CAPIRE , a R&D program for parallel plates glass counters

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LCWS05

Stanford 18-22/03/2005

RPC's: why… how

- Parallel plate counters have many interesting features:
  - They are very easy to build
  - They have high efficiency to detect minimum I particles
  - They are quite fast (very high cathode field).
- In all, they are a good match whenever one has to detect over large areas min. I particles.
- Applications may include:
  - Digital calorimetry
  - Muon detectors

Main lines for R&D program

- The Program has two main lines:
  - Develop a set of operating characteristics : e.g. gas mix, electrode thickness, H.V., resistivity, amplification regime….
  - Develop an industrial building procedure so that large area detectors could be contracted out.
- In this line of thought, glass is a good material as industries have been working with this material for quite some time.

Today's menu

- Operational
  - Results from test beam exposures
    - Low charge streamer regime
  - Results from cosmic ray test stand
    - A first look at different gas mixes
    - The role of the main components : R134A, Isobutane, Sulfur hexafluoride.
- Engineering and construction
  - Test of new U.V. drying resistive paint
  - Long term tests

Test beam

- Using the BTF @ Frascati one is able to mimic the working condition for RPC in a linear collider type of environment.
- The BTF can pack a given number of electrons ($1–10^{10}$) in a adjustable spatial spot with a repetition frequency up to 50 Hz.
- Typical time buckets are of the order of 1 nsec.

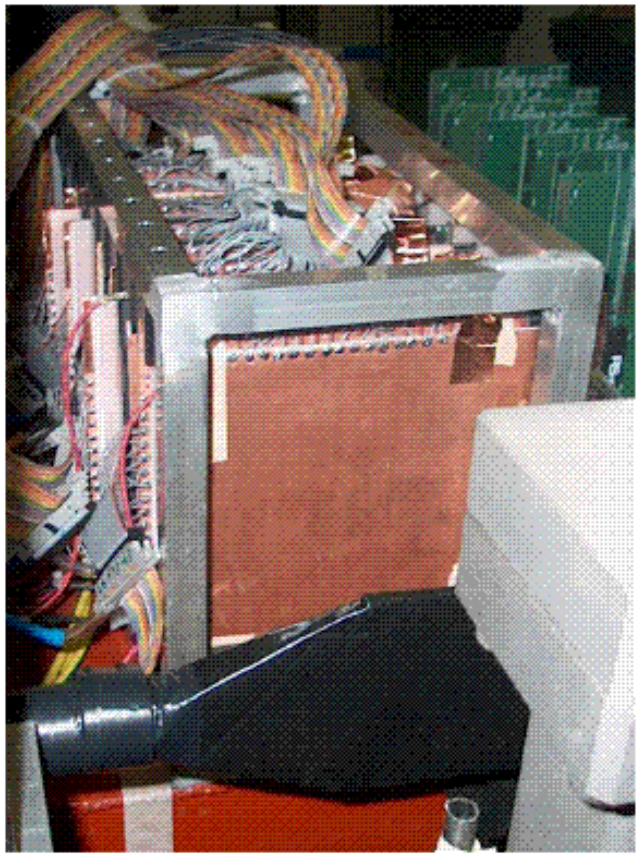
Test beam (cont.)

- The test was carried out on 7 detectors: 20x20 cm^2 in size.
- They were equipped with strips on both sides at orthogonal angles.
- 4 chambers had 3 mm. thick electrodes, the other 3 had 2 mm. thick electrodes, all of them had the new U.V. drying paint with a surface resistivity of $500K\Omega$/square.
- The glass resistivity was $1.2 10^{13}$ Ωcm for the 3mm chambers, $4.0 10^{12}$ Ωcm for the 2 mm chambers. Glass surface resistivity was $4 10^{12}$ Ω/square.
- Dielectric constant for the float glass used was about 9.

Test beam (cont.)

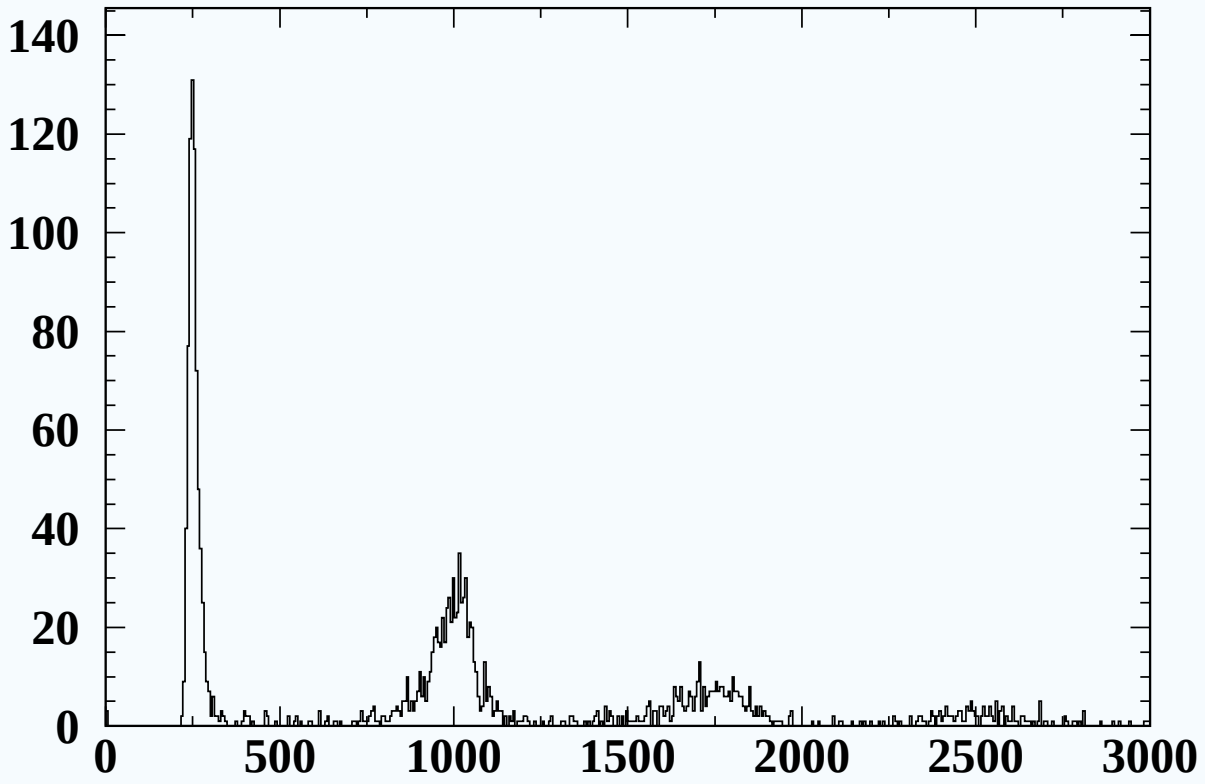
- Strip size on both views was 0.78 cm, which corresponds to a spatial resolution of about 2 mm.
- We used gas mix that would lead to limited streamer operation, even if the charge on the pick-up electrodes was relatively small (~30 pCoul): in principle small charges enhance the high rate capability of the detectors.
- Spatial response was measured together with pulse height.
- The trigger was a minimum bias one
- The number of particles hitting the chambers was measured by a total absorption e.m. crystal calorimeter.

The setup on the beam line

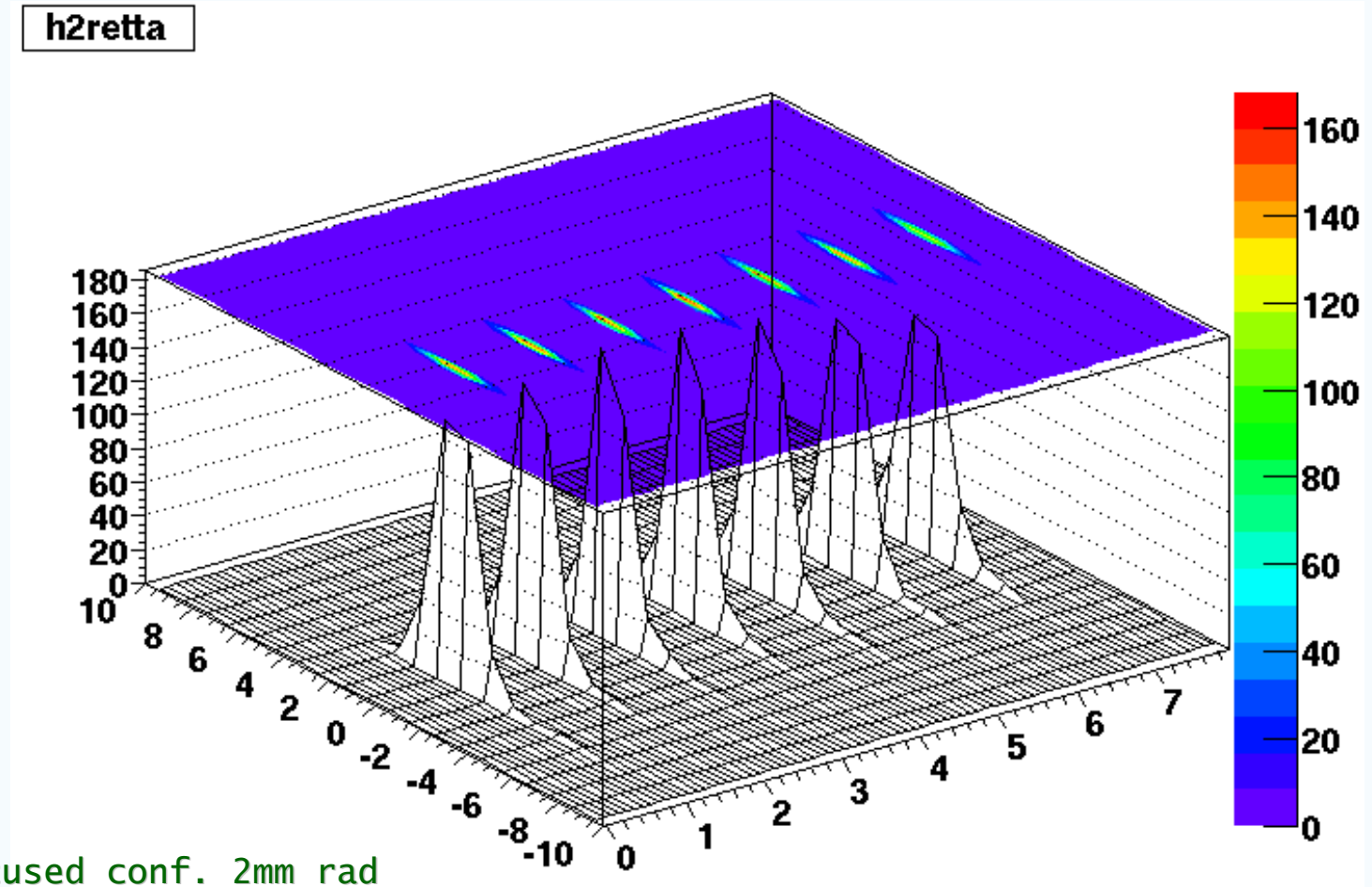


Here is the setup on the beam line.
Triggering is beam-only
Event selection done a posteriori

Particles counting by calorimeter

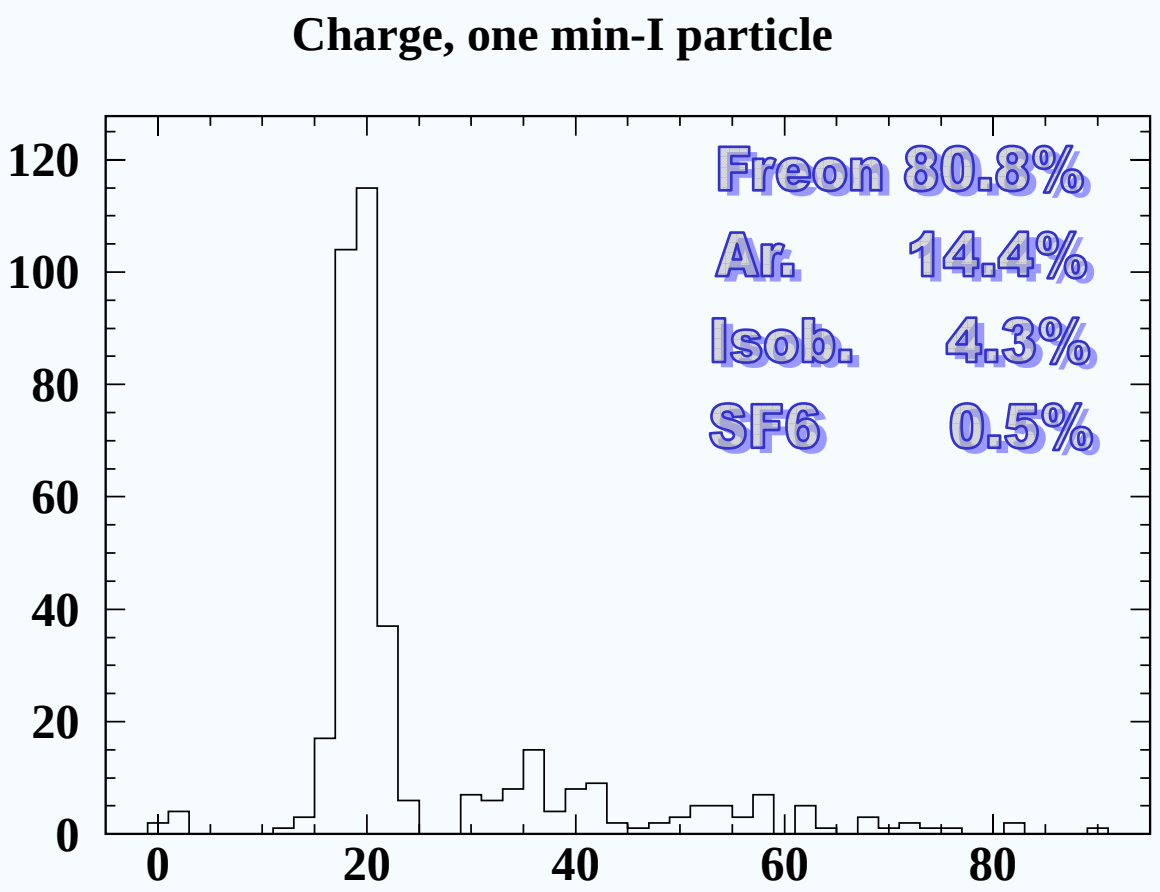


Beam characteristics

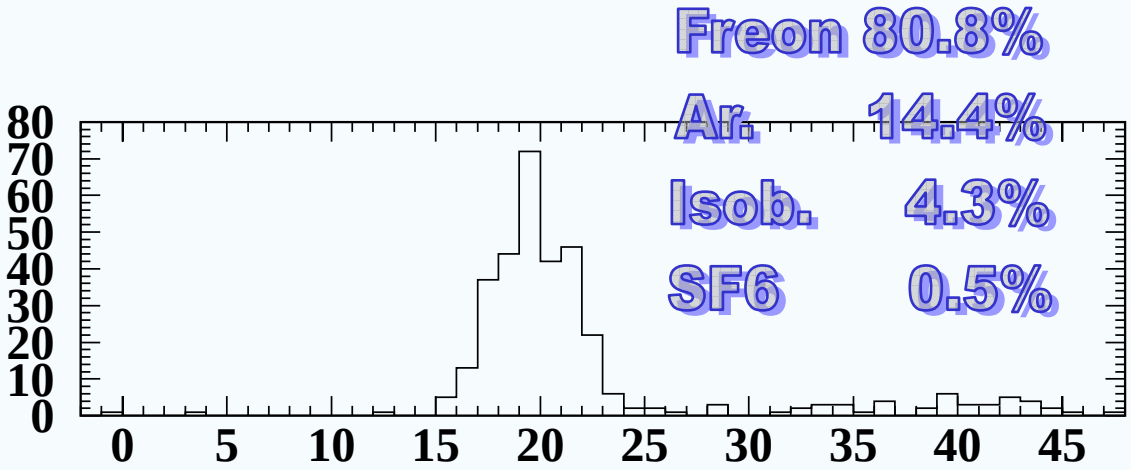


Focused conf. 2mm rad
Defocus conf 2cm rad

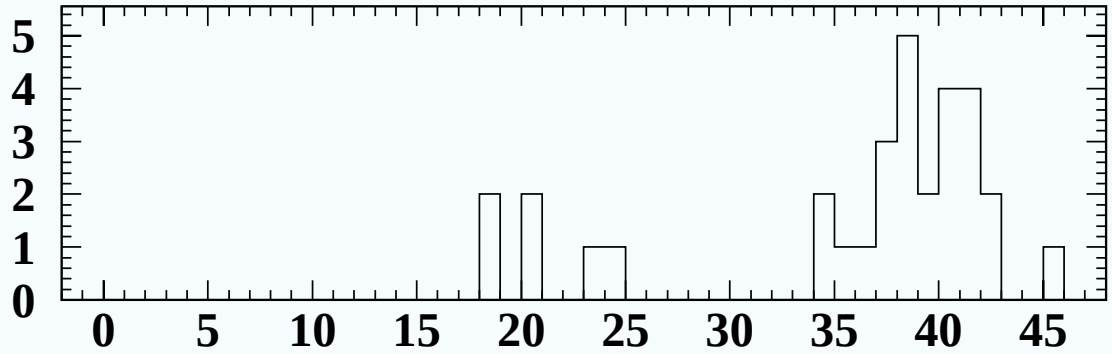
Min-I charge response



Charge spectra

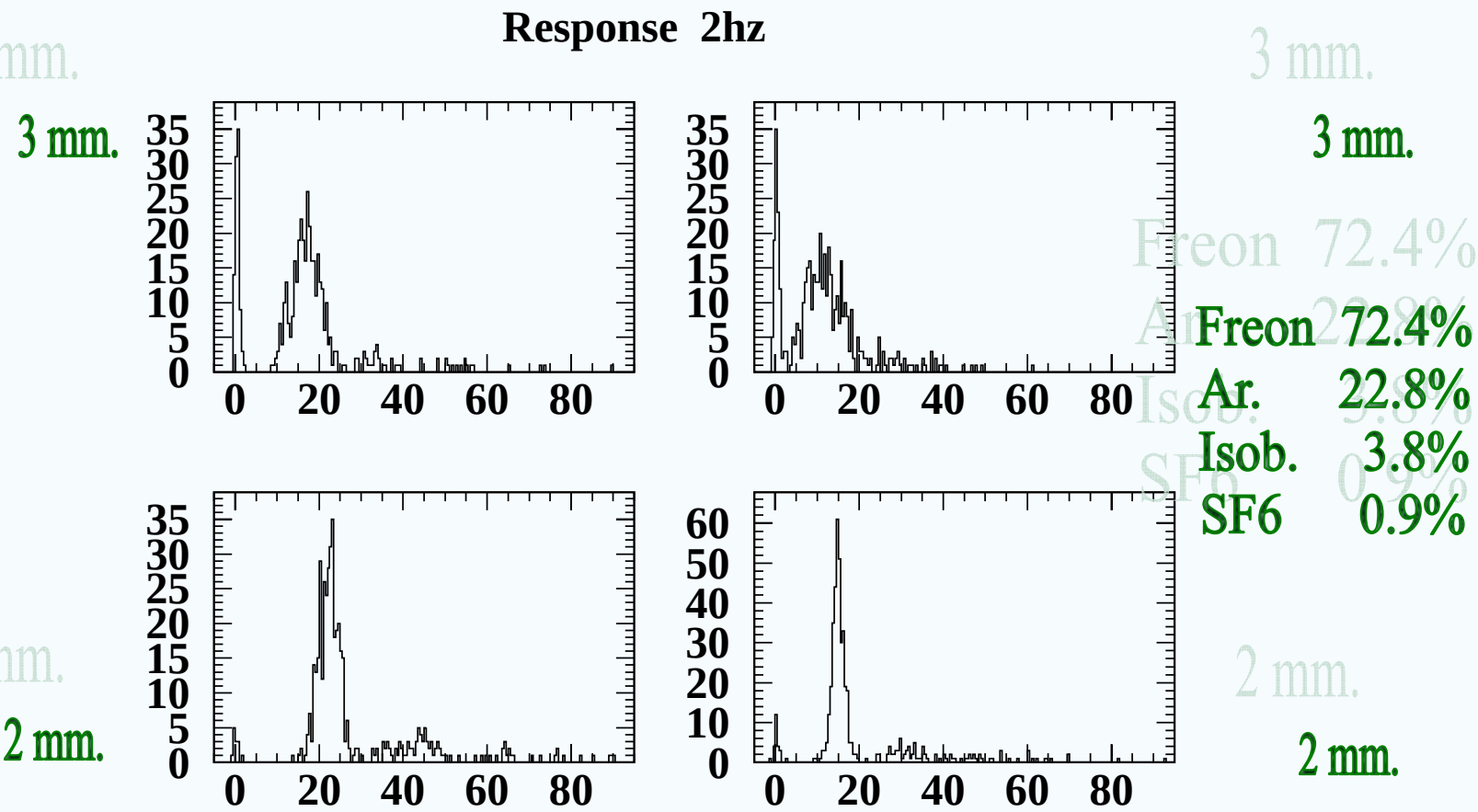


One electron

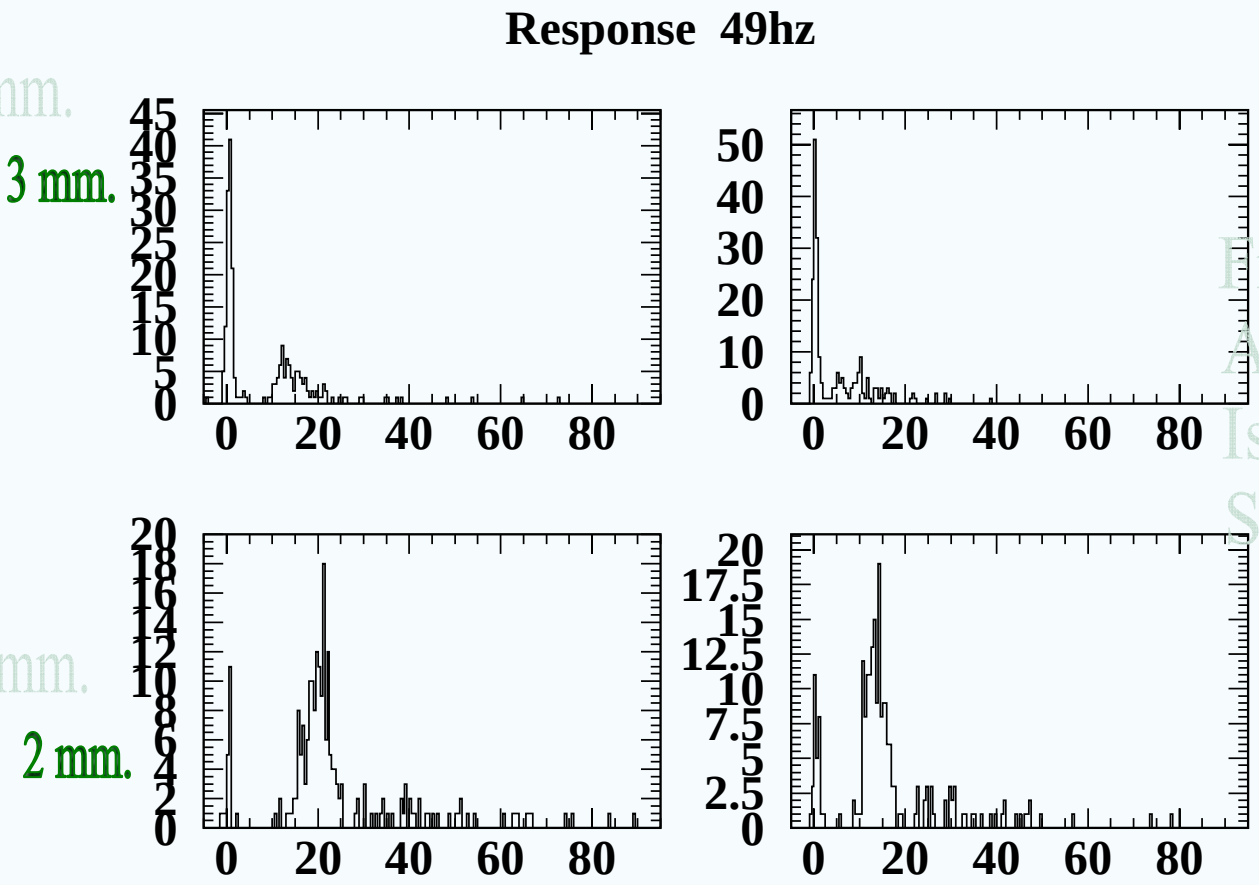


Two electrons

Low frequency response



High frequency response

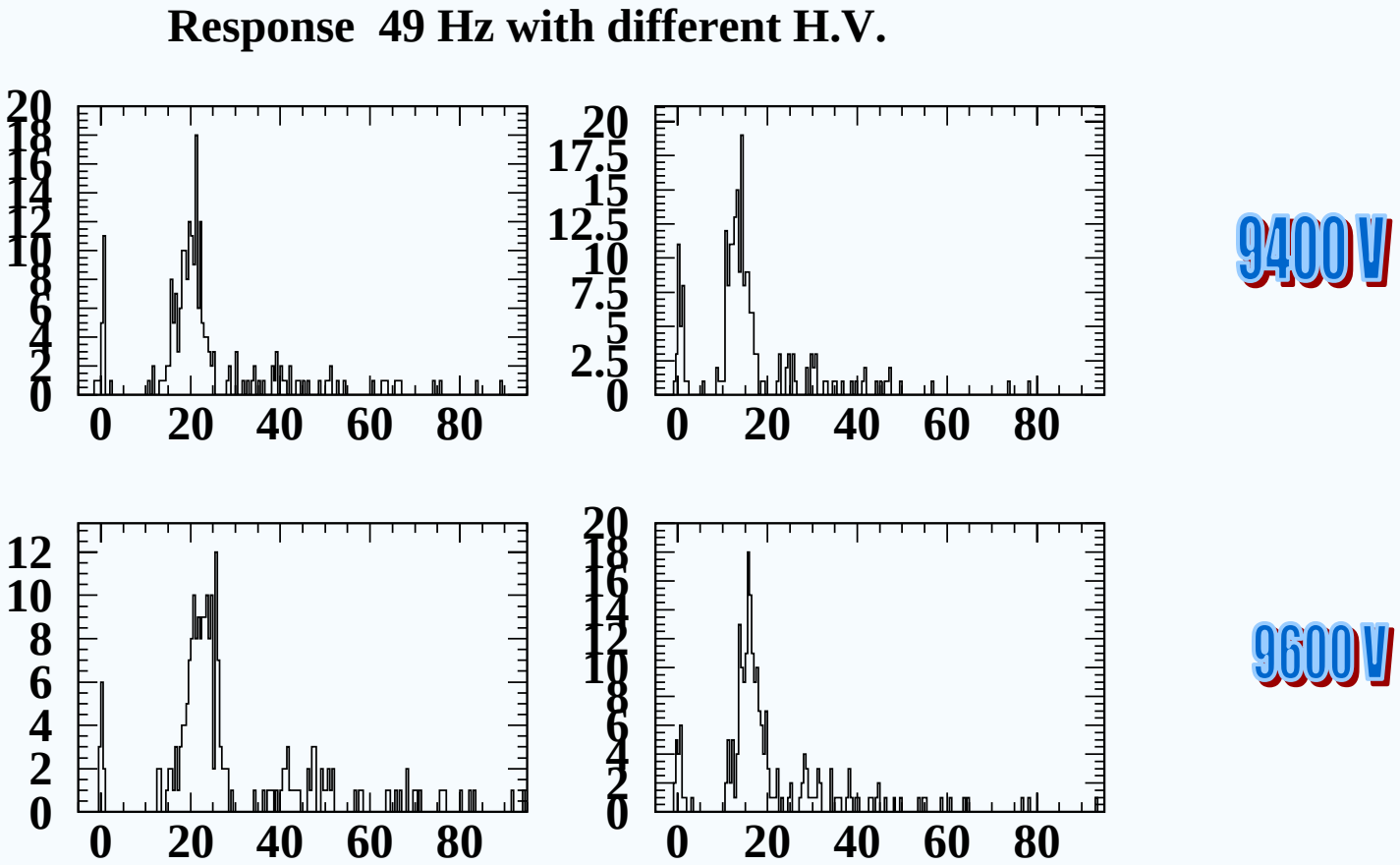


3 mm.

Freon 72.4%
Ar. 22.8%
Isob. 3.8%
SF6 0.9%

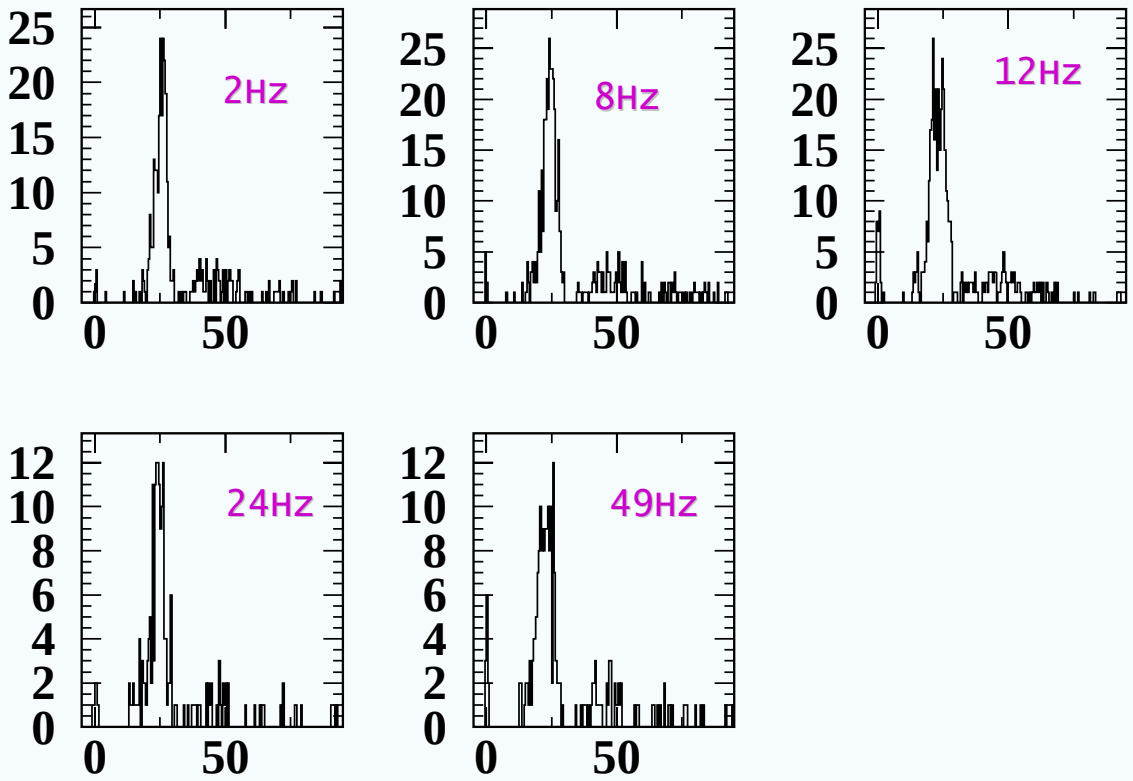
2 mm.

Frequency behavior (2mm)

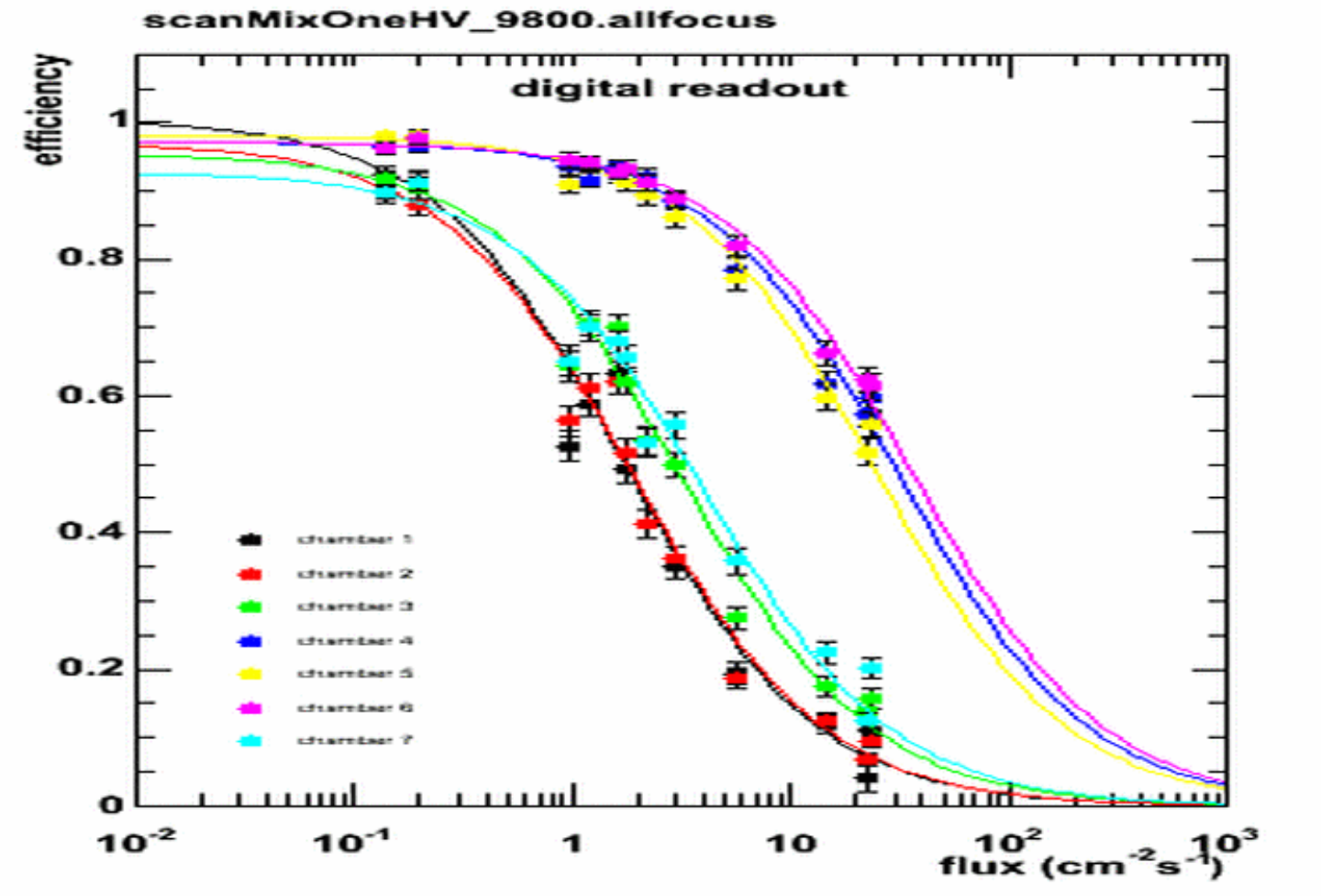


P.H. spectra vs Frequency

Amplitude spectra vs frequency ch 4 2 mm. elect



Putting all together



Cosmic data

- The same setup has been used to study gas mixtures.
- Main answer we were after, was whether a reliable avalanche mix, could be found at operational H.V. below 12 KV.
- Details of the two regimes ratio, as a function of the operating voltages have been studied too.

Experimental details

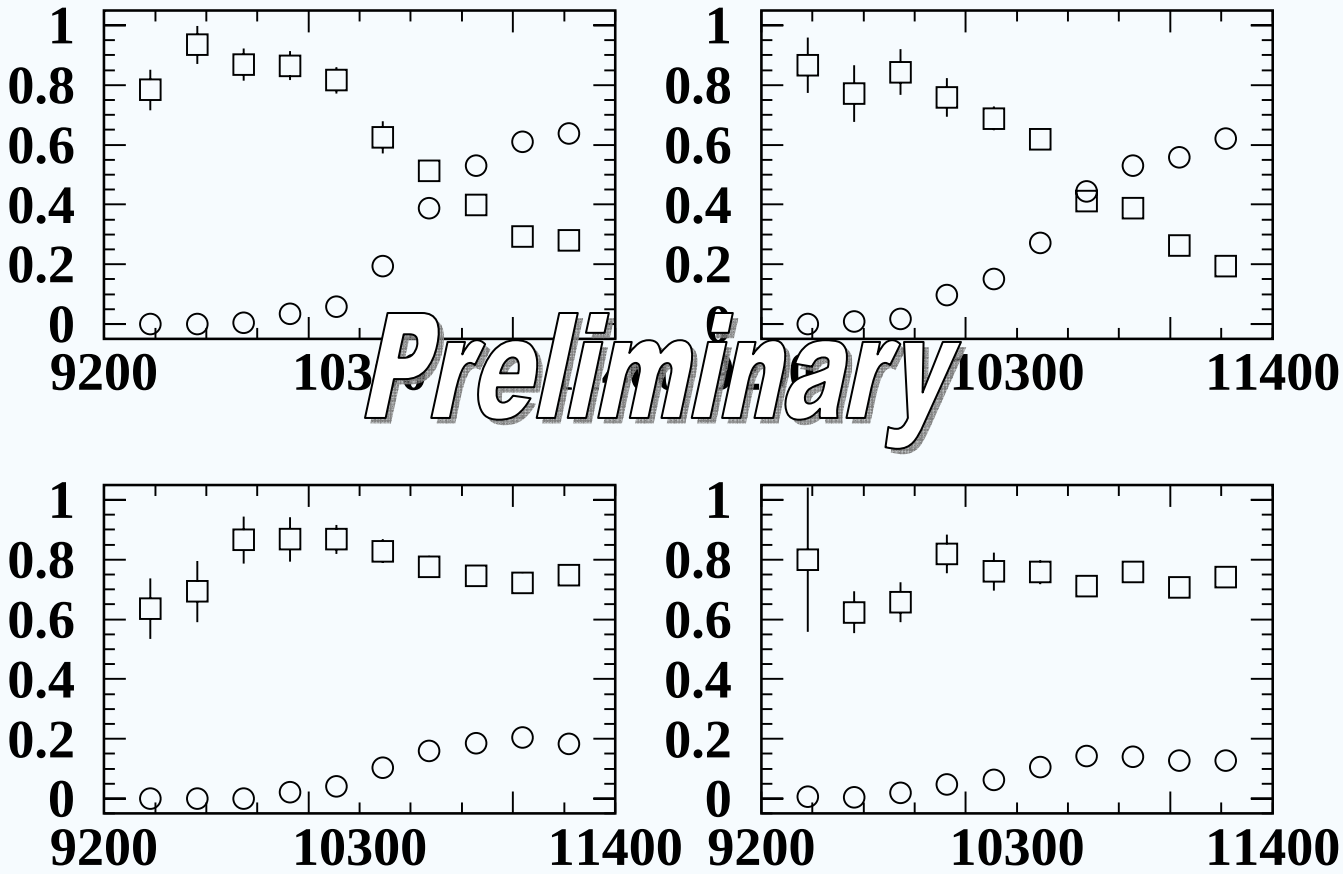
- Not easy to set up a minimum bias trigger.
- Ended up with two (big) scint. counters.
- Data analysis requires a couple of RPC to be on, in order pick a smaller fiducial volume.
- Data rate relatively low (1-2 Hz)

Mixtures tested

- Many mixtures have been tested
- Starting from pure freon up to quaternary mixes.
- The phase space to map is big, and the work to compile everything is under way.
- As of now I would say that SF_6 should be considered a necessary ingredient…

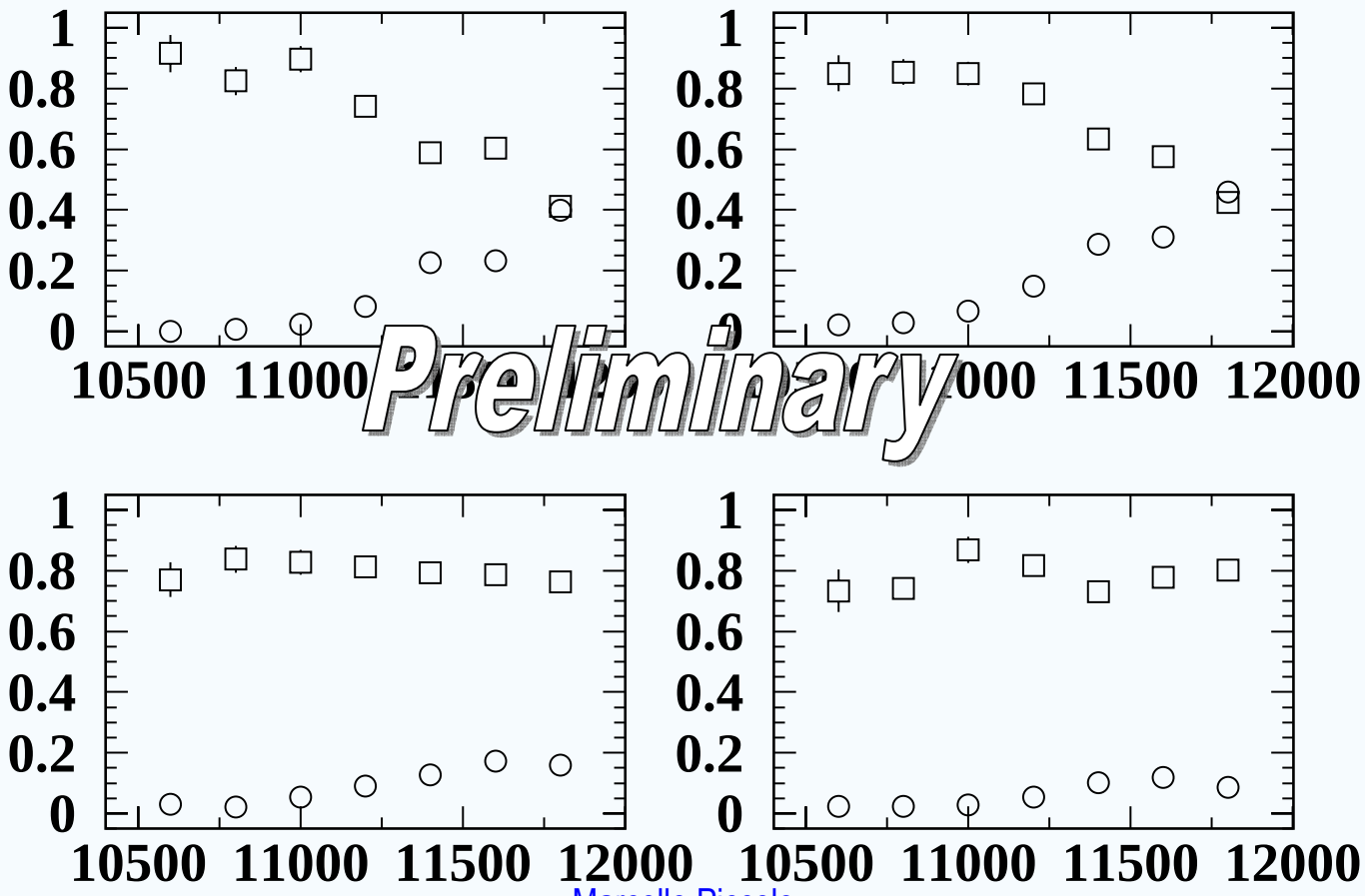
Looking at gas mix

Gas Mix 93% freon 6.6% Isob. 0.4% sf6



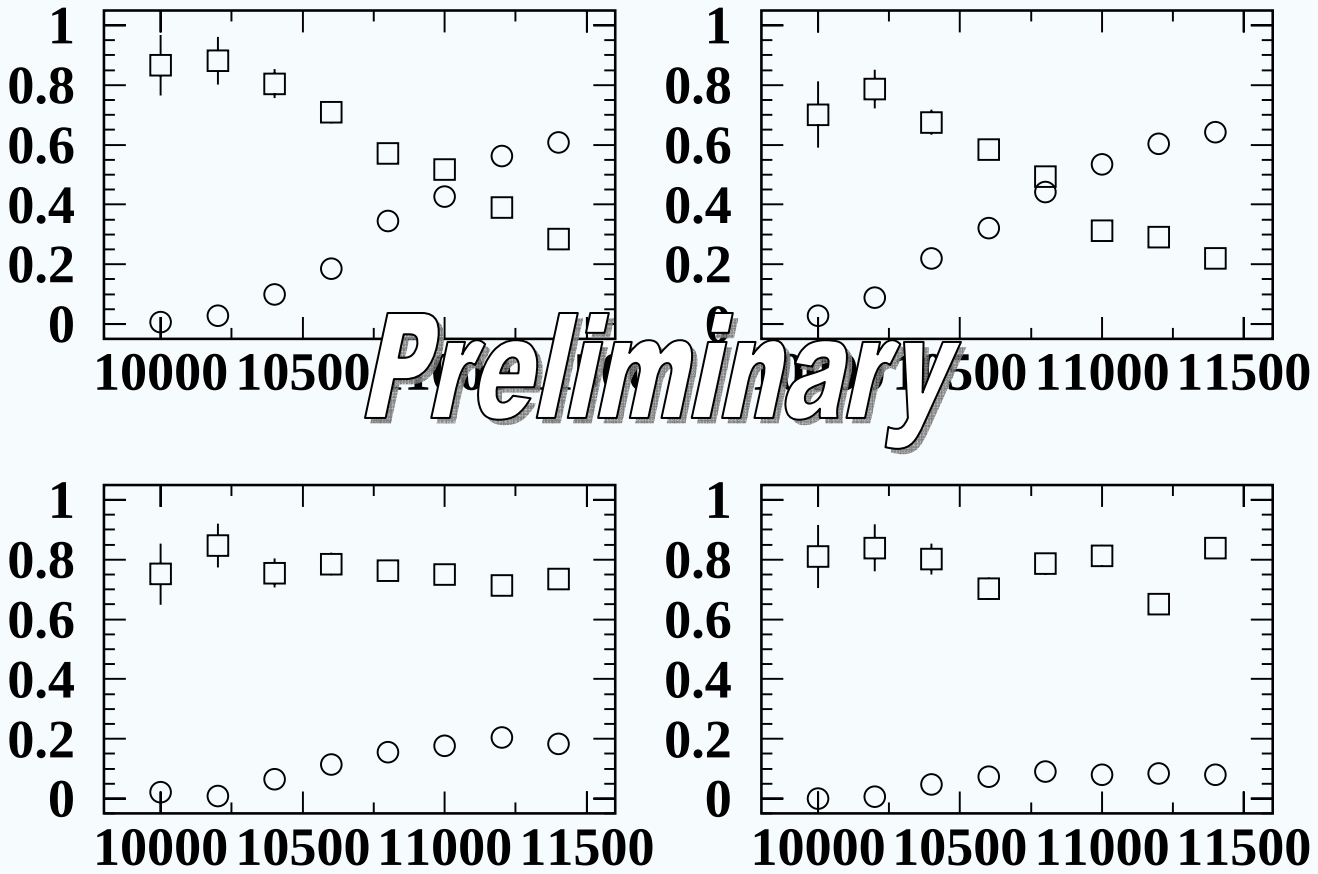
Looking at gas mix

Gas Mix 87.5% Freon 9.7% Isob. 1.8% SF6



Looking at gas mix

Gas Mix 80.7% Freon 17.6% Isob. 1.7% SF6



Summary and conclusions

- A relevant quantity of information has been gathered on operational behavior of glass RPC
- Low charge *streamer* mixtures have proven to reliably work during the test beam runs.
- Next test beam run will test avalanche mixture we are selecting and characterizing with cosmic ray data.
- Long term tests with large area detectors are continuing….