



LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS
partículas e tecnologia



Ciências
ULisboa

Elastic α -scattering on heavy exotic nucley - report on IS698

D. Galaviz

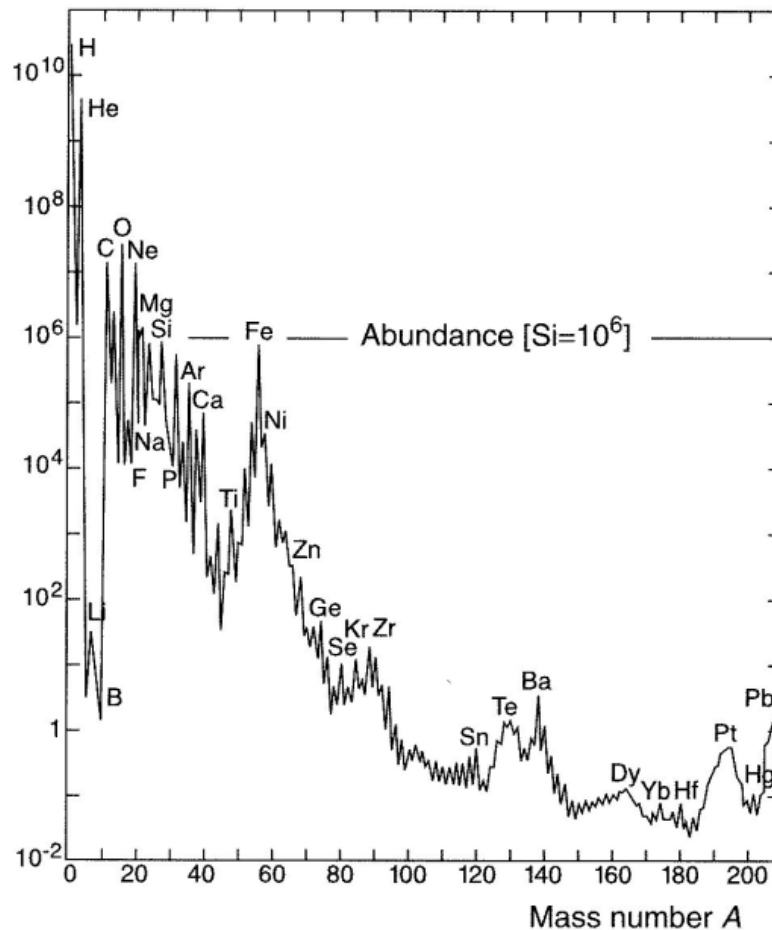
ISOLDE Users Workshop

December 1st 2022

Overview

- Motivation: **p-process nucleosynthesis** and **α -nuclear potentials**
- Opportunity: thin **silicon/helium** films
- IS698 experiment
 - Experimental setup at **SEC**
 - First (very) **preliminary** analysis
- Summary and Outlook

Solar Abundance Distribution

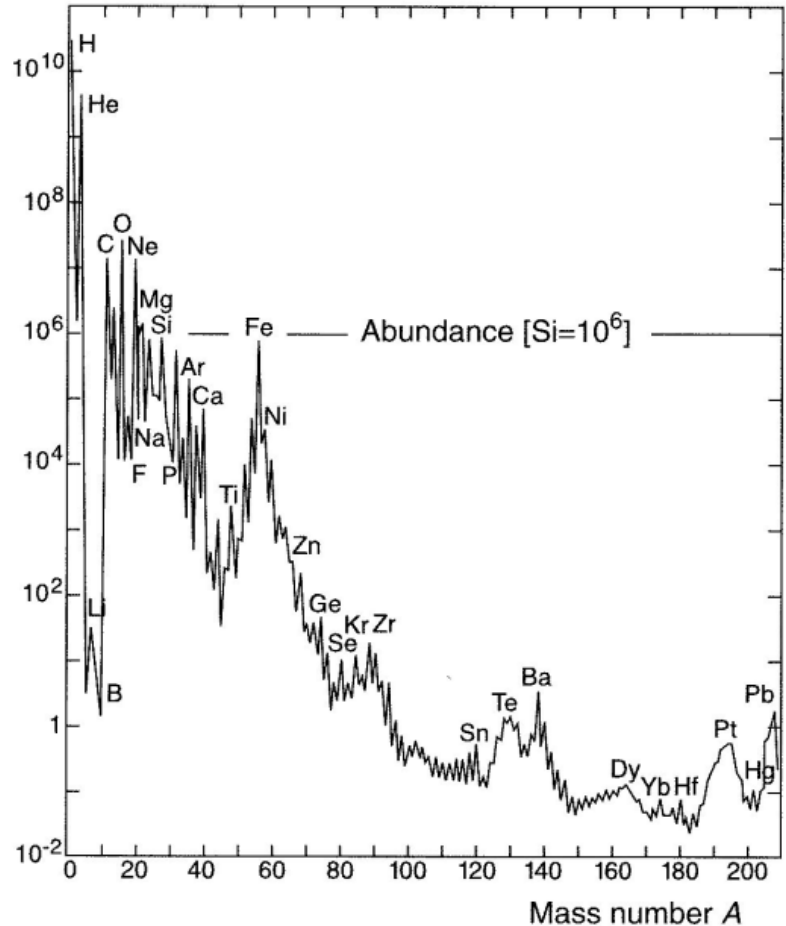


Solar Abundance Distribution

➤ Bulk of elements:

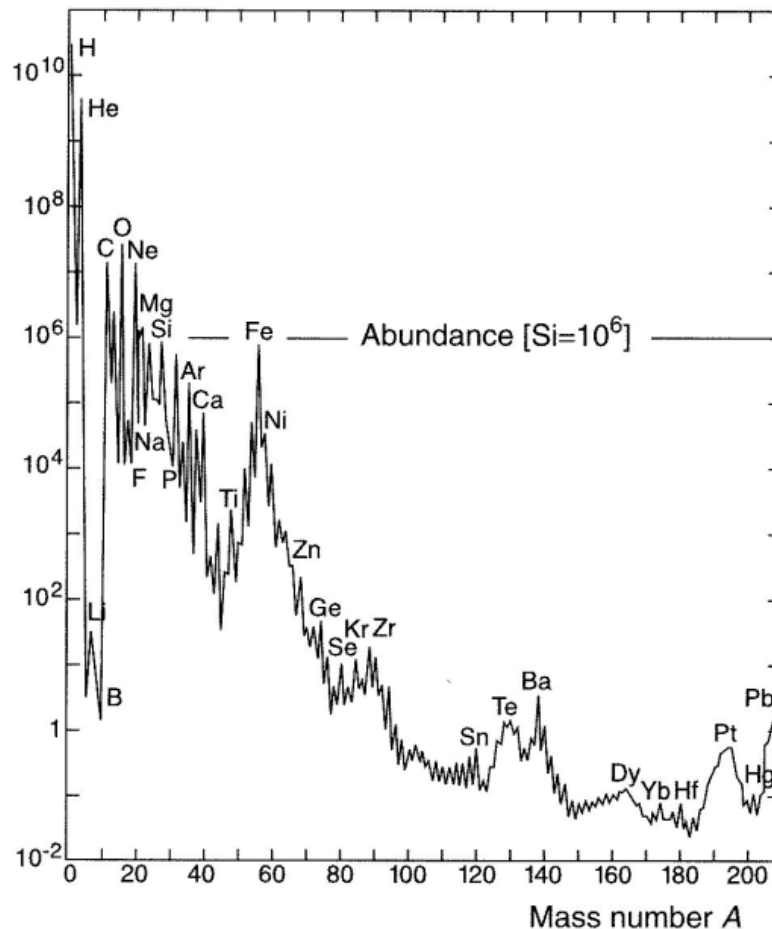
➤ **BBN**

➤ **Fusion phase**



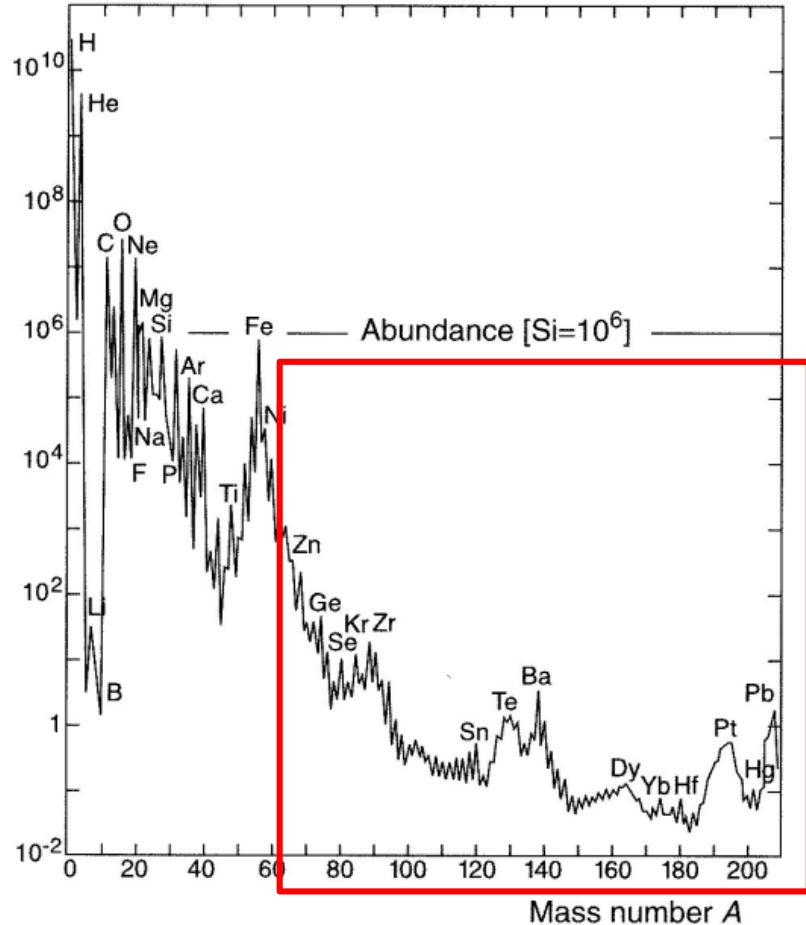
Solar Abundance Distribution

- Bulk of elements:
 - BBN
 - Fusion phase
- Heavy elements:
 - Neutron capture processes

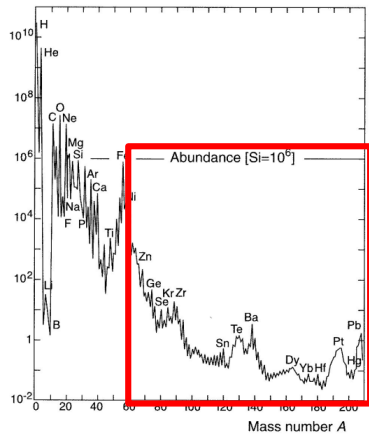


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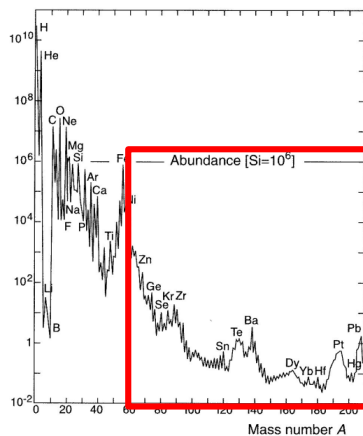
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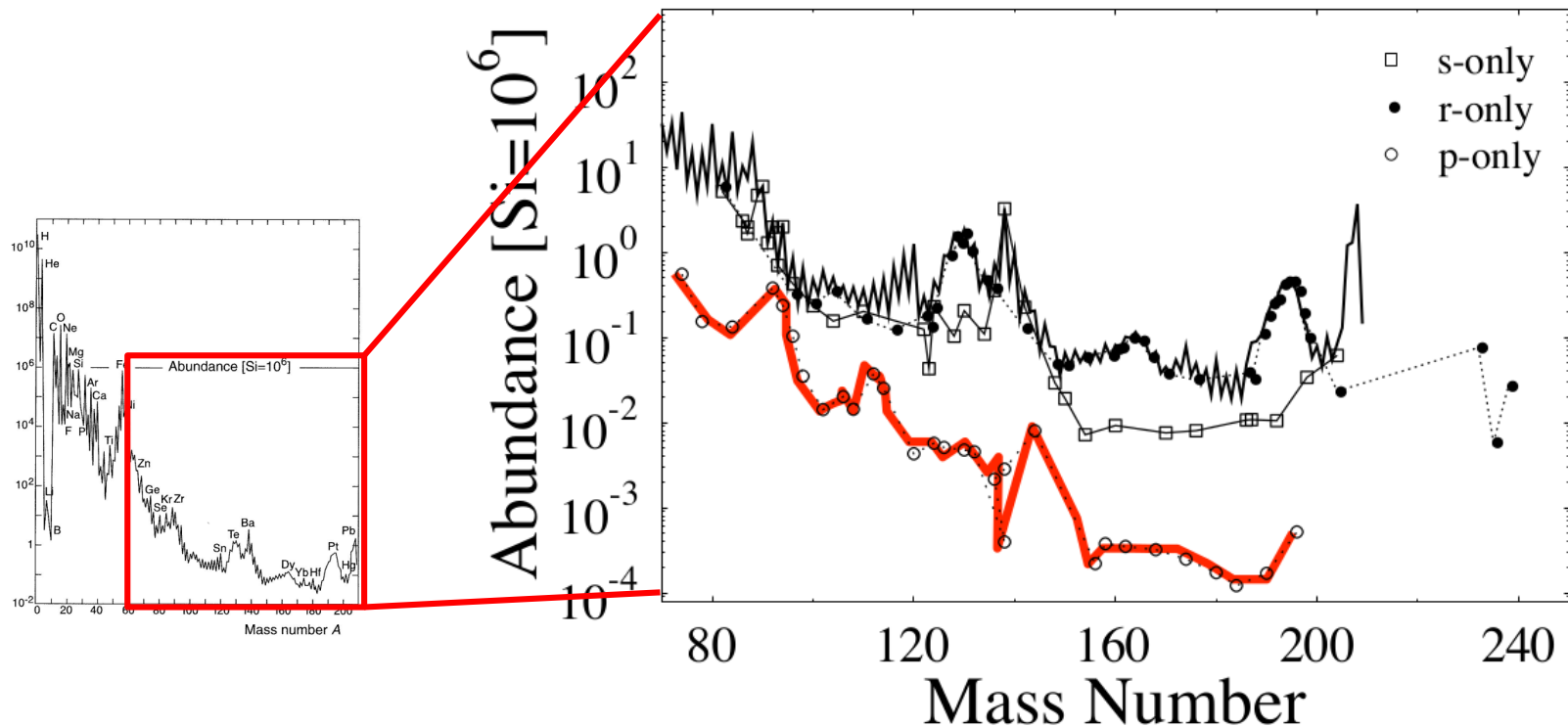
P-nuclei



P-nuclei



P-nuclei



P-process nucleosynthesis

P-process nucleosynthesis

Sensitivity studies of **p-process** nucleosynthesis point out the strong dependence of the **α -nuclear potential** in the production of

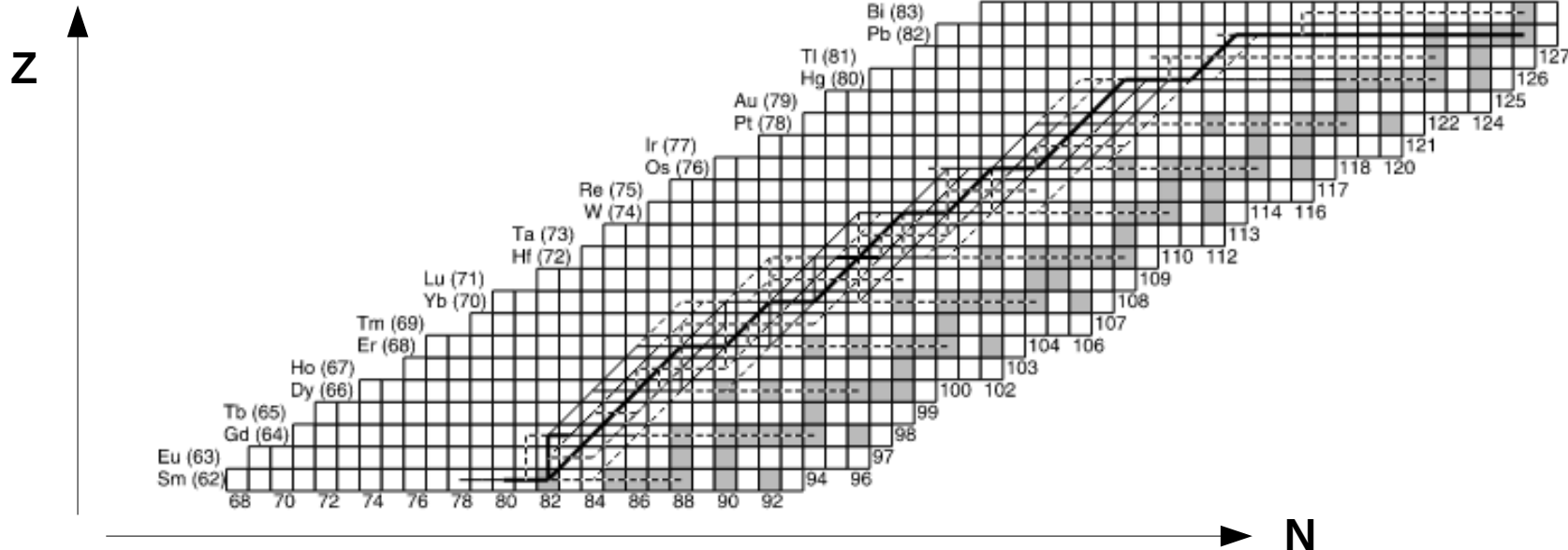
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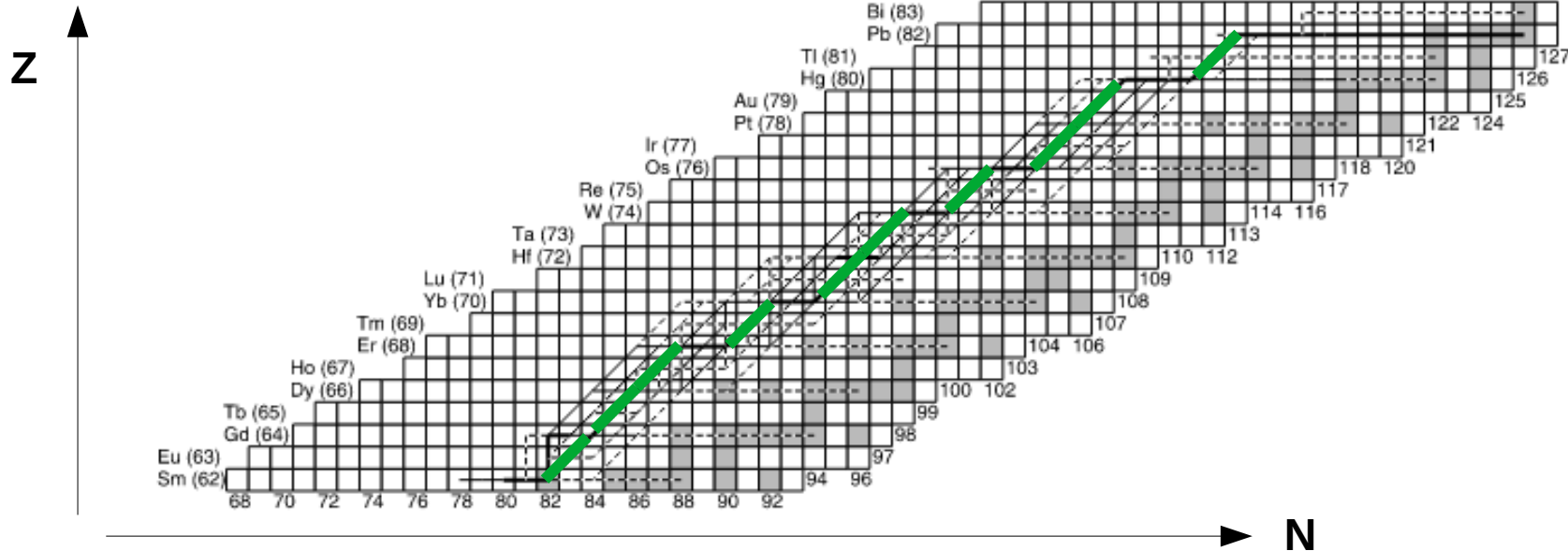
W. J. Rapp et al., *Astrophys. J* 653, 474 (2006)



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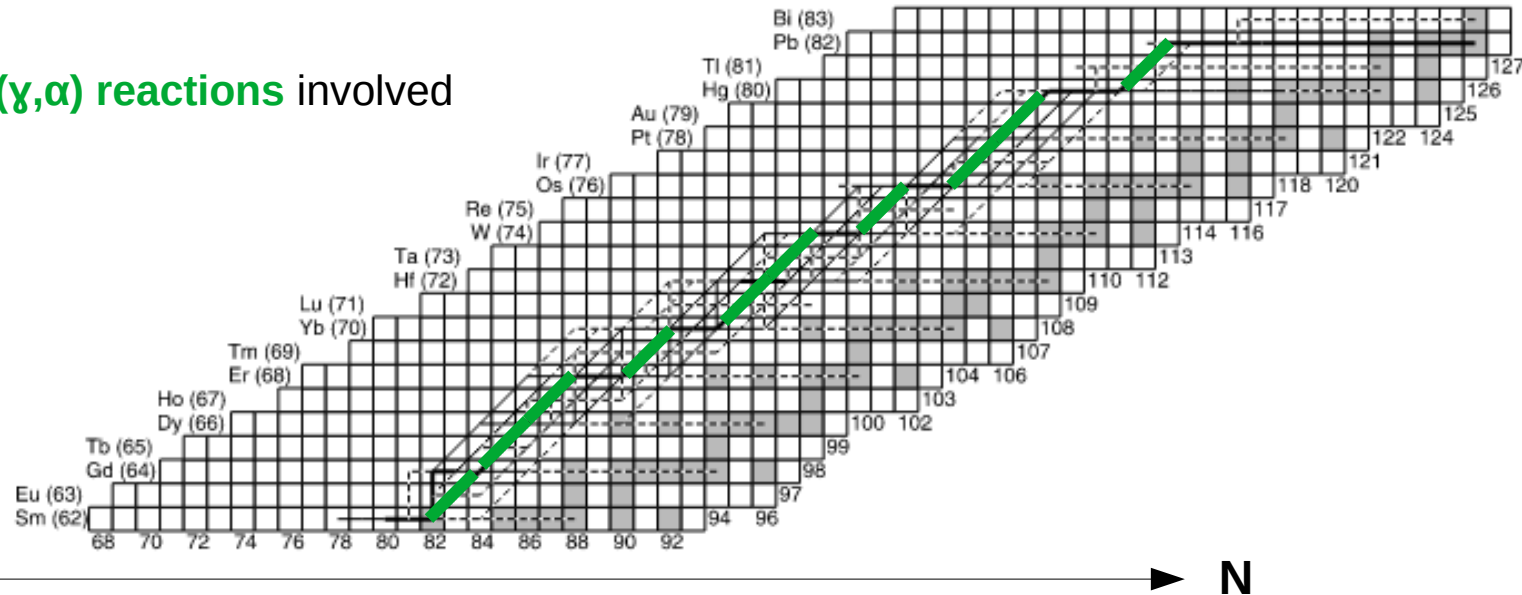
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Z
↑

(γ, α) reactions involved



▶ N

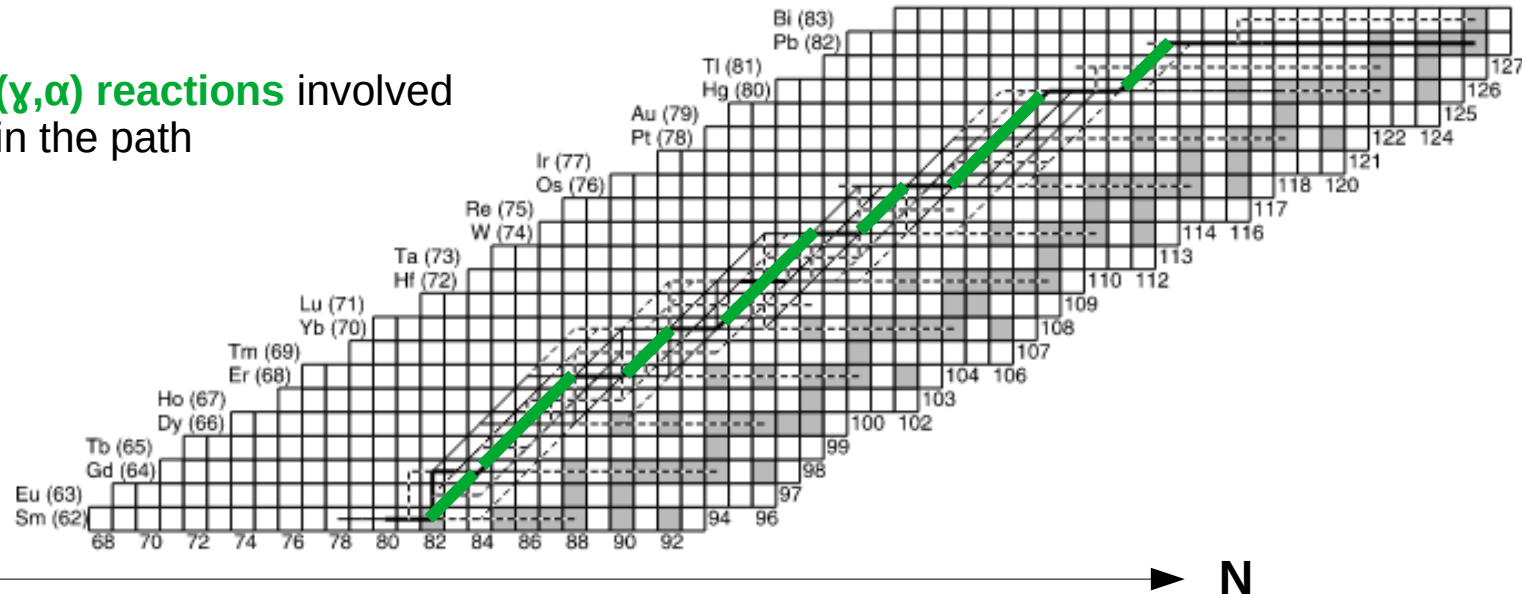
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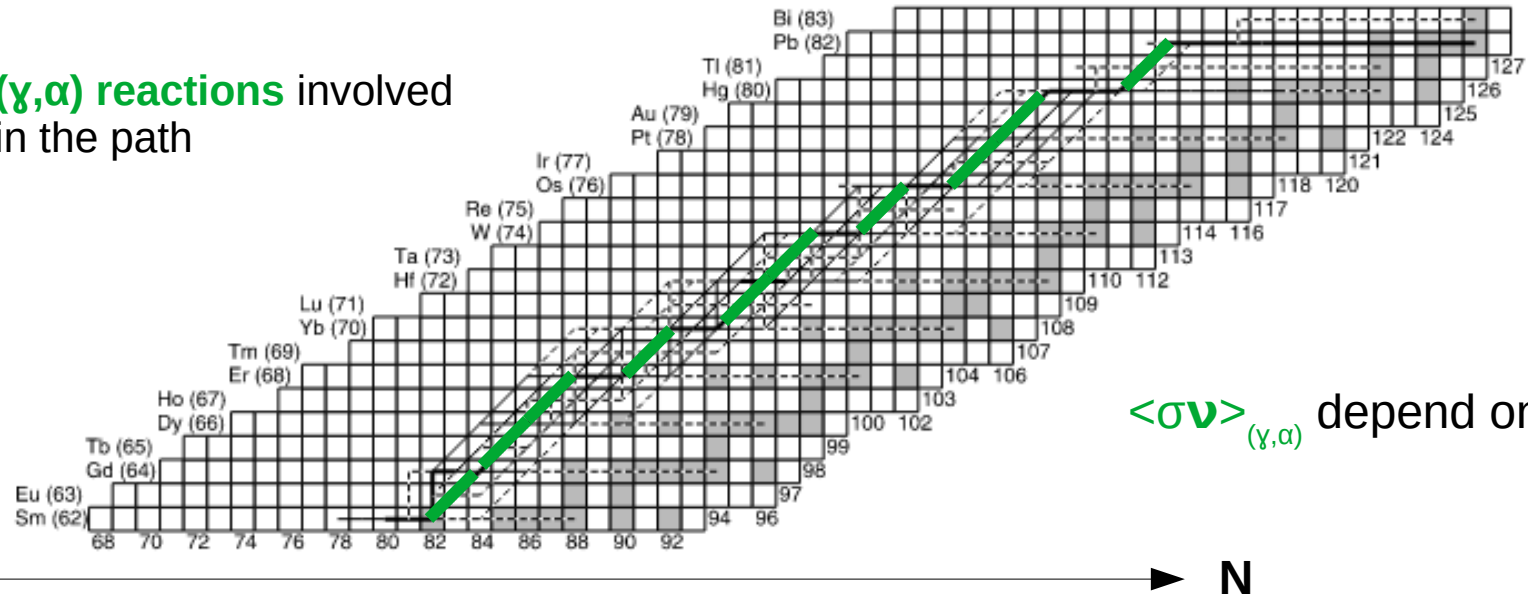
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$\langle \sigma v \rangle_{(\gamma, \alpha)}$ depend on the

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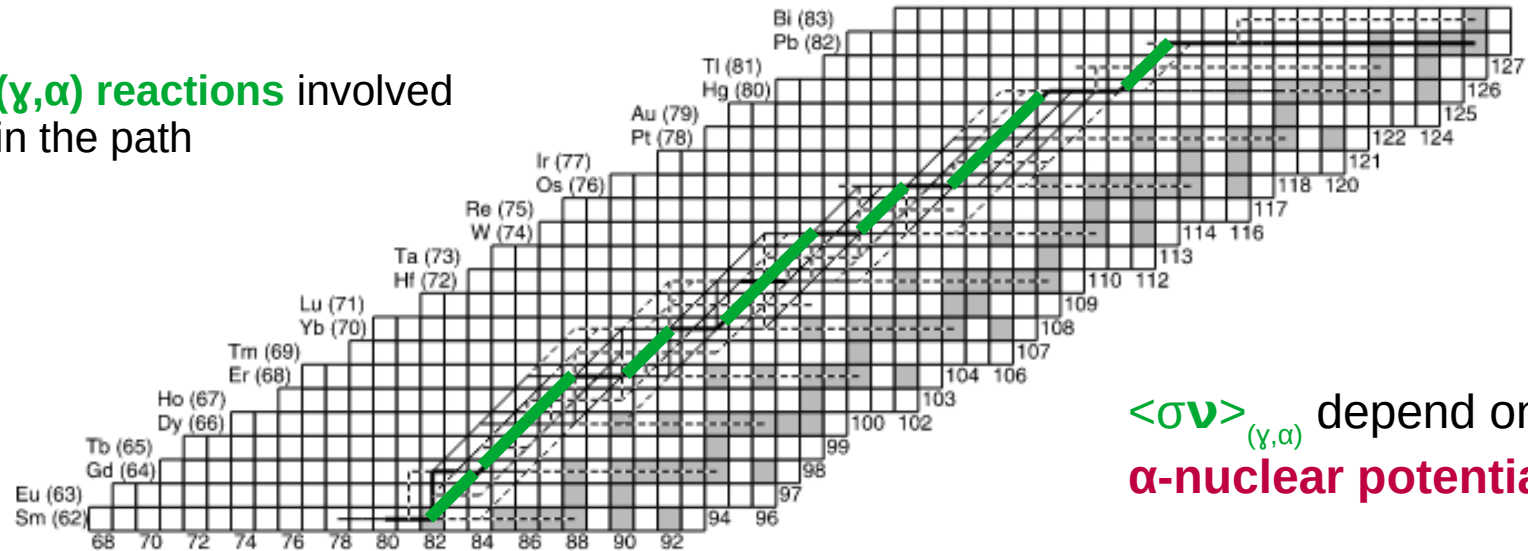
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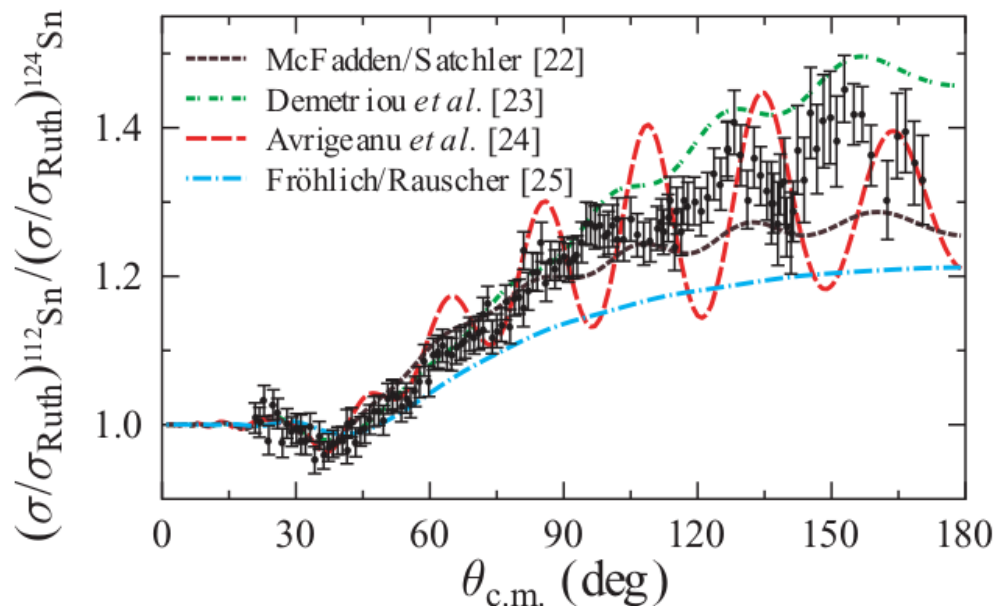


$\langle \sigma v \rangle_{(\gamma, \alpha)}$ depend on the **α -nuclear potential**

N

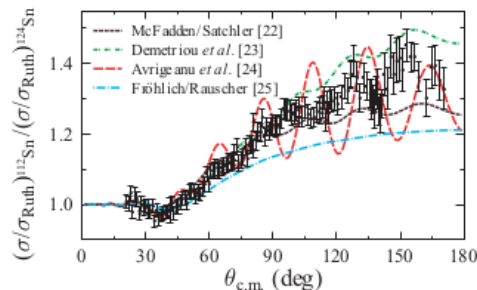
α -nuclear potentials

Mass dependence in stable Sn isotopes

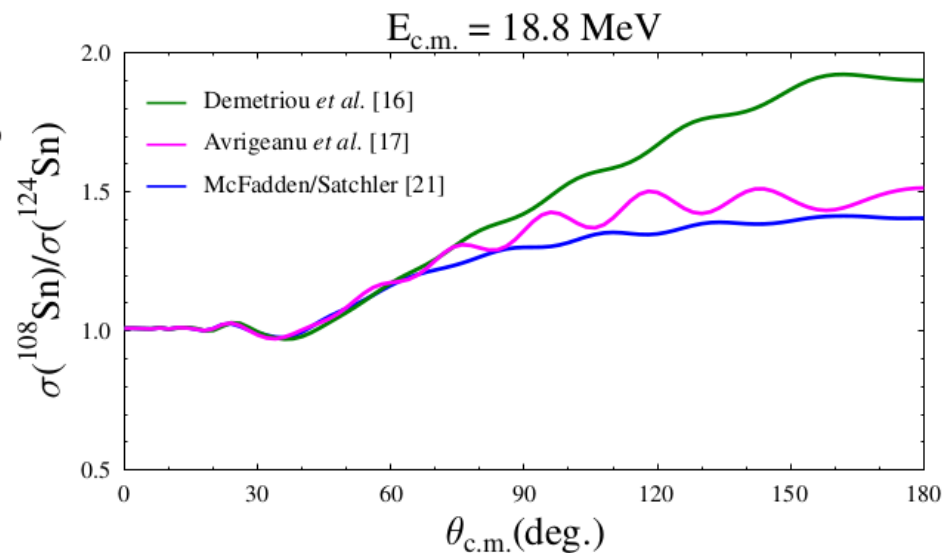


α -nuclear potentials

Mass dependence in stable Sn isotopes



D. Galaviz *et al.*, Phys. Rev. C 71,
065802 (2005)

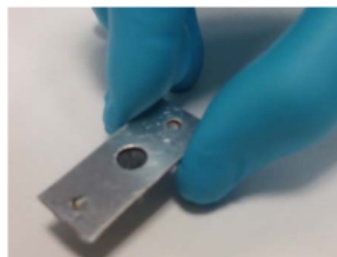
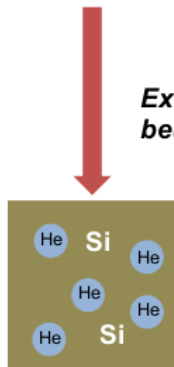


Magnetron sputtering Si/He films

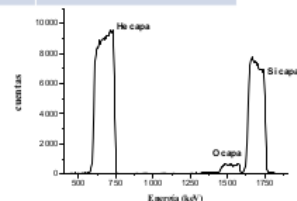


Development of He solid targets for nuclear reaction experiments

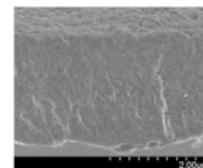
	GODINHO et al. (MS)	Vanderbist et al. (Ionic Implant.)	Raabe et al. (Ionic Implant.)	Ujic et al. (Ionic Implant.)
Metal (10^{15} at/cm ²)	9250 (Si)	1200 (Al)	4200 (Al)	1200 (Al)
He (10^{15} at/cm ²)	4060	275	270	130
O (10^{15} at/cm ²)	700	60	100	??



Self-supported Si:He target



RBS spectrum of Si:He target using 2,0 MeV protons and 165° scattering angle



SEM cross section of the Si:He target

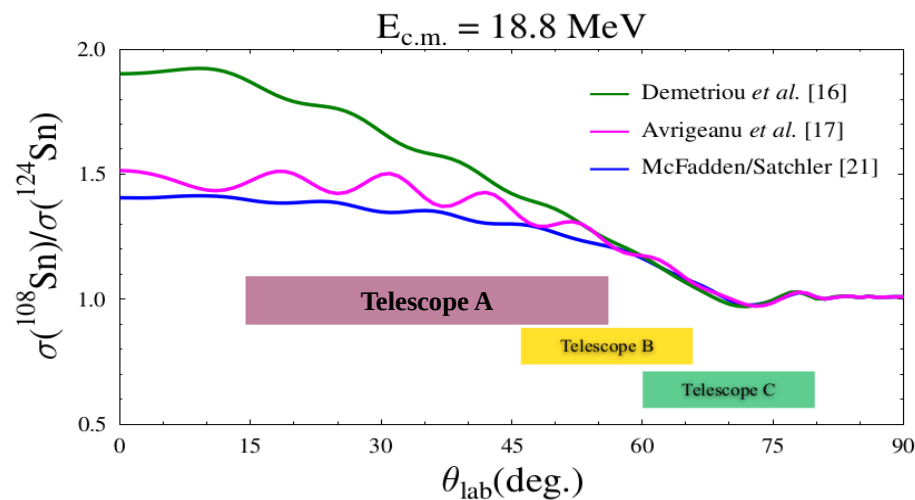
V. Godinho *et al.*, ACS Omega 2016, 1 (6), 1229 (2016)

Elastic α -scattering, IS698

Proposed experiment

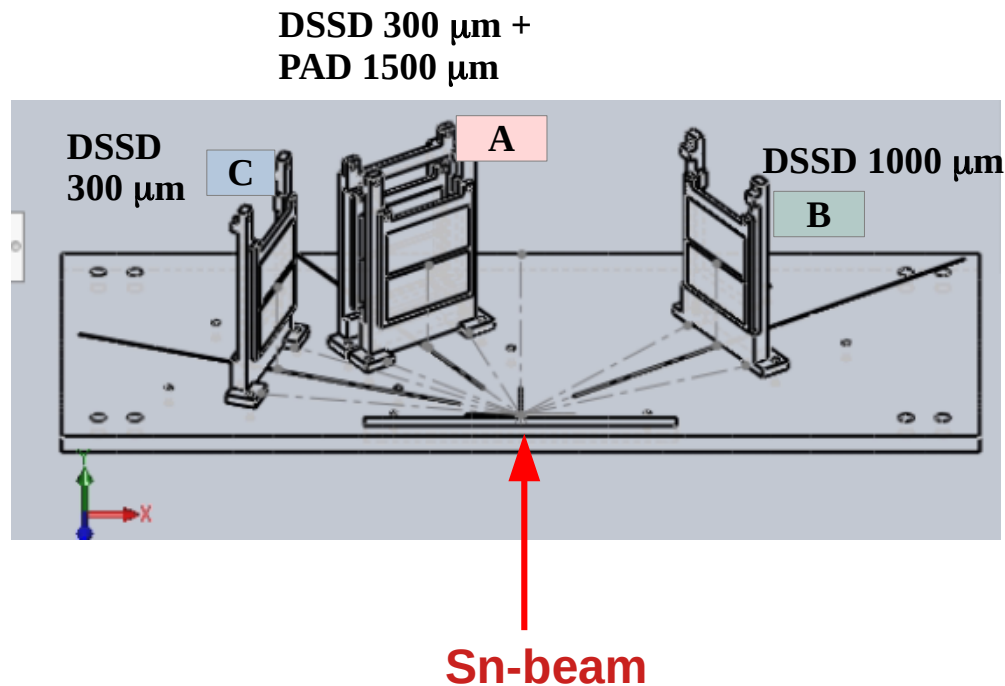
Measurement of the ${}^4\text{He}({}^A\text{Sn}, {}^4\text{He}){}^A\text{Sn}$ in inverse kinematics at the same $E_{\text{c.m.}}$:

mass dependence of α -nuclear potentials along the Sn isotopic chain

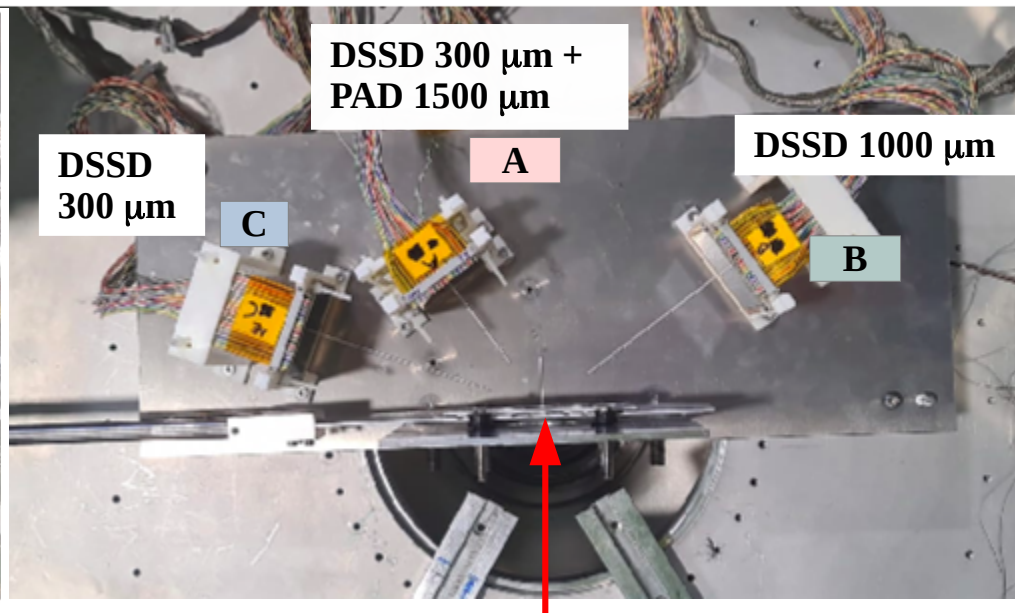


Isotope	# shifts
${}^{112}\text{Sn}$	3
${}^{110}\text{Sn}$	5
${}^{108}\text{Sn}$	15

Experimental setup



Experimental setup



Sn-beam

Online spectra

Cocktail pilot beam scattering on **Au-target**

Online spectra

Cocktail pilot beam scattering on **Au-target**

$$E = 4.9 \text{ MeV/u} \quad \theta_{\text{lab}} \approx 62^\circ$$

Online spectra

Cocktail pilot beam scattering on **Au-target**

$$E = 4.9 \text{ MeV/u} \quad \theta_{\text{lab}} \approx 62^\circ$$

²⁰Ne

¹²C

¹⁶O

³²S

Online spectra

Cocktail pilot beam scattering on **Au**-target

$E = 4.9 \text{ MeV/u}$

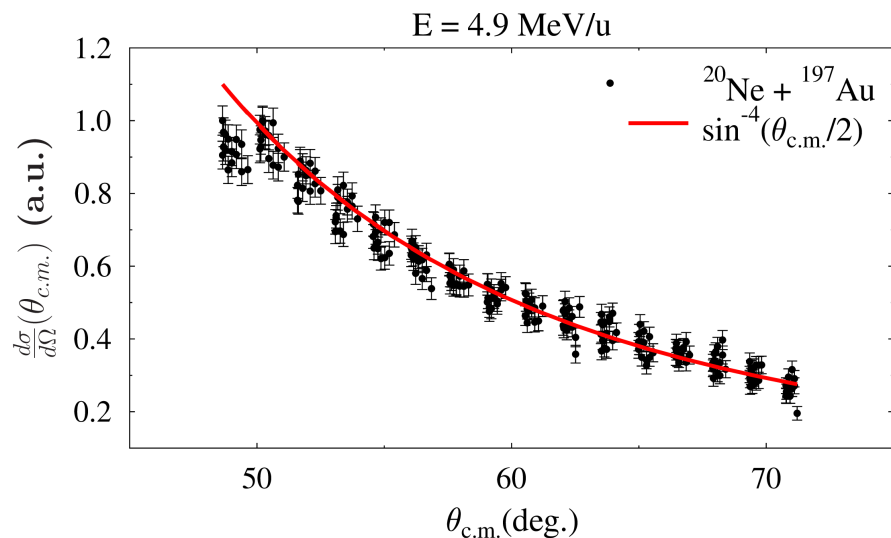
$\theta_{\text{lab}} \approx 62^\circ$

^{20}Ne

^{12}C

^{16}O

^{32}S

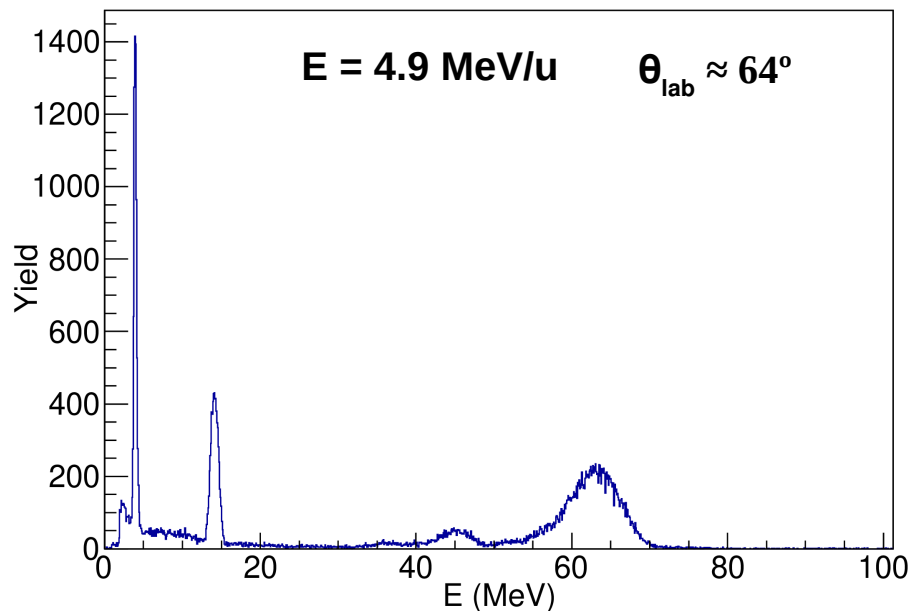


Online spectra

^{108}Sn beam scattering on **Si/He-target**

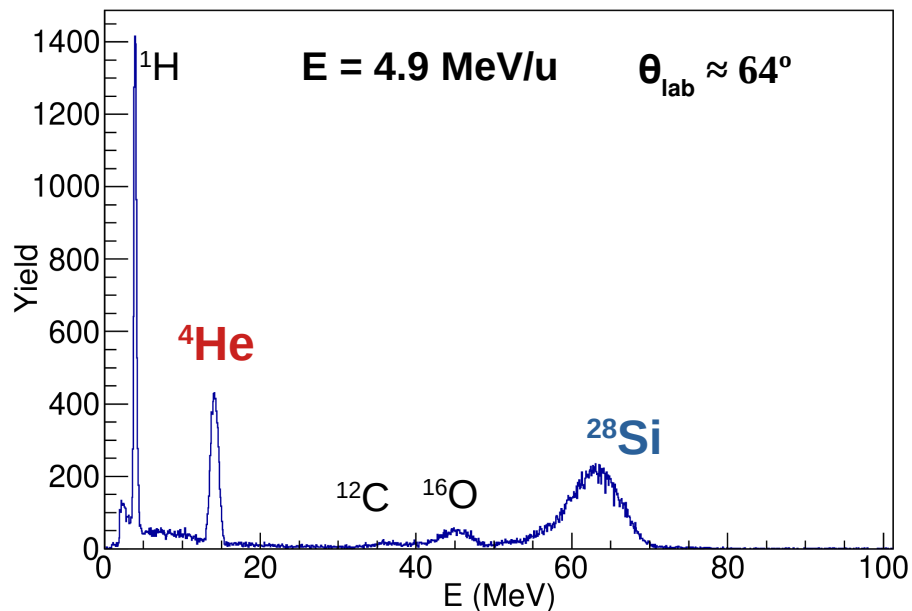
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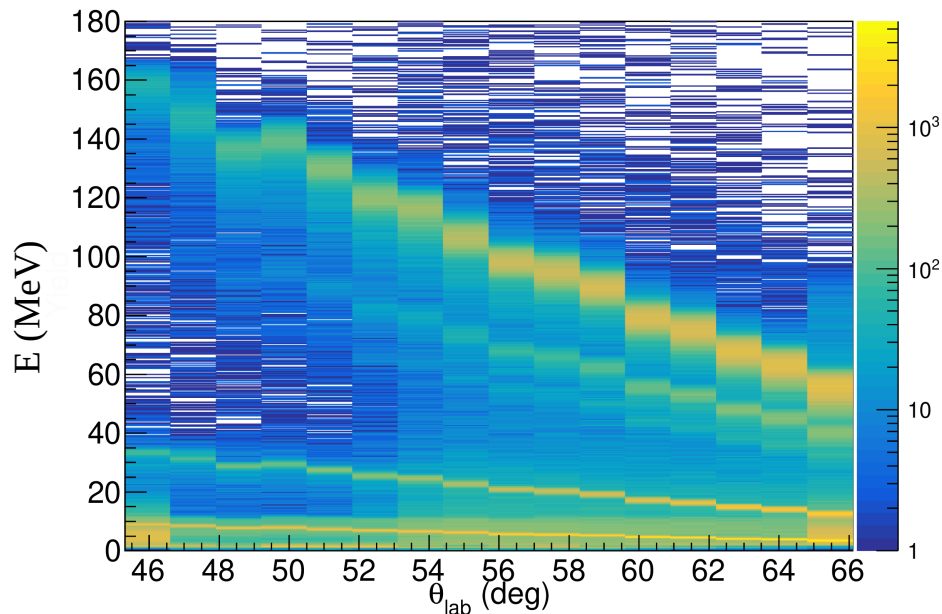
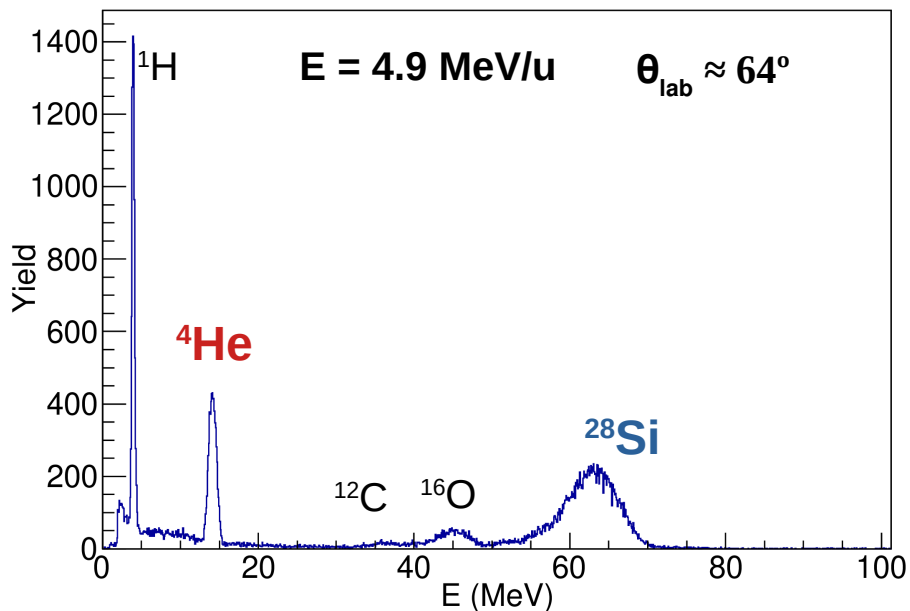
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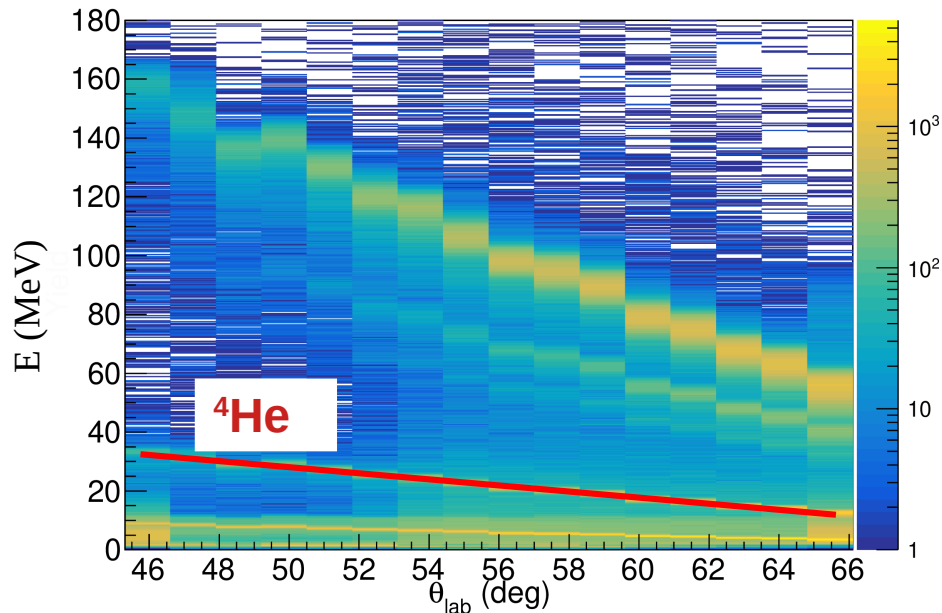
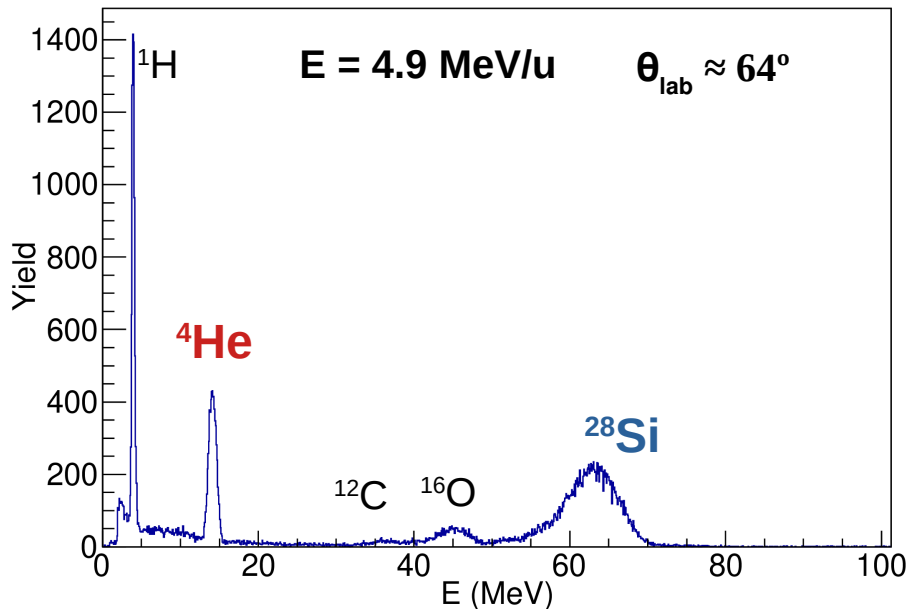
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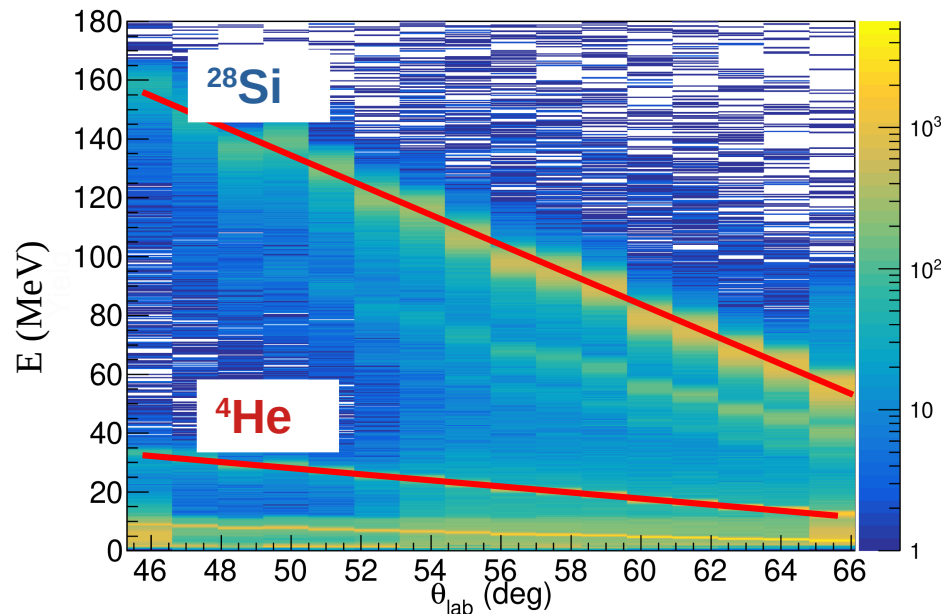
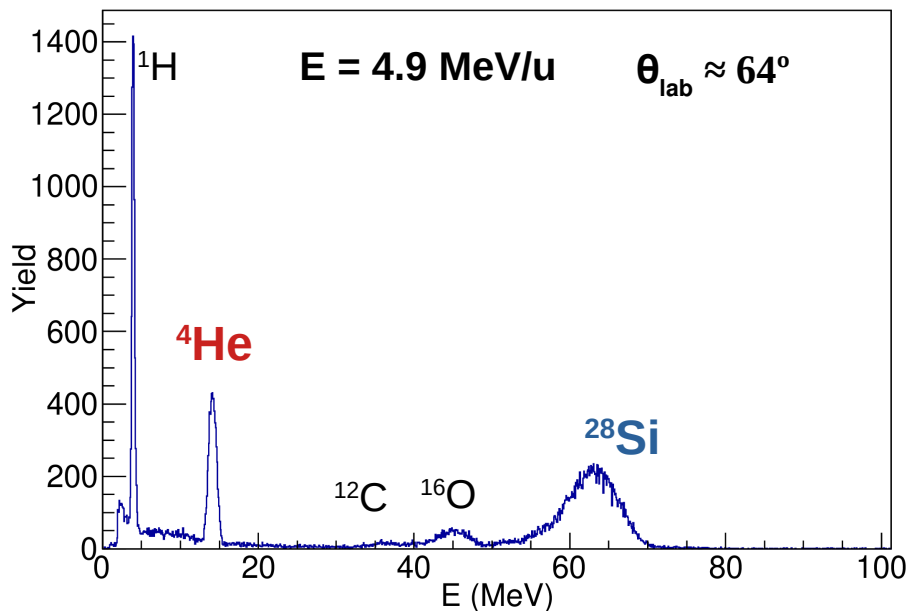
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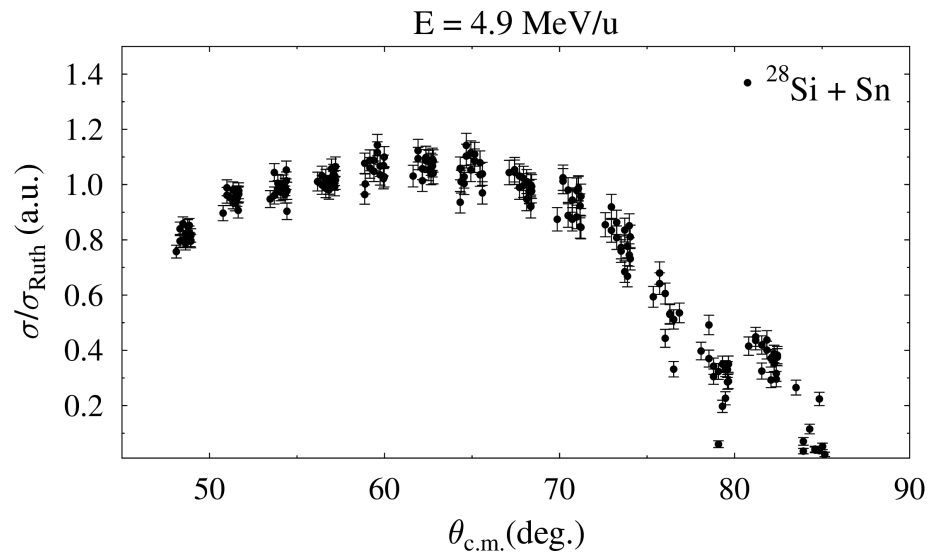
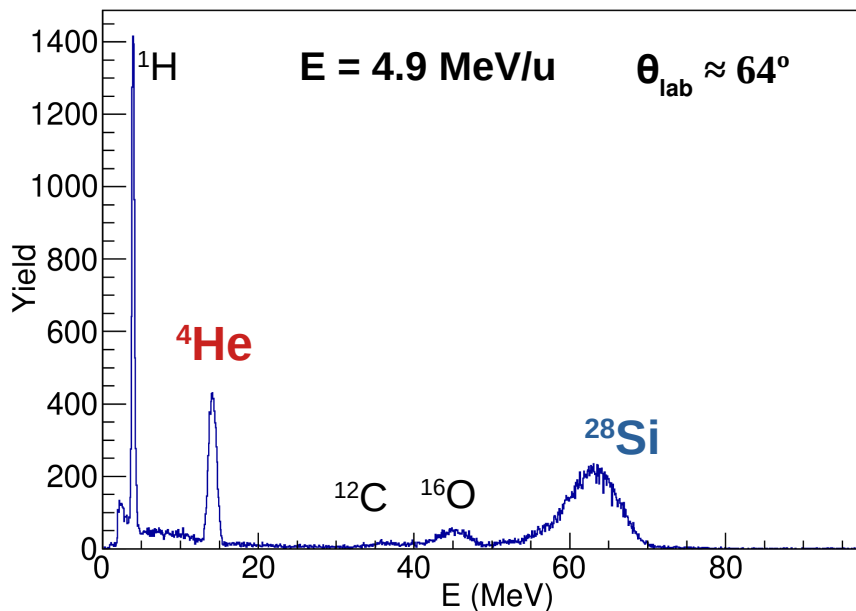
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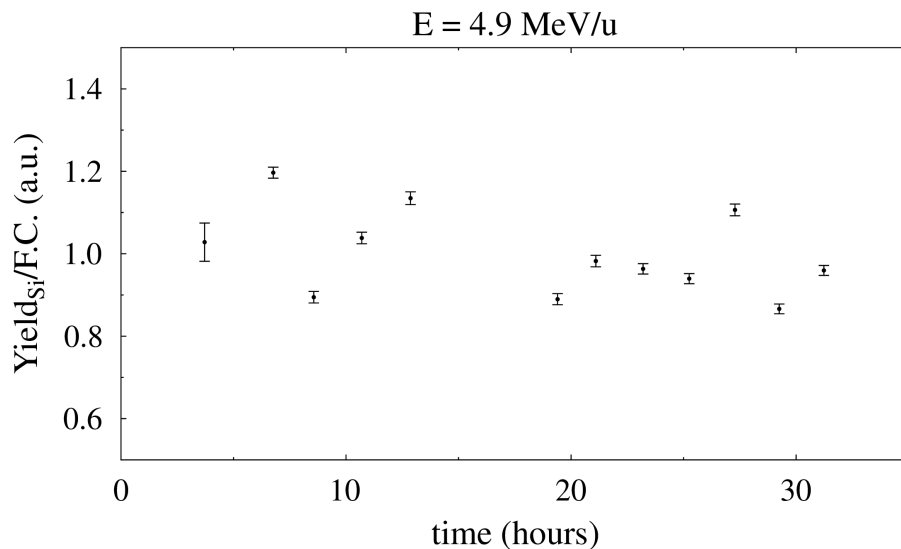
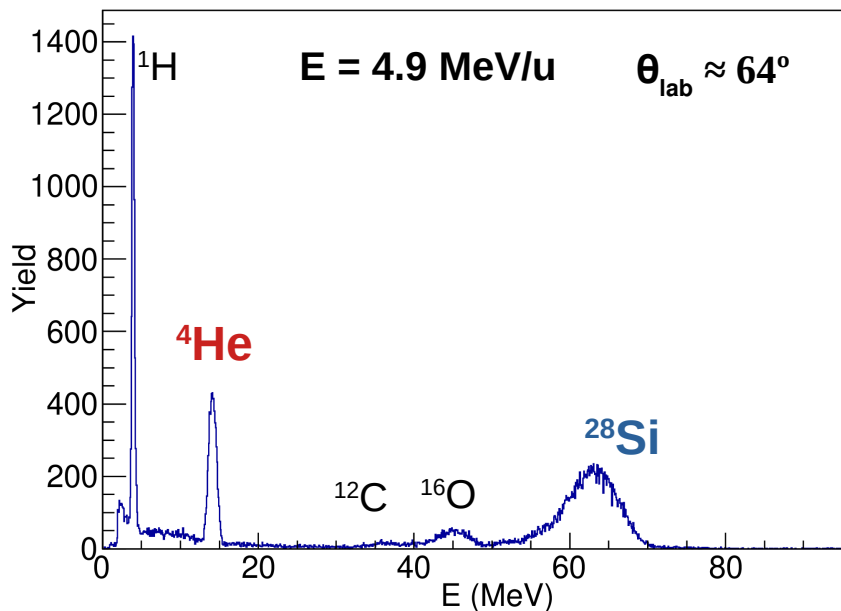
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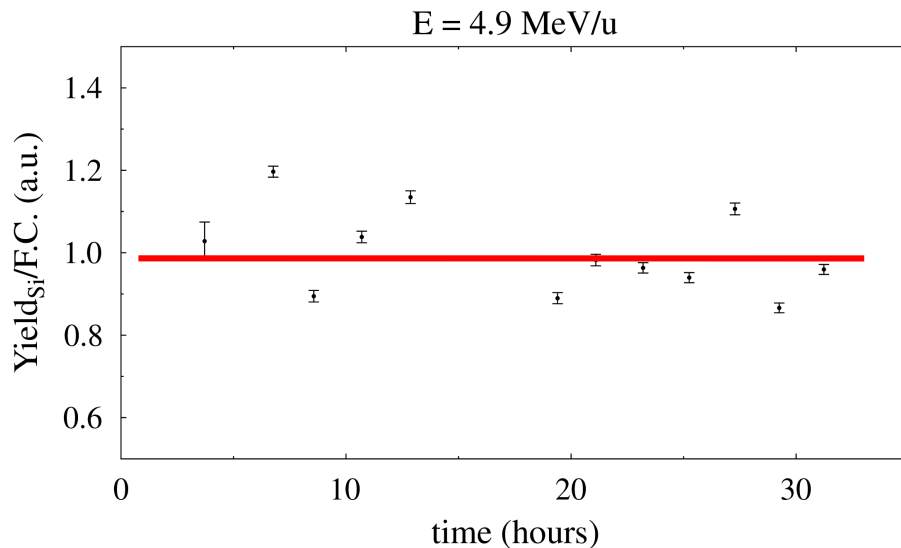
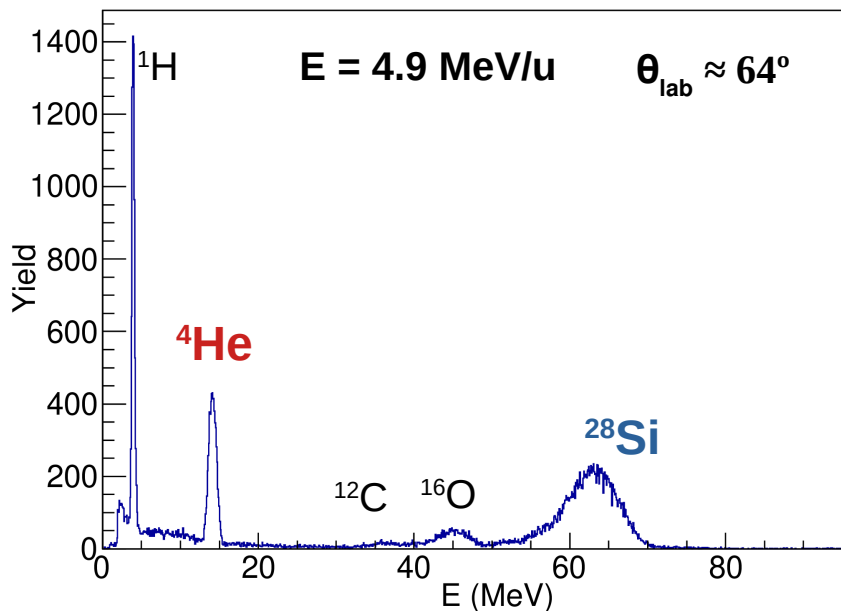
Online spectra (target)

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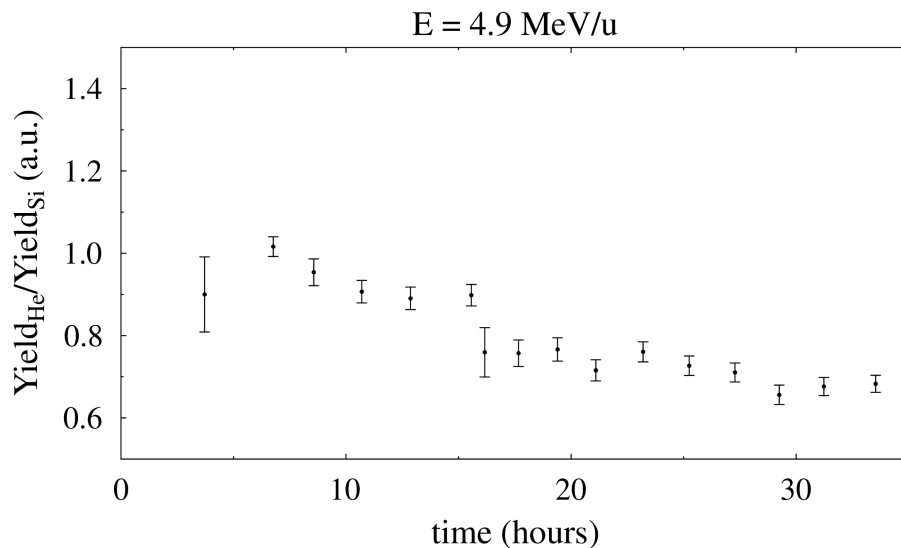
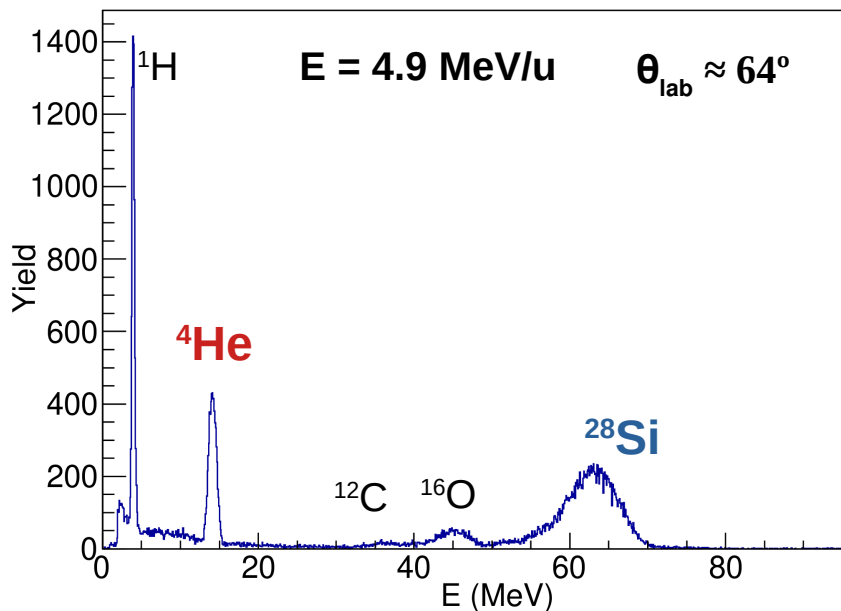
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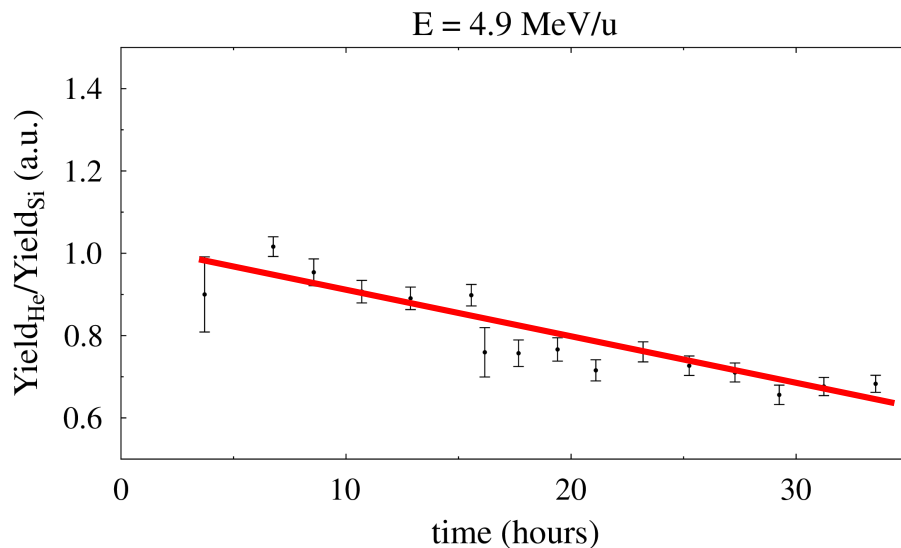
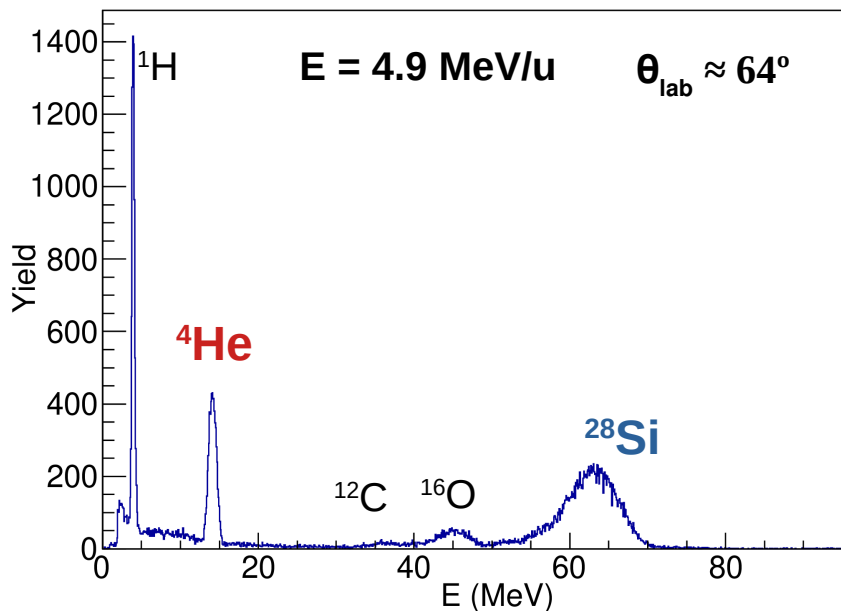
Online spectra

^{108}Sn beam scattering on **Si/He-target**



Online spectra

^{108}Sn beam scattering on **Si/He-target**



Summary & Outlook

- Experiment: success execution of elastic scattering on:
 - ^{108}Sn , ^{109}Sn & ^{110}Sn (in addition to stable ^{112}Sn)
 - Clear ^4He signal over a **large angular range**
- Target performance:
 - **Very suitable** to perform **reaction experiments** in inv. kinem.
- Outlook:
 - Extract **α -nuclear potential** parameters on **exotic** nuclei
 - Study impact in **nuclear astrophysics** models

Acknowledgments

- Special thanks to ISOLDE!
- Excellent beam time, **not just the beam!**
- Thanks to SEC and to the experiment participants!

Portugal	Spain	Italy	Sweden	Germany	France	Mexico
LIP,C2TN	US, NanoMatμ, UHU, IEM/CSIC	LNS	Lund	TUDa	Lyon	UMAM

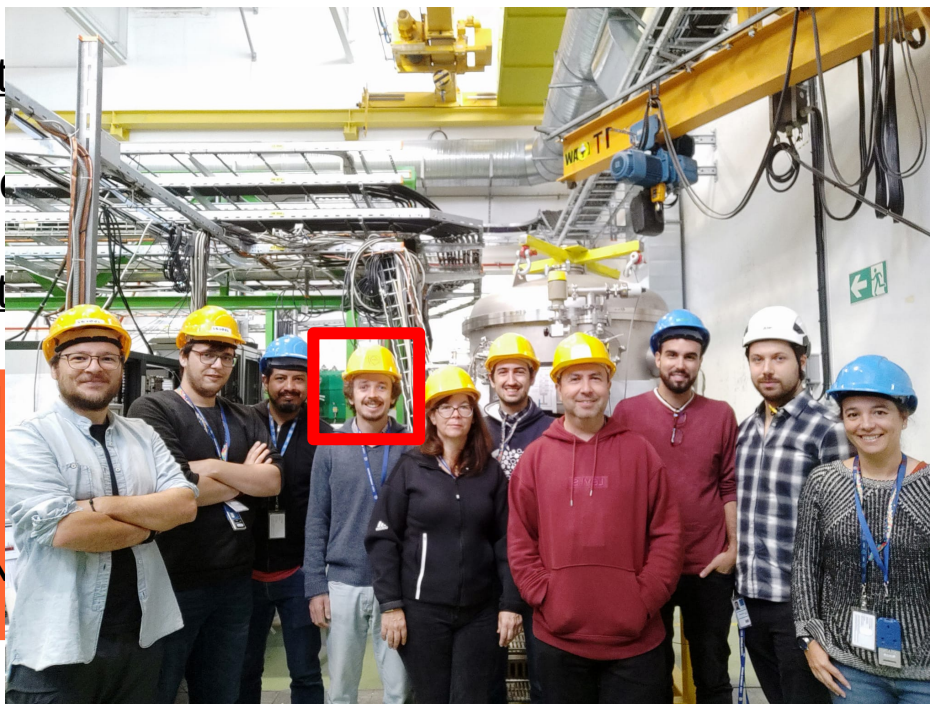
CERN/FIS-PAR/0009/2021

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Acknowledgments

- Special t
- Excell
- Thanks t



Portugal

LIP,C2TN

France

Lyon

Mexico

UMAM

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BASED SCIENCES

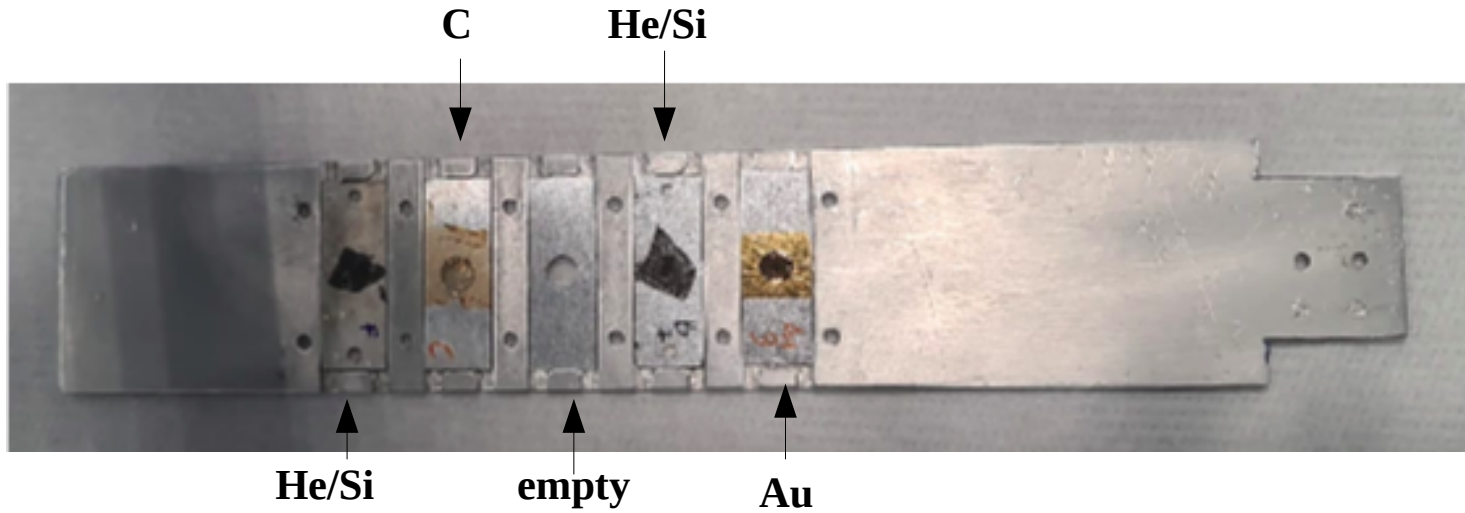


Obrigado!



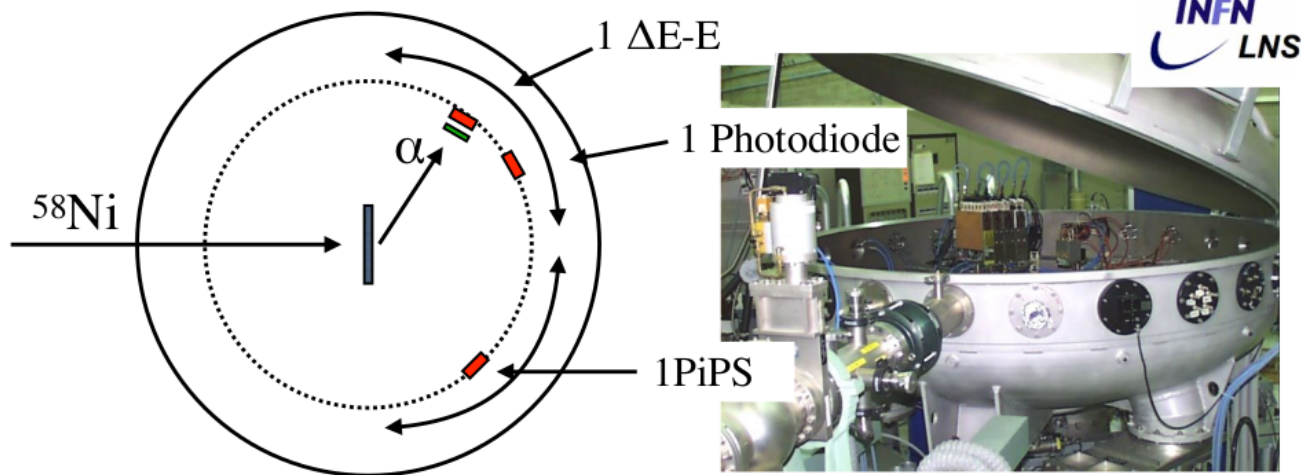
Backup Slides

Target ladder



Viability test at LNS

- Performed at INFN/LNS
- Developed in the framework of an stable beam experiment proposed at the CT2000 scattering chamber



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${}^4\text{He}({}^{58}\text{Ni},\alpha){}^{58}\text{Ni}$ @ 150 MeV

