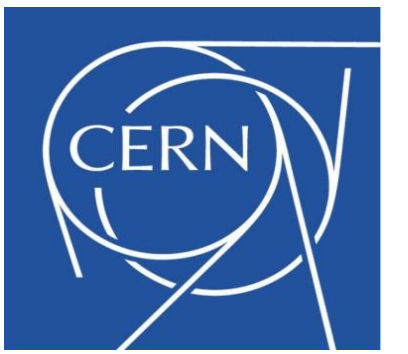


Test of new Eco-Gas mixtures for the Multigap Resistive Plate Chambers of the EEE Project

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The EEE Project

The Extreme Energy Events [1], [2] experiment is a project by Centro Fermi (Museo Storico della Fisica e Centro Studi e Ricerche “Enrico Fermi”) in collaboration with INFN (Istituto Nazionale di Fisica Nucleare), CERN (European Organization for Nuclear Research) and MIUR (the Italian Ministry of Education, University and Research).

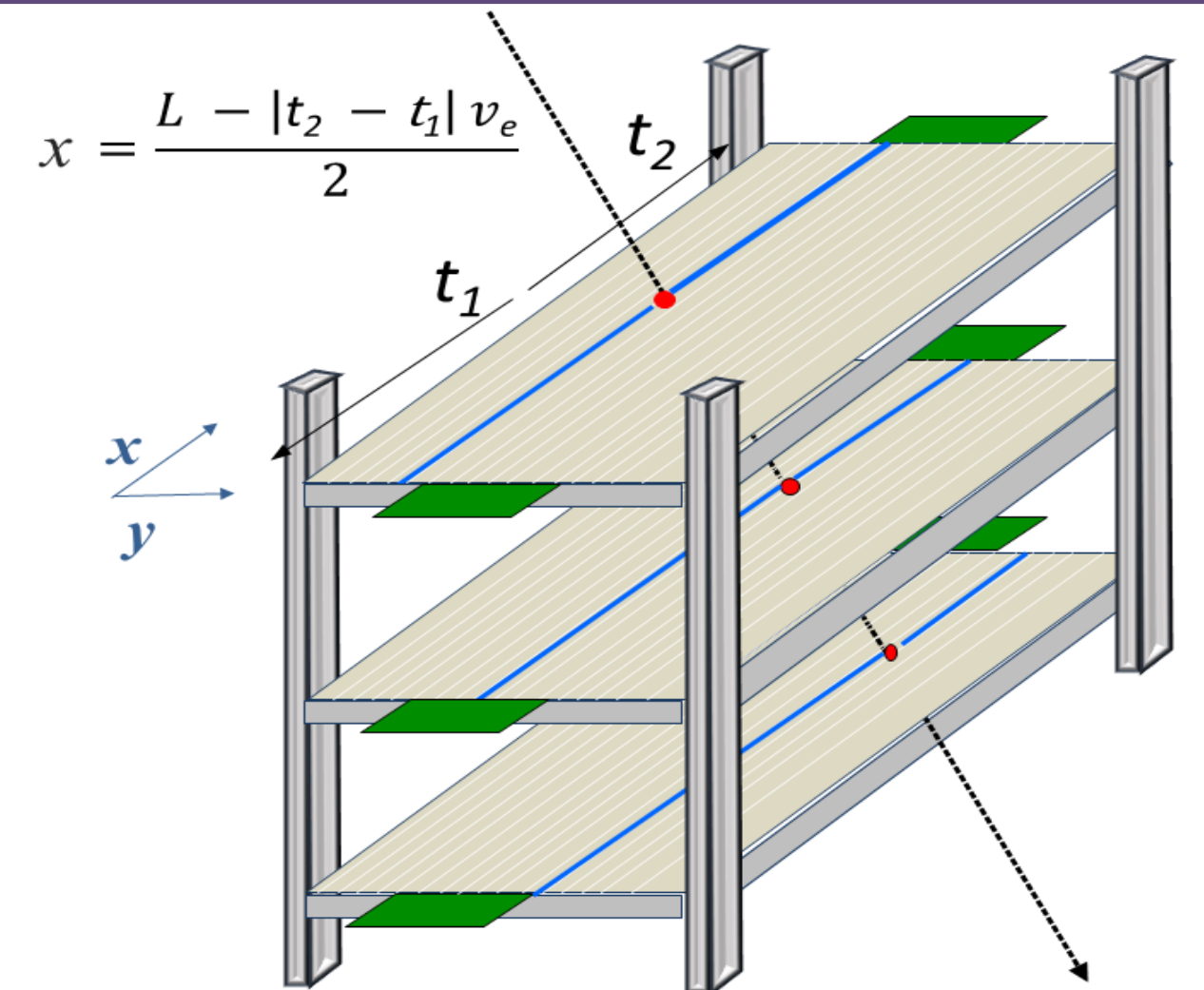
EEE is designed to study Cosmic Rays and related phenomena, via a synchronous sparse network of 56 tracking detectors installed in High Schools, each made of 3 MRPC detectors, deployed over an area covering more than 10° in latitude and 11° in longitude, corresponding to more than $3 \times 10^5 \text{ km}^2$.



The EEE muon telescopes

Three Multigap resistive Plate Chambers (MRPC), providing the impact coordinates of incoming muons, hence the reconstruction of its track, with high efficiency and good angular resolution.

Each detector is operating in avalanche mode, with characteristic similar to the ones built for the Time Of Flight array of ALICE at LHC.



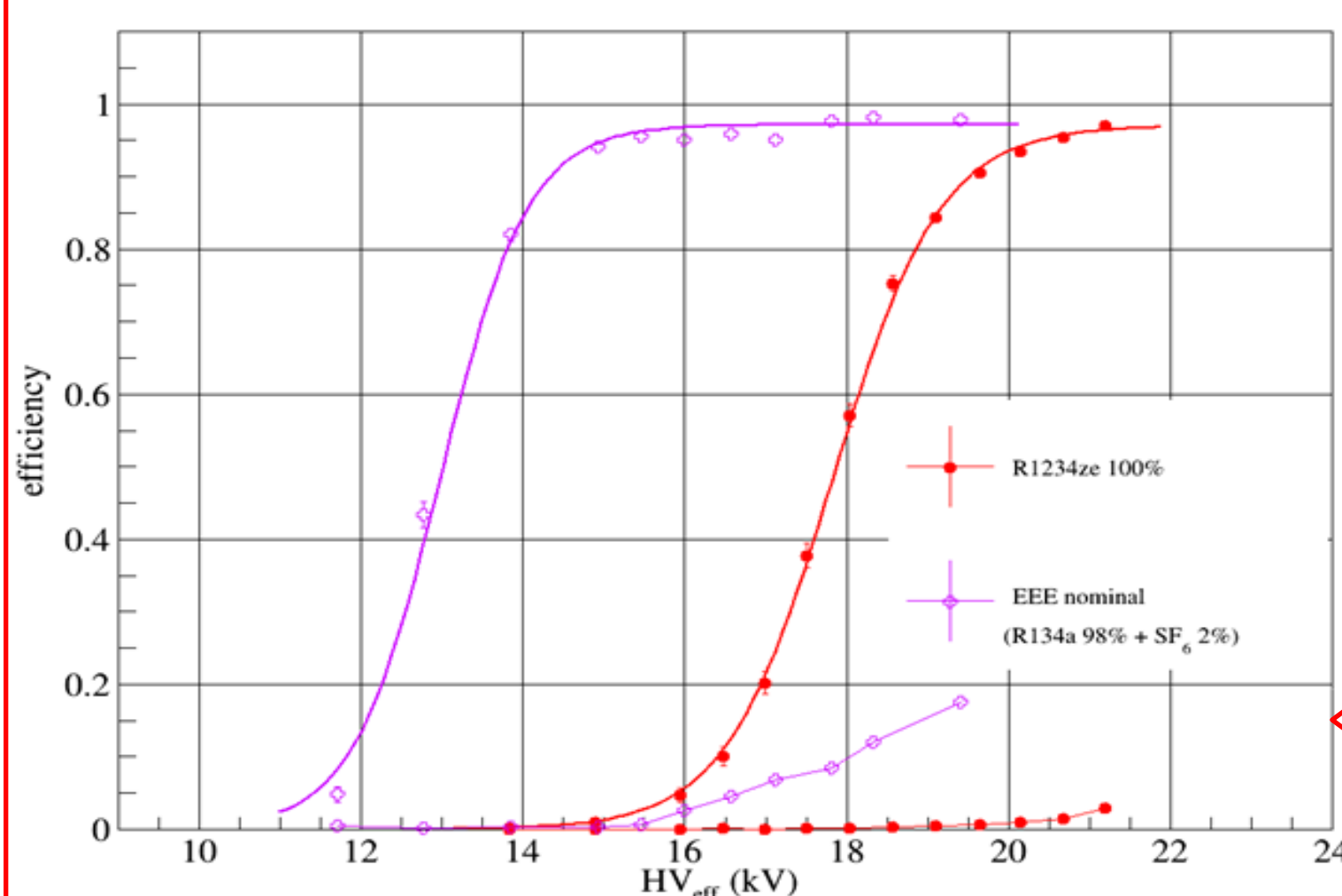
The Global Warming Potential reduction problem

MRPC chambers of the EEE telescopes are filled with a gas mixture of 98% of tetrafluoroethane and 2% of sulfur hexafluoride, but recent restrictions on greenhouse gases have prompted the study of the performance of these chambers with new gas mixtures.

Extensive tests of several gas mixtures with cosmic muons detected by one of the telescopes installed at CERN have been carried out.

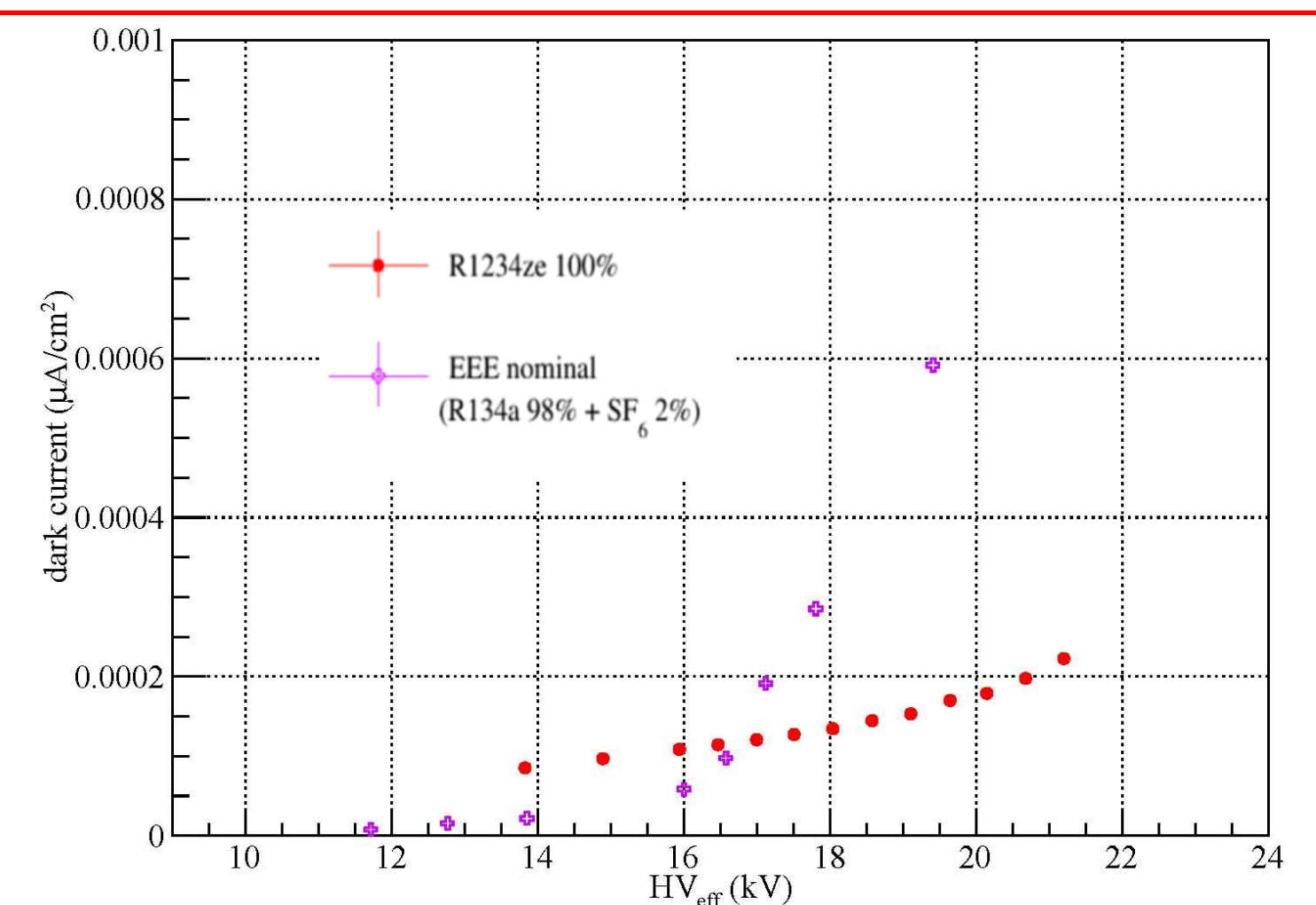
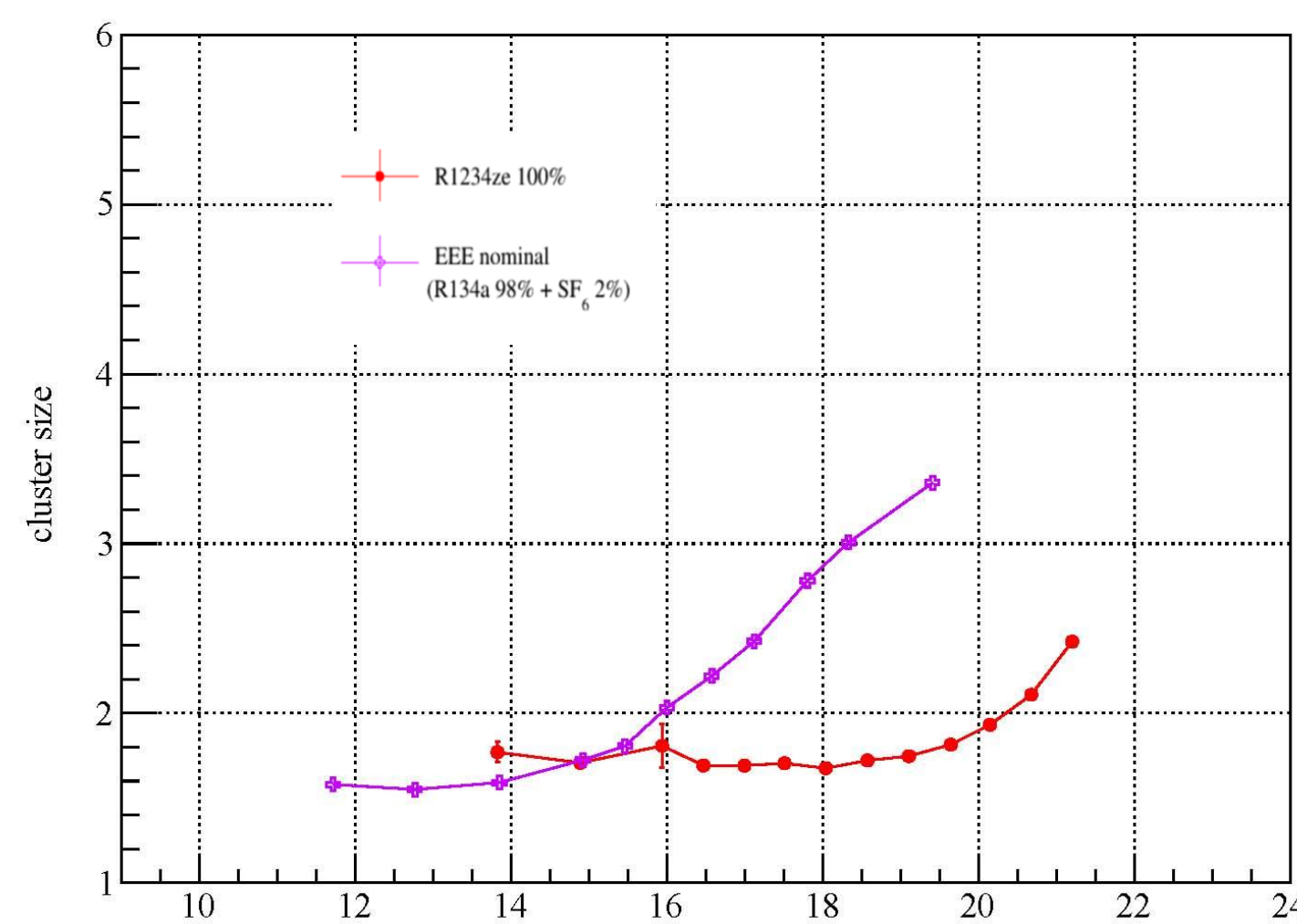
The detection efficiency, the current and the cluster size with new mixtures of tetrafluoropropane and carbon dioxide or sulfur hexafluoride have been studied under different conditions as a function of the applied high voltage.

Pure tetrafluoropropene (R1234ze)



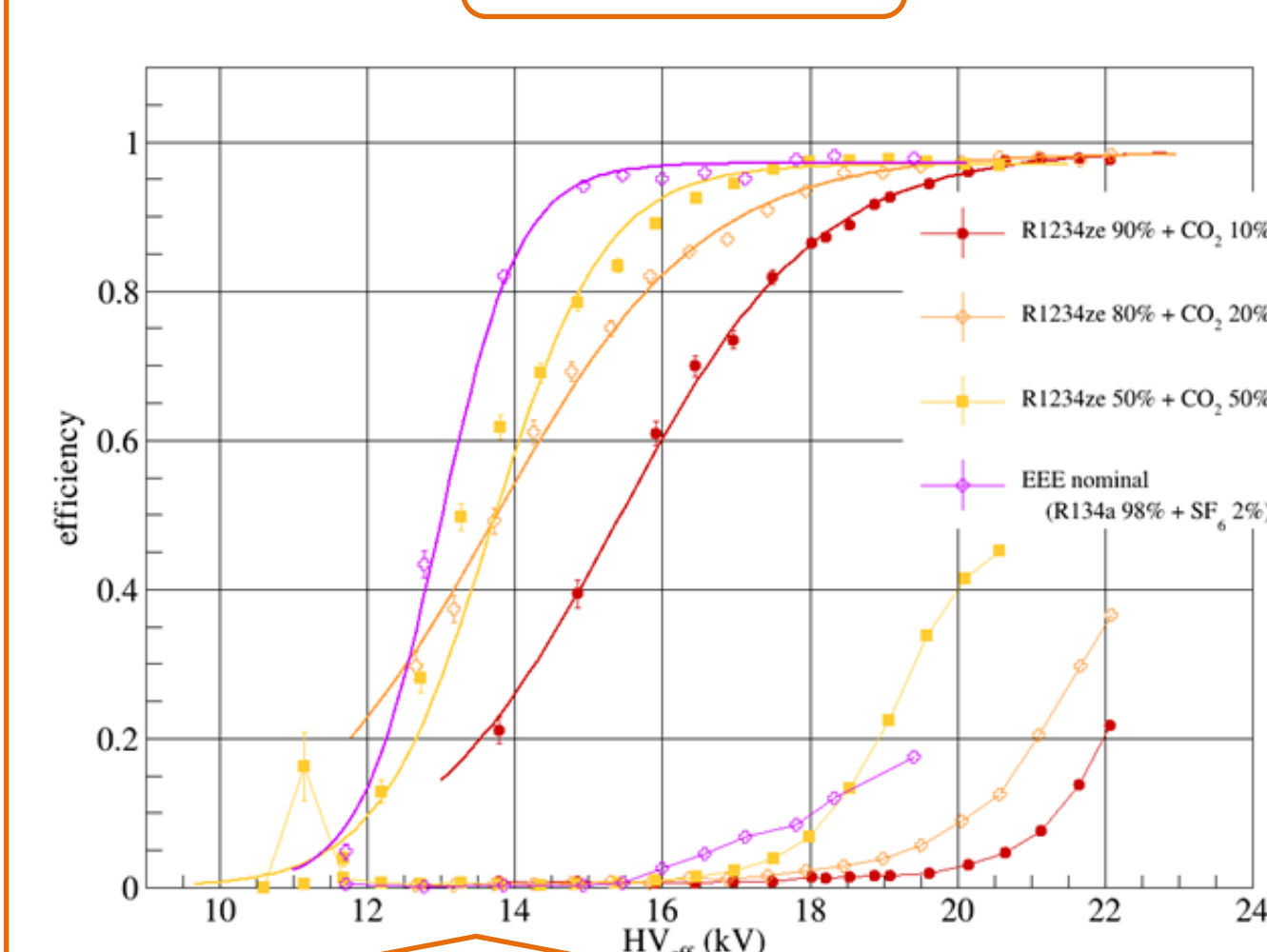
Higher HV setting point

Streamer percentage under control



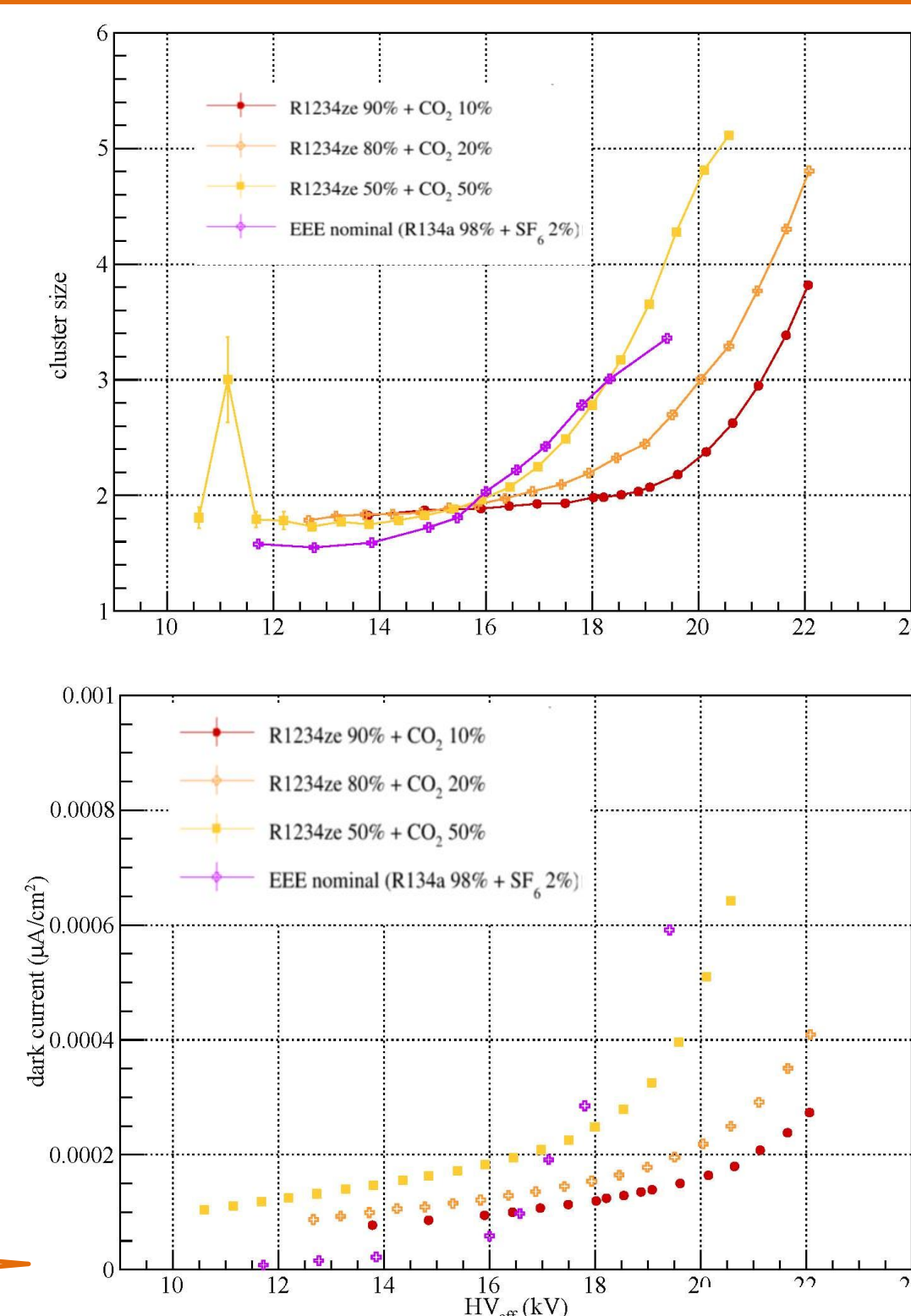
Low dark current & Stable Cluster size

R1234ze + CO2

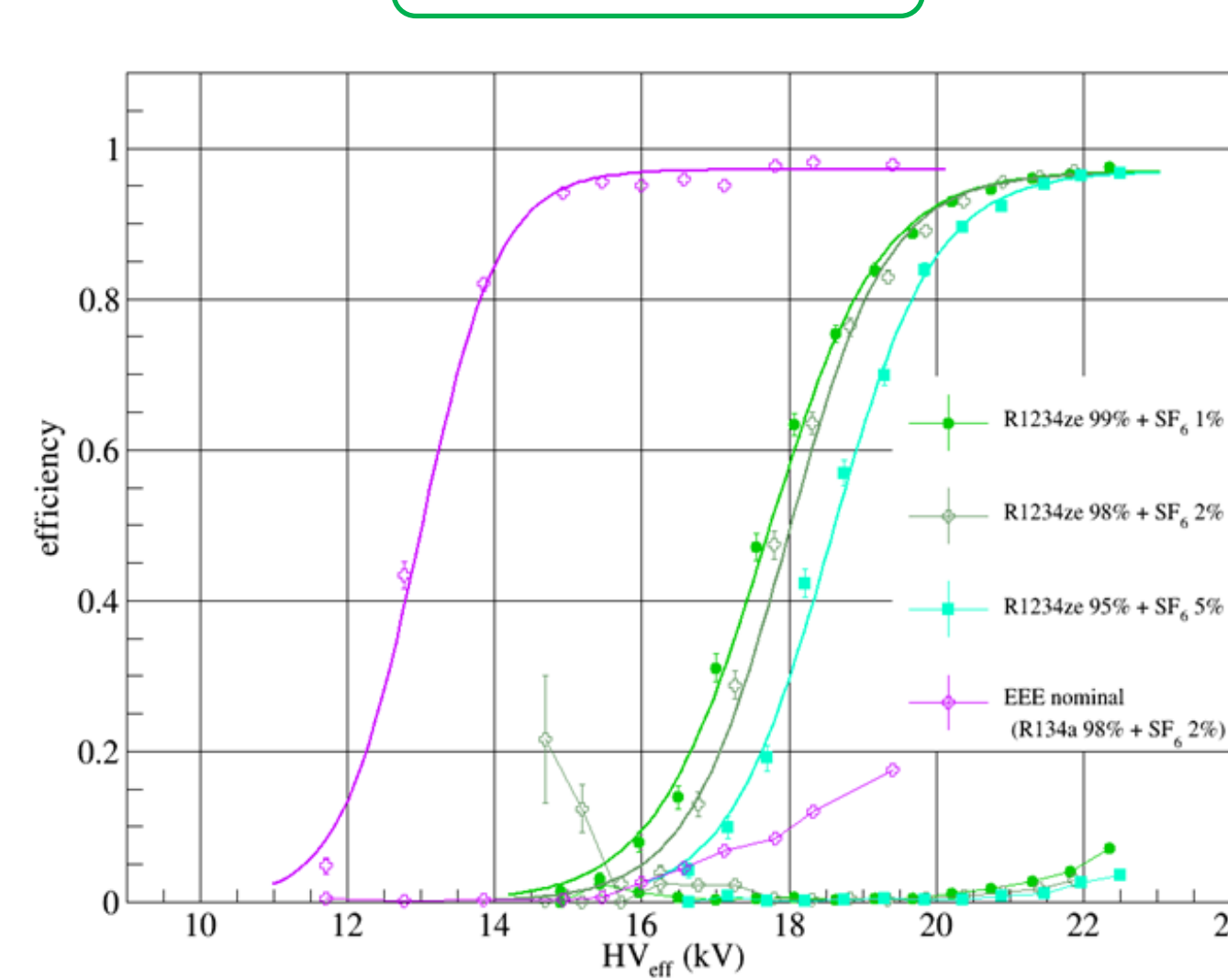


Lower HV setting point
Streamer percentage increases

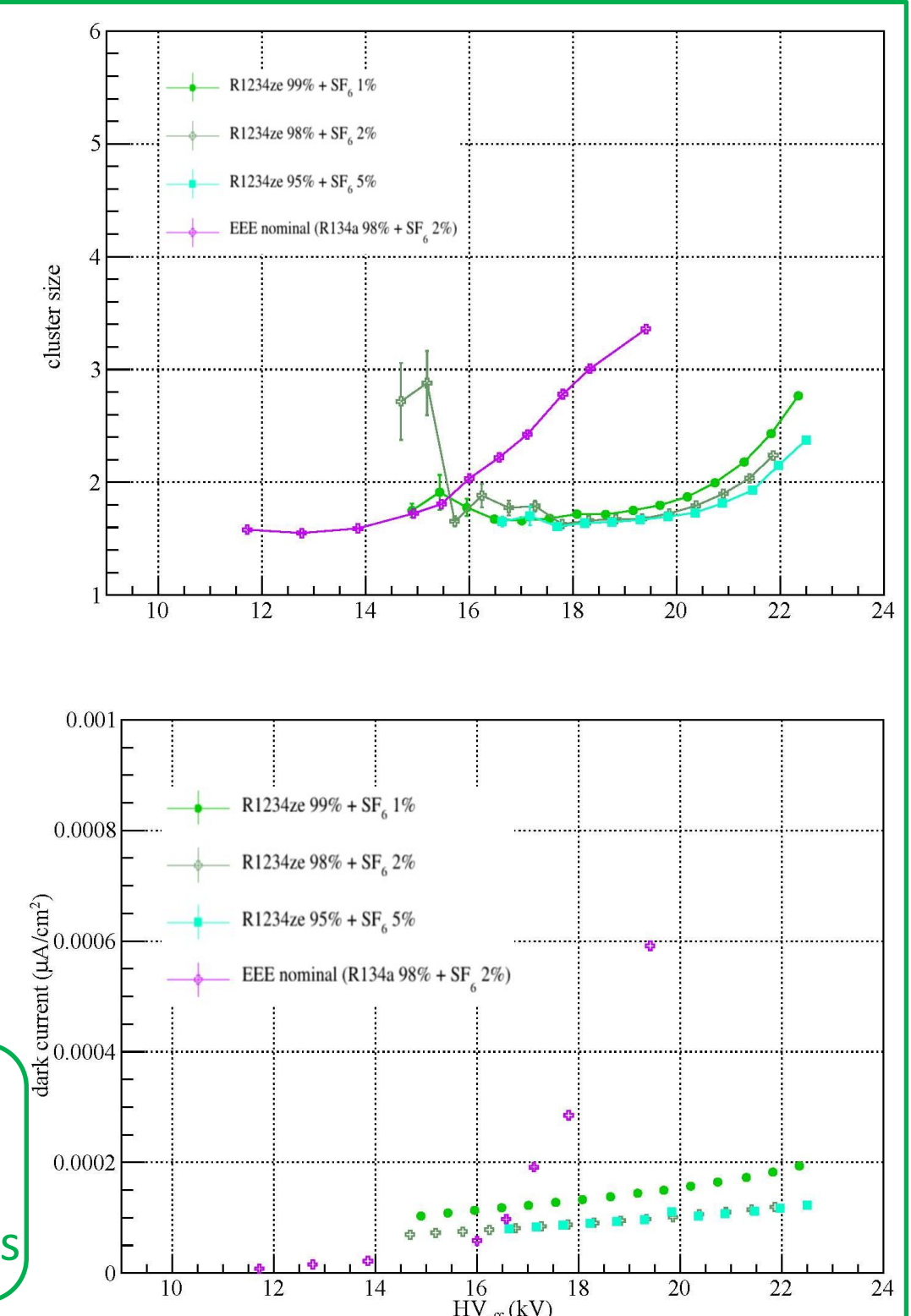
High dark current & High cluster size



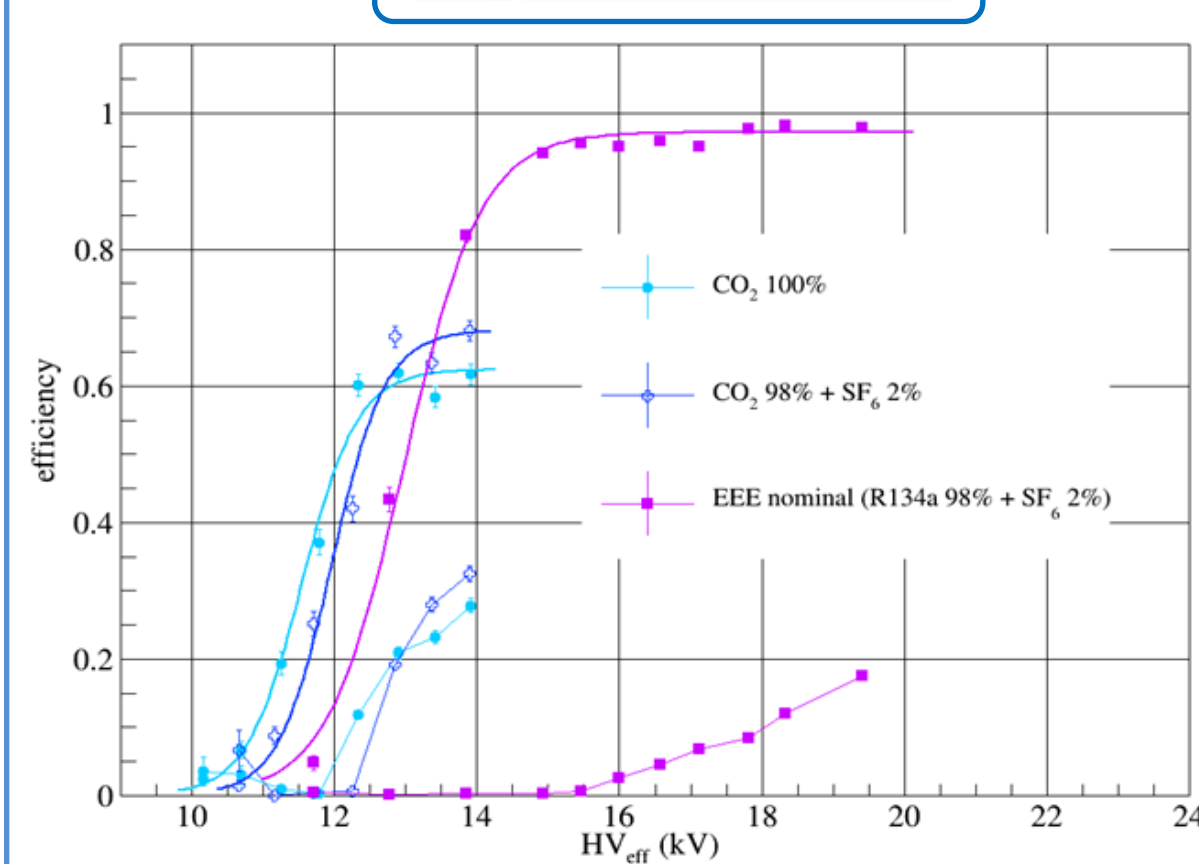
R1234ze + SF6



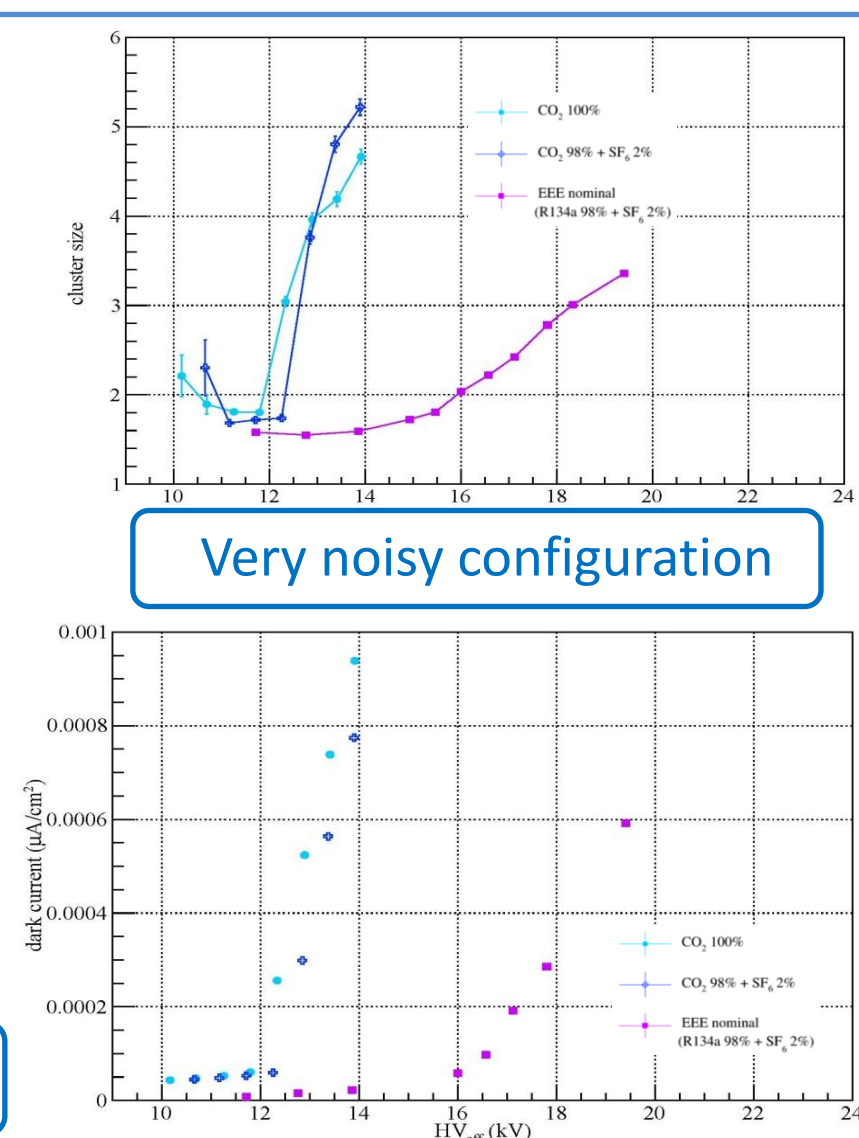
High HV setting point
Noise highly suppressed by SF6
SF6 percentage still too high for GPW requirements



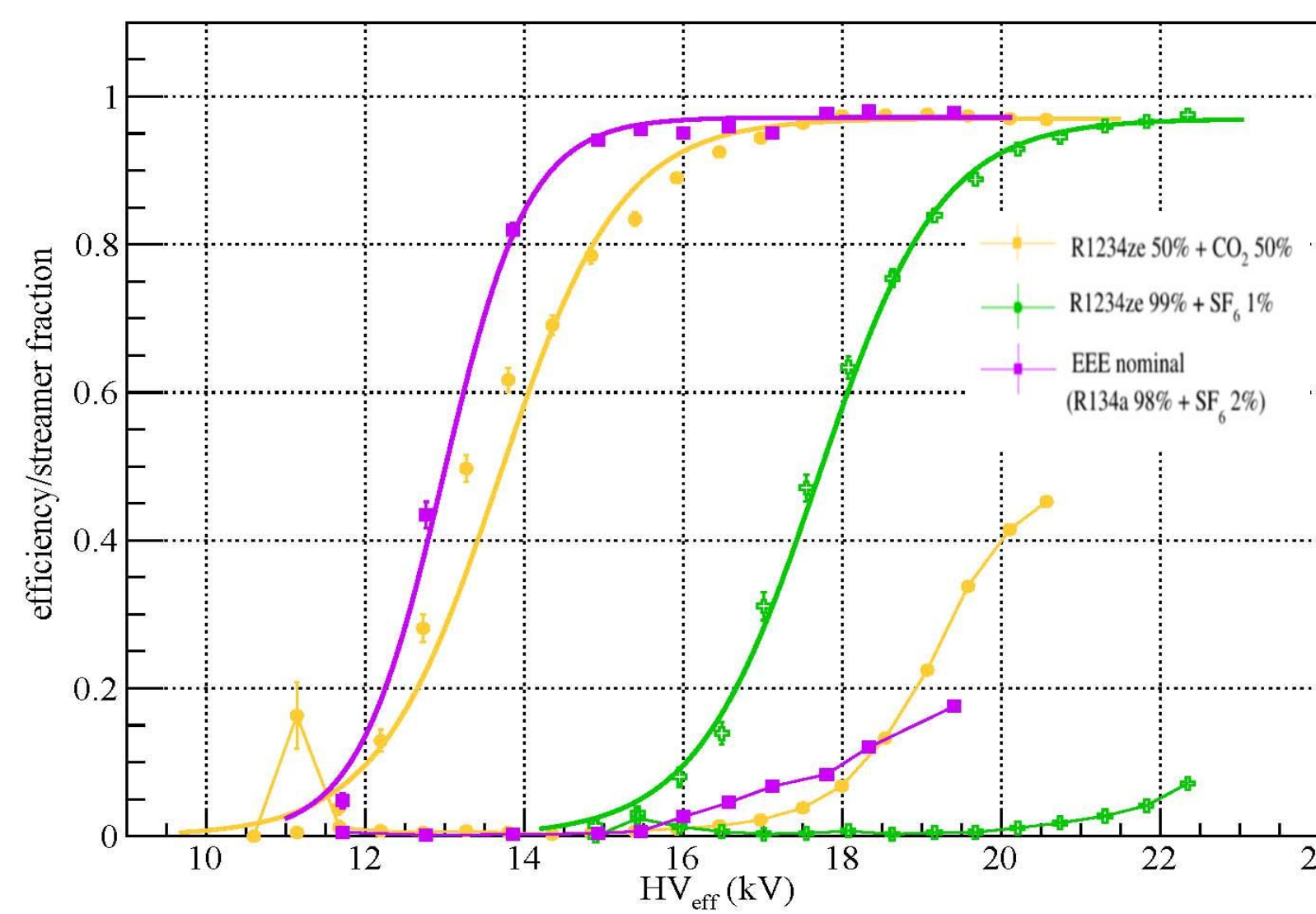
CO2-based mixtures



Very low HV setting point → efficiency too low



Very noisy configuration



Conclusions

Most promising configurations:

- R1234ze(50%) + CO2 (50%)
- R1234ze(99%) + SF6(1%)

Future Plans

- CF3I
- R1234ze(99,5%) + SF6(0,5%)

References

- [1] Centro Fermi web site: <http://www.centrofermi.it/eee>.
- [2] M. Abbrescia et al. Eur.Phys.J.Plus (2013) 128: 63
- [3] M. Abbrescia et al. Eur.Phys.J.Plus (2018) 133: 34.
- [4] F. Noferini et al. (EEE Coll.), Nucl. Instr. Meth. A824 (2016) 329