COMPARATIVE ANALYSIS OF CROSS SECTIONS OF RESIDUAL NUCLEI ON SEPARATED TIN ISOTOPES AT A BEAM ENERGY OF PROTONS AND DEUTERONS 3.65 GeV/NUCLEON.

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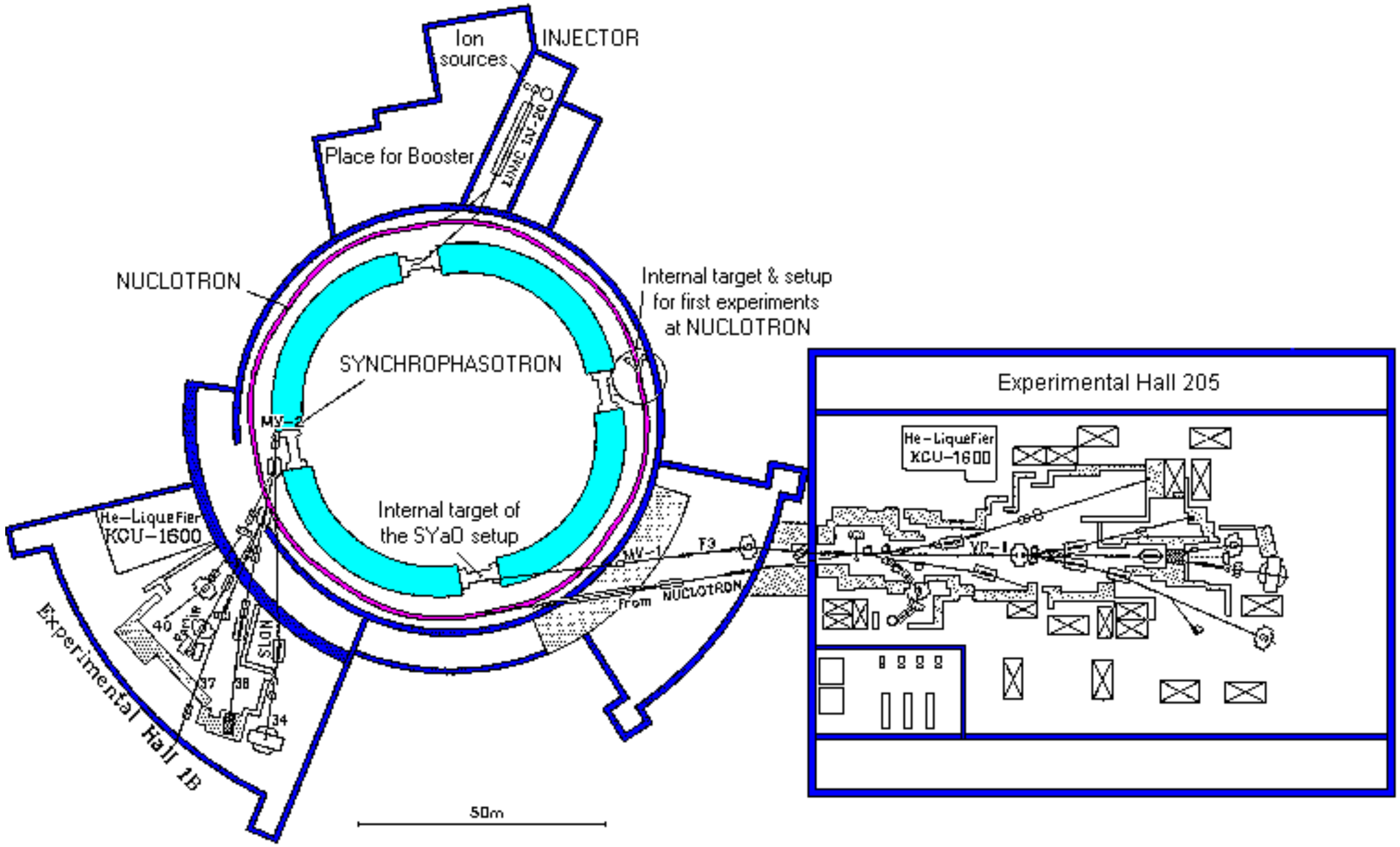
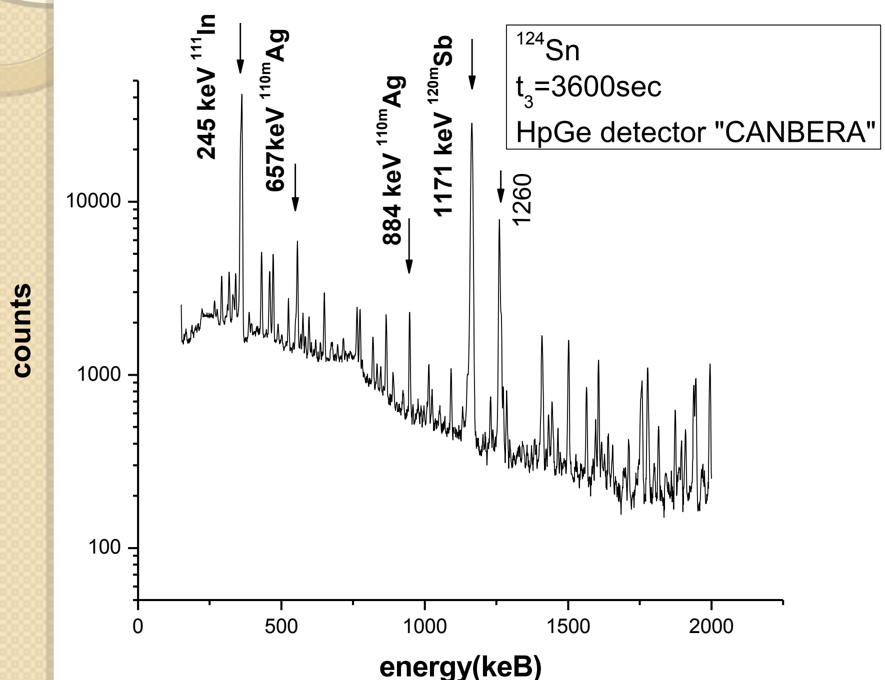
Experimental Setup



Characteristical Gamma Spectrum of residual nuclei



- Targets: ^{112}Sn
  ^{118}Sn
  ^{120}Sn
  ^{124}Sn

Energy of protons and deuterons beams: 3.65GeV/nucleon

Analytic representation of cross-sections

$$\sigma(A,Z) = \exp(a1 + a2\cdot A + a3\cdot A^2 + a4\cdot A^3 + (a5 + a6\cdot A + a7\cdot A^2)\cdot \left|Z_p - Z\right|^{a8})$$

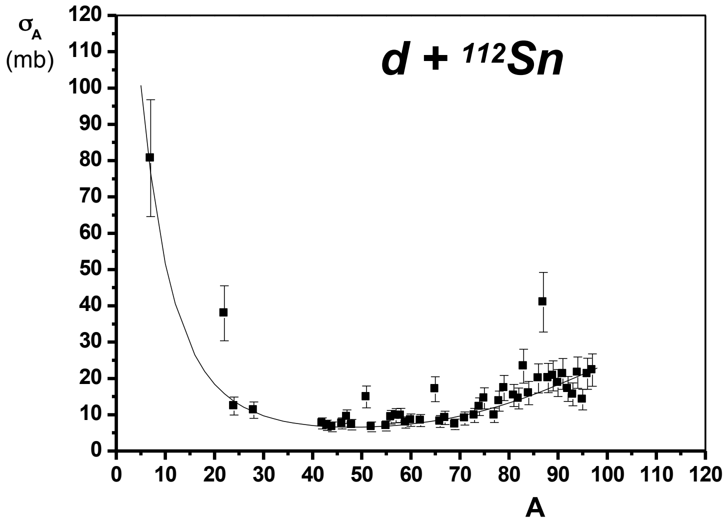
$$Z_p = a9\cdot A + a10\cdot A^2$$

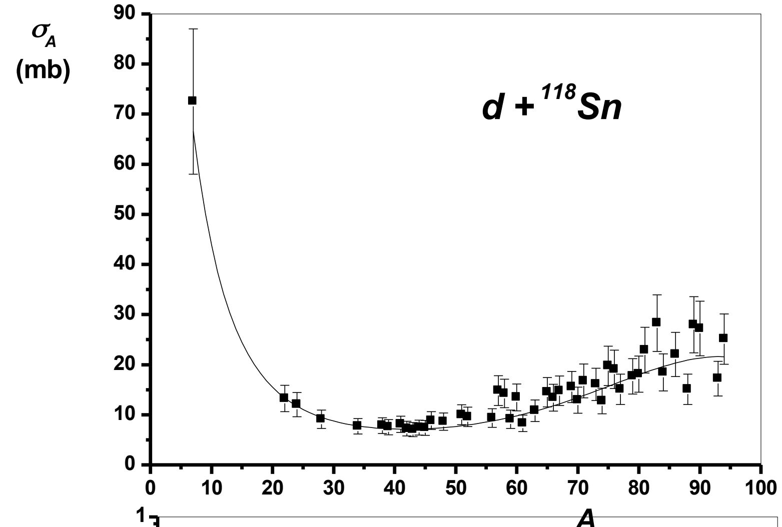
A1, A2, A3, A4 give the shape of mass-yield curve
A5, A6, A7 give the width of isobaric distribution
A9, A10 give the position of peak of isobaric distribution

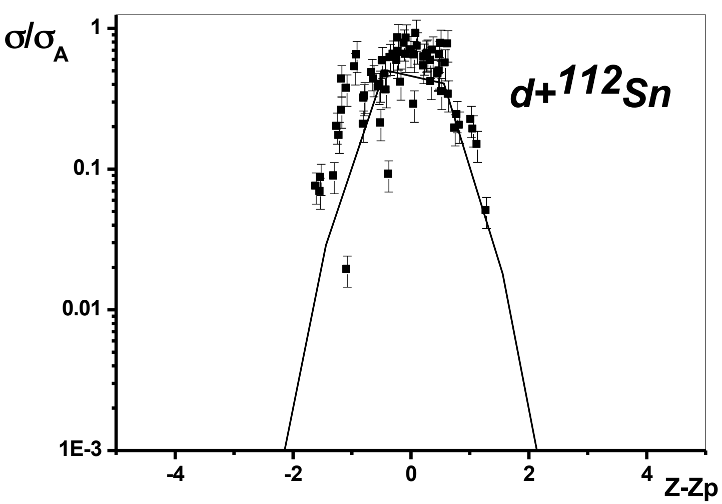
Table 1. The parameters of fitting for the targets ^{112}Sn, ^{118}Sn, ^{120}Sn и ^{124}Sn

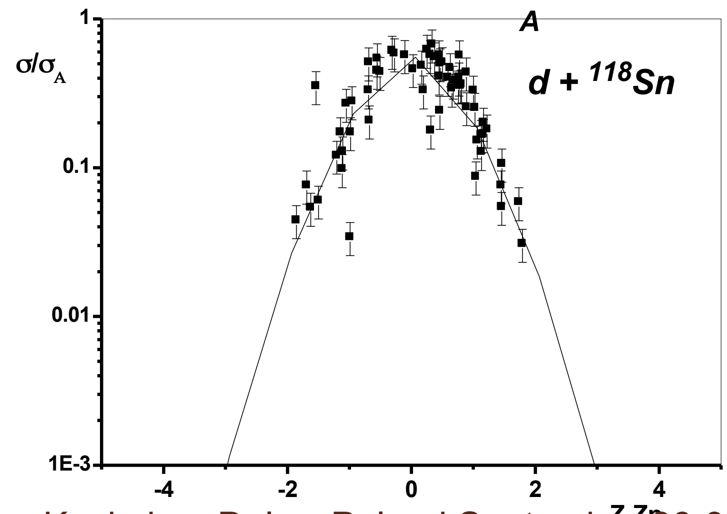
Parameters	^{112}Sn	^{118}Sn	^{120}Sn	^{124}Sn
a1	5.1 ± 0.11	5.1 ± 0.2	7.31 ± 0.2	4.2 ± 0.2
a2	-0.167 ± 0.002	-0.195 ± 0.009	-0.325 ± 0.009	-0.139 ± 0.008
a3	0.0025	0.0033 ± 0.00013	0.0058 ± 0.00012	0.0026 ± 0.00012
a4	$(-10.71 \pm 0.12)10^{-6}$	$(-16.52 \pm 0.64)10^{-6}$	$(-30.39 \pm 0.53)10^{-6}$	$(-14.08 \pm 0.61)10^{-6}$
a5	-1.54 ± 0.06	-1.49 ± 0.16	-4.14 ± 0.22	-0.82 ± 0.14
a6	-0.018	0.006 ± 0.004	0.115 ± 0.007	-0.018 ± 0.003
a7	$(20.4 \pm 0.6)10^{-5}$	$(1.4 \pm 0.3)10^{-5}$	$(-10.5 \pm 0.6)10^{-4}$	$(1.99 \pm 0.2)10^{-4}$
a8	1.7	1.7	1.8	1.7
a9	0.483 ± 0.0005	0.477 ± 0.0004	0.4619 ± 0.0005	0.4752 ± 0.0005
a10	$(-27.7 \pm 0.5)10^{-5}$	$(-29.1 \pm 0.5)10^{-5}$	$(-5.4 \pm 0.5)10^{-5}$	$(-31.8 \pm 0.6)10^{-5}$

Mass yield and charge dispersion curves









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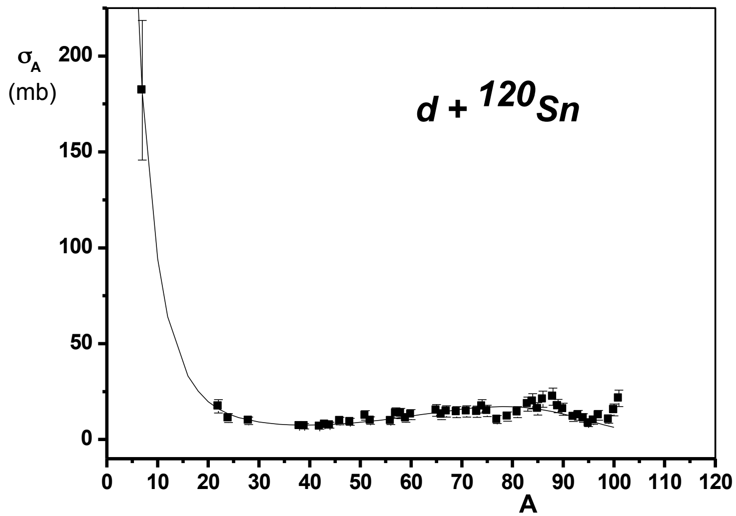
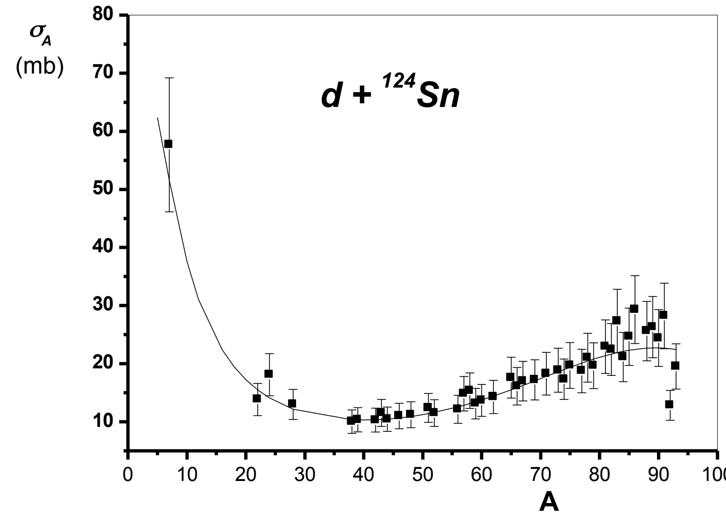
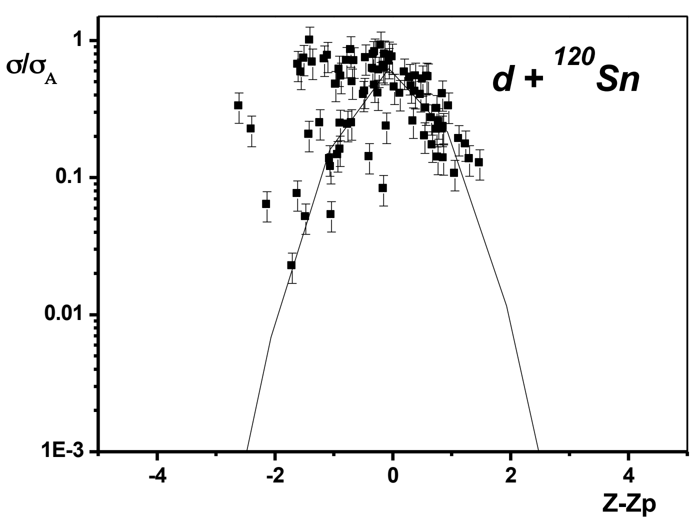
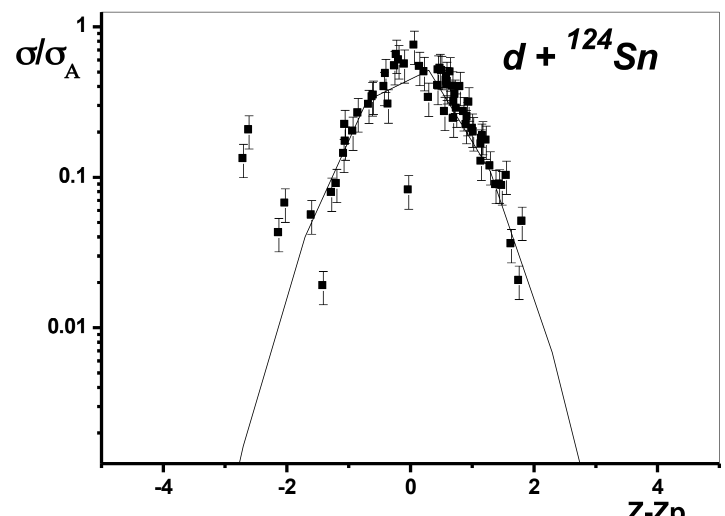
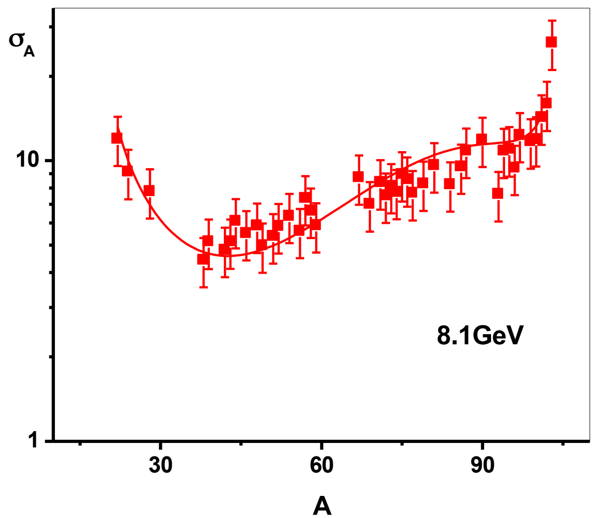


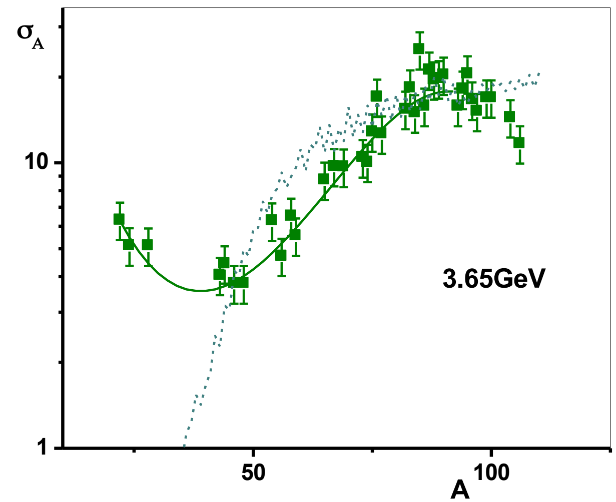


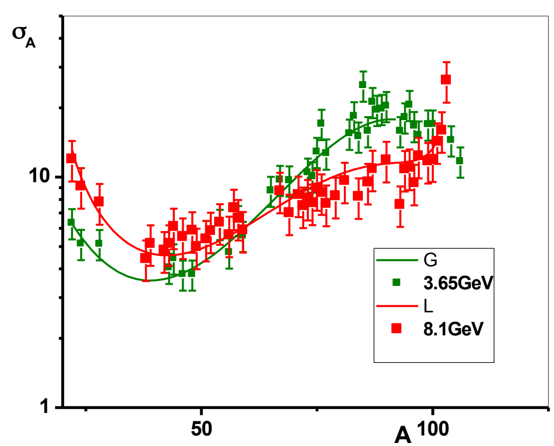




Comparison of mass-yield curves for 3.65 GeV and 8.1 GeV protons







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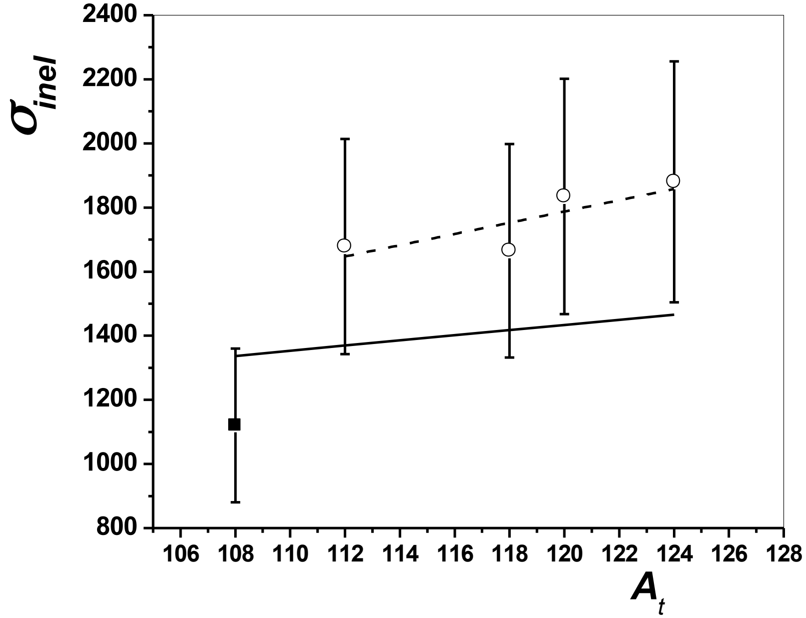
Total inelastic cross-sections



$$\sigma(A) = \sum_Z \sigma(A,Z)$$

$$\sigma_{inel} = \sum_A \sigma(A)$$

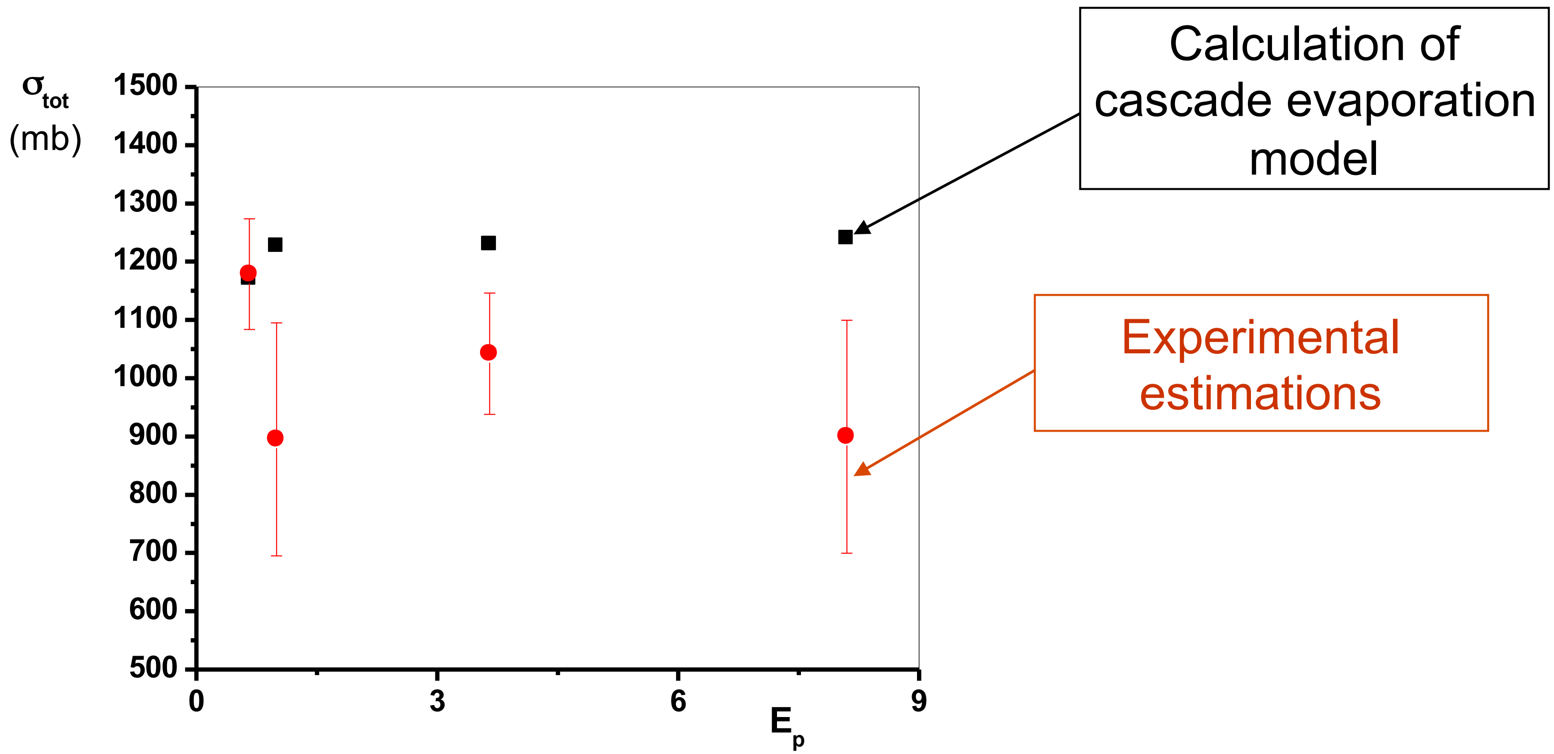
Theoretical estimation made by the formula (H.H.Hekman, D.E.Greiner, P.J.Lindstrom,Phys.Rev.C 17,1735,1978)

$$\sigma_{inel} = \pi r_0^2 [A_B^{1/3} + A_T^{1/3} - b_0(A_B^{-1/3} + A_T^{-1/3})]^2$$

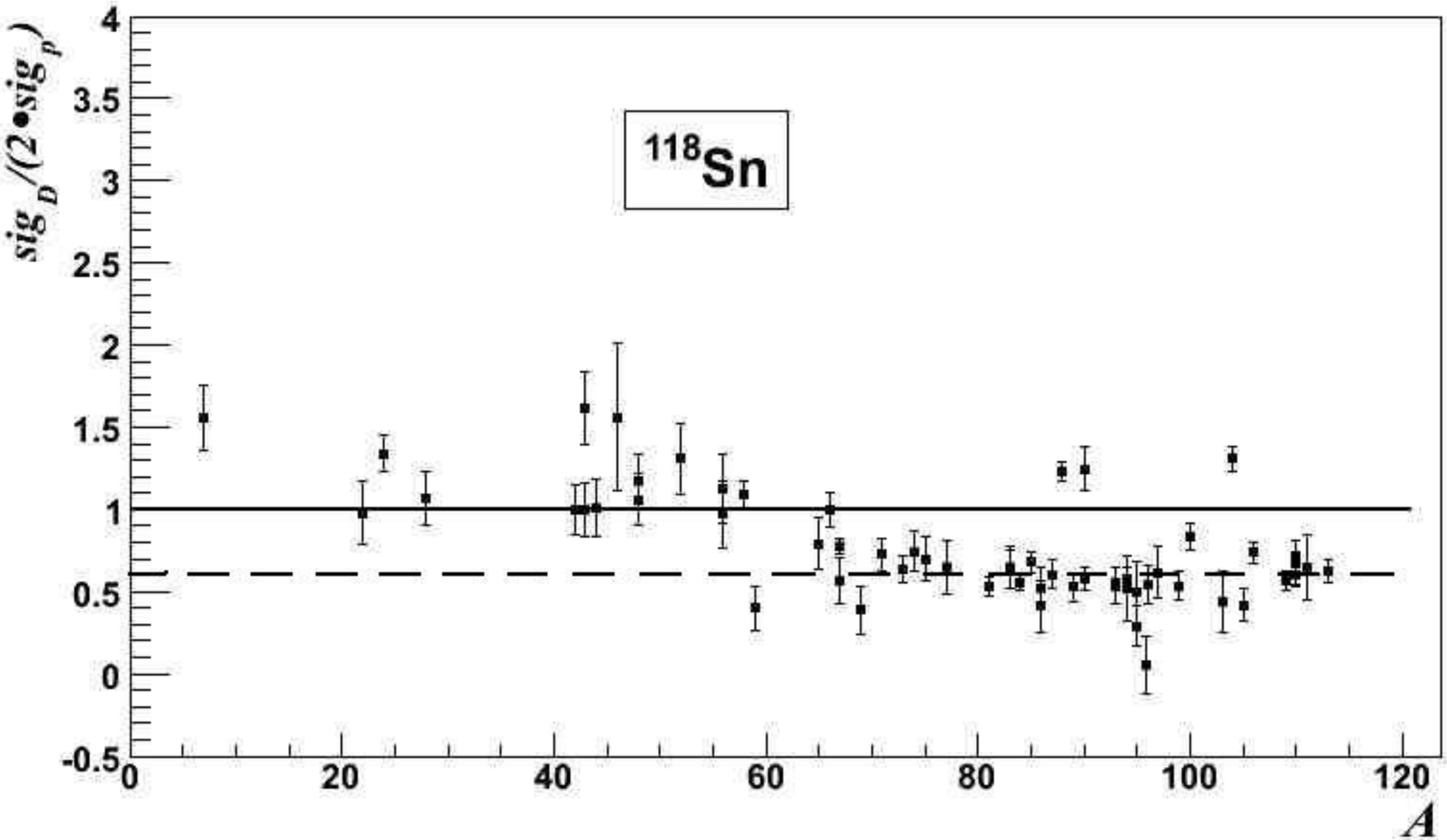
where b_0 is the overlap parameter, A_B is the mass number of the beam nucleus and A_T is the mass number of the target nucleus

Dashed curve is the $\sigma \approx A^{2/3}$ dependence

Dependence of inelastic cross sections via energy of protons



The dependence of ratio on the mass number of products



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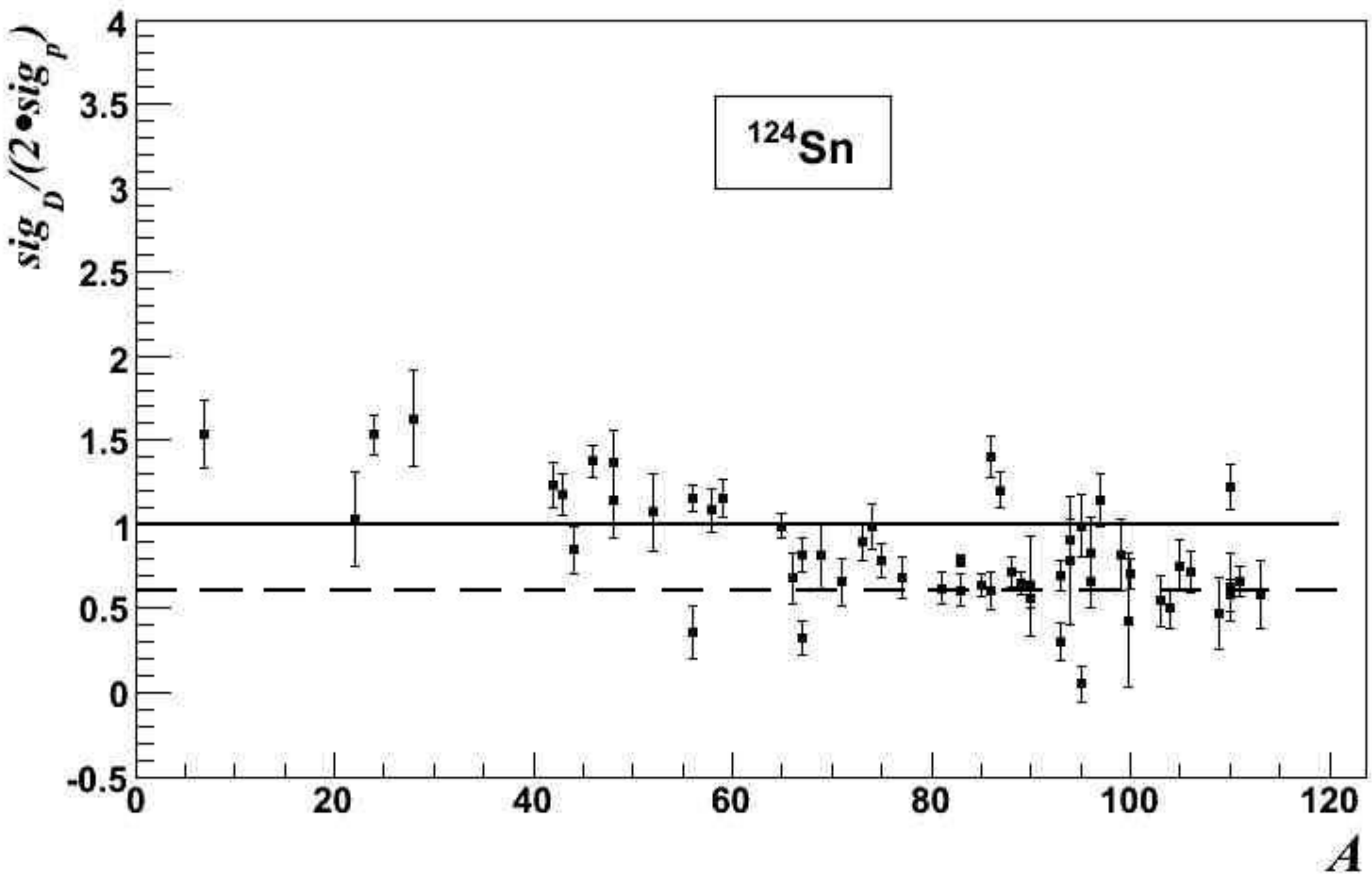


Table 2. The total cross sections of deuteron incident reactions for the targets ^{112}Sn, ^{118}Sn и ^{124}Sn

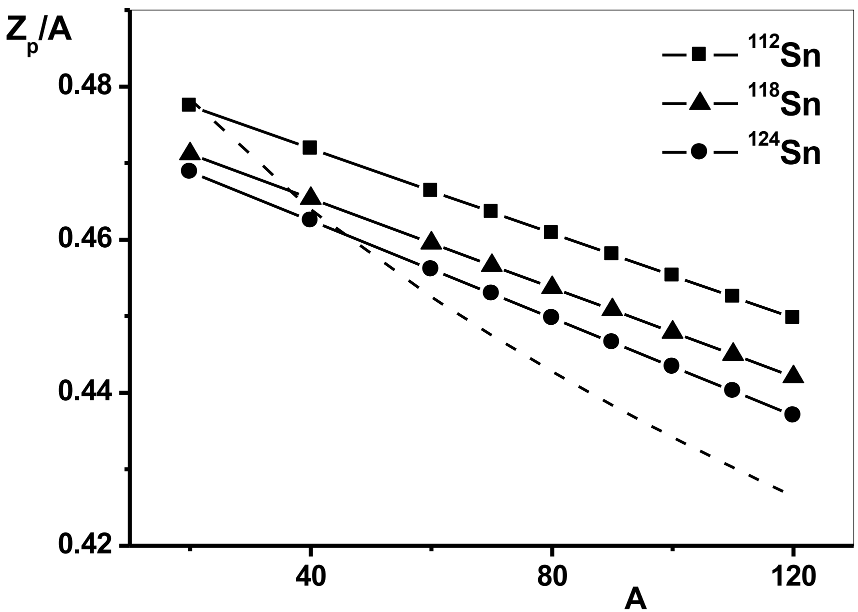
Targets	σ_{tot}(theor.), mb	σ_{tot}(exp.), mb	$\frac{2\sigma_p}{\sigma_D}$(theor.)	$\frac{2\sigma_p}{\sigma_D}$(exp.)	Δ (theor.), mb	Δ (exp.), mb
^{112}Sn	1578.34	1689 ± 338	1.7	1.23 ± 0.34	1106.2	391.0 ± 109.5
^{118}Sn	1630.43	1665 ± 333	1.71	1.14 ± 0.32	1150.3	237.3 ± 66.4
^{124}Sn	1681.58	1880 ± 376	1.71	1.19 ± 0.33	1194.6	204.0 ± 57.12

$$\sigma_d^{tot} = \sigma_p^{tot} + \sigma_n^{tot} - \Delta$$

$$\Downarrow$$

$$\Delta = 2 \bullet \sigma_p^{tot} - \sigma_d^{tot}$$

The dependence of Z_p/A on the mass number of products



- the dotted line marks the position of Z_A /A more stable charge for a given A.

For the products A<40 the peak position of the isobaric distribution is on the neutron deficient side of the line of beta stability. And for the rest of the products the peak position lies on the neutron-rich side of the line of beta stability with increasing mass number of the target to move to a more neutron-rich nuclei of the residual.

Conclusion

- The parameter computed from the experimental data of scattering of fast protons and deuterons on separated tin isotopes do not coincide with the theoretical predictions. Theoretical and experimental ratio of the cross sections for deuteron nuclear reactions to a double proton nuclear reaction cross-section are the same for the reactions of deep spallation.
- The experimental estimates can be used to refine the model representations of nuclear reactions in the above energy and mass regions.

THANK YOU FOR YOUR ATTENTION!