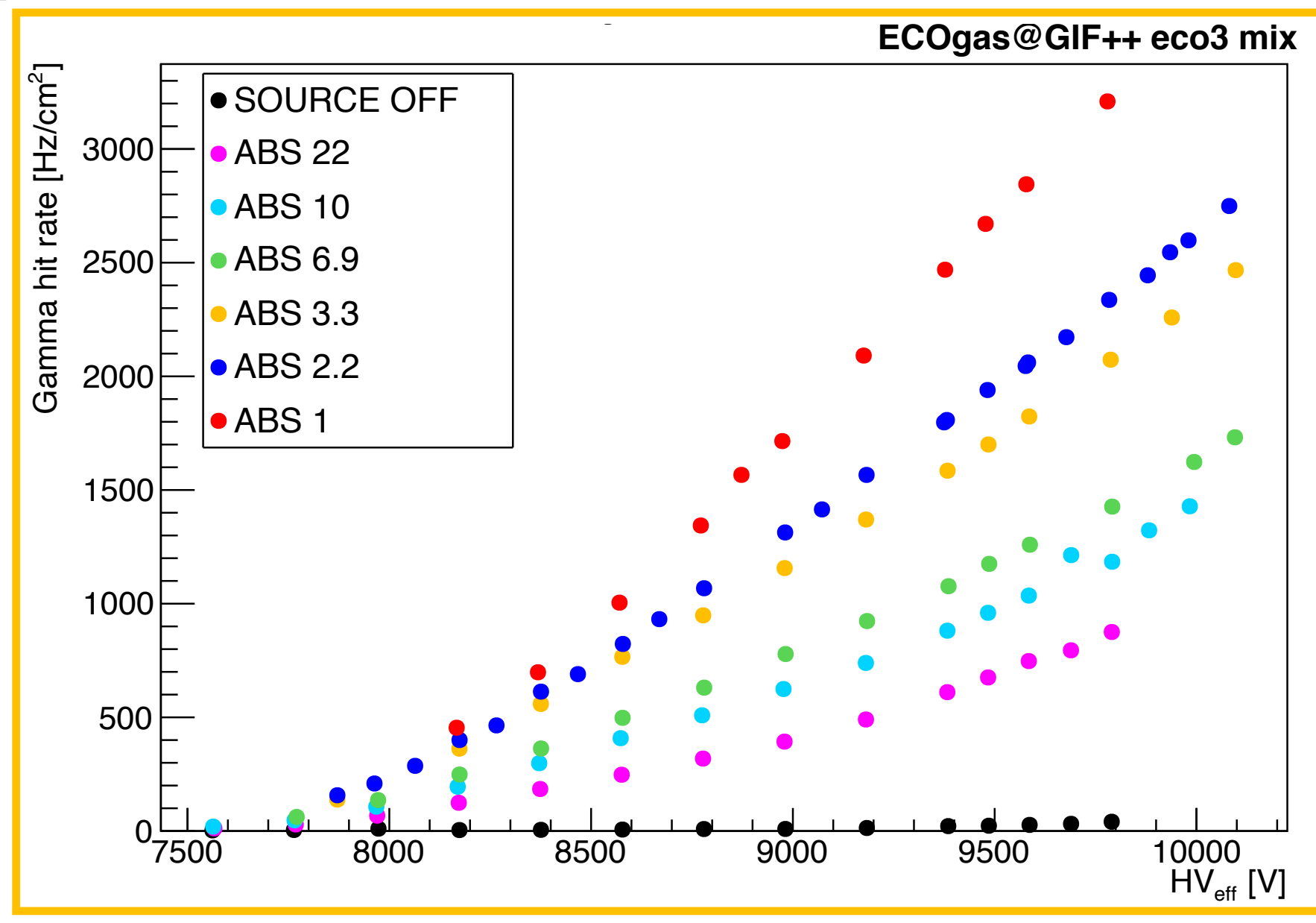
Gamma Hit Rate X (2023)

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



ABS	2022	2023	Delta
OFF	7.04	18.57	11.53
22	660.80	543.03	-117.77
6.9	1372.87	1615.74	242.87
3.3	2326.51	2788.57	462.06
2.2	2761.22	3096.23	335.01
1*	5175.37	11172.06	5996.69

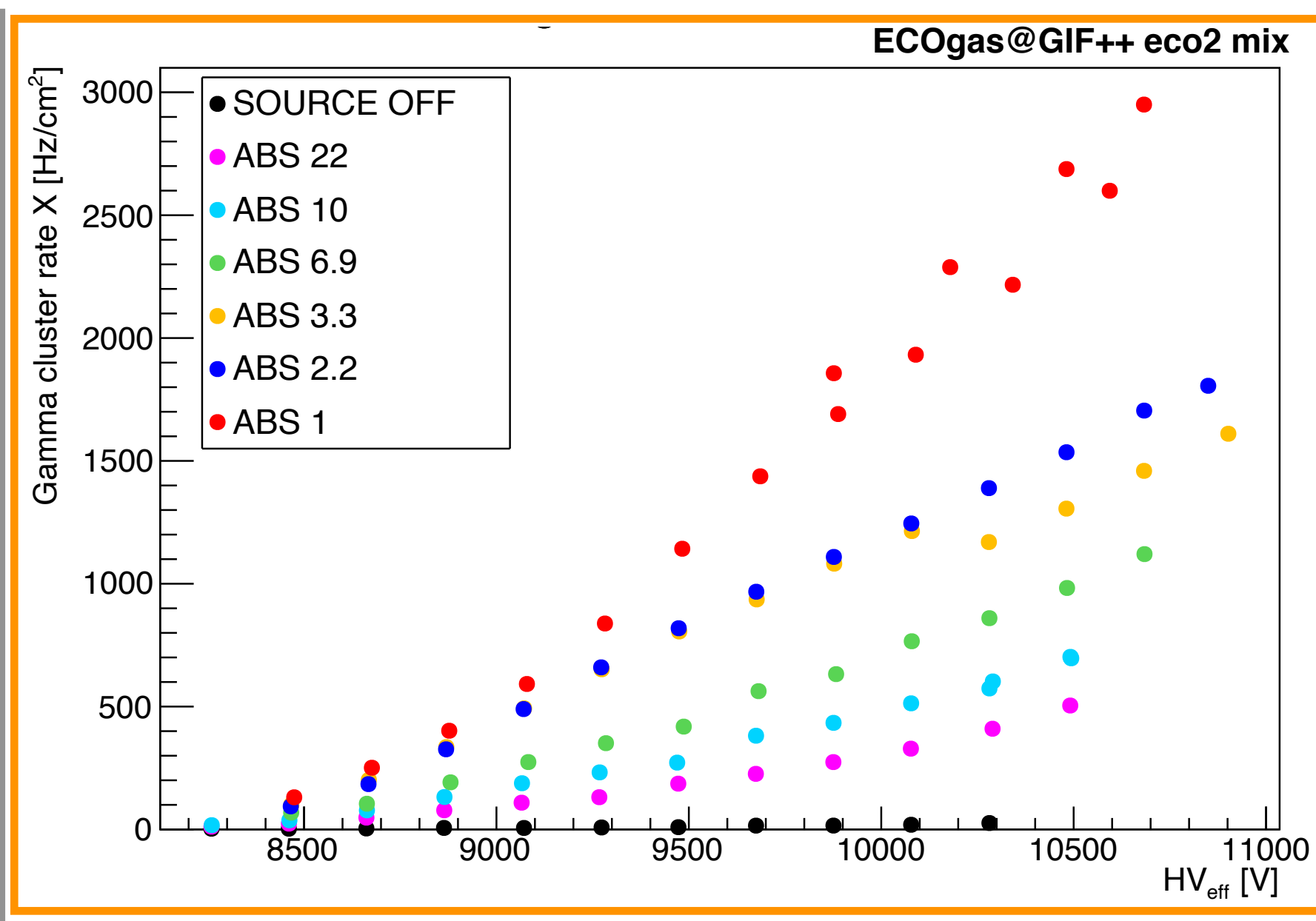
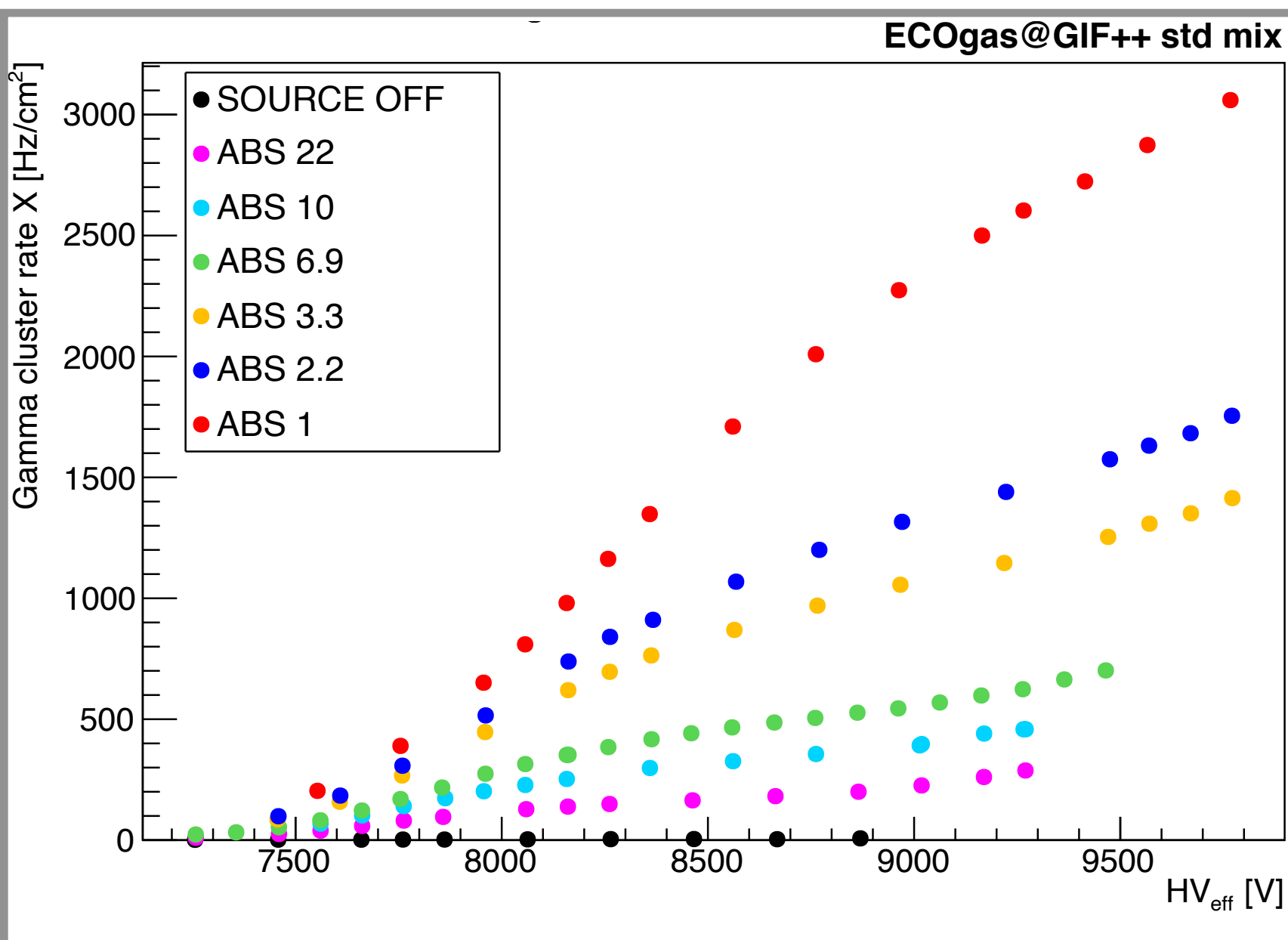
ABS	2022	2023	Delta
OFF	1.91	5.32	3.41
22	463.68	358.96	-104.72
6.9	1259.42	1124.91	-134.51
3.3	2229.07	2038.89	-190.18
2.2	2737.92	2616.78	-121.14
1*	4973.92	4663.00	-310.92



ABS	2022	2023	Delta
OFF	31.47	70.76	39.29
22	656.26	242.35	-413.91
6.9	1386.89	539.90	-846.99
3.3	2512.25	821.91	-1690.34
2.2	3029.87	1049.11	-1980.76
1*	4847.96	1803.30	-3044.66

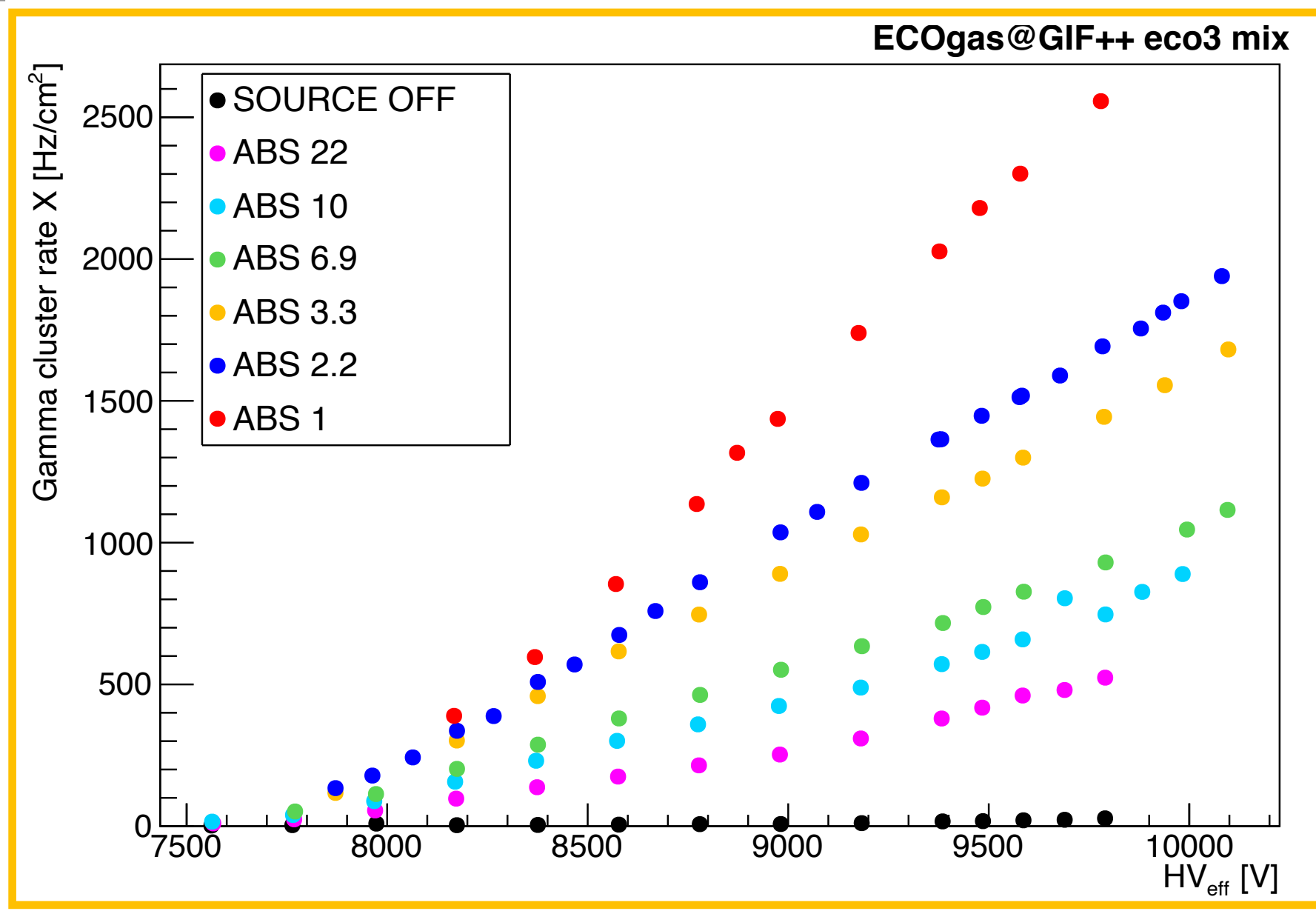
Gamma cluster rate X (2023) - TABLES corrected for efficiency

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



ABS	2022	2023	Delta
OFF	3.44	16.13	12.69
22	345.76	335.80	-9.96
6.9	811.51	1095.15	283.64
3.3	1522.12	1919.69	397.57
2.2	1962.28	2213.54	251.26
1*	4038.23	9670.41	5632.18

ABS	2022	2023	Delta
OFF	1.24	4.57	3.33
22	227.50	176.52	-50.98
6.9	680.06	552.96	-127.1
3.3	1350.26	1127.35	-222.91
2.2	1751.38	1496.37	-255.01
1*	3542.66	3102.44	-440.22



ABS	2022	2023	Delta
OFF	17.66	11.60	-6.06
22	345.35	449.04	103.69
6.9	826.56	1203.56	377
3.3	1612.02	2264.15	652.13
2.2	2006.94	2850.51	843.57
1*	3656.27	5810.06	2153.79