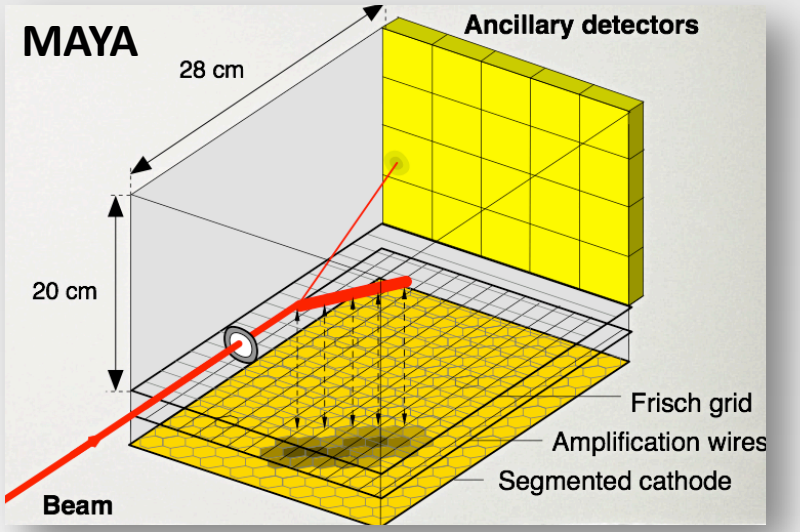
# ACTAR in PARIS

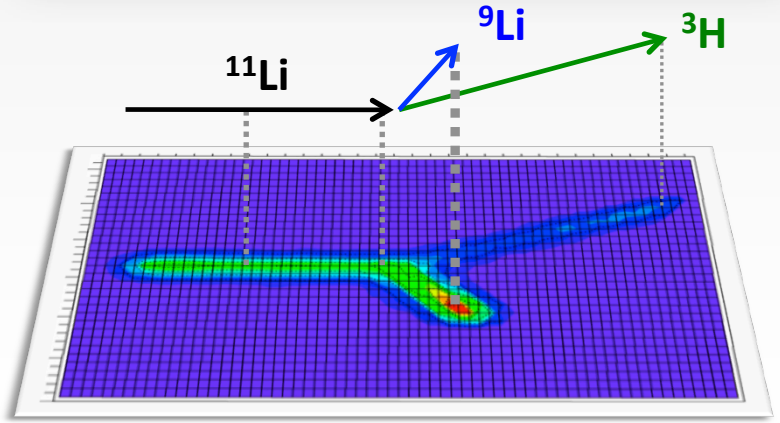
**Present status of ACTAR and possibilities for ACTAR in PARIS**

**Geoff Grinyer**
grinyer@ganil.fr

# What is ACTAR?

- New ACtive TARget for SPIRAL2
  - Charge and time projection chamber
  - Gas volume acts as the reaction target
    - High efficiency
    - Low thresholds
    - Thick targets
    - Angular and spatial resolution
- Physics Cases
  - One and two nucleon transfer reactions
  - Resonant scattering
  - Inelastic scattering and giant resonances
  - Nuclear astrophysics
  - Exotic nuclear decay (2p, β3p, βαp, …)



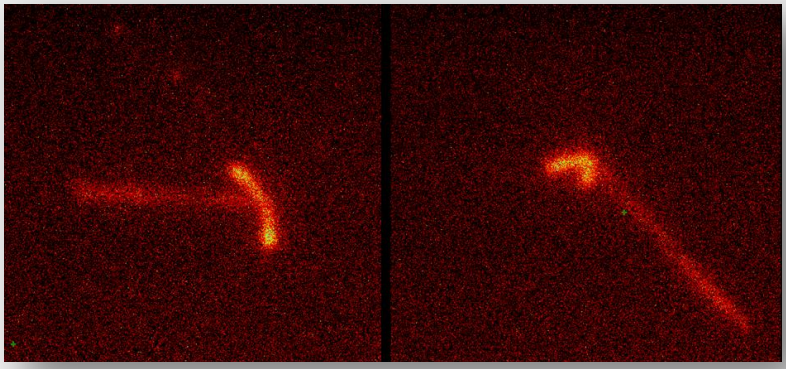




*Figures courtesy of M.Camaano and T.Roger*

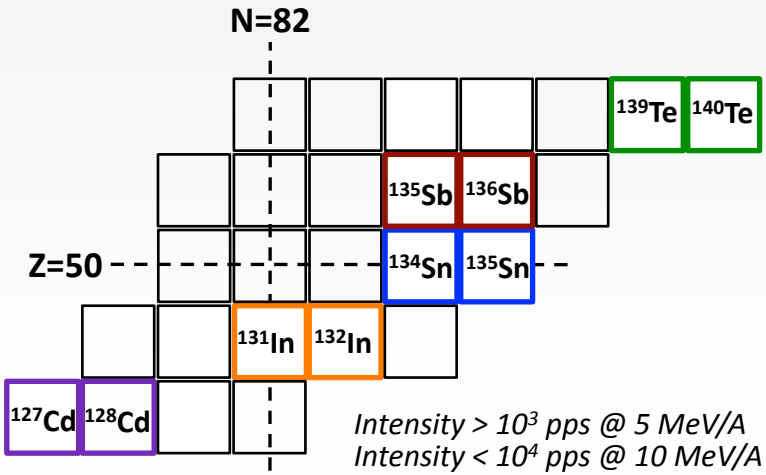
# Why do we need ACTAR?

- Ion trajectories and energies in a gas
  - Unambiguous identification of rare events
  - Kinematic selectivity
- Target thickness
  - In 50 mm of $D_2$ gas (1 atm pressure)
    - $5.4 \times 10^{20}$ deuterons/cm$^2$
  - In 500 ug/cm$^2$ $CD_2$ solid target
    - $3.8 \times 10^{19}$ deuterons/cm$^2$
- With high-efficiency
  - Focus on the most exotic nuclei and decays
  - Complete experiments with less beam time

***2p decay of $^{45}$Fe**



**ACTAR Reach – SPIRAL2 Phase II Day 1**

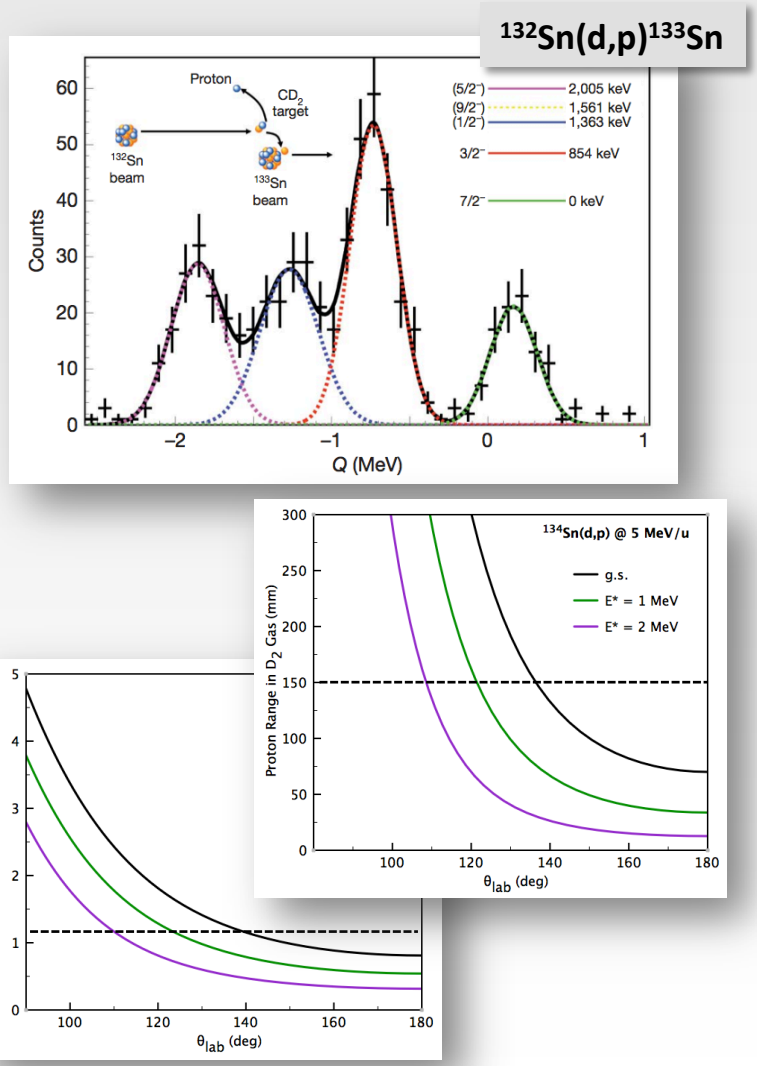



*Intensity > $10^3$ pps @ 5 MeV/A*
*Intensity < $10^4$ pps @ 10 MeV/A*

# ACTAR for (d,p) Transfer Reactions

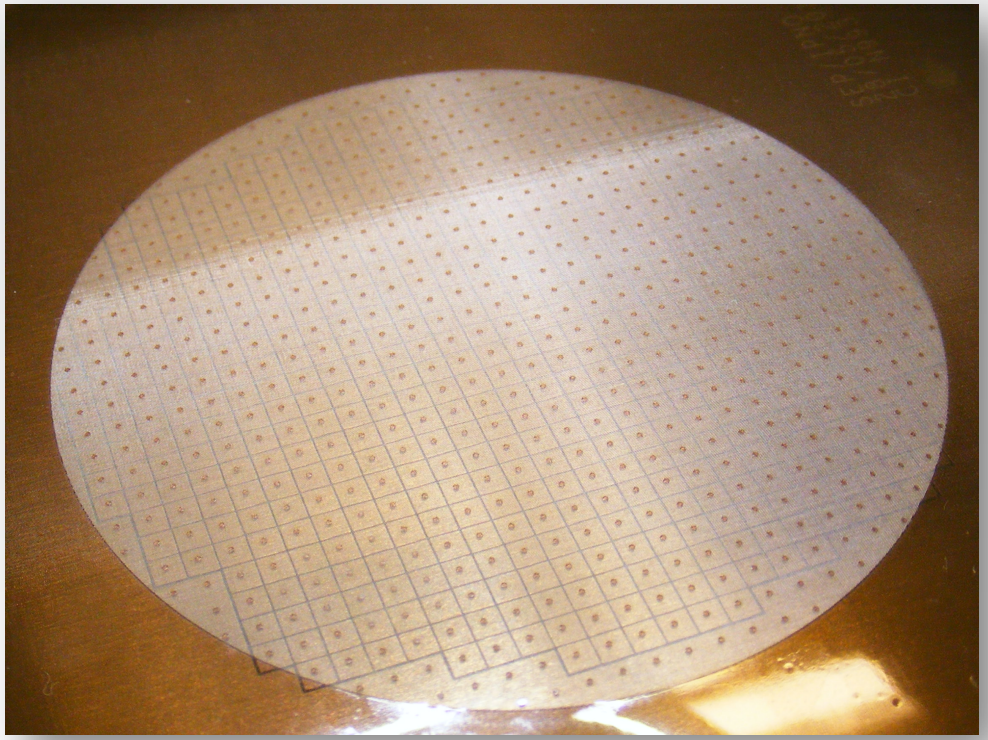
- A quantitative spectroscopic tool
  - Level energies
  - Cross sections and Q-values
  - Angular distributions (spin and parity)
  - Spectroscopic factors (neutron states)

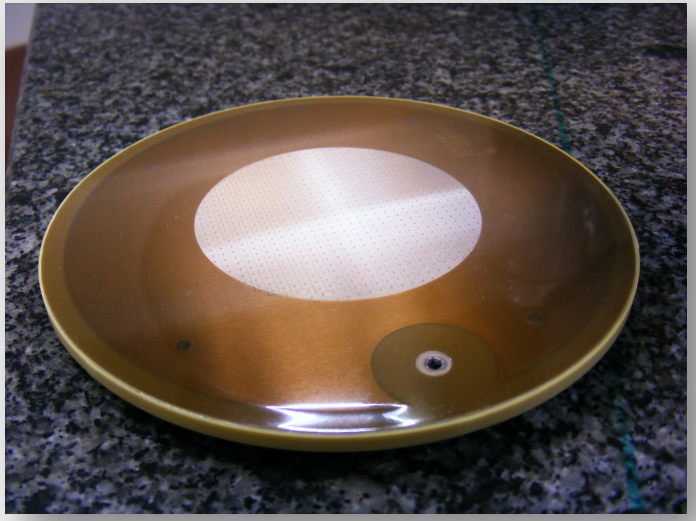
- Characteristics of (d,p) @ 5 MeV/u
  - Proton kinematics
    - Backward angles in the laboratory
    - Low-energy (stopped in gas)
    - Need excellent energy resolution
  - Complement with γ-ray spectroscopy
    - Tag the final states

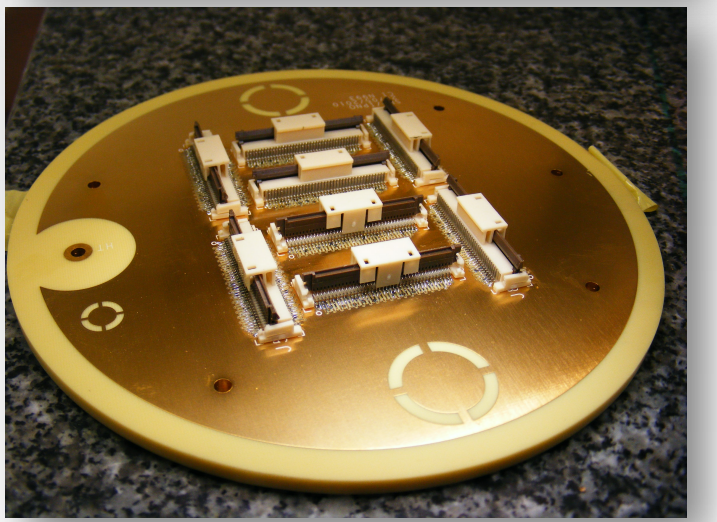


# ACTAR Prototype

- 576 channel prototype
  - Pad pitch 2 x 2 $mm^2$
  - Connections @ IPN Orsay (Jan 2011)
  - Source tests @ GANIL (Feb 2011)

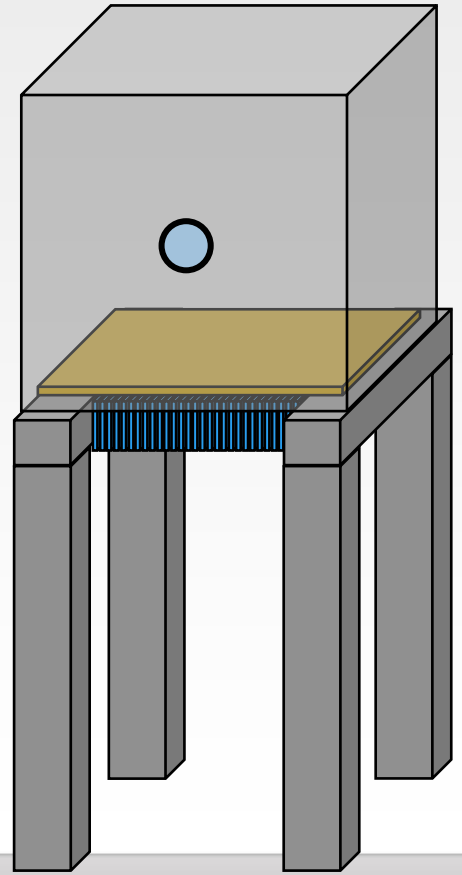






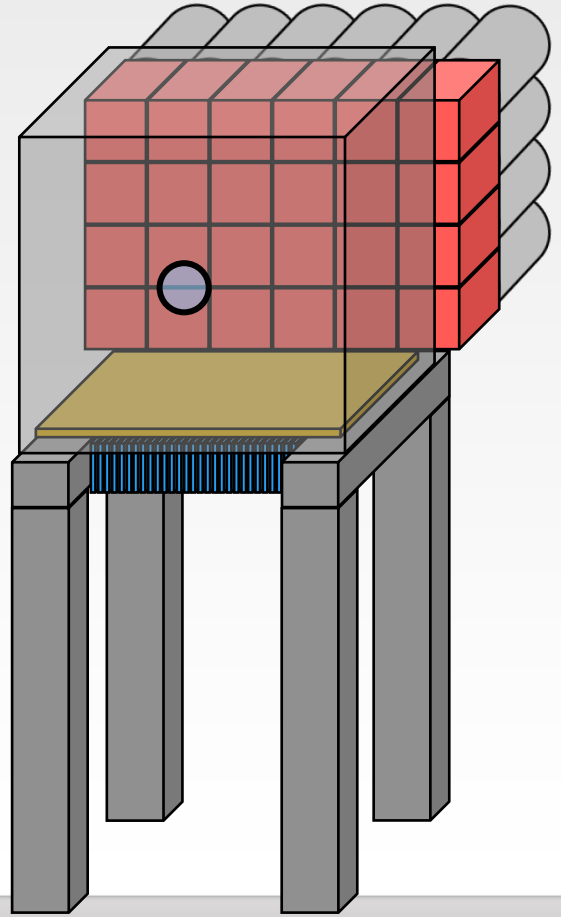
# ACTAR + PARIS

- ACTAR
  - 27 cm cubic gas box
  - 25.6 x 25.6 $cm^2$ active pad plane
  - Pad pitch 2 x 2 $mm^2$
  - 3 cm ø entrance window



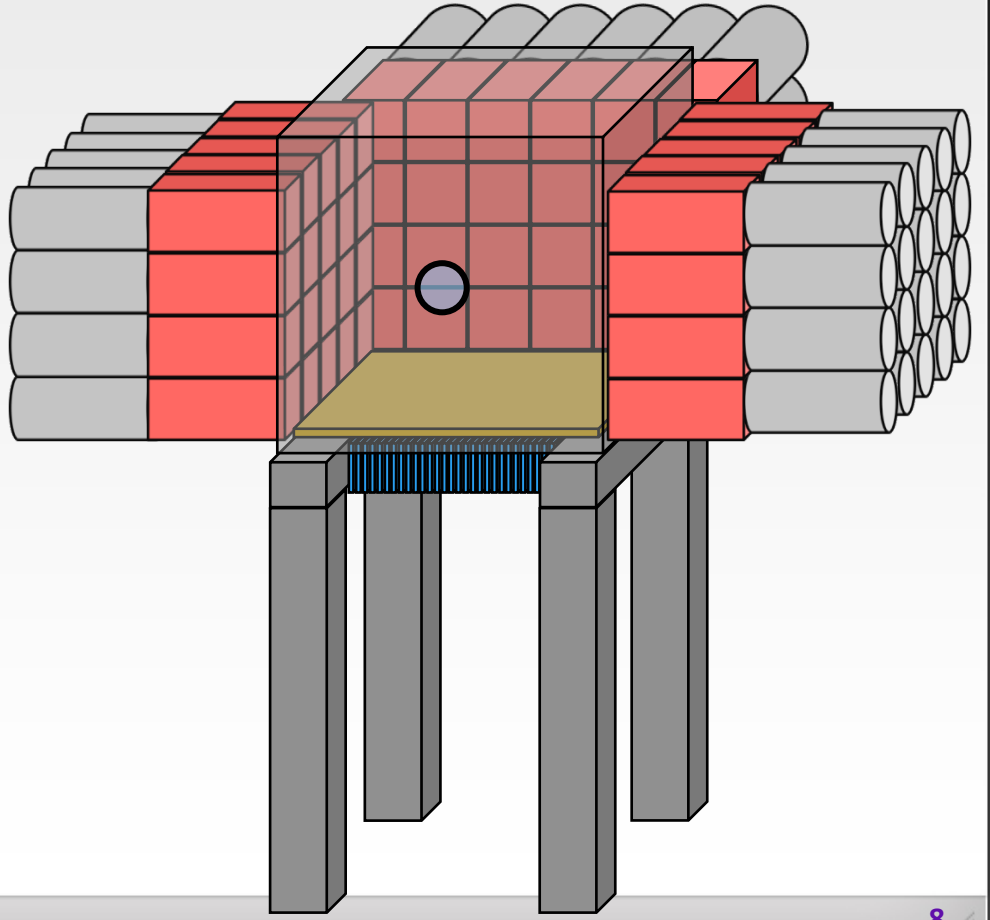
# ACTAR + PARIS

- ACTAR
  - 27 cm cubic gas box
  - 25.6 x 25.6 $cm^2$ active pad plane
  - Pad pitch 2 x 2 $mm^2$
  - 3 cm ø entrance window
- PARIS (2 x 2 x 4 inch)
  - 4 x 6 detectors downstream



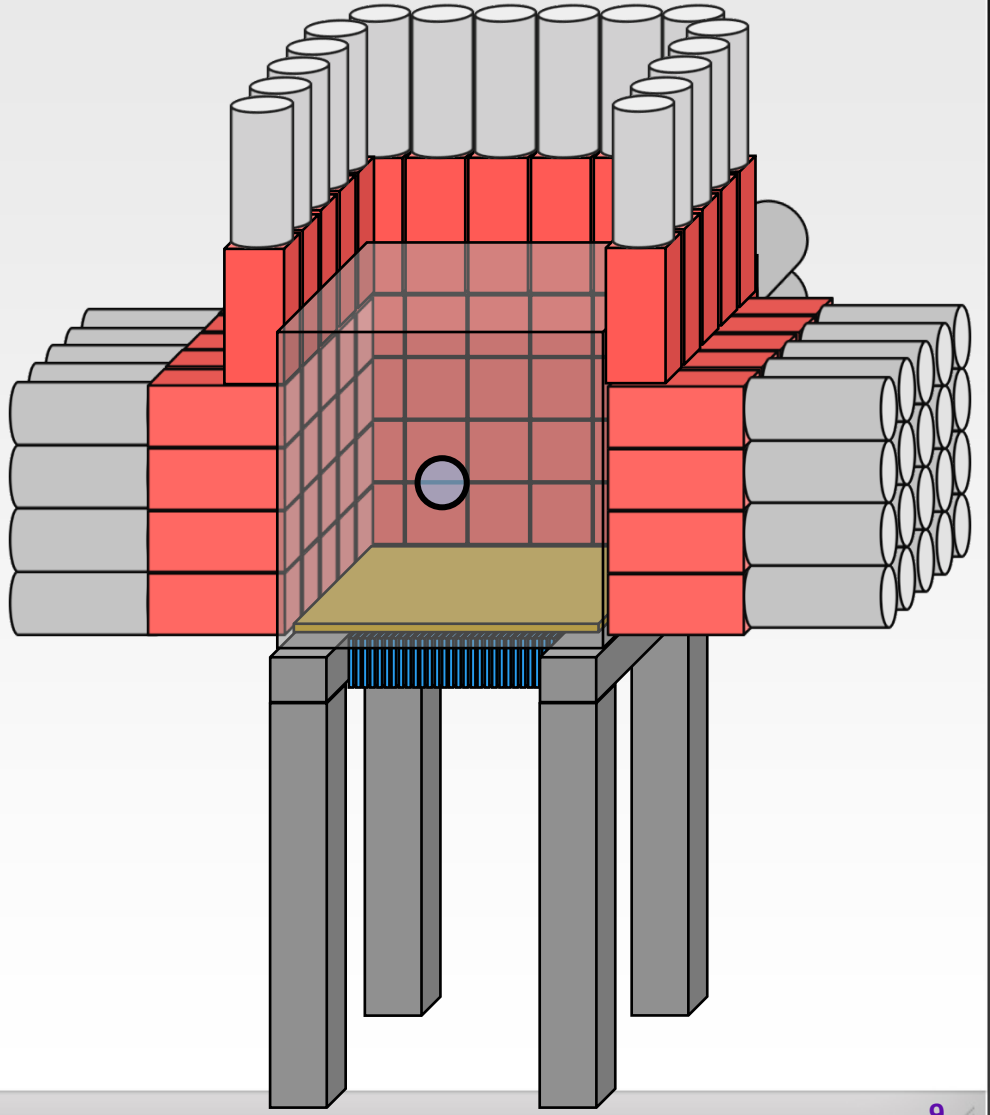
# ACTAR + PARIS

- ACTAR
  - 27 cm cubic gas box
  - 25.6 x 25.6 $cm^2$ active pad plane
  - Pad pitch 2 x 2 $mm^2$
  - 3 cm ø entrance window
- PARIS (2 x 2 x 4 inch)
  - 4 x 6 detectors downstream
  - 4 x 5 detector cluster each side



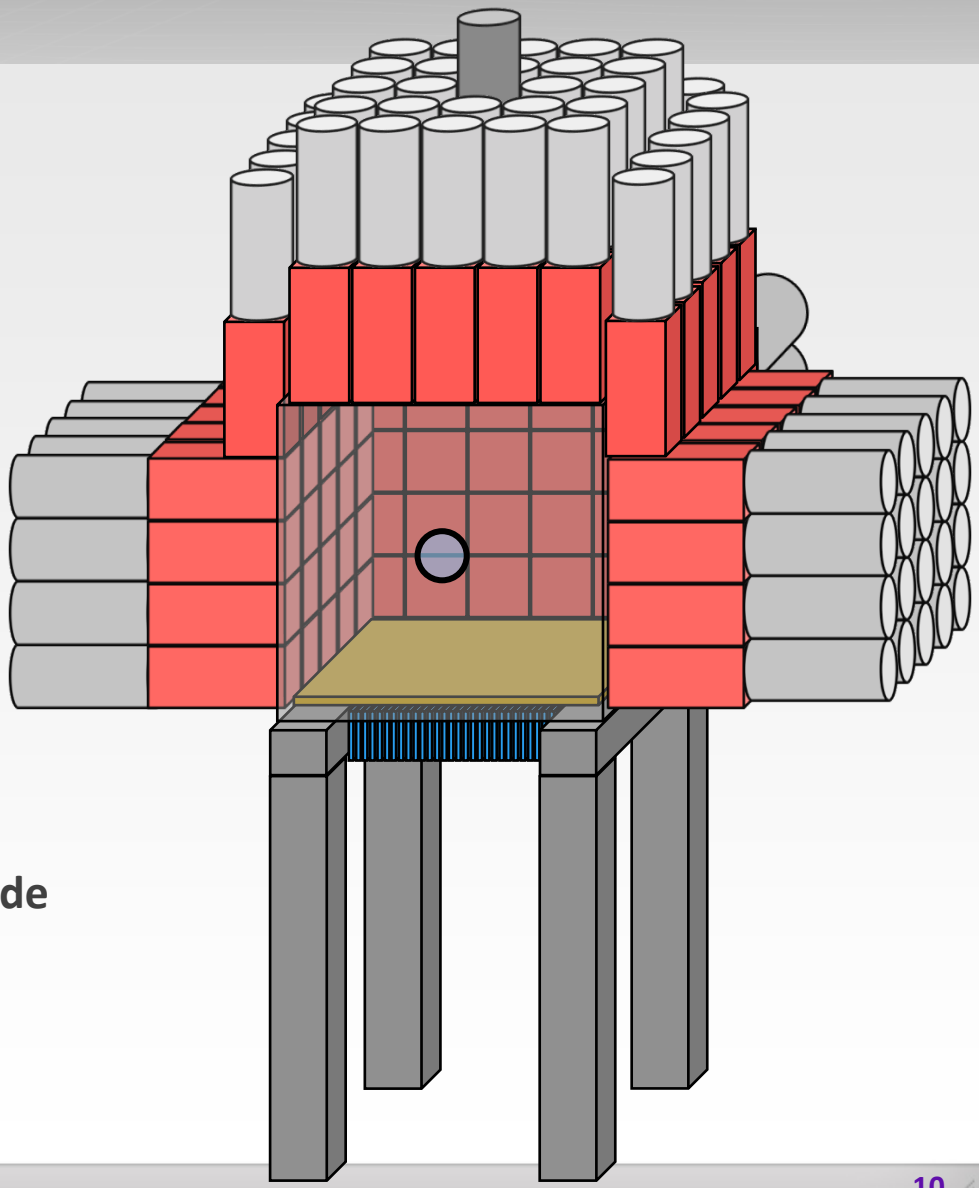
# ACTAR + PARIS

- ACTAR
  - 27 cm cubic gas box
  - 25.6 x 25.6 $cm^2$ active pad plane
  - Pad pitch 2 x 2 $mm^2$
  - 3 cm ø entrance window
- PARIS (2 x 2 x 4 inch)
  - 4 x 6 detectors downstream
  - 4 x 5 detector cluster each side
  - 16 vertical detectors around box



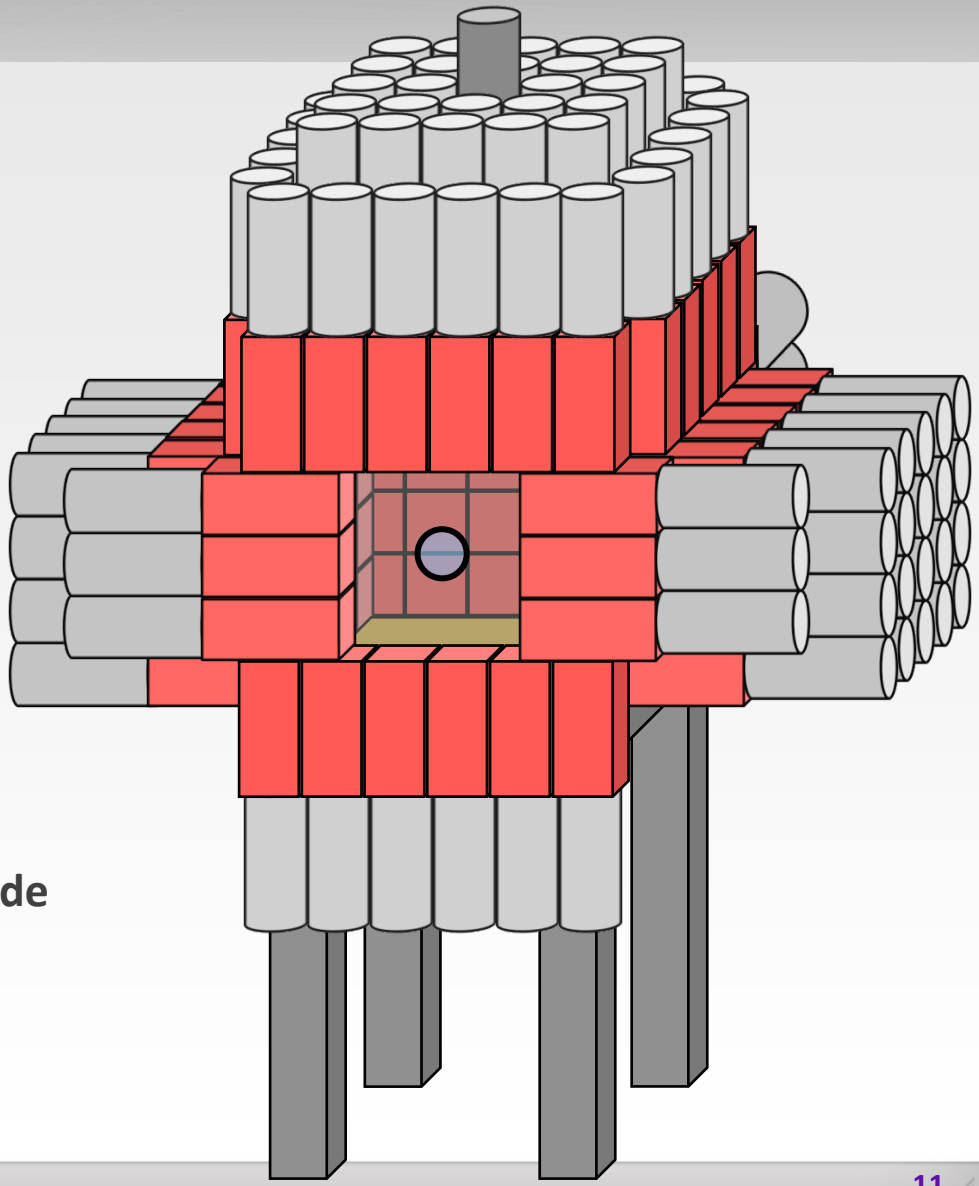
# ACTAR + PARIS

- ACTAR
  - 27 cm cubic gas box
  - 25.6 x 25.6 $cm^2$ active pad plane
  - Pad pitch 2 x 2 $mm^2$
  - 3 cm ø entrance window
- PARIS (2 x 2 x 4 inch)
  - 4 x 6 detectors downstream
  - 4 x 5 detector cluster each side
  - 16 vertical detectors around box
  - 5 x 5 detectors on top – 1 for cathode



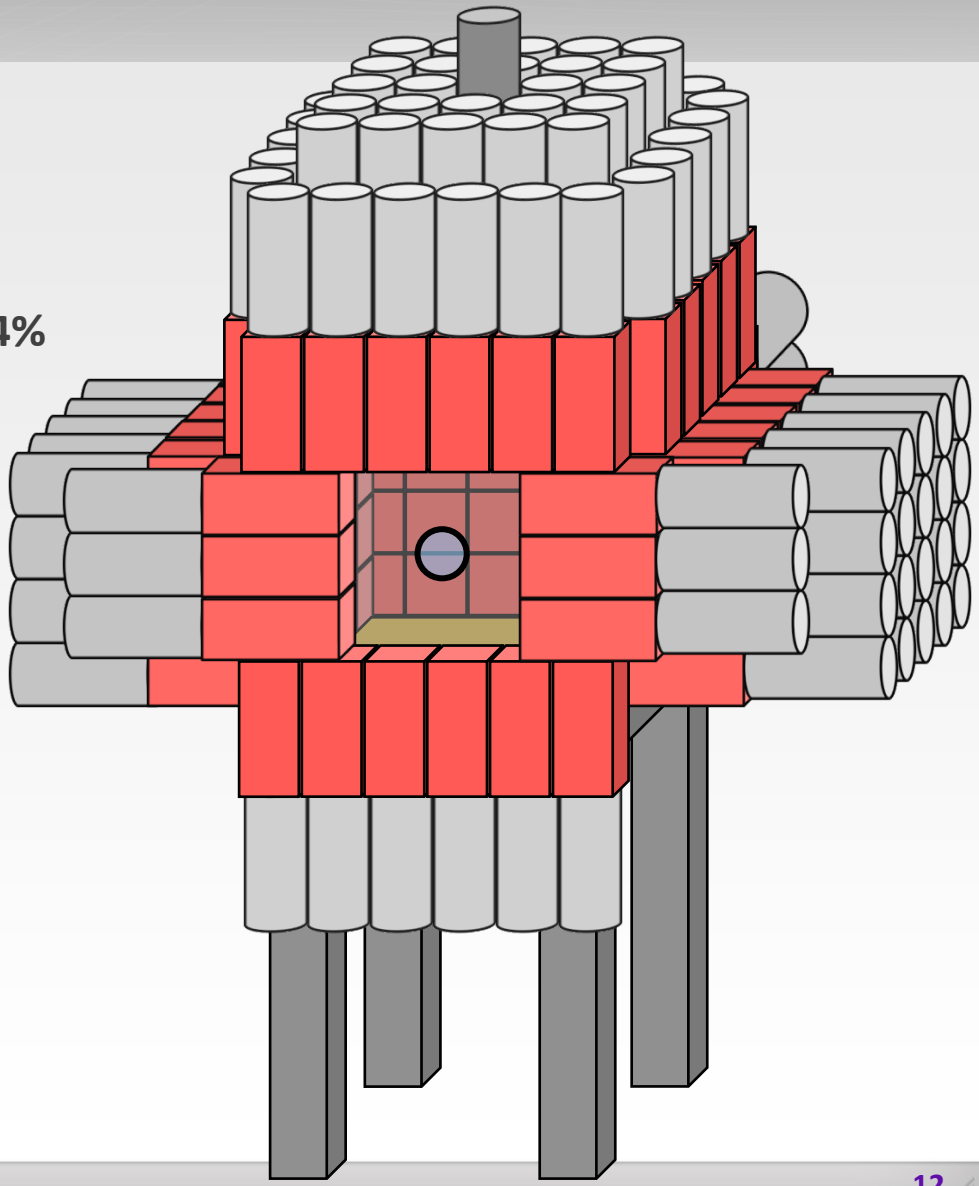
# ACTAR + PARIS

- ACTAR
  - 27 cm cubic gas box
  - 25.6 x 25.6 $cm^2$ active pad plane
  - Pad pitch 2 x 2 $mm^2$
  - 3 cm ø entrance window
- PARIS (2 x 2 x 4 inch)
  - 4 x 6 detectors downstream
  - 4 x 5 detector cluster each side
  - 16 vertical detectors around box
  - 5 x 5 detectors on top – 1 for cathode
  - 18 detectors upstream



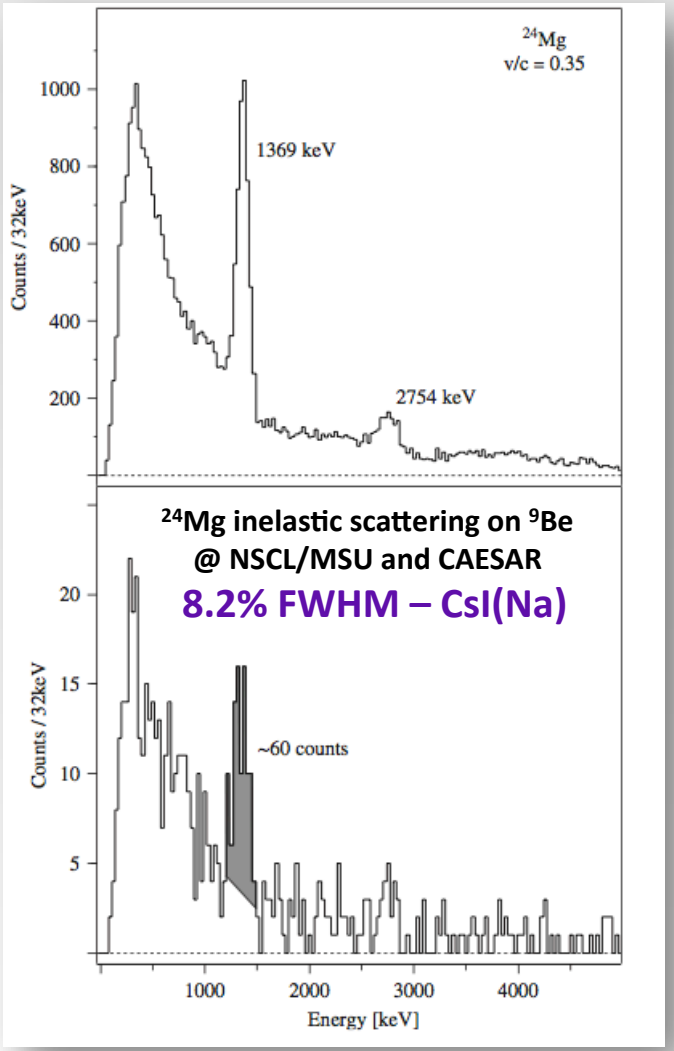
# ACTAR + PARIS

- Characteristics
  - 122 PARIS detectors
  - Solid angle coverage ~ 76%
  - Photopeak efficiency @ 1 MeV ~ 24%
  - With NN addback ~ 30%
  - Detector to source ~ 13.5 cm



# Feasibility and Rate Estimates

- ACTAR ($D_2$ gas at 1 atm)
  - $5.4 \times 10^{20}$ deuterons/cm$^2$
  - Integrated cross section = 10 mb
  - Beam rate = 1000 pps
    - 20 counts per hour
- With PARIS
  - 10% population of an excited state
  - 25% photopeak efficiency for 1 MeV
    - 15 photopeaks per day



# Other Considerations

- Trigger and timing
  - ACTAR upstream - clean for (d,p)
  - Charge collection time ~ 10 µs
  - Prompt γ-rays delayed ~ 10 µs
  - Correlate data with time stamps
- Detector orientation
  - Phoswich response from the side?
- Decay of the beam ($10^3$-$10^4$ pps)
  - Stop inside ACTAR? (uncorrelated γ-rays)
  - Transport outside? (less solid angle)
- Natural $^{138}$La decay, 1.4 MeV γ ray
  - ACTAR trigger – uncorrelated

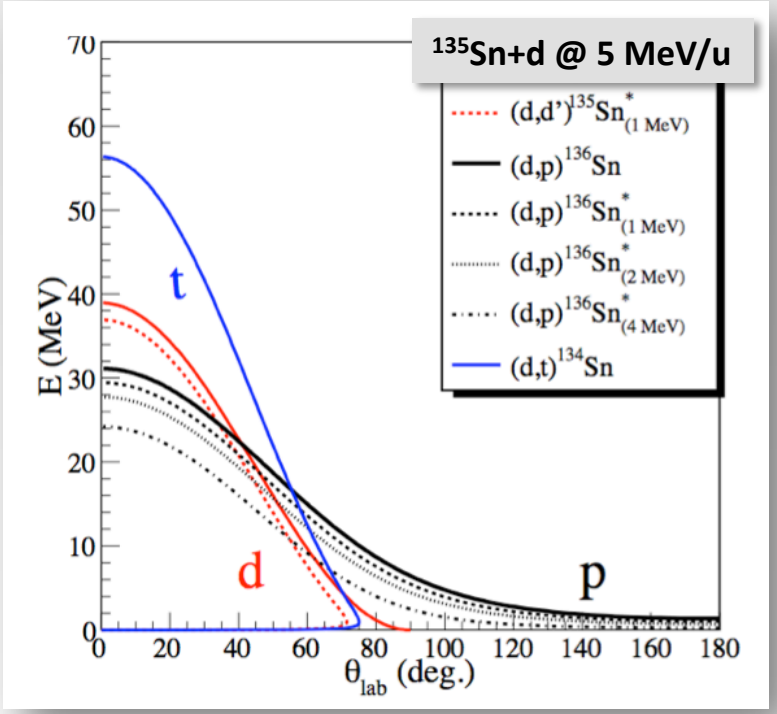



*Figure courtesy of V.Lapoux*