

EXO R&D in Bern

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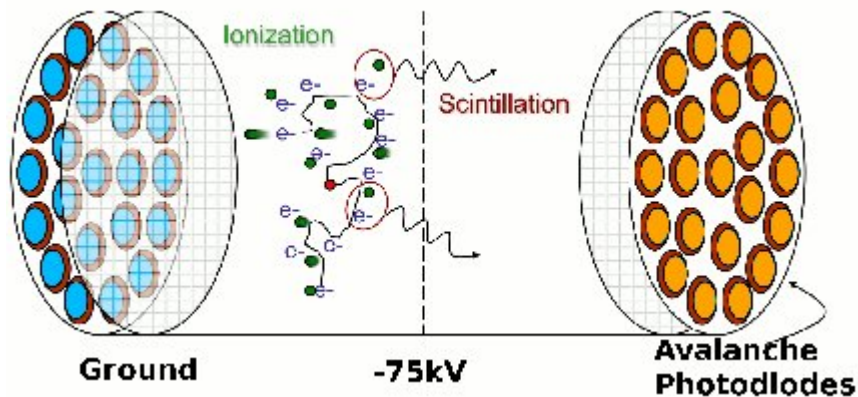
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EXO project

- Probing the $0\nu 2\beta$ decay of Xenon-136 (80% enriched)



- Readout of the charge and scintillation light in a LXe TPC (200kg)



EXO Gas phase

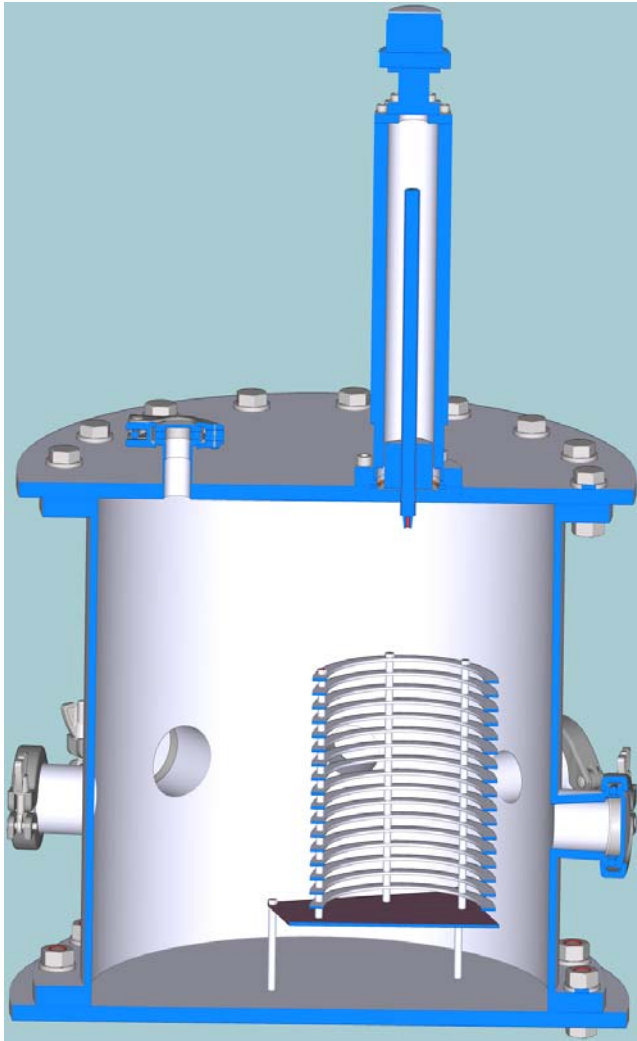
- Future phase of EXO: ton-scale detector.
 - Gaseous xenon TPC a possibility.
 - Need to run at high pressure for space economy (10 bars).
 - R&D needed to develop a high pressure Gxe TPC with good energy resolution ($\sim 1\%$) + tracking capability.
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EXO gas R&D in Bern



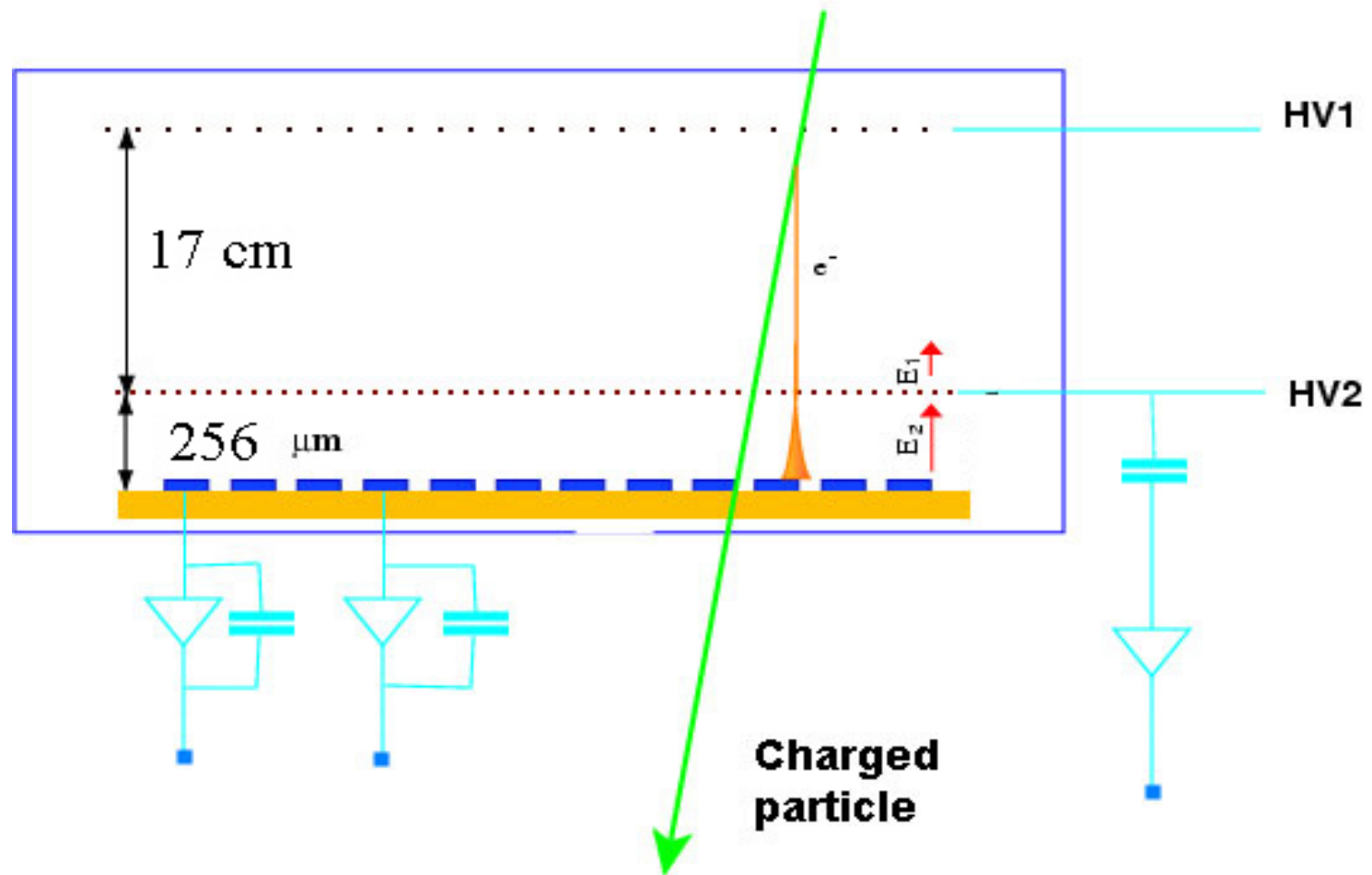
- Prototype mini TPC
- Gas purification system
- 64 channels DAQ
- CAEN ADC
(sampling 62.5 MHz,
12 bit, 3072
samples/event)

The mini TPC



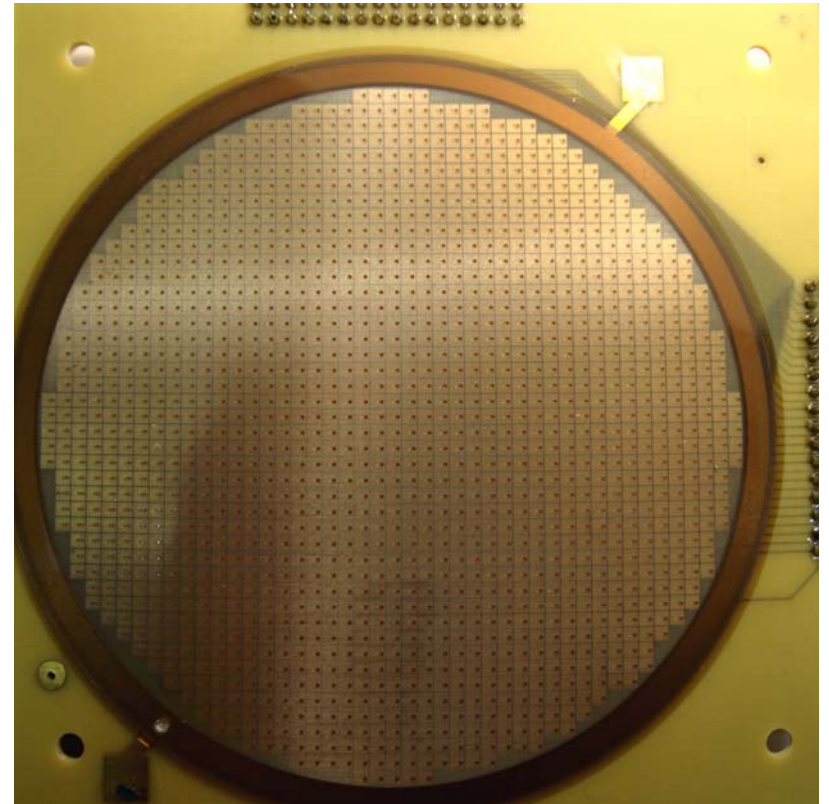
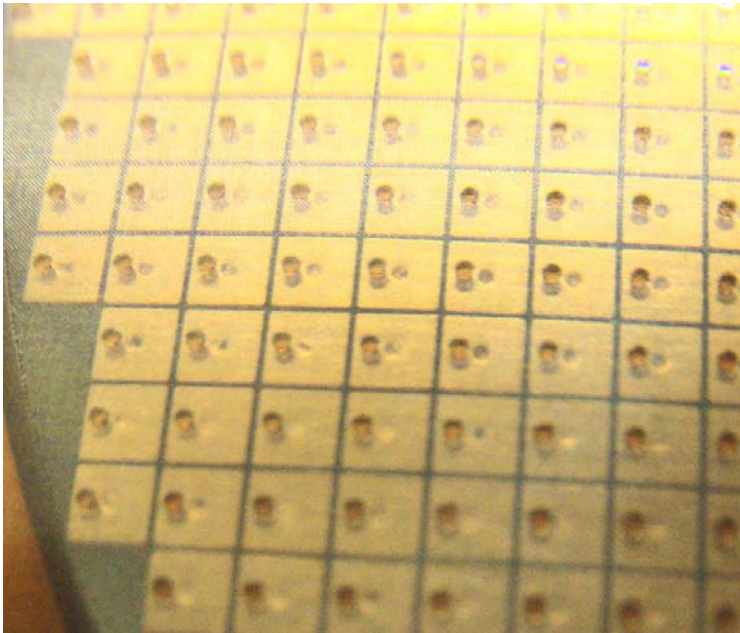
- Active volume: 10 cm diameter + 17cm drift
- Charge collected by a micromegas detector (MicroMEsh GAseous Structure)
- Calibration source position apparatus
- Pressure rated to 10 bars

The micromegas



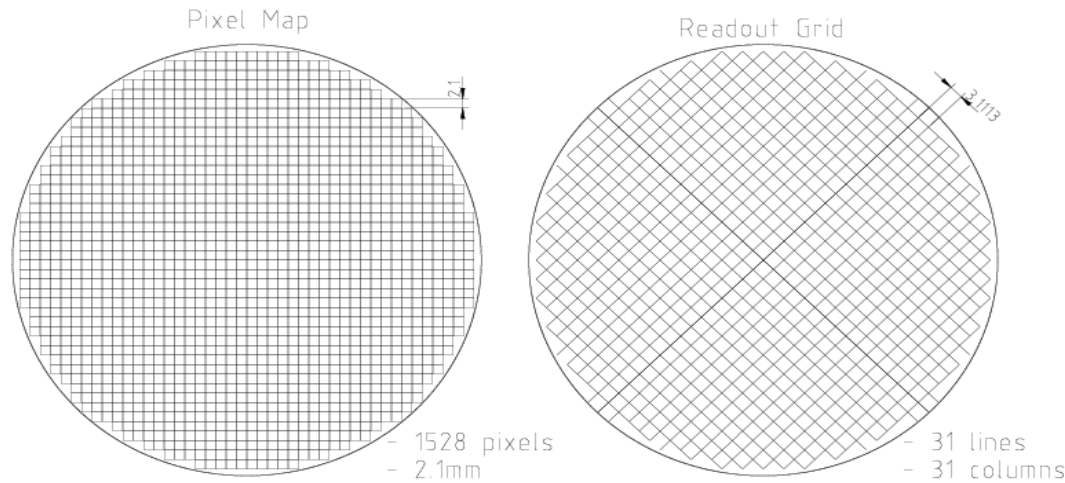
The Micromegas

- made at CERN (R. Oliveira et al.)
- active diameter 100 mm



The micromegas

X-Y Pattern Anode

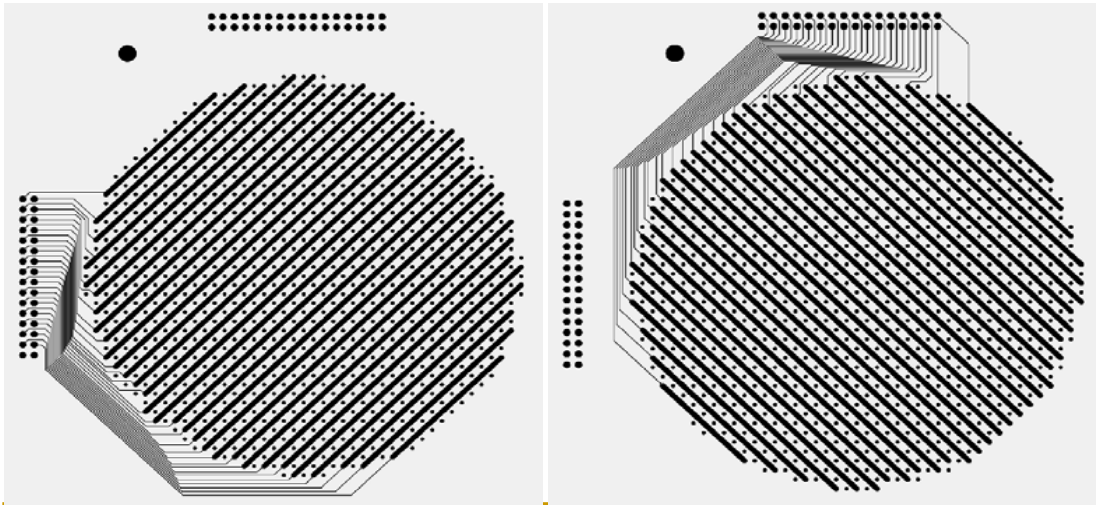


- 1528 pixels (2.1 mm wide)

- Connected by 2 planes of reading strips

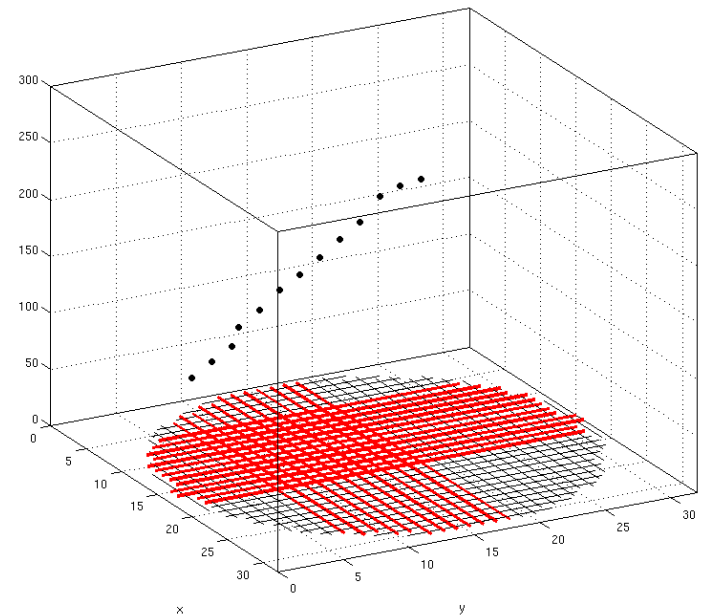
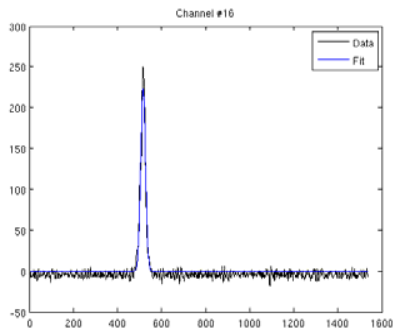
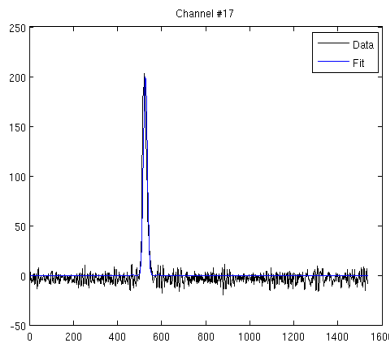
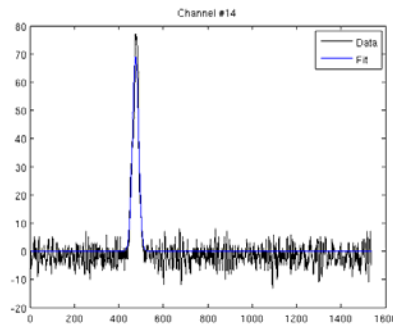
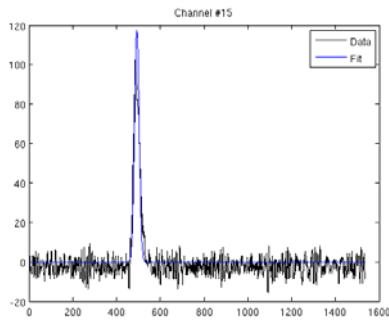
- 31 x 31 x-y strips

- Amplification gap: 256 μ m



Results

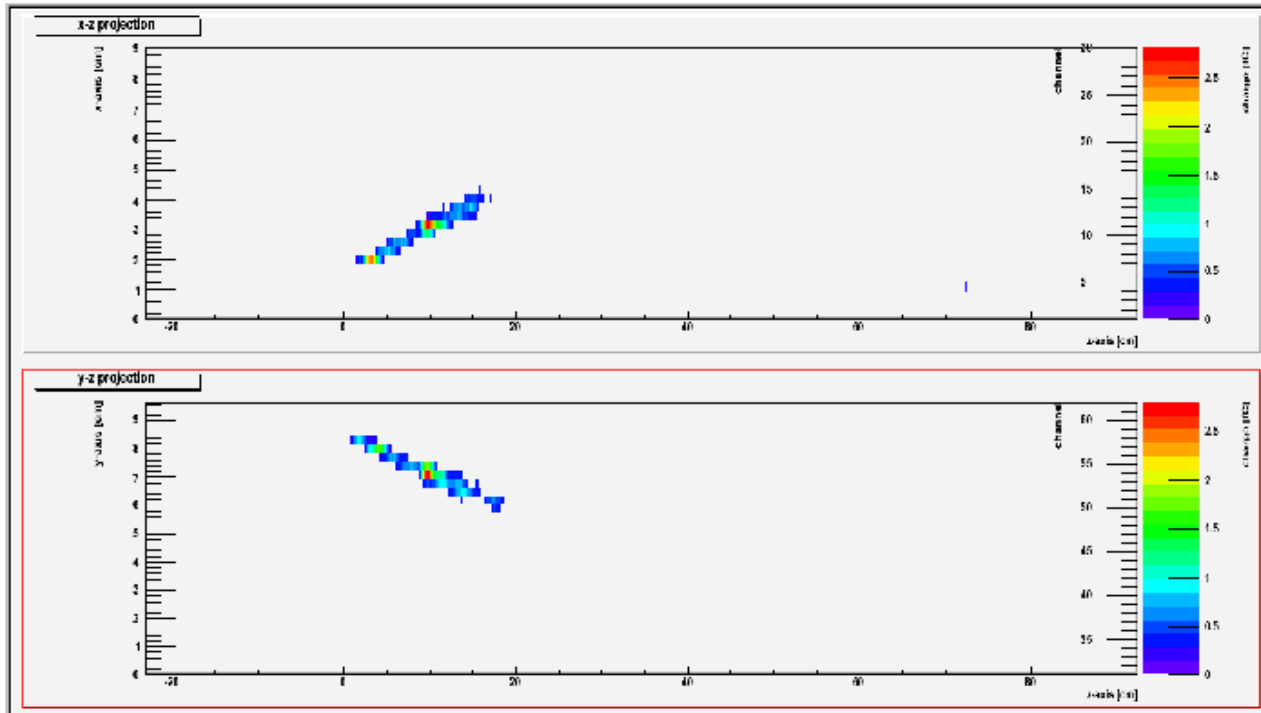
- Sample cosmic muon (using argon(90)-CH₄(10) gas (1bar))
- Track reconstructed using x-y planes and drift time



Results

Some sample events

Run# 534, event 3, muon run



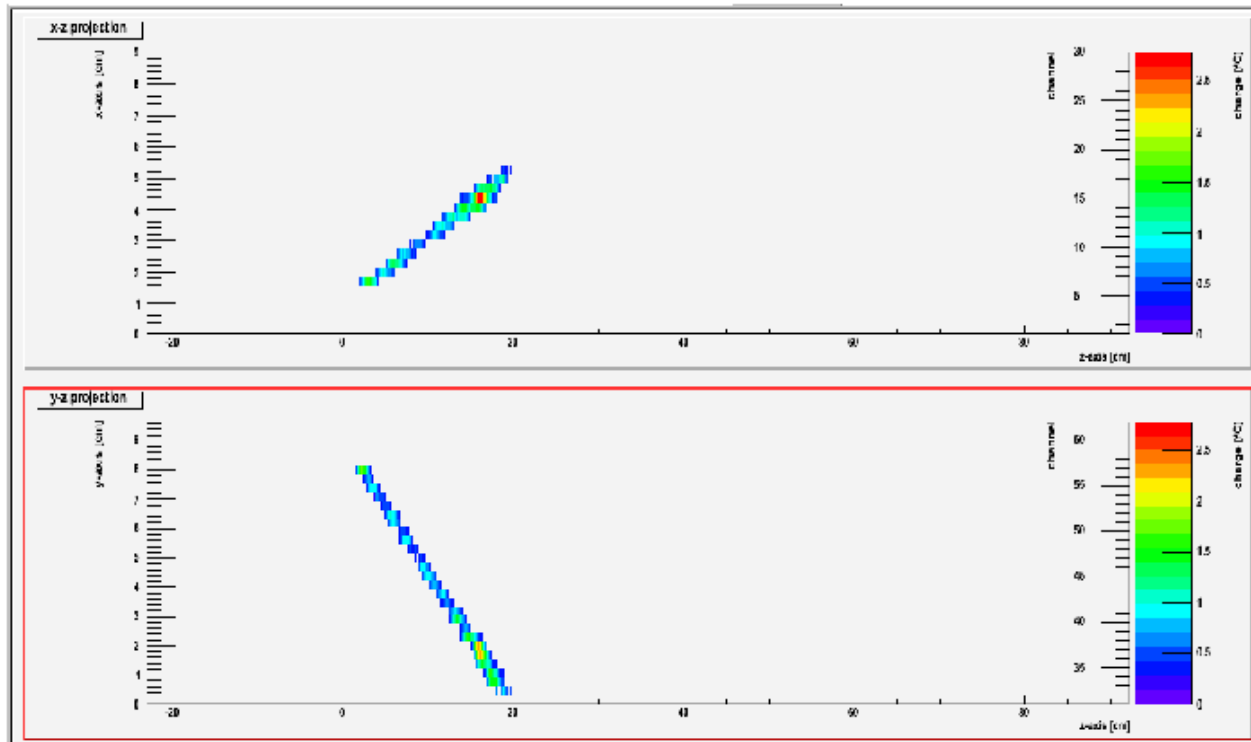
Total charge x: 284.44 fC
Total charge y: 306.82 fC
Total charge grid: 277.51 fC

- Cosmic muon with vertical muon veto

Results

Some sample events

Run# 568, event 7, muon run



Total charge x: 393.97 fC
Total charge y: 443.64 fC
No grid

- Cosmic muon track with muon veto at 45° angle.

Light collection

- Xenon and CF_4 scintillate
- Scintillation light in the UV
- PMTs and APDs have bad efficiency with UV
- Need to shift wavelength in the visible spectrum
- Light collection useful for determination of the events t_0 (z-position)
- Also used for improving energy resolution

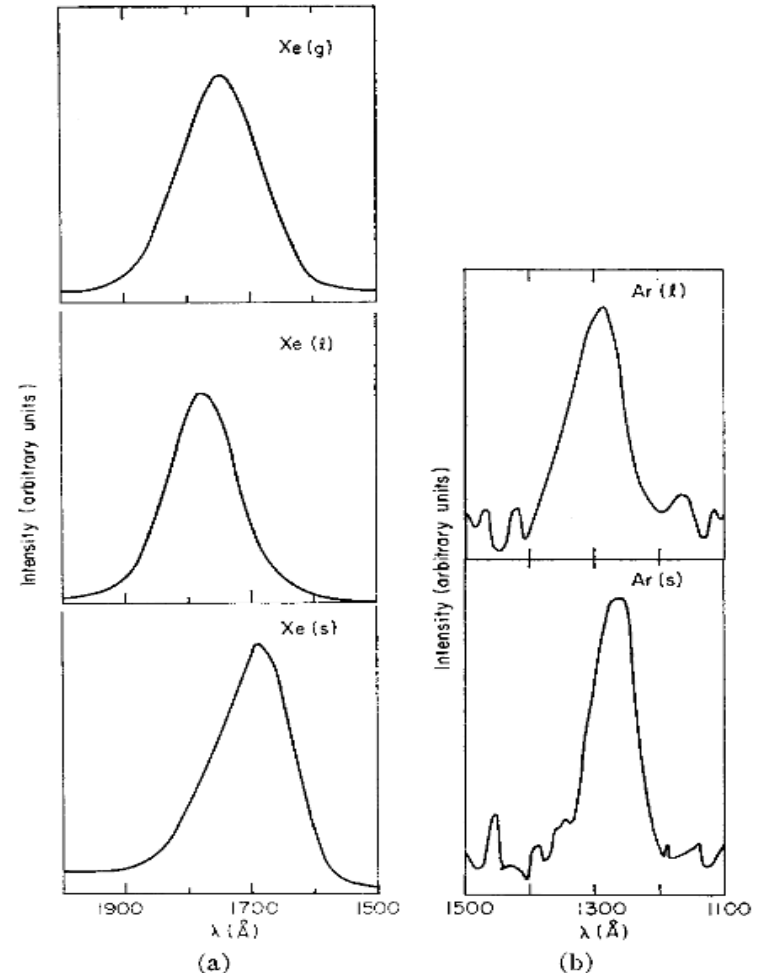
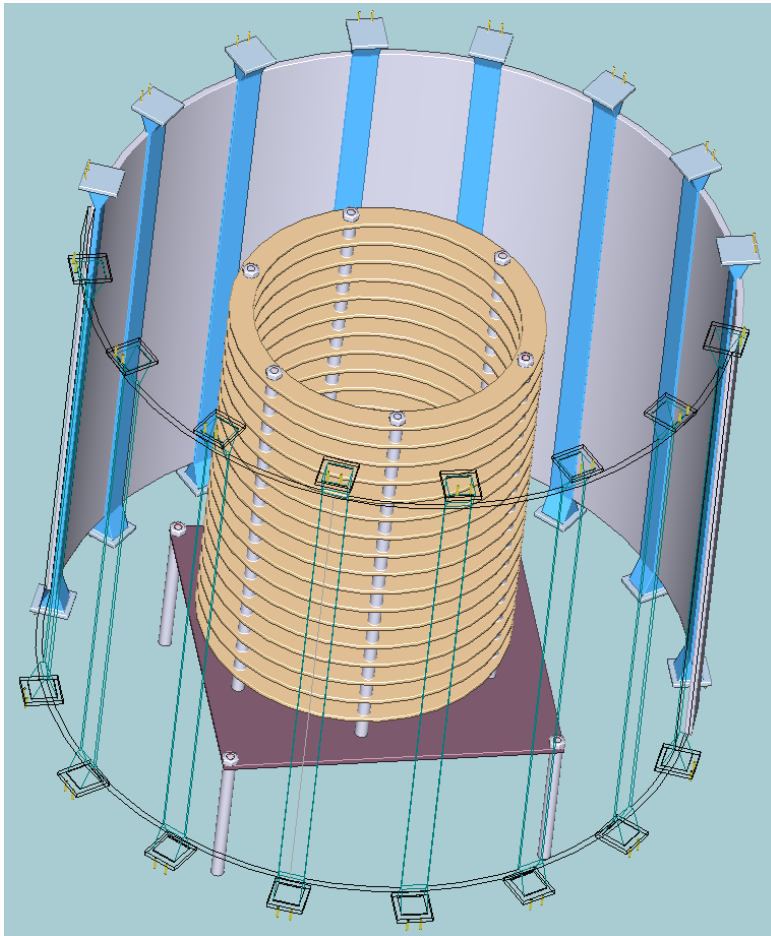


FIG. 2. Emission spectra of α -particle excited (a) Ar and (b) Xe in several states of aggregation.

Light collection



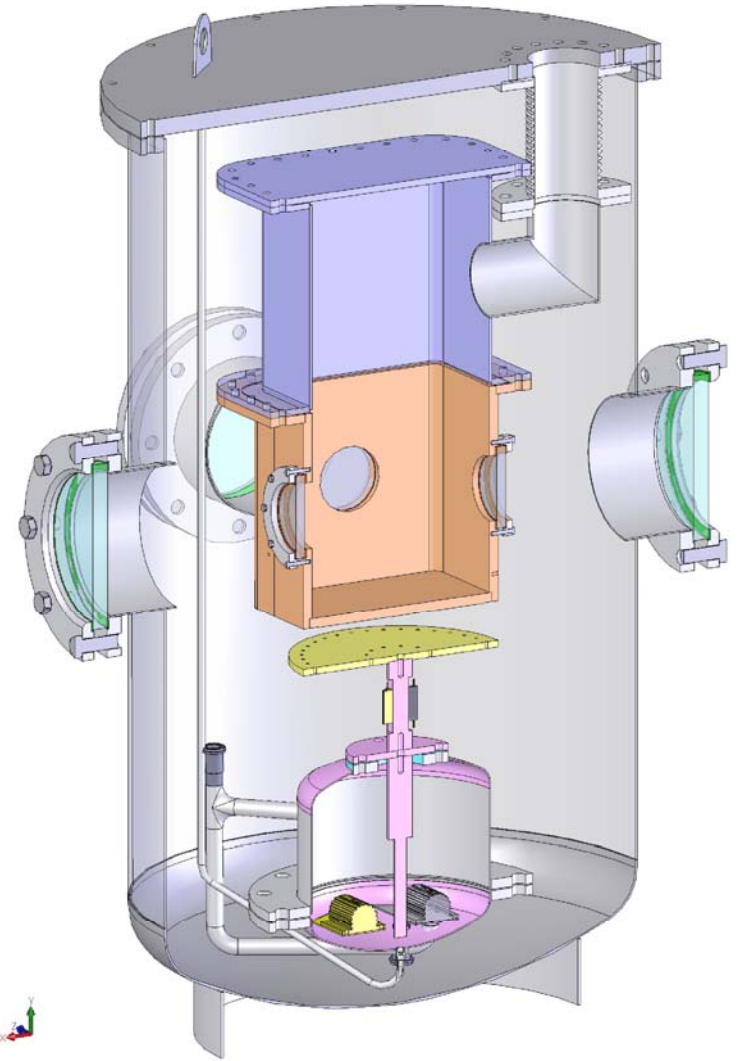
- Looking for different methods and geometry
- Use of wavelength shifting material (TPB)
- Refletors coated with TPB for collection efficiency
- TPB doped (or coated) light guides
- APDs

Barium tagging

- Detection of the $^{136}\text{Ba}^{++}$ reaction product would be a powerful discriminator from background events



- A cryostat able to liquify ~100 kg of xenon arrived in Bern before Christmas (collaboration with EIVD Yverdon)
- Various procedures for the single barium atom tagging have been proposed and will be tested in Bern.



What's next

- Optimise the drift/amplification fields
- Run at 10 bars
- Implement the reading of the scintillation light
- Instrument the cryostat and start the R&D for barium tagging