Discrete gamma-ray spectroscopy of neutron-rich nuclei with „incomplete fusion" reactions induced by radioactive beams on a ^{7}Li target

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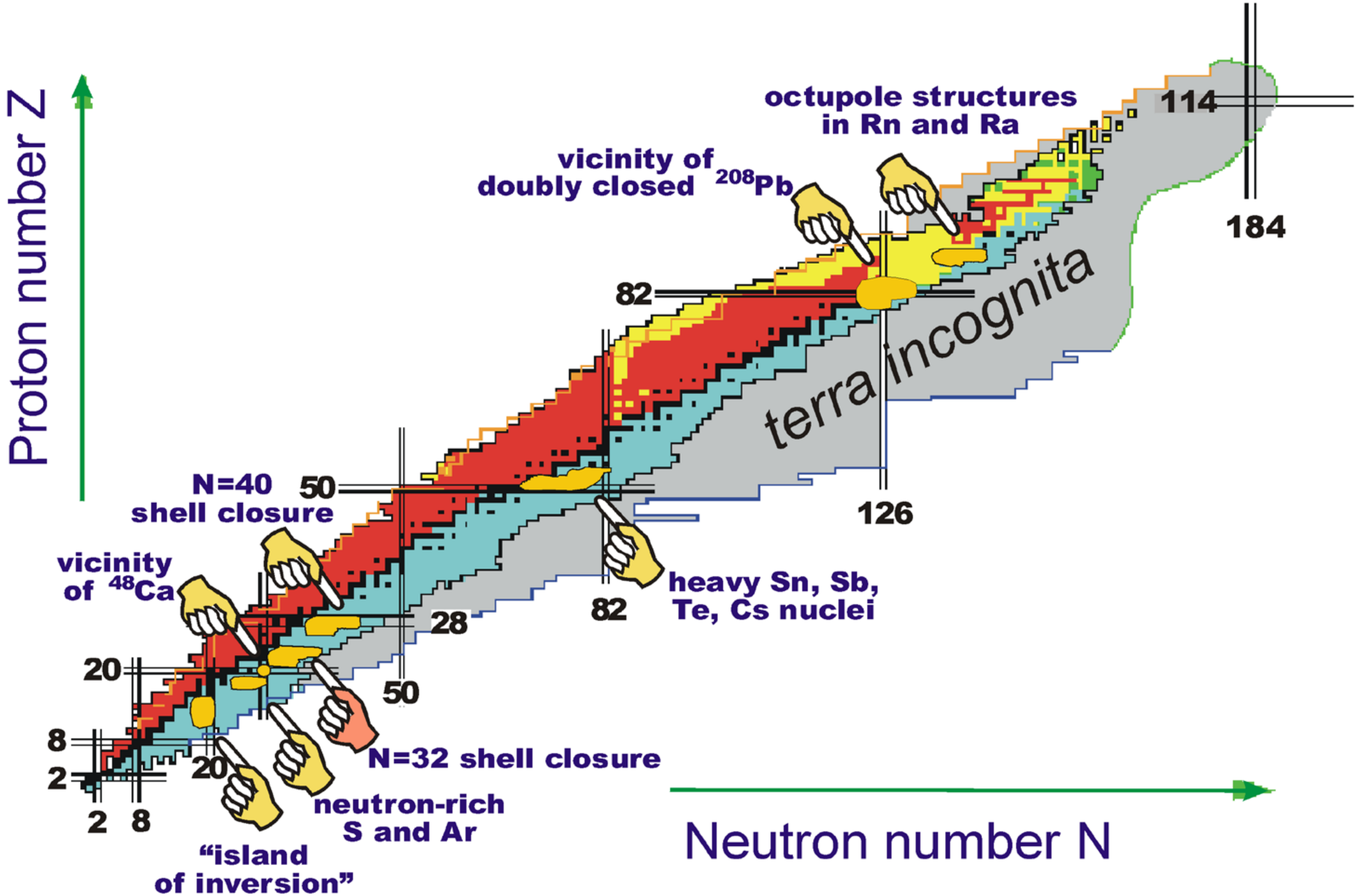
In the collaboration

IFJ PAN Krakow – Argonne -

Purdue University
University of Maryland
INFN Laboratori Nazionali di Legnaro
University of Padova
ANU Canberra
Univ. of Surrey
NSCL MSU

we have carried out (for more than 20 years)
the experimental program
aimed at discrete gamma-ray spectroscopy of **YRAST** structures
in neutron-rich nuclei

by using γ–coincidence technique with deep-inelastic heavy-ion reactions



Proton number Z
Neutron number N
octupole structures
in Rn and Ra
vicinity of
doubly closed 208Pb
114
184
82
126
terra incognita
N=40
shell closure
50
vicinity
of 48Ca
28
82
heavy Sn, Sb,
Te, Cs nuclei
20
50
8
2
20
N=32 shell closure
2
8
neutron-rich
S and Ar
“island
of inversion”

Anticipated problems in deep-inelastic reaction product studies with low-intensity radioactive beams

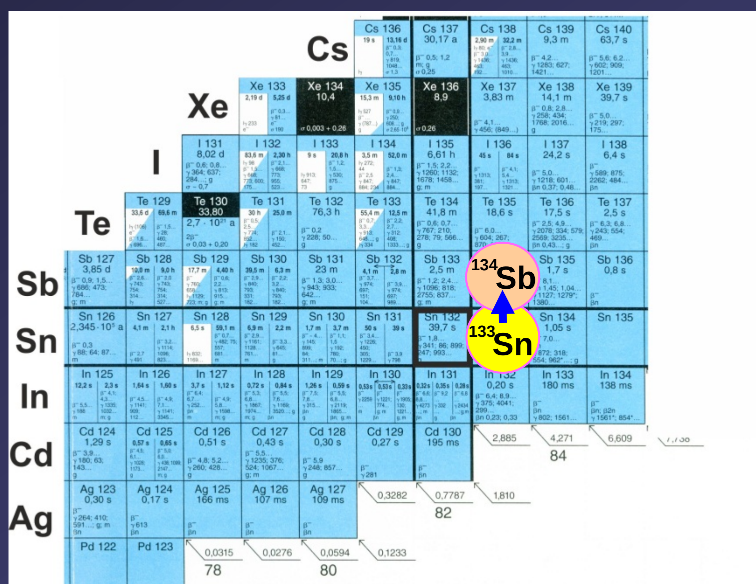
- **low cross-section for population of individual products** – of the order of a few mb
- **accumulation of radioactivity** in case of thick-target measurements
- **low efficiency of the magnetic spectrometers,** for thin-target experiments which require product identification

We have proposed another method for gamma-ray spectroscopic studies of low-lying structures in nuclei lying close to the projectile nucleus.

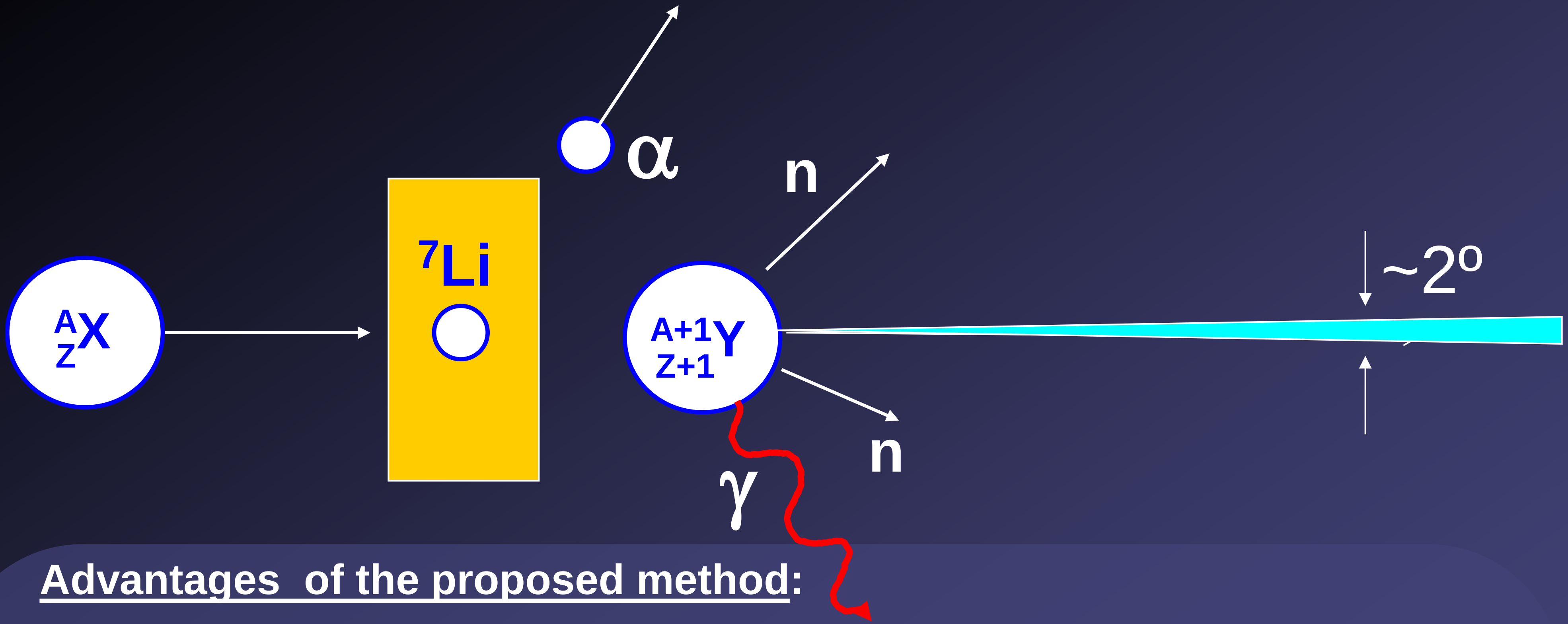
The method relies on the triton transfer process induced by radioactive beams on a ^{7}Li target.

$$ {}^{A}_{Z}\mathrm{X} + {}^{7}\mathrm{Li} \longrightarrow {}^{A+3-x}_{Z+1}\mathrm{Y} + \alpha + xn $$

for example:



$$ {}^{133}\mathrm{Sn} + {}^{7}\mathrm{Li} \rightarrow {}^{134}\mathrm{Sb} + \alpha + 2n $$



Advantages of the proposed method:

The very inverse kinematics guarantees that the product nuclei travel downstream in a very small recoil cone, thus Doppler correction does not require recoil detection.

Reaction channel of interest will be uniquely associated with the emission of an α particle. The emitted alpha particles may be used as event tags.

Our REX-ISOLDE experiment

(November 2012)

Spectroscopy of n-rich

$^{98-100}$Sr nuclei with ^{7}Li(^{98}Rb,αxn) reaction at ~3MeV/u

Collaboration: IFJ PAN Kraków, Univ. of Milan, SLCJ Warsaw, GANIL, LNL Legnaro, Univ. of Padova, K.U.Leuven, Université Libre de Bruxelles, CSNSM Orsay, Univ. of Köln, TU Darmstadt, TU Munchen, LPSC Grenoble, Argonne Nat. Lab., IFIN-HH Bucharest, IRNE-BAS Sofia, ISOLDE CERN.

$$^{98}\mathrm{Rb} + {}^{7}\mathrm{Li} \longrightarrow {}^{101-x}\mathrm{Sr} + \alpha + xn$$

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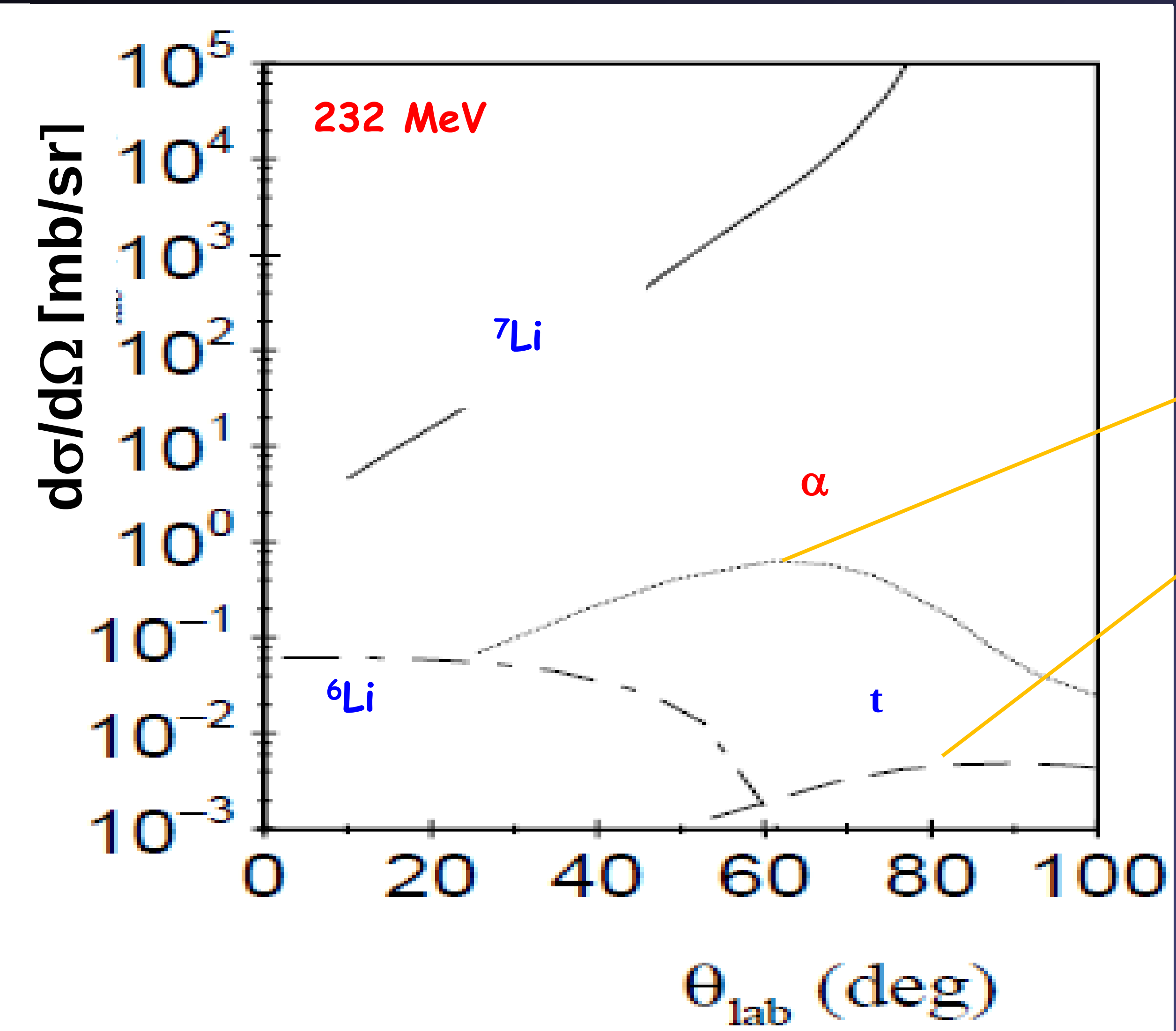
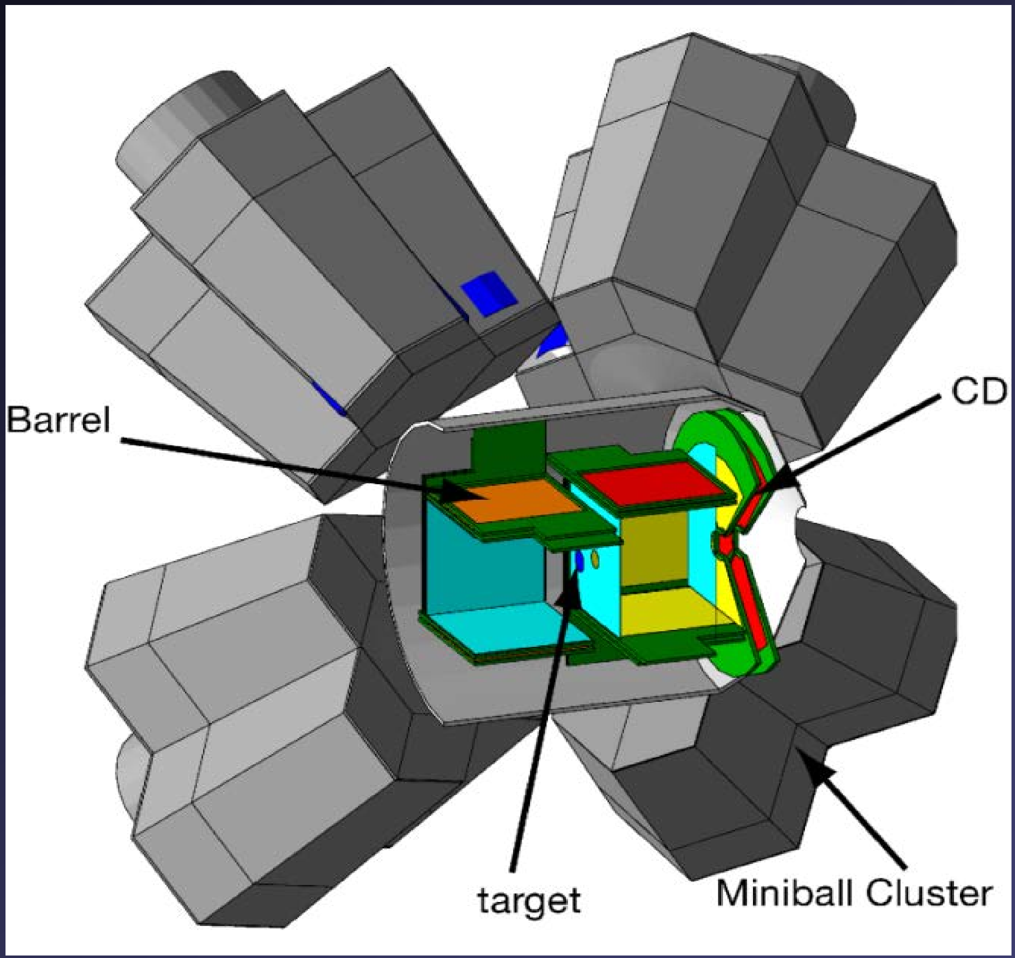
DWBA calculations for transfer processes in the ^{98}Rb + ^{7}Li reaction



Process	Cross section [mb]
triton transfer	**~50**
α transfer	**<1**
breakup	~30
fusion	~300

Experiment @ISOLDE:
MINIBALL + T-REX
^{98}Sr (2.84 MeV/u) + ^{7}LiF (1.5 mg/cm^2)



MINIBALL specifications:

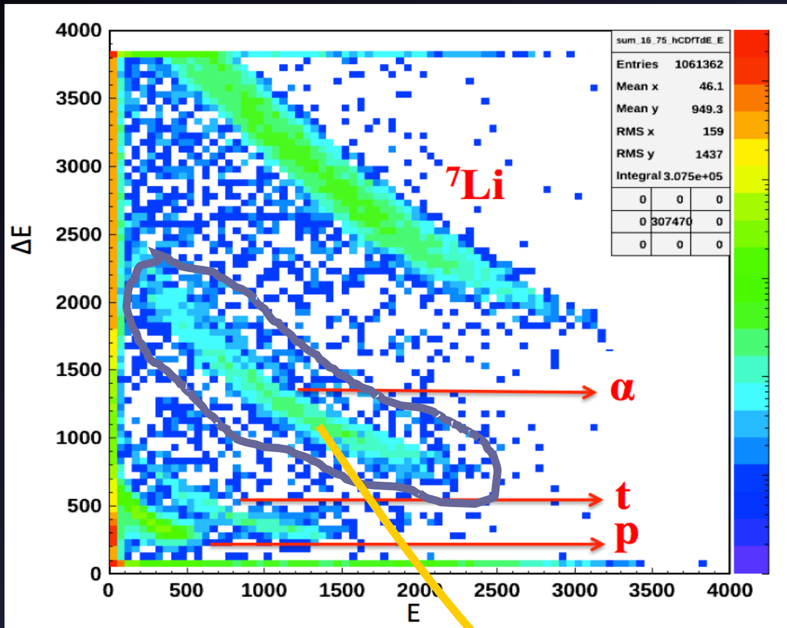
Granularity: 8 x 3 x 6 = 144 segments

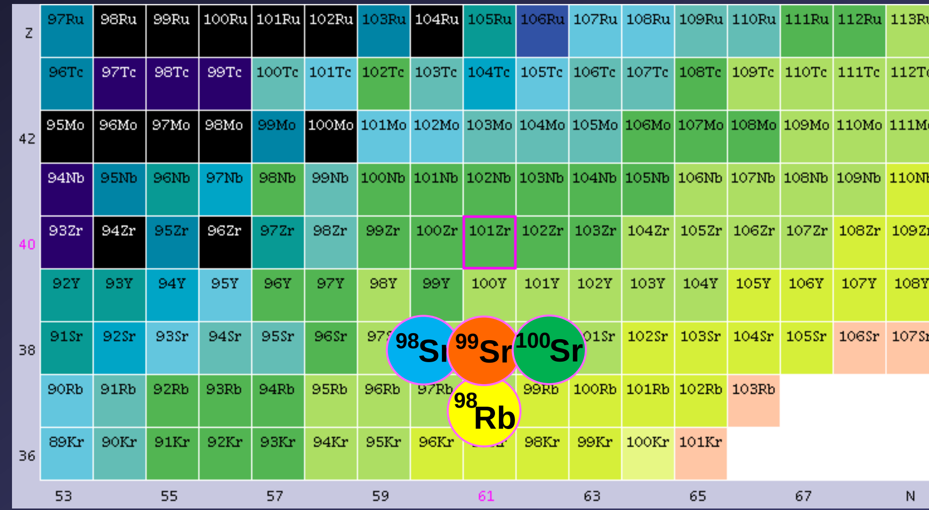
Efficiency: ε_{ph} ~ 7 % at E_γ= 1.3 MeV

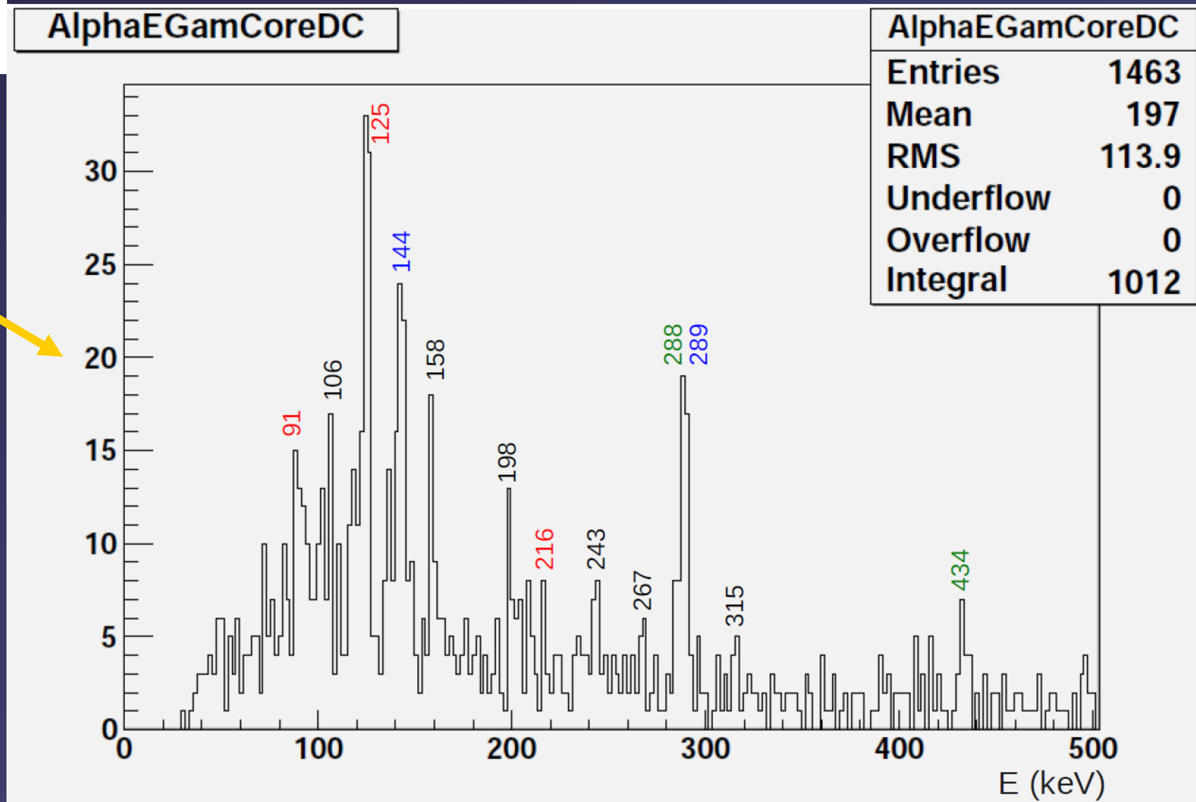
Localization of 1.3 MeV γ-ray: 1 cm

T-REX specifications

CD: DE-E : 35 + 1000 μm
Barrel: DE-E 140 + 1000 μm



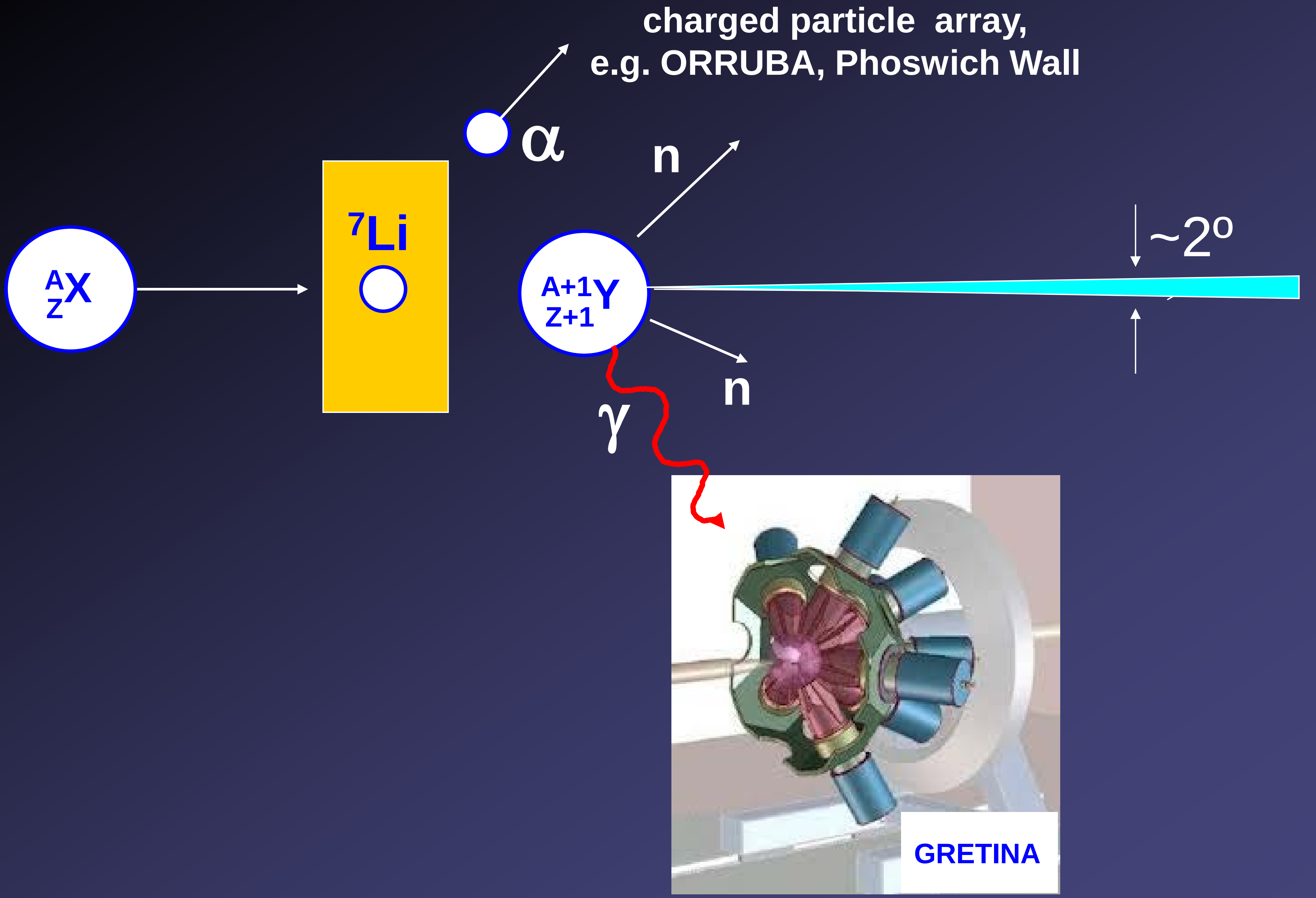




I_{BEAM} (^{98}Ru) ≈ 10^5 pps

Counting rate:

~0.03 ev/s **for** α-γ
(10 k in 4 days)



charged particle array,
e.g. ORRUBA, Phoswich Wall
α
n
$^{A}_{Z}X$
^{7}Li
$^{A+1}_{Z+1}Y$
~2°
γ
n
GRETINA

THE NEW COLLABORATION

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