Studio degli effetti d'isospin sulla densità dei livelli ed iniziative strumentali in vista della futura sperimentazione con SPES

- Fisica
- Studi con fasci ricchi di neutroni di SPES (LoI)
- Studi con fasci stabili
- Iniziative strumentali: R&D per la realizzazione di un rivelatore di neutroni di nuova generazione per la futura sperimentazione con SPES
- Stima dei costi per il 2011

Search for isospin effects on nuclear level density

A. Brondi[1], A. Di Nitto[1], G. La Rana[1], R. Moro[1], P.N. Nadtochy[1], E. Vardaci[1], A. Ordine[1], A. Boiano[1], M. Cinausero[2], M. Degerlier[2], F. Gramegna[2], V. Kravtchouk[2], T. Marchi[2], G. Prete[2], V. Rizzi[2], N. Gelli[3] and F. Lucarelli[3]

B.M. Nyakó[4], A. Algora[4], Zs. Dombrádi[4], J. Gál[4], Gy. Hegyesi[4], G. Kalinka[4], A. Krasznahorkay[4], I. Kuti[4], J. Molnár[4], J. Timár[4], L. Zolnai[4], K. Juhász[5], S.M. Grimes[6], A.V. Voinov[6]

[1]Università di Napoli and INFN Sezione di Napoli, Italy;
[2]Laboratori Nazionali di Legnaro (Padova), Italy;
[3]Univeristà di Firenze and INFN Sezione di Firenze, Italy
[4]Institute of Nuclear Research of the Hungarian Academy of Sciences (ATOMKI)
[5]Dept. of Information Technology, Faculty of Informatics, Univ. of Debrecen
[6]Physics and Astronomy Department, Ohio University, Athens OH, USA

Study of isospin effects on level density through fusion-evaporation reactions

$$P(U_o, J_o, \varepsilon, l, U, J) \propto \rho(U,J) \,.\, T_l(\varepsilon)$$

$$\rho(U) = \frac{1}{12\sqrt{2}} \frac{1}{\sigma a^{1/4}} \frac{\exp[2\sqrt{a(U-\delta)}]}{(U-\delta)^{5/4}}.$$

$$\rho(U,J) = \frac{(2J+1)}{2\sigma^2} \exp\left[\frac{-\left(J+\frac{1}{2}\right)^2}{2\sigma^2}\right] \rho(U).$$

Angular momentum, Pairing & Shell effects ...

Isopin (?)

Isospin can affect two quantities:: **Level density parameter** *a*

Symmetry Energy

Effects on level density parameter *a*

PHYSICAL REVIEW C, VOLUME 63, 065803

Are the level densities for *r*- and *rp*-process nuclei different from nearby nuclei in the valley of stability?

S. I. Al-Quraishi,[1] S. M. Grimes,[2] T. N. Massey,[2] and D. A. Resler[2]

$$\rho(U) = \frac{\sqrt{\pi}}{12} \frac{\exp(2\sqrt{aU})}{a^{1/4}U^{5/4}},$$

Form A: $a = \alpha A$

Form B: $a = \alpha A / \exp[\beta(N-Z)^2]$.

Form C: $a = \alpha A / \exp[\gamma(Z-Z_0)^2]$,

ρ ↘ N-Z ↗

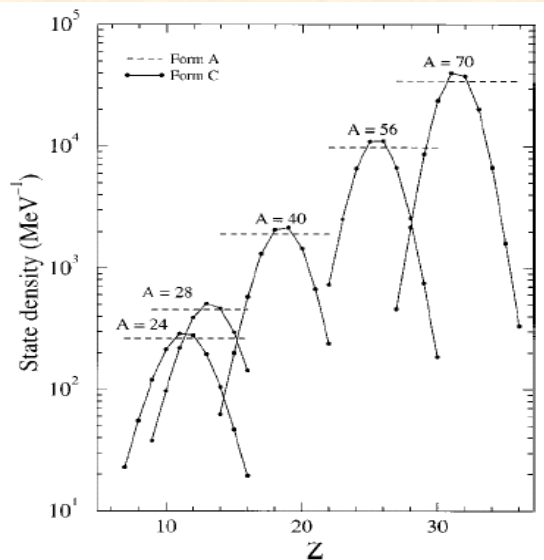
Strong support from recent LD calculations

Best fit: 241 nuclei

E_x up to 7 MeV

20<A<110 ENSDF

Z-Zo dependence: better reproduction of data



Strong implications in nuclear astrophysics

SYMMETRY ENERGY

VOLUME 72, NUMBER 18 PHYSICAL REVIEW LETTERS 2 MAY 1994

Temperature Dependence of the Nucleon Effective Mass and the Physics of Stellar Collapse

P. Donati,[1] P. M. Pizzochero,[1] P. F. Bortignon,[1] and R. A. Broglia[1,2]

Framework: Dynamical Shell Model
Hartree-Fock Coupling single particle states to suface vibrations

Increasing T

↓

Decrease of the nucleon effective mass m^* → decrease of a(T)

Increase of E_{sym} → increase of M, decrease of B

SPES offers the opportunity of a systematic study of these isospin effects

-Observables: multiplicitities, energy spectra, ER-lp angular correlations, ER yield.

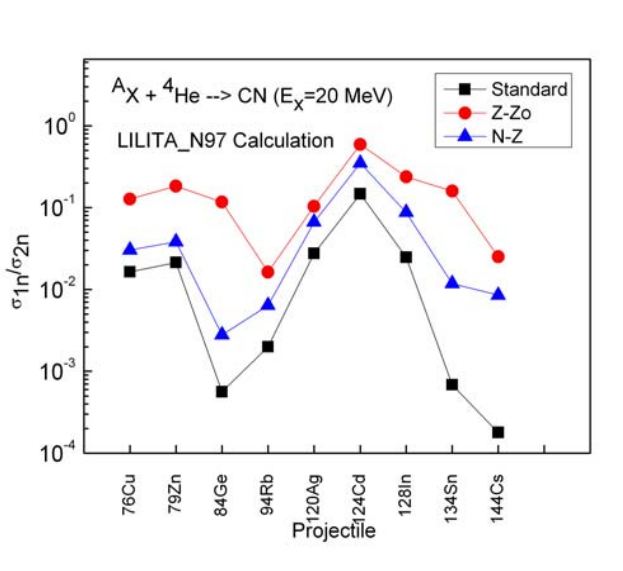
-Reactions on ^{4}He: low angular momentum effects, possibility to produce CN starting from low Ex (~ 20 MeV).

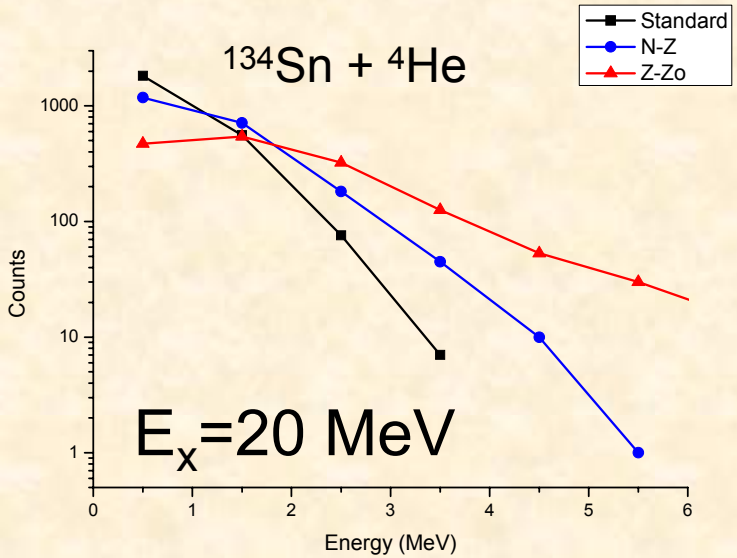
-Possible reactions:
^{76}Cu, ^{79}Zn, ^{84}Ge, ^{94}Rb, ^{120}Ag, ^{124}Cd, ^{128}In, ^{134}Sn, ^{144}Cs + ^{4}He

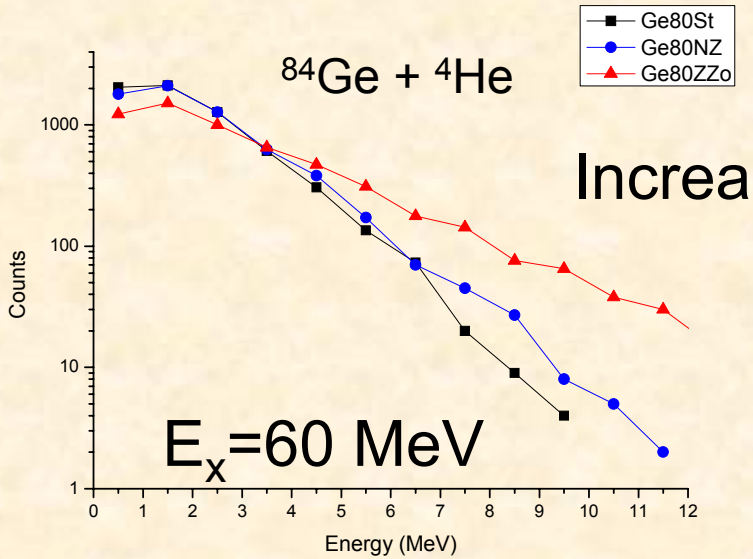
Elab ~ 3 – 10 MeV/A; Ex ~ 20 – 50 MeV; σ_{FUS} ~ 0,2 – 1 barn

Simulations with Lilita_N97 for these reactions, including all the isospin effects, indicate that these effects are relevant and can be sistematically studied with SPES

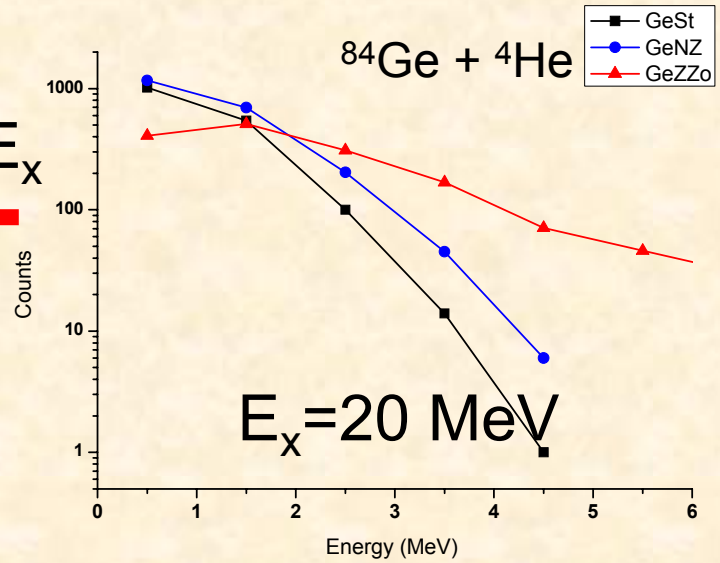
SM predictions for n-rich nuclei







Increasing E_x

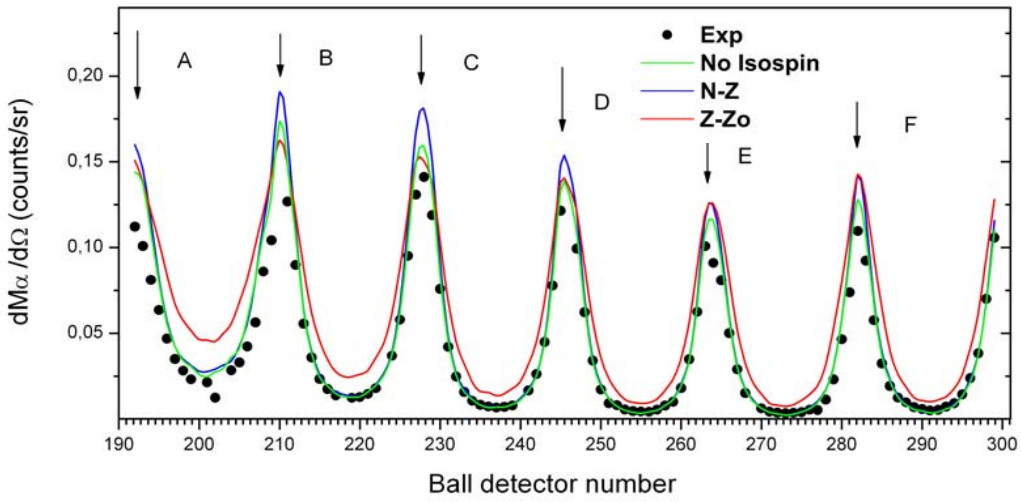


Studies with stable beams

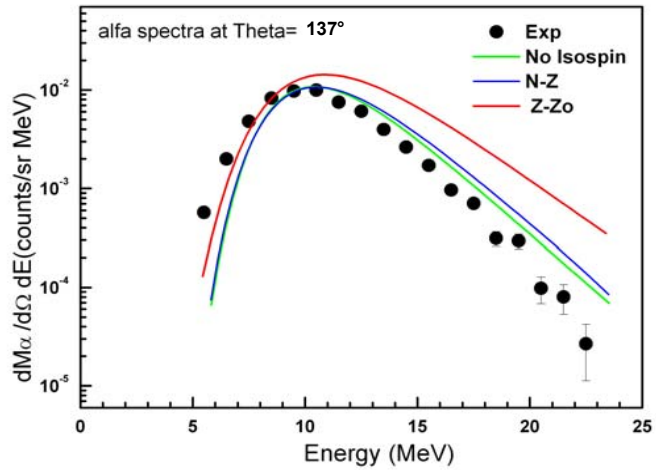
$^{32}S + ^{107}Ag$ a E_{LAB} = 180 MeV:data against SM simulations

Code Lilita_N97; Optical model transmission coefficient; level density from Al-Quraishi et al.

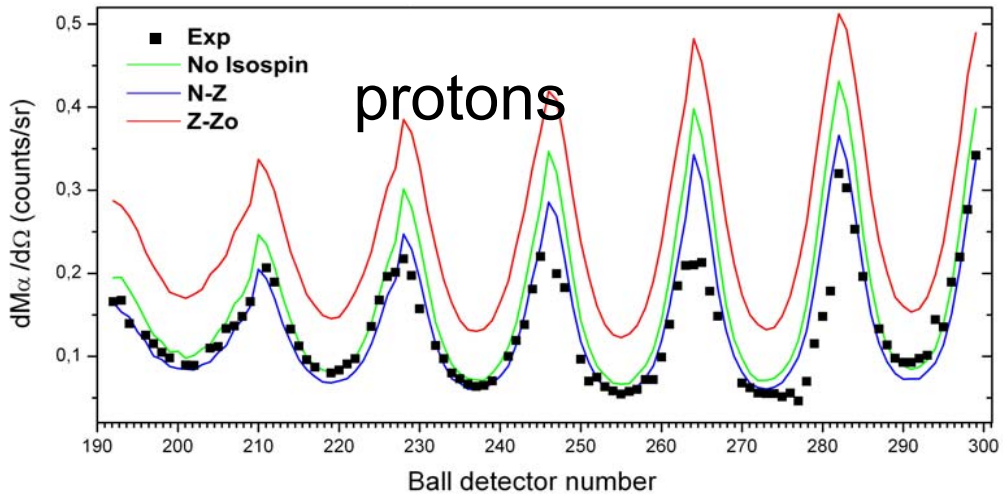
Multiplicity distribution of alpha particles

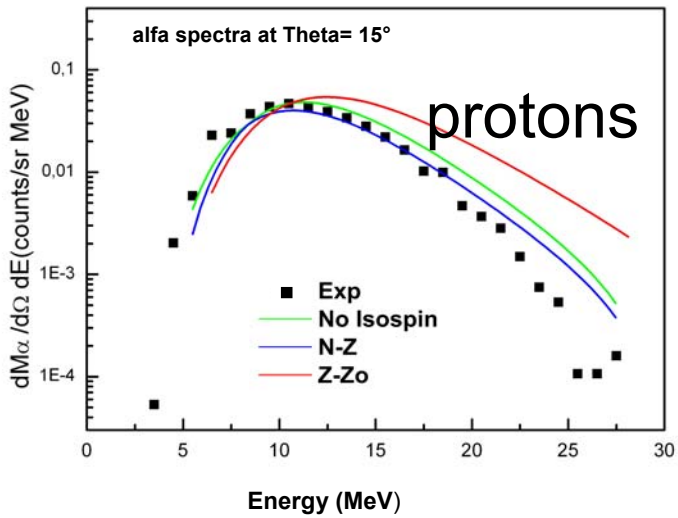


α energy spectrum



No evidence of Z-Zo effects – No possible to discriminate between st. and N-Z

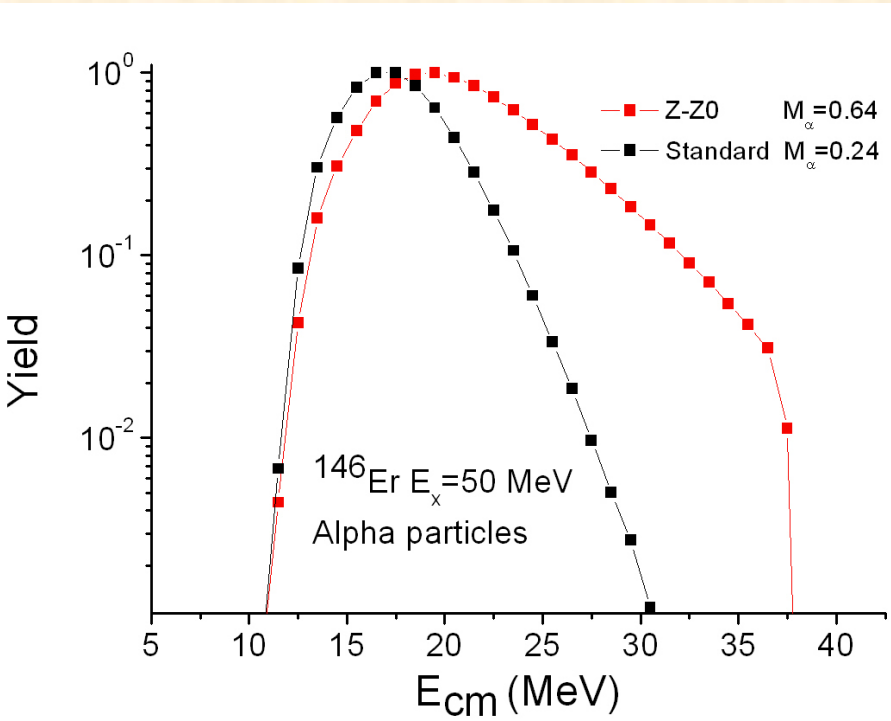


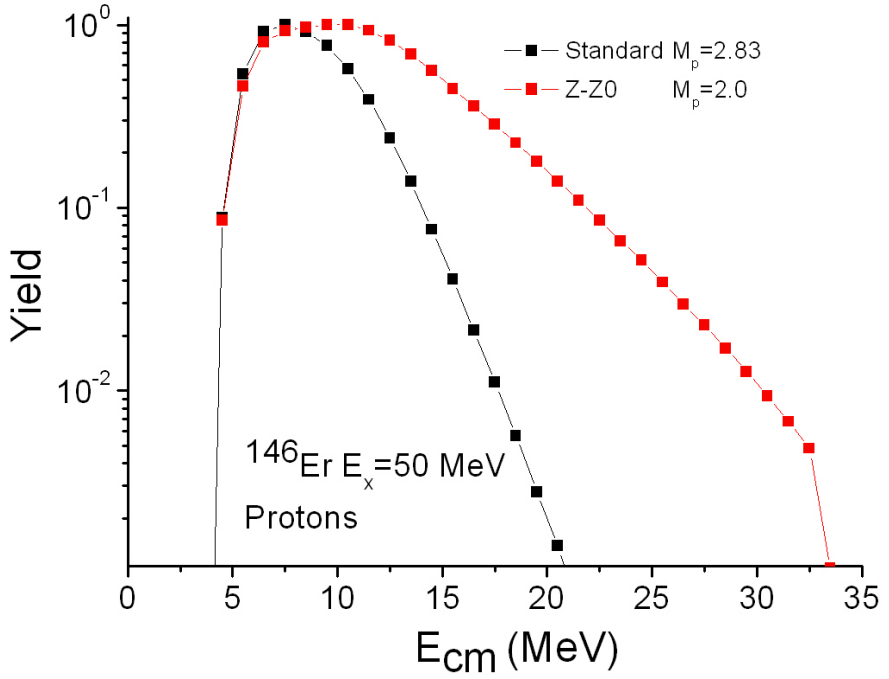


Al Quraishi parameters are not appropriate for this Ex (?)

Possibile sistema da studiare:

180 MeV ^{40}Ca + ^{106}Cd → ^{146}Er (E_x=50 MeV, Z-Zo=6,78)





σ_{fus}=370 mb

LoI Voinov et al.

Energia di simmetria: in corso delle simulazioni per i sistemi: ^{7}Li + $^{62,64}Ni$ -> $^{69,71}Ga$ E_x=30-50 MeV

1 turno/anno

Iniziative strumentali:

Riunione del 14/4 ai LNL: RIPEN, NEDA, LNS

NEDA: p.p. phase SPIRAL2 – fine dei lavori (ottobre 2010 – probabile estensione di un anno). A seguire il MoU

Coordinamento di iniziative trasversali in diversi esperimenti: nostro, Gamma, Exochim per attività di R&D. Obiettivo principale: realizzazione di un rivelatore di neutroni di nuova generazione per la futura sperimentazione con SPES, partendo dalle attuali attività(RIPEN, NEDA, LNS)

Possibile attività di R&D 2011 nell'ambito del progetto NEDA

- Test scintillatori liquidi BC501A (C_9H_{21}); BC537 (C_7D_7) presso i LNL
- Test SiPM (limite nelle dimensioni e costi): il piccolo spessore apre la possibilità di un rivelatore per neutroni a stack. (buona risoluzione temporale per misure di TOF). Collaborazione con IRST (Tn)
- Simulazioni Monte Carlo

Attuale geometria in studio per NEDA: sferica compatta, d=1 m, risoluzione E=1 MeV 16%, E=8 MeV 30 % -> intervento della com. italiana per soluzioni che permettano misure di TOF

Piano finanziario linea 3 (Napoli)

- Esperimenti per lo studio degli effetti di isospin

  Interno

  1 turno di misura nel 2011 presso i LNL:

  1 viaggiox2ric. - 10gg prepar. turno 2 Keuro

  1 viaggiox5ric. – 35gg turno 6 Keuro

●Iniziative strumentali

Consumo (da distribuire sul ns esp. e GAMMA)

2 MCP-PMT (Planacon XP85012) 10 Keuro

4 Si-PM IRST (Trento) 4 Keuro

Interno

Contatti IRST (Trento): 2 viaggix1ric.-4gg. 1 Keuro

Test LNL: BC501A, BC537, MCP-PMT: 2 viaggix1 ricercatore - 2 sett. 2.5 Keuro

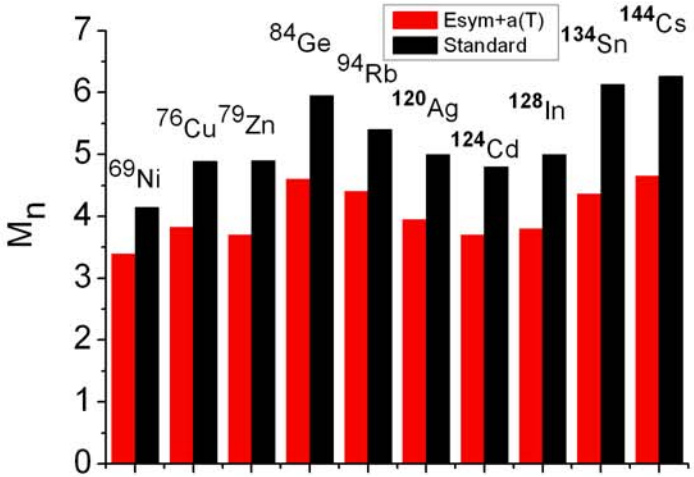
Riunioni della collaborazione NEDA presso i LNL 3 viaggix1 1 ric. – 6 gg. 1.5 Keuro

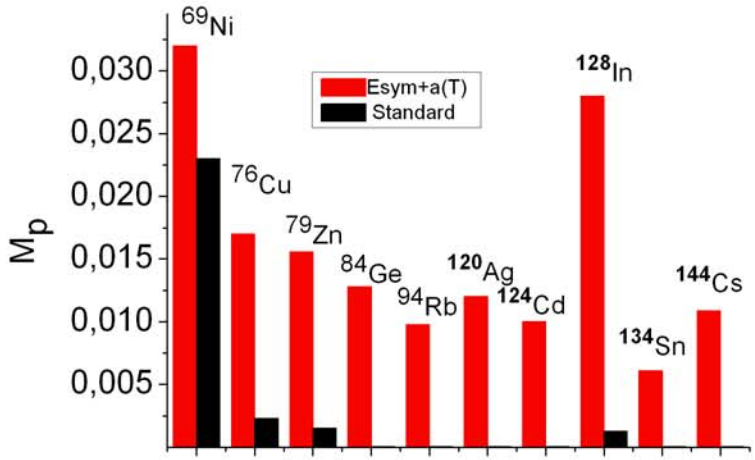
Estero

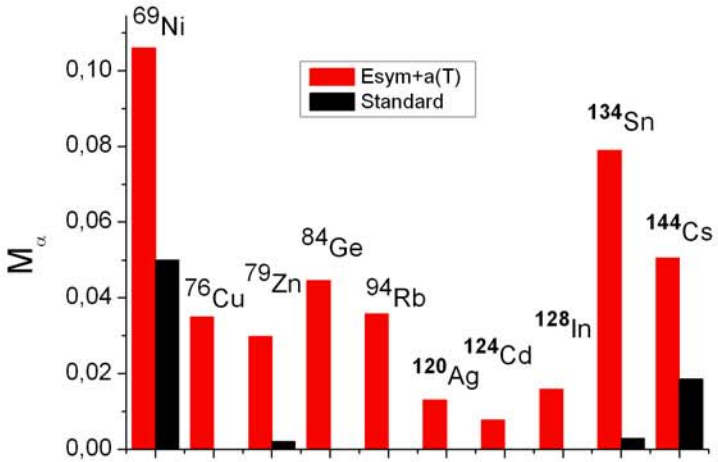
Collaborazione scientifica (Polonia, Upssala) 2 viaggix1ric.-2 sett. 2.5 Keuro

Totale 21.5 Keuro

SM predictions for exotic nuclei (RIB + ^{4}He)

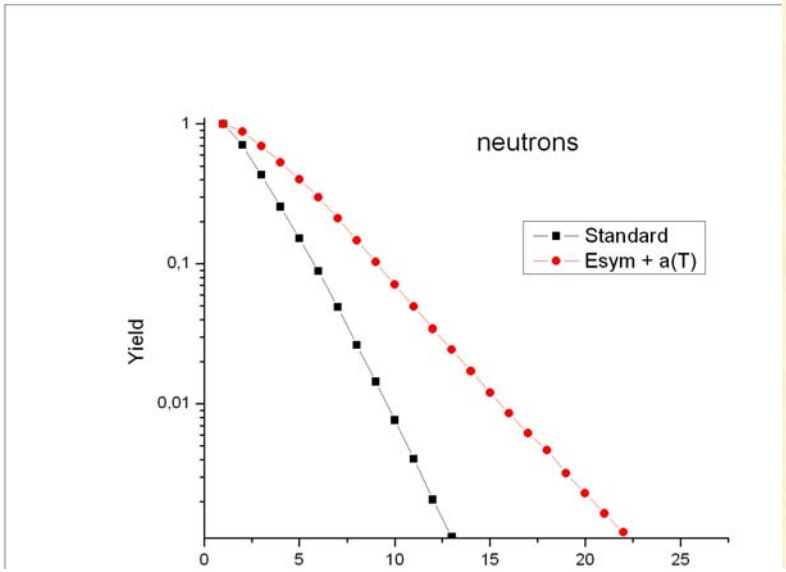






Icp channels are open assuming Esym+a(T) effects

Energy spectra $^{120}Ag + {}^{4}He$



Importance to select xn channels