First results from the "Nossa Caixa" gamma spectrometer

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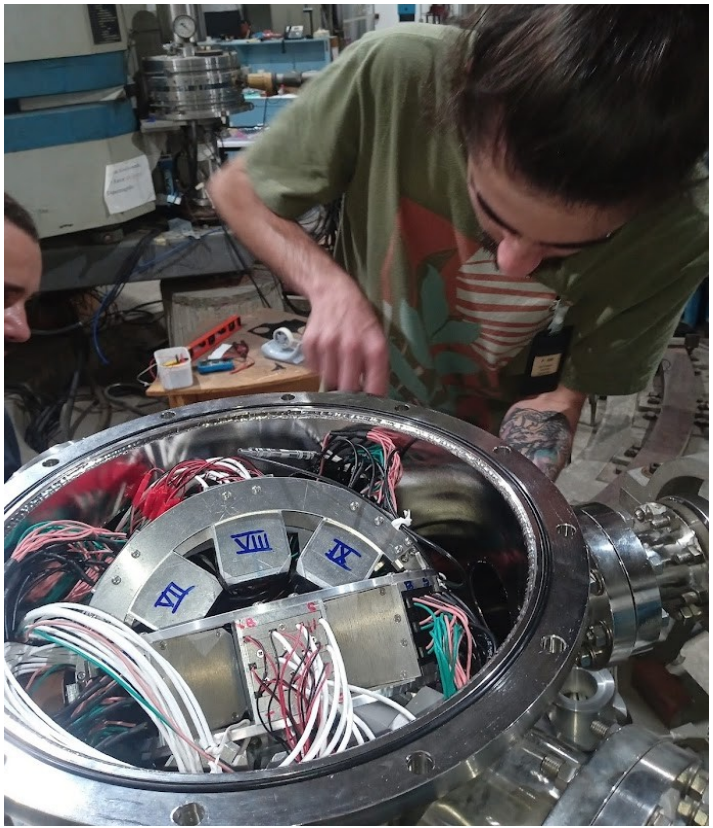
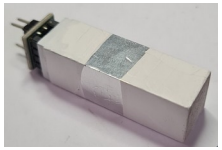
Sumário

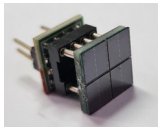
- Características do espectrômetro
- Validação de simulações de eficiência
- Testes com a reação $^{10}B+^{120}Sn$ @ 33.5 MeV:
  - n-pickup and BU/Incomplete fusion
- Considerações finais

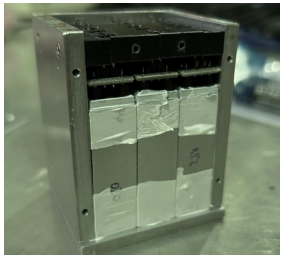
O espectrômetro NC



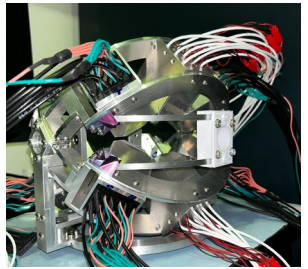
- 108 cristais cintiladores de LYSO(Ce) 12.4 mm^2 X 40 mm (pixels) com SiPM

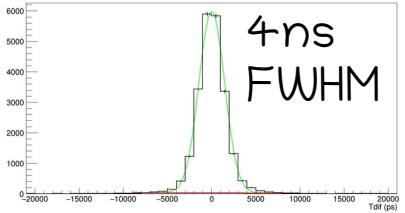






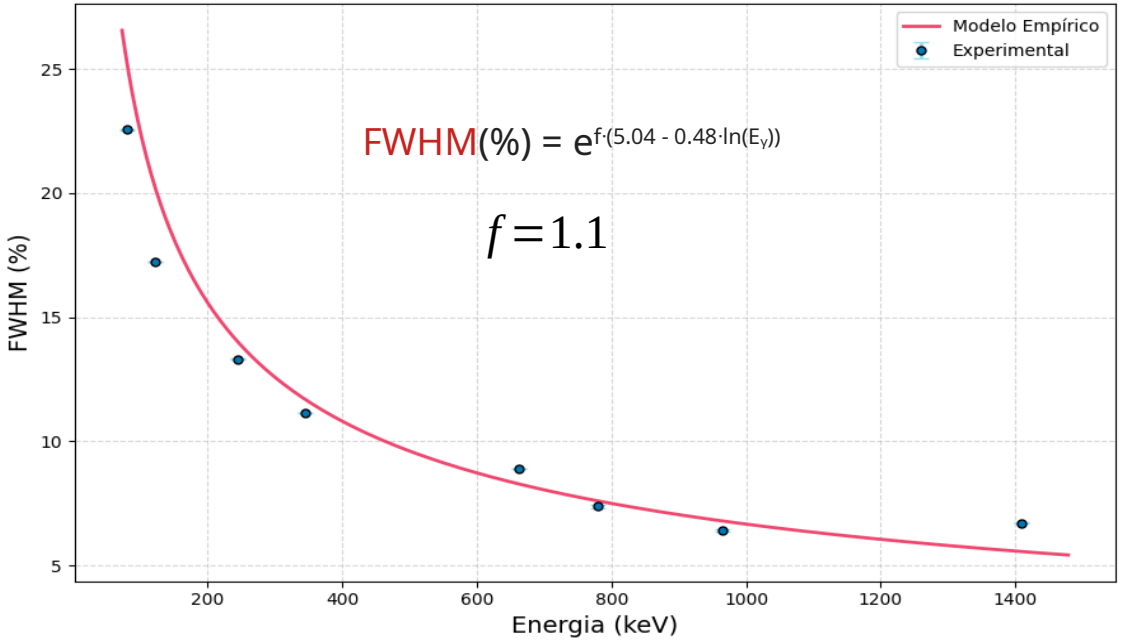
- 12 detectores (conjuntos de 3 X 3 pixels detectors)
- Opera em ar ou em vácuo
- Compacto (54 mm do alvo) $\Delta\Omega \sim 1.5\pi$
- Tolerante a radiação de n e campos magnéticos (RIBRAS)
- Alta resolução temporal





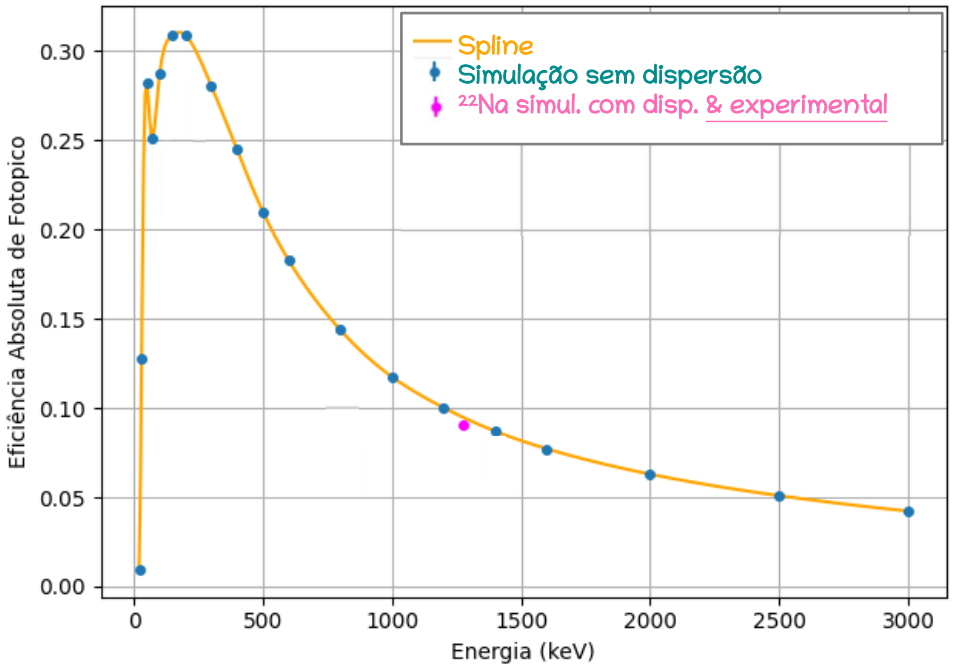
Resolução em energia

C.E.C.Vasconcellos, MSc Dissertation, IFUSP, 2025



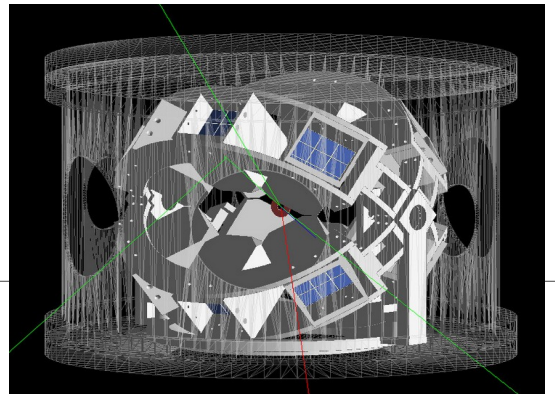
Próxima da ideal para LYSO(Ce)

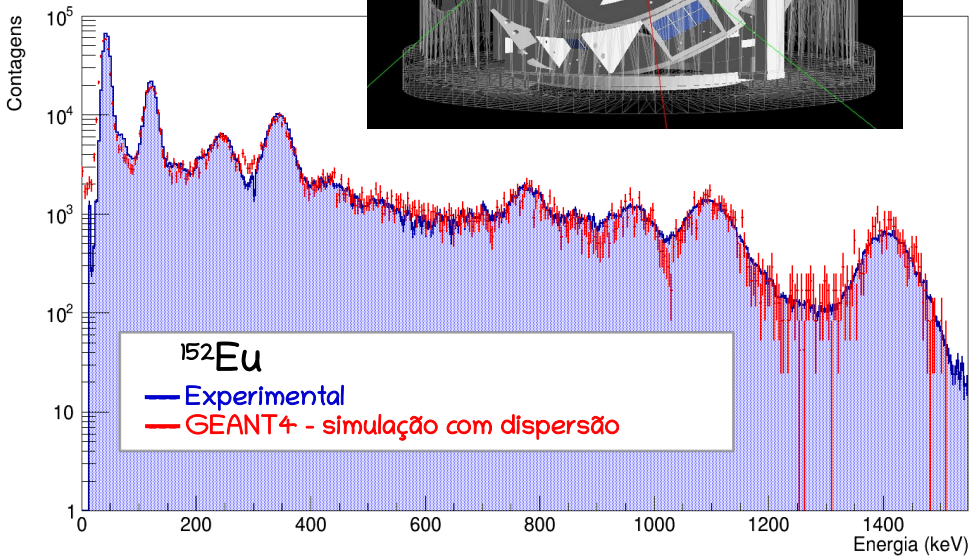
Efficiency and simulation validation



31% a 250 keV (max.)
10% a 1.2 MeV

GEANT4
Modelo
→ CAD

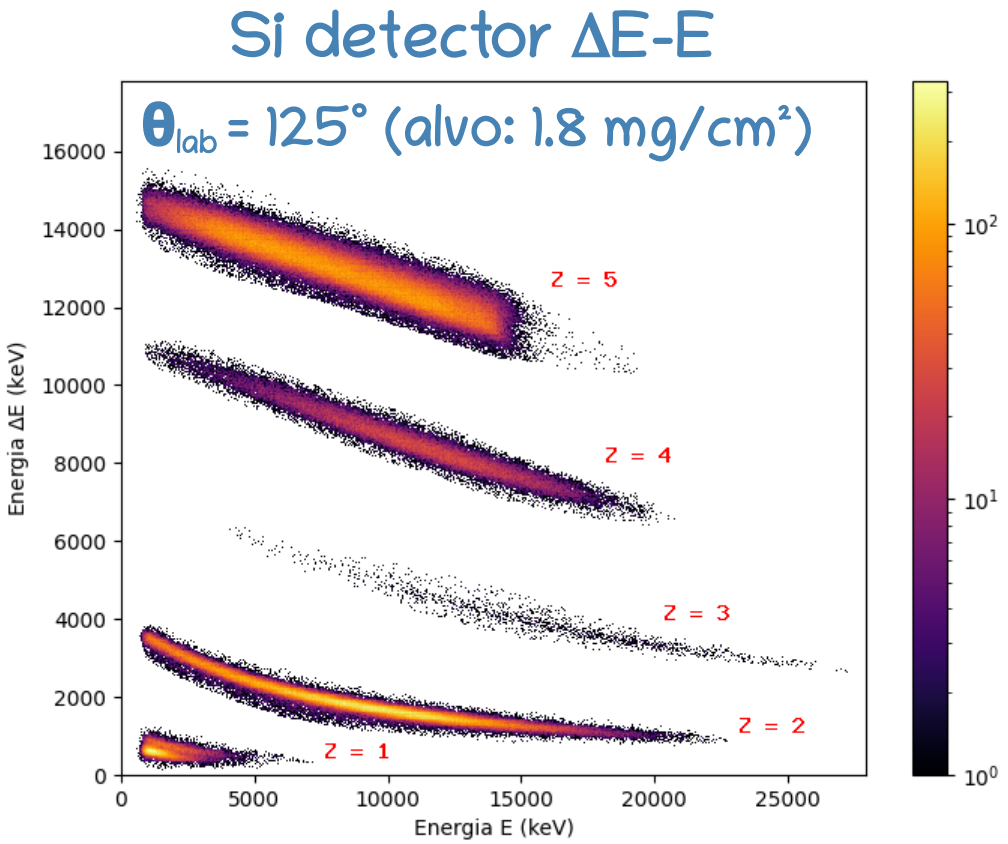




Teste com feixe

- Inelásticos
- Transfer/BU/ICF
- "Função de excitação"

$^{10}B+^{120}Sn$ @ 33.5 MeV



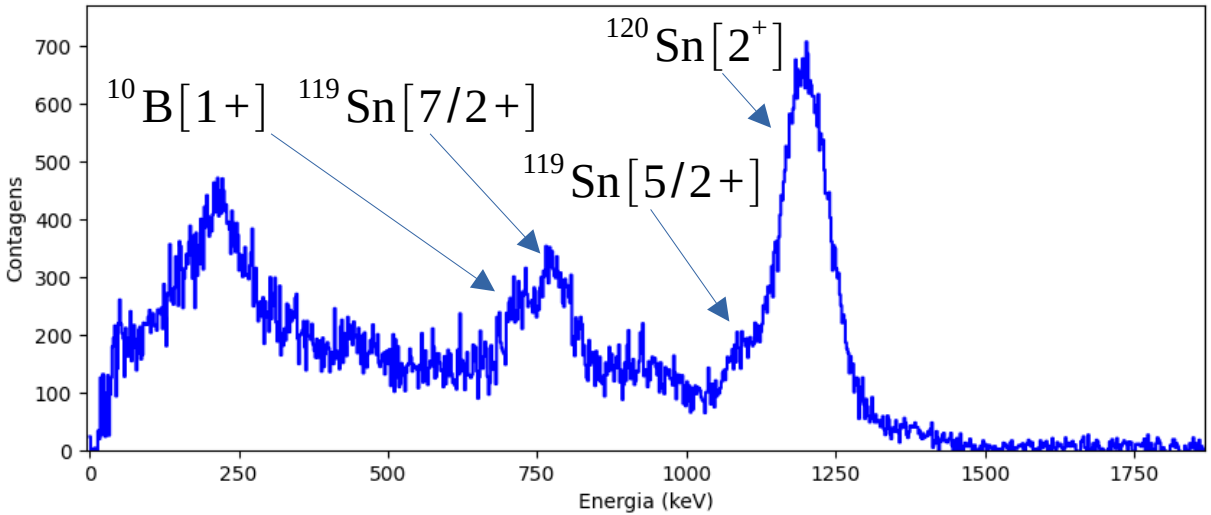
In-beam tests

$^{10}B+^{120}Sn$ @ 33.5 MeV

- Inel. & n pickup

$$^{120}\mathrm{Sn}[2^+] \rightarrow \frac{d\sigma}{d\omega} = 1.41(2)\ \mathrm{mb/sr}$$

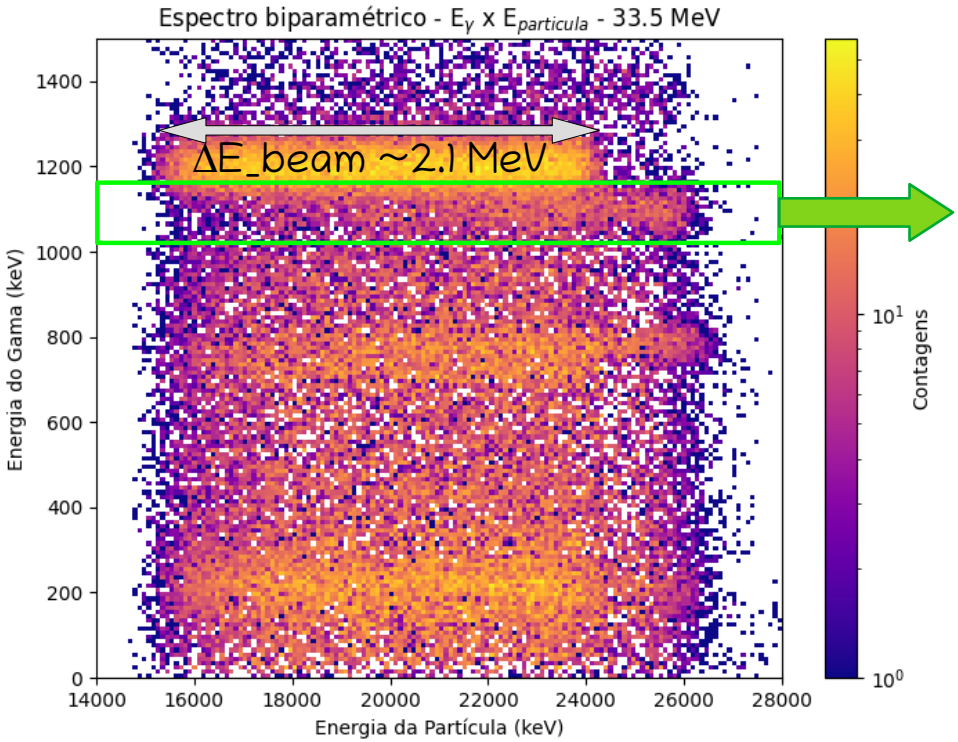
Cut @ Z=5

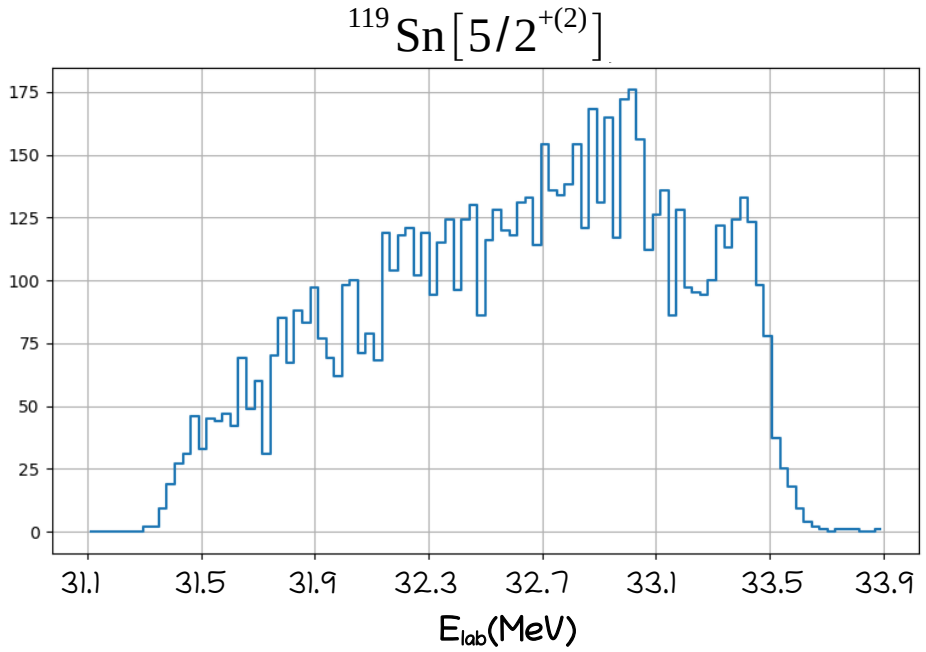


n - pickup

$^{10}B+^{120}Sn$ @ 33.5 MeV→ 31.4 MeV

Cut @ Z=5 & $E_\gamma \sim 1066$ keV



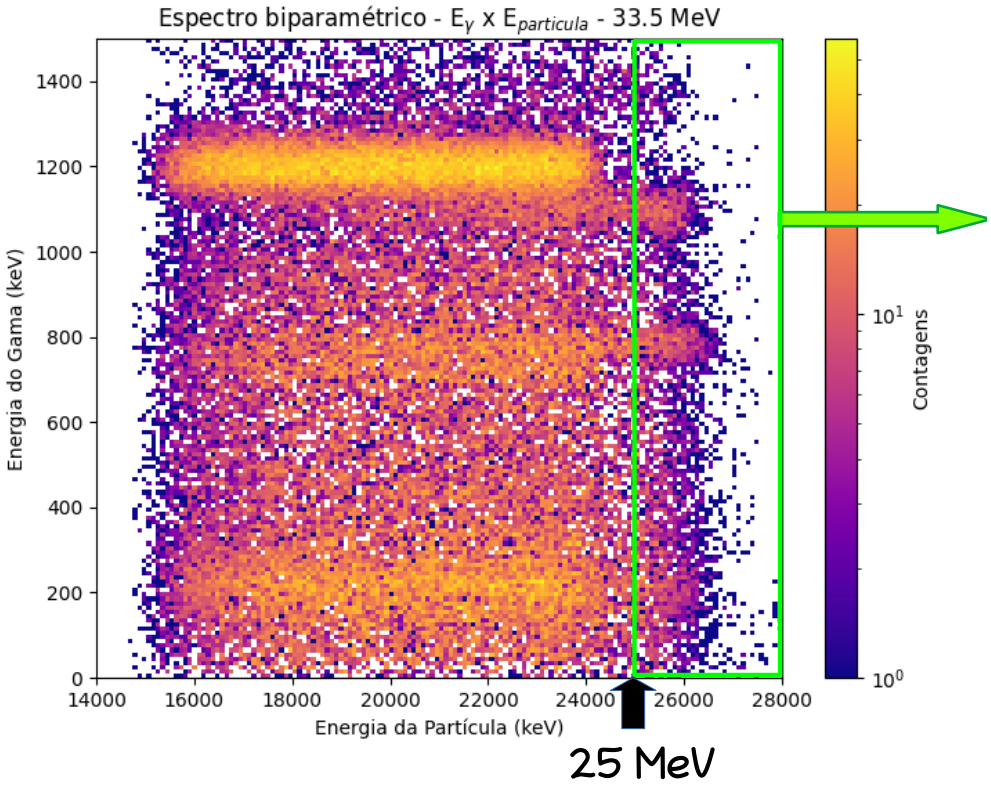


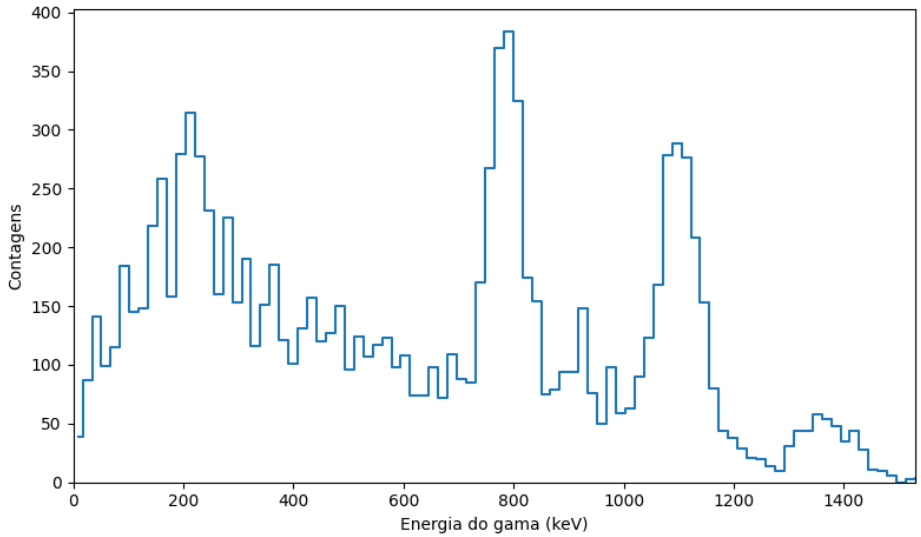
"Função de excitação"

n - pickup

$^{10}B+^{120}Sn$ @ 33.5 MeV

Cut @ Z=5 & E_P> 25 MeV
(Q=+2.35MeV)





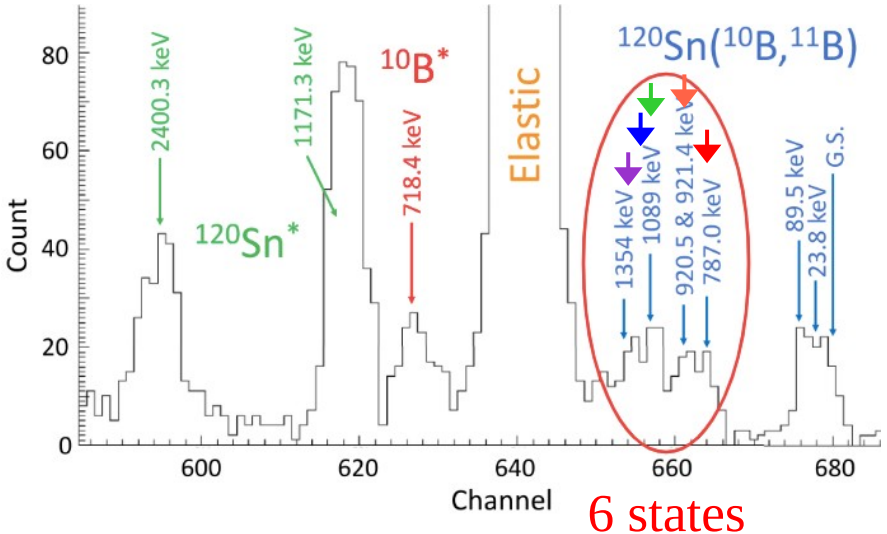
n - pickup

$^{10}B+^{120}Sn$ @ 33.5 MeV

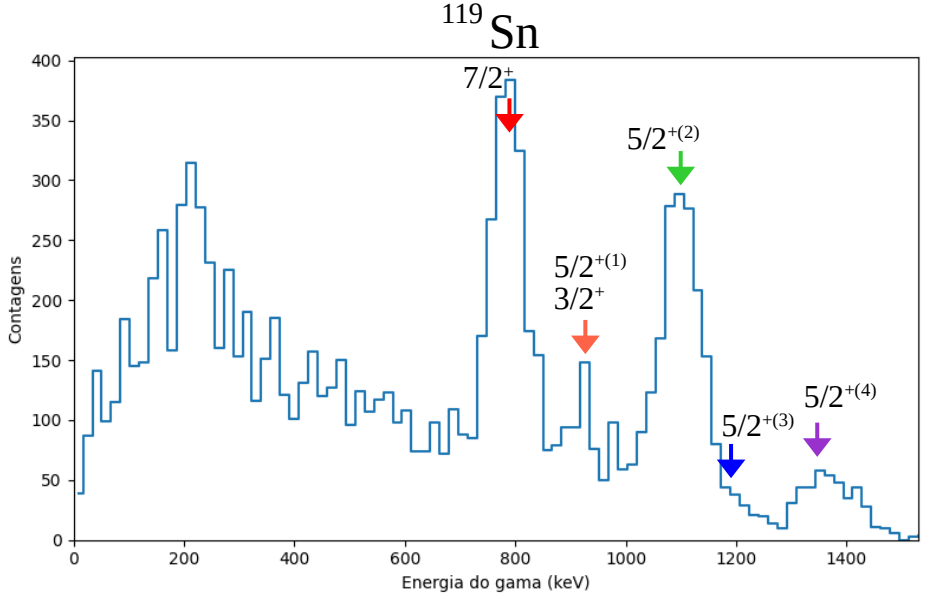
Cut @ Z=5 & E_P> 25 MeV

Si detector particle energy spectrum (@ 37.5 MeV)

L.R. Gasques,et al. *Physical Review C* 97.3 (2018): 034629.



6 states



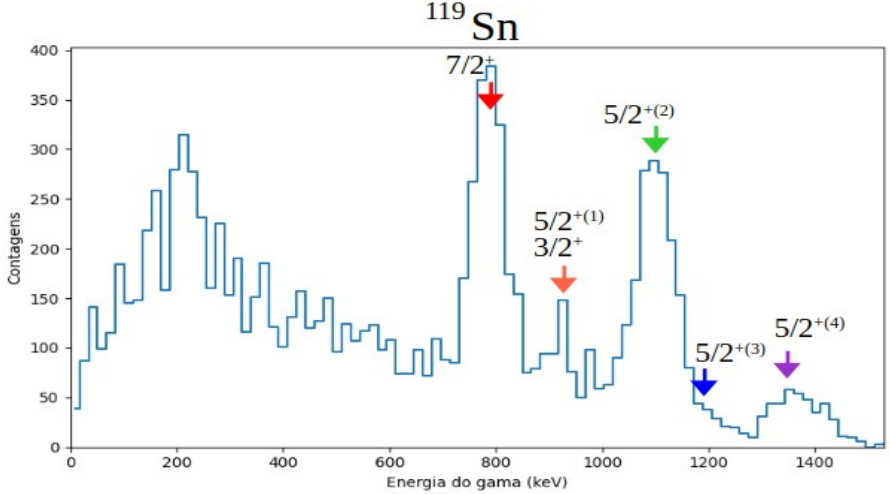
$$^{119}\mathrm{Sn}\,[\text{sum of 3 main states}] \rightarrow \frac{d\sigma}{d\omega} = 0.71(5)\ \text{mb/sr}$$

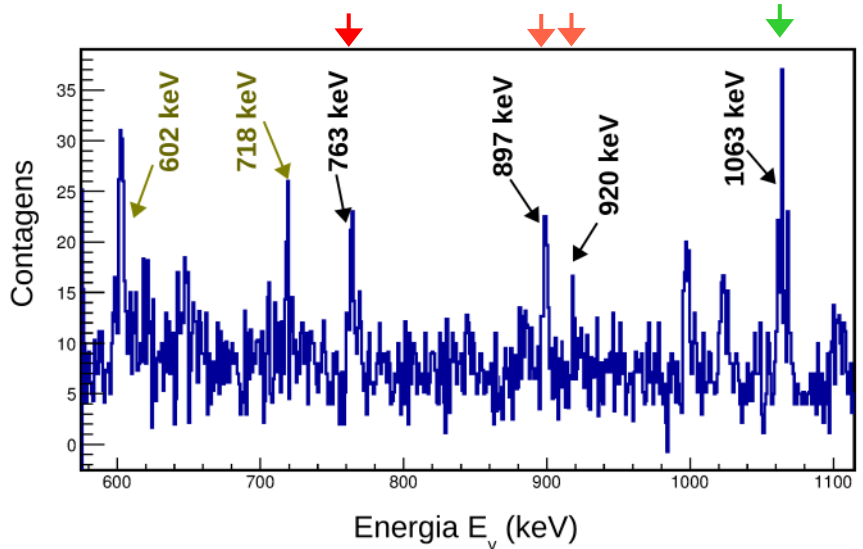
$$0.26(3)[7/2^+], 0.34(3)[5/2^{+(2)}], \text{and } 0.11(2)[5/2^{+(4)}]\ \text{mb/sr}$$

(resultados preliminares)

Nossa caixa X Saci-Perere

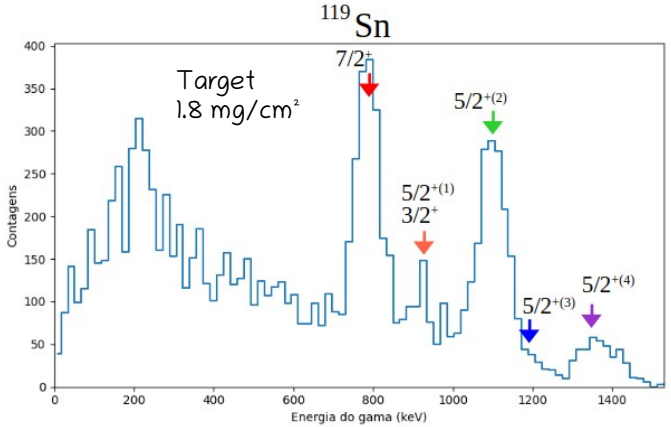
- = Baixa X Alta resolução em energia do gama
- = Alta X Baixa resolução em energia da partícula

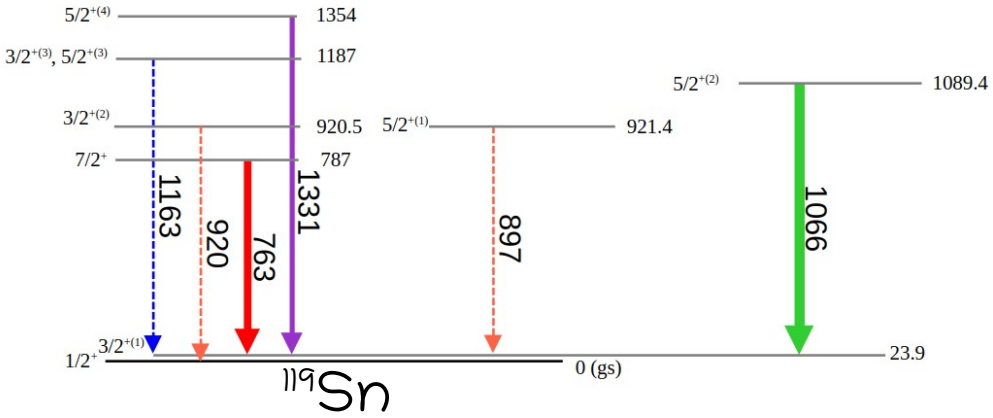




A. Freitas, PhD Thesis, IFUSP 2018

^{119}Sn esquema de níveis e FS





Spectroscopic Factors

E_x (keV)	State $(n\ell j)$	$C^2S_{\ell j}$
787.0	$1g_{7/2}$	5.15
920.5	$2d_{3/2}$	0.35
921.4	$2d_{5/2}$	0.30
1089	$2d_{5/2}$	2.82
1354	$2d_{5/2}$	0.98

L. Gasques et al., Phys. Rev. C 97, 034629 (2018)

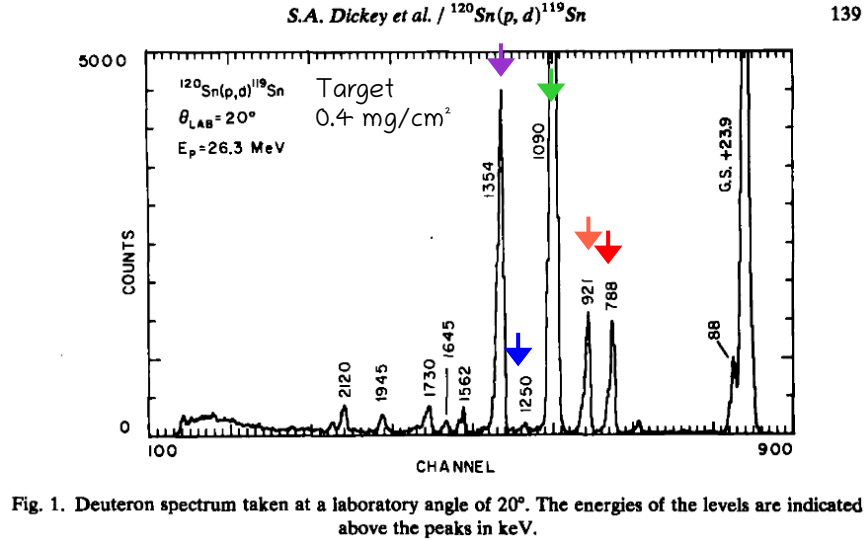
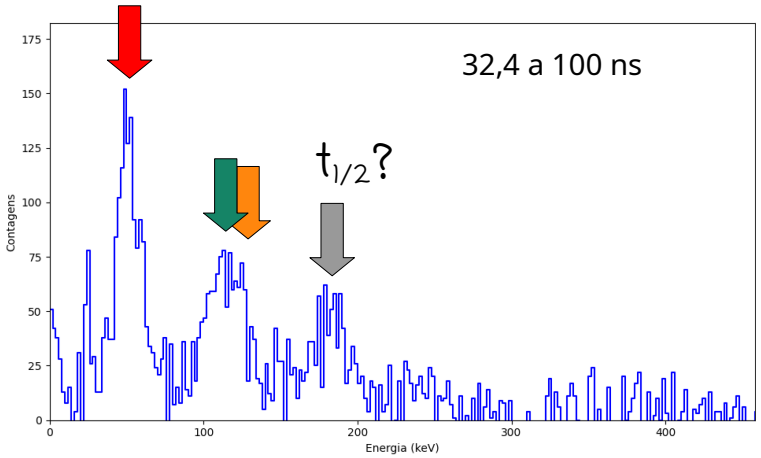


Fig. 1. Deuteron spectrum taken at a laboratory angle of 20°. The energies of the levels are indicated above the peaks in keV.

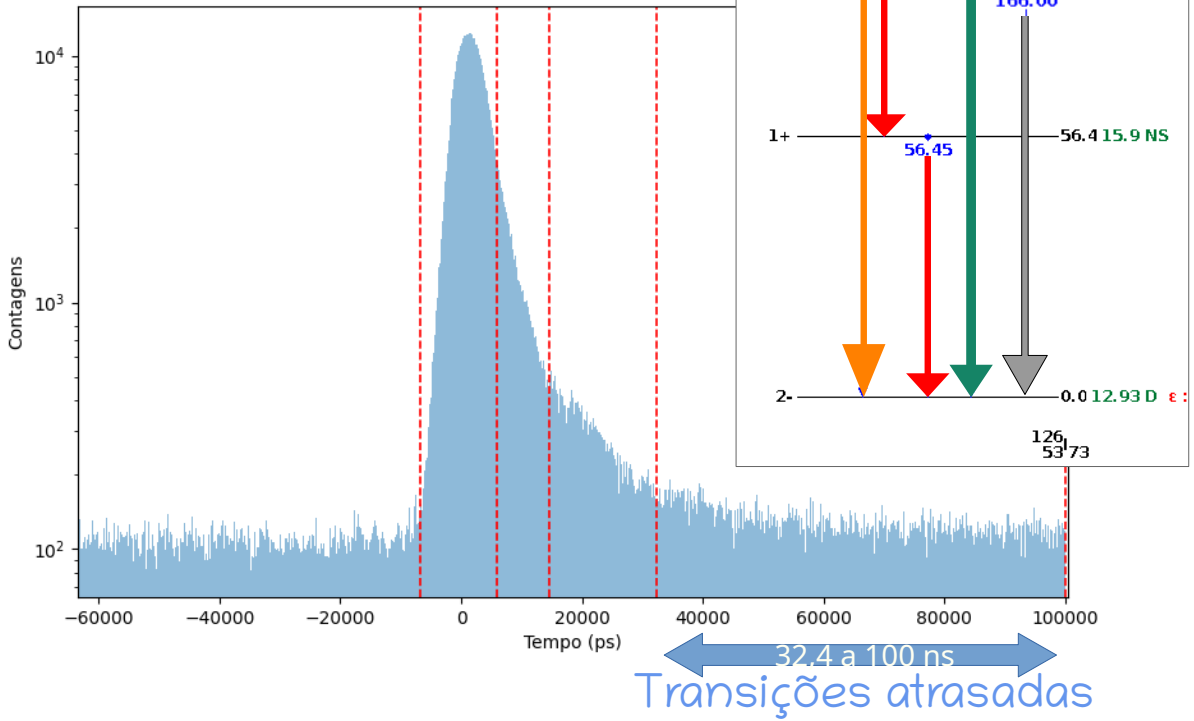
BU/Fusão incompleta

- $^{10}B \rightarrow {}^{6}Li + \alpha$
- $^{6}Li + {}^{120}Sn \rightarrow {}^{126}I$



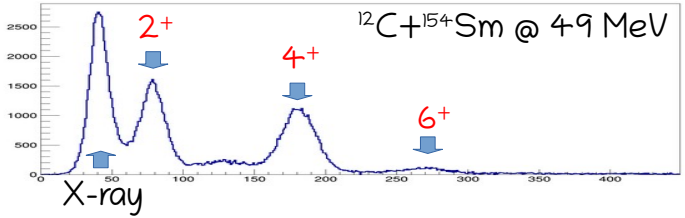
Corte em 2=2

Espectro de tempo



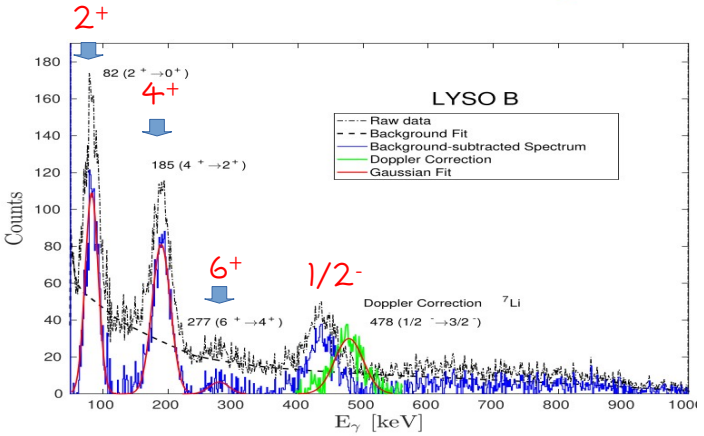
Outros experimentos

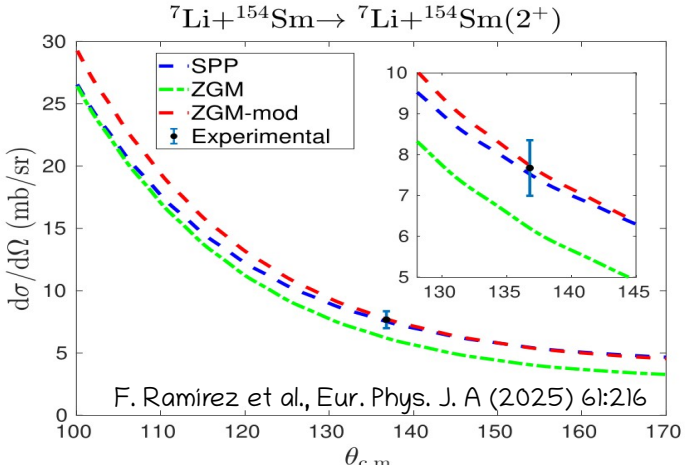
- $^{7}Li+^{154}Sm$: 1/6 NC (fase 1) →
- $^{12}C+^{154}Sm$ (G.B. Dacal)



- $^{8}Li+^{120}Sn$ - RIBRAS (O.C. Botelho)

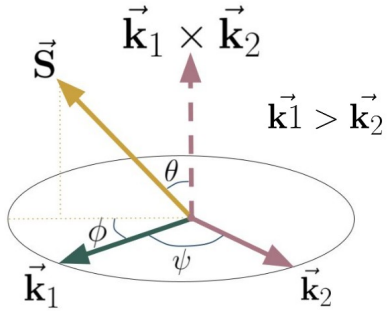
  B(E2), E*= 981 keV, S(n)~2 MeV





Outra linha de pesquisa com NC

- CP violation - Poster: J. V. L. do Nascimento
  - o-Ps - correlação angular de 2 (3) gamas



$$C_{CP}(\boldsymbol{s}\cdot\boldsymbol{k}_1)[\boldsymbol{s}\cdot(\boldsymbol{k}_1\times\boldsymbol{k}_2)]$$
$$= \mathrm{C_{CP}}\frac{P_2}{2}\sin 2\theta \sin\psi\cos\phi$$

Considerações finais

- NC operacional
- Boa sensibilidade em casos específicos
- Informações complementares às de outras técnicas
- Simulações com GEANT4 devem permitir extrair informações mais precisas
- Correlação angular gama-partícula - deve ser considerada informação adicional para testes de modelos
- Mais e/ou melhores detectores de partícula devem ser incorporados
- Disponível para propostas de experimentos
- + estudantes podem contribuir...

Colaboradores

IFUSP, IPEN, IFUFF:

C.E.C. Vasconcellos, N. Added, V.A.P. Aguiar, O.C. Botelho, **G.B. Dacal,** P.N. Faria, **C. Guimarães,** R. Lichtenthäler Fo., E.L.A. Machione, N.H. Medina, M. Moralles, **J.V.L. Nascimento,** S. Olorunfunmi, J.V. Schervelin, V. Zagatto

Obrigado!