Update from laboratories on Eco-gas studies

D. Piccolo

On behalf of Ghent and LNF

Experimental approach

- Eco gas studies cover different activities:
  - Simulation and theoretical evaluation of eco gas parameters
    - *"PROPERTIES OF POTENTIAL ECO-FRIENDLY GAS REPLACEMENTS FOR PARTICLE DETECTORS IN HIGH-ENERGY PHYSICS" INFN-14-13/LNF*
  - Chemical analysis of interactions between gas and materials
    - *Draft of the plans in progress*
  - **Experimental test of RPC performance with new eco-gas based mixtures**
  - On longer time base test of new mixtures at GIF++
- **In this talk a summary of experimental activities in LNF and Gehnt**

Experimental approach

Compare results from standard gas mixtures vs mixtures with eco-gases

Tetrafluorepropene:

HFO-1234ze bottle already available in Frascati and Ghent

HFO-1234yf also available in Frascati

The LNF plan is to analyze:

- induced charge spectrum
- streamer probability
- time resolution
- signal shape
- Use of standalone electronics

The Ghent plan is to analyze:

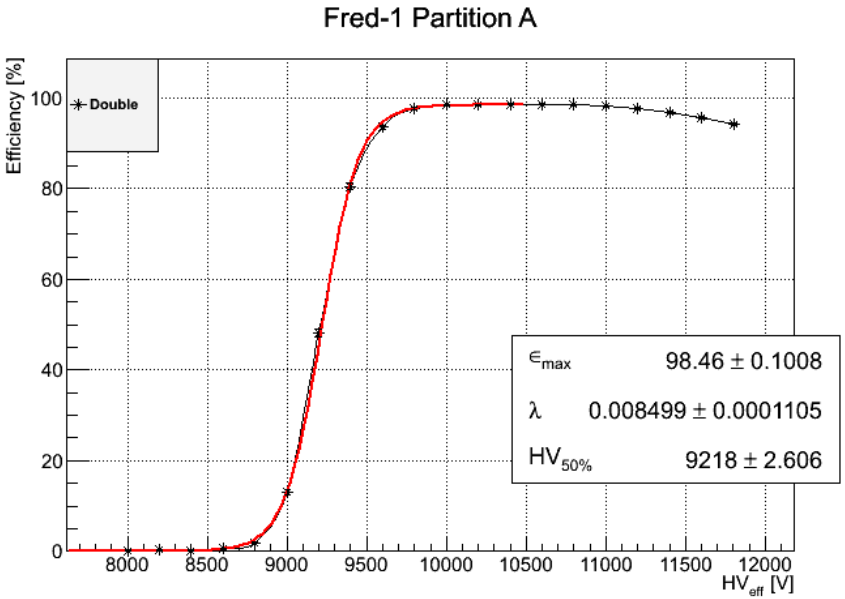
- dark current
- single rate
- efficiency
- Use of the the standard CMS electronics

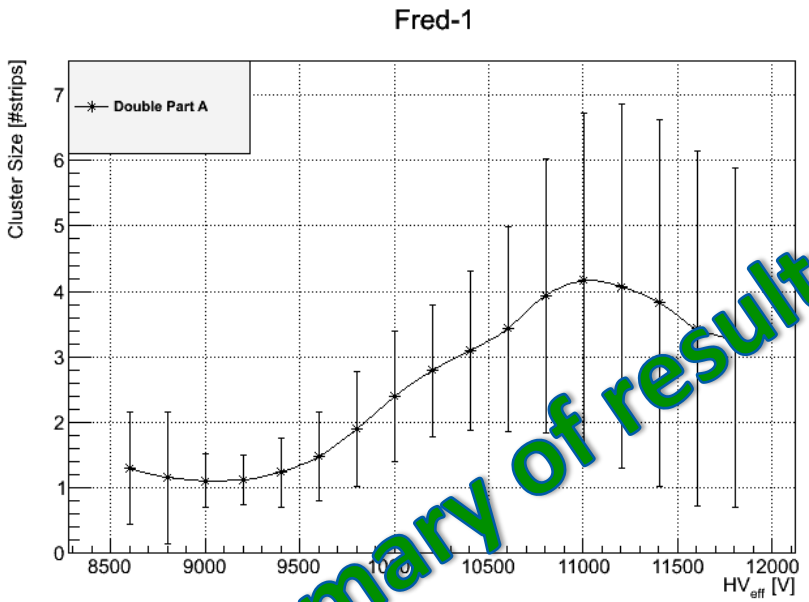
Two complementary approaches. Synergies to be explored

S. Cauwenbrgh, M. Tytgat

Standard Gas Mixture @ Ghent

- **Characterization of the test chambers with the standard RPC gas mixture**
- **Pushing them into the streamer regime to see the range of operation**





Summary of results

S. Cauwenbrgh, M. Tytgat

CO_2-based Mixtures

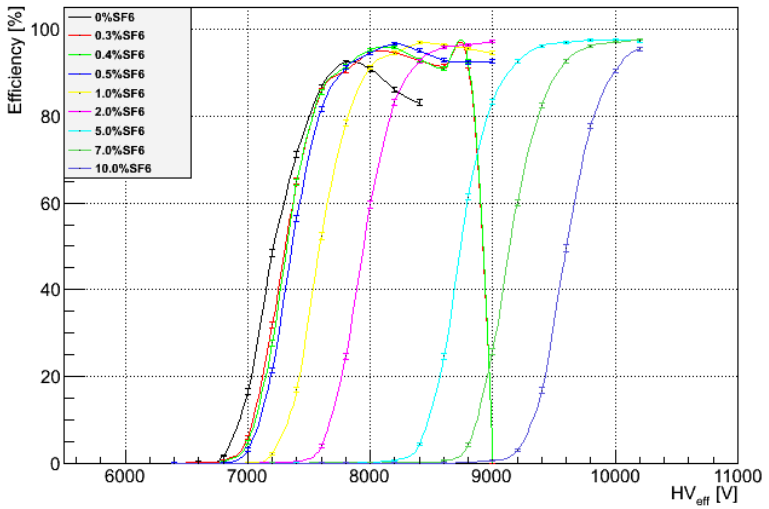
- **CO_2 based mixtures (as replacement of R134a)**

- **Chamber performance for various SF_6 percentages; effect of SF_6 clearly visible**

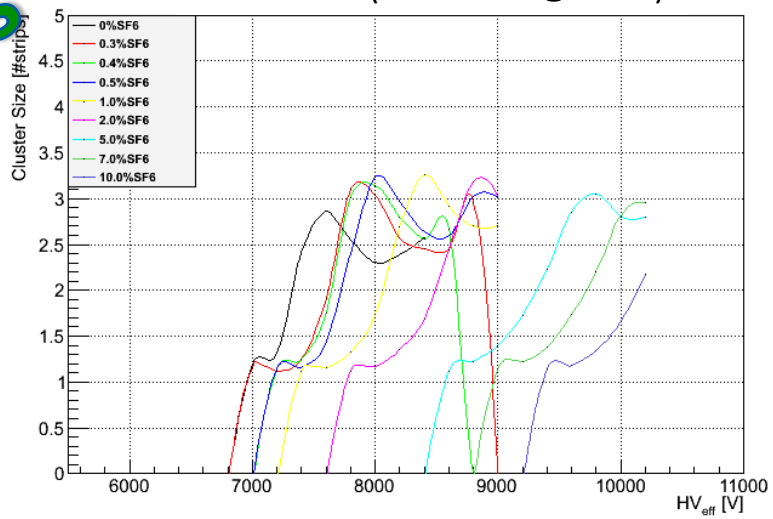
- **Full, stable chamber efficiencies can be recovered for >1-2% SF_6 however, cluster size is higher wrt. standard gas mixture**

Summary of results

CO2 vs SF6 (isobutane @ 4.5%)

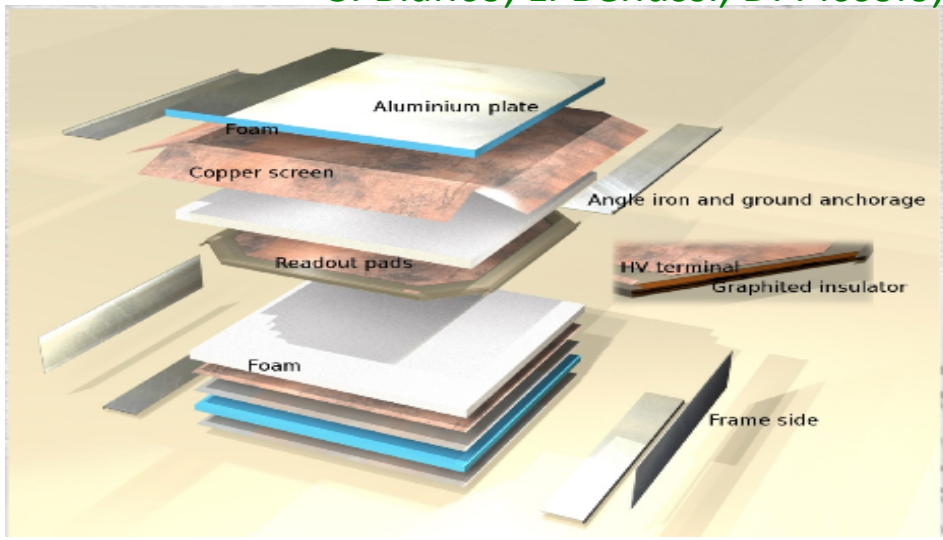


CO2 vs SF6 (isobutane @ 4.5%)



Experimental Set-up in Frascati

S. Bianco, L. Benussi, D. Piccolo, L. Passamonti, D. Pierluigi, A. Russo



- 12 single gap RPCs, 2 mm wide gas gap
- 50 x 50 cm^2
- Double Pad readout
  - partial cancellation on single mode noise
  - Expected about x2 induced signal charge
- Scintillator layers on top and bottom for trigger

Data taken with oscilloscope

- Gas chromatograph: for gas mixture analysis
- 4 channels Oscilloscope lecroy104xi (5 Gsamples, 1 GHz): for signal readout
  - Full digitization of signal
  - By hand measurement

See https://indico.cern.ch/event/337691/ for previews presentation

HFO based mixtures test at LNF

- Several tests done with HFO1234ze (based mxitures)
- HFO1234ze: 1,3,3,3 tetrafluorepropane ($C_3H_2F_4$)
  - Remember R134 ($C_2H_2F_4$)
  - C=C bound seems to have improved quenching characteristics
    - Working point shifted at higher values with respect to R134 based mixture
- See
  - https://indico.cern.ch/event/337691/
  - https://indico.cern.ch/event/343160/

- **LNF internal note:** *"A study of HFO-1234ze (1,3,3,3-Tetrafluoropropene) as an eco- friendly replacement in RPC detectors " INFN-14-14/LNF*
  - First results on HFOze in several Ar, R134a based mixtrures

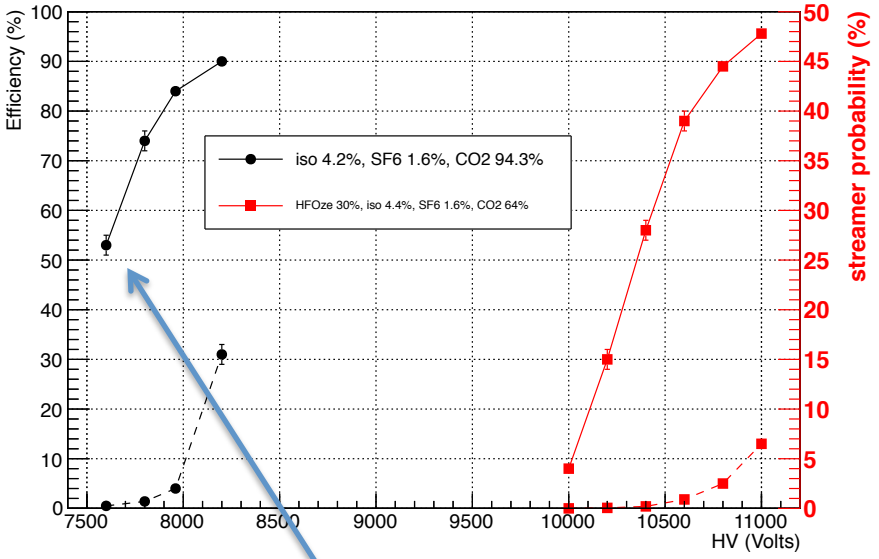
Common plans and work in progress Ghent-LNF

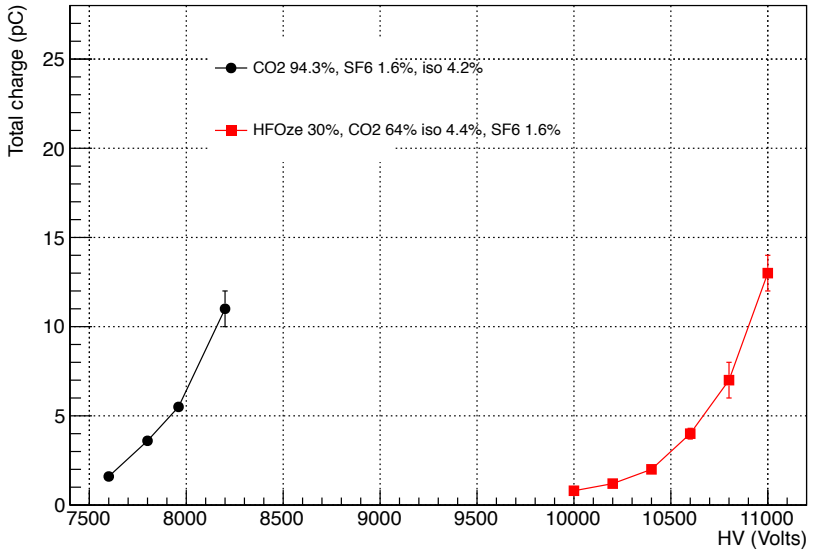
- Calibration of the mass flowmeter in Ghent
  - Contacts with cern gas group
- Implementation of T/P correction in Gehnt

- Experimental setups in Ghent and LNF ready in few days to restart after 2 months break
  - Oscilloscope reparation in LNF
  - Other activities and mass flowmeter calibration in Ghent

- **Comparison of the methods**
  - Use of CO_2 in LNF setup (done .. See next slides)
  - New comparison on HFOze mixtures
    - Ar 80 % - HFOze 20 % (done at LNF, in prepartion in Ghent)
    - Ar 70 % - HFOze 30 % (in preparation in LNF and Ghent)
- More tests
  - Preliminary comparison between HFOze and HFOyf in Frascati (see next slides)

CO_2 mixtures in Frascati





Methods in LNF and Ghent in good agreement:

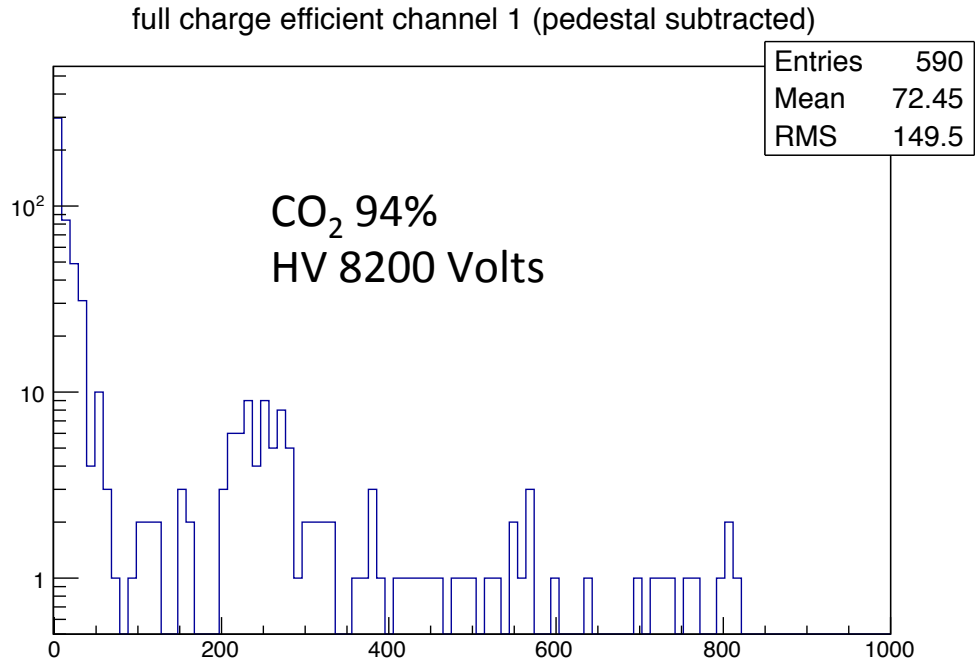
HV_{50} ~ 7600 Volts (see slide 4 for Ghent results yellow line)

- LNF results normalized at P0=990 mbar
- Ghent results still not normalized
- Ghent cluster size ~ 3 correspond to ~ 30% streamer prob. In LNF (to be better studied)

Addition of HFO reduce streamers.

Work in progress

CO2 mixtures in Frascati (2)

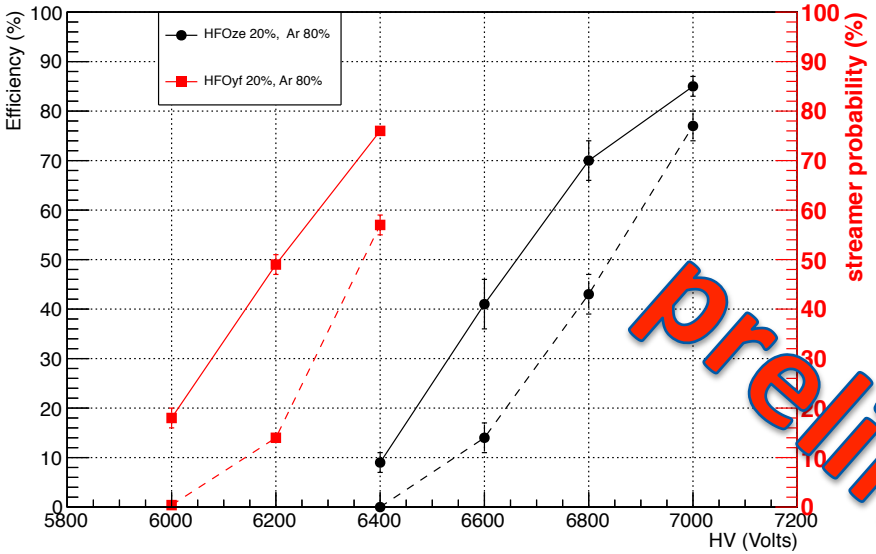


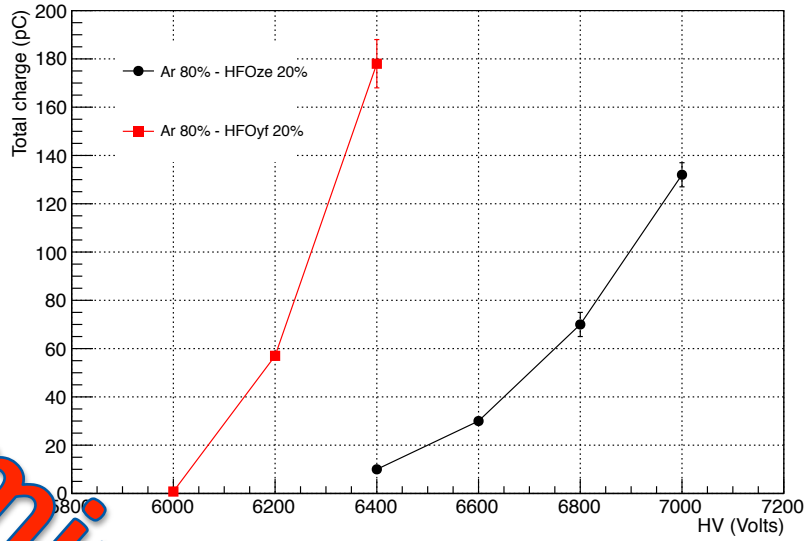
CAVEAT

CO_2 mixture seems interesting BUT dark current should be monitored on longer time.
Usually CO_2 mixtures show several discharges after the first signal and with our setup these multiple signals could not be detected

Moreover increasing HV result in a long tail on charge distribution

Preliminary comparison between HFOze and HFOyf





preliminary

Binary mixtures working mainly in streamer mode:
Interesting for xcheck with Atlas results

HFOyf seem to be less quenching than HFOze (about 400 volts shift in plateau)

Caveat: HFOyf is flammable

Conclusions

- Work on eco gas studies is restarting in LNF and Ghent
- We will start to calibrate our setups for coherent results comparisons
- Comparison LNF-Ghent of results with Ar-HFOze will be ready at beginning of March
- Additional tests ongoing:
  - CO_2 - HFOze mixtures
  - HFOze vs HFOyf comparisons