



UNIVERSITÀ
DEGLI STUDI DI BARI
ALDO MORO



Update on performance of the SHiP RPC with eco-gas

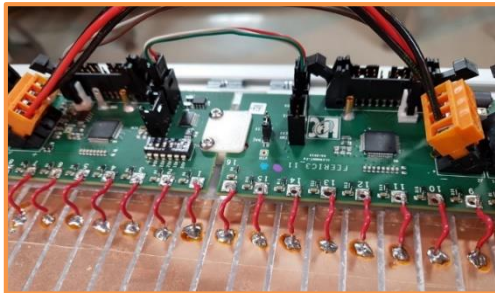
Ecogas@gif++ group meeting
13/01/2021

*L. Congedo and A. Pastore on behalf of the **Bari SHiP-LHCb** group*

Tests in the Bari RPC laboratory



*Avalanche RPC:
strips readout
by ALICE
FEERIC ASICs,
providing LVDS
signals*

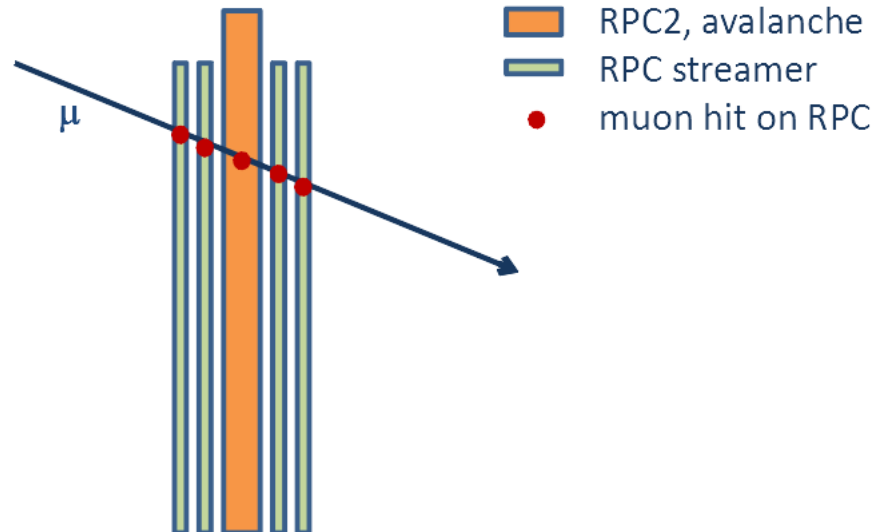


Tests with cosmic rays:

- 4 OPERA chambers ($\sim 3 \times 1 \text{ m}^2$) operated in streamer mode, used for **triggering** and **tracking**;

Trigger: coincidence of the streamer RPC vertical strips covering the area of the avalanche RPC

- 1 **avalanche RPC** ($\sim 2 \times 1 \text{ m}^2$, under test):
Gap width: 2mm
Readout by 2 panels of perpendicular strips:
pitch $\sim 1 \text{ cm}$



Eco-friendly gas mixtures tested

Standard gas mixture: 94.5% R134a - 5% iso - 0.5% SF_6 (GWP=1471)

- First step: different concentrations of R134a replaced with HFO-1234ze

1) 84.5% R134a - 10% HFO - 5% iso - 0.5% SF_6 (GWP=1329)

2) 74.5% R134a - 20% HFO - 5% iso - 0.5% SF_6 (GWP=1186)

3) 69.5% R134a - 25% HFO - 5% iso - 0.5% SF_6 (GWP=1115)

4) 0% R134a - 94.5% HFO - 5% iso - 0.5% SF_6 (GWP=125)

- Second step: CO₂ addition in order to reduce the WP

5) 25% HFO - 20% R134a - 49.5% CO₂ - 5% iso - 0.5% SF_6 (GWP=408)

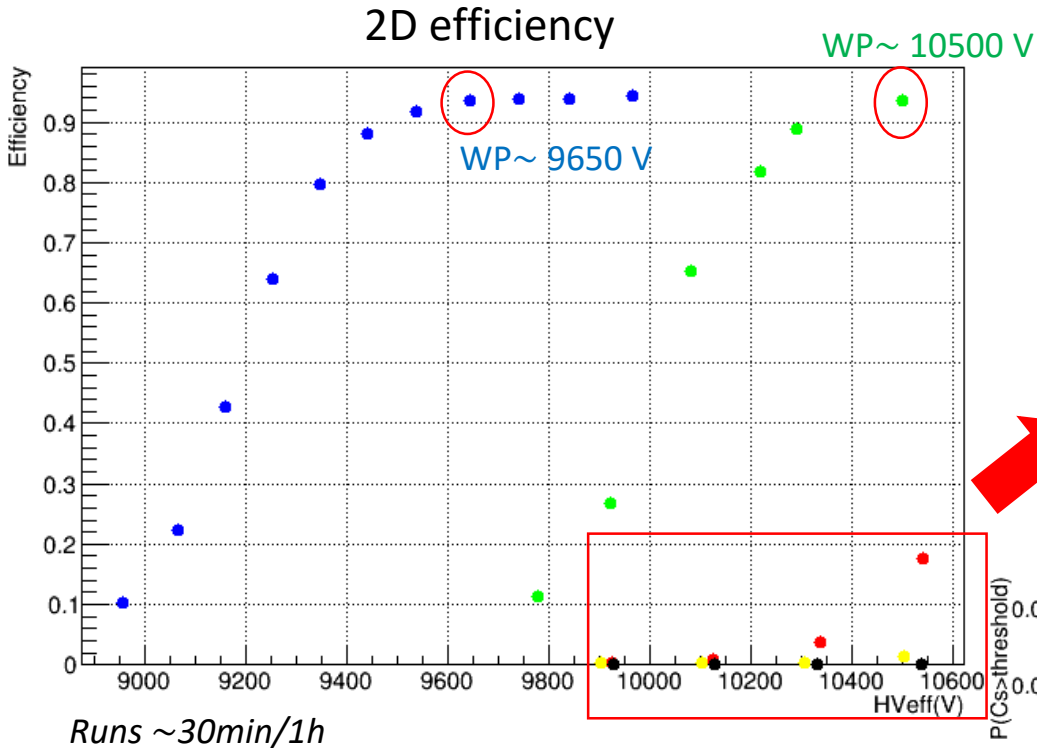
6) 25% HFO - 0% R134a - 69.5% CO₂ - 5% iso - 0.5% SF_6 (GWP=122)

New
mix

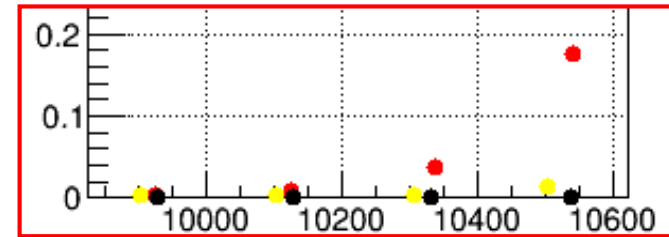
7) 35% HFO - 0% R134a - 60% CO₂ - 4.5% iso - 0.5% SF_6 (GWP=122)

8) ecogif mixt: 35% HFO - 0% R134a - 60% CO₂ - 1% SF_6 - 4% iso (GWP=242)

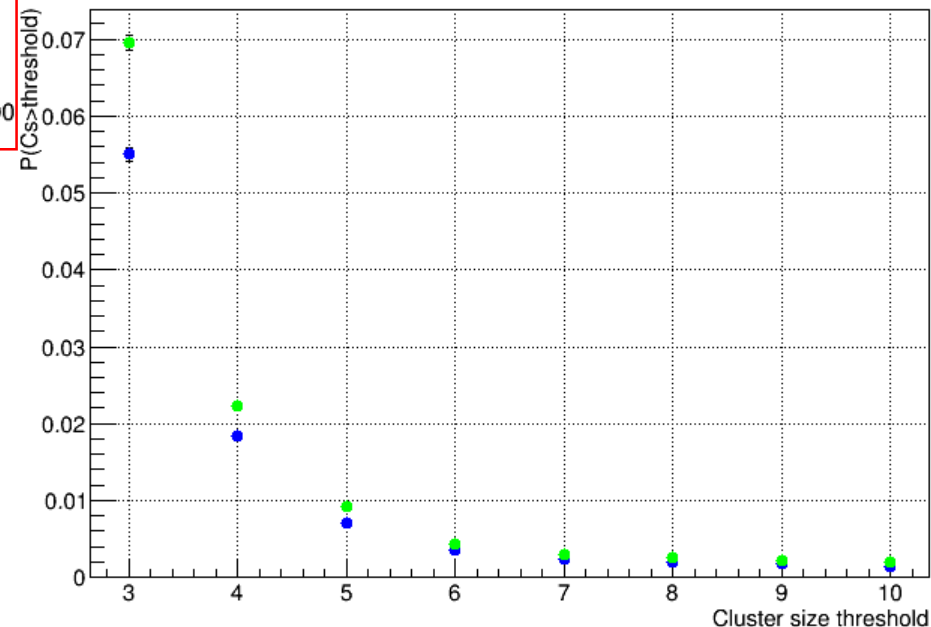
RPC performance with HFO-based mixtures



See: Bari SHiP-LHCb presentation @
25/11/2020 group meeting

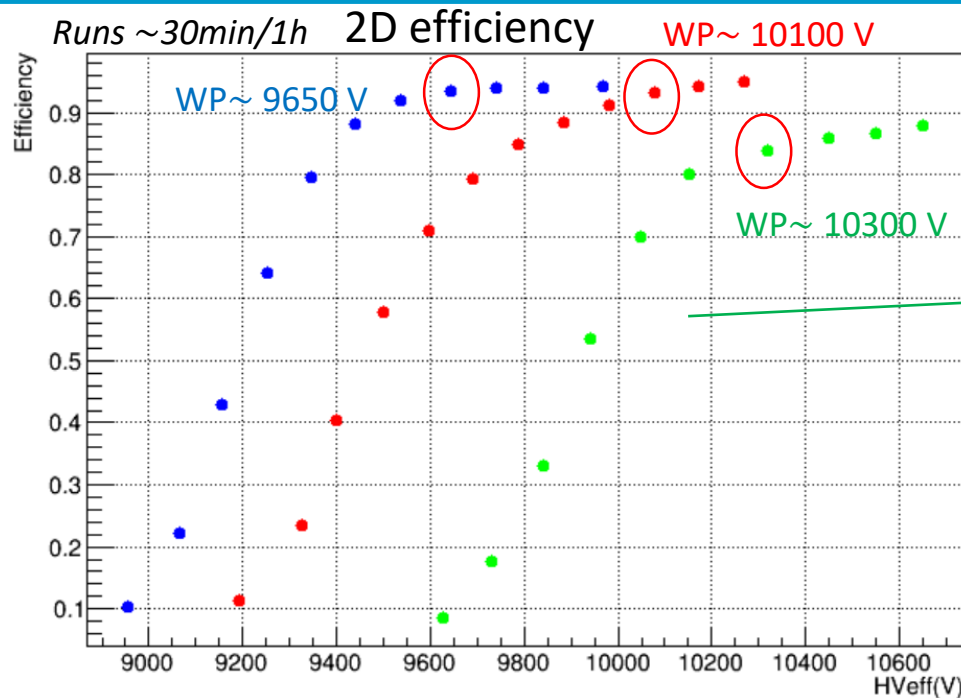


Probability cluster size > Threshold (horizontal strips)



- Standard gas mixture:
94.5% R134a - 0% HFO - 5% iso - 0.5% SF_6
- 1) 84.5% R134a - 10% HFO - 5% iso - 0.5% SF_6
- 2) 74.5% R134a - 20% HFO - 5% iso - 0.5% SF_6
- 3) 69.5% R134a - 25% HFO - 5% iso - 0.5% SF_6
- 4) 0% R134a - 94.5% HFO - 5% iso - 0.5% SF_6

RPC performance with HFO/CO₂ mixtures

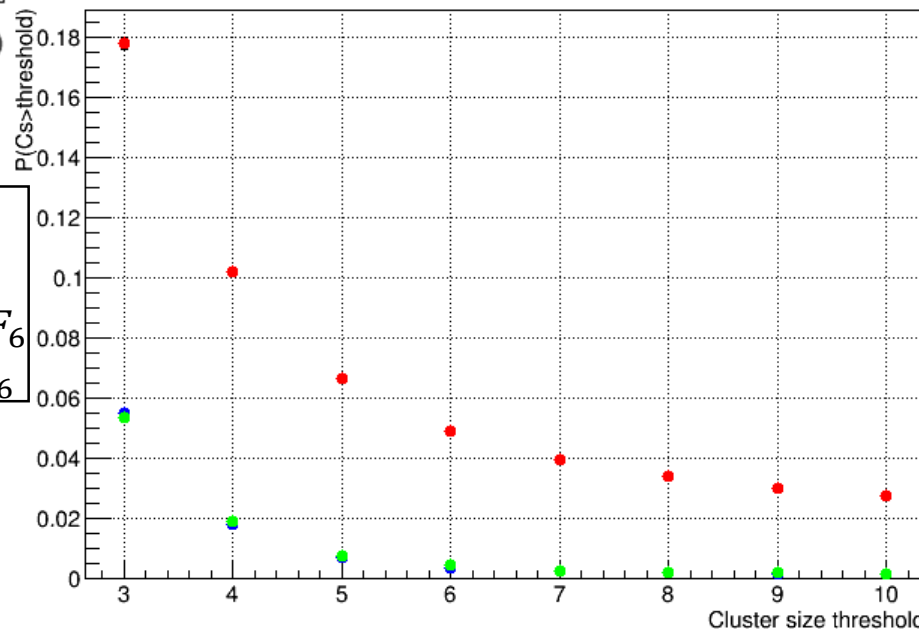


See: Bari SHiP-LHCb presentation @
25/11/2020 group meeting

Meas. with $V_{th}=100\text{mV}$ (~ 200 fC charge);

With $V_{th}=70\text{mV}$ (~ 130 fC charge):
the efficiency is $> \sim 2.5\%$

Probability cluster size > Threshold (horizontal strips)



Standard gas mixture:

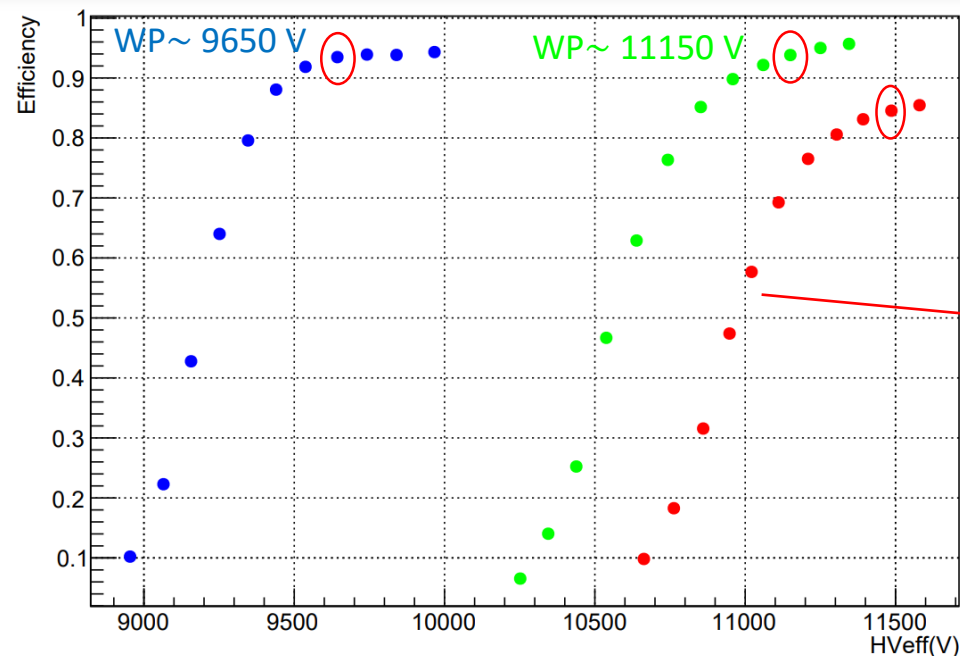
0% HFO- 94.5% R134a- 0% CO_2 - 5% iso- 0.5% SF_6

5) 25% HFO- 20% R134a- 49.5% CO_2 - 5% iso- 0.5% SF_6

6) 25% HFO- 0% R134a- 69.5% CO_2 - 5% iso - 0.5% SF_6

RPC performance with new HFO/CO2 mixtures

Runs ~30min/1h 2D efficiency WP~ 11500 V



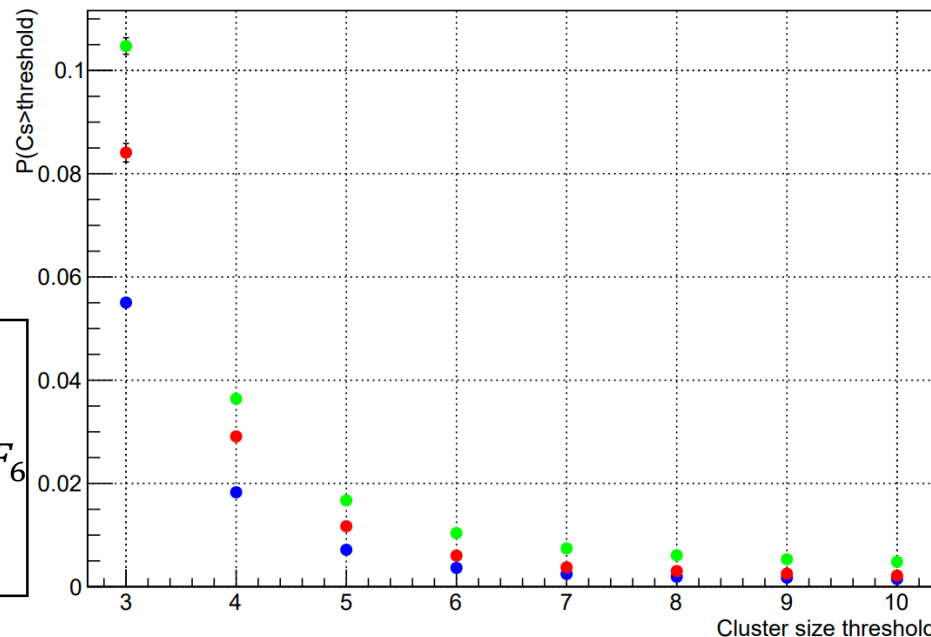
$$HV_{eff} = HV \frac{T}{T_0} \frac{P_0}{P} \left\{ \begin{array}{l} T_0 = 300K, \\ P_0 = 1000hPa \end{array} \right.$$

New tests

Cluster correlated to the reconstructed track if it is within 10 cm from the expected position

Meas. with $V_{th}=100mV$ (~200 fC charge);
With $V_{th}=70mV$ (~130 fC charge):
the eff is $> \sim 0.8\%$

Probability cluster size > Threshold (horizontal strips)



- Standard gas mixture:
0% HFO- 94.5% R134a- 0% CO_2 - 5% iso- 0.5% SF_6
- 7) 35% HFO- 0% R134a- 60% CO_2 - 4.5% iso- 0.5% SF_6
- ecogif mixture:
8) 35% HFO- 0% R134a- 60% CO_2 - 4% iso- 1% SF_6

Summary

Gas mixture	GWP	WP (V)	2D Eff	Av. cluster size (H)	Prob Cs > 3 (H)	Prob Cs > 5 (H)
0% HFO/94.5% R134a/0% CO2 5% iso/0.5% SF6 (standard)	1471	9650	94%	2.3	5.5%	0.8%
10% HFO/84.5% R134a/0% CO2 5% iso /0.5% SF6	1329	10500	94%	2.4	7%	1%
25% HFO/20% R134a/49.5% CO2 5% iso/0.5% SF6	408	10300	84%	2.2	5.4%	0.8%
25% HFO/0% R134a/69.5% CO2 5% iso/0.5% SF6	122	10100	93.5%	3.2	18%	6.5%
35% HFO/0% R134a/60% CO2 4.5% iso/0.5% SF6	122	11150	94%	2.6	10.5%	1.6%
35% HFO/0% R134a/60% CO2 4% iso/1% SF6 (ecogif mix)	242	11500	85%	2.5	8.5%	1.2%

**Thank you for your
attention!**