

The ACTAR project at SPES

Status and perspectives

Riccardo Raabe

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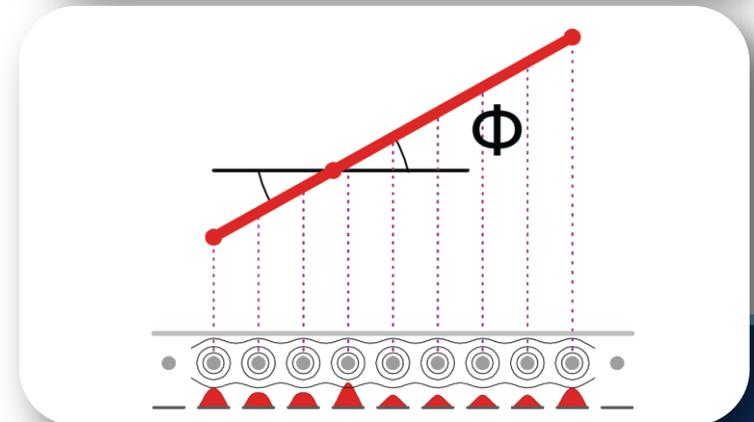
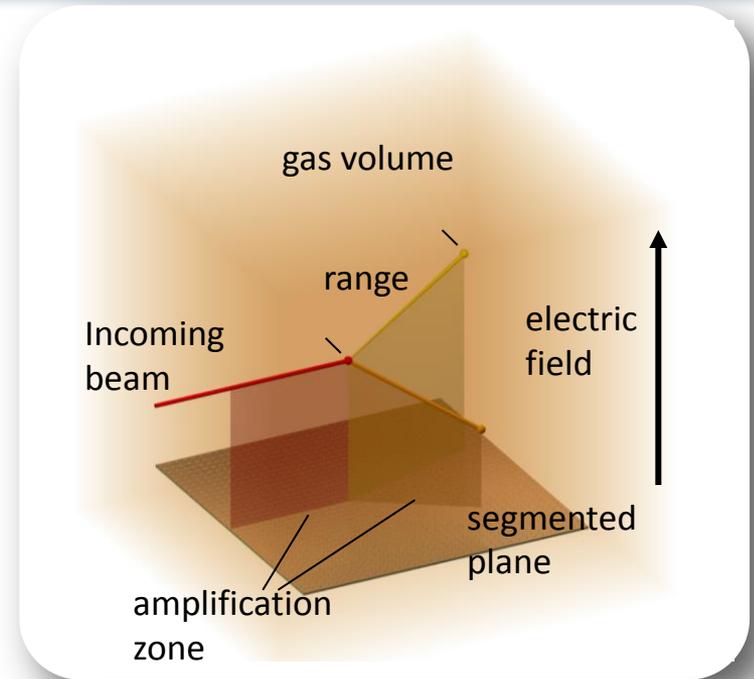
SECOND SPES INTERNATIONAL WORKSHOP

The active target concept

Time-Projection Chamber (TPC)...

- Electrons produced by ionization drift to an amplification zone
- Signals collected on a segmented “pad” plane \Rightarrow 2d-image of the track
- 3rd dimension from the drift time of the electrons

...+ the detection gas is the target

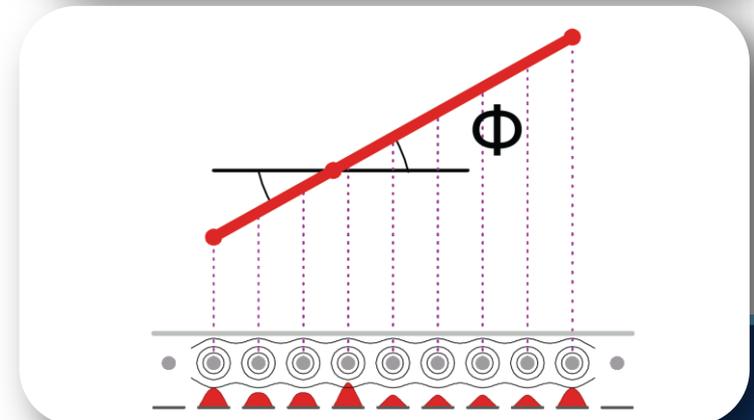
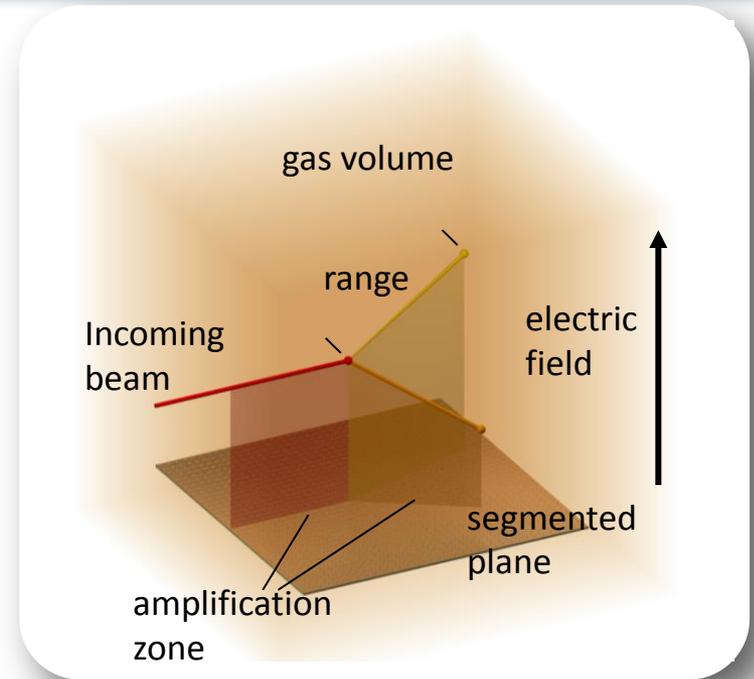


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Characteristics and advantages

- Large target thickness possible without losing resolution
- Efficiency
- Low detection threshold
- Particle identification

- Portable
- Different target/detection gases
- Adjust pressure
- Optimize amplification voltage
- Trigger choice

Characteristics and advantages

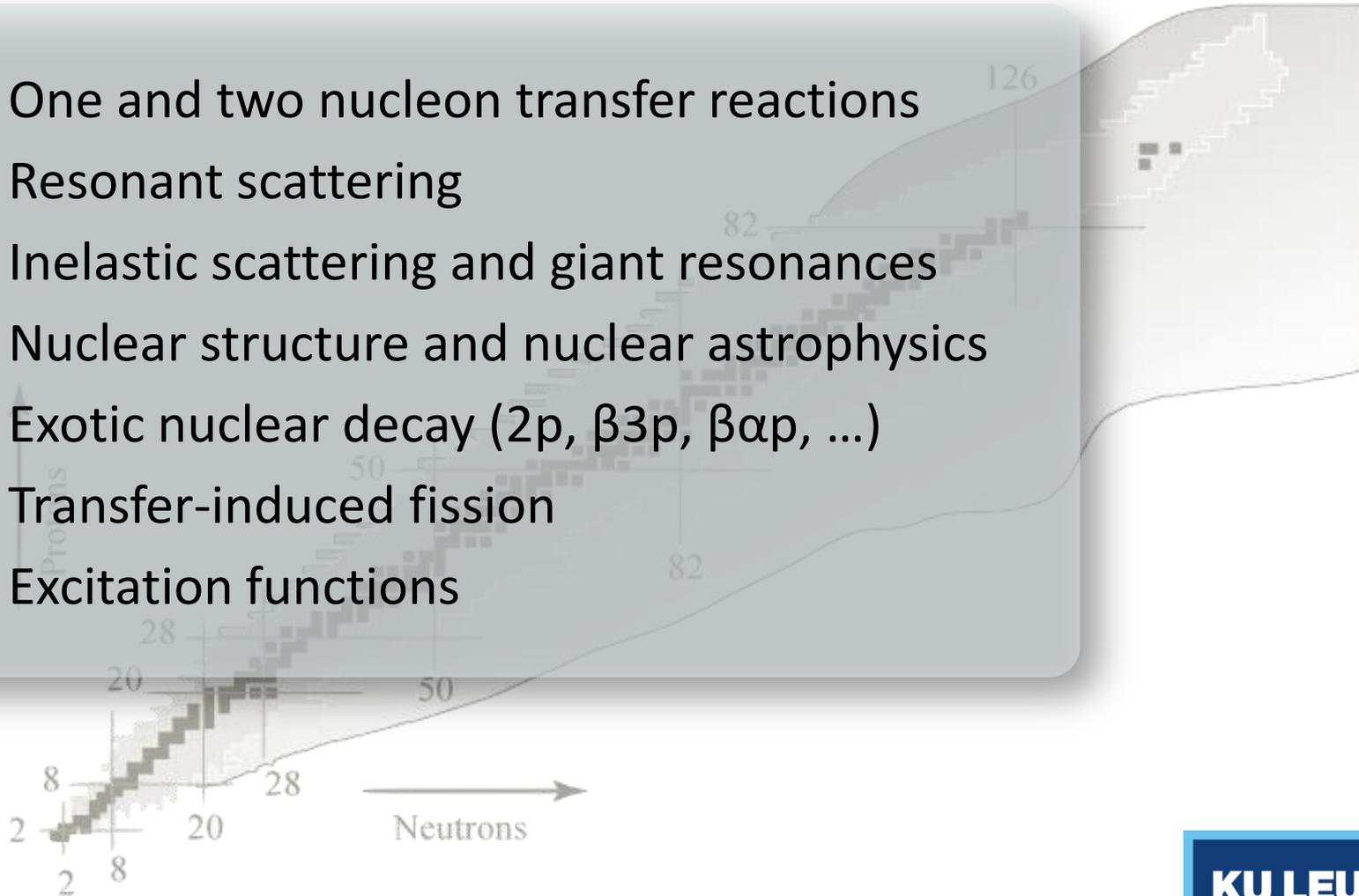
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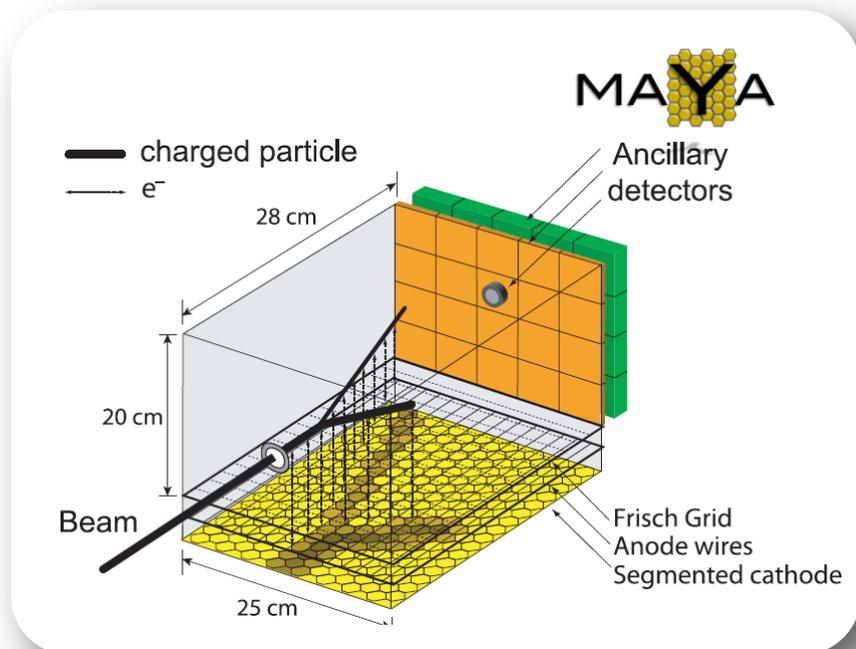
Broad scope: reactions, decays...

- One and two nucleon transfer reactions
- Resonant scattering
- Inelastic scattering and giant resonances
- Nuclear structure and nuclear astrophysics
- Exotic nuclear decay ($2p$, $\beta 3p$, $\beta\alpha p$, ...)
- Transfer-induced fission
- Excitation functions



Results with Maya

Demonchy et al., NIMA 573 (2007) 145

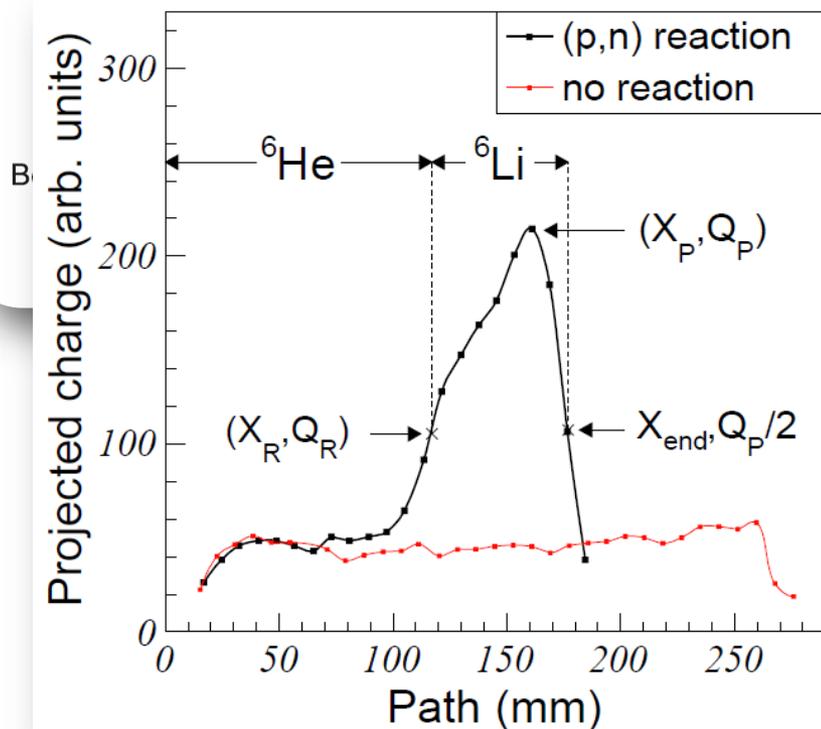
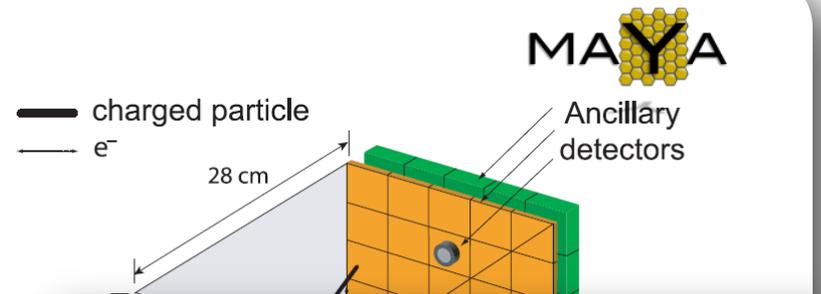


Reactions with light nuclei

- $^{12}\text{C}(^8\text{He}, ^{13}\text{N})^7\text{H}$ at GANIL
M. Caamaño et al., PRL 99 (2007) 062502
- $^{11}\text{Li}(p,t)$ at TRIUMF
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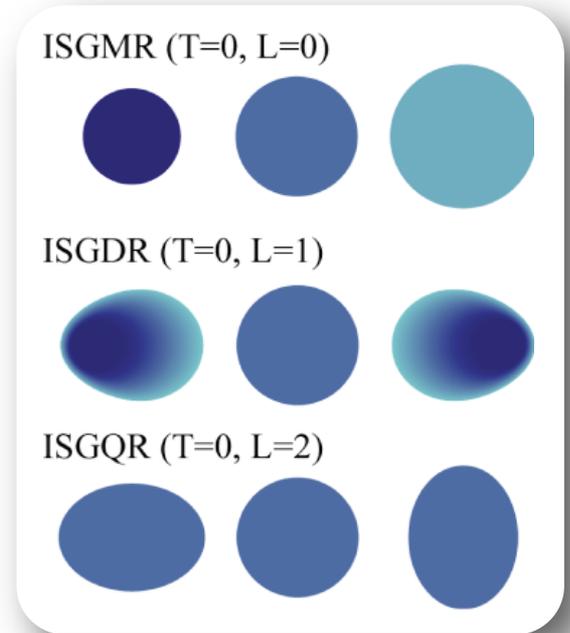
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Investigations of collective modes: isoscalar resonances

- $^{56}\text{Ni}(d,d')$ at GANIL
C. Monrozeau et al., PRL 100 (2008) 042501
- $^{68}\text{Ni}(d,d')$ and (α,α') at GANIL
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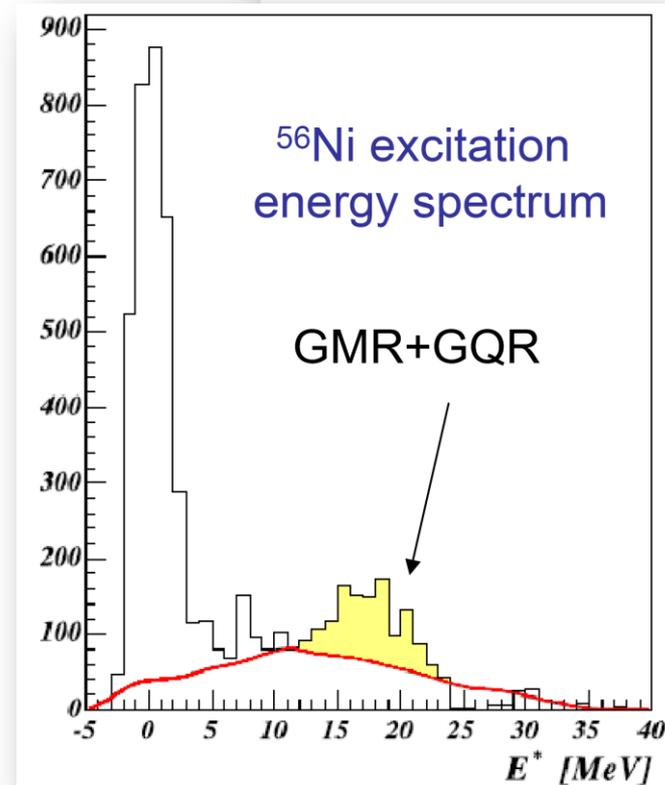
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ISGMR ($T=0, L=0$)

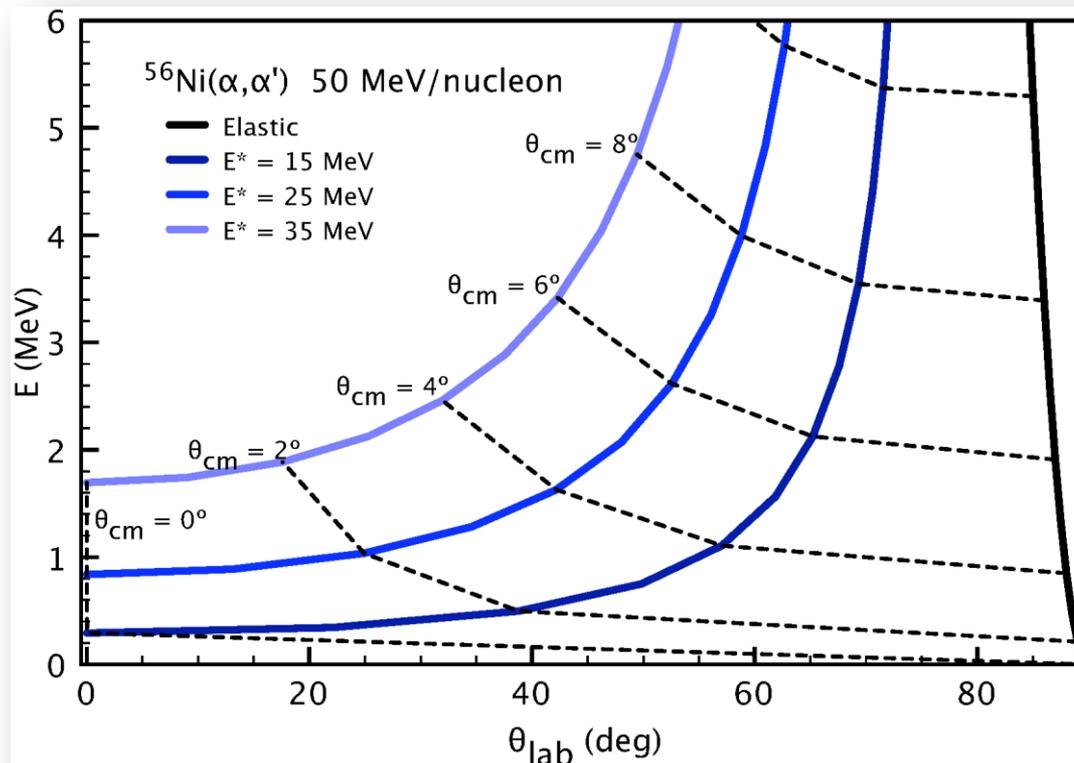


ISGDR ($T=0, L=1$)



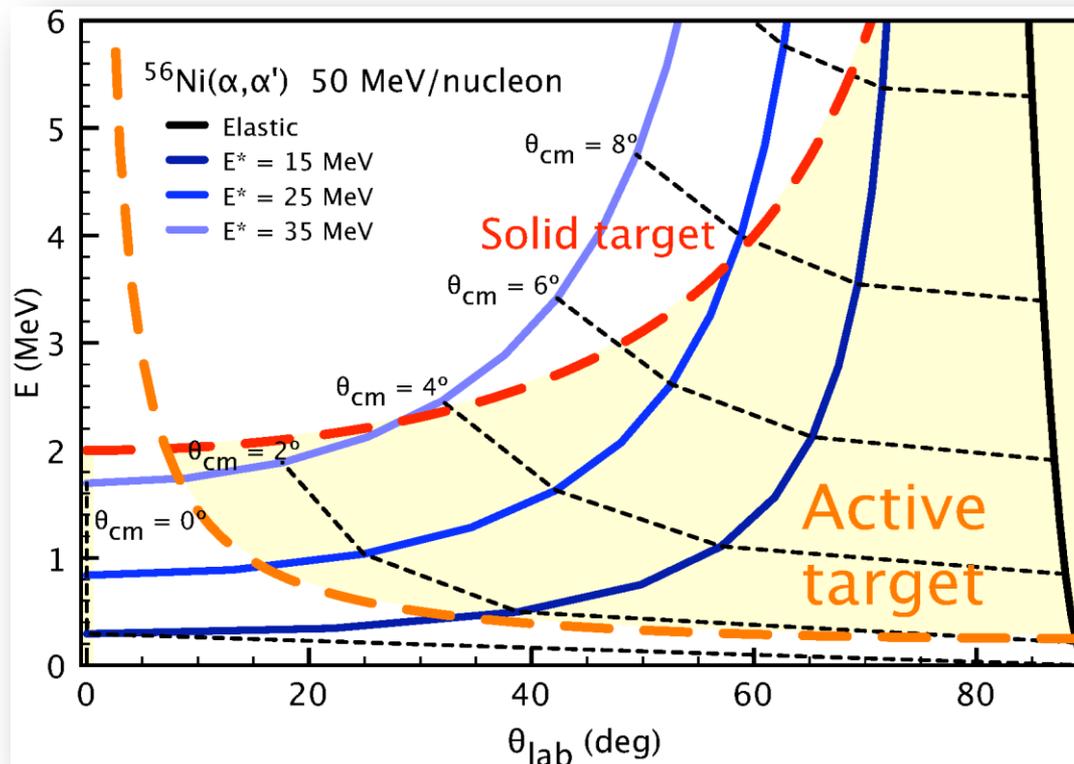
Collective modes: inelastic scattering

- Inelastic scattering:
 - low-energy recoils at small angles
 - multipole decomposition



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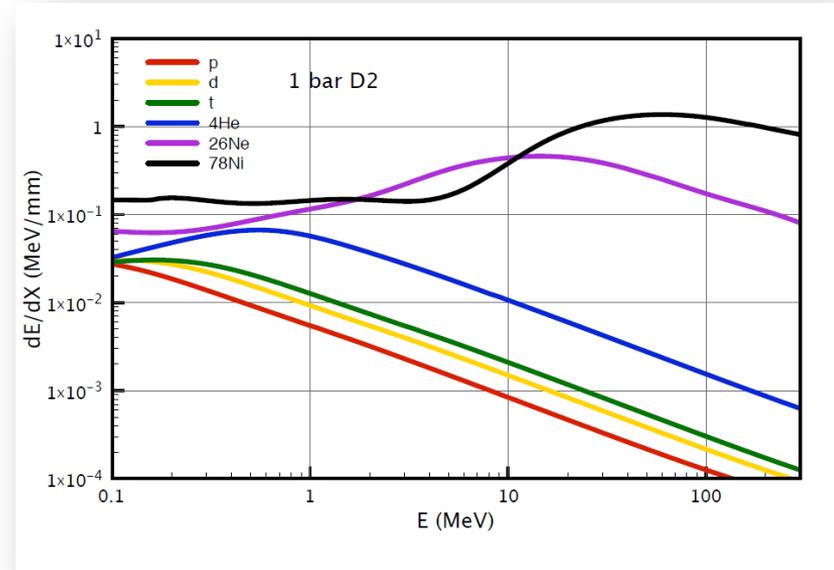
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 - multipole decomposition



The new device: ACTAR TPC

Design goals

- Dynamic range to 10^3
- Multiple tracks
- Spatial resolution $< 2\text{mm}$
- Energy resolution 2%
- Beam intensities up to 10^7
- Counting rate 10^3 events/s



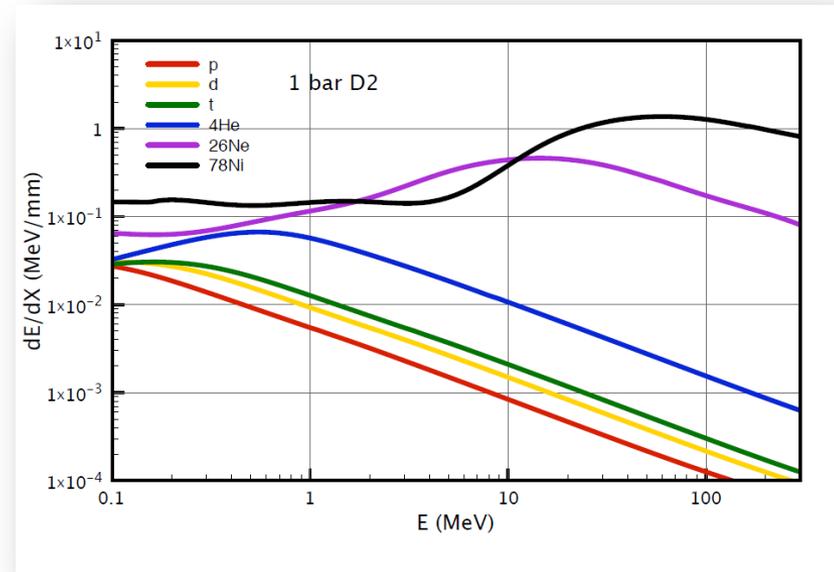
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- Detector hardware
- Electronics
- Data acquisition software

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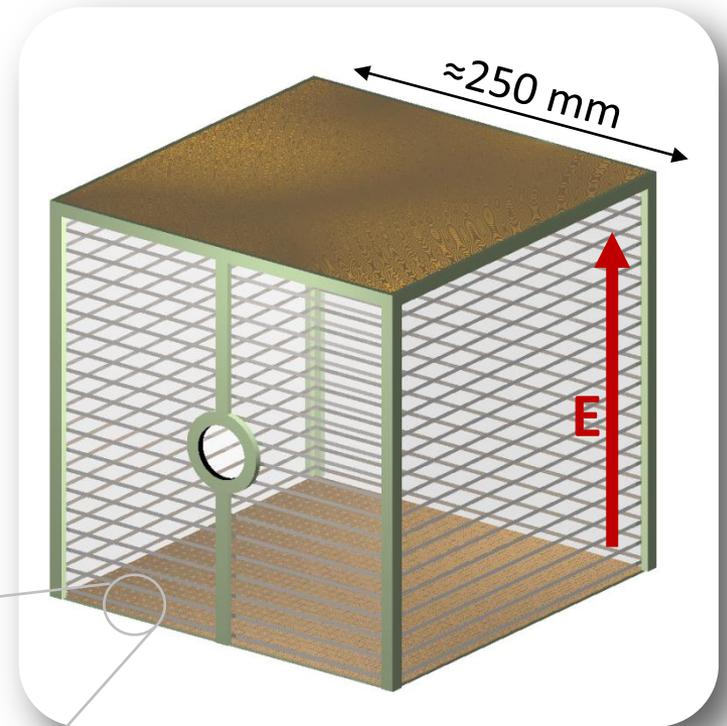
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Design

ACTAR TPC CDR available on SPIRAL2 website

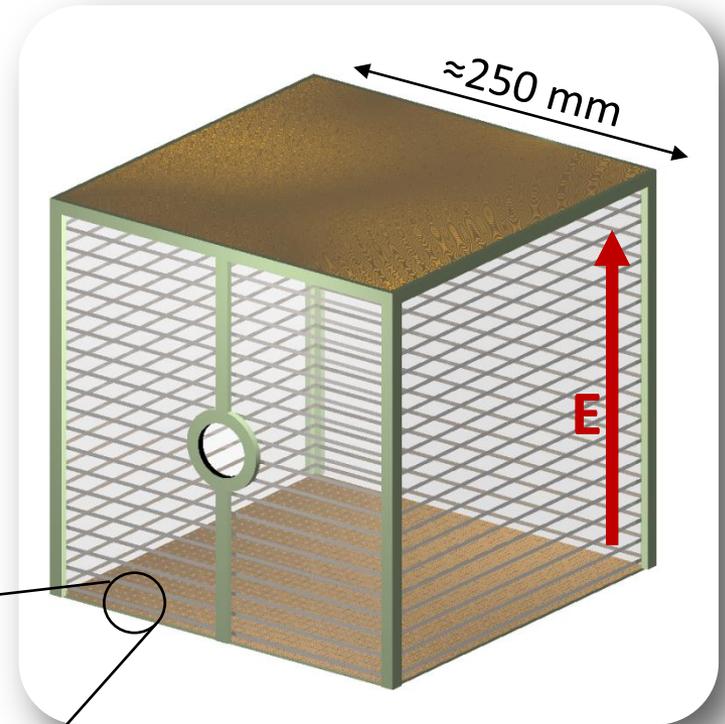
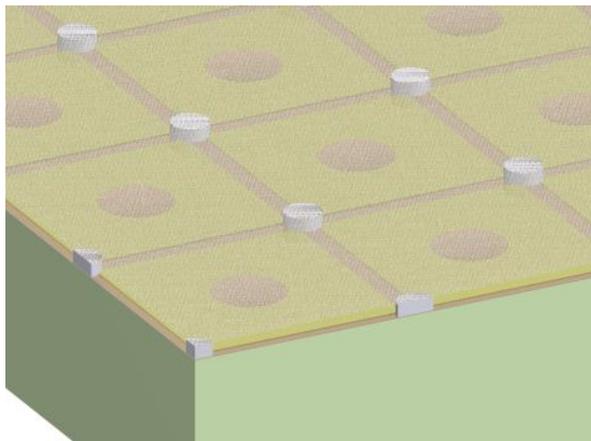
- Cubic geometry (mainly)
- Amplification: Micromegas
- Ancillary detectors
- Independent pads, $2 \times 2 \text{ mm}^2$
- More than 16k channels



Design

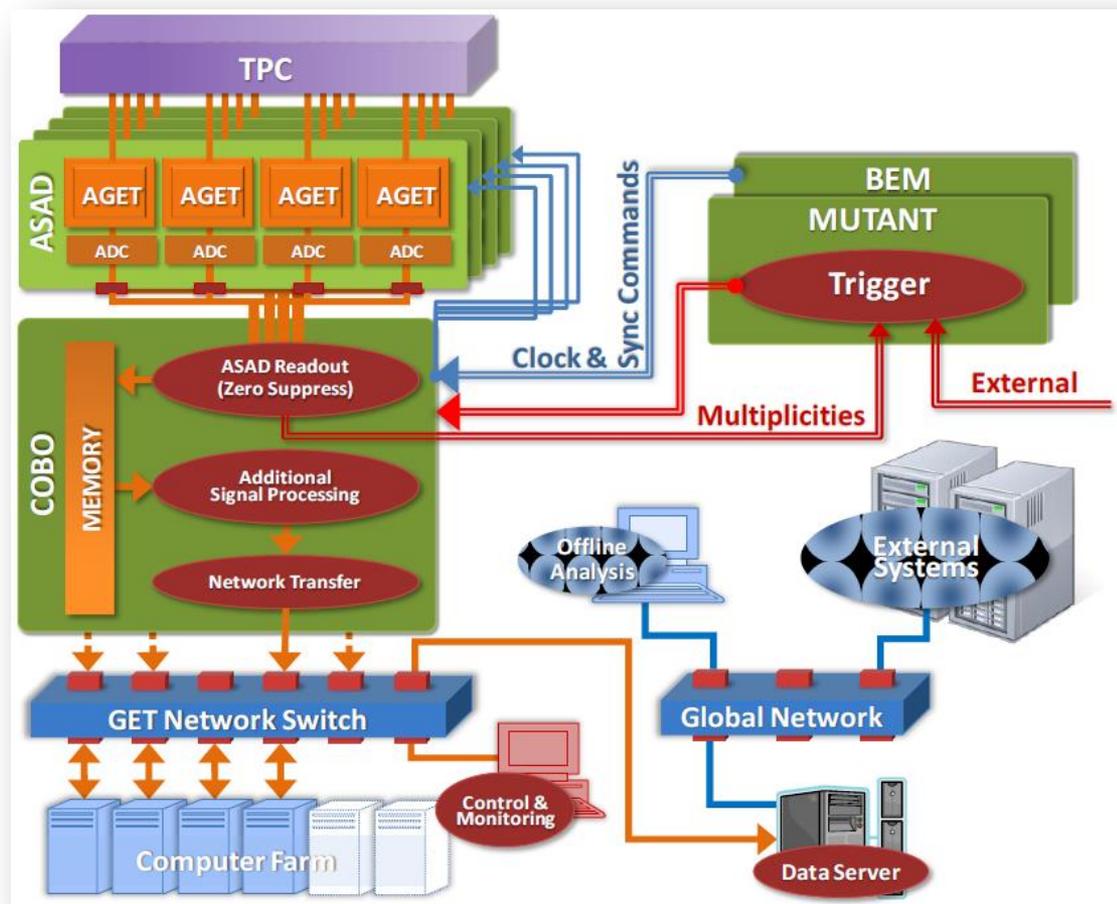
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General Electronics for TPCs – GET

- High front-end density
- High-rate throughput (selective readout, zero suppression)
- High S/N ratio
- High dynamic range
- Manage time stamp, other detectors, control...
- **Intelligent trigger**
 - L0 external
 - L1 multiplicity
 - L2 topology



Status

Collaboration

- **Begin 2012: ACTAR TPC Collaboration Agreement**
(G. Grinyer spokesperson)
GANIL, CEA Saclay, CENBG, IPN Orsay, KU Leuven, Univ. Santiago de Compostela
R&D timeline 2012-2014: Demonstrator
- New partnership form in 2015

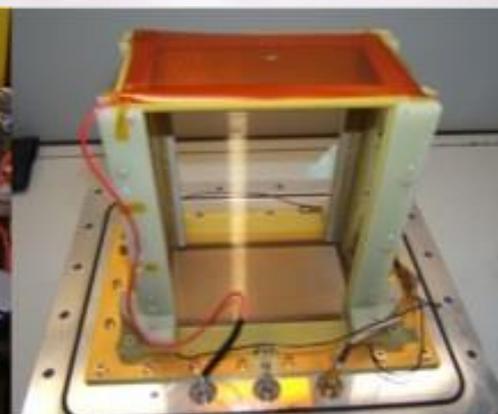
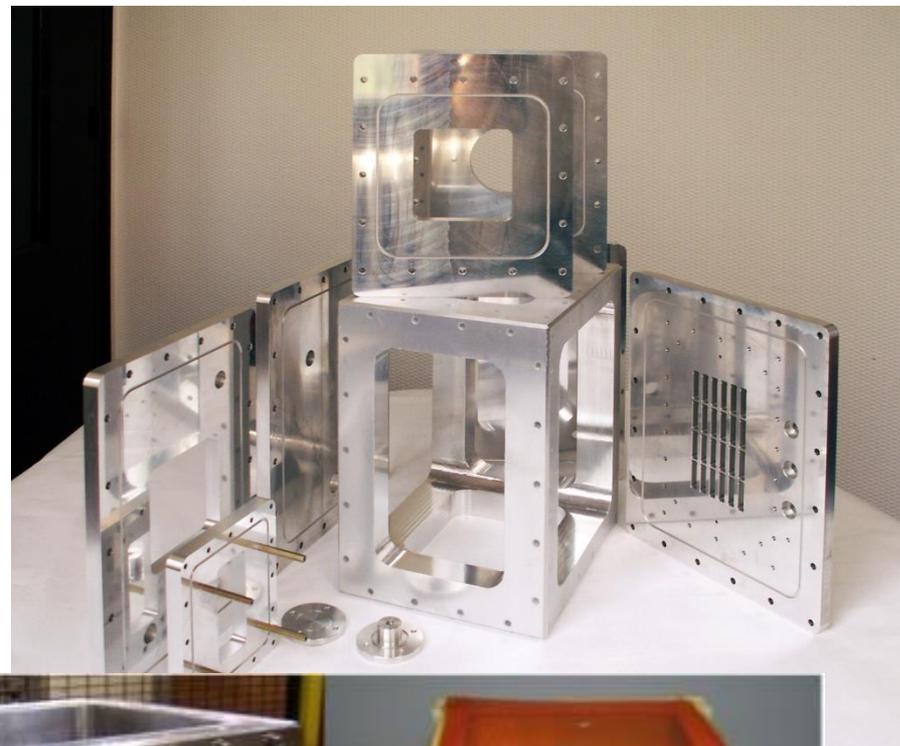
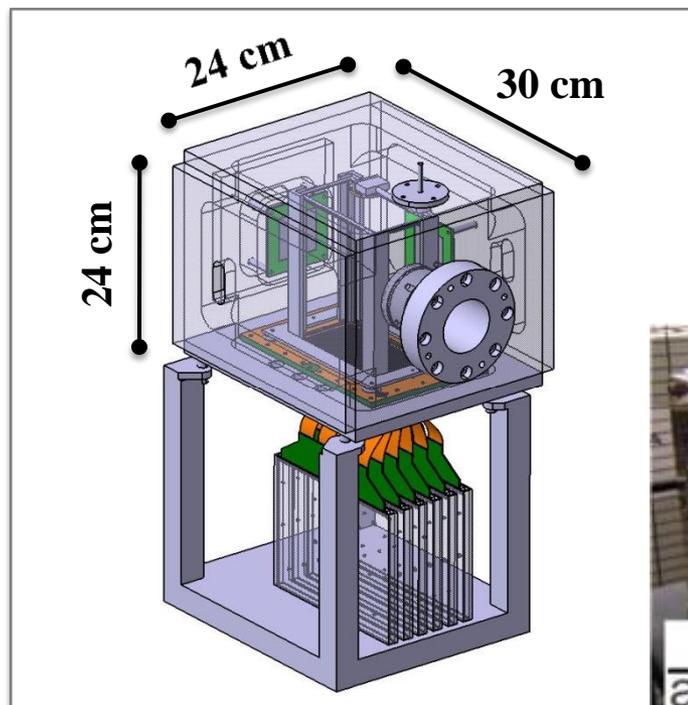
Financial

- 2009: ANR project GET electronics **550 k€**
(total project 4.3 M€)
- Feb 2014: ERC StG (G. Grinyer) **1.29 M€**
detector ready begin 2016
- June 2014: ERC CoG (R. Raabe) **1.94 M€**
- 2014: SIR proposal (T. Marchi) **≈1 M€**

ACTAR TPC demonstrator(s)

(IPN Orsay, CENBG Bordeaux)

- Define the final detector design
- Building and testing a complete GET system (2048 channels)



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NUCLEAR AND RADIATION PHYSICS

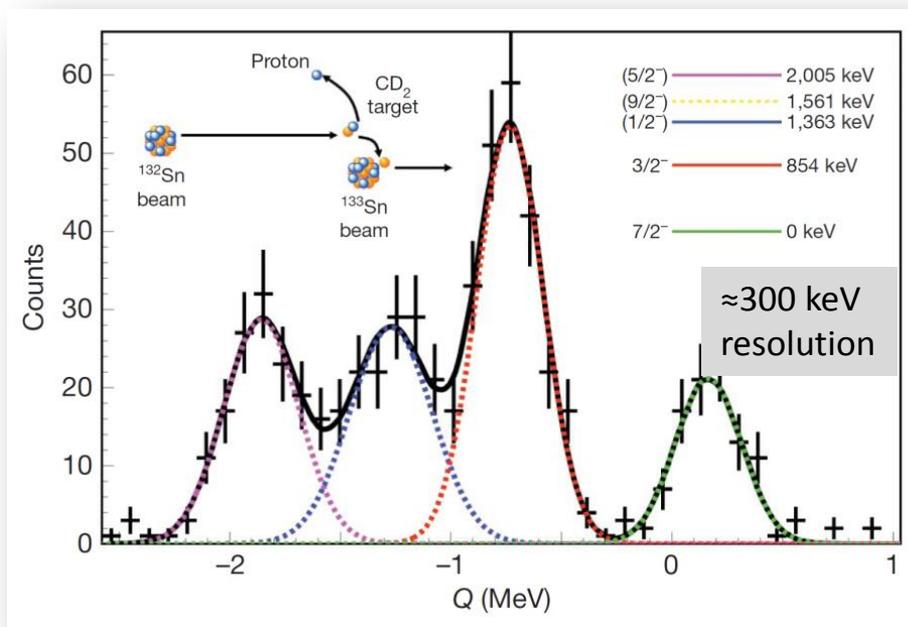
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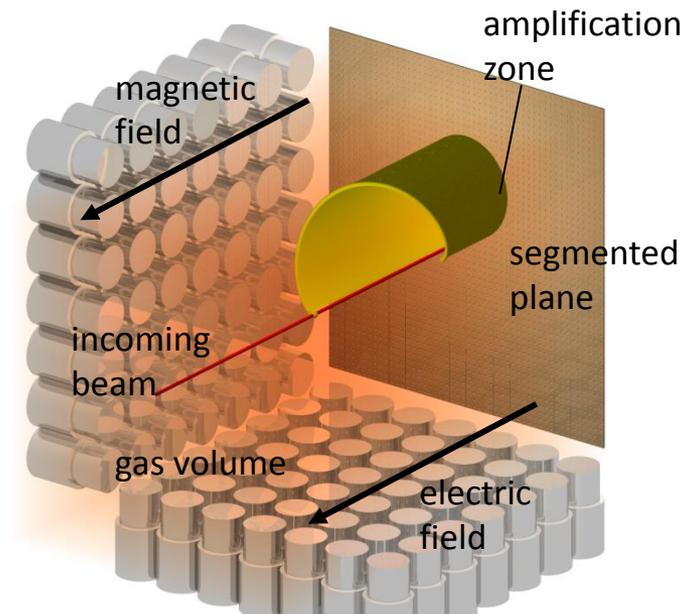
erc

European Research Council
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- Array of γ -ray scintillators
LaBr₃ or CeBr₃



K.L. Jones et al., Nature 465 (2010) 454



- Design 2014-2015
- Assembly 2015-2016
- Detector ready begin 2017

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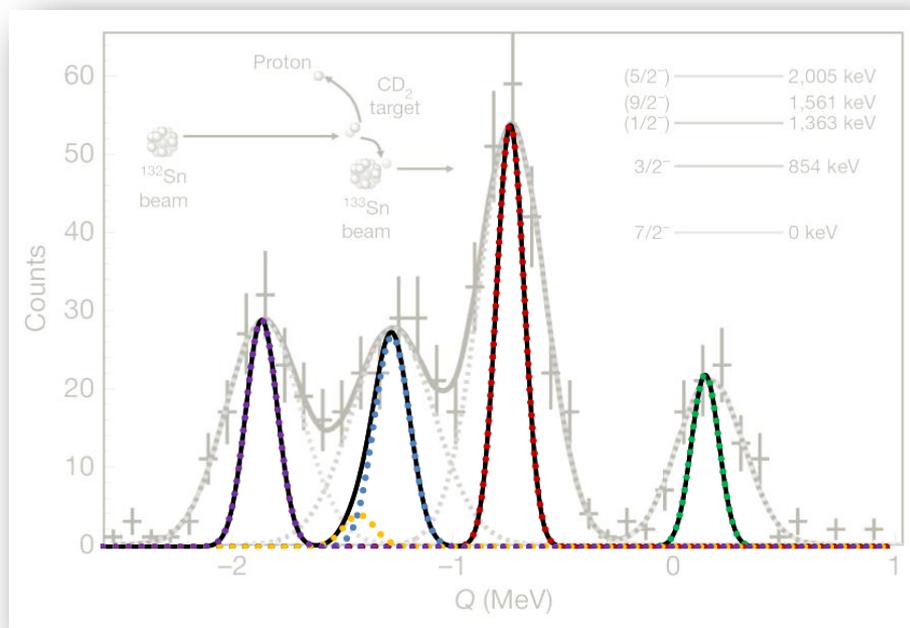
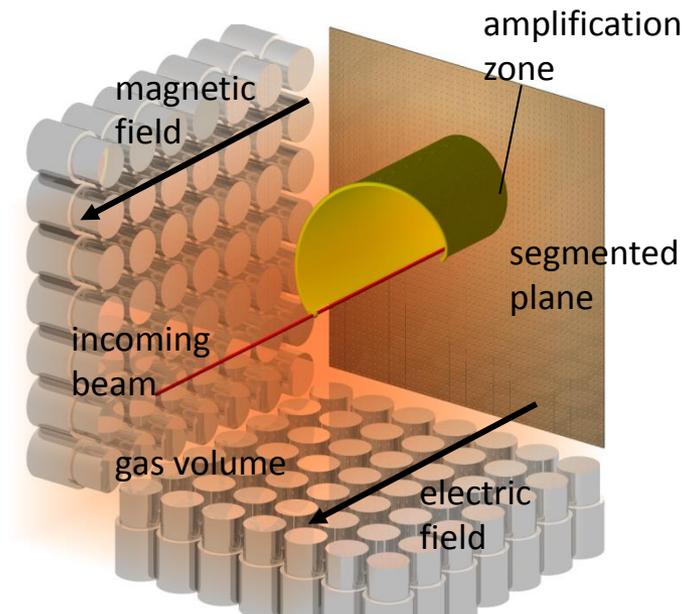
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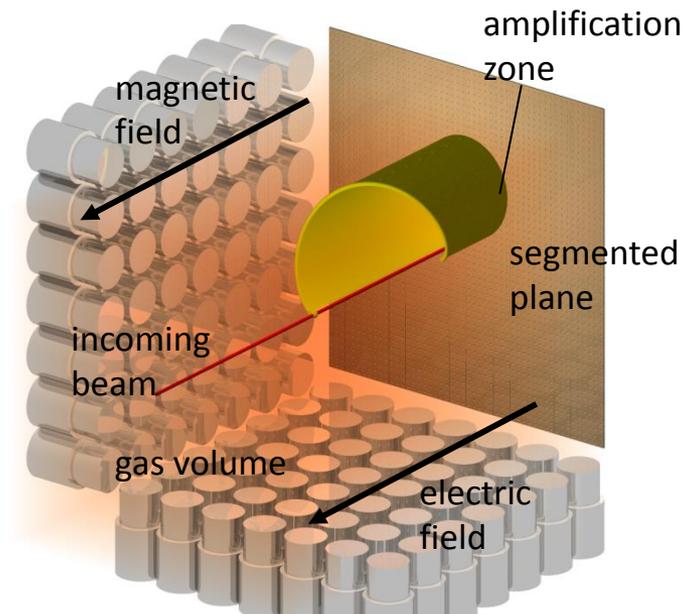
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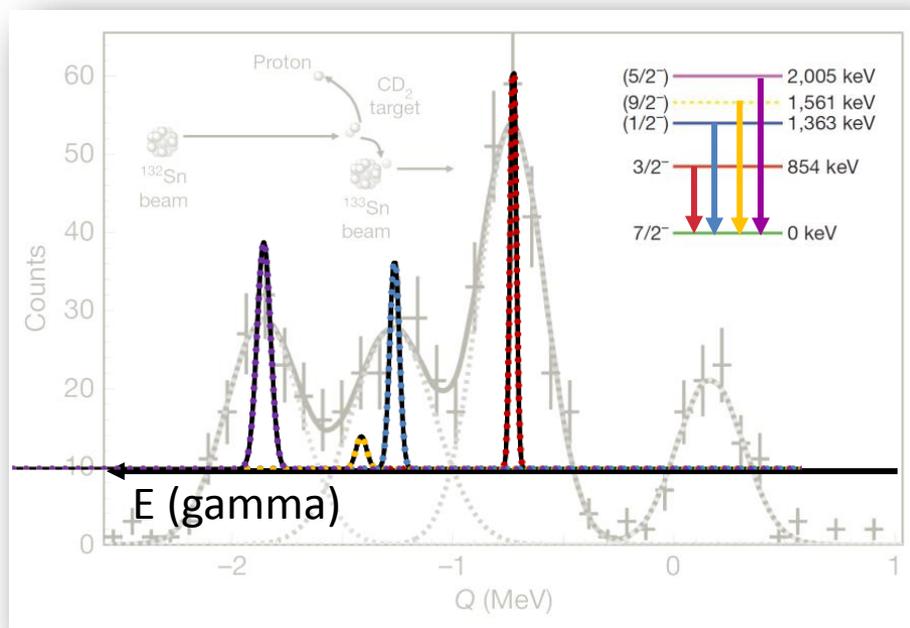
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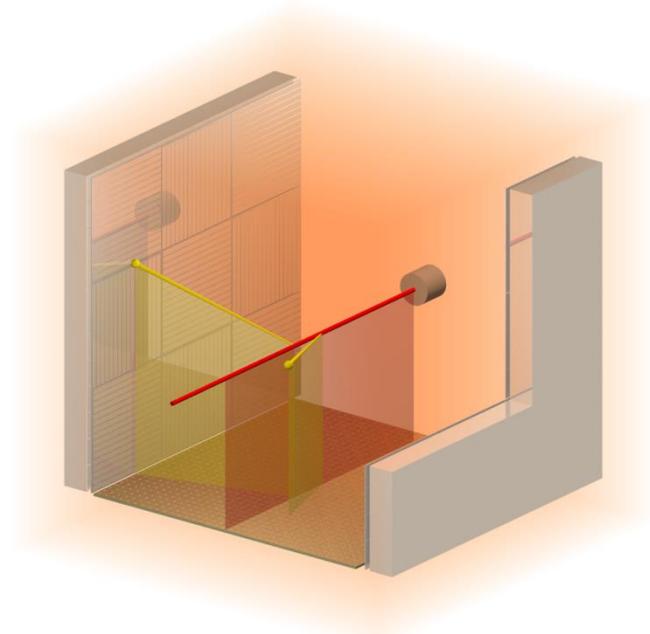
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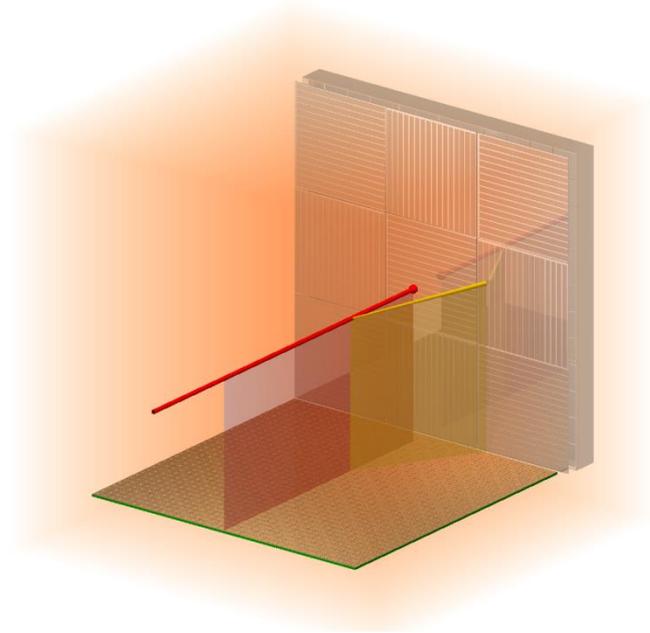
Active Target at SPES: ATS

- SIR proposal (T. Marchi)
 - Dedicated detector (cage, Micromegas, chamber)
 - Tests on dynamic range
 - Development of custom electronics (GPU-based)
- Other in-kind contributions possible (tests, commissioning)
- Physics cases:
 - Transfer reactions (2 Lols)
 - Resonant reactions (1 Lol)
 - Pigmy resonances?



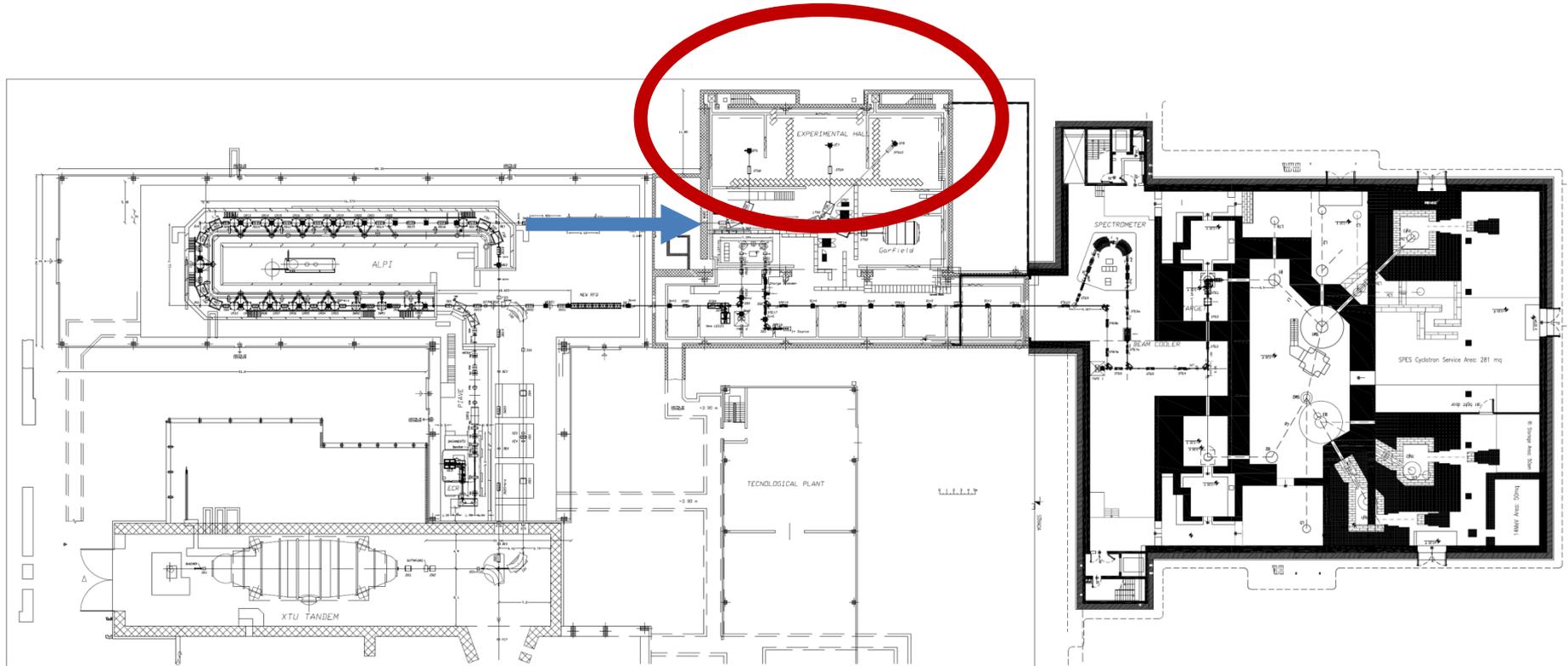
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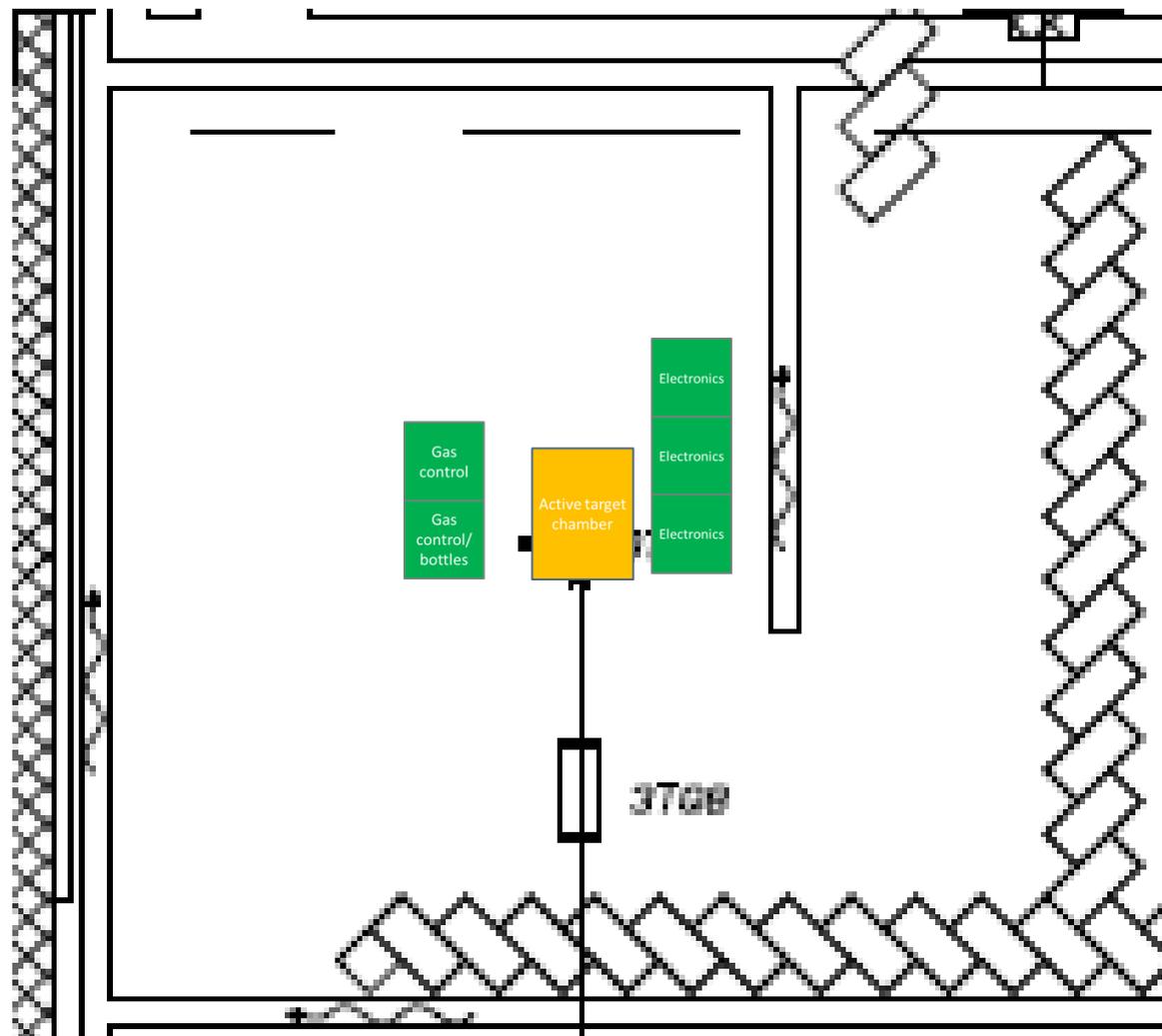
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Location



Active Target at SPES: ATS

Footprint



Summary

ACTAR TPC at SPES

- Transfer reactions with most exotic and weak beams
- Particle-gamma coincidence possible
- Resonant reactions
- Inelastic scattering

INFN Legnaro, INFN and Univ. Padova, INFN and Univ. Florence, INFN and Univ. Bologna, INFN LNS and Univ. Catania, INFN and Univ. Napoli, INFN and Univ. Milano (Italy), Univ. Nevsehir (Turkey), KU Leuven (Belgium), GANIL Caen, CEA Saclay, IPN Orsay (France), Univ. Lisboa (Portugal), Univ. Santiago de Compostela (Spain), Ruder Boskovic Institute (Croatia)