



New eco-friendly gas mixture for Resistive Plate Chambers in CMS in the framework of HL-LHC

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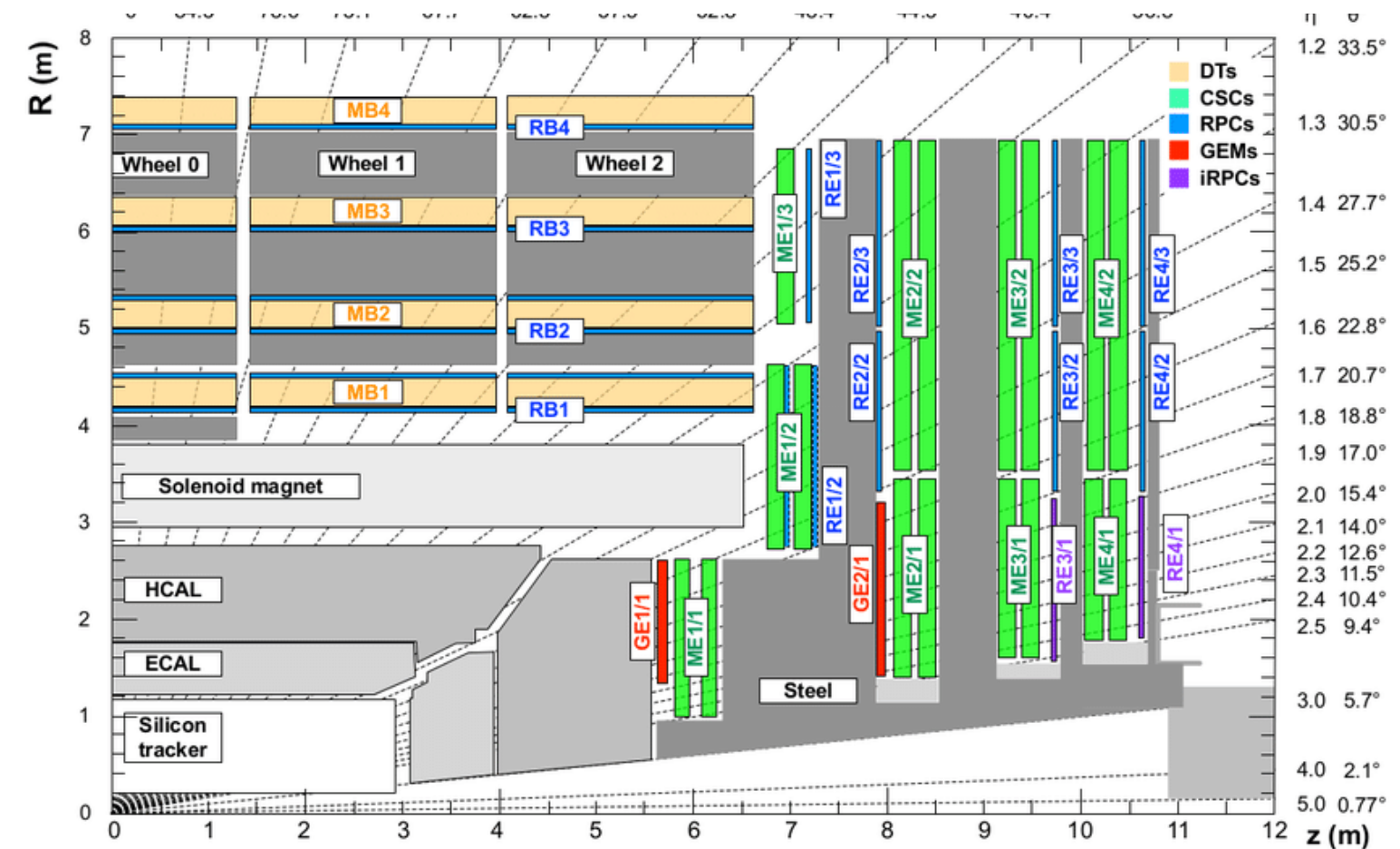
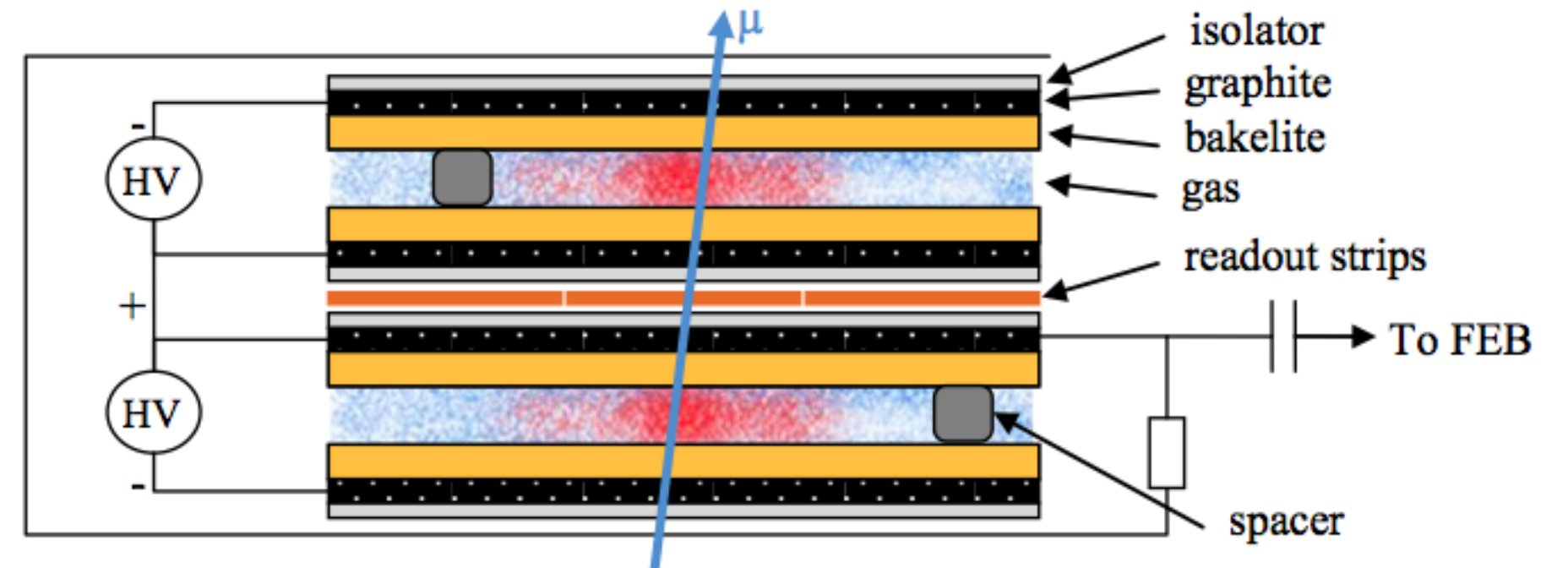
CERN Summer Student Sessions
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Outline

- Resistive Plate Chambers in CMS detector
- GHG emissions and strategies to reduce them
- Gamma Irradiation Facility and Test Beam
- Offline Analysis and Results
- Conclusions and perspectives for the future

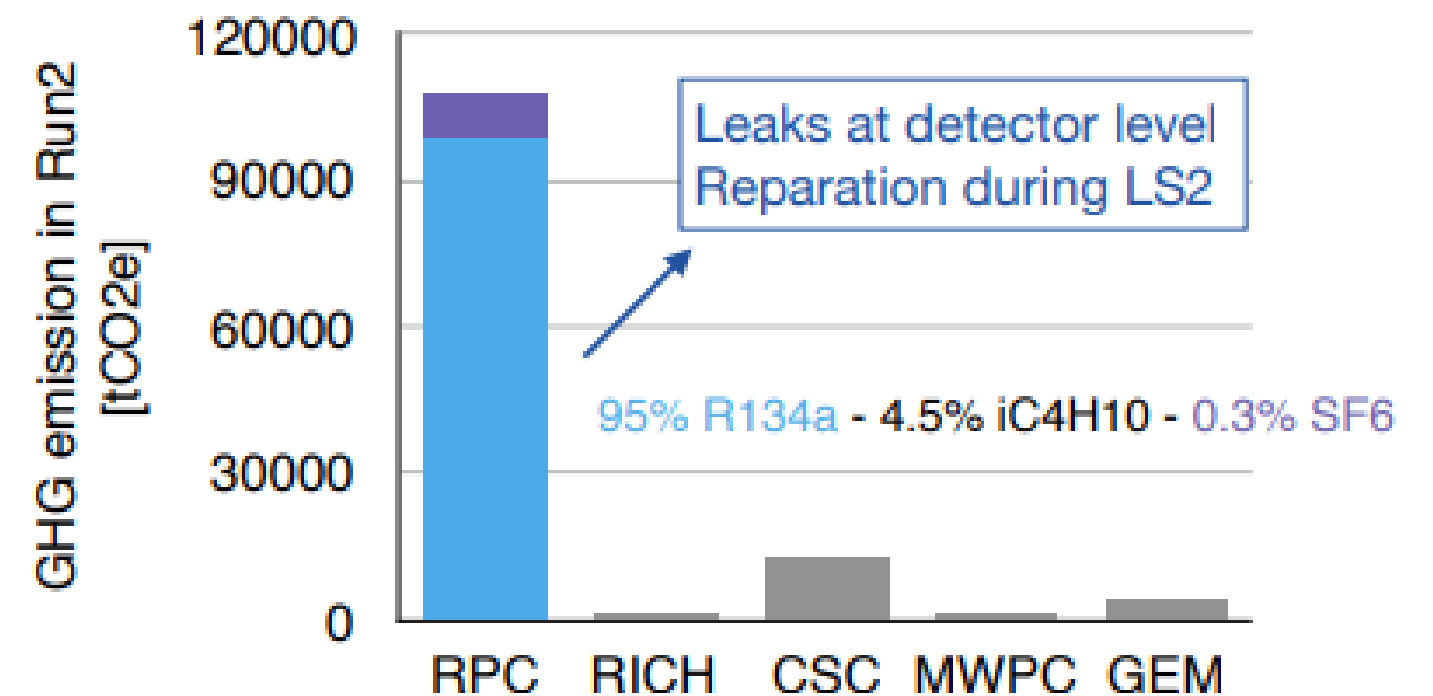
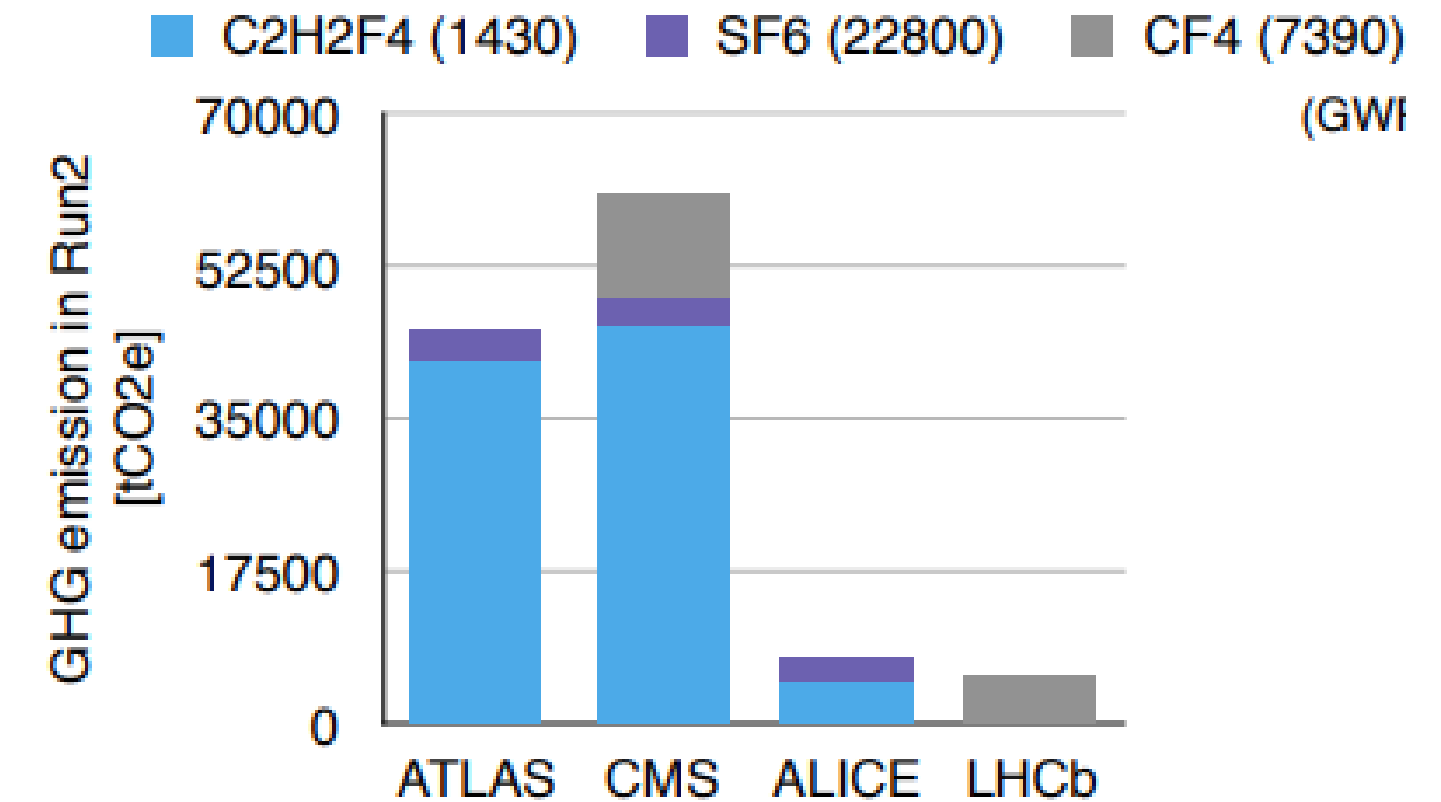
Resistive Plate Chambers in the CMS detector

- Gaseous ionization device designed to detect charged particles.
- One of the main features in the muon detector within CMS.
 - Located at the endcaps and barrel.
 - Useful for position and Trigger systems.



Greenhouse Gases emissions at CERN

- **Standard gas mixture in CMS RPC:**
95.2% C₂H₂F₄ + 4.5% iC₂H₁₀ + 0.3%SF₆
- **High Global Warming Potential (GWP)**
1430 (C₂H₂F₄) and 22800 (SF₆)
CO₂ (1)
- **Prices increasing in the EU and availability not sure for the future.**
- **Reduction of F-gases is fundamental for future particle detectors.**



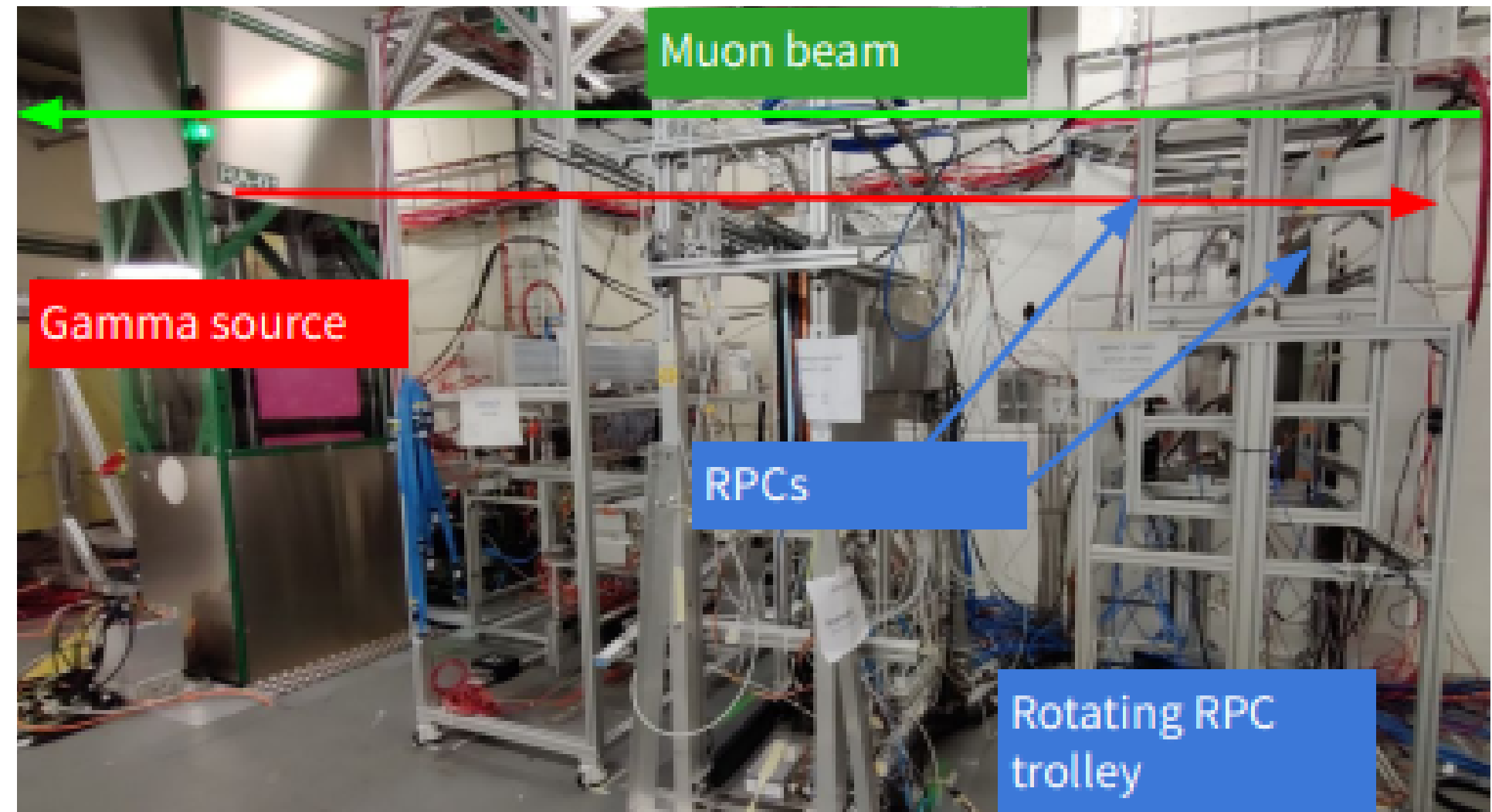
Gamma Irradiation Facility and Test Beam

RPCs under study

- iRPC prototype chamber (KODEL-E)
- 16 copper strips
- double 1.4 mm gap
- 50x50 cm²

GIF++ setup

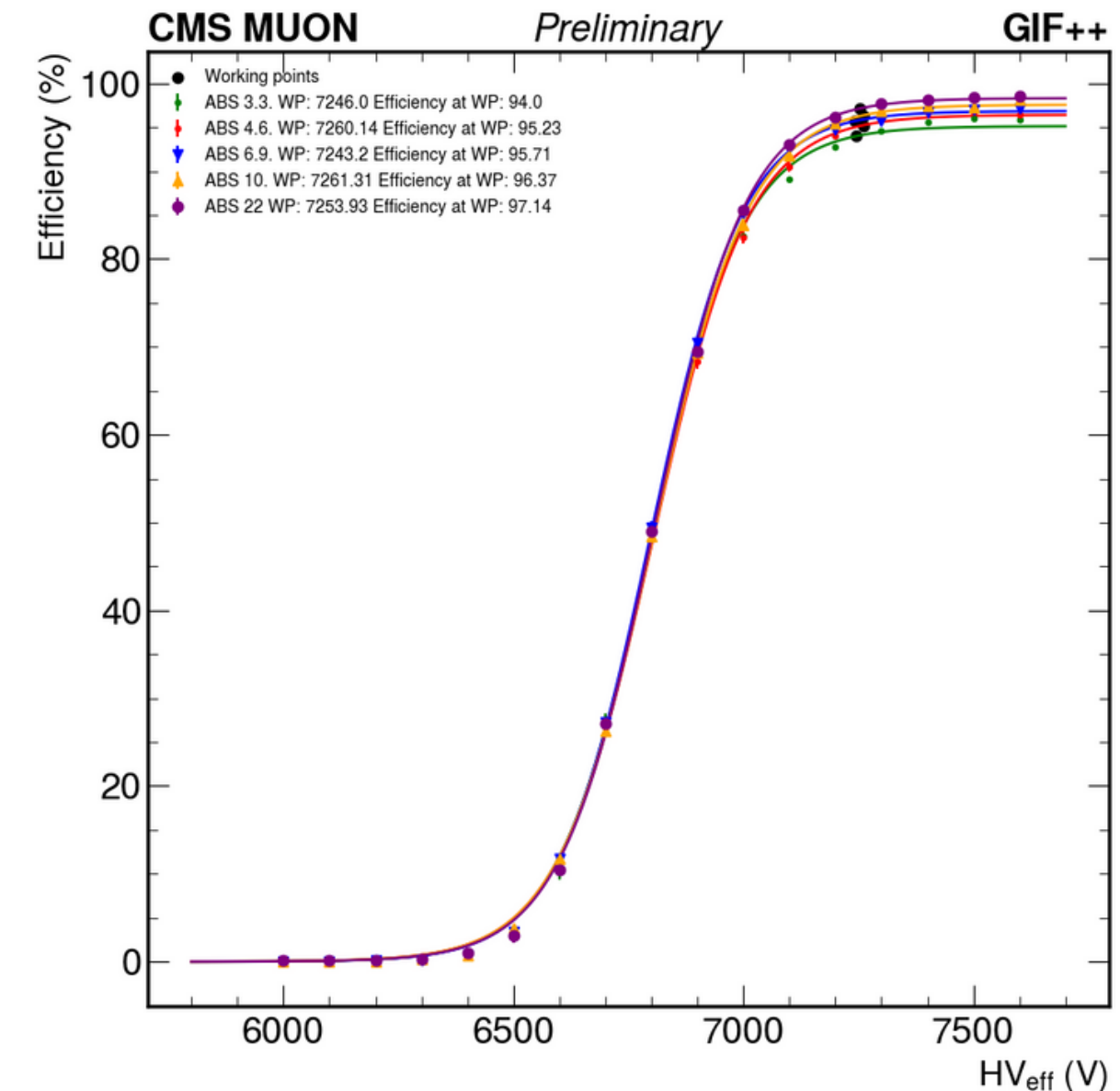
- Muon beam
- Cs-137 radioactive source (with ABS filters)
- Different gas mixtures available



Offline analysis and results



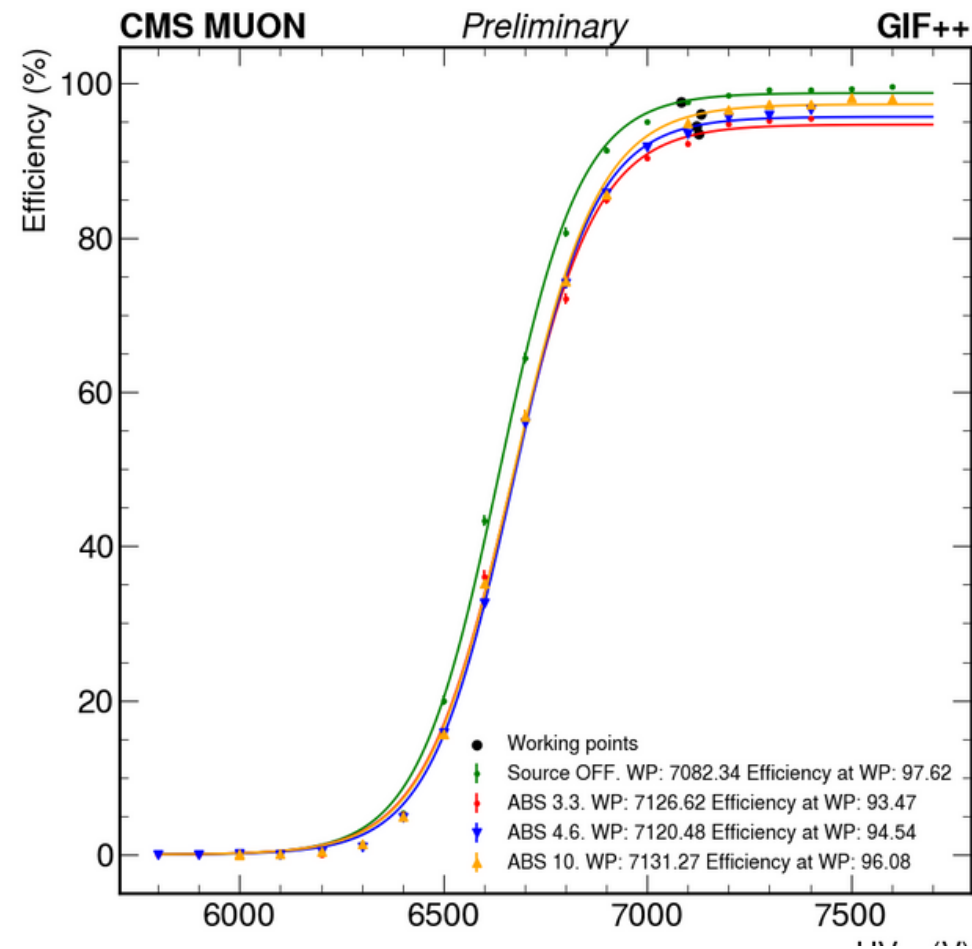
- Data acquisition done via WebDCS.
- Extraction of the efficiency for the muon reconstruction with and without gamma background.
- Fit of an S-curve.
 1. Working point (WP)
 2. Efficiency at the WP
 3. Gamma background rate



$$\epsilon = \frac{\epsilon_{max}}{1 + e^{-\lambda(HV_{eff} - HV_{50\%})}}$$

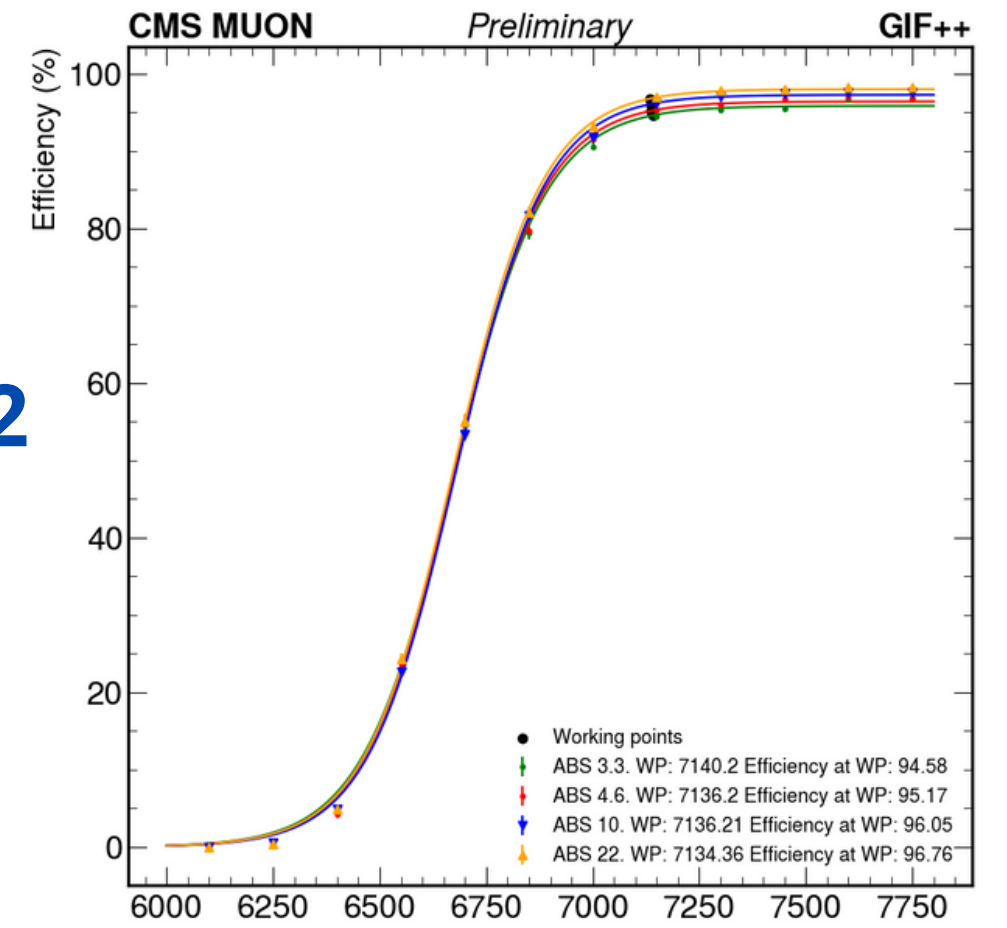
April Test Beam

30% CO2
1% SF6

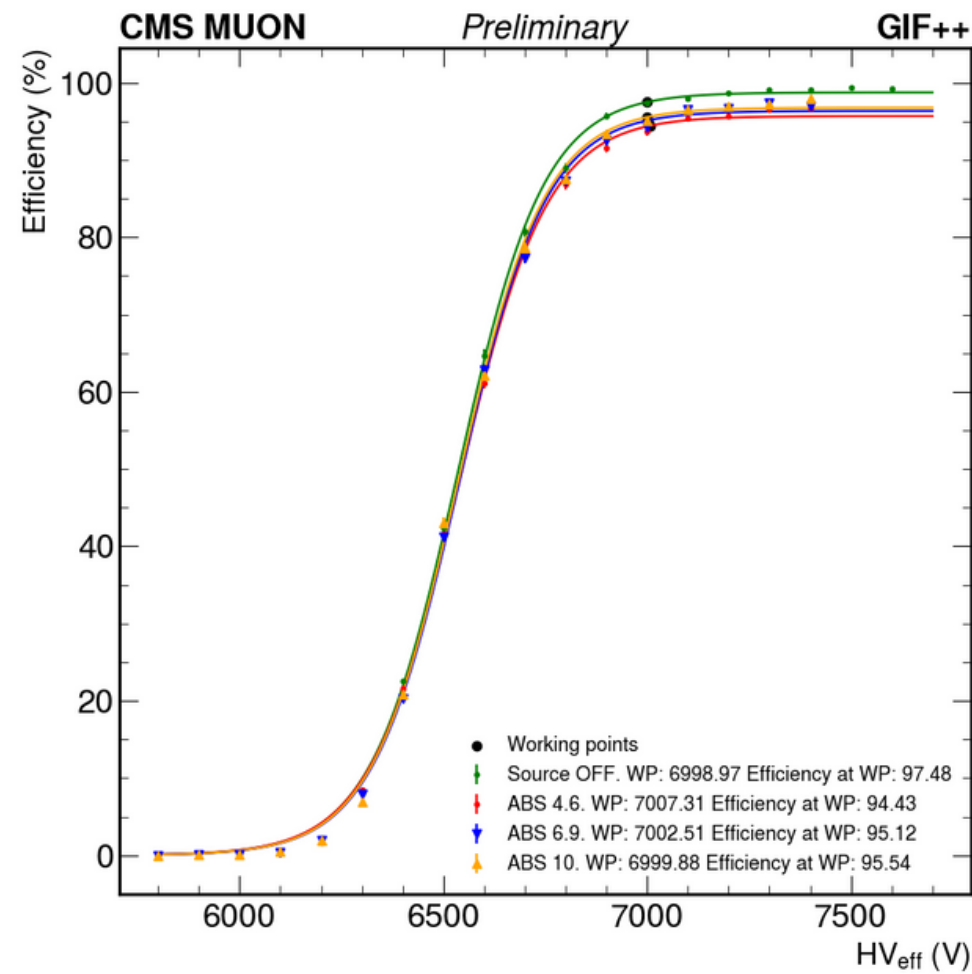


July Test Beam

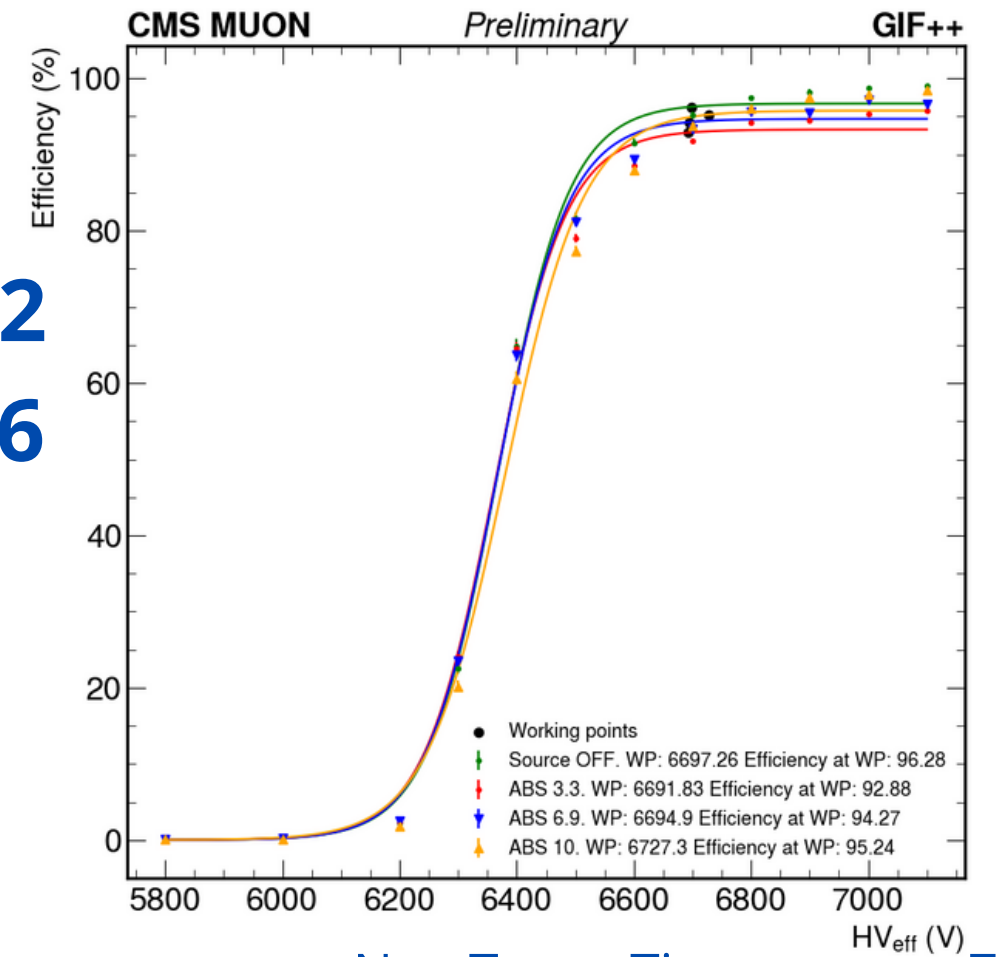
30% CO2
1% SF6



40% CO2
1% SF6



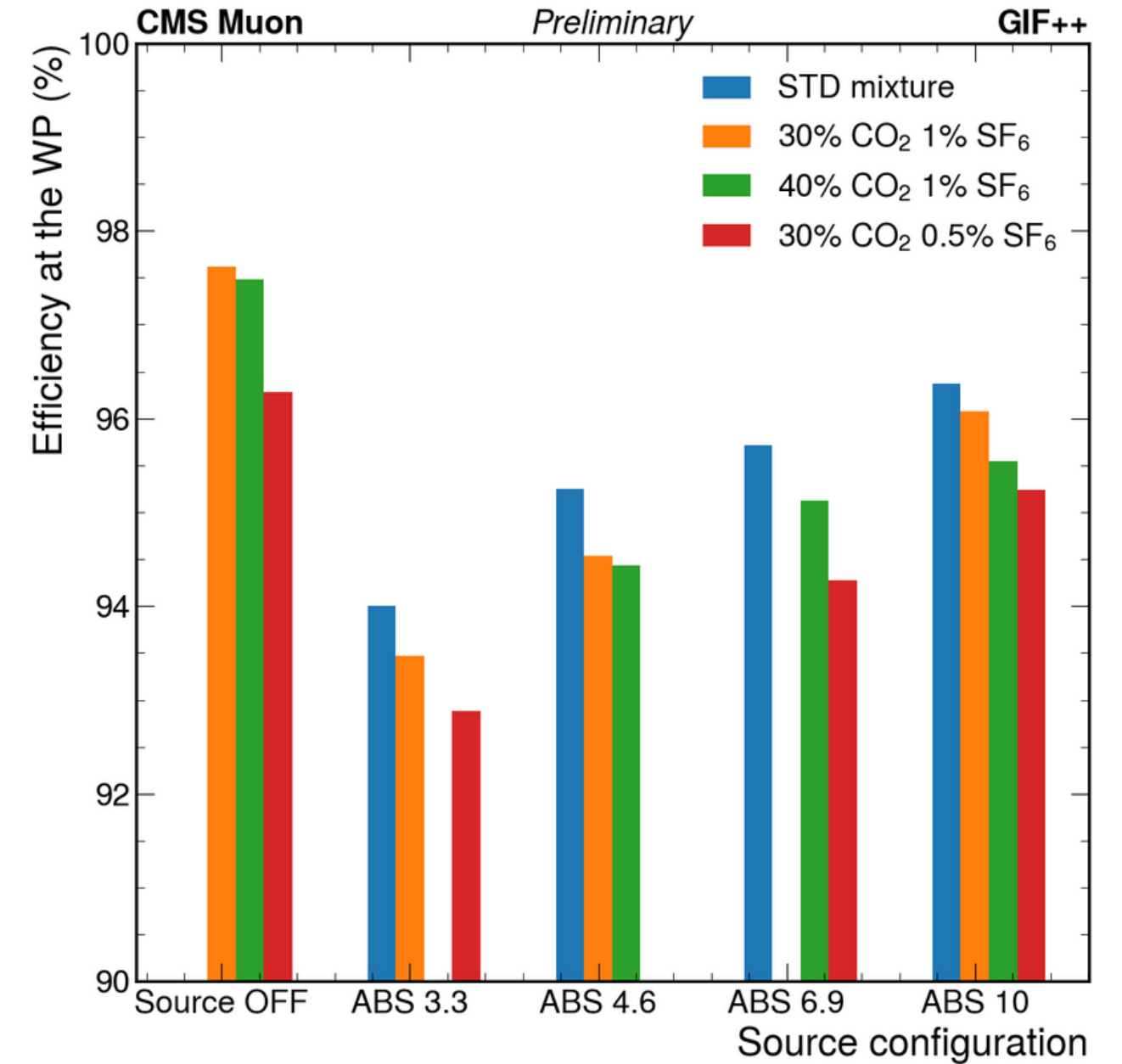
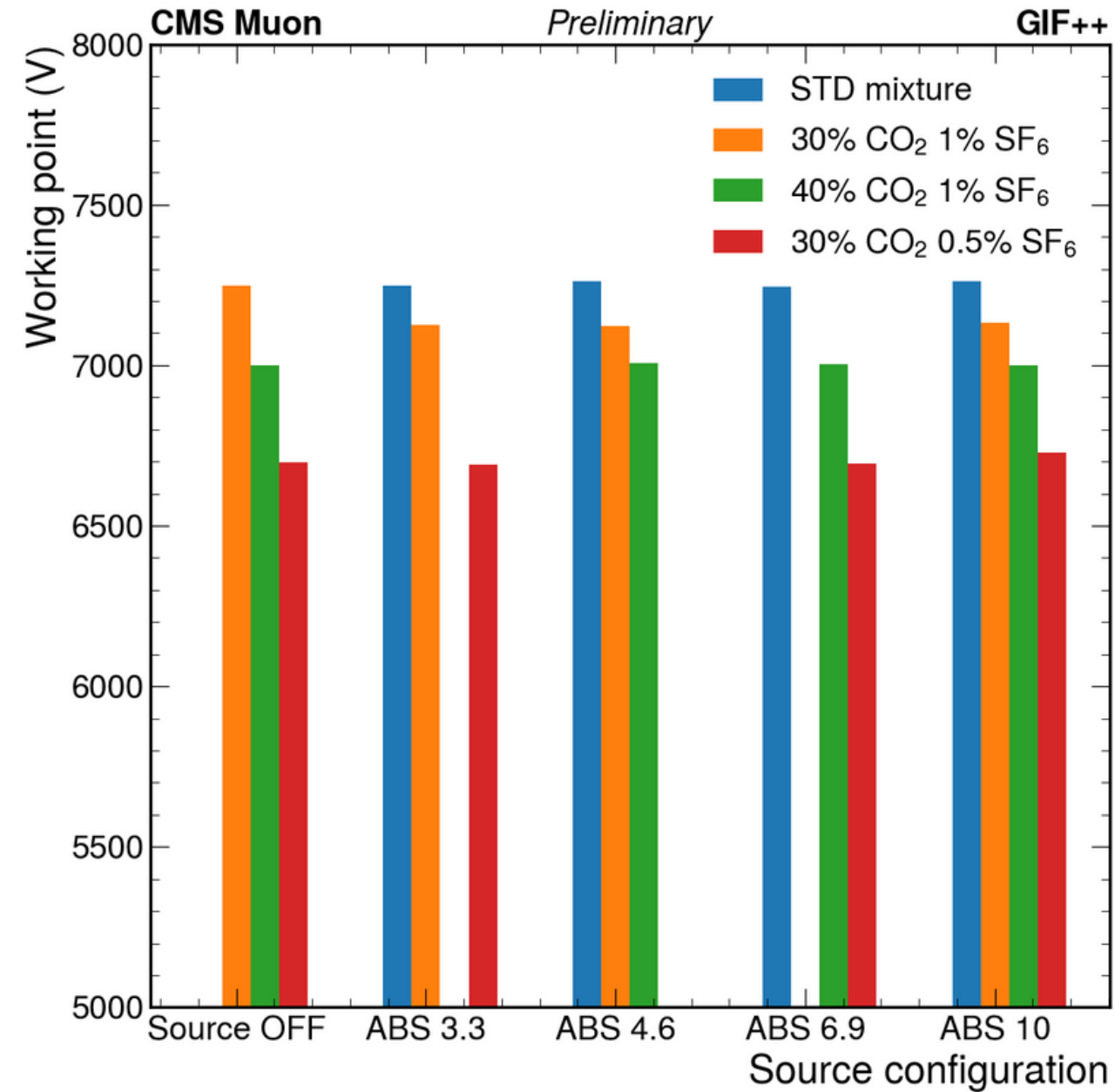
30% CO2
0.5% SF6



WP and efficiency

ABS Filters	STD	Mix 1	Mix 2	Mix 3
Source OFF	–	7246.00	6998.97	6697.26
3.3	7246.00	7126.62	–	6691.83
4.6	7260.14	7120.48	7007.31	–
6.9	7243.20	–	7002.51	6694.90
10	7261.31	7131.27	6999.88	6727.30
22	7253.93	–	–	–

ABS Filters	STD	Mix 1	Mix 2	Mix 3
Source OFF	–	97.62%	97.48%	96.28%
3.3	94.00%	93.47%	–	92.88%
4.6	95.25%	94.54%	94.43%	–
6.9	95.71%	–	95.12%	94.27%
10	96.37%	96.08%	95.54%	95.24%
22	97.14%	–	–	–



Conclusions and perspectives for the future

- General behaviour **preserves** the shape of the S-curve
- An expected drop in the efficiency is observed
- The WP is affected for different concentrations of CO₂ and SF₆:
 - A drop is observed for the WP and the efficiency at the WP when increasing the CO₂.
 - The more amount of SF₆ that is included in the mixture, the greater is the efficiency at the WP and the WP.
- CO₂ based mixtures seem to be good but more studies are on their way.

Backup slides

How does a raw event looks like?

- Collection of fired TDC channels
- We apply a clusterization algorithm to select the ones corresponding to: a single muon/muon + gamma/only gamma.

