Preliminary Results of Different Gas Mixtures on a Micromegas prototype for ATLAS NSW

Valerio D'Amico, M. Alviggi, M. Della Pietra, C. Di Donato, E. Farina, Givi, P. Iengo, M. Iodice, L. Martinelli, F. Petrucci

Università & INFN Roma Tre

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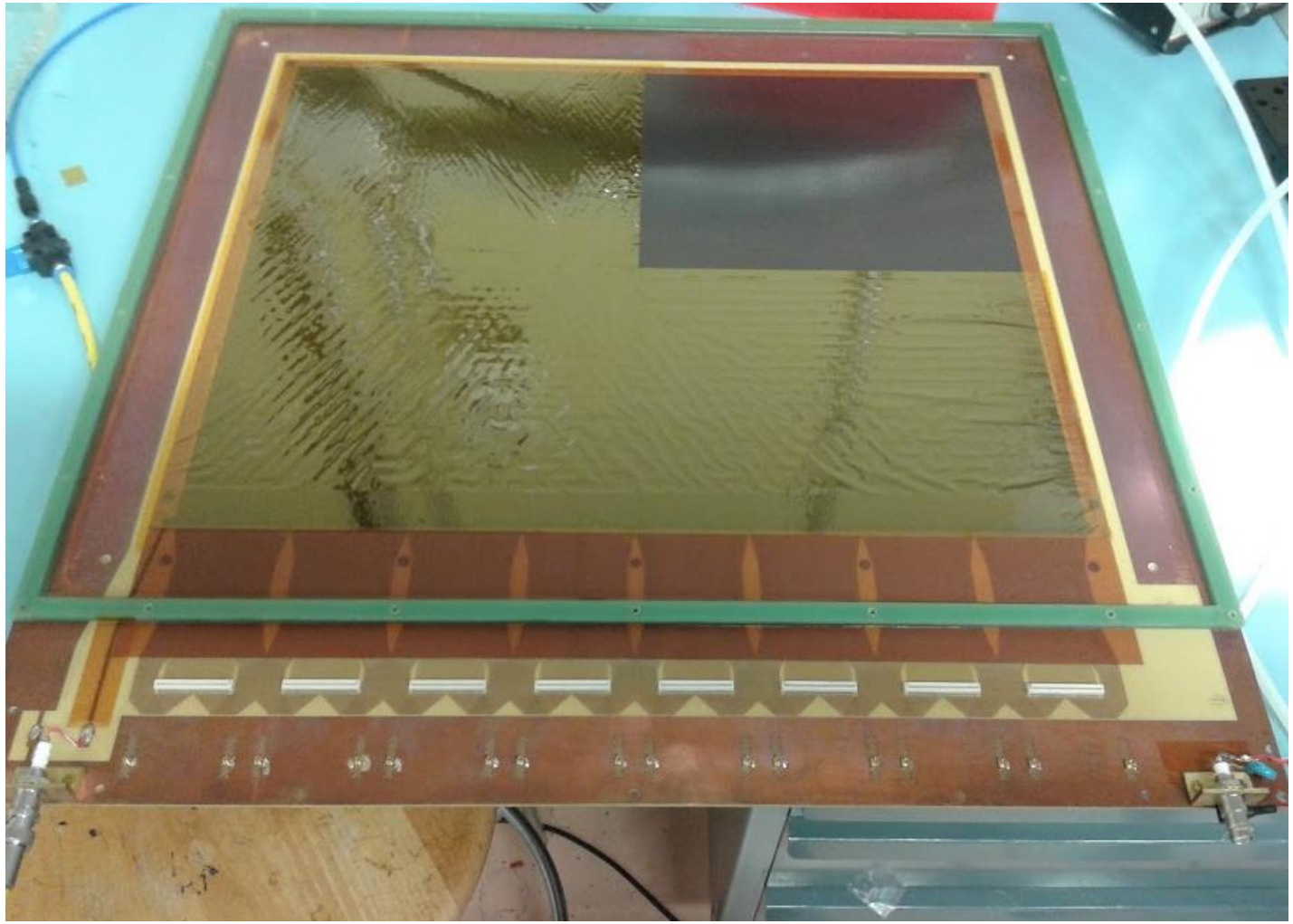
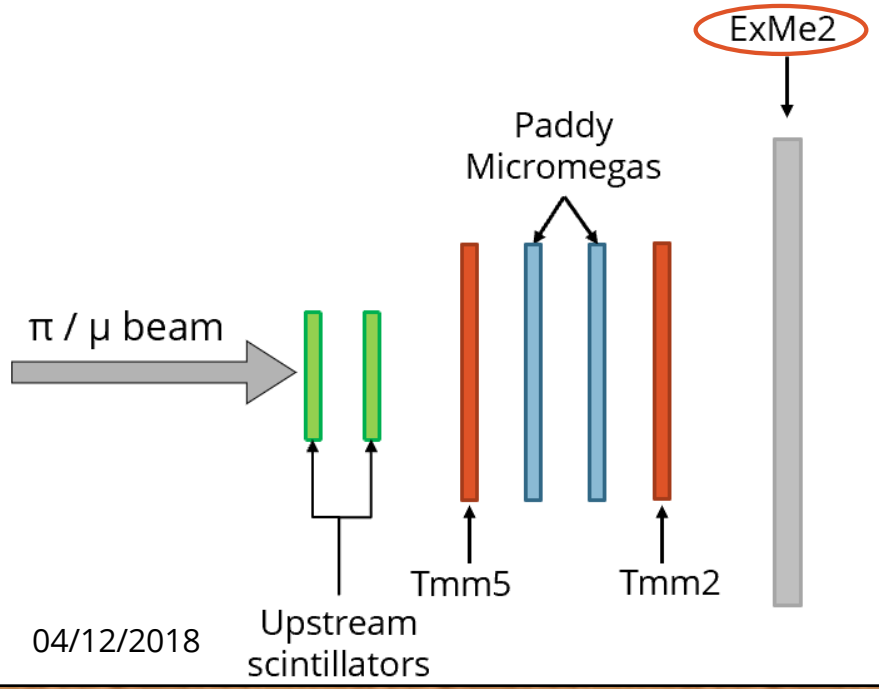
ExMe detector

- Exchangeable Mesh detector, Micromegas prototype
- 4 areas (quarter of surface) with different pillar spacing
- Only sector with 7 mm pillar spacing active
- Other sectors passivated with 12.5 μm kapton film on top of the pillars
- 18-45 mesh calendared used



Experimental setup

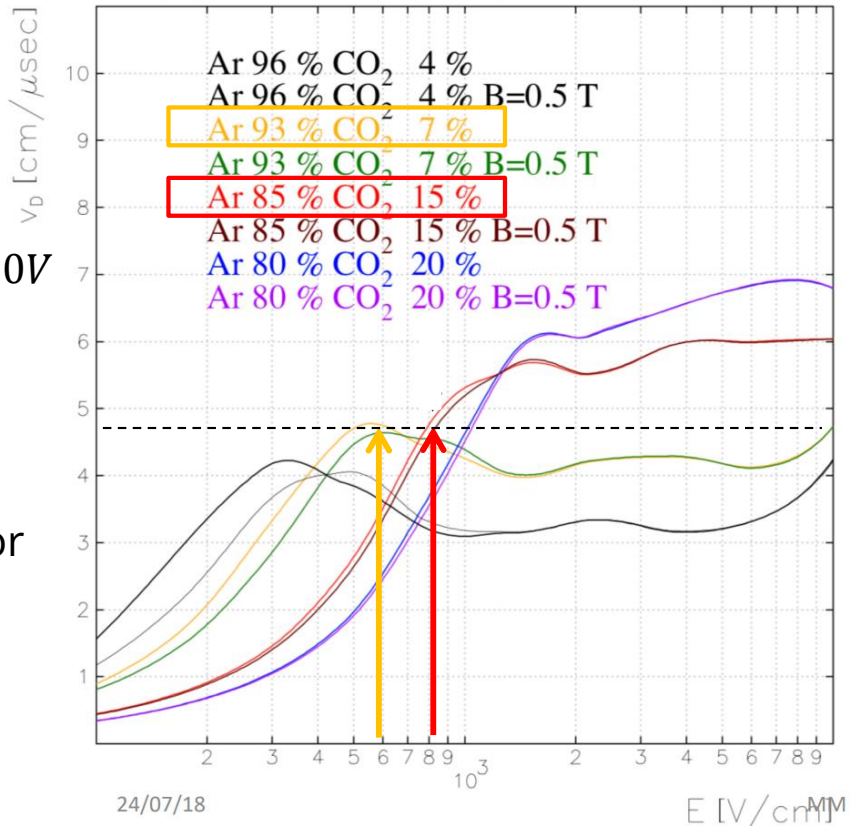
- Test with pion/muon beam @H4, different energy of the beams during the test: $150GeV$ and $80GeV$
- Intensity between 1.3 $MHz/spill$ and 120 $kHz/spill$
- Tracking telescope with 2 Tmm 10x10 cm^2 chambers
- Tmm and ExMe2 equipped with APV25, readout SRS
- Trigger provided by 2 plastic scintillators upstream (with some bulky material close to scintillators)



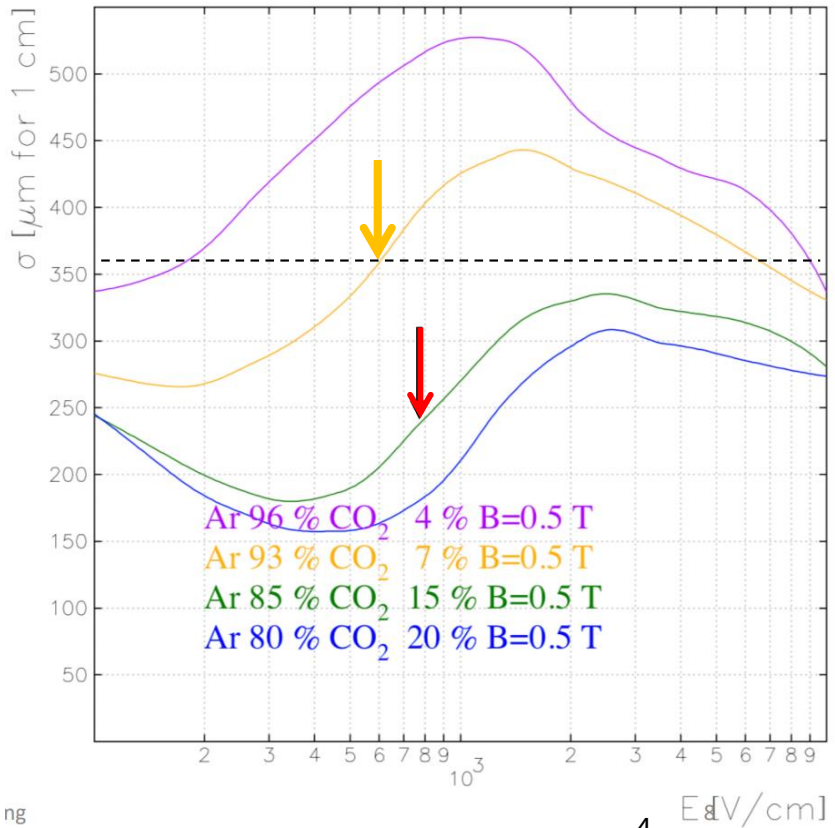
Outline of gas mixtures used

- Runs with tracks @ 0° and 30°
- 3 different gas mixtures from pre-mixed bottles → **93:7, 85:15, 88:10:2** (Ar:CO_2:isobutane)
- RH ~10%
- Drift voltage changed for each gas mixtures to have in the 3 cases the same drift velocity of ~47 μm/ns:
  - 93:7 and 88:10:2 $HV_{drift} = 300V$ $E_{drift} = 600V/cm$
  - 85:15 $HV_{drift} = 400V$ $E_{drift} = 800V/cm$
  - Also performed a drift scan for the 85:15

Drift velocity



Transverse diffusion

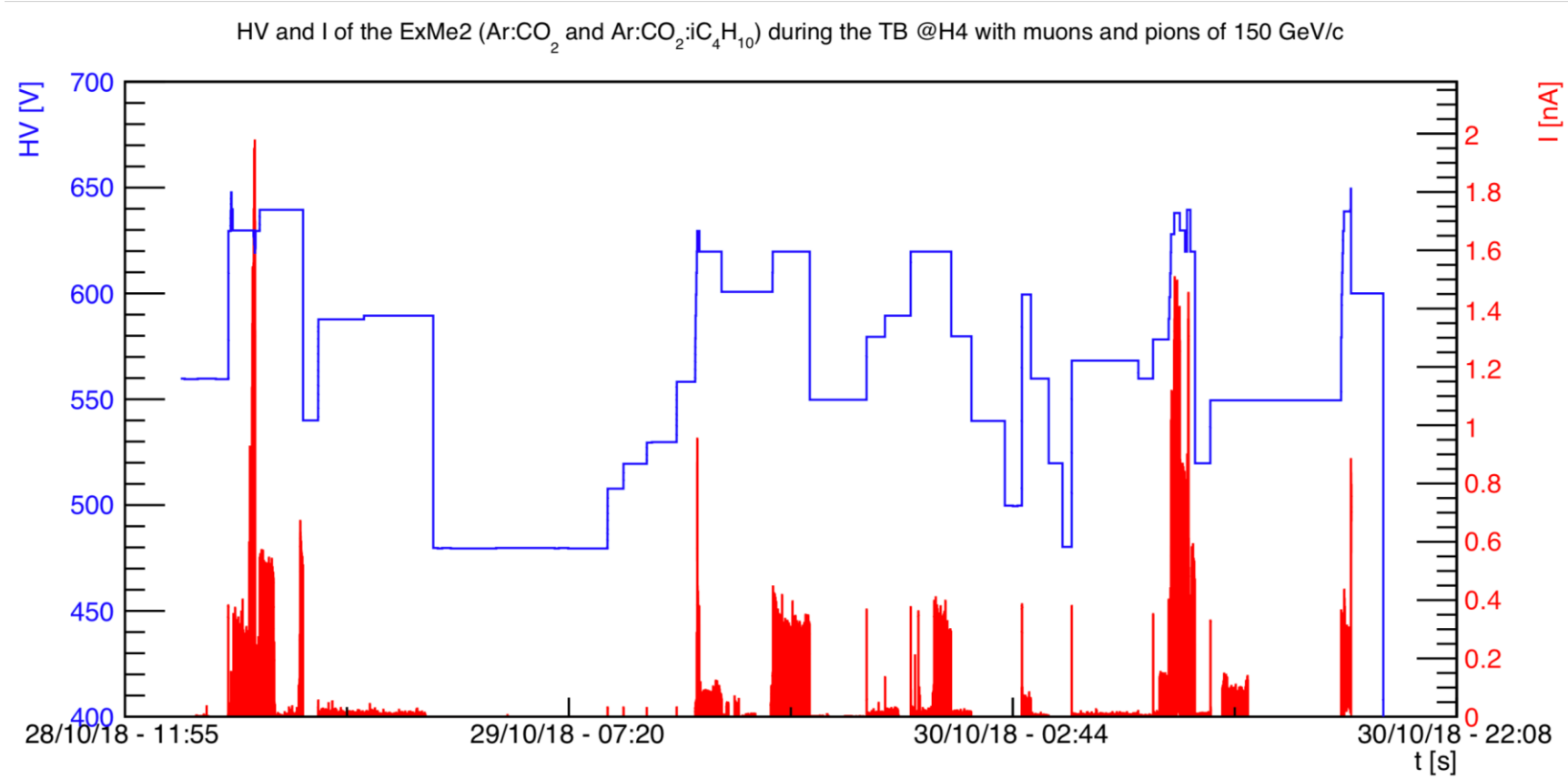


Currents overview

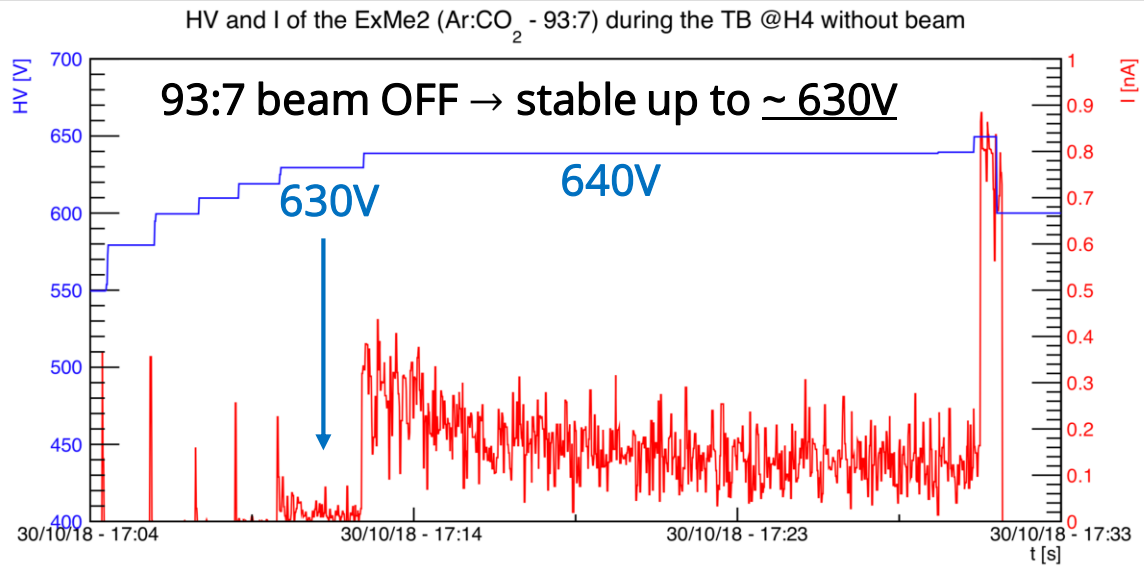
Currents and Voltages ramp of ExMe2 during the first 3 days of the Test-Beam (only 93:7 and 88:10:2 in the plot)

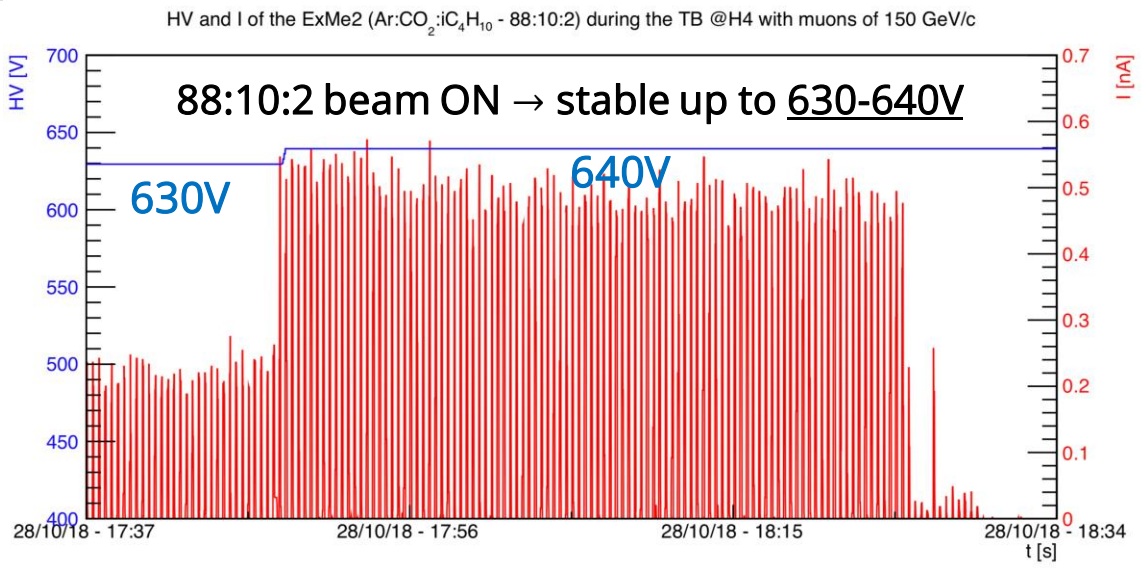
Peaks in current during the spills, better visible with zoomed pictures in next slides

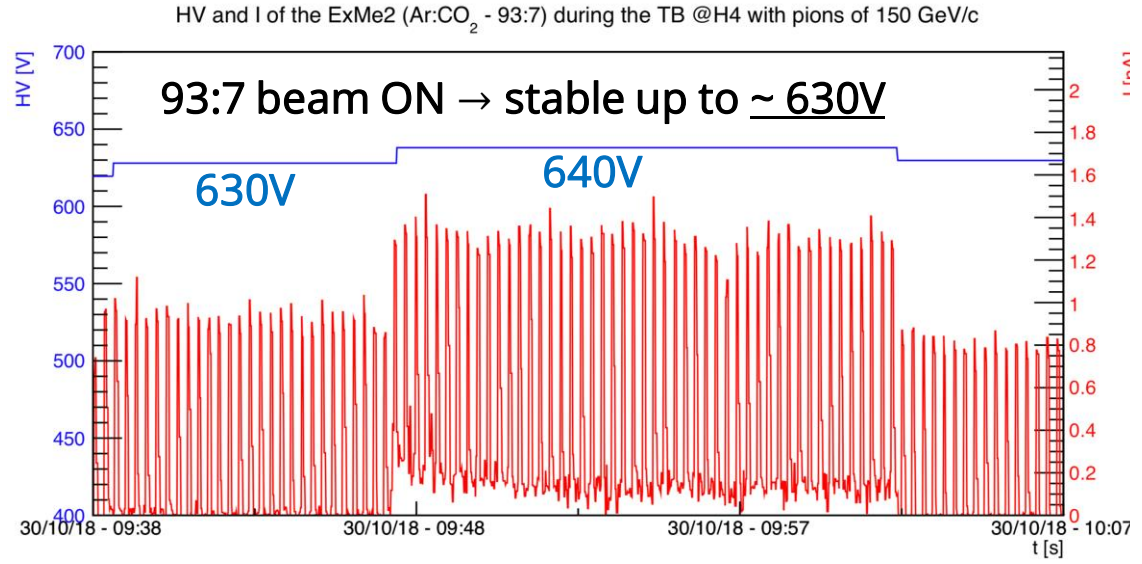
Max stable HV: current must go back stably to 0 between two consecutives spills

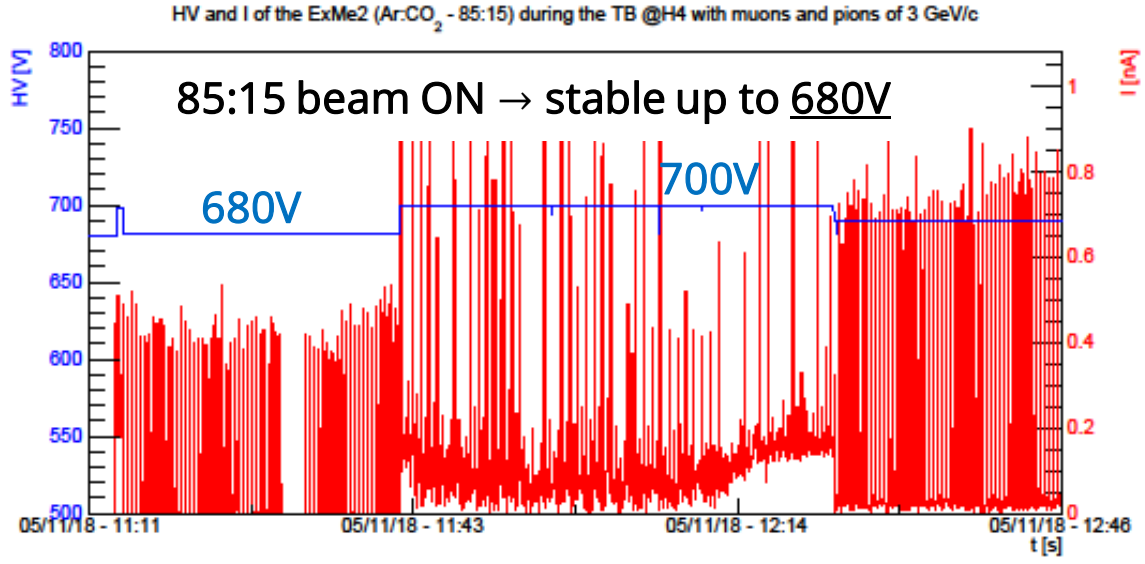


Currents overview







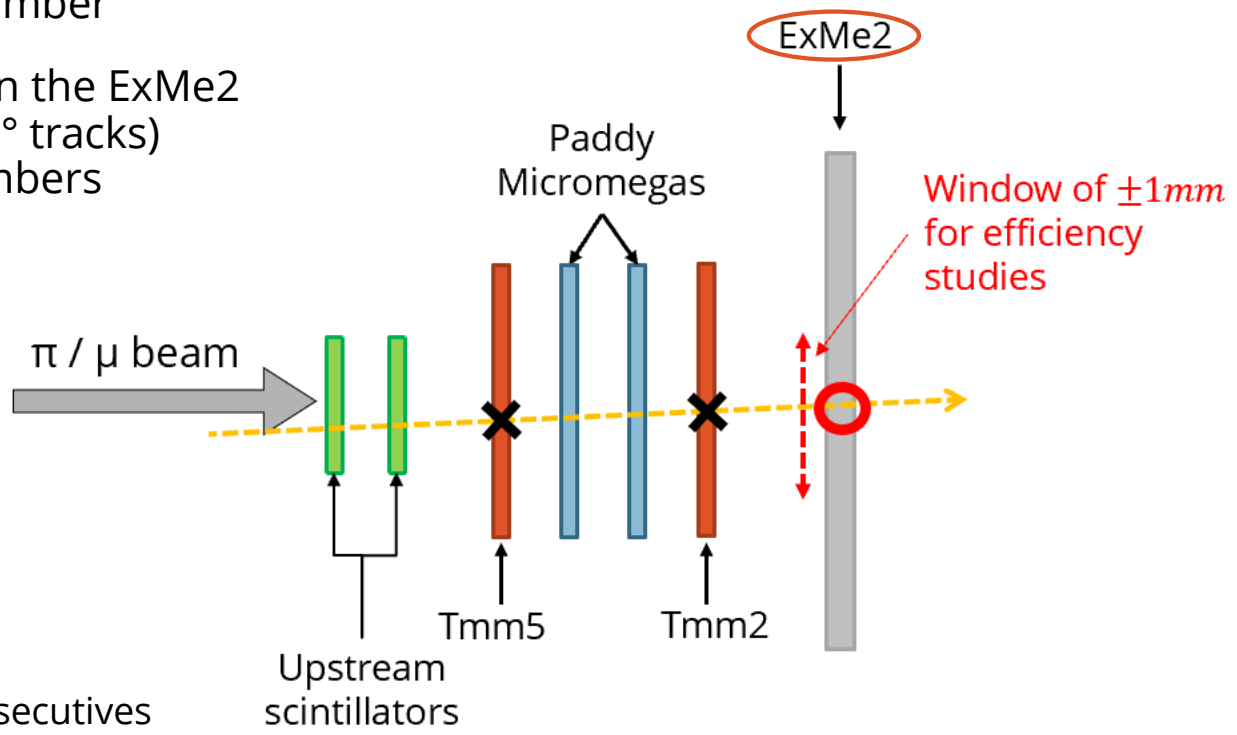


Definition of the software efficiency

Tracking with 2 Tmm chambers:

- Requires only 1 cluster in each of the 2 tracking chambers
- Cut on the angle reconstructed from the linear fit: |ang| ≤ 1°
- Offset used to centre the position of the ExMe2 chamber
- Position of the cluster (using the charge centroid) on the ExMe2 in a region of $\pm$ 1 mm ($\pm$4 mm) for normal tracks (30° tracks) from the extrapolated position by the tracking chambers

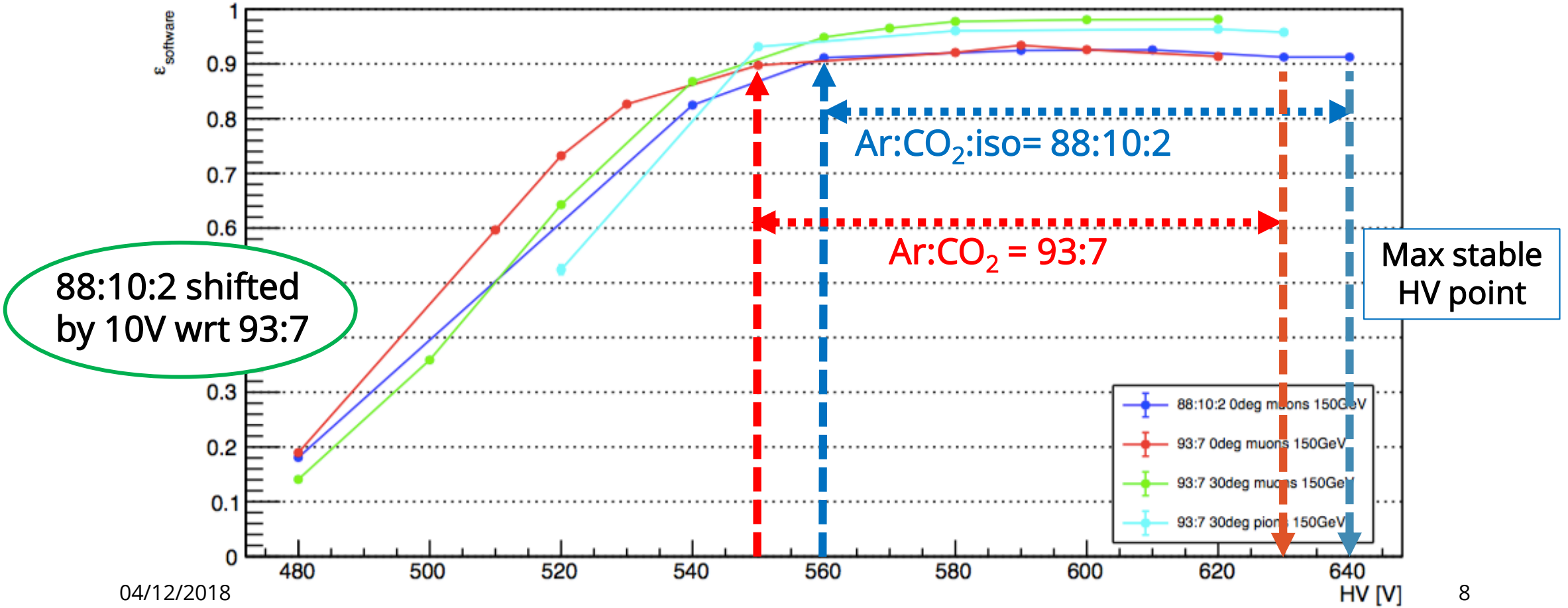
$$\varepsilon = \frac{n_{cluster\ layer}}{n_{tracks}}$$



- Strip charge ≥ (pedestal+3σ) ADC counts
- Number of strips per cluster ≥ 2
- Maximum number of missing strips in cluster = 2, non consecutives

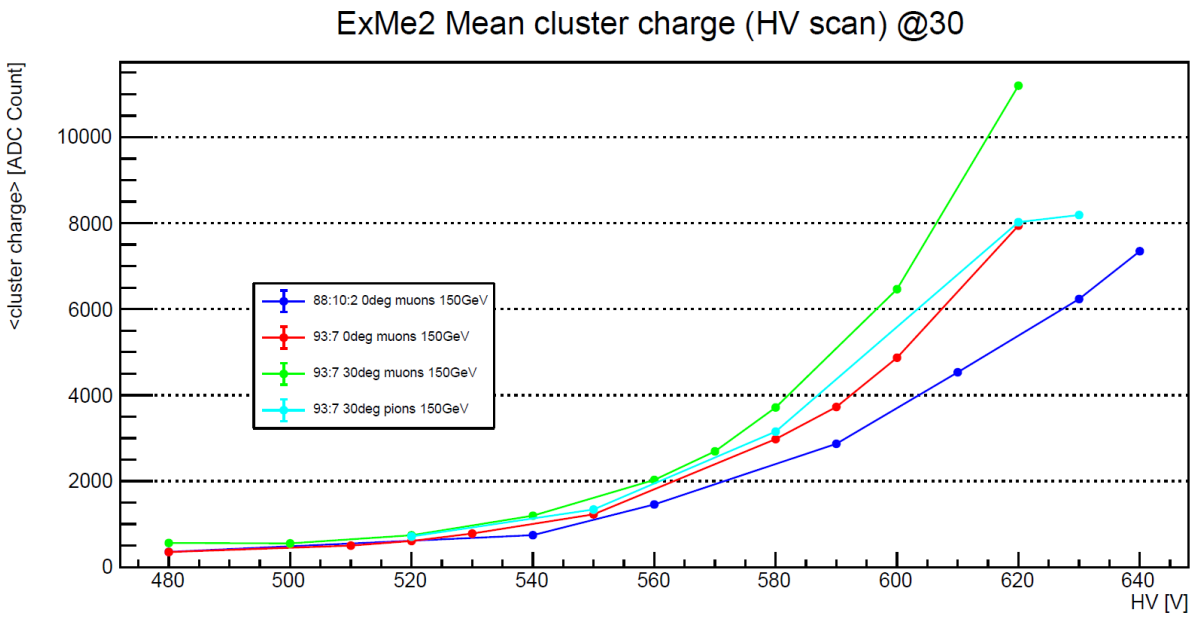
Efficiency vs HV @0° and 30° - 150GeV beam

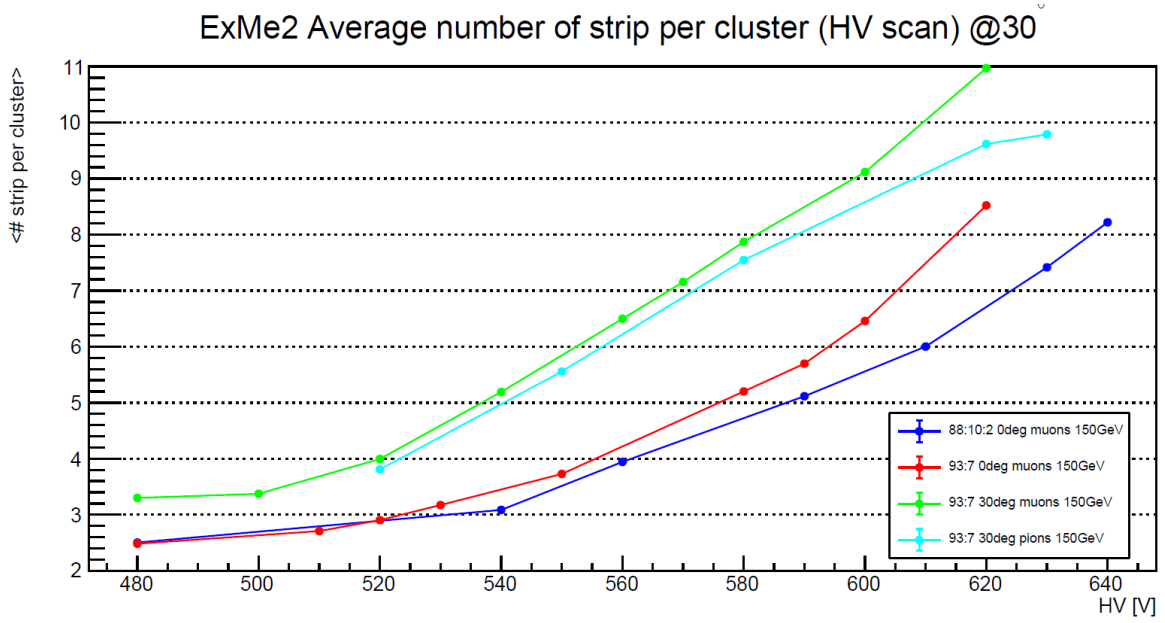
- Reference working point (arrows) at the beginning of the efficiency plateau for 0° runs
- Single layer efficiency ~90% @working point, ~80V away from the Max stable HV point for the 2 gas mixtures



Cluster charge and size vs HV @0°/30°

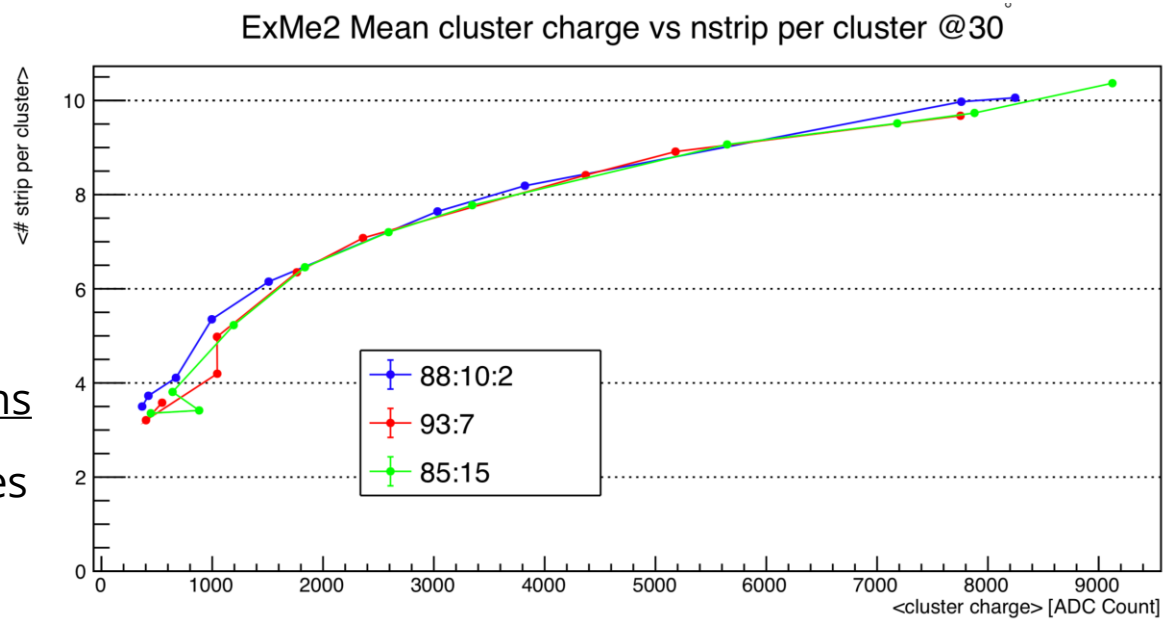
- Quite similar values for the two mixtures
- More strips for inclined runs as expected, charge shared between more strips respect to perpendicular runs

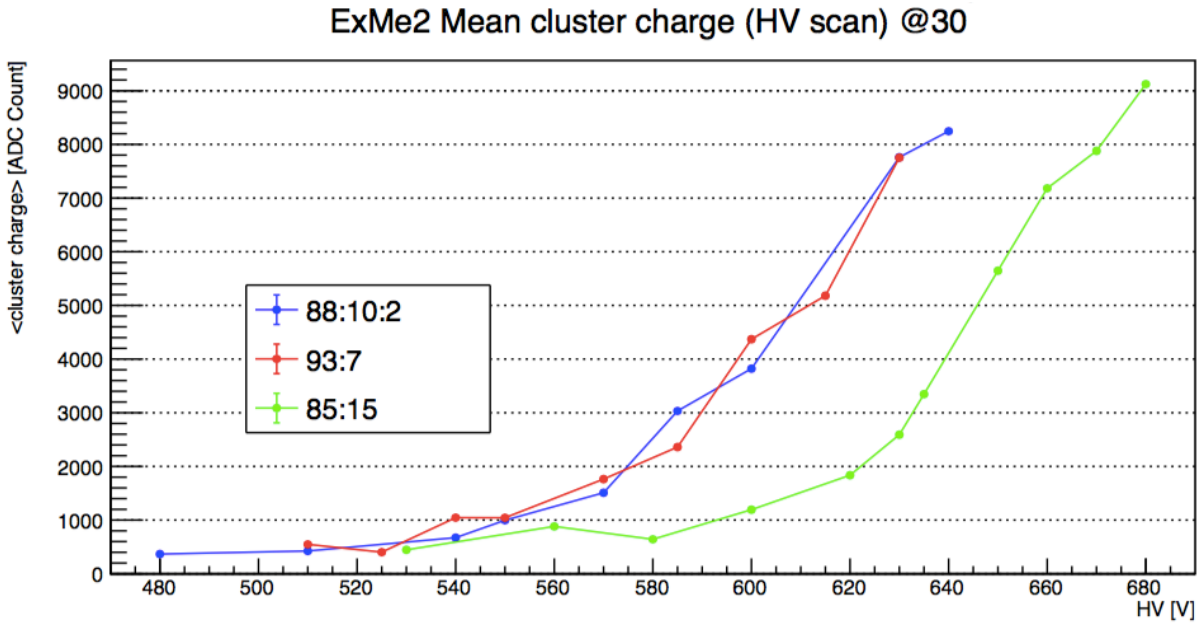


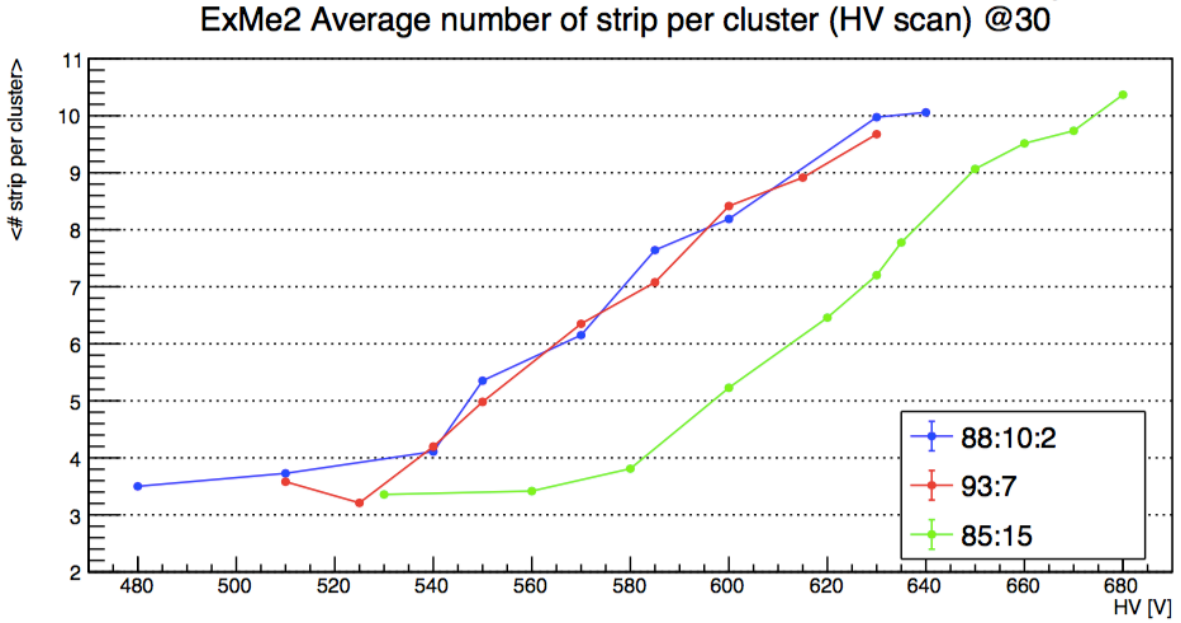


Runs @30° with 80GeV

- 85:15 mixture used only with a different beam: 80GeV pions
- Done again the scans for 93:7 and 88:10:2 .
  Now the 3 mixtures compared with the same conditions
- Shift in voltage for 85:15 respect to the other 2 mixtures
- Charge vs size shows good agreement of the results



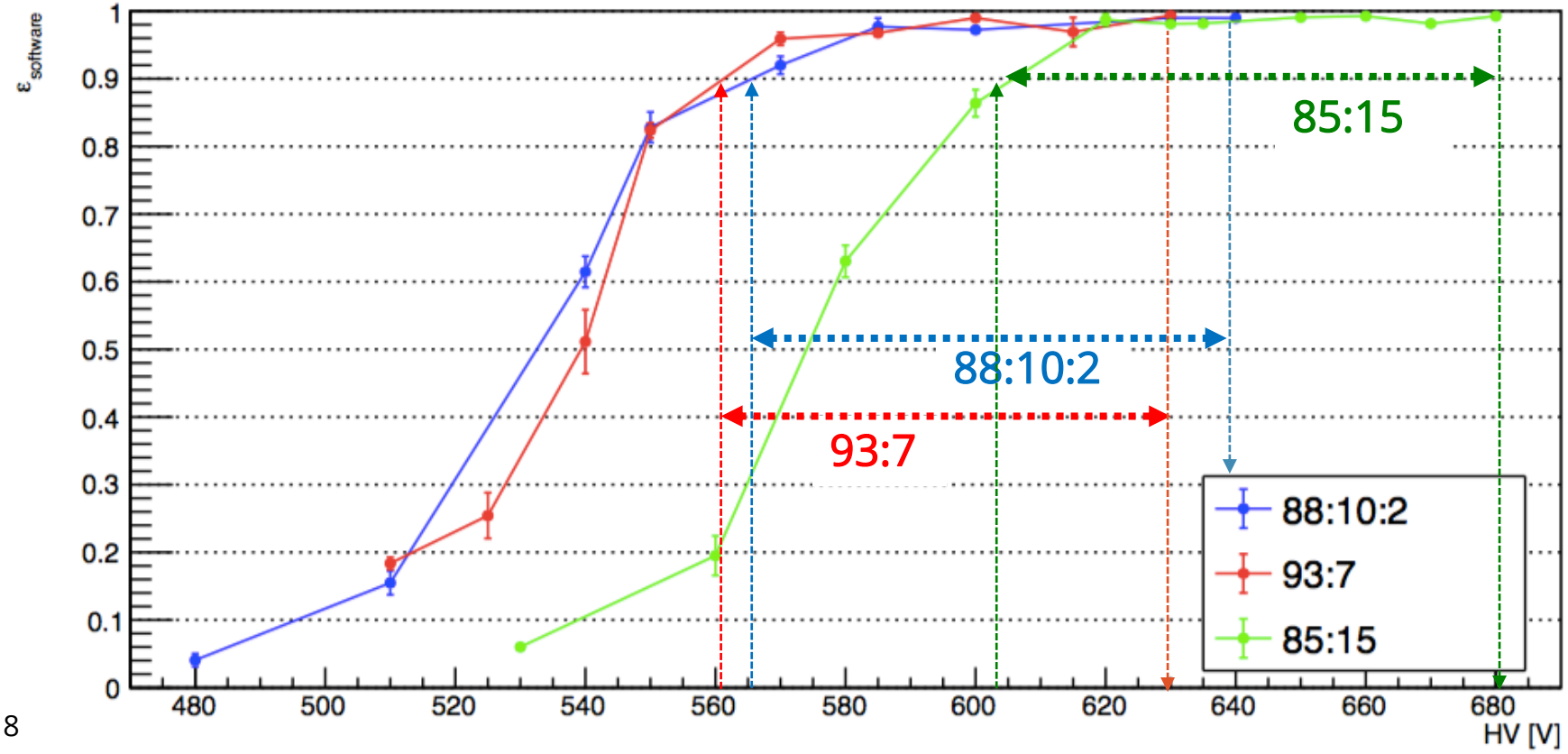




Efficiency vs HV @30° with 80GeV

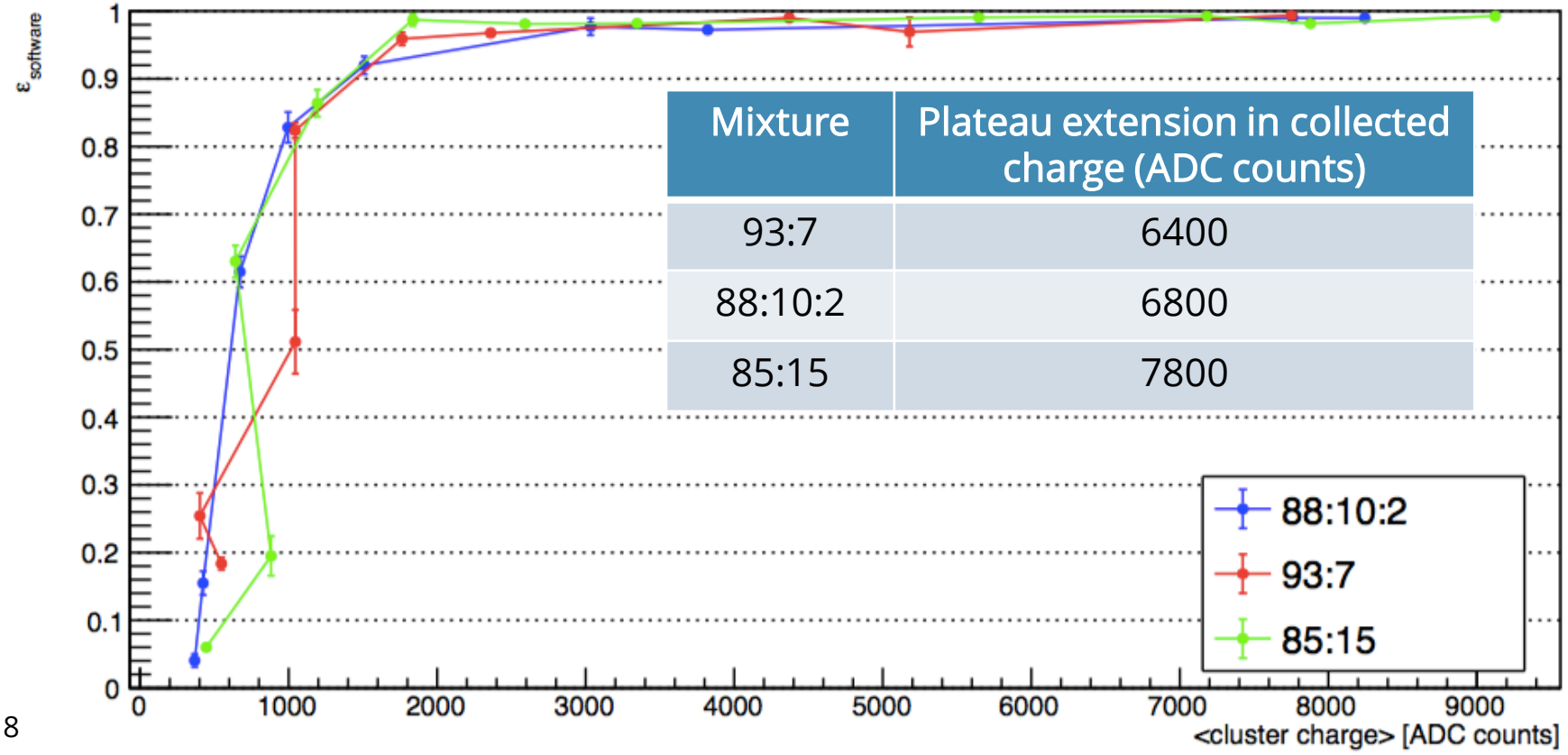
- Different starting point of the plateau (90% shifted by 10V)
- Distance between HV point at 90% to the Max stable HV point:
- 88:10:2 and 85:15 have both a wider stability region than 93:7 → gain of 5-10V

Mixture	|WP-Max|
93:7	70V
88:10:2	75V
85:15	75-80V



Efficiency vs cluster charge @30° with 80GeV

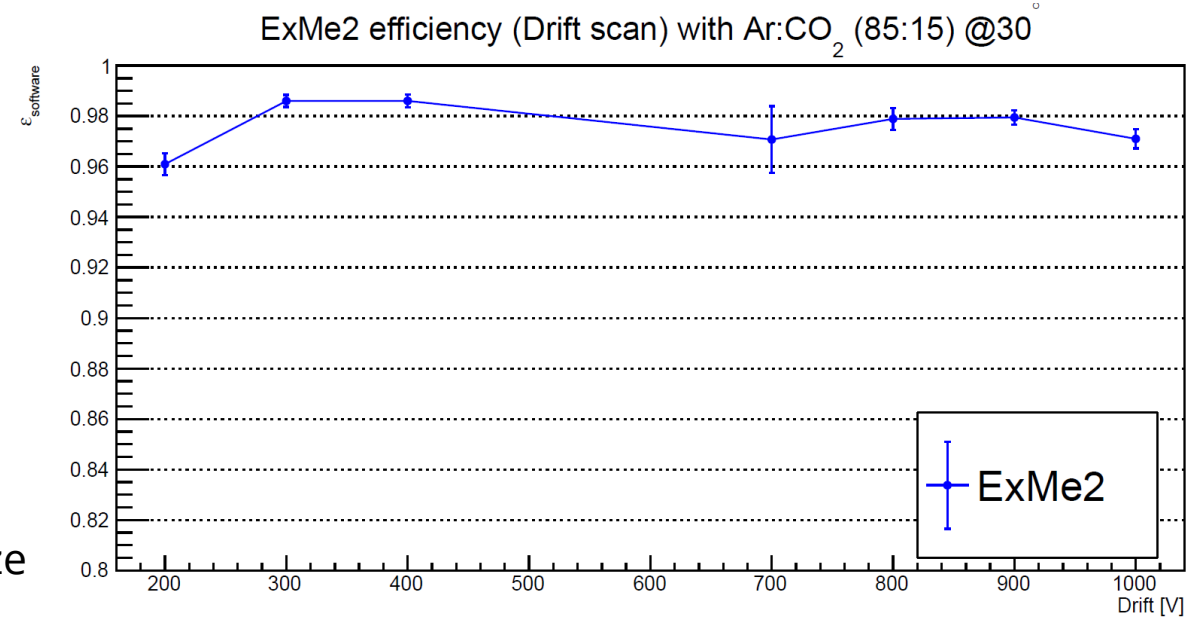
- From this plot we can extract the gain difference in ADC counts between the start of the plateau (90%) to the last point (Max stable HV point).
- **Plateau extension in collected charge (gain) higher for 85:15 respect to the other mixtures!**
- **Fixing the distance from the start of the plateau, 85:15 has more gain respect to 88:10:2**

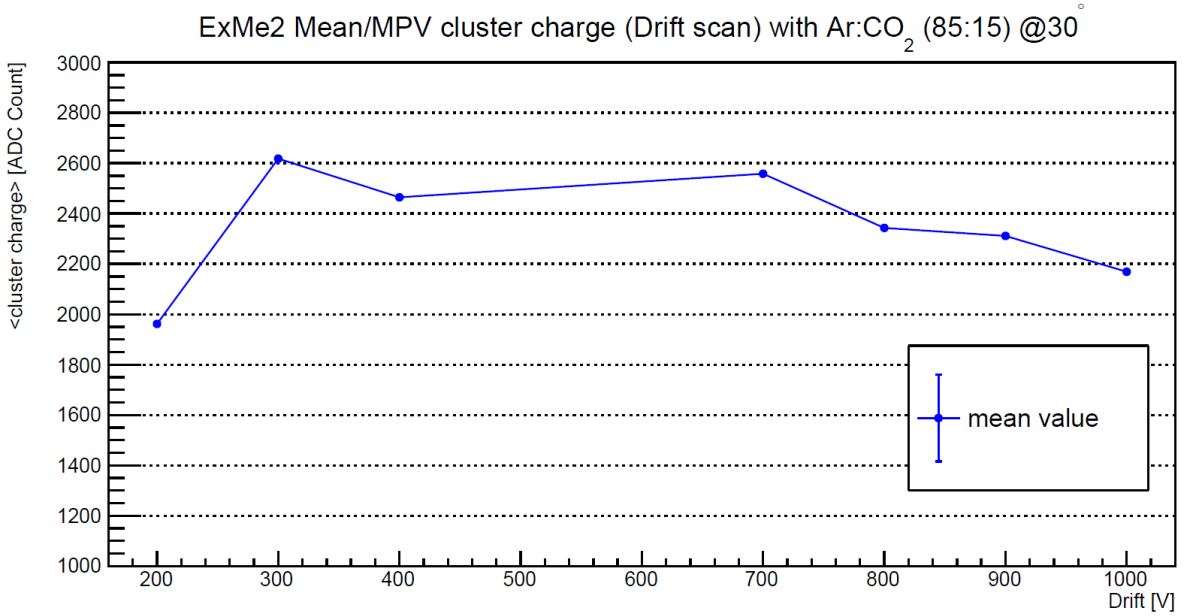


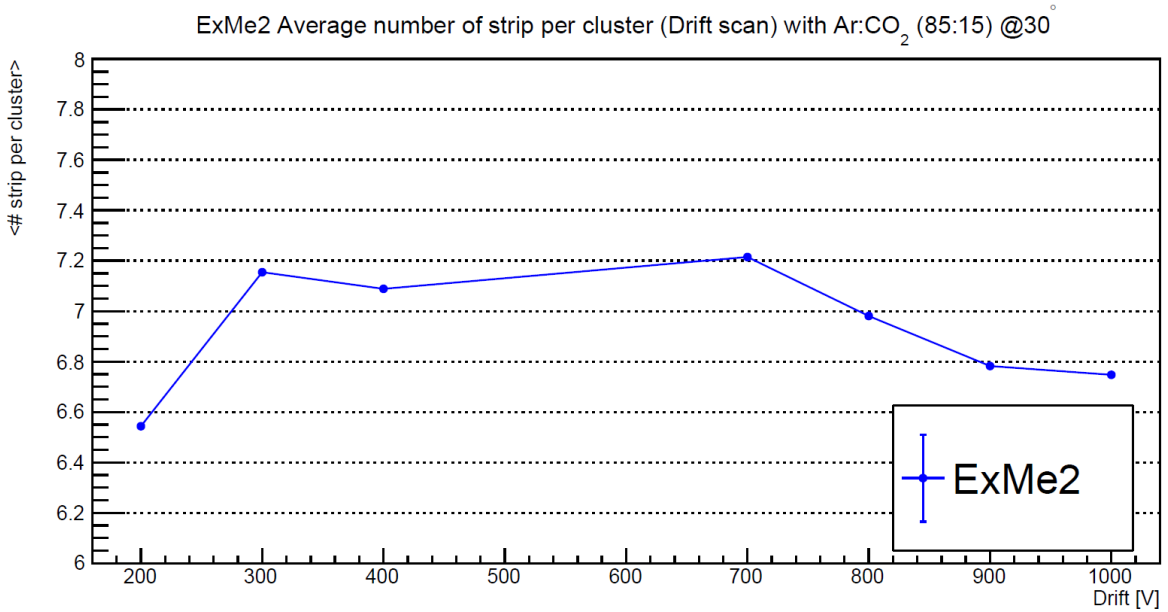
Mixture	Plateau extension in collected charge (ADC counts)
93:7	6400
88:10:2	6800
85:15	7800

85:15 drift scan

- $HV_{drift} = 200, 300, 400, 700, 800, 900, 1000V$
- $HV_{readout} = 630V$ for all drift voltages ($\varepsilon(630V) = 98\%$)
- Points at 500V and 600V unfortunately not available
- Drop in efficiency at 200V and 1000V
- Interesting the 300V case: $\varepsilon = 98\%$ and same cluster size







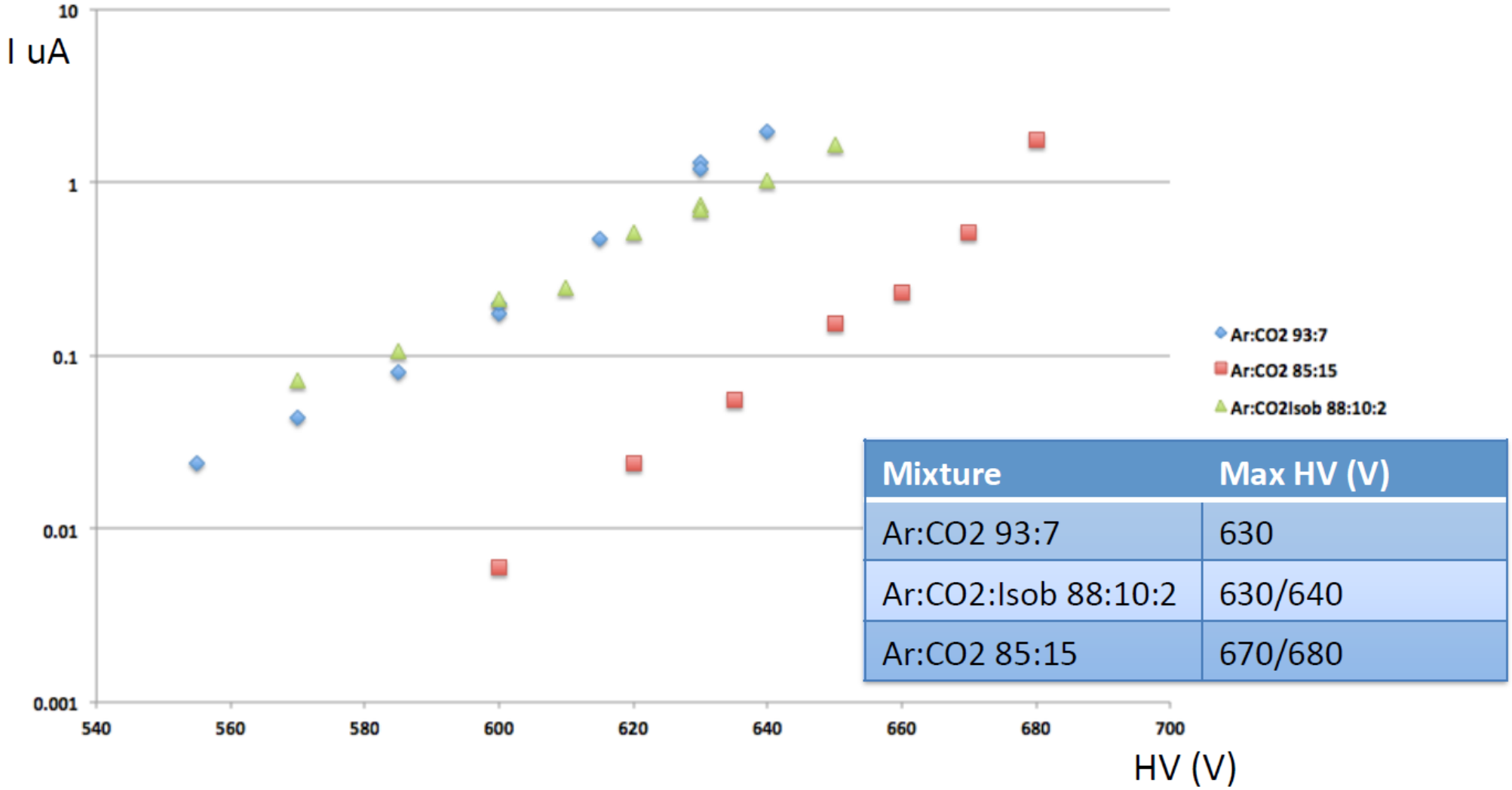
Conclusions

- ExMe2 with 18-45C mesh tested with different gas mixtures: 93:7, 88:10:2 and 85:15
- Working point selected at the beginning of the efficiency plateau: ExMe2 efficiency ~90%
- Max stable HV point with ~0nA current between the spills (or beam OFF)
- Quite the same HV behaviour for 93:7 and 88:10:2, efficiency curves superimposed, little gain in stability region with 88:10:2
- 85:15 and 88:10:2 have a gain of ~10V in the distance WP-Max respect to 93:7: ~80V instead of 70V
- With the 88:15 an higher gain can be achieved within the stability conditions
- Moreover, possible alternative working point using a different and lower drift voltage for the 85:15 mixture and so a lower drift velocity:
  - not strictly necessary to have the same drift velocity, but important to keep the drift time < 200ns for electronic reasons
  - Efficiency still at 98% as for 400V drift
  - Reducing 85:15 drift voltage to 300V (or 350V), possible gain in transparency, should be tested with perpendicular tracks to check the effect of the lower transverse diffusion.
- Good Agreement between Test Beam and Lab results (by Paolo).

Thanks for your attention!

Back-Up

Currents during spills



Mixture	Max HV (V)
Ar:CO2 93:7	630
Ar:CO2:Isob 88:10:2	630/640
Ar:CO2 85:15	670/680