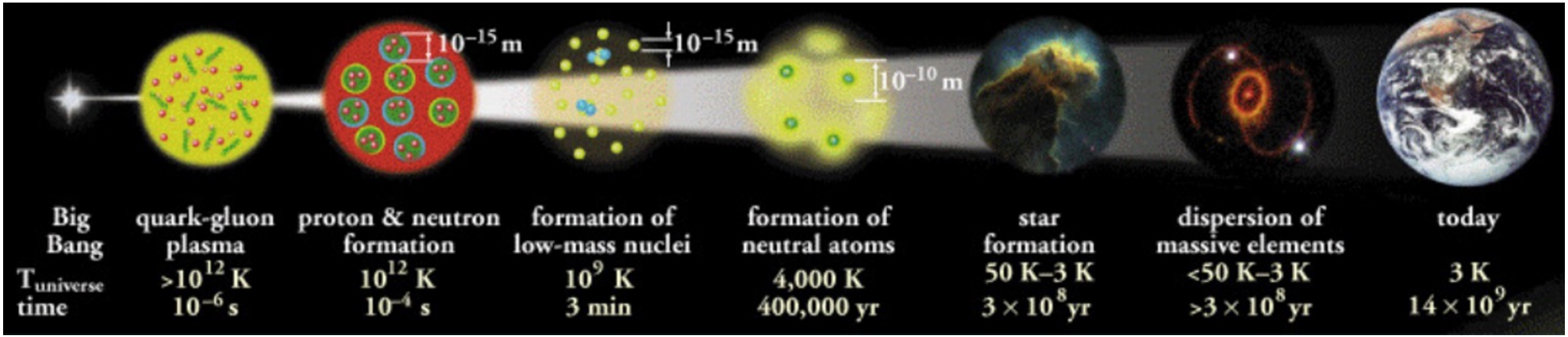
The *ILL journey* : nuclear structure with neutrons

Caterina Michelagnoli, Institut Laue-Langevin - Milano, 18/10/2024 - Auguri!!!

The "*Universe Essentials*"

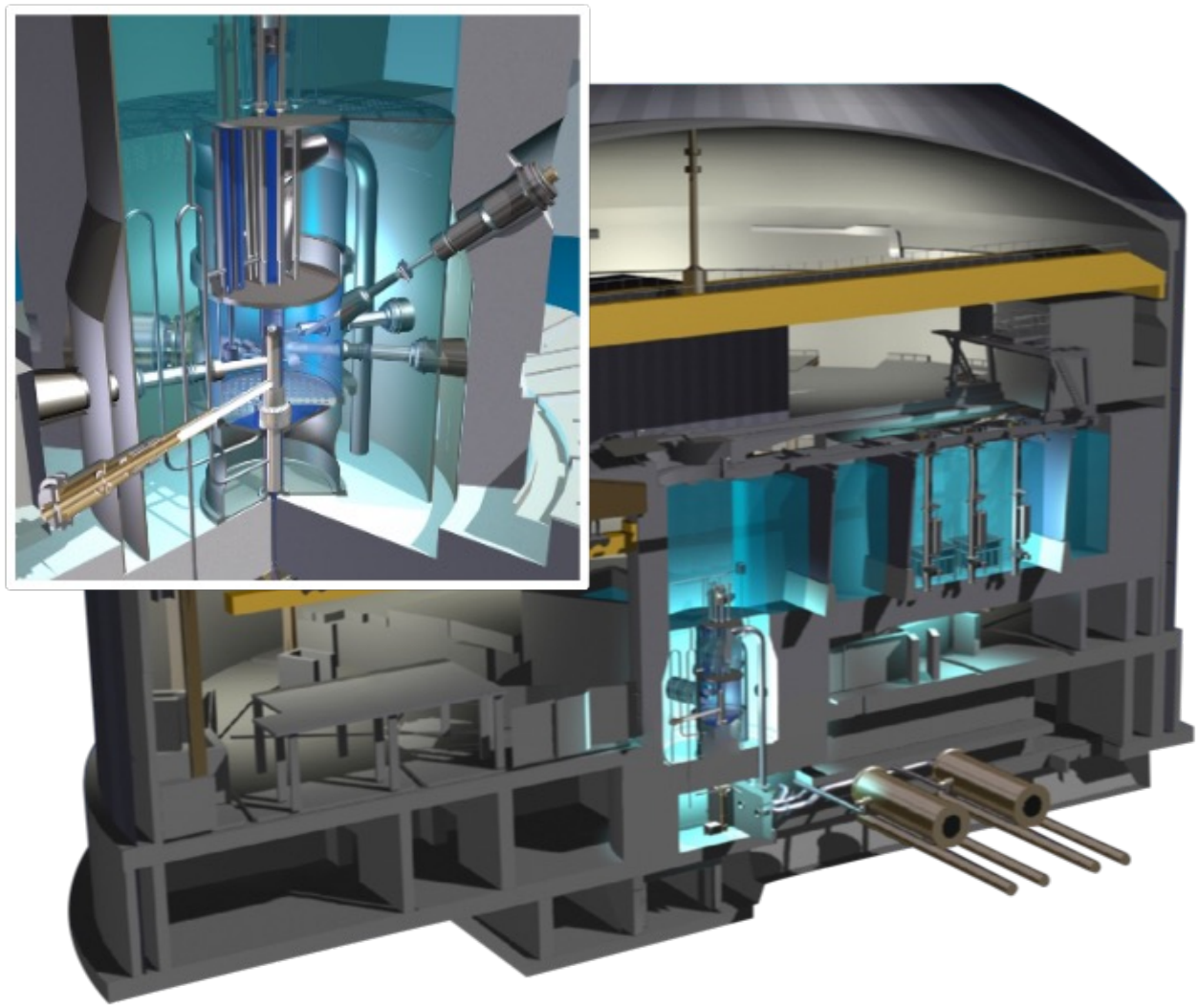


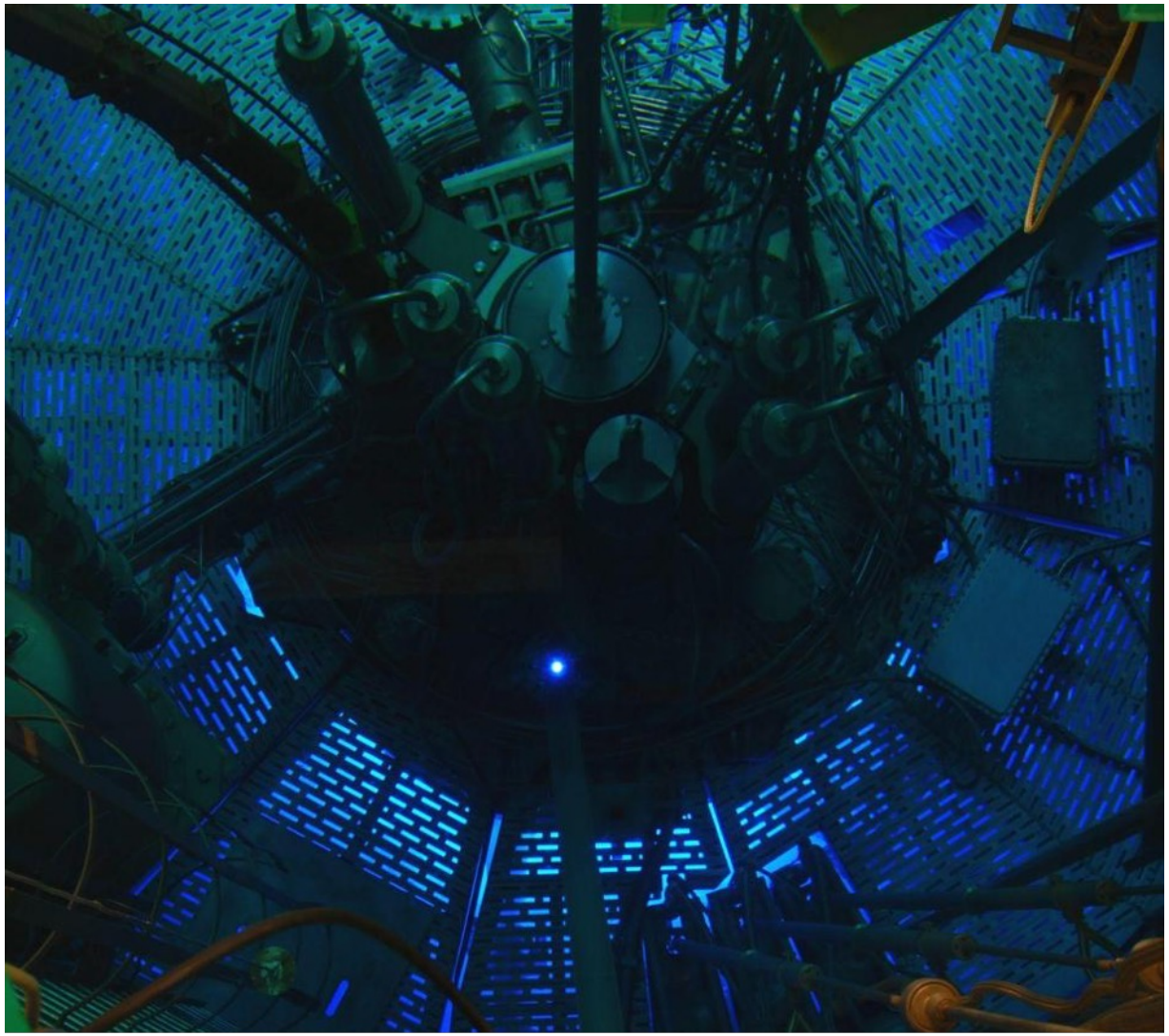
Particle Physics → Nuclear Physics → Applications

precision vs discovery frontiers

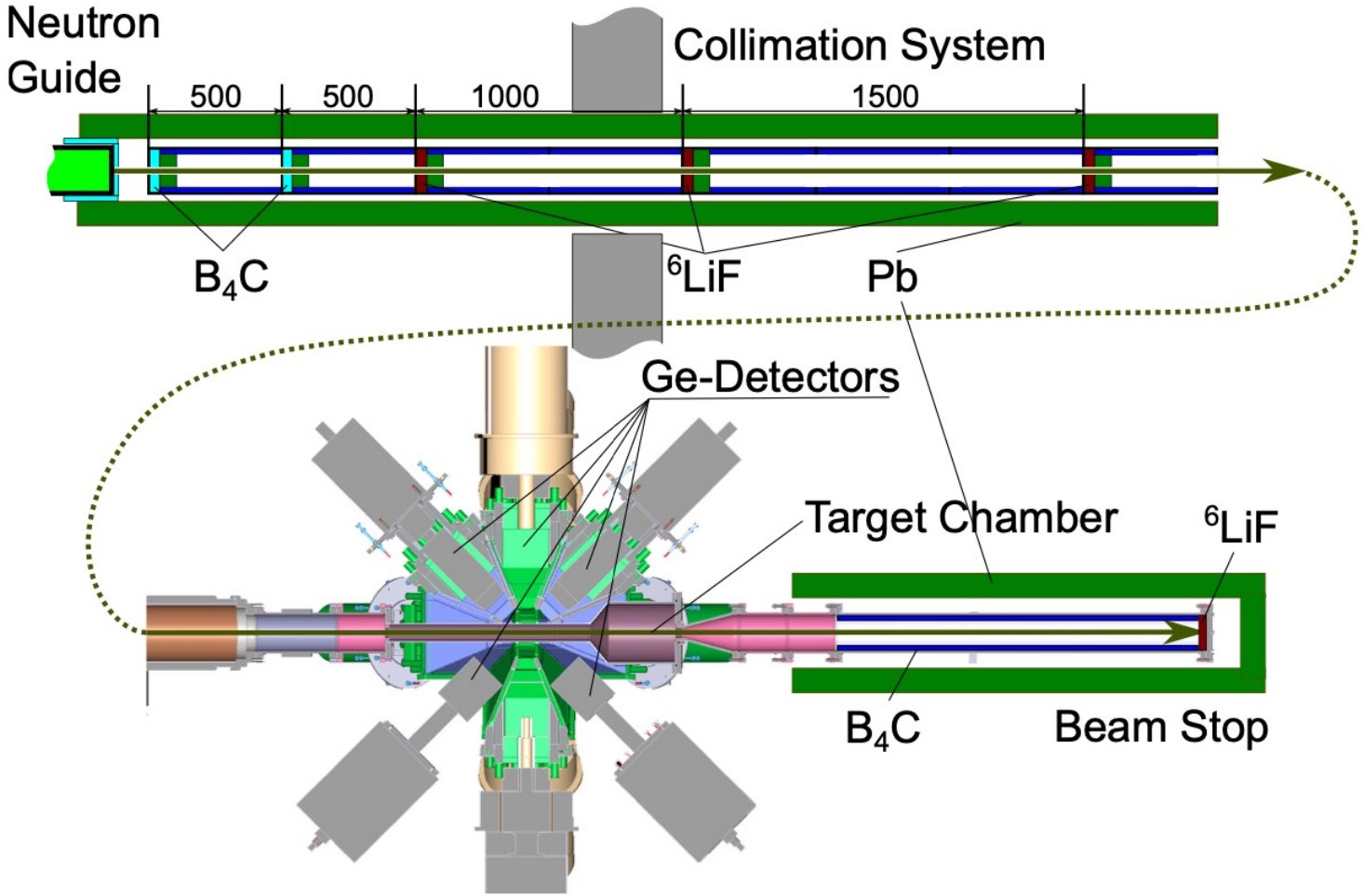
different probes, different methods, different laboratories world-wide

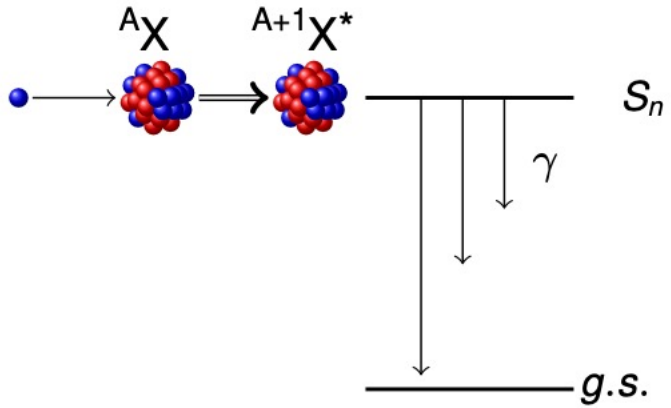
The ILL reactor





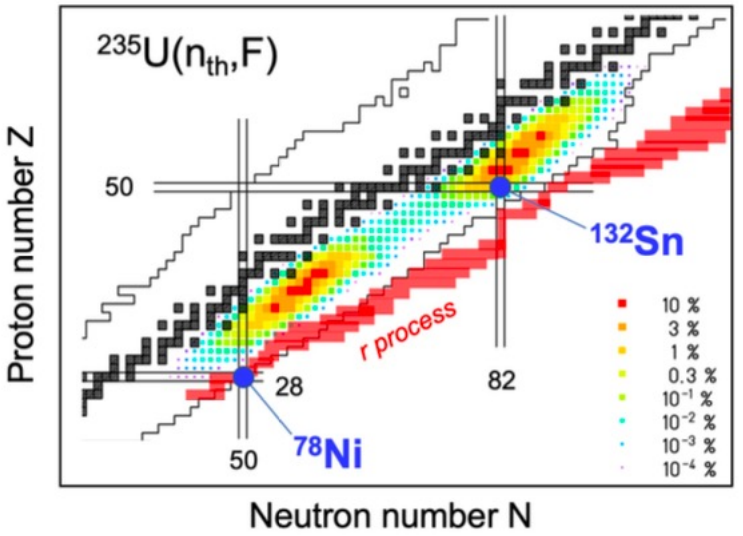
EXogam@ILL campaign



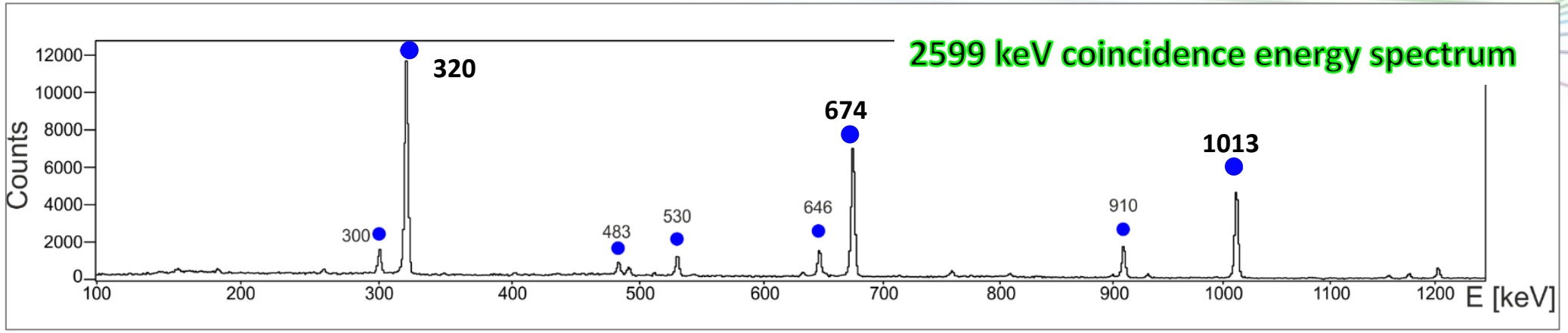


$^{27}Al(n,\gamma)$: σ=0.2 b; ^{157}Gd: 2.5 10^5b

^{235}U: σ_f=585 b; ^{245}Cm: σ_f=2141 b



M. Jentschel et al 2017 JINST 12 P11003



4605

New γ transitions placed in complex level scheme through coincidence analysis of high resolution data

2599

1013

674

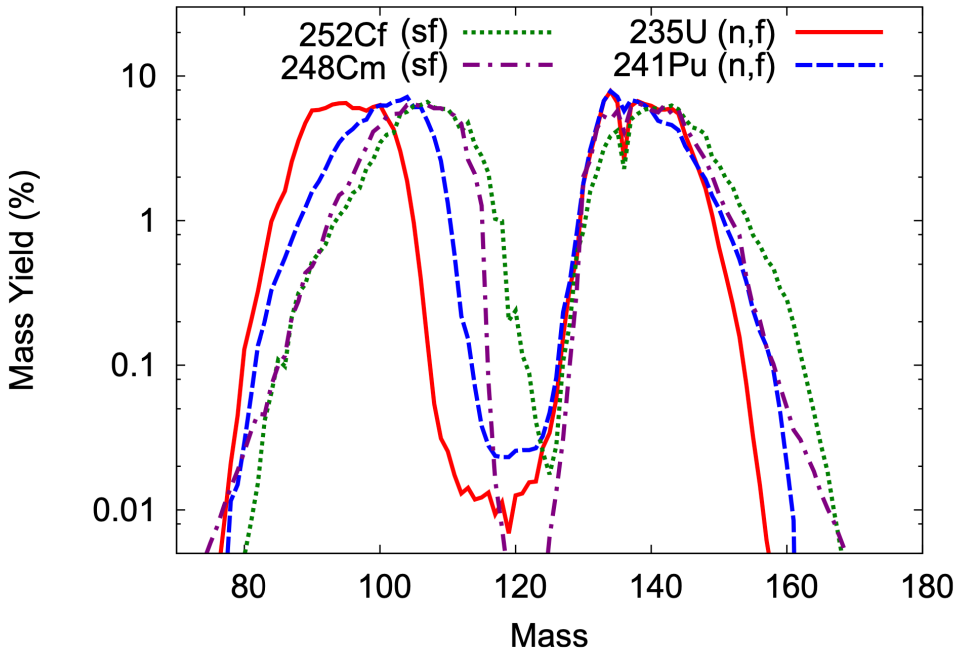
320

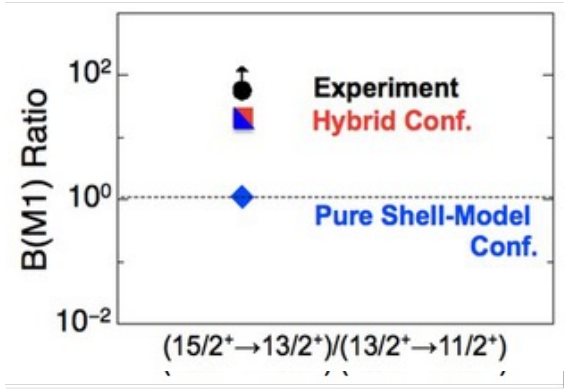
0

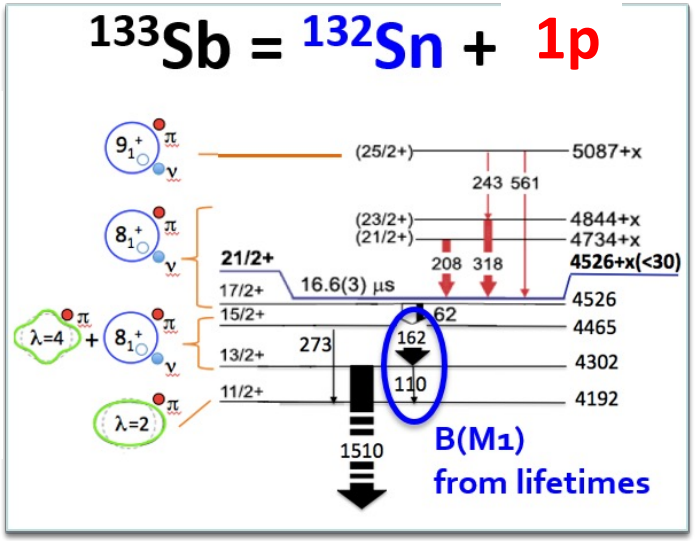
^{210}Bi

N. Cieplicka-Orynczak et al., PRC 93 (2016) 054302

Particle-core excitations in ^{133}Sb





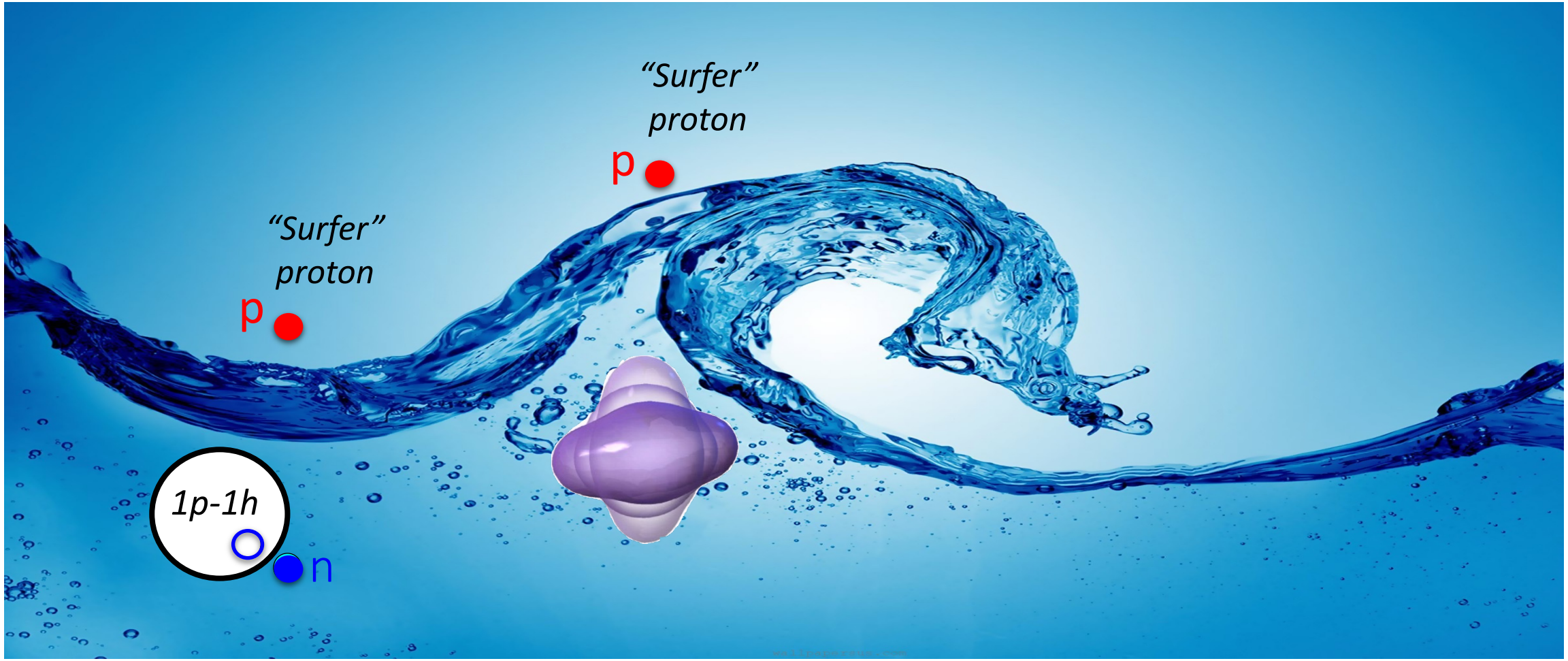


^{132}Sn core excitations are very relevant.

New microscopic model, starting point for new investigations in medium/heavy nuclei

G. Bocchi et al., PLB 760 (2016) 273

The proton catching the wave of the phonon

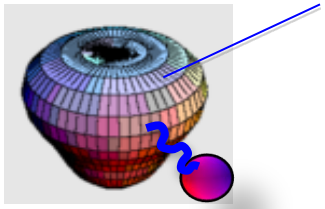


Courtesy of B. Fornal

In NUCLEI

Particle-Phonon Couplings

Coupling between
Particles and Core Vibrations



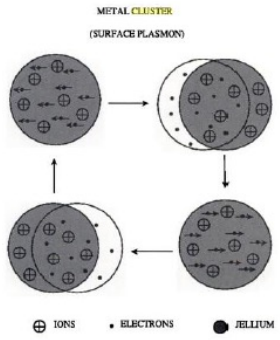
Key Ingredient for:

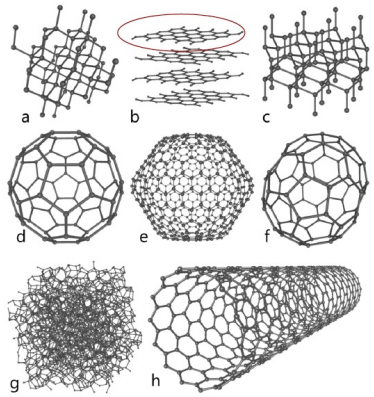
- Anharmonicity of vibrational spectra
- Damping of Giant Resonances
- Quenching of Spectroscopic Factors, …

In CONDENSED MATTER

Electron-Phonon Couplings

Coupling between
Electrons and plasmons and phonons





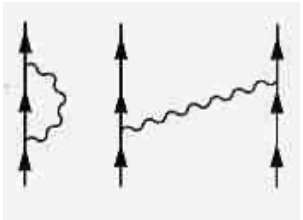
Key Ingredient for:

- Electromagnetic Response
- Superconductivity

in Metal Clusters, Fullerenes, …

Common many-body diagrammatic techniques

Different energy scales …

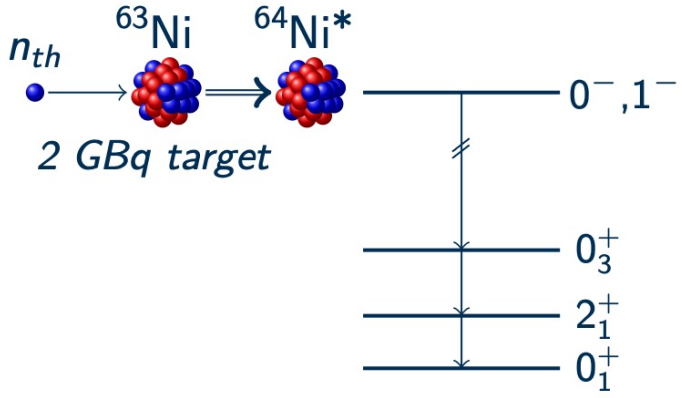


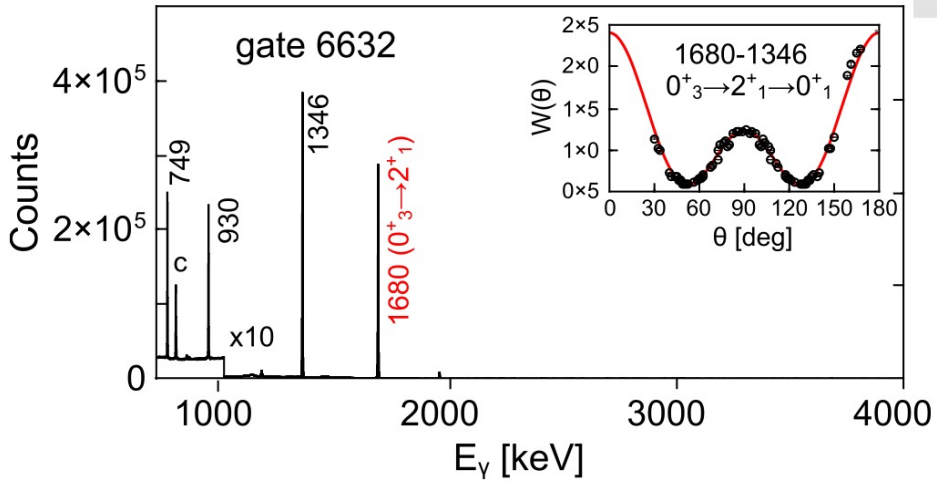
6th Workshop
on Nuclear Fission
and Spectroscopy
of Neutron-Rich Nuclei
(FISSION 2017)

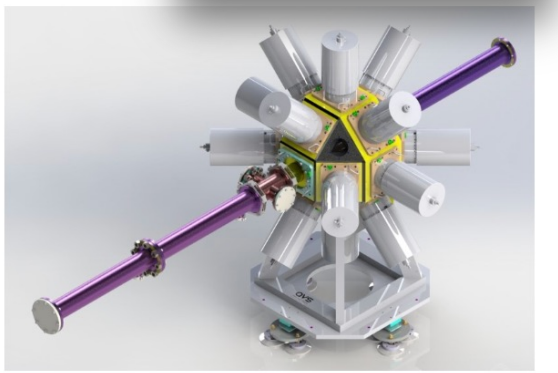
20-24 March 2017
Chamrousse, France

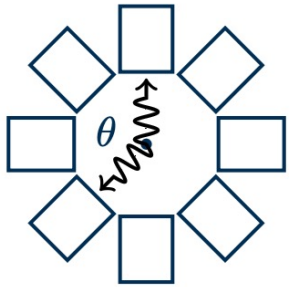
EPJ Web of Conf.

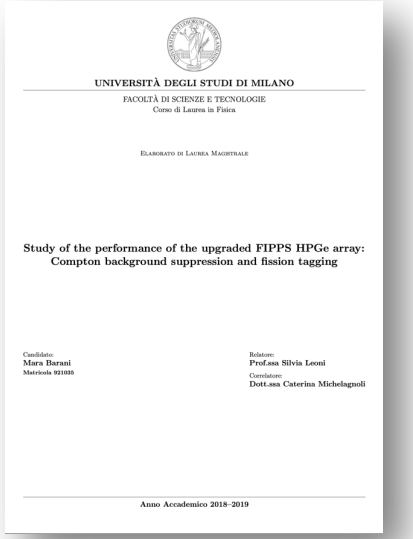
FIPPS+IFIN @ ILL











UNIVERSITÀ DEGLI STUDI DI MILANO

FACOLTÀ DI SCIENZE E TECNOLOGIE

Corso di Laurea in Fisica

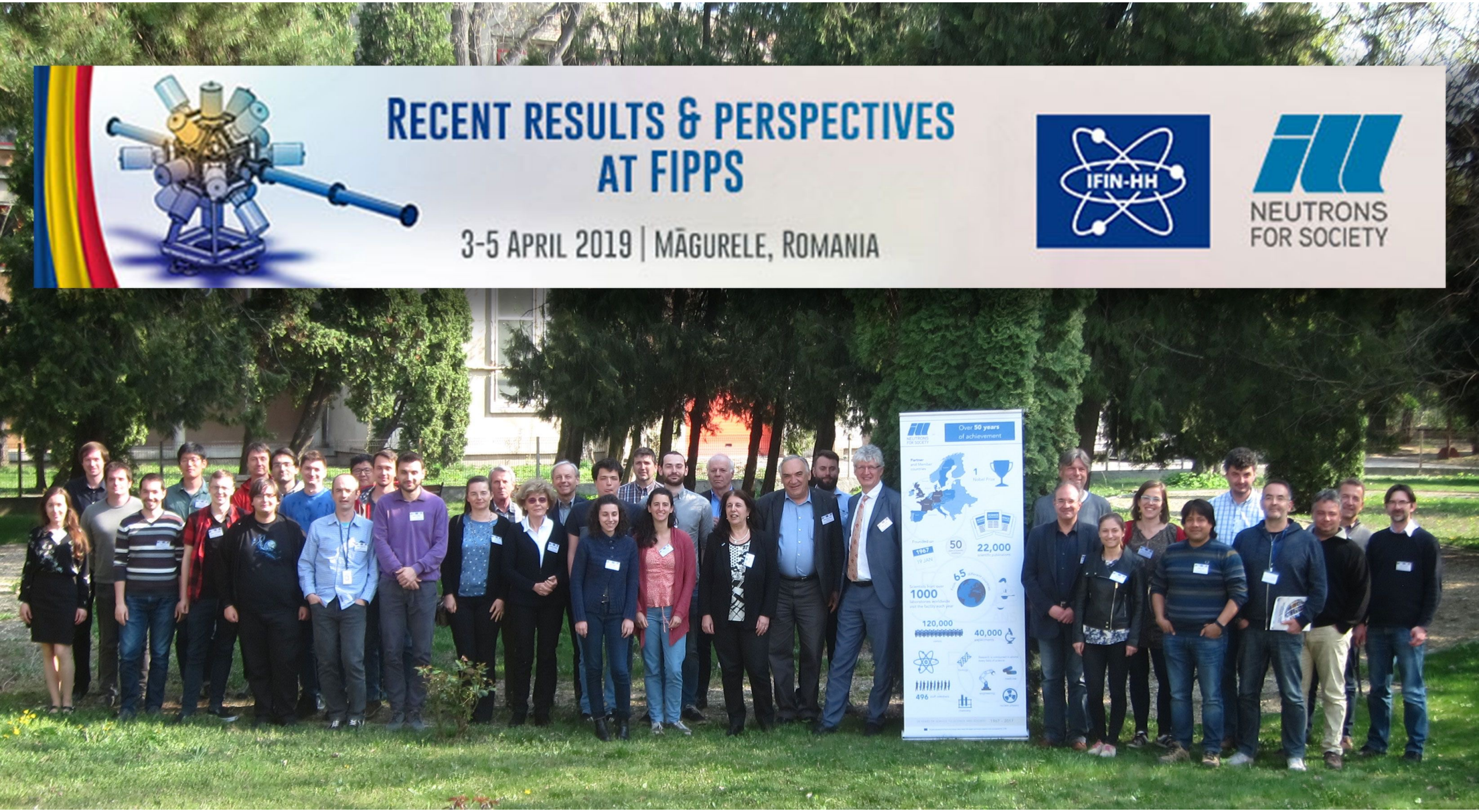
Elaborato di Laurea Magistrale

Study of the performance of the upgraded FIPPS HPGe array: Compton background suppression and fission tagging

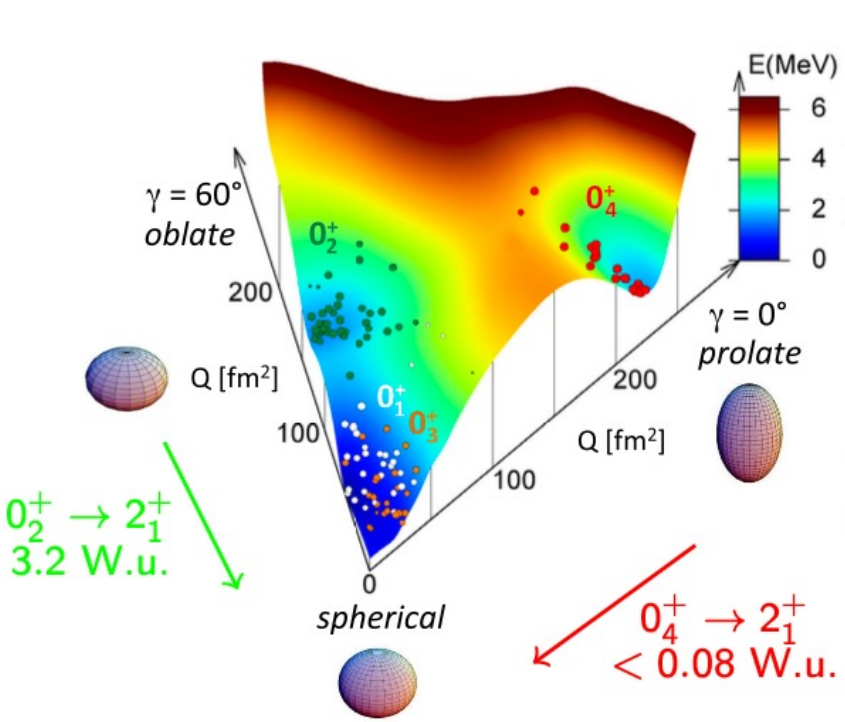
Candidato:
Mara Barani
Matricola 921035

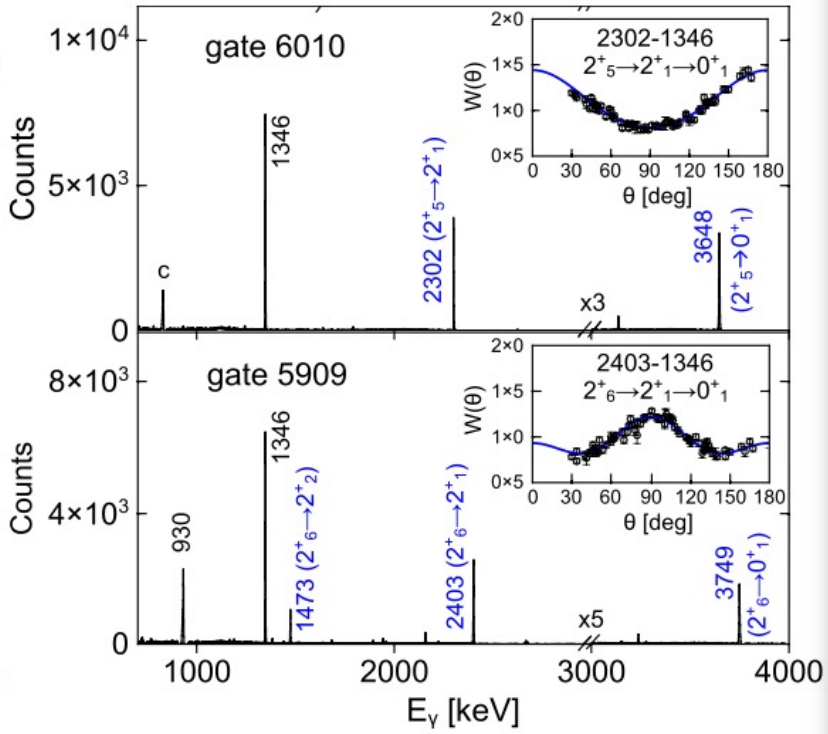
Relatore:
Prof.ssa Silvia Leoni
Correlatore:
Dott.ssa Caterina Michelagnoli

Anno Accademico 2018–2019

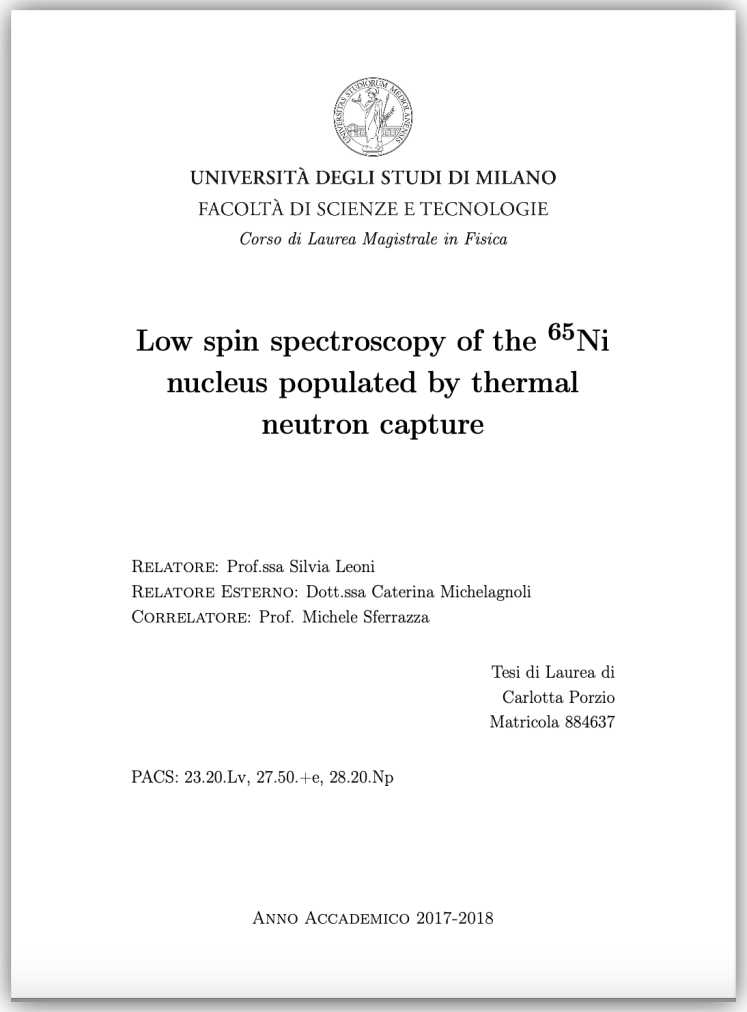

RECENT RESULTS & PERSPECTIVES AT FIPPS
3-5 APRIL 2019 | MĂGURELE, ROMANIA
IFIN-HH
NEUTRONS FOR SOCIETY
Over 50 years of achievement
1
50
22,000
1000
120,000
40,000
496

Shape coexistence at zero spin in Ni isotopes





Adapted from N. Marginean at al., Phys. Rev. Lett. 118 (2017) 162502



UNIVERSITÀ DEGLI STUDI DI MILANO
FACOLTÀ DI SCIENZE E TECNOLOGIE
Corso di Laurea Magistrale in Fisica

Low spin spectroscopy of the ^{65}Ni nucleus populated by thermal neutron capture

RELATORE: Prof.ssa Silvia Leoni
RELATORE ESTERNO: Dott.ssa Caterina Michelagnoli
CORRELATORE: Prof. Michele Sferrazza

Tesi di Laurea di
Carlotta Porzio
Matricola 884637

PACS: 23.20.Lv, 27.50.+e, 28.20.Np

ANNO ACCADEMICO 2017-2018

C. Porzio et al., Phys. Rev. C 102 (2020) 064310

Structure of rare-earth nuclei: the case of ^{161}Gd

Rare-earth nuclei (Dy, Gd, Eu, ...)

Nuclear structure between Z=50 and Z=126

Single-particle orbitals in deformed potential

Scissor modes

Very complex level scheme

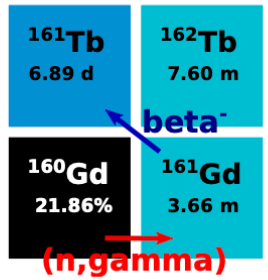
^{161}Gd (Z=64, N=97)

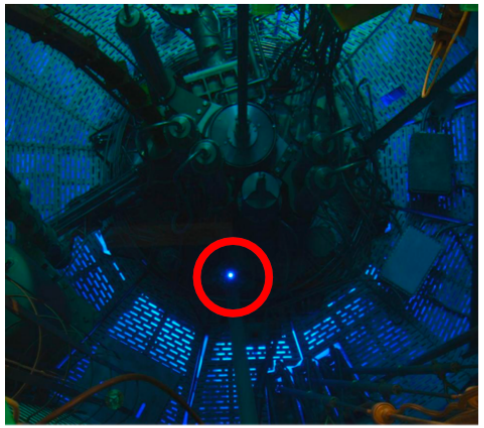
Close to N=90 ”questioned” magic number

Medical interest (^{161}Tb production)

Only few excited states are known

^{160}Gd(n,γ)^{161}Gd $\Leftrightarrow$ highly isotopically pure target



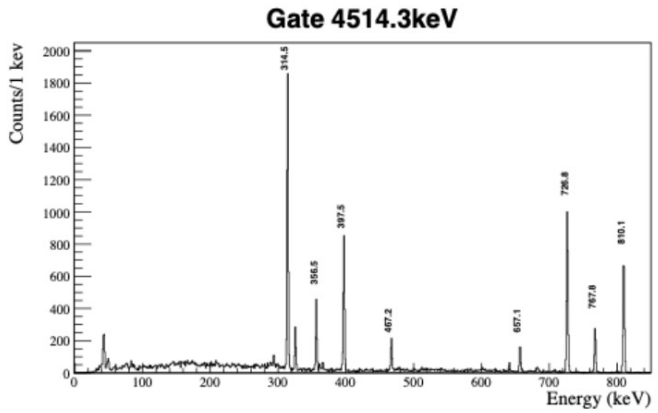


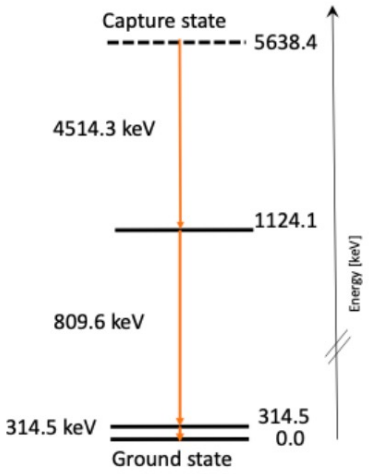
Target produced at the ILL V4 position

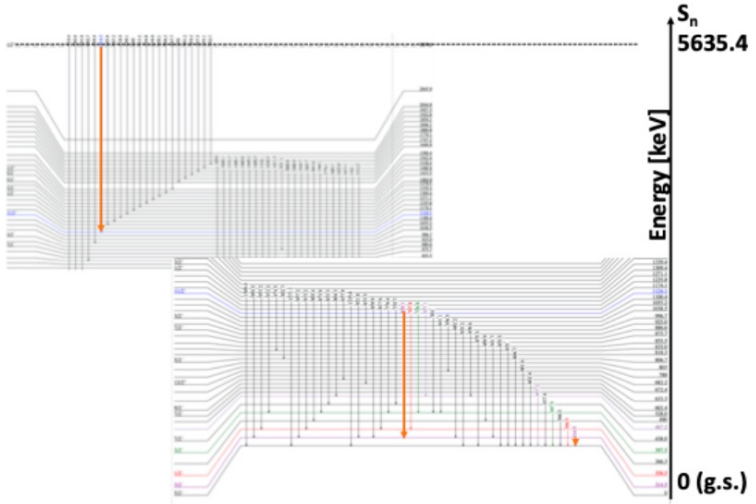
Isotope	σ (b)	A ($\frac{g}{mol}$)	fraction of captures (%)	Compos. (%)
^{155}Gd	60330	155	0.3	$3.3 * 10^{-5}$
^{157}Gd	254000	157	0.8	$4.2 * 10^{-6}$
^{160}Gd	1.4	160	98.9	98.10

A. Saracino, Master Thesis, Univ. Milano ILL

(Almost) complete spectroscopy of ^{161}Gd at low spin



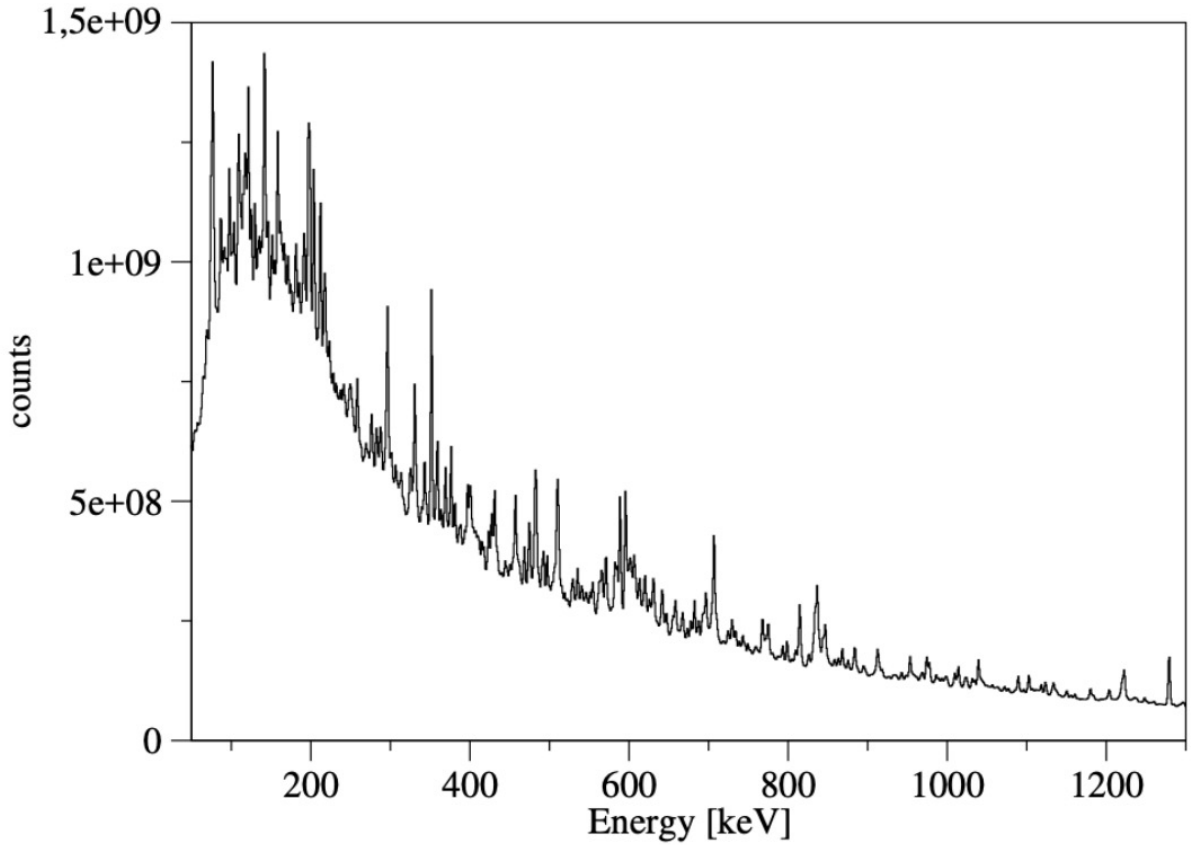


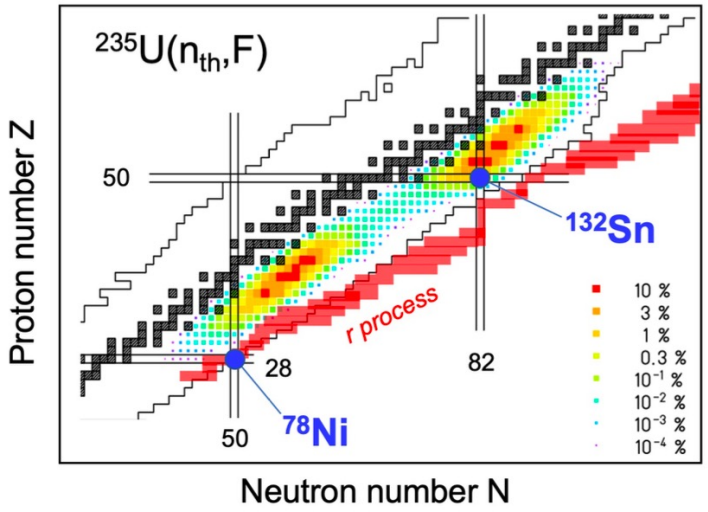


35 new excited levels, 294 new γ transitions found
Performed experiment at IFIN-HH (multinucleon transfer)

A. Saracino, Master Thesis, Univ. Milano ILL; A. Saracino et al., to be submitted to Phys. Rev. C

Challenges in γ spectroscopy of fission fragments





La Rivista del Nuovo Cimento
https://doi.org/10.1007/s40766-022-00033-2

REVIEW PAPER

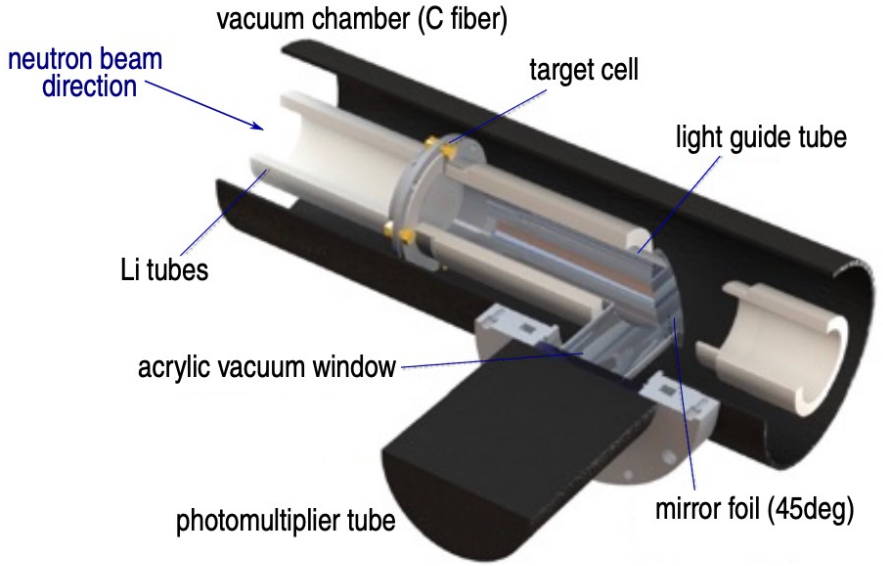
Check for updates

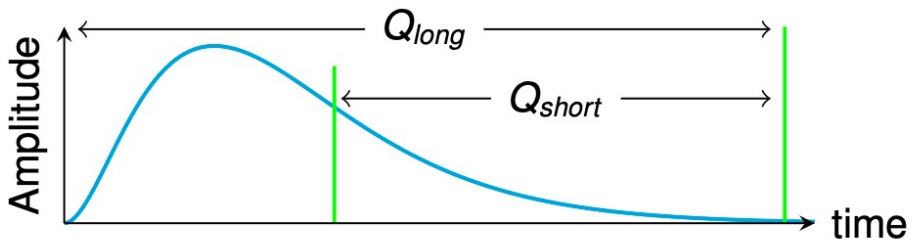
Gamma-ray spectroscopy of fission fragments with state-of-the-art techniques

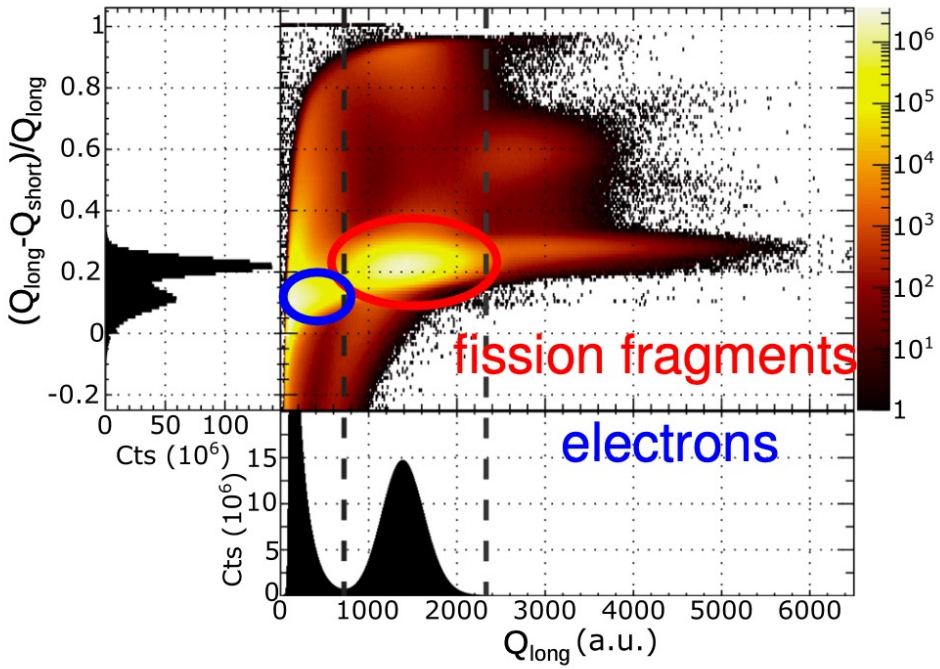
S. Leoni[1,2] · C. Michelagnoli[3] · J. N. Wilson[4]

Received: 21 December 2021 / Accepted: 2 March 2022

Fission challenges and FIPPS Active target

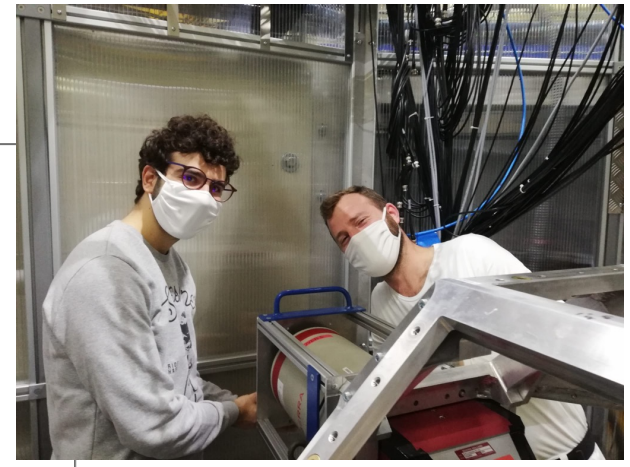


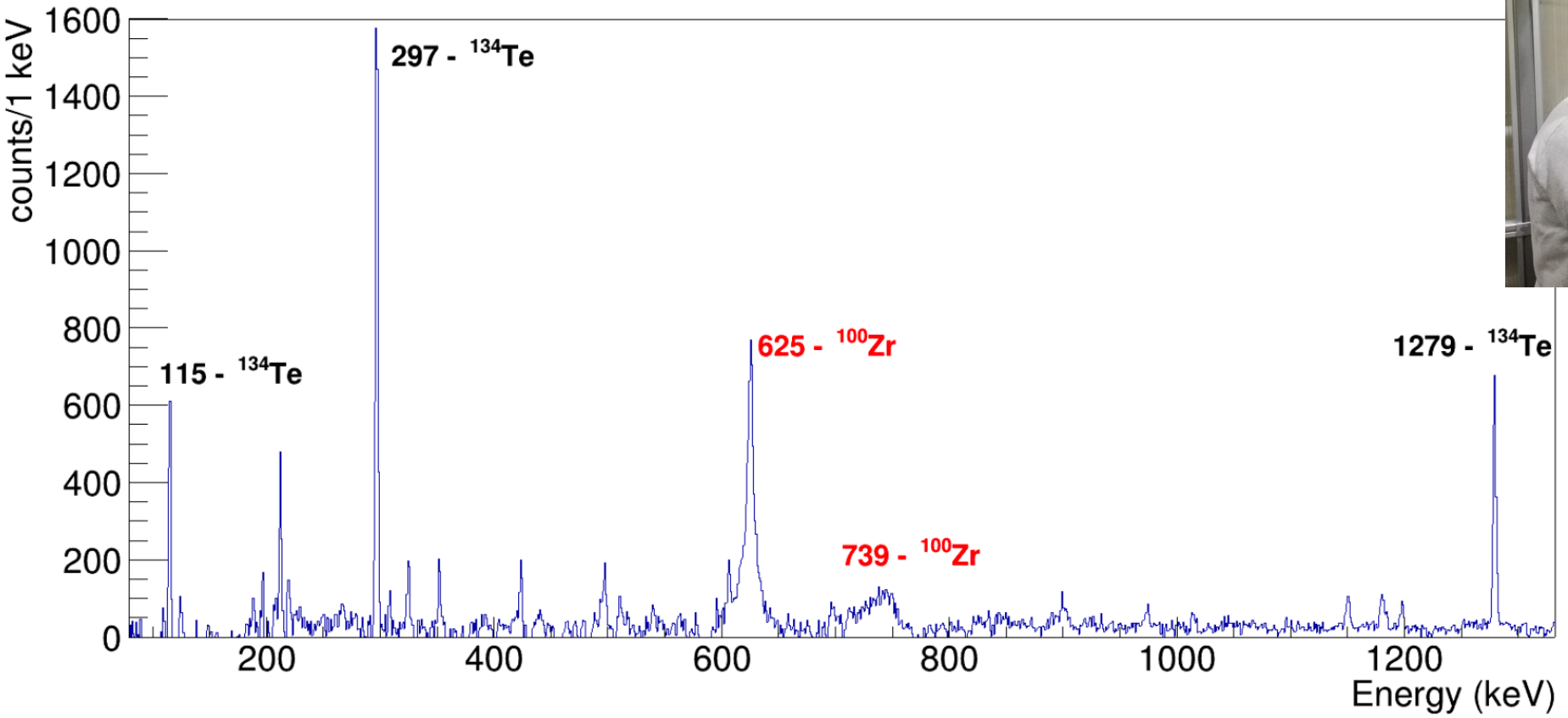




Adapted from F. Kandzia et al., Eur. Phys. J A 56 (2020) 207

Lineshapes in multi-γ coincidence spectra





G. Colombi, PhD Thesis, Univ. Grenoble-Alpes, ILL and Univ. Milan, 2023

UNIVERSITÀ DEGLI STUDI DI MILANO

UGA Université Grenoble Alpes

THÈSE

Pour obtenir le grade de

DOCTEUR DE L'UNIVERSITÉ GRENOBLE ALPES
et de L'UNIVERSITÀ DEGLI STUDI DI MILANO

École doctorale : PHYS - Physique
Spécialité : Physique Subatomique et Astroparticules

Étude de la déformation nucléaire des fragments de fission à l'aide de nouvelles techniques de mesure de temps de vie par décalage Doppler

Nuclear deformation in fission fragments studied with novel implementations of Doppler shift lifetime measurement techniques

Présentée par : **Colombi Giacomo**

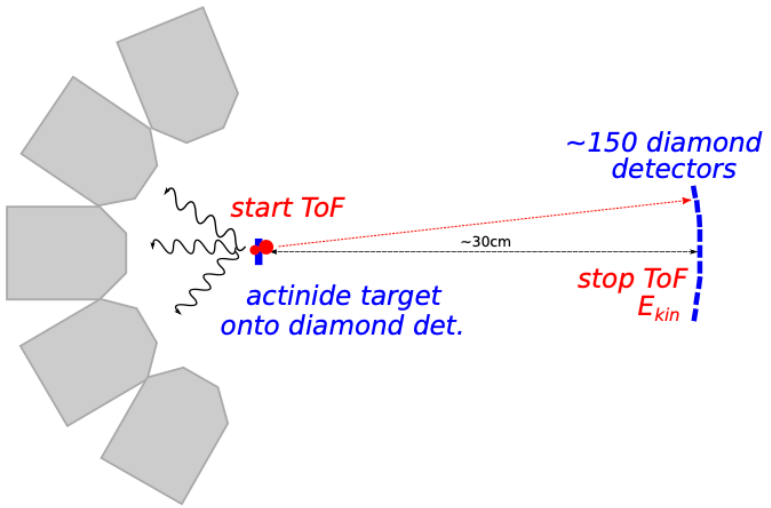
Direction de thèse :

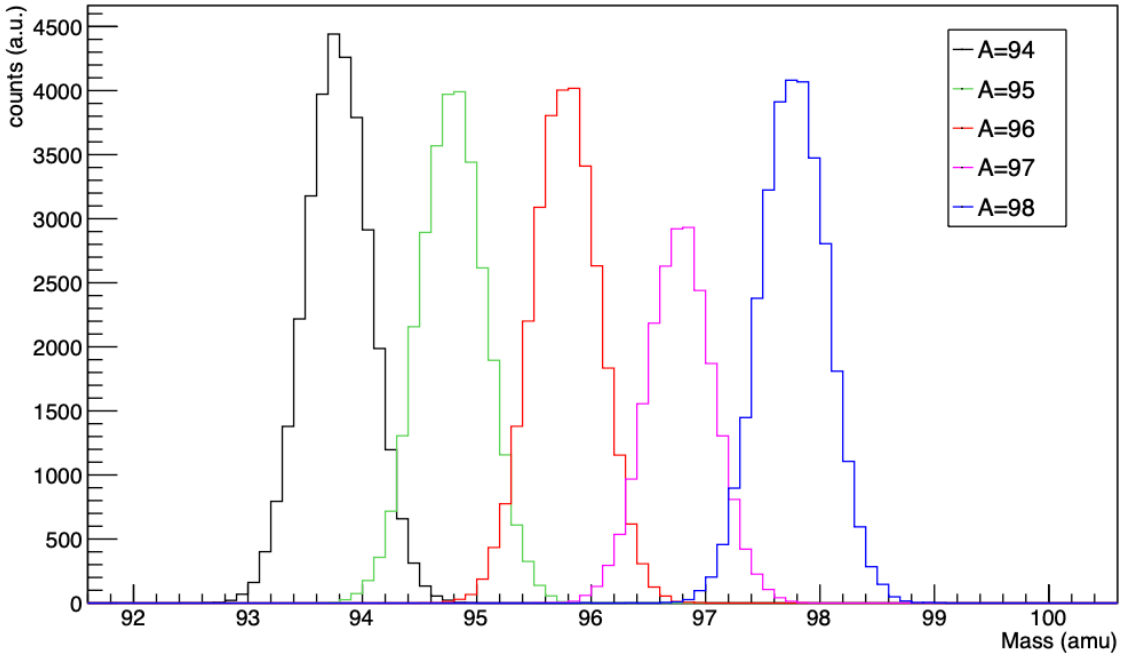
Caterina Michelagnoli Chargée de Recherche, HDR, Institut Laue-Langevin	Directrice de thèse
Silvia Leoni Professeure, Università degli studi di Milano	Co-Directrice de thèse
Joa Ljungvall Directeur de Recherche au CNRS, IPHC Strasbourg	Co-Directeur de thèse
Jérémie Dudouet Chargé de Recherche au CNRS, IP2I de Lyon	Co-Encadrant

Thèse soutenue publiquement le **8 Décembre 2023**, devant le jury composé de :

Judith Peters Professeure, Université Grenoble-Alpes	Présidente du Jury
Anu Kankainen Professeure, University of Jyväskylä	Rapporteure
Ann-Cecilie Larsen Professeure, University of Oslo	Rapporteure
Jean-Michel Daugas Chargé de Recherche, HDR, Institut Laue-Langevin	Examinateur
Matthieu Lebois Maître de Conférence, HDR, IJCLab	Examinateur
Araceli Lopez-Martens Directrice de Recherche au CNRS, IJCLab	Examinatrice
Caterina Michelagnoli Chargée de Recherche, HDR, Institut Laue-Langevin	Directrice de thèse

A diamond-based fission fragment id setup





Very grateful for past and present collaboration (and friendship!)

Looking forward for future projects!!!

ILL Science Strategy working group