

CHARACTERIZATION OF PICASSO/PICO DETECTORS USING UNIVERSITY OF MONTREAL TANDEM VAN DE GRAAFF ACCELERATOR

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Picasso

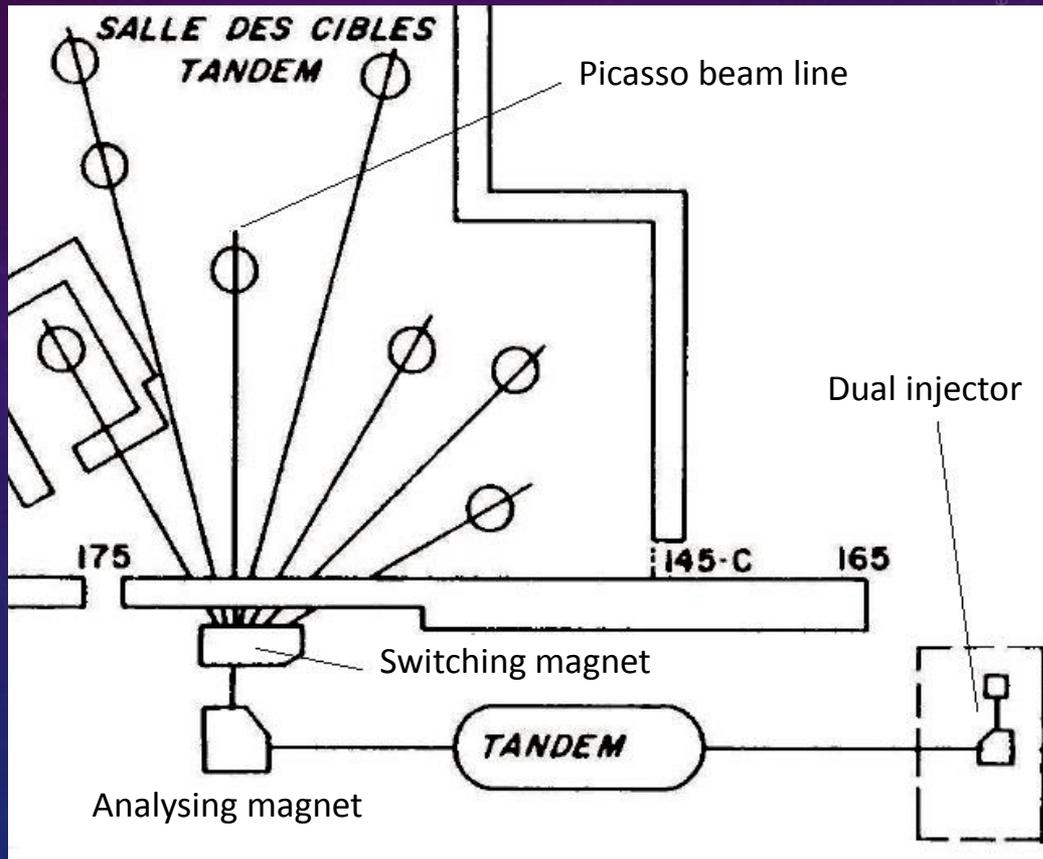


TANDEM VAN DE GRAAFF ACCELERATOR

- Model EN-1 from HVEE
- Terminal voltage : 6 MV
- Maximum proton energy : 11 MeV
- Maximum current : 10 μA
- Beam spot size : $\approx 2 \text{ mm}^2$
- Beam stability : $\pm 1 \text{ keV}$

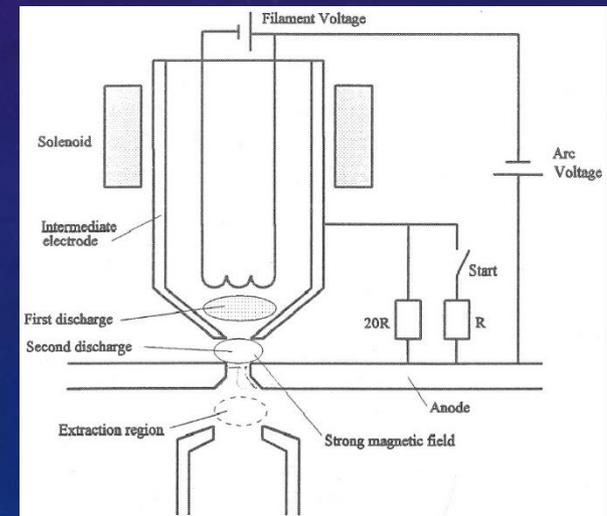
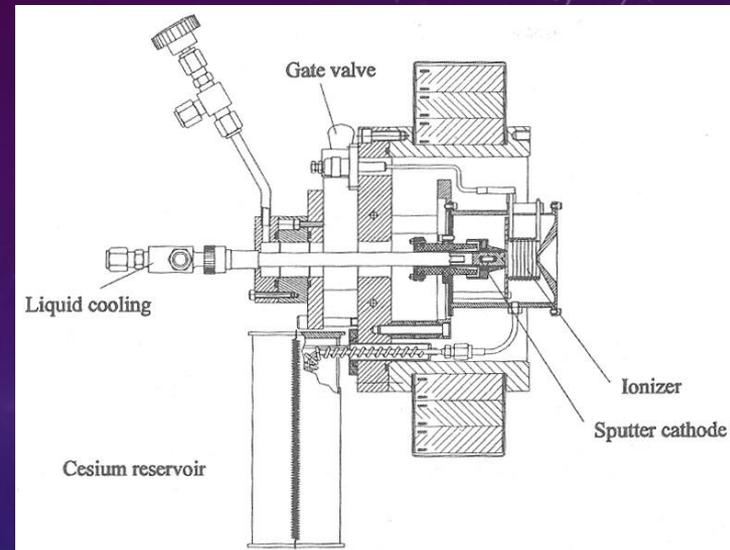


ACCELERATOR SETUP

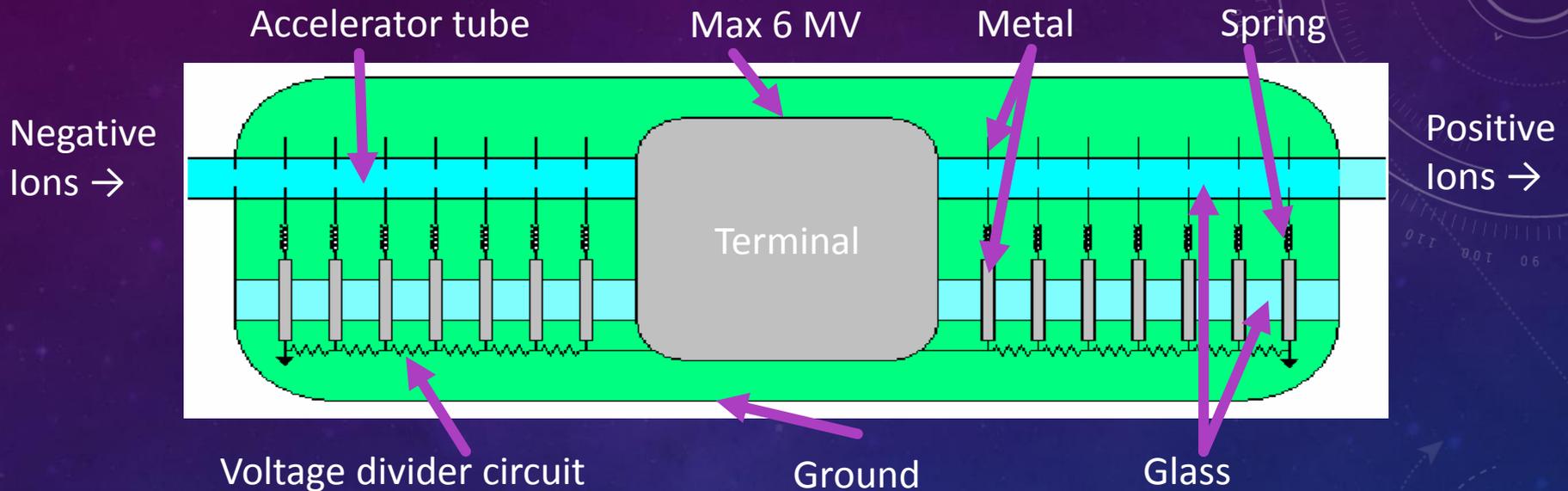


DUAL INJECTOR

- Negative sputter ion source
 - Ions sputtered by cesium ions
 - Almost any element can be used
 - Cathode can be change really quickly
 - Negative ions
 - Cathode don't last for long
- Duoplasmatron ion source
 - Ions extracted from plasma
 - H_2 , He_2 or other gases can be used
 - Positive and negative ions (need charge exchange canal for positive ions)
 - High current
 - Works as long as there is gas



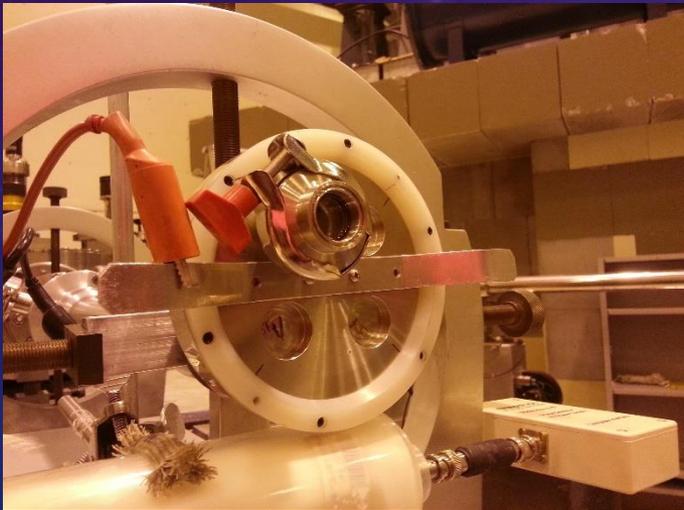
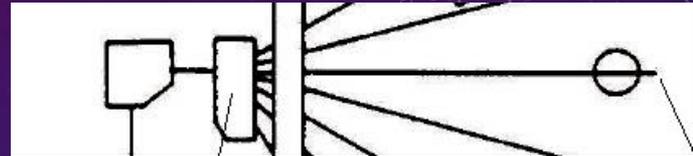
INSIDE TANDEM



- Tandem → Dual acceleration!
- O_2 stripper removes electrons at the terminal, several charged states can be achieved
- Pressurized with insulating gas SF_6 at 180 PSI
- Whole column supported with 20 t of force applied via a huge spring

PICASSO 0° BEAM LINE

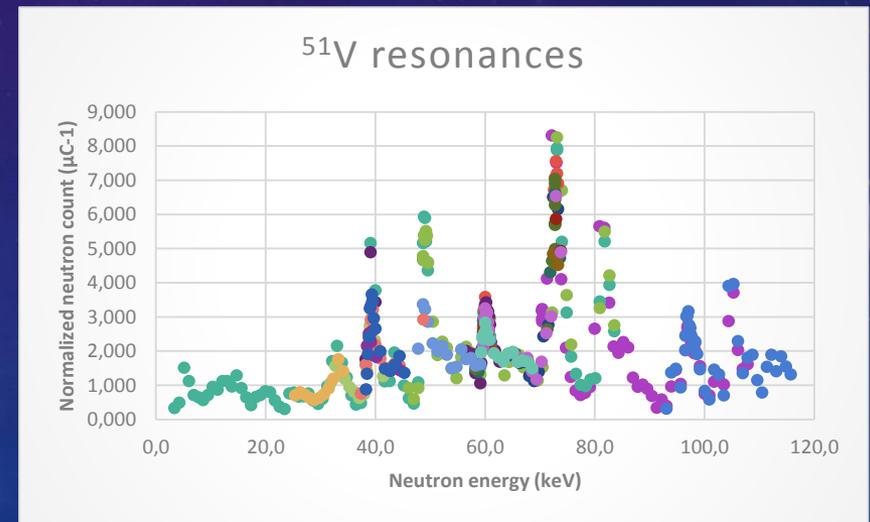
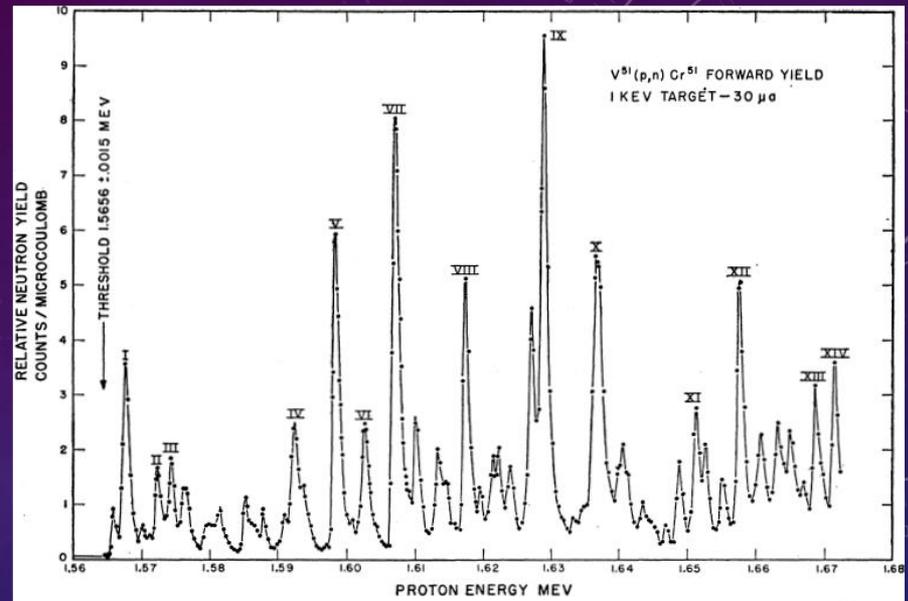
- Proton energy selected by analysing magnet field with NMR system
- Proton current : max 4 μA
- ${}^7\text{Li}$ and ${}^{51}\text{V}$ targets



NEUTRON PRODUCTION

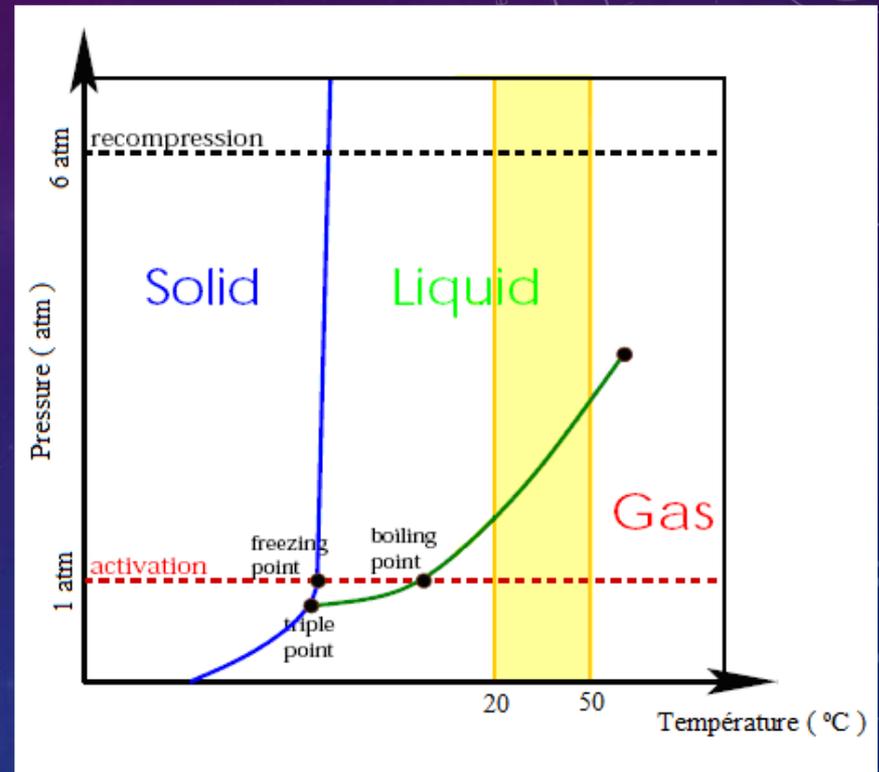
- ${}^7\text{Li}(p,n){}^7\text{Be}$ and ${}^{51}\text{V}(p,n){}^{51}\text{Cr}$ resonances produce monoenergetic neutron beam
- Every run, beam must be calibrated to find correspondance between analysing magnet field and neutron energy ($\frac{1}{2}$ hr)
- Analysing magnet resolution : $\pm 0,05$ G
- Neutron energy resolution : $\pm 0,2$ keV

Résonance	E_p (MeV)	E_n (keV)
I	1.568	4.8
II	1.573	11.3
III	1.575	13.6
IV	1.592	34
V	1.598	40
VI	1.603	45
VII	1.607	50
VIII	1.617	61
IX	1.629	74
X	1.637	82
XI	1.651	97
XII	1.658	104
XIII	1.669	116
XIV	1.672	119



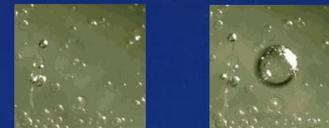
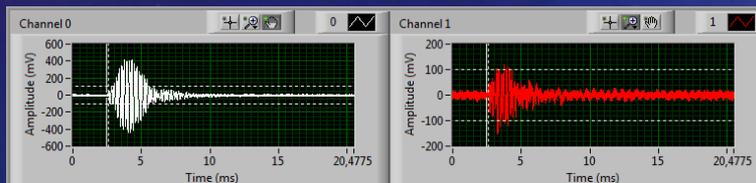
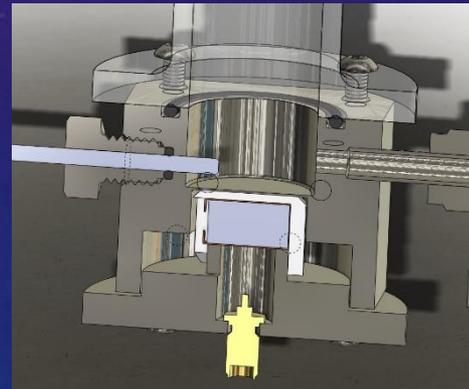
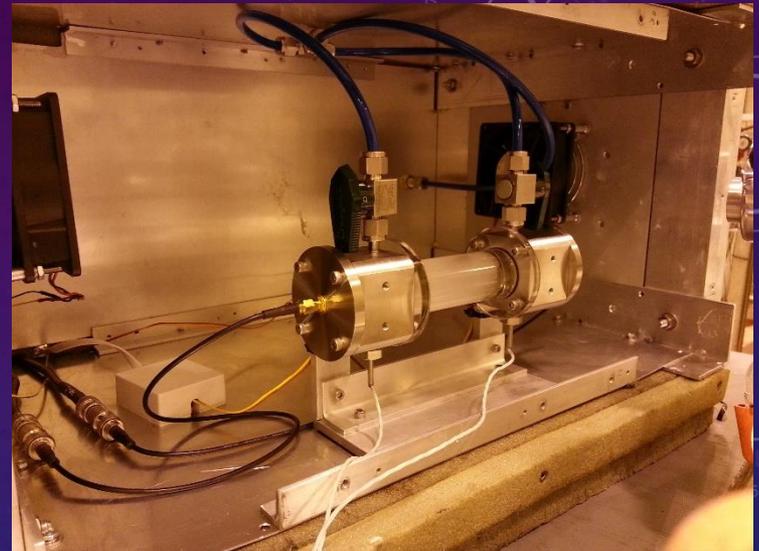
SUPERHEATED LIQUID DETECTORS

- Active liquid heated above boiling point
- Small energy deposition can trigger phase change (down to 1 keV)
- Recompression system must be used to condense evaporated gas
- Decompression reactivate the detector
- Whole system must be clean, surface smooth, radioactively pure, ...



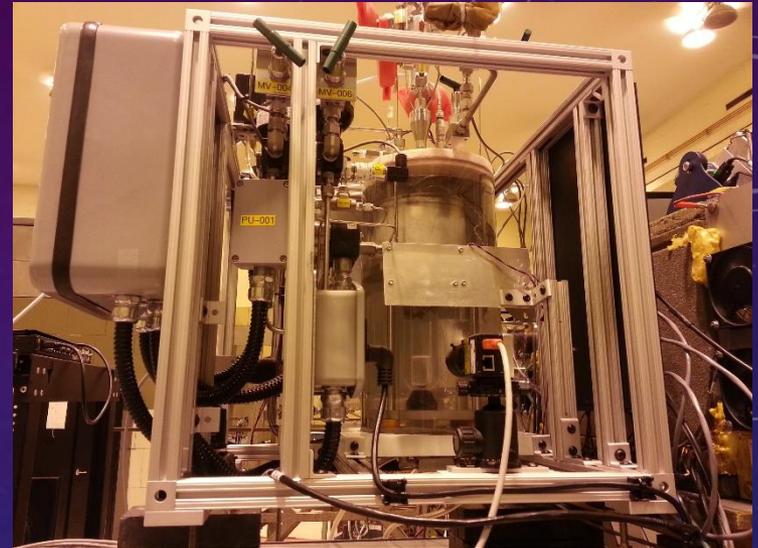
PICASSO BEAM DETECTOR

- C_4F_{10} droplet detector
 - ≈ 5 g of active mass
 - Acrylamide polymer matrix
 - Mineral oil recompression fluid
- Acoustic trigger
 - 2 PZT piezos
 - 800 MS/s
- Temperature threshold scan
- 1 h recompression every 100 events



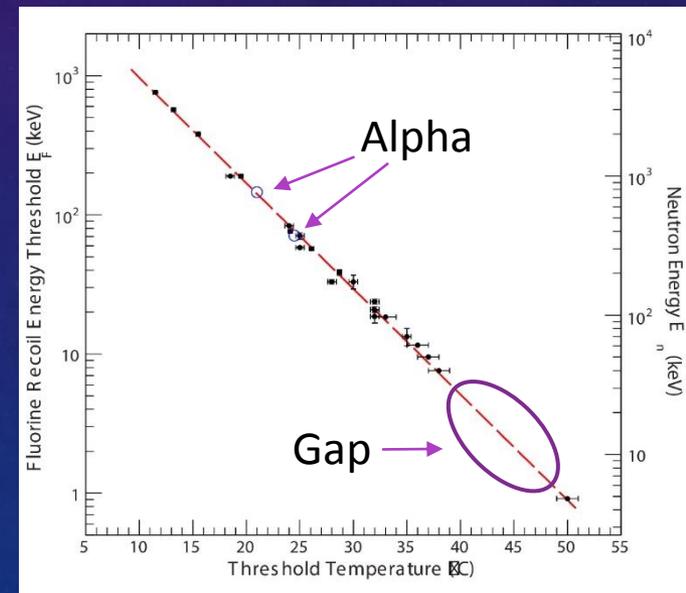
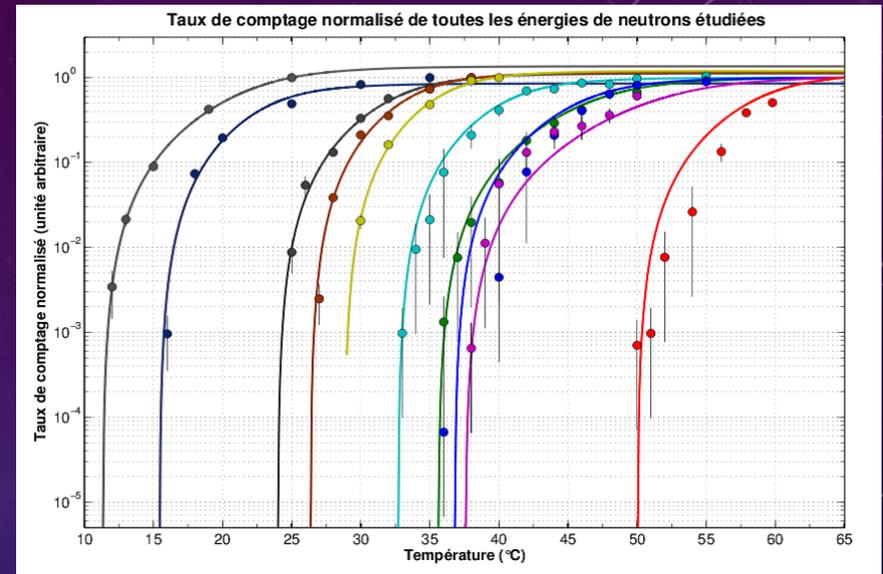
PICO 0.1 DETECTOR

- C_3F_8 bubble chamber
 - 36 g of active mass
 - LAB buffer fluid
 - Mineral oil recompression fluid
- Video/pressure trigger
 - 150 fps – 2,5 MS/s
- Acoustics on the way
- Pressure threshold scan
- 1 min recompression every events



BEAM CALLIBRATION

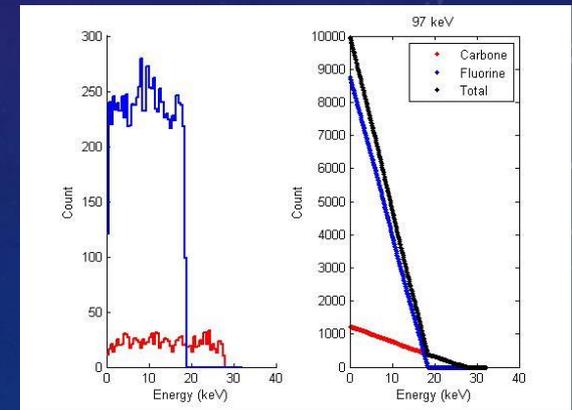
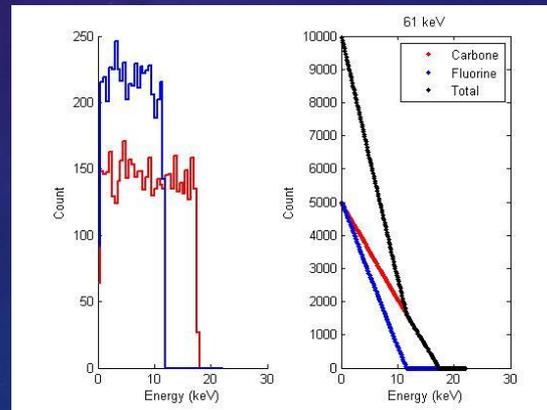
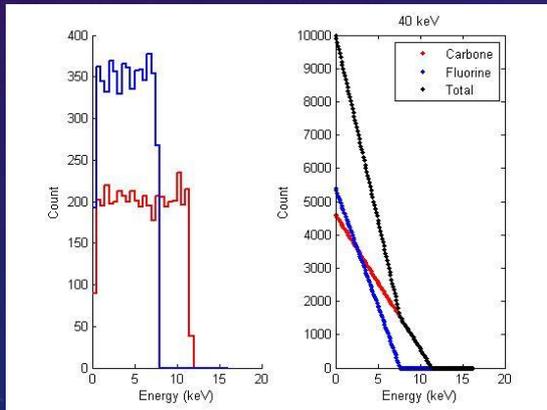
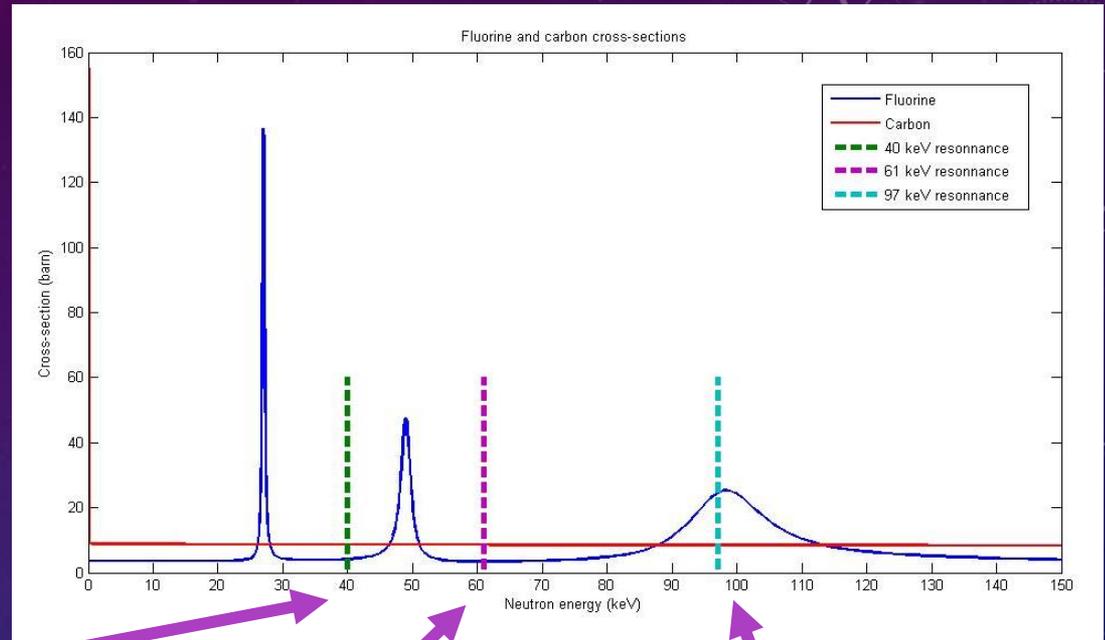
- Calibration done with Picasso
 - High uncertainties on proton energies
 - Gap between 4,8 and 40 keV
- Current calibration runs
 - Better energy resolution with NMR
 - Better temperature control
 - Complete scan between 4,8 and 119 keV
 - Never done before
 - For a Pico bubble chamber
 - For C_3F_8



EXPECTED RESPONSE

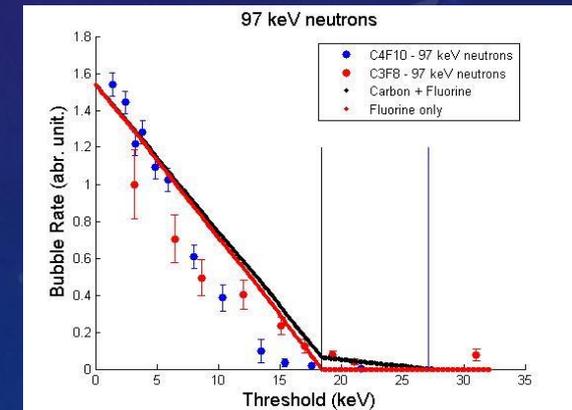
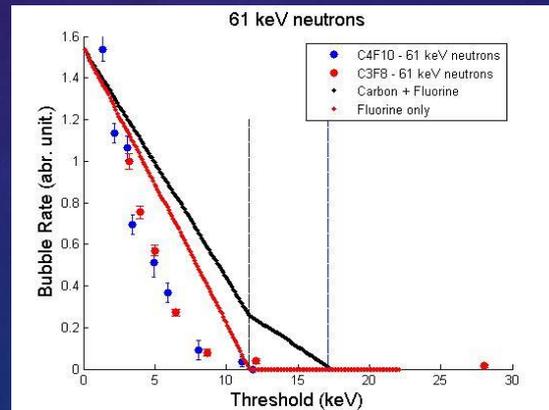
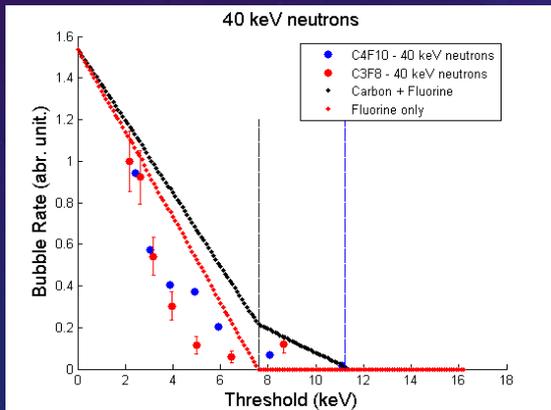
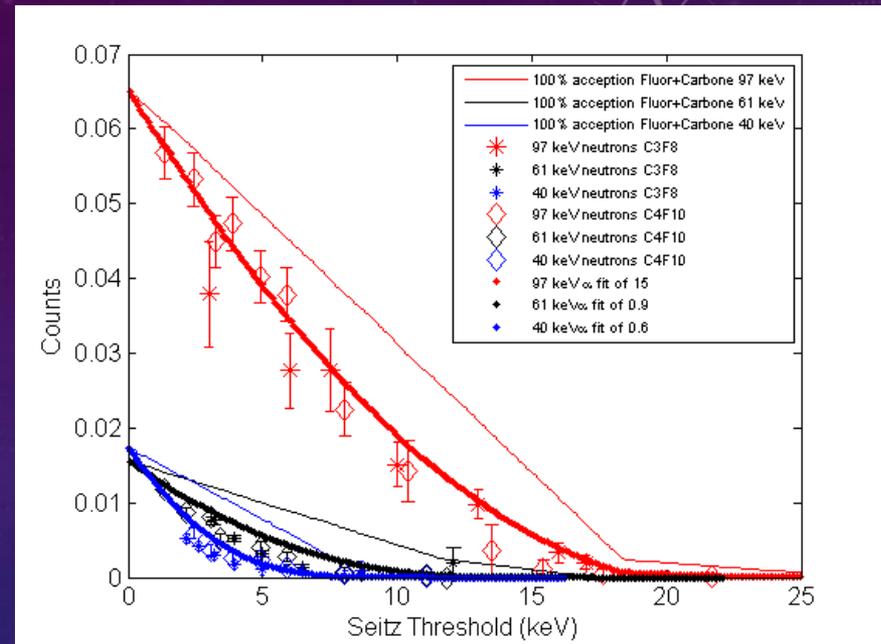
$$E_r = \frac{2A}{(1+A)^2} (1 - \cos \theta) E_n$$

- Fluor $E_{r, \max} = 0,19 E_n$
- Carbone $E_{r, \max} = 0,28 E_n$



DATA COMPARISON

- C_3F_8 and C_4F_{10} in good agreement
- Count rate proportionnal to cross section as expected
- Soft threshold need to be characterized
- Does C or F trigger?
- See A.Plante poster



CONCLUSION

- Data taking on the way
- Improved energy resolution
- **Good agreement between freons/detectors**
- Gradual threshold as to be studied
- Gap region will be probed soon

BACKUP

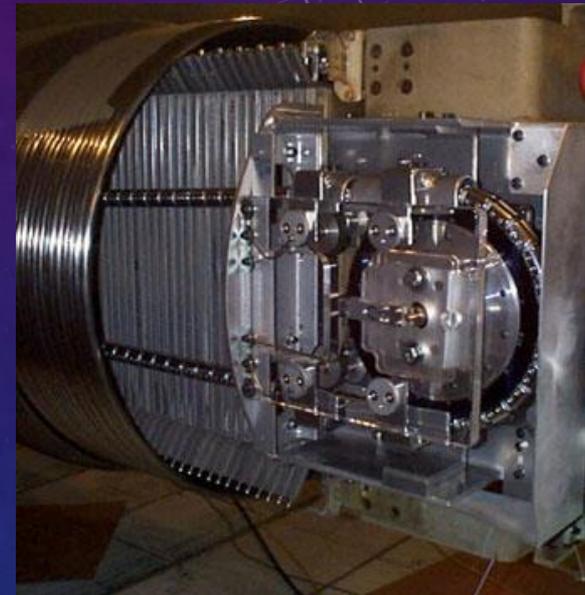
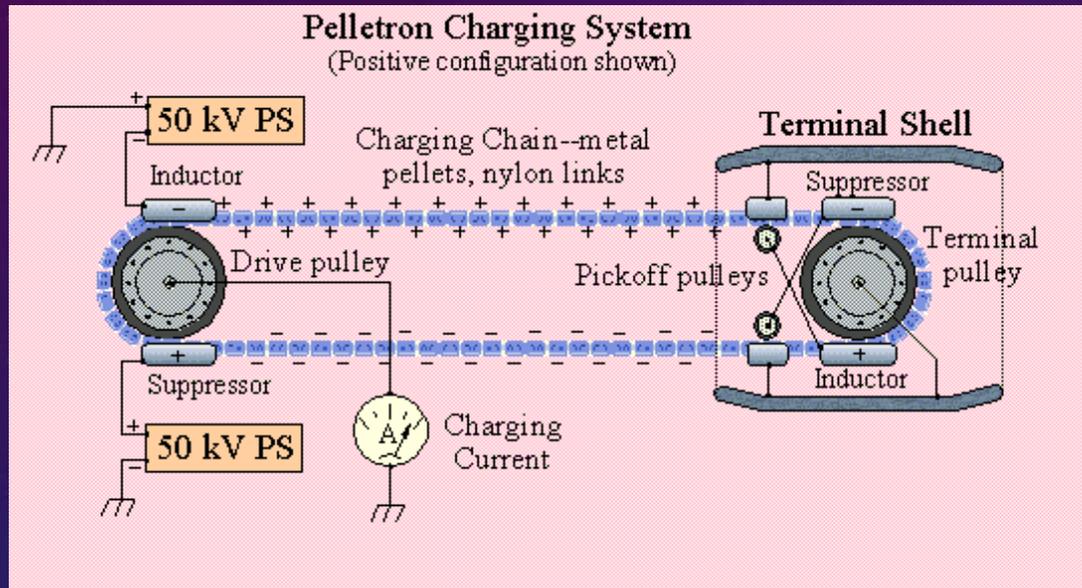
WHY TANDEM?

- Negative ions enter acceleration tube
- Ions are attracted towards central terminal
- Then they enter the stripper section filled with O_2 gas, where they lose their electrons
- Because of the polarity change, the ions are now repulsed from the central terminal towards the end of the tube
- Dual acceleration!

INSIDE TANDEM

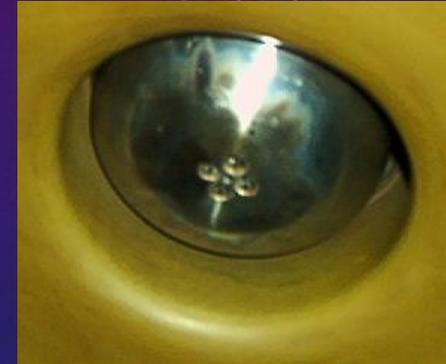
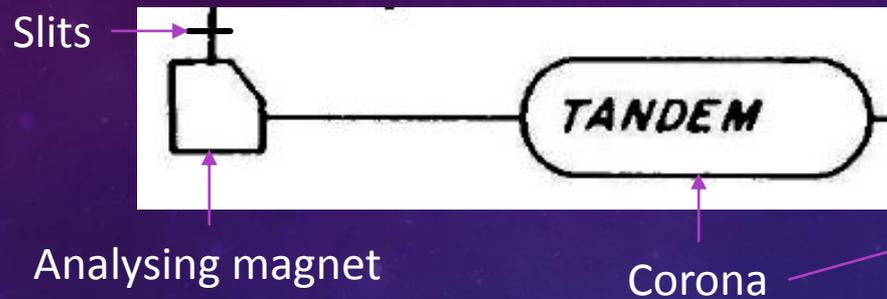


PELLETRON CHARGING SYSTEM



- Not a Van de Graaff anymore
- Belt replaced with 2 Pelletron system

ENERGY SELECTION/CORRECTION SYSTEM



- Analysing magnet sets the ion energy
- Slits are used to measure deviation and to control the corona probe
- The corona probe draws more or less current on the terminal to adjust its voltage, correcting the energy

PICO 0,1

