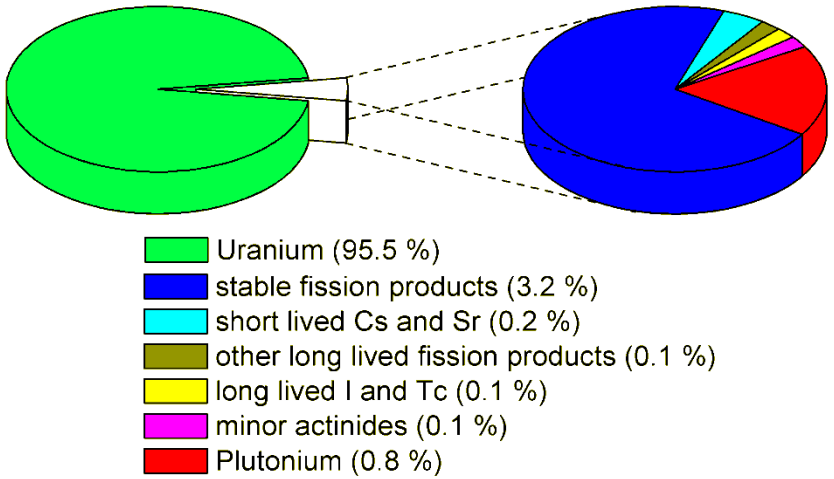
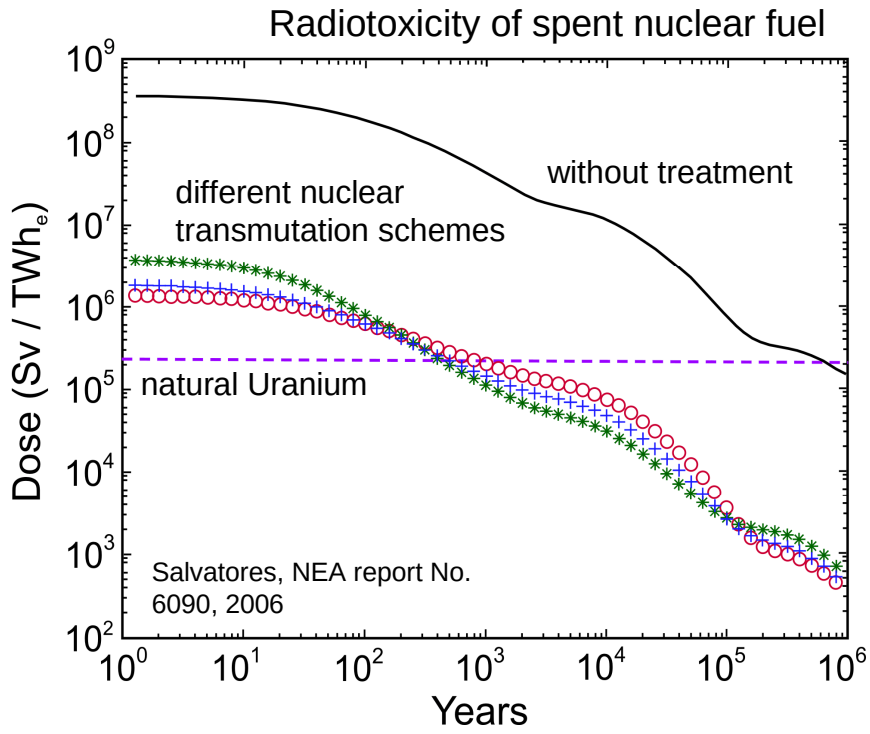
Inelastic Neutron Scattering at nELBE

by Roland Beyer, Institute of Radiation Physics, FWKK

Treatment of spent nuclear fuel





long lived isotopes cause main part of long term radiotoxicity

➔ **safe disposal is necessary for more 500,000 years**

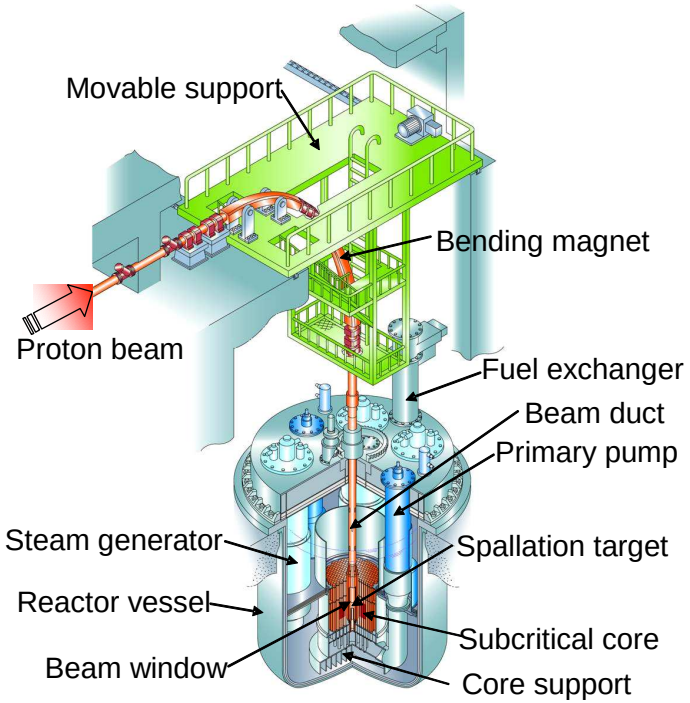
➔ treatment of nuclear waste can **reduce disposal time by 4 orders of magnitude**

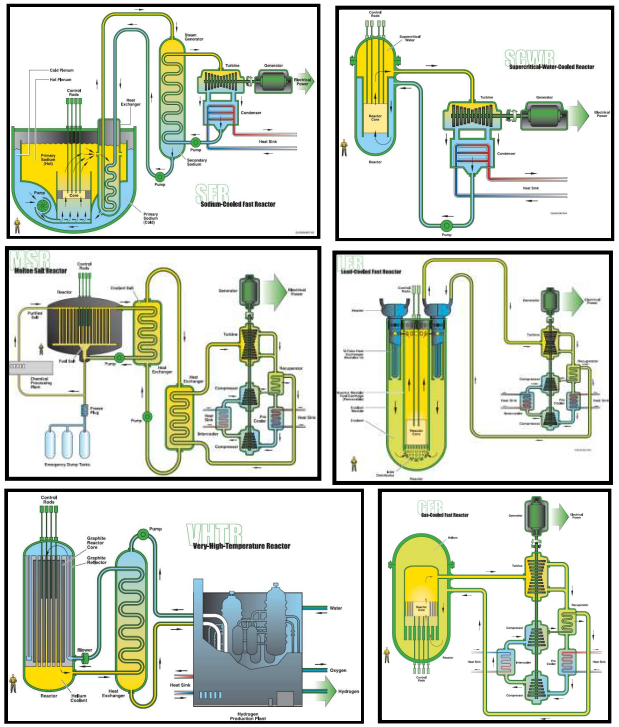
➔ **Partitioning:** separate actinides from the rest

➔ **Transmutation:** convert long lived isotopes into short lived ones

➔ via neutron induced reactions

Accelerator driven Systems / Generation IV nuclear reactors





➔ fast neutron induced fission is used to produce electrical power (and hydrogen)

and to burn up long lived actinides

Hiroyuki OIGAWA
Presentation at Euratom PARTRA Cluster Meeting at FZK, Feb. 2008

http://www.gen-4.org/Technology/roadmap.htm

Data Needs

- for simulations and calculations to design such facilities **detailed knowledge about the neutron interactions are necessary**

→ for nuclei to be transmuted as well as for structural materials

Object	Nuclides/Elements
Target materials	^{209}Bi, ^{208}Pb, ^{207}Pb, ^{206}Pb, ^{204}Pb Pb, ^{186}W, ^{184}W, ^{183}W, ^{182}W, W, ^{181}Ta, Ta, Zr, Sn, Hg, U, Pu, F, Cl, Na, Fe, Al
Po production	^{209}Bi(p,xn)$^{207, 208, 209}$Po, ^{209}Bi(n,γ)^{210}Bi--> ^{210}Po
Minor actinides	^{237}Np, ^{238}Np, ^{241}Am, ^{242m}Am, ^{242}Am, ^{243}Am, ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{248}Cm
Long-lived FP	^{79}Se, ^{93}Zr, ^{99}Tc, ^{107}Pd, ^{126}Sn, ^{129}I, ^{135}Cs
Fuel compositions	^{238}U, ^{235}U, ^{239}Pu, ^{238}Pu, $^{14, 15}$N, O, F, Cl
Th cycle	^{232}Th, ^{231}Pa, ^{232}Pa, ^{233}Pa, ^{233}U, ^{234}U
Structural materials	Zn, Cu, Ni, Co, Fe, Mn, Cr, Ti, Ca, Ar, Al, Mg, Na, O, N. C, B, Be, He ^{3}T
Shielding	O, Si, P, Ca, Ti, Fe

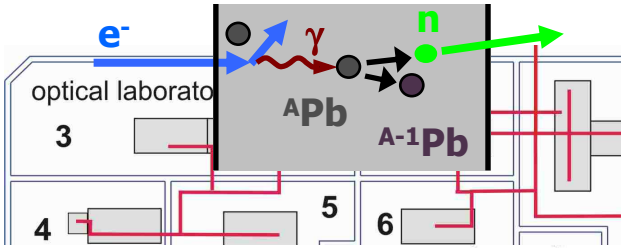
Y. Ikeda, Journal of Nucl. Sci. and Technology (2002) pp. 13-18

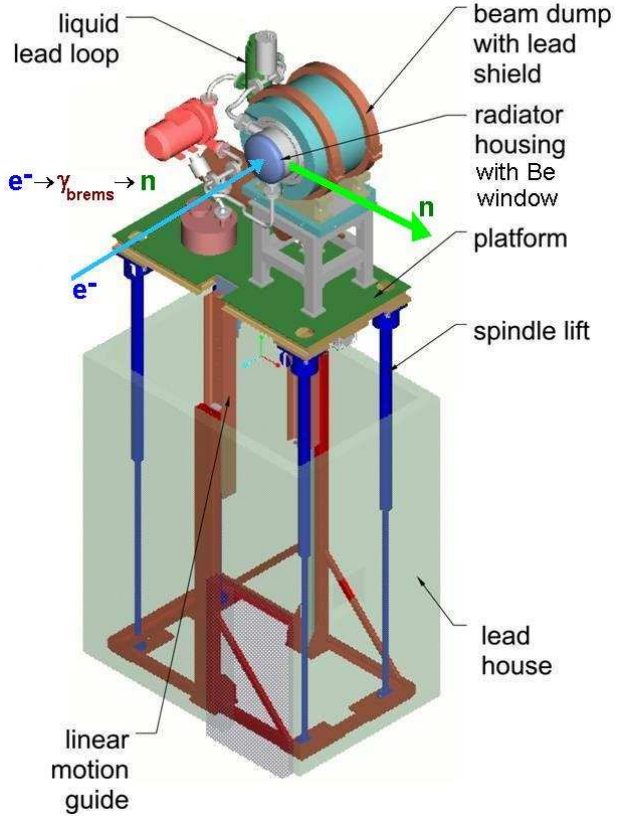
measure reaction cross section in dependence of neutron energy $\sigma(E_n)$

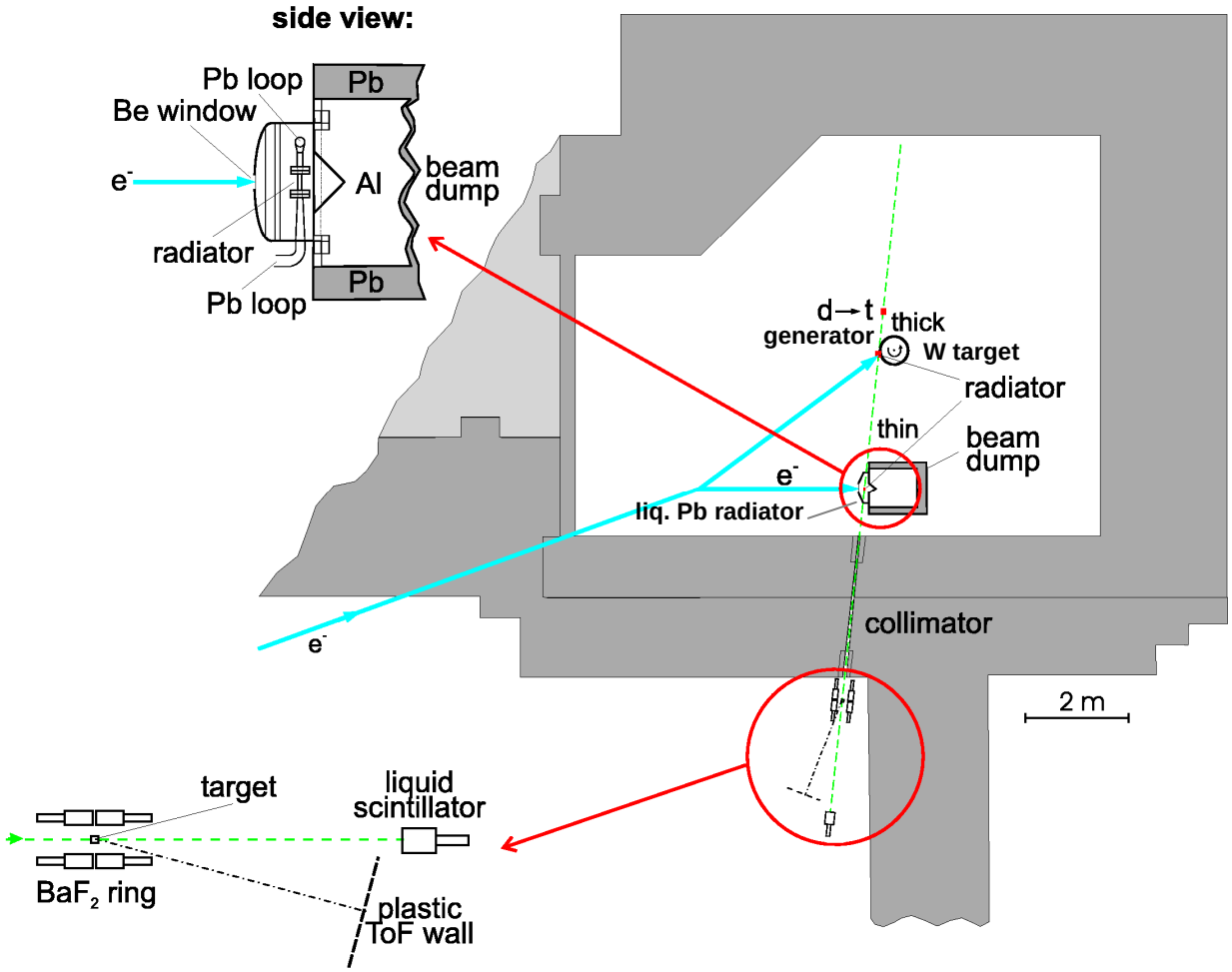
➔ ^{56}Fe (n,γ) ^{57}Fe

^{56}Fe (n,n'γ) ^{56}Fe

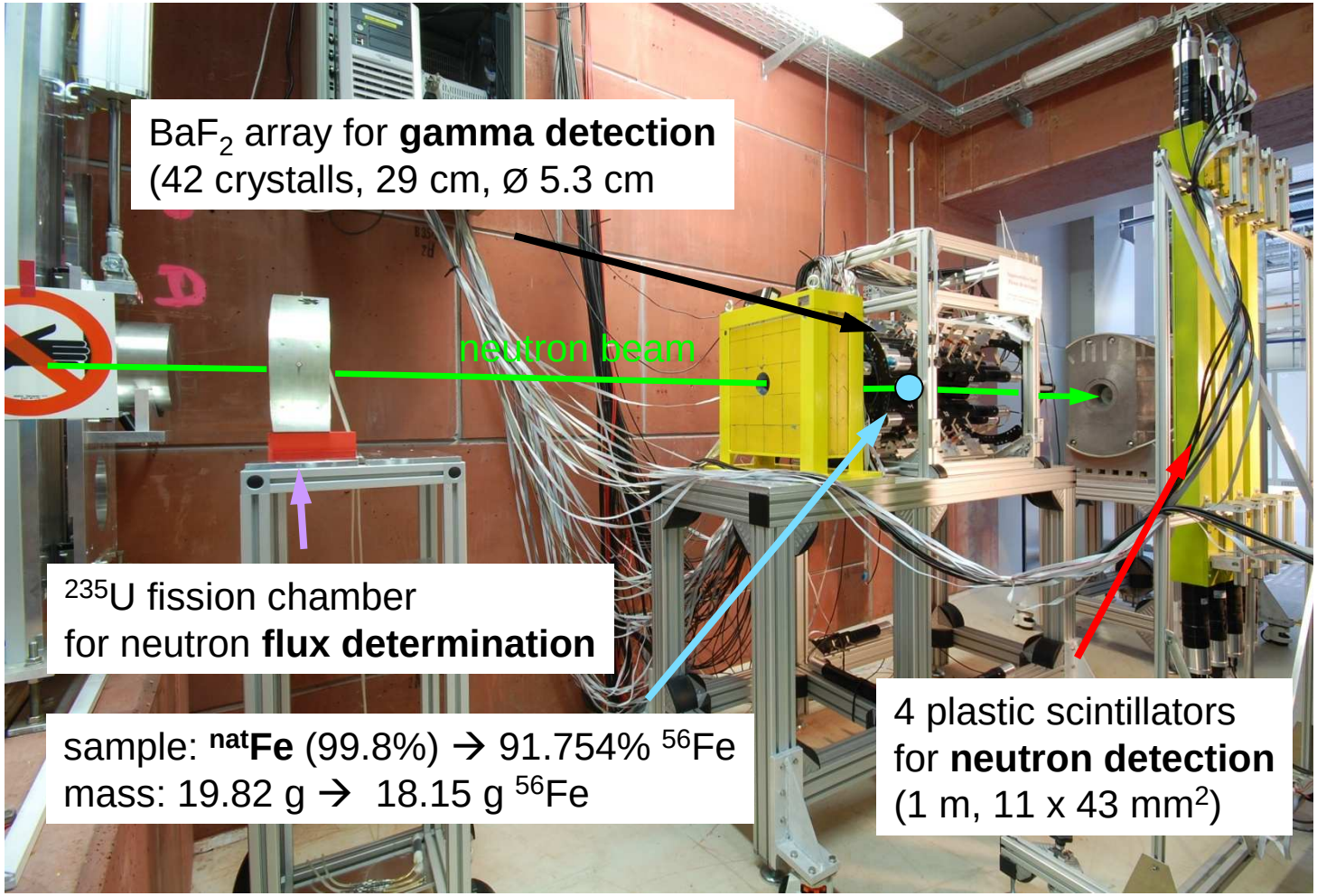
nELBE – neutron facility at ELBE







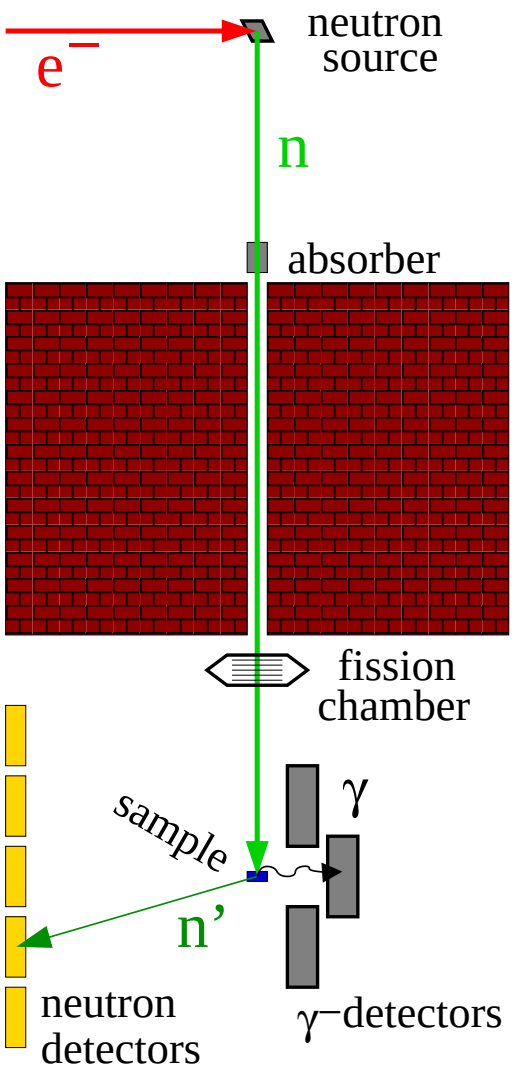
nELBE – Detector Setup



flight paths:
source – sample:
600 cm
sample – BaF2:
30 cm
sample – Plastics:
100 cm

measurement time:
34,9 h with sample
32,2 h without

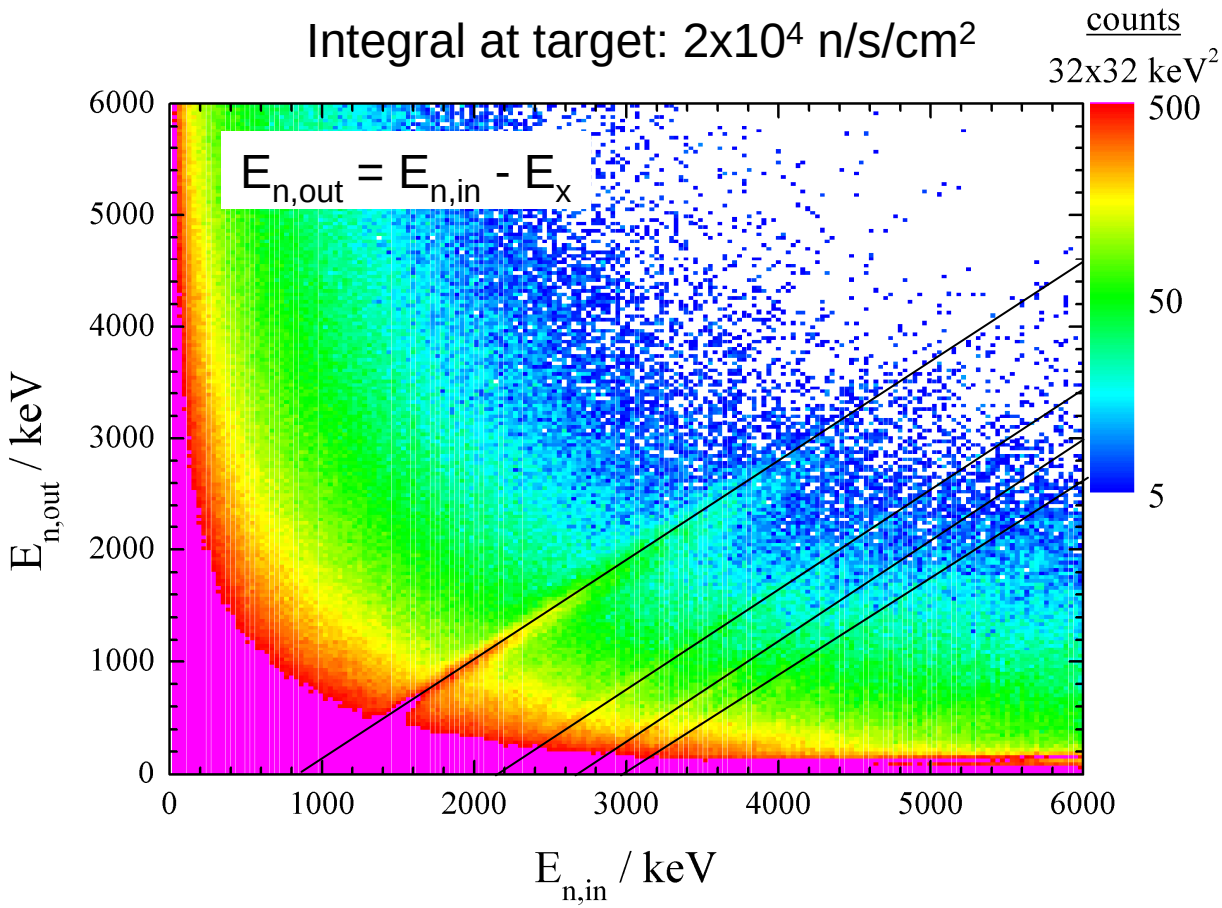
Experimental methods and results – Inelastic Scattering



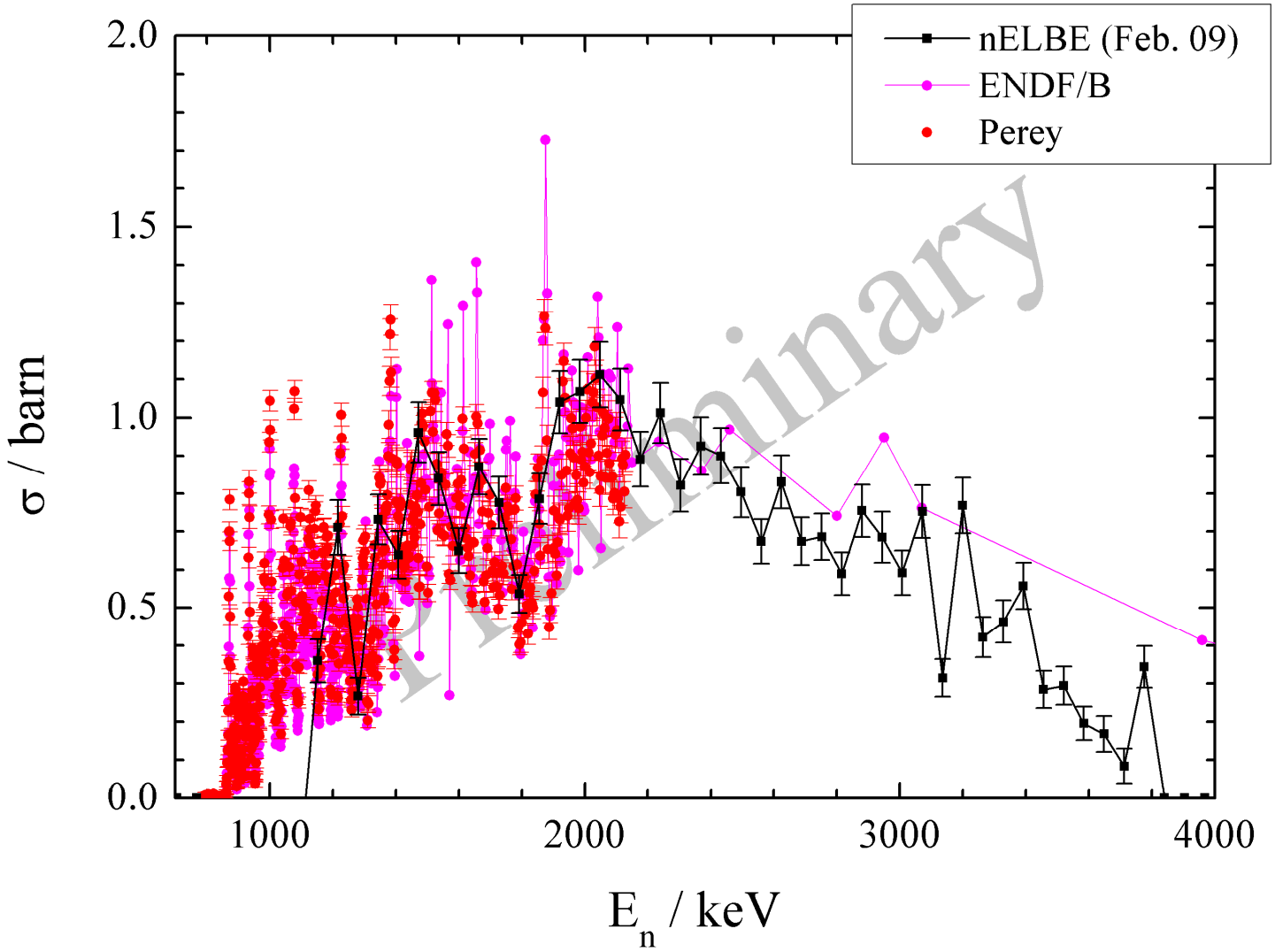
$^{56}Fe(n,n'\gamma)^{56}Fe$ $\begin{cases} ^{56}Fe + n \rightarrow ^{56}Fe^{*} + n' \\ ^{56}Fe^{*} \rightarrow ^{56}Fe + \gamma \end{cases}$

$E_{n,min} = 847\,keV$

Integral at target: $2x10^4$ n/s/cm²



The ^{56}Fe(n,n'γ) cross section



Summary and Outlook

- nELBE is intended to deliver data on fast neutron induced reactions
- first experiments were performed on inelastic neutron scattering using a double time of flight setup
- the ELBE electron beam deliver high neutron flux,
  new injector will deliver ~60 times more
- further investigations have to be done to determine and reduce all sources background

Thanks to all Collaborators

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