Exp setup

The Active Target for SPES

SPES-β

Low energy experiments

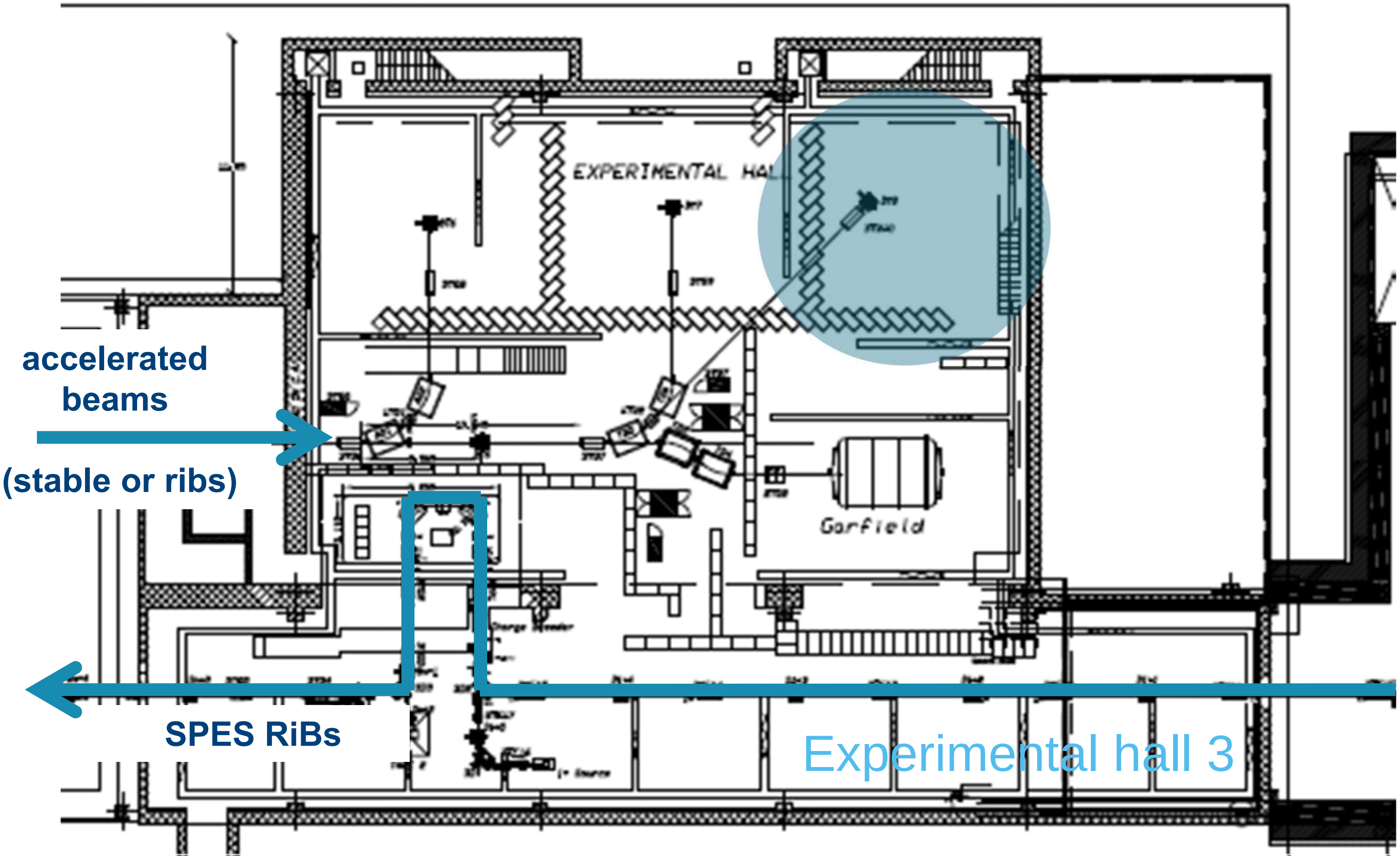
The tape station for beam diagnostics

T. Marchi, 21 Nov 2017

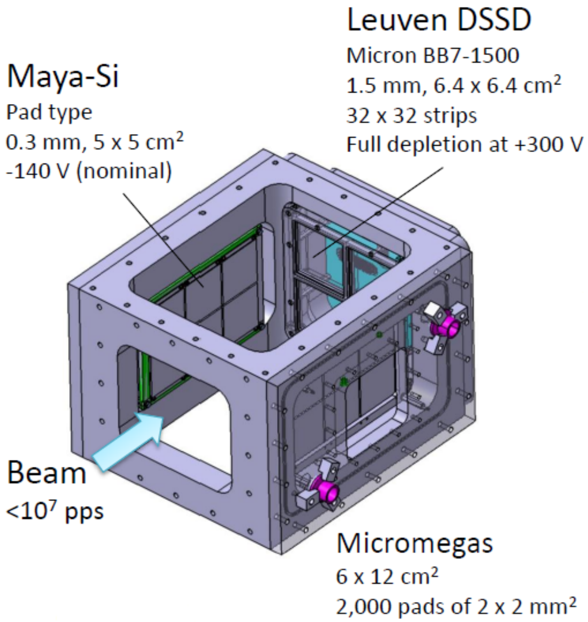
LNL User Group Meeting

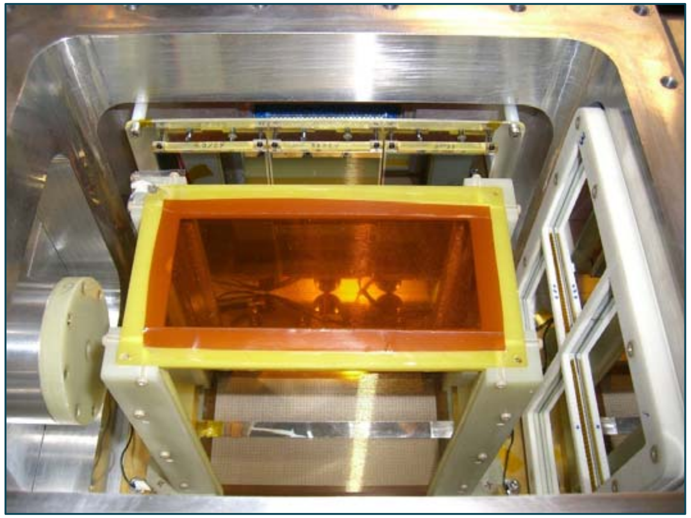
Istituto Nazionale di Fisica Nucleare

ATS – Active Target for SPES



ACTAR TPC Demonstrator chamber





Demonstrator runs with Bacchus Spectrometer at IPN Orsay, June/July 2015

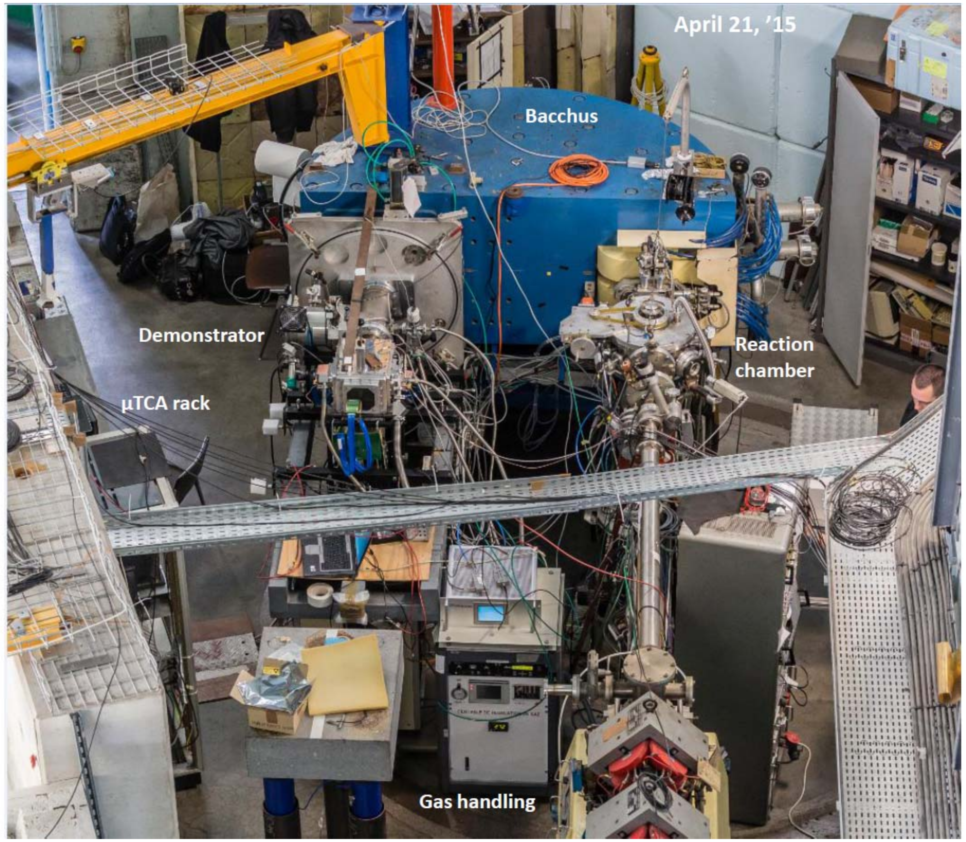
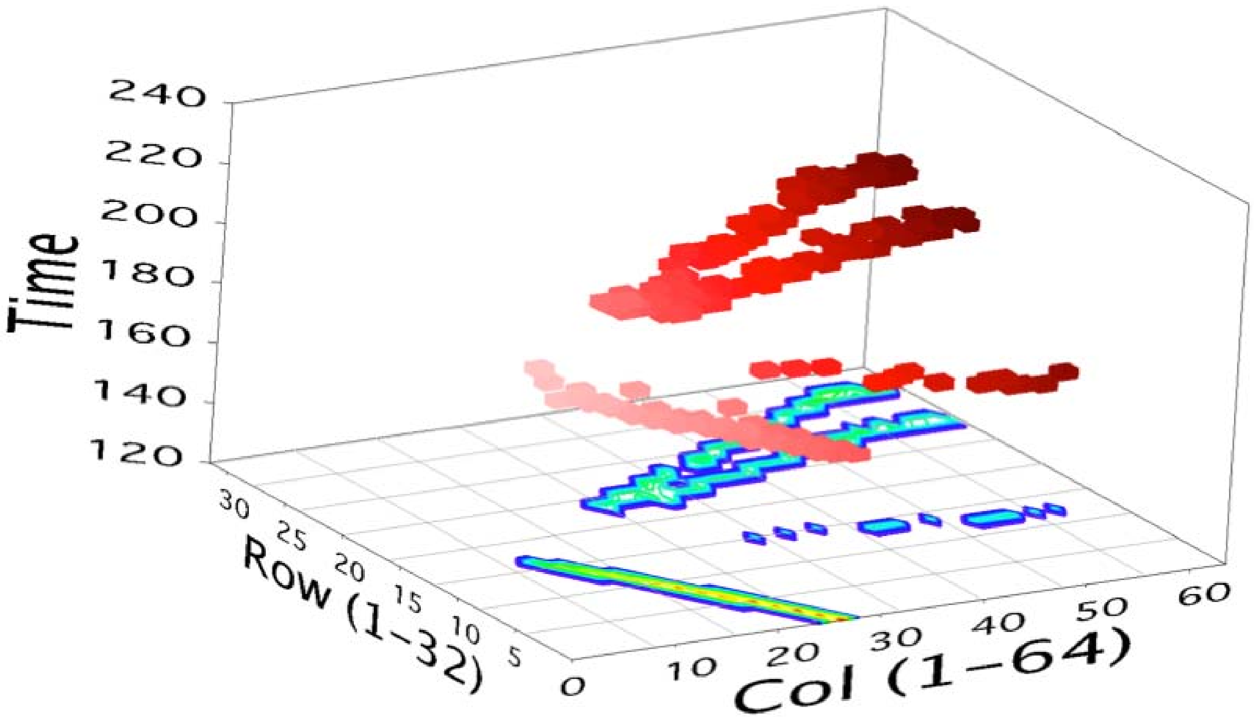


Figure and photos from D. Suzuki

ACTAR TPC @ IPNO

^{12}C on He:C_4H_{10}

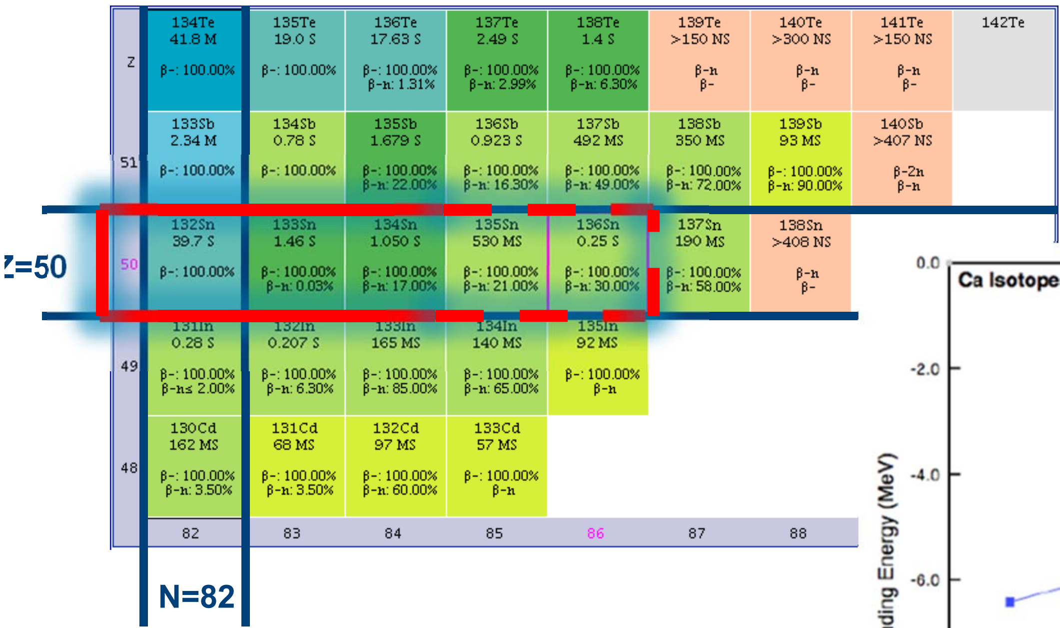
- **4-particle event**



Courtesy of G.F. Grinyer

$f_{7/2}$ vs $p_{3/2}$ neutron orbitals, in Sn like in Ca?

MagicTin



[Adapted from O. Sorlin, M.-G. Porquet, Progr Part. Nucl Phys 61 (2008) 602]

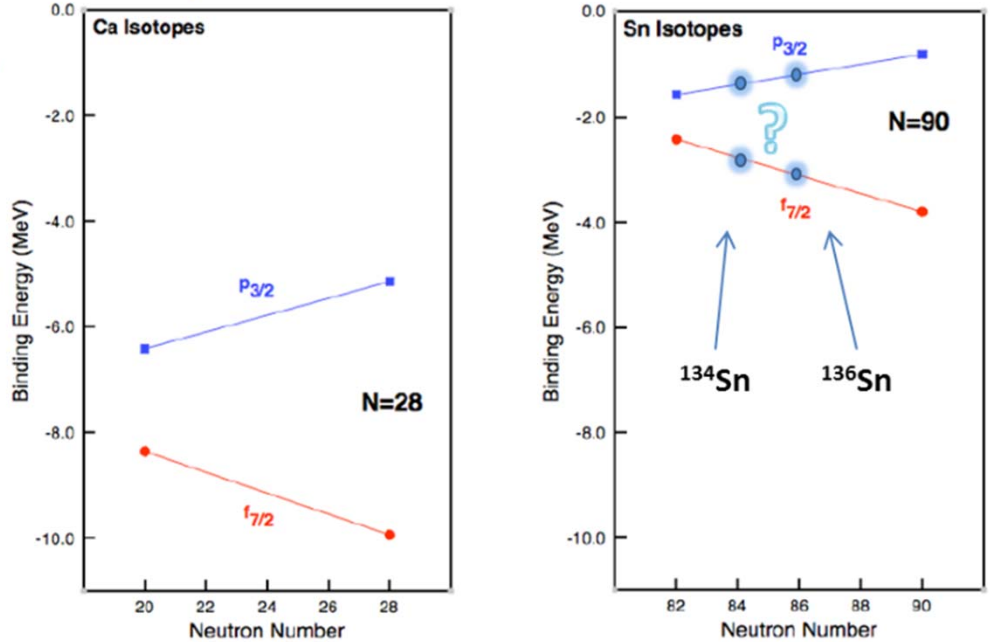


Fig.1 Analogy between f7/2 and p3/2 evolution of binding energies in the known Ca isotopes to what could be expected for the Sn isotopes approaching N=90. Figure adapted from[13].

Possible setup and beams

Expected beam intensities @ 10 AMeV		
	SPES 1st day (5 μA p beam)	SPES full power (200 μA p beam)
^{132}Sn	7.8 10^5	3.1 10^7
^{133}Sn	7.0 10^4	2.8 10^6
^{134}Sn	1.2 10^4	4.9 10^5
^{135}Sn	1.6 10^2	6.2 10^3
^{136}Sn	-	0.9 10^2

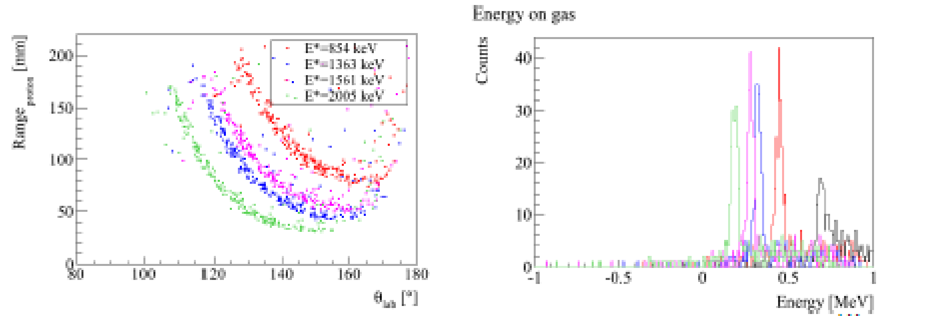


Fig. 5: Reconstructed kinematics plot for the different excited states populated in ^{133}Sn for protons stopped in the gas at a pressure of 400 mbar. Note that the majority of protons populating the ground state escape the gas and the resolution is thus slightly degraded.

Stopped in gas: ~ 110 keV FWHM res

ACTAR + Si wall

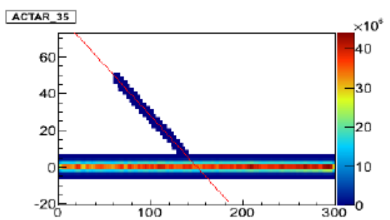
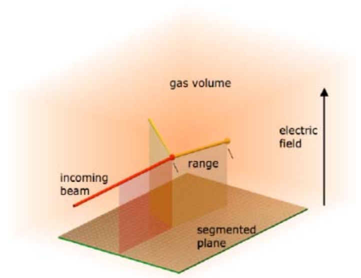


Fig. 4: Sample digitized trace for a ^{132}Sn(d,p) reaction with 2x2mm^2 sized pads. The red line corresponds to the fitted trajectory used for determining the range of the proton.



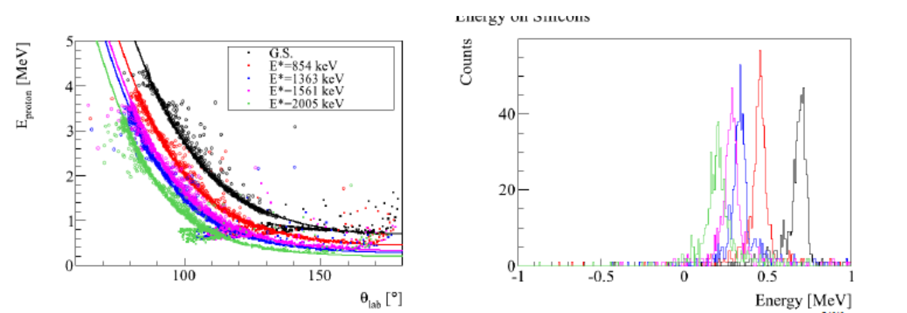


Fig. 6: Reconstructed kinematics plot for the different excited states populated in ^{133}Sn for protons stopped in the Si detectors (open circles) and stopped in the gas (closed circles).

^{132}Sn(d,p)^{133}Sn @ 5 AMeV
400 mbar D_2

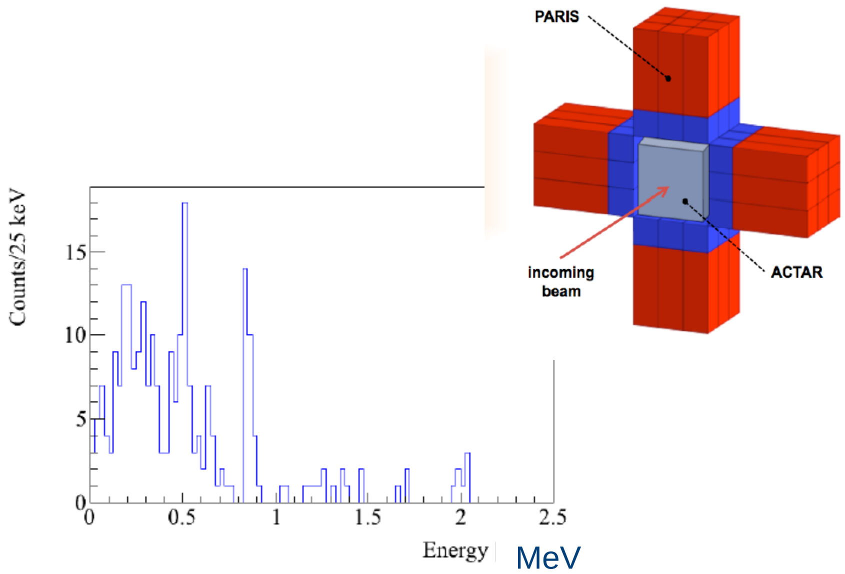
Gas-Si (ΔE-E): ~ 90 keV FWHM res

[D..Perez-Loureiro and G.F.Grinyer, ACTARsim Report (2013)]

Improving resolution with gamma-ray detectors

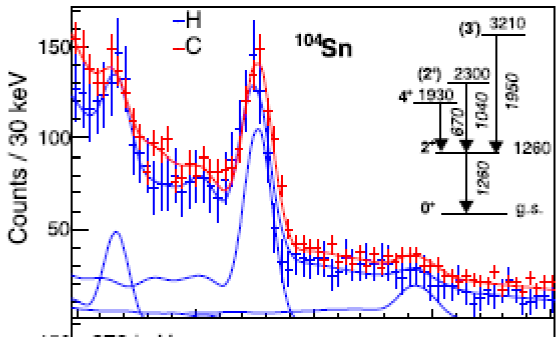
- γ-rays in PARIS-like detectors
from population of 854, 1363, 2005 keV states in ^{133}Sn

- Statistics corresponding to 2 days of beam time at 10^3 pps (total cross section 10 mb, photopeak eff 17%)



Issue: might reduce global efficiency

Further steps… (p,p')



[A. Corsi et al, PLB 743 (2015) 451]

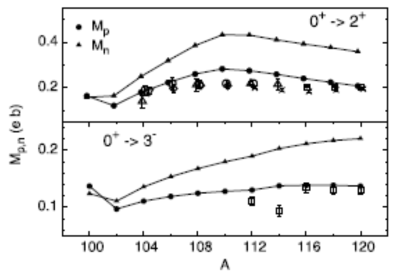
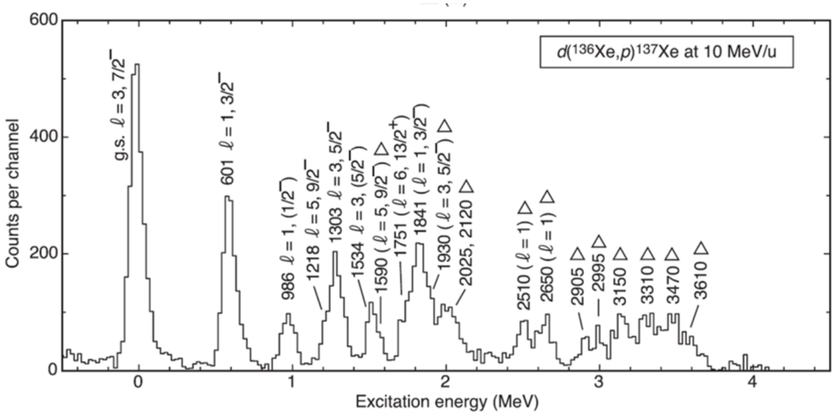


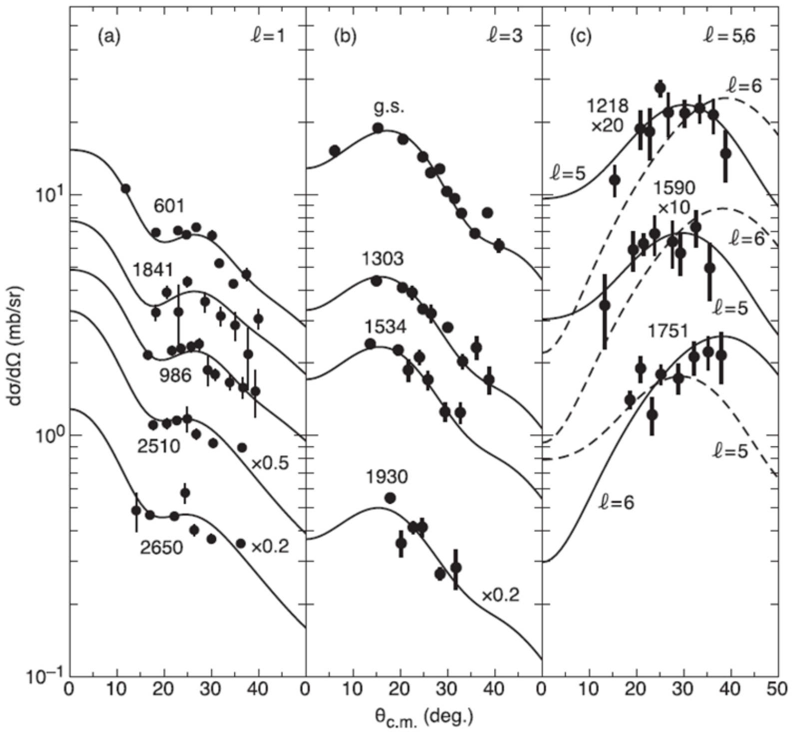
Fig. 4. M_p (•) and M_n (▲) from QRPA calculations with the Gogny D1M interaction compared to experimental M_p (▽: RIKEN [14], ○: NSCL [9,13], ×: GSI Doppler Shift Attenuation Method [34], △: GSI Coulomb excitation [6,10–12], ◇: ISOLDE [7,8], □: NNDC [28]). Top: 2_1^+. Bottom: 3_1^-. Experimental M_n values are taken from the literature [22].

Getting ready for RIBs: MT implementation

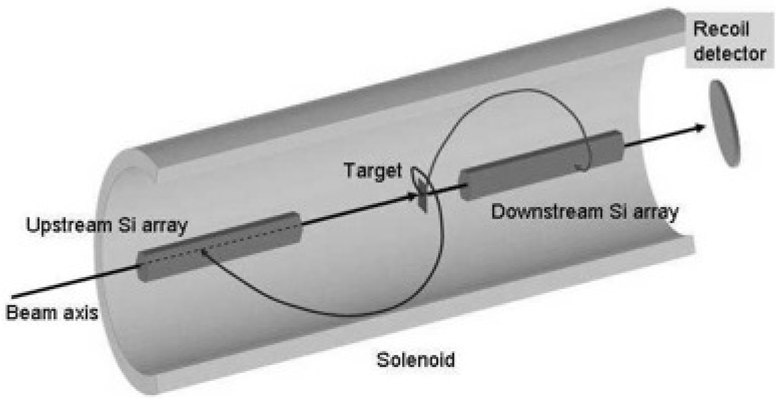
MagicTin*

Benchmark: ^{136}Xe(d,p)^{137}Xe - inv kinem

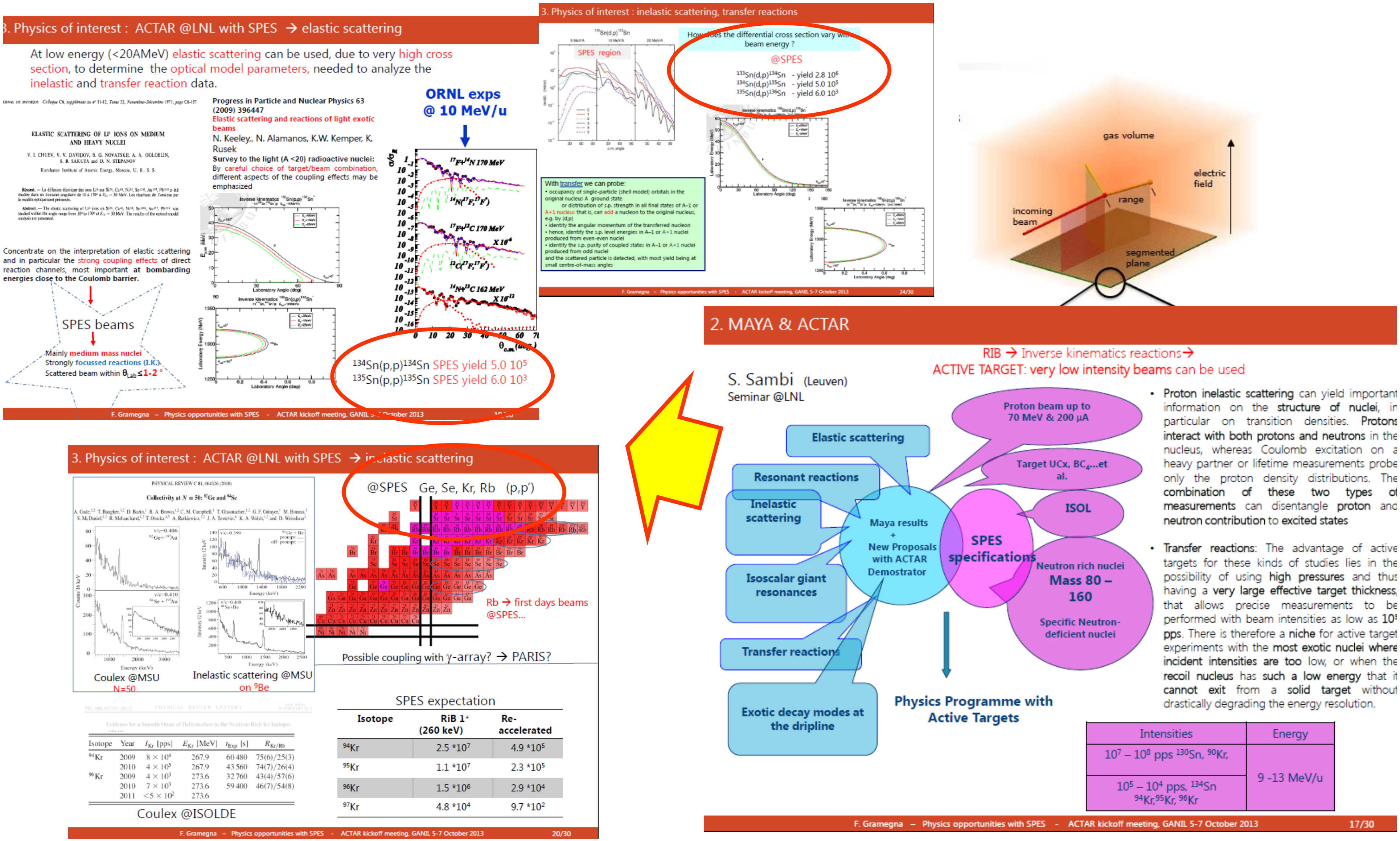




B.P. Kay et al, PRC 84 0243325 (2011)
HELIOS @ ANL

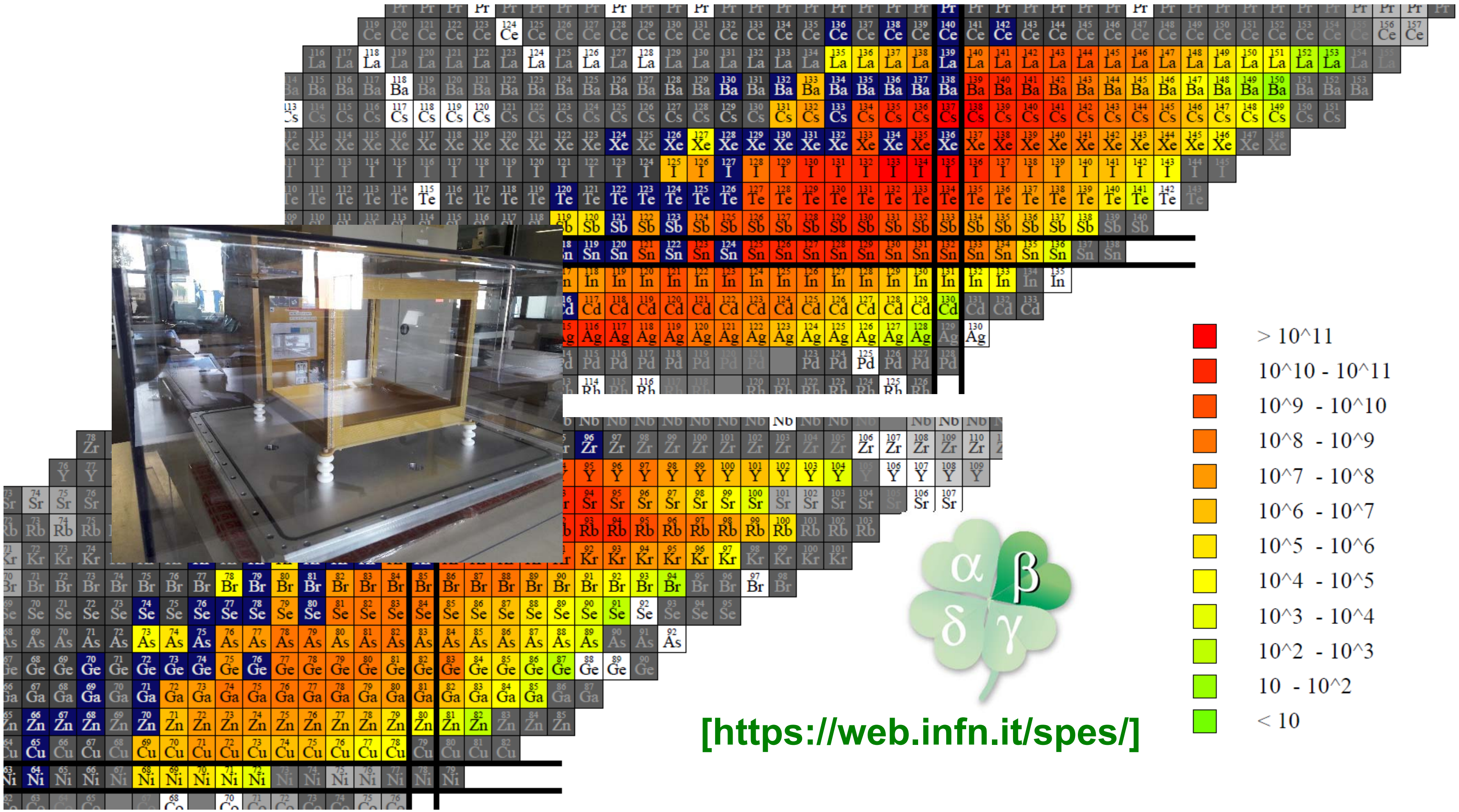


Beyond MagicTin: physics opportunities with an active target at SPES



[F. Gramegna, ACTAR TPC Kickoff meeting 2013]

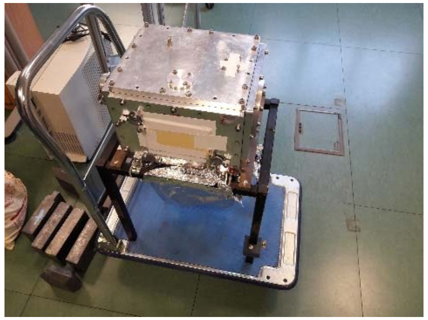
Beyond MagicTin: physics opportunities with an active target at SPES



[https://web.infn.it/spes/]

Two letters of intent for SPES endorsed by the SAC:
B. Fernandez Dominguez et al, Direct Reactions with exotic nuclei in the r-process using an active target
R. Raabe, T. Marchi et al, Shell Structure in the vicinity of ^{132}Sn with an active target

Ongoing activities and plans



Actar demonstration installation at LNL

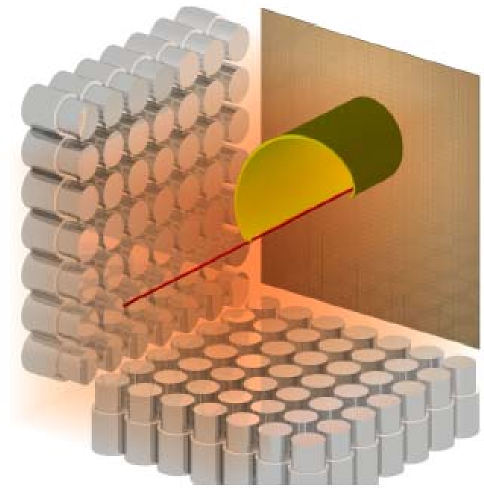
- Detector setup in the lab
- Runs with low energy beams at CN
- Energy loss measurement in different gases

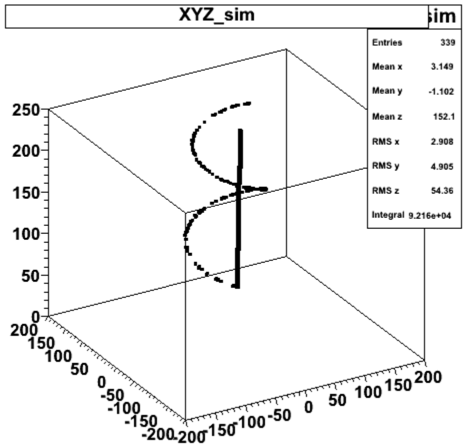
Further detector R&D with heavy ions at 10 AMeV (proposal submitted to LNS PAC)

Infrastructure - Setting up a new experimental area for SPES

- Clearing out and cleaning up
- Services
- New beamline installation
- Setup installation

Outlook

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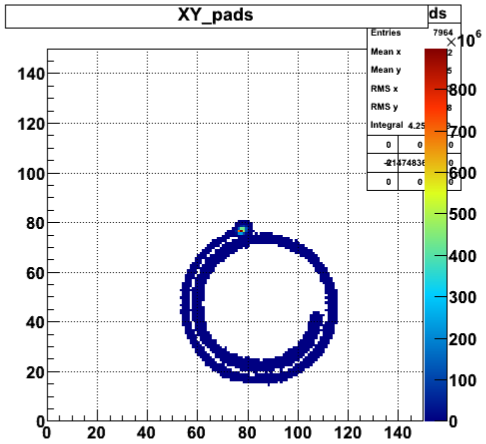
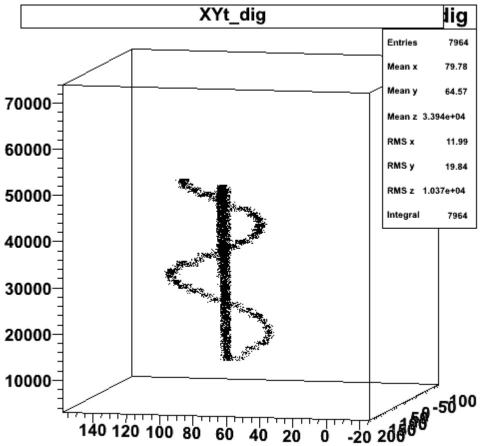
Entries 339
Mean x 3.149
Mean y -1.102
Mean z 152.1
RMS x 2.908
RMS y 4.905
RMS z 54.36
Integral 9.216e+04


XY_pads


XYt_dig
Entries 7964
Mean x 79.78
Mean y 64.57
Mean z 3.394e+04
RMS x 11.99
RMS y 19.84
RMS z 1.037e+04
Integral 7964

ENSAR2 Network Activity: Gas Detection Systems

W.P. Leader: T. Roger (GANIL)
Deputy Leader: F. Gramegna (LNL)

Task 1: … gather together the GDS community …

4 topical meetings

Task 2: GDS in strong and non-uniform magnetic fields

Task 3: Novel detection systems for high-intensity and heavy beams
January 2018 at USC - Santiago De Compostela

Task 4: Rare gas target handling and recycling systems

Task 5: Auxiliary detectors

Exp setup

The GARFIELD array

The Active Target for SPES

SPES-β

Low energy experiments

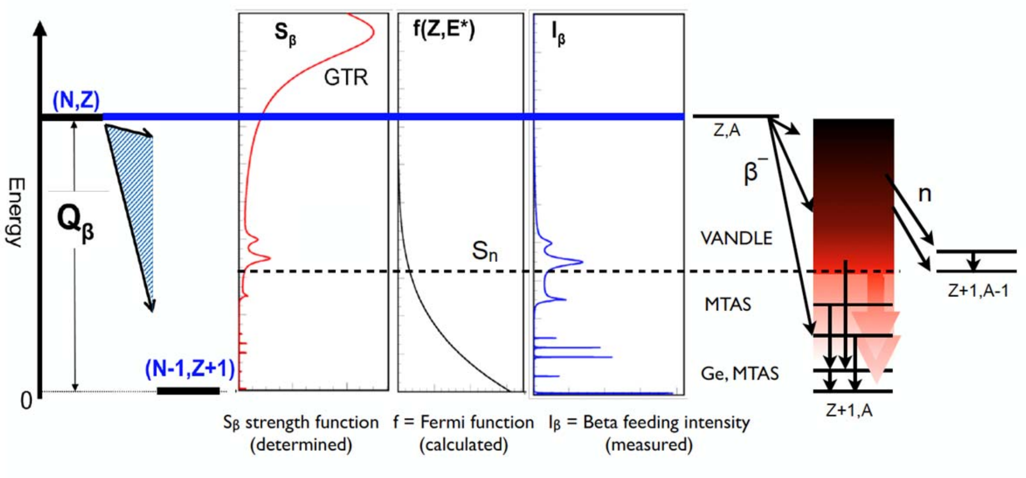
The tape station for beam diagnostics

T. Marchi, 21 Nov 2017

LNL User Group Meeting

1+ area (A13) mainly devoted to β-decay related studies

- Study of β decay properties ($T_{1/2}$, P_n, BR, S_β…..)
  - ➔ strong link to astrophysics
  - ➔ inputs for r- and s-process
- Study of nuclear structure complementing data coming from
  - ➔ selective tool
  - ➔ egs. Study of shape coexistence and exotic shapes
  - ➔ evolution of magic numbers
- Exotic decay modes: PDR via β decay
- Fundamental questions: CKM unitarity via study of super-allowed decays



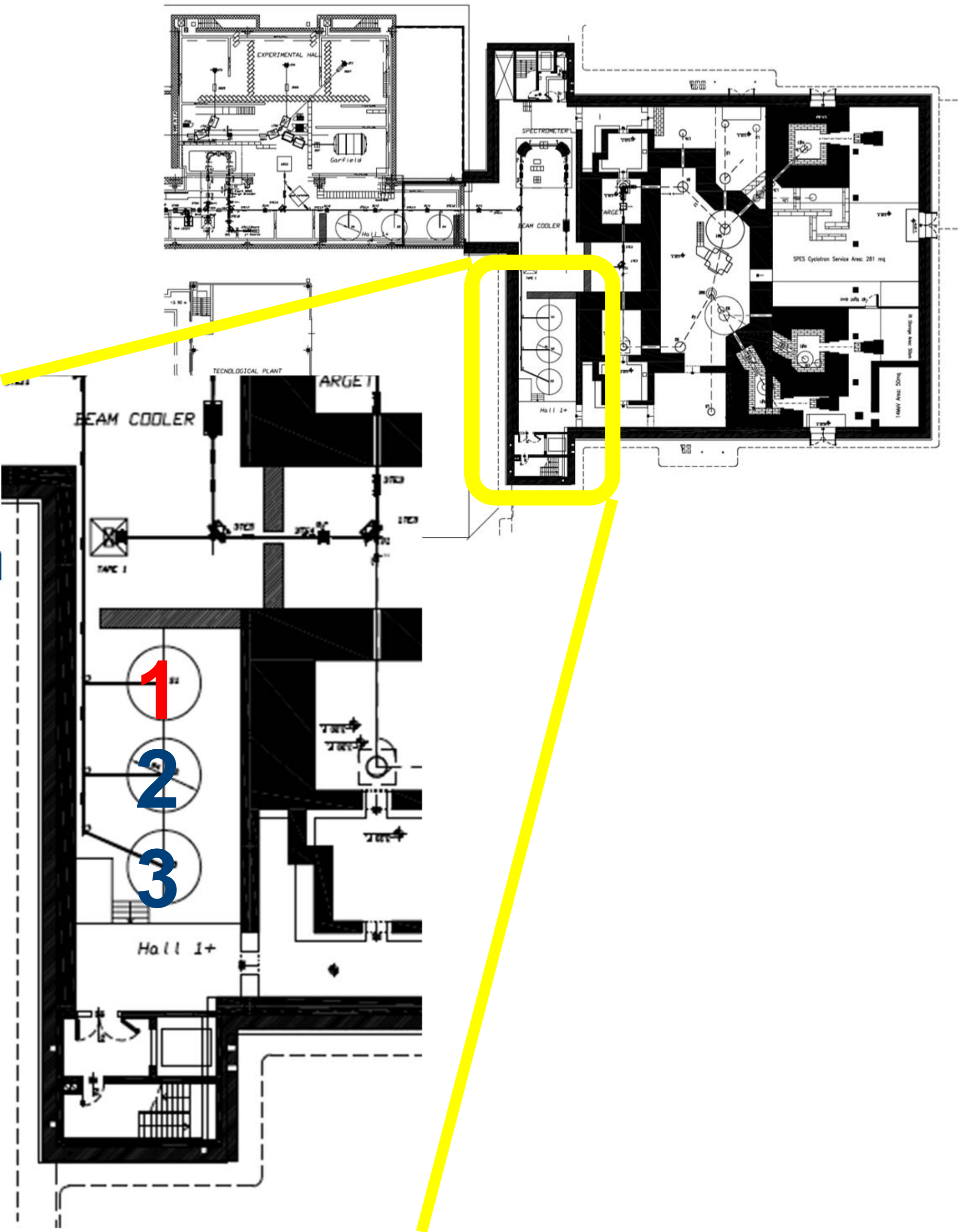
Going away from stability we have access to larger part of the decay strength

Study group for 1+ installation: M.Cinausero, G.Benzoni, D.Scarpa, T. Marchi, F. Gramegna

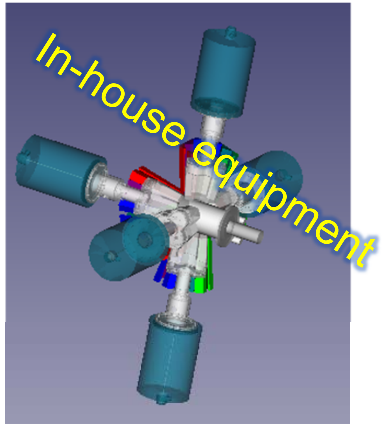
1+ area (A13)

3 main installations:

1-Beam diagnostic Tape station
2- β-decay station
+ E0 measurement
+ VANDLE/3HEN
3- MTAS (Oak Ridge)

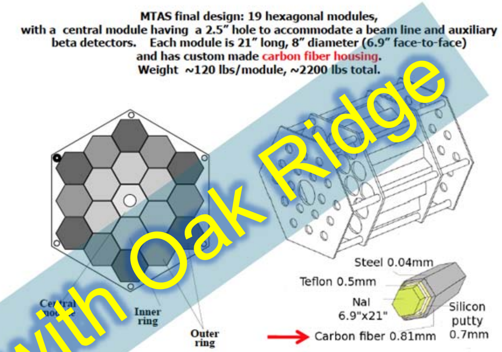


Proposed setups for β decay studies

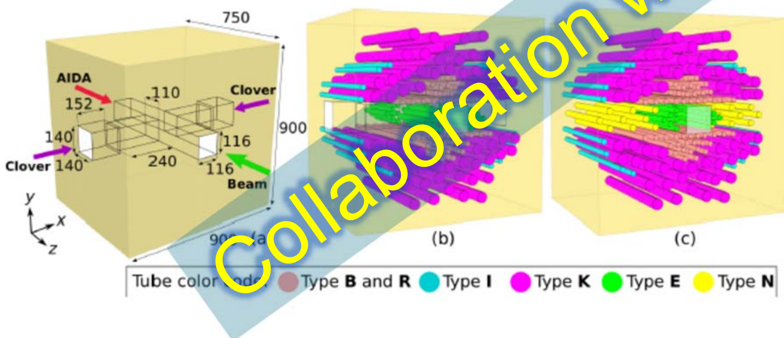


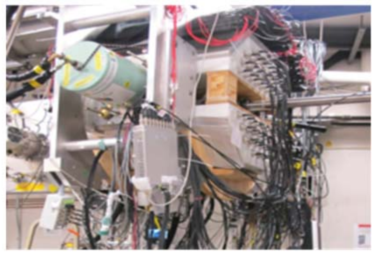
- SPES β decay station (β–DS)
  - o Plastic β detectors, covering large solid angle
  - o HPGe detectors (Galileo triple clusters)
  - \+ LaBr3(Ce)
  - \+ second decay chamber for E0 measurements (collaboration with INFN-Firenze and Universita' di Camerino)

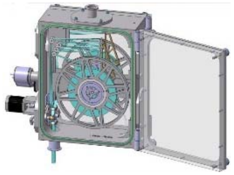
- **M**odular**T**otal**A**bsorption**S**pectrometer:
  - NaI covering 4π
  - Single crystal HPGe
  - β detector



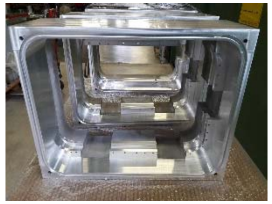
- 3Hen:
  - 3He tubes
  - Single crystal HPGe
  - β detector

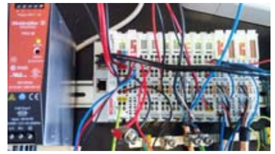






SPES β decay station (β–DS)





- Cassette design adapted from BEDO @ ALTO
- Common element to beam diagnostic installations (STS1-STS2)
- Realization: LNL + Milano INFN Mechanical workshops
- Low level controls developed together with IThemba-LABS (South Africa)
- High level developed by electronic workshop in LNL

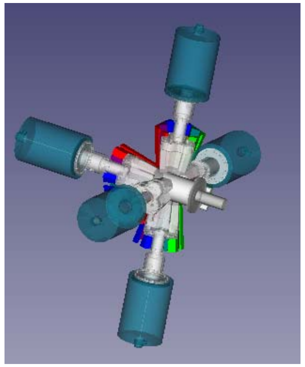
➔ Delivery and commissioning Summer/Fall 2017

- Simulations for β and γ detectors:

  Simulated efficiency with the Co-60 in the center: 7.0% @ 1332 keV
  Simulated P/T: 51.0 %
  Simulated β efficiency: 70%

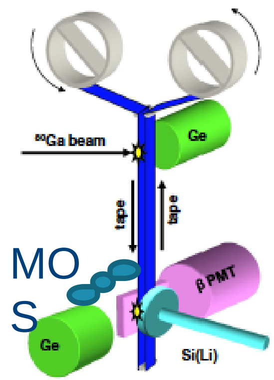
- Design of the setup (Milano)
- Design of MOS and 2nd decay chamber (Milano/Camerino/Firenze)

➔ Delivery in 2019



1st decay chamber

2nd decay chamber



Joint collaboration with **LNL + INFN-Mi** + **ALTO Orsay** (France) + **iThemba-Labs** (South Africa) for mechanics/electronics/controls

STS – SPES TAPE STATION

Mechanics

Cassette: Design completed (IPN Orsay)
Cassette: Production completed (INFN-LNL INFN-MI)
Cassette: Assembly and test in progress (LNL/MI/IPNO)
Scattering Chamber: Design started (LNL)

Motion and Control

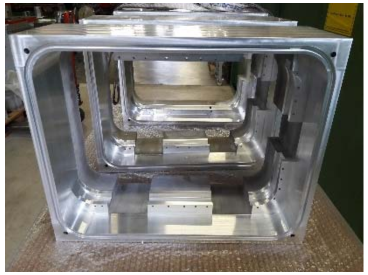
Beckhoff Hardware purchased
Beckhoff Driver for EPICS system: test bench OK (iThremba/LNL)
High level EPICS software: in progress (LNL)

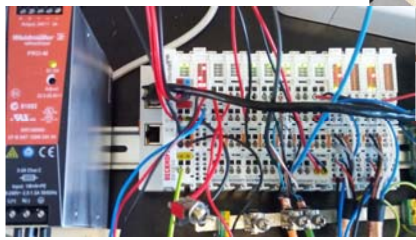
Data Acquisition

ALL Hardware purchased (CAEN+WIENER+Servers+PC)
EPICS compatible acq software: in progress (INFN-NA / LNL)

Detectors

3 HPGe detectors purchased (n-type, C window. Canberra - REGe)
β-counter design in progress





Documentation

STS Project description delivered. DOC_00000050
Detailed design documentation in preparation
Safety assessment with PILZ performed. Reply with partial corrections submitted. No major issues identified.
CE certification might be needed for the machine.