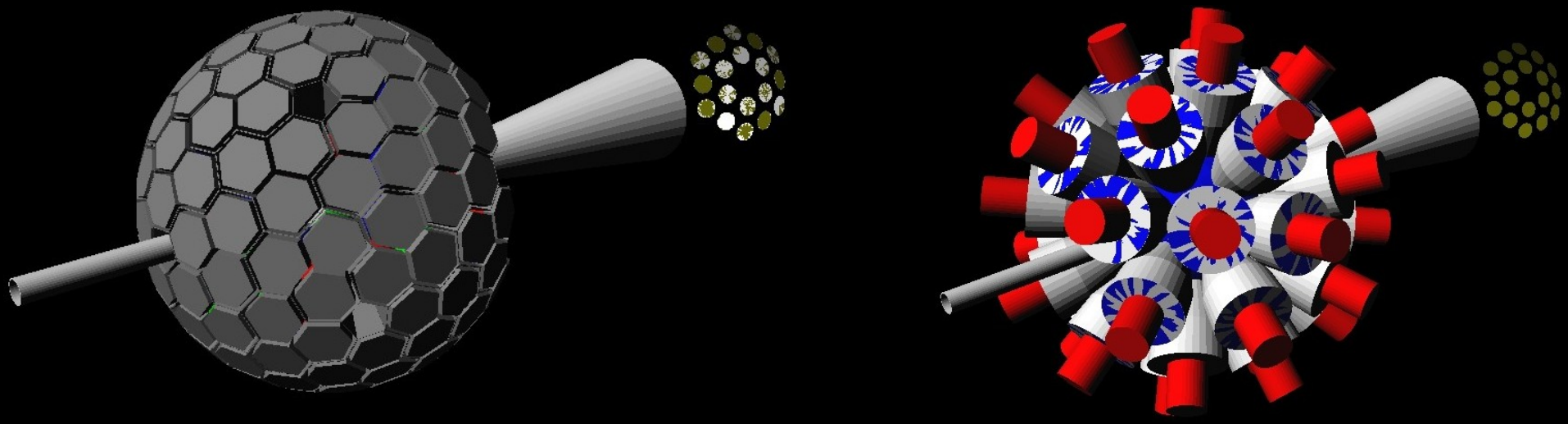
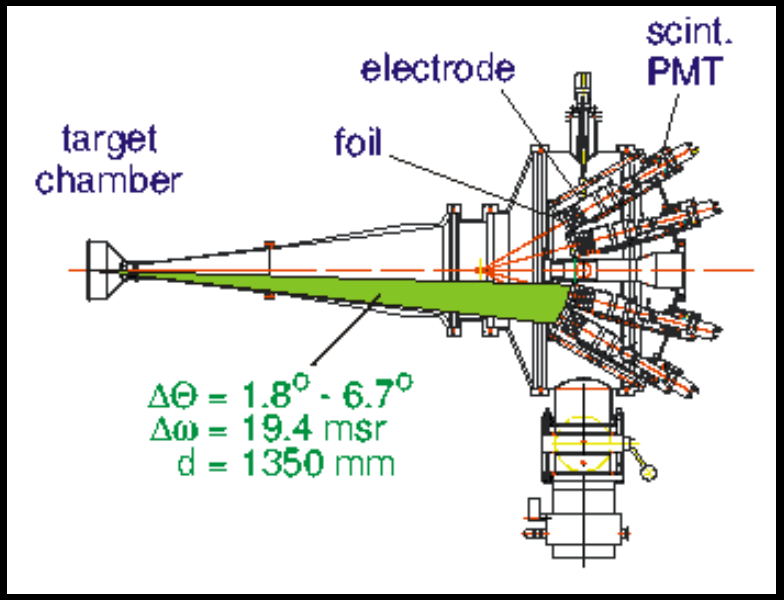
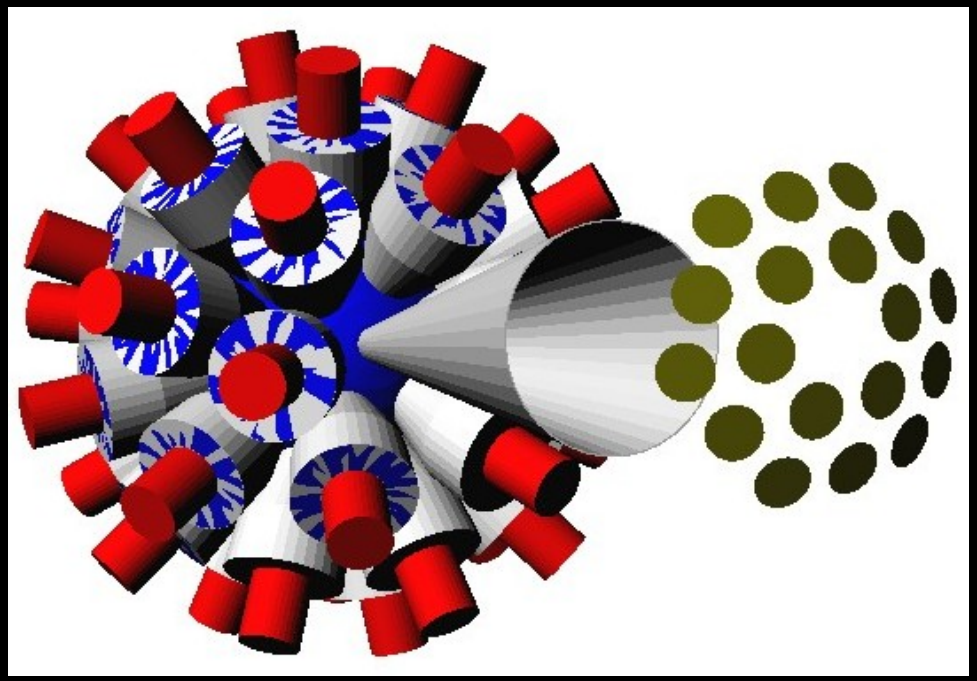
Simulations of lifetime measurements with RFD, AGATA and GASP



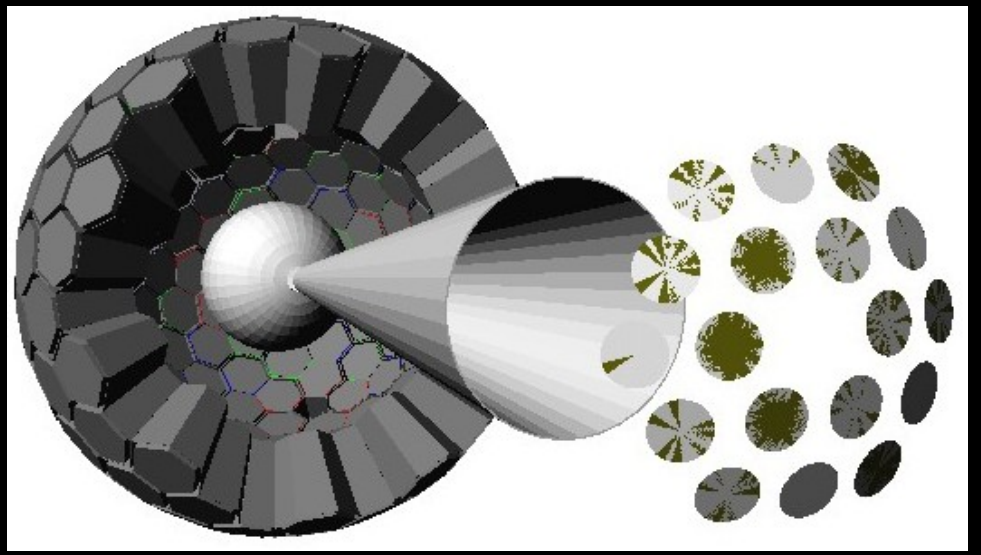
Grzegorz Jaworski – Uppsala 09.07.2008

Faculty of Phycics, Warsaw Univ. of Technology
Heavy Ion Laboratory, University of Warsaw





GASP in configuration II
Ge 20 and 24 cm
from the target



3Π AGATA

Reaction of interest:

$^{40}Ca(^{32}S,2\alpha)^{64}Ge$

110MeV, 0.7mg/cm^2

σ_{64Ge}=5mb (0.8% σ_{tot})

P. Bednarczyk et al. GASP+RFD proposal

Motivation:

- deformed rotational bands have never been observed in the closest vicinity of ^{64}Ge

Aim of the experiment:

- measuring rotational bands in ^{64}Ge
- measuring level lifetimes

Tools

Fusion-evaporation and recoil transport code

(COMPA and GAMMA) E. Grodner et al., Eur. Phys. Jour. A27, 325 (2006)

by A. A. Pasternak, (J. Mierzejewski)

fusion-evaporation events generated and properly placed in the target

transport of recoils in the target

emission of single 1.3 MeV gammas with $e^{-\lambda t}$ *distribution*

ASC

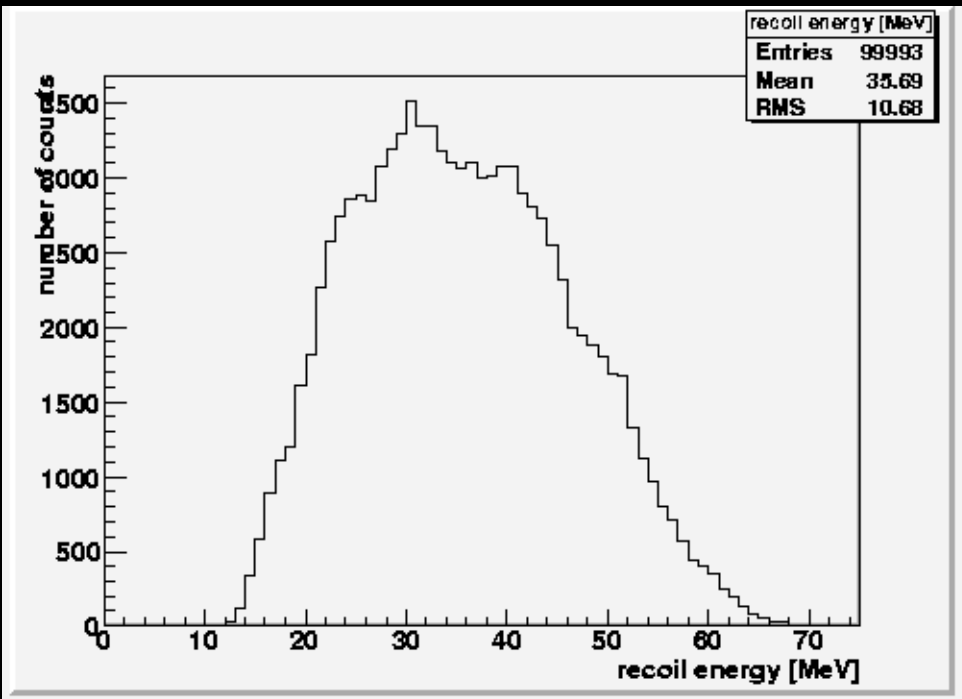
E. Farnea

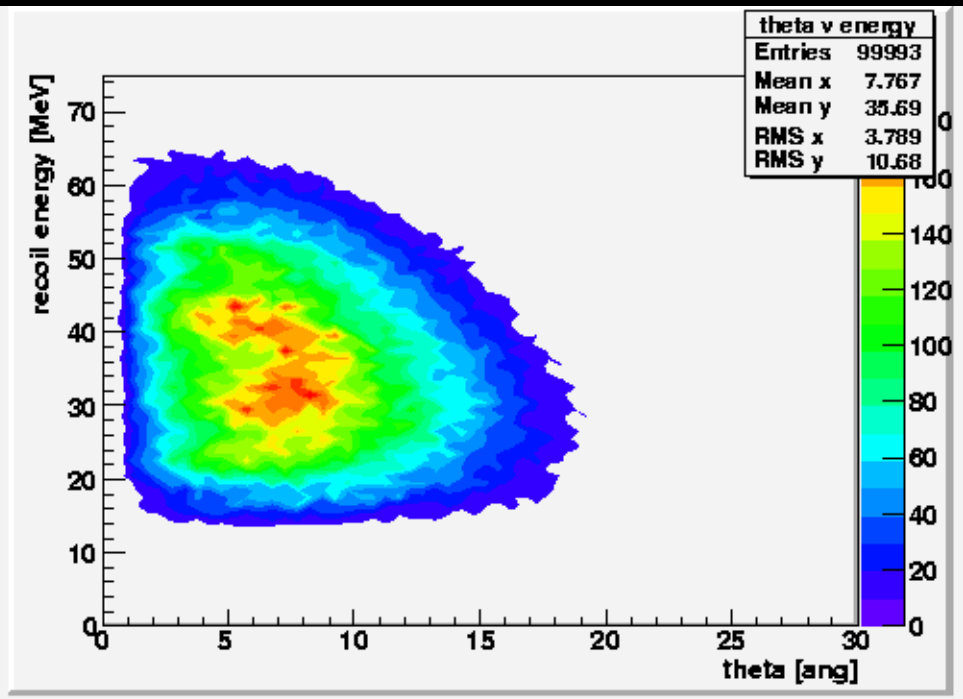
exactly the same tool to simulate AGATA+RFD, GASP+RFD measurements

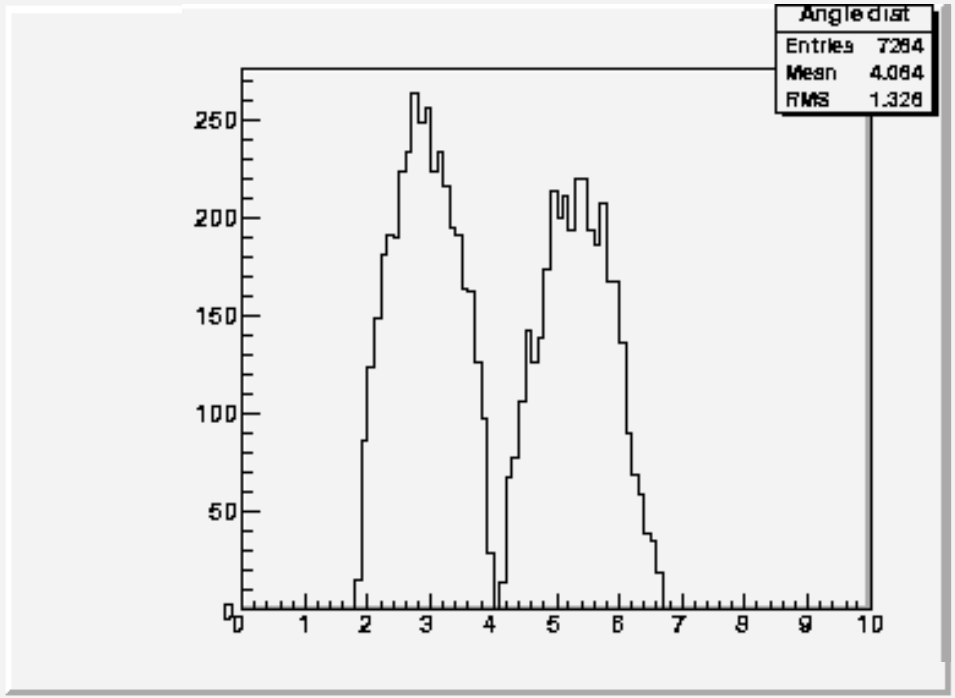
AGATA – tracking (A. Lopez-Martens)

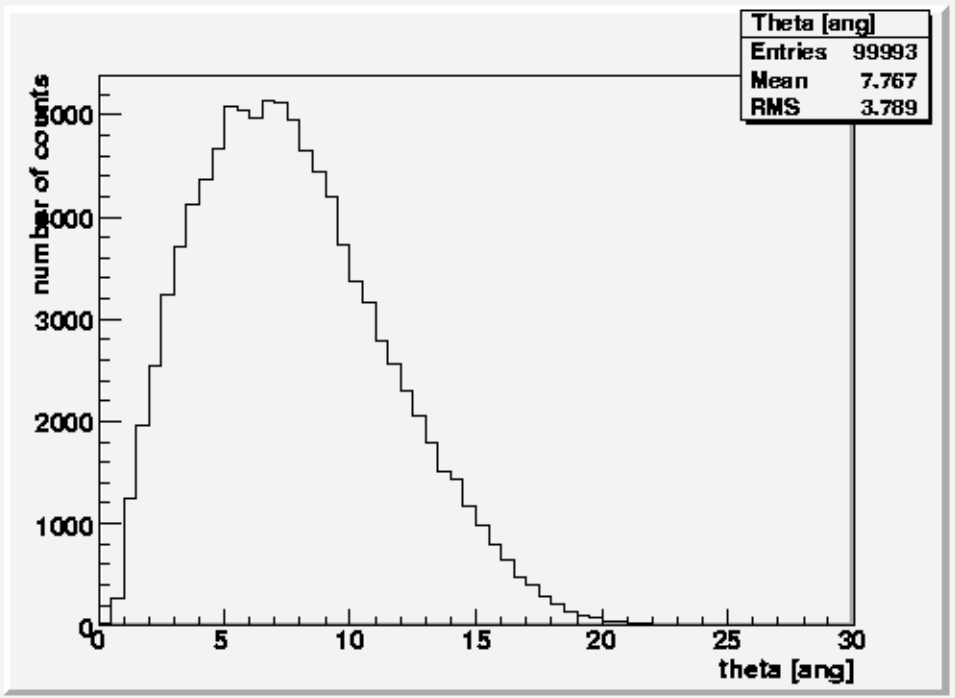
RFD data used to Doppler correct AGATA and GASP

^{64}Ge energy and angular distribution



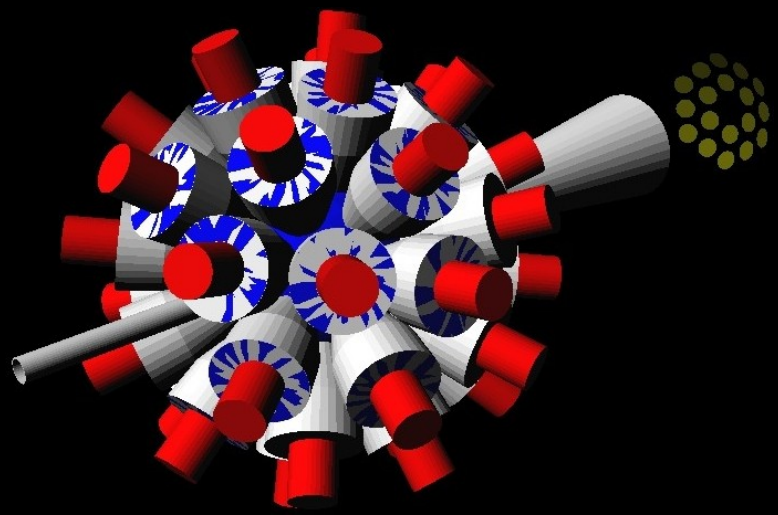


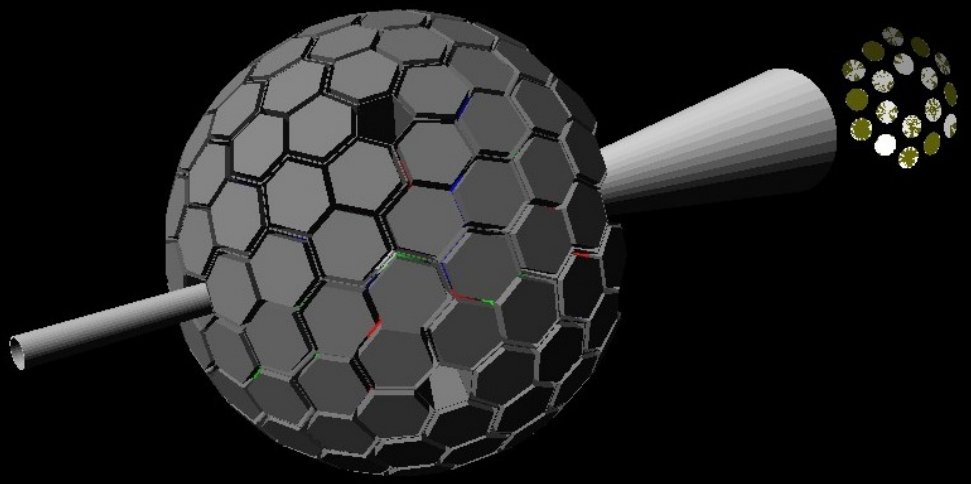




Efficiency:

ε_{RFD}=24%





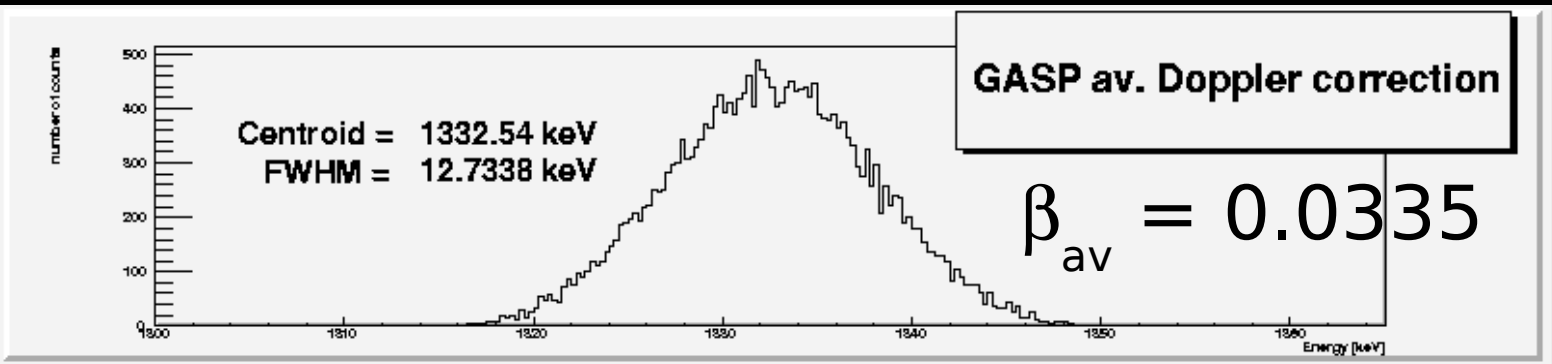
ε_{GASP}=5.0%

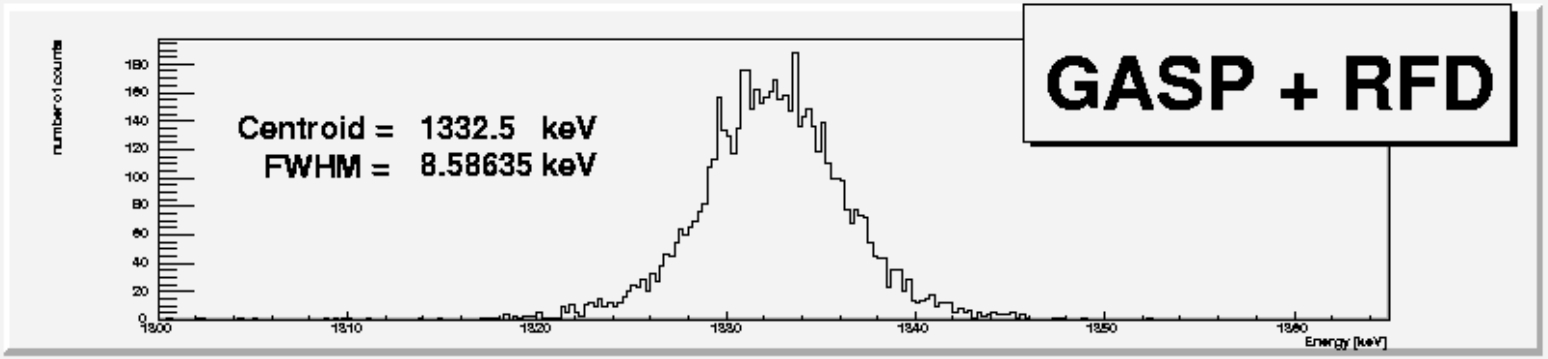
P/T = 0.71

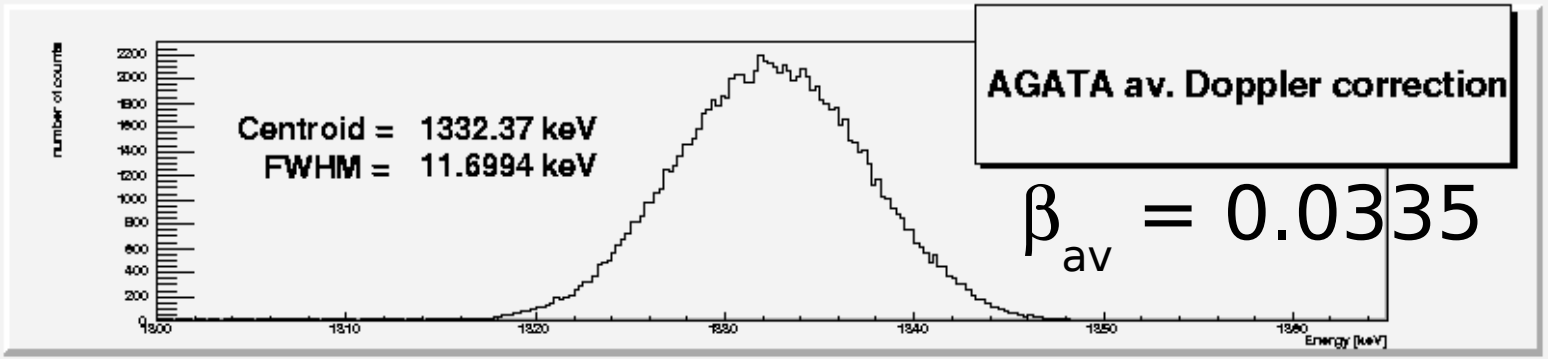
$\varepsilon_{3\Pi}$=22%

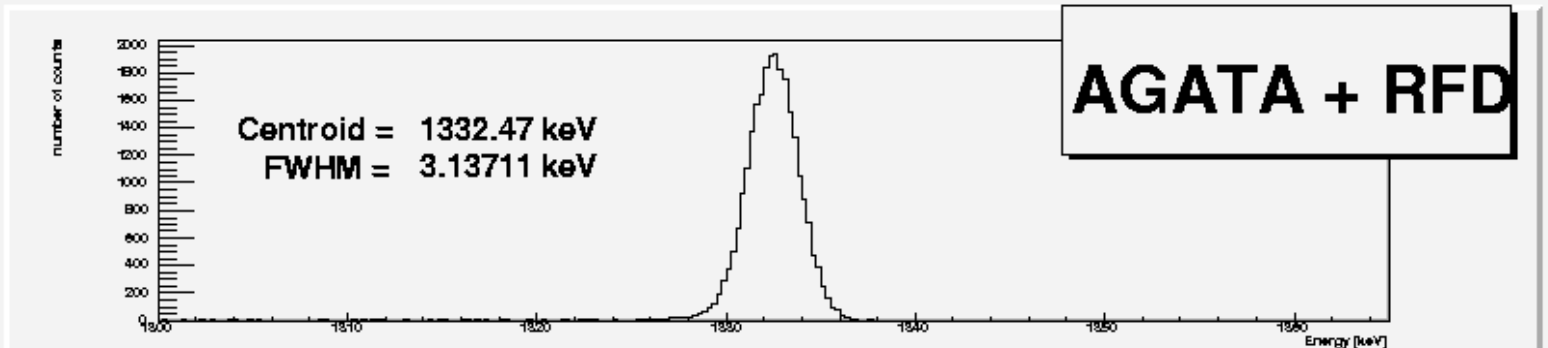
P/T=0.67

FWHM = 2.4 keV @ 1.3 MeV



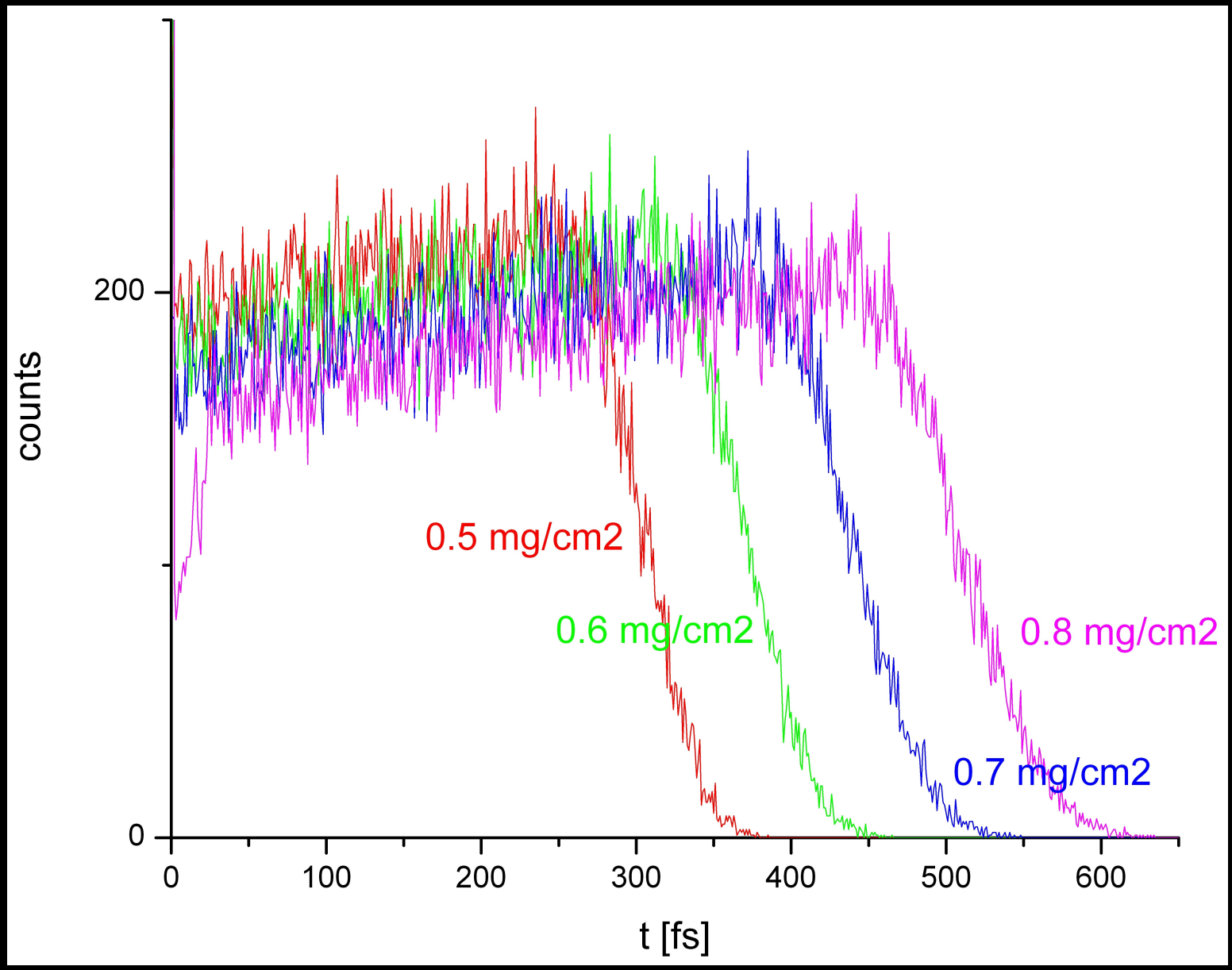




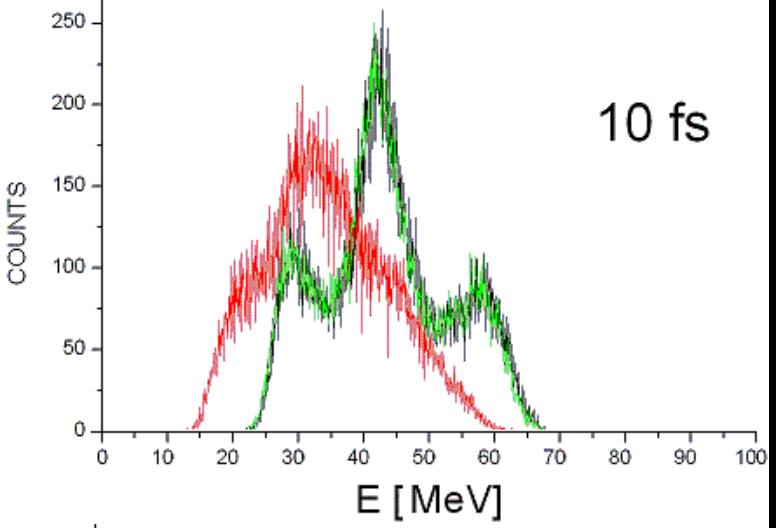


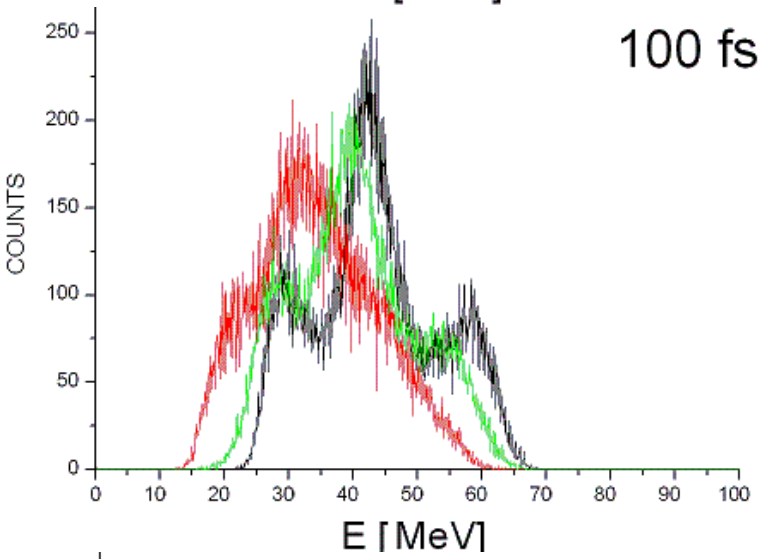
γ emission after passing through the target

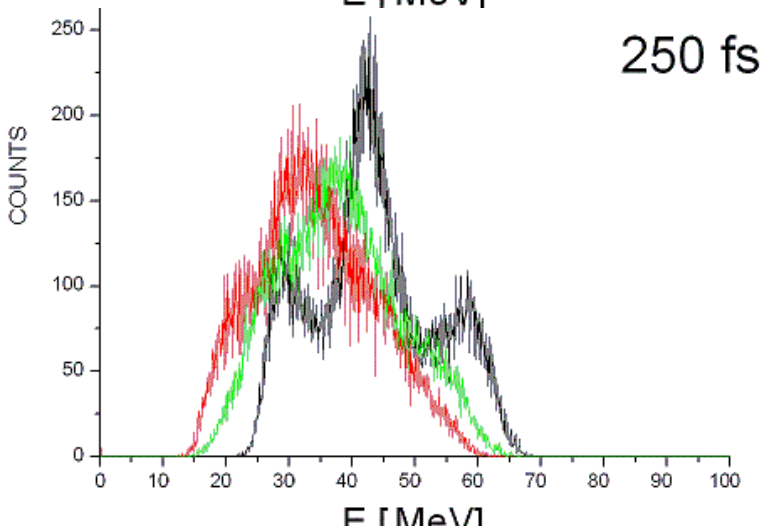
Time of recoils in the target

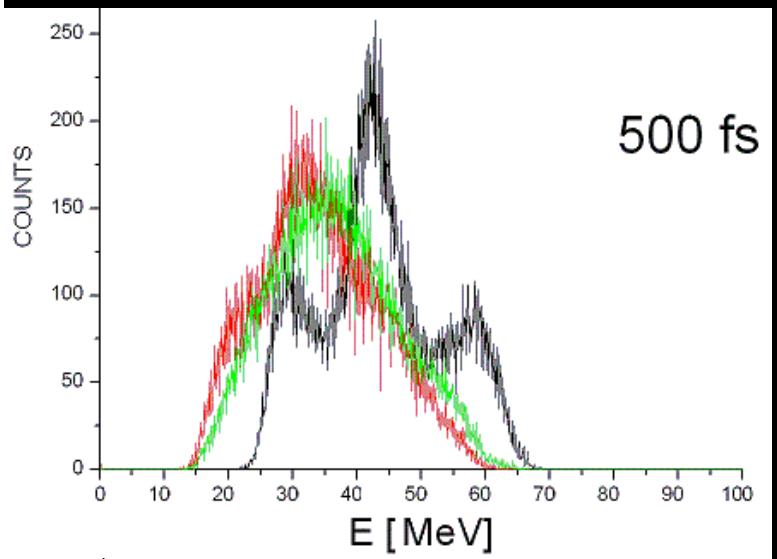


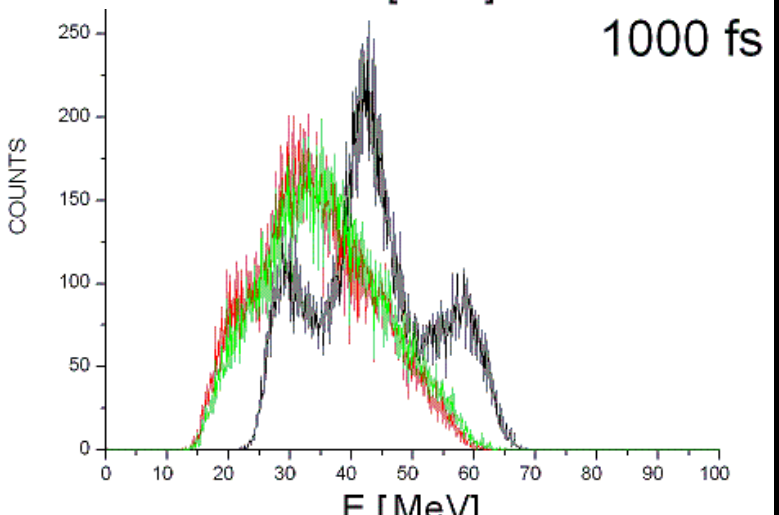
Energy of recoils when emitting γ



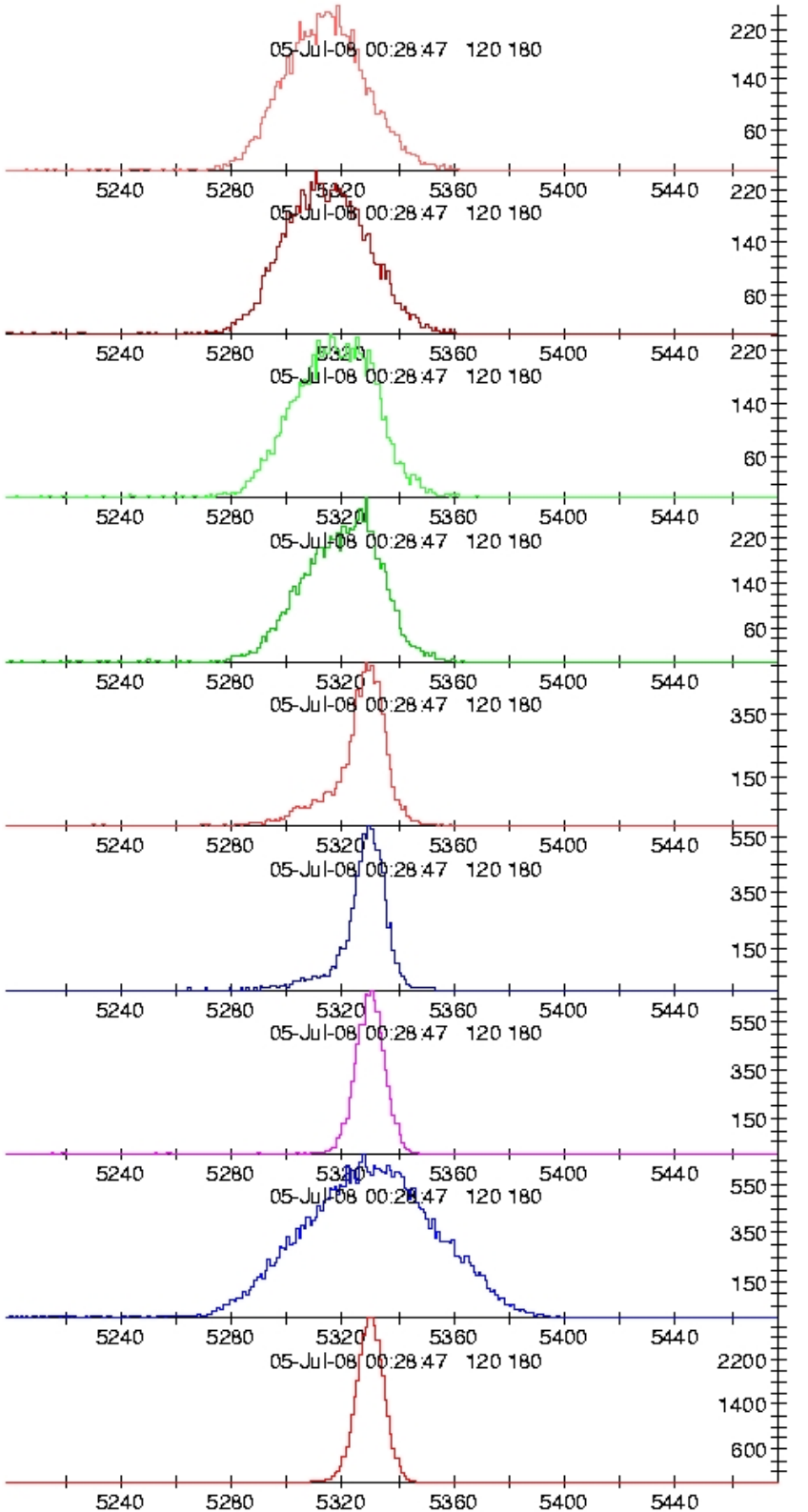








after fusion-evaporation
outside the target
when emitting γ



prompt γ emission

τ = 0.01 ps

τ = 0.05 ps

τ = 0.1 ps

τ = 0.5 ps

τ = 1.0 ps

γ emission outside the target

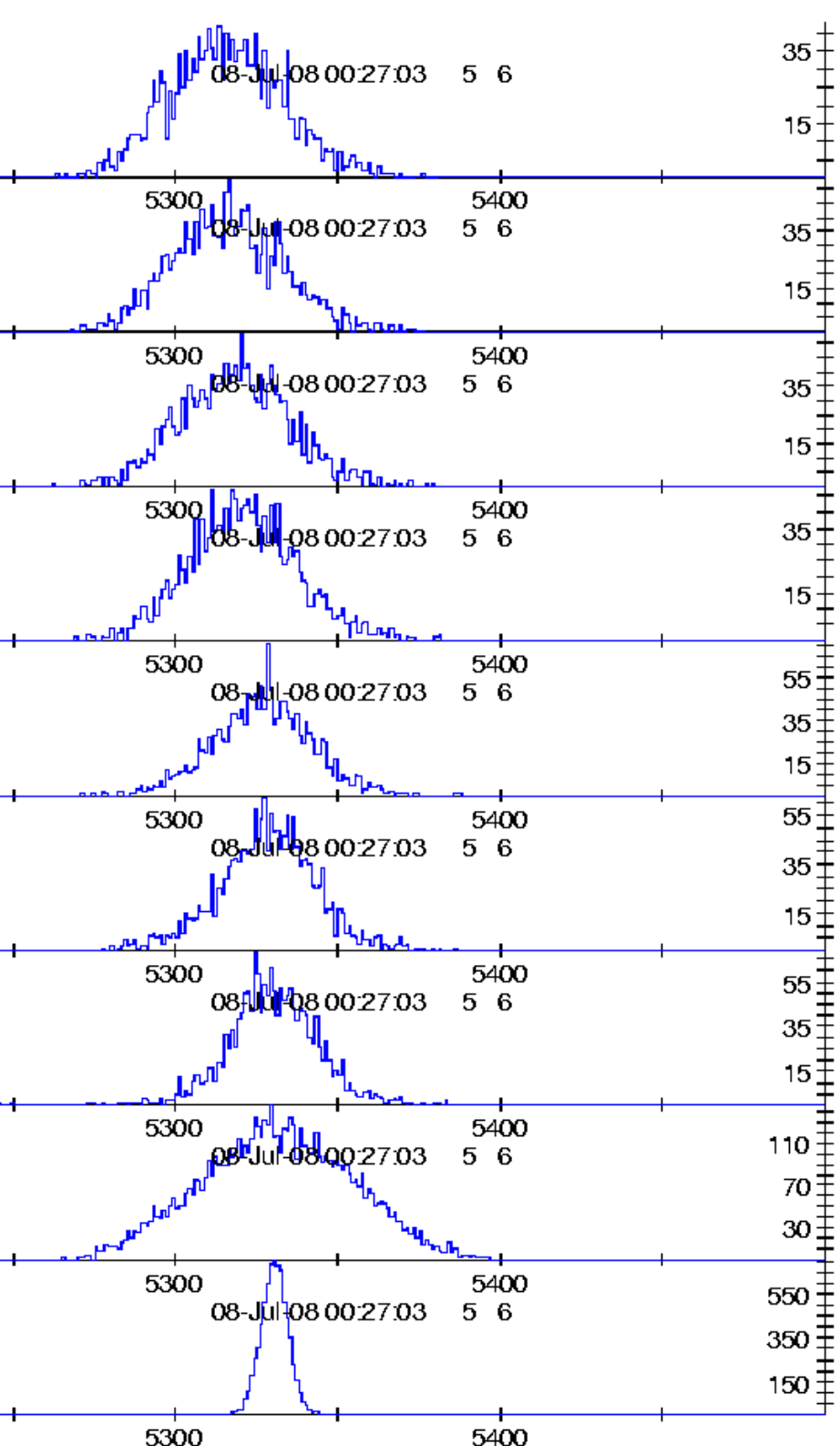
average Doppler correction

stopped source

AGATA

120-180°

lifetime determination:
P.Bednarczyk et al.
EPJA 20(2004)45



prompt γ emission

τ = 0.01 ps

τ = 0.05 ps

τ = 0.1 ps

τ = 0.5 ps

τ = 1.0 ps

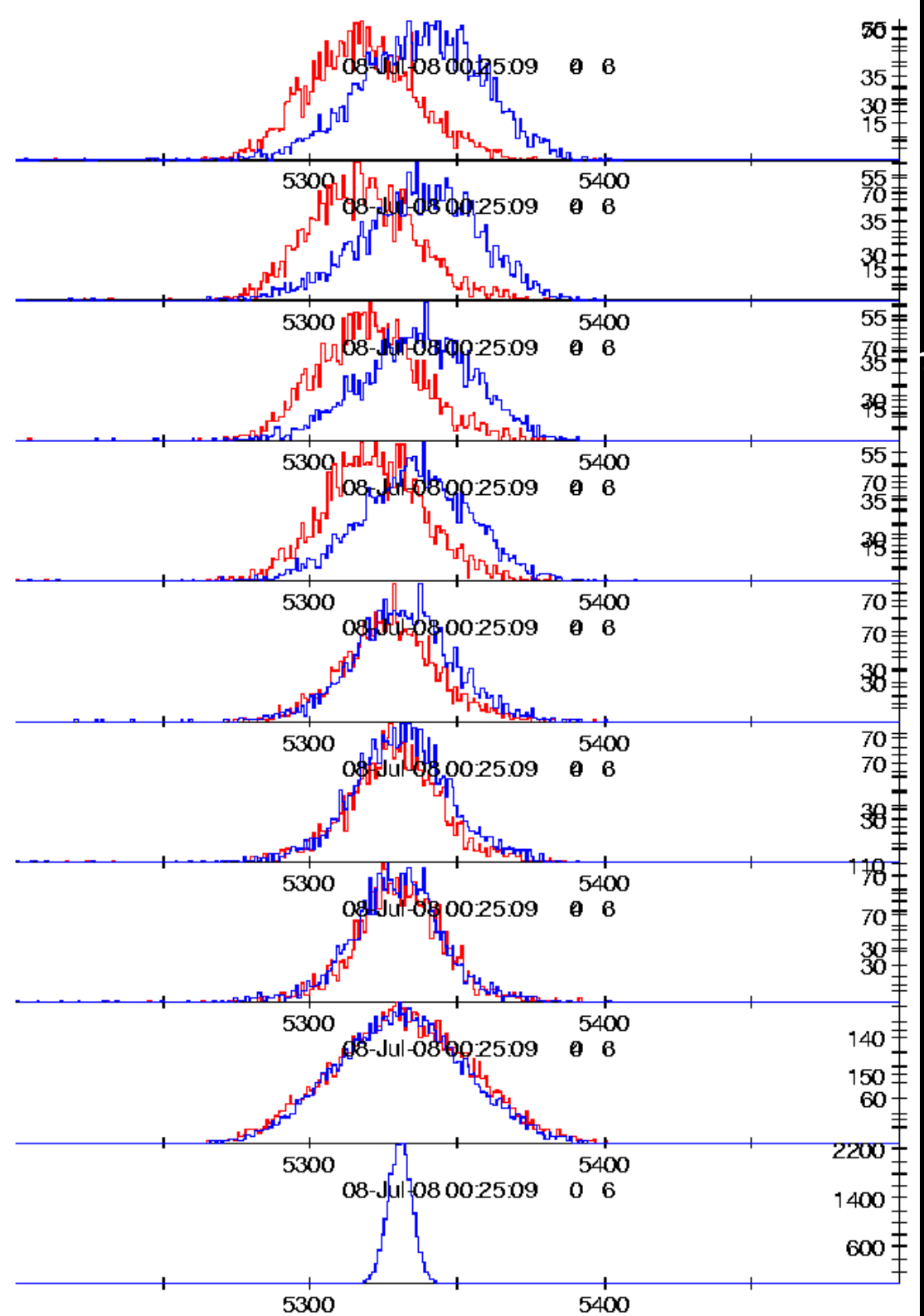
γ emission outside the target

average Doppler correction

stopped source

GASP

120°,145°



prompt γ emission

τ = 0.01 ps

τ = 0.05 ps

τ = 0.1 ps

τ = 0.5 ps

τ = 1.0 ps

γ emission outside the target

average Doppler correction

stopped source

GASP

backward /forward

Conclusions:

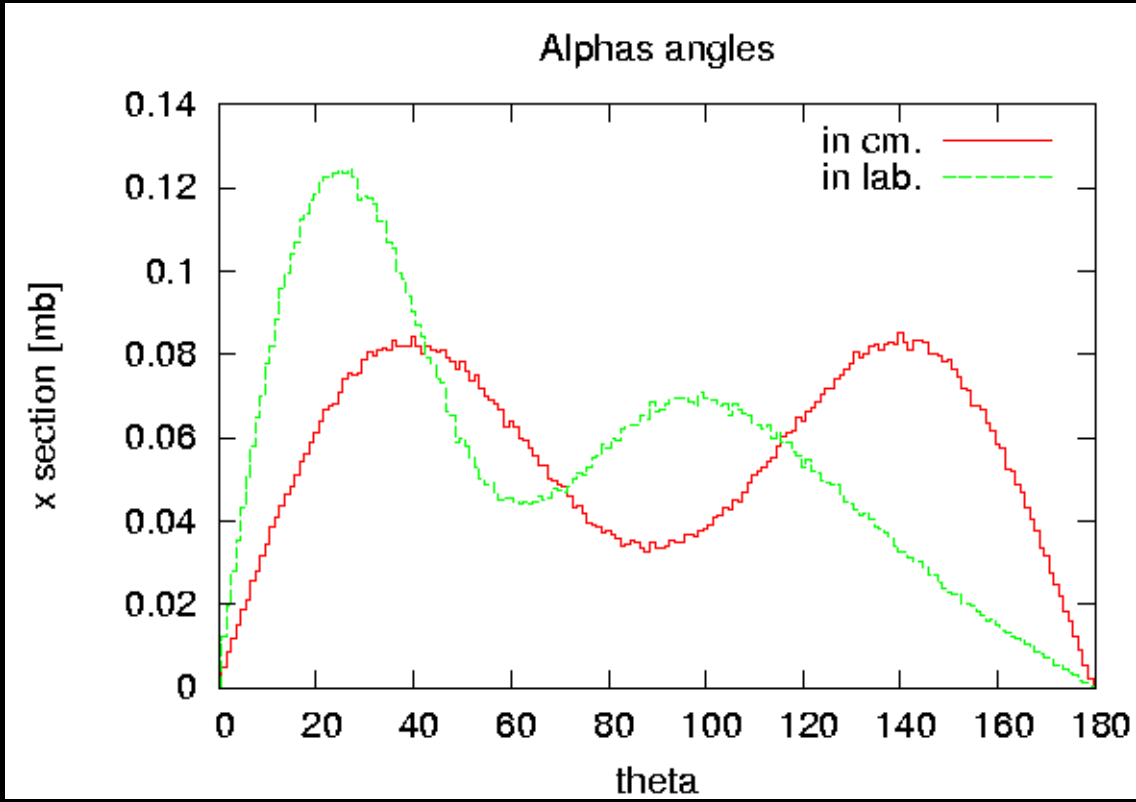
- complete simulations of GASP+RFD & AGATA+RFD performed
- AGATA+RFD setup sensitive to lifetimes in the range 0.01-1.00ps
- recoil velocity vector necessary
- GASP+RFD measurement possible but more difficult

Collaborators:

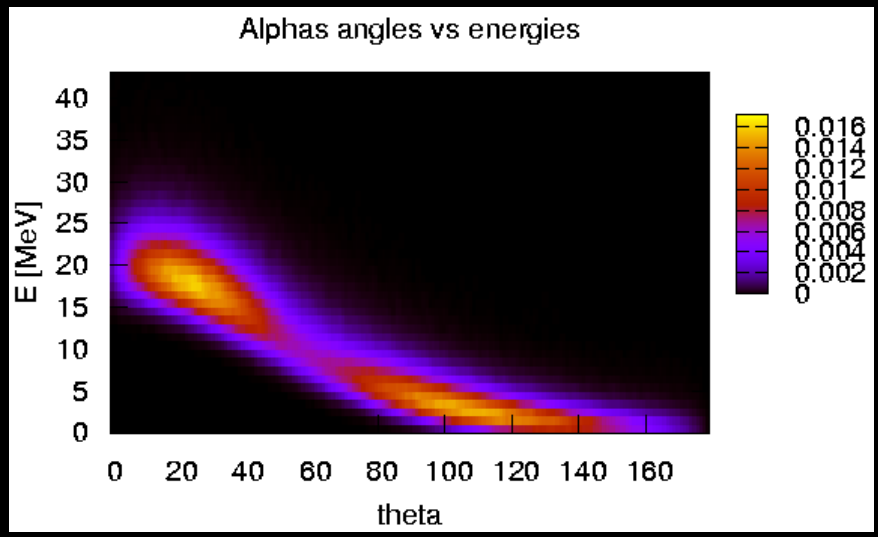
Piotr Bednarczyk
Enrico Farnea
Jan Mierzejewski
Witold Męczyński
Marcin Palacz
Aleksander Pasternak

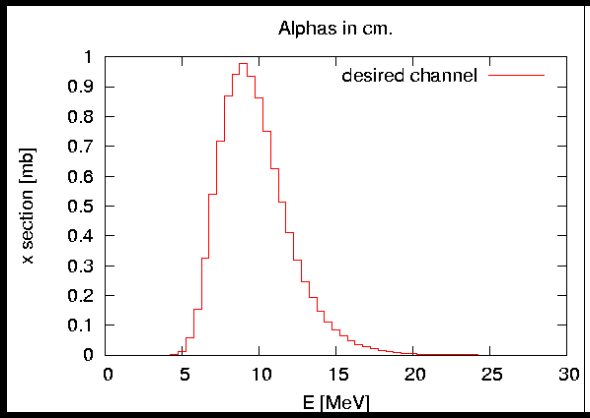
Thanks for your attention!

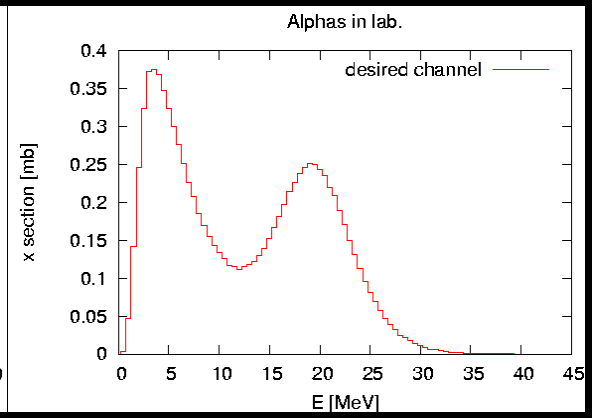
Angular and energy distribution of α particles and recoils

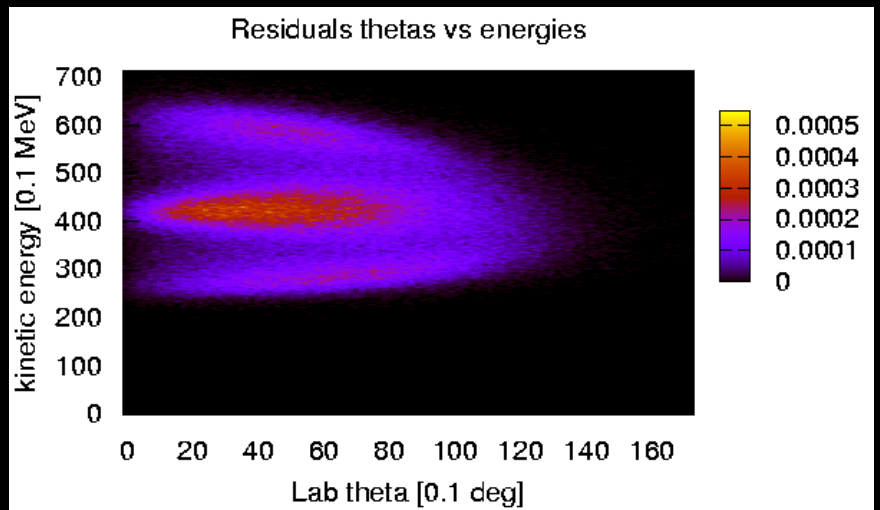


J. Mierzejewski









J. Mierzejewski:

Angular distribution of particles

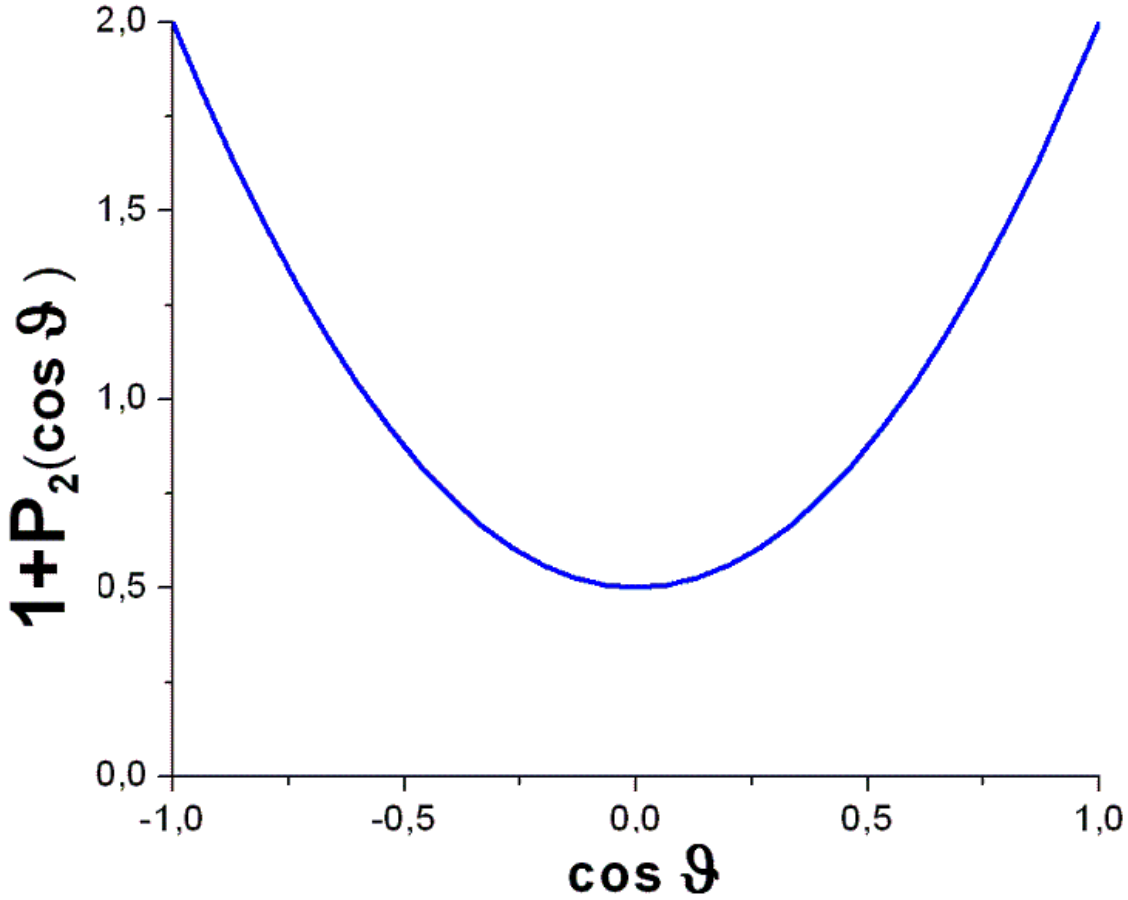
$$\frac{\partial^2 \sigma_{\alpha\beta}}{\partial \epsilon_\beta \partial \Omega_\beta} \approx \frac{d\,\sigma_{\alpha\beta}}{d\,\epsilon_\beta} \frac{1}{4\pi} \left(1 + A_2 P_2(\cos\theta)\right)$$

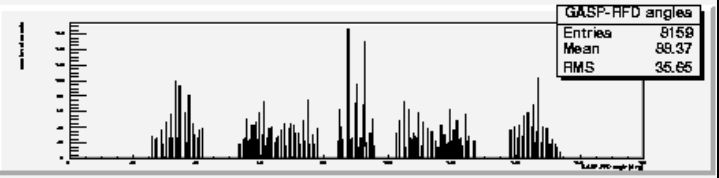
$$A_2 = \frac{L_p(L_p+1)L_n(L_n+1)}{12\,I^2 T^2}$$

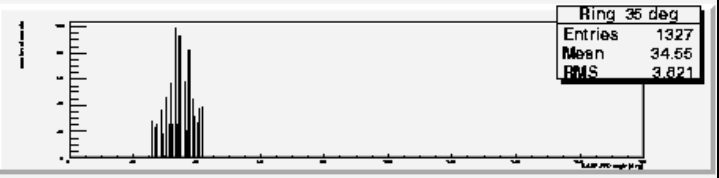
L_p,L_n – particle and nucleus angular momentum [hbar],

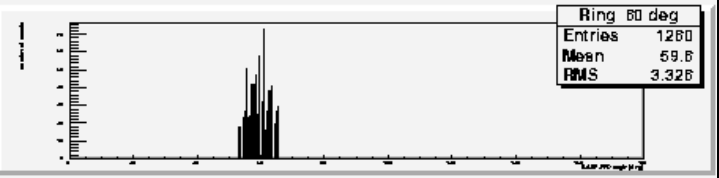
J- moment of inertia of the nucleus [in units of J_0], where J_0 is a moment of inertia of the spherical nucleus.

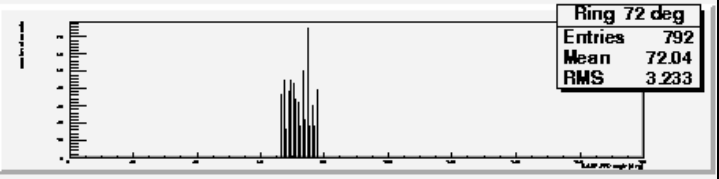
T – nucleus temperature [MeV].

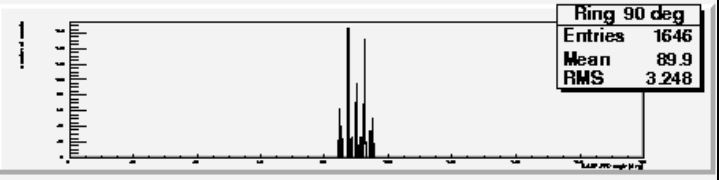


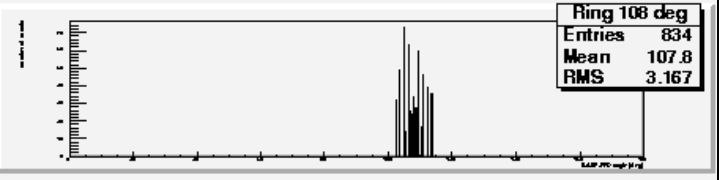

GASP-RFD angles
Entries 8159
Mean 88.37
RMS 35.65

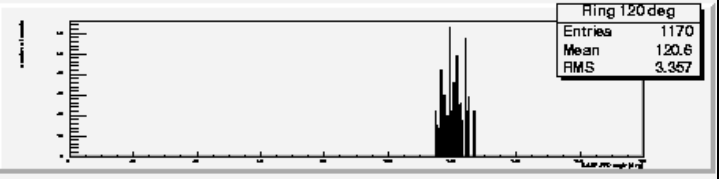

Ring 35 deg
Entries 1327
Mean 34.55
RMS 3.821

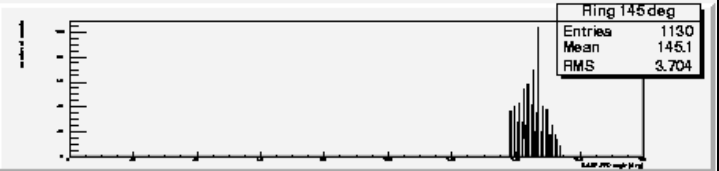

Ring 60 deg
Entries 1260
Mean 59.6
RMS 3.326

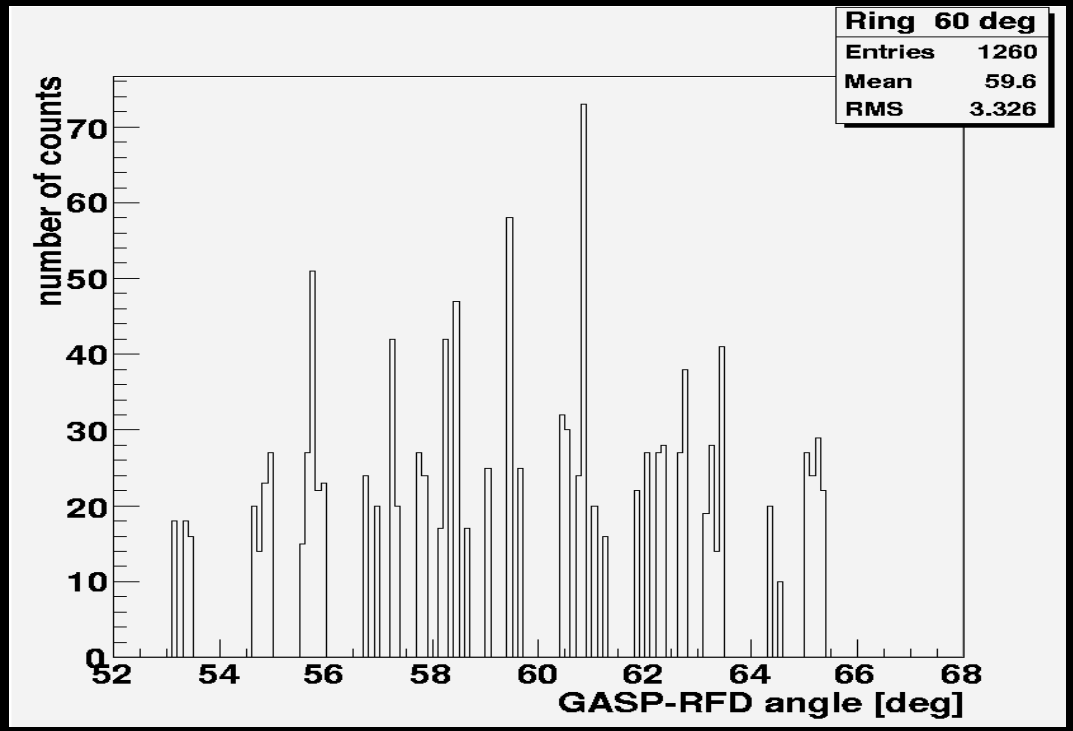

Ring 72 deg
Entries 792
Mean 72.04
RMS 3.233

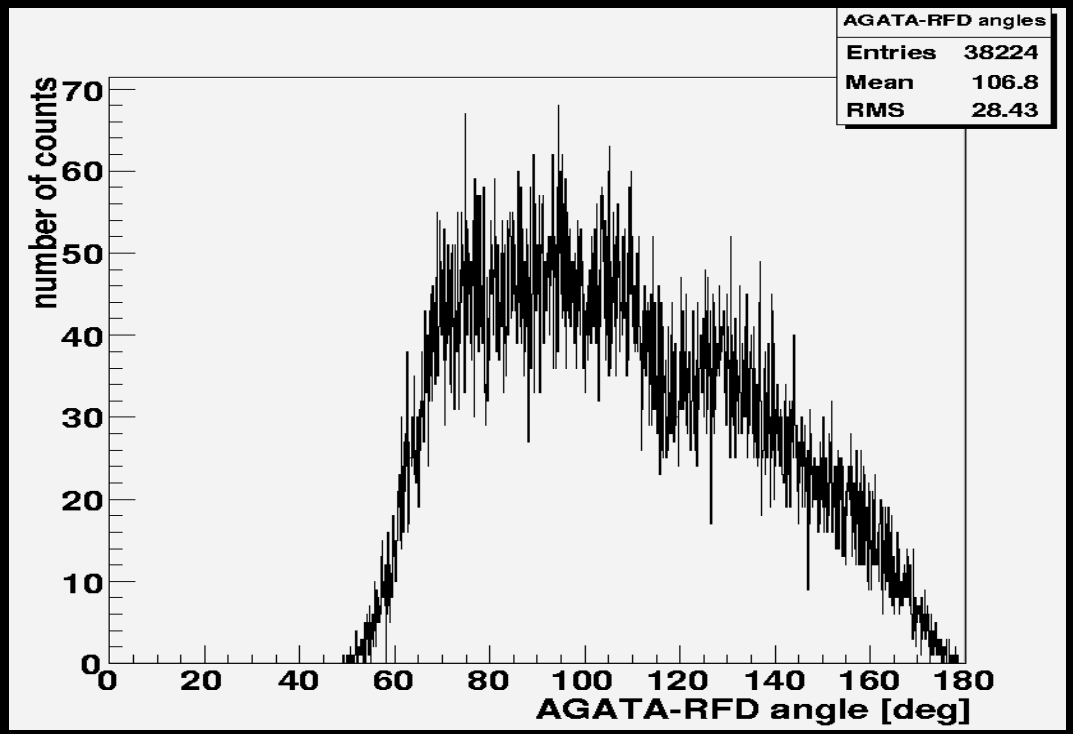

Ring 90 deg
Entries 1646
Mean 89.9
RMS 3.248


Ring 108 deg
Entries 834
Mean 107.8
RMS 3.167

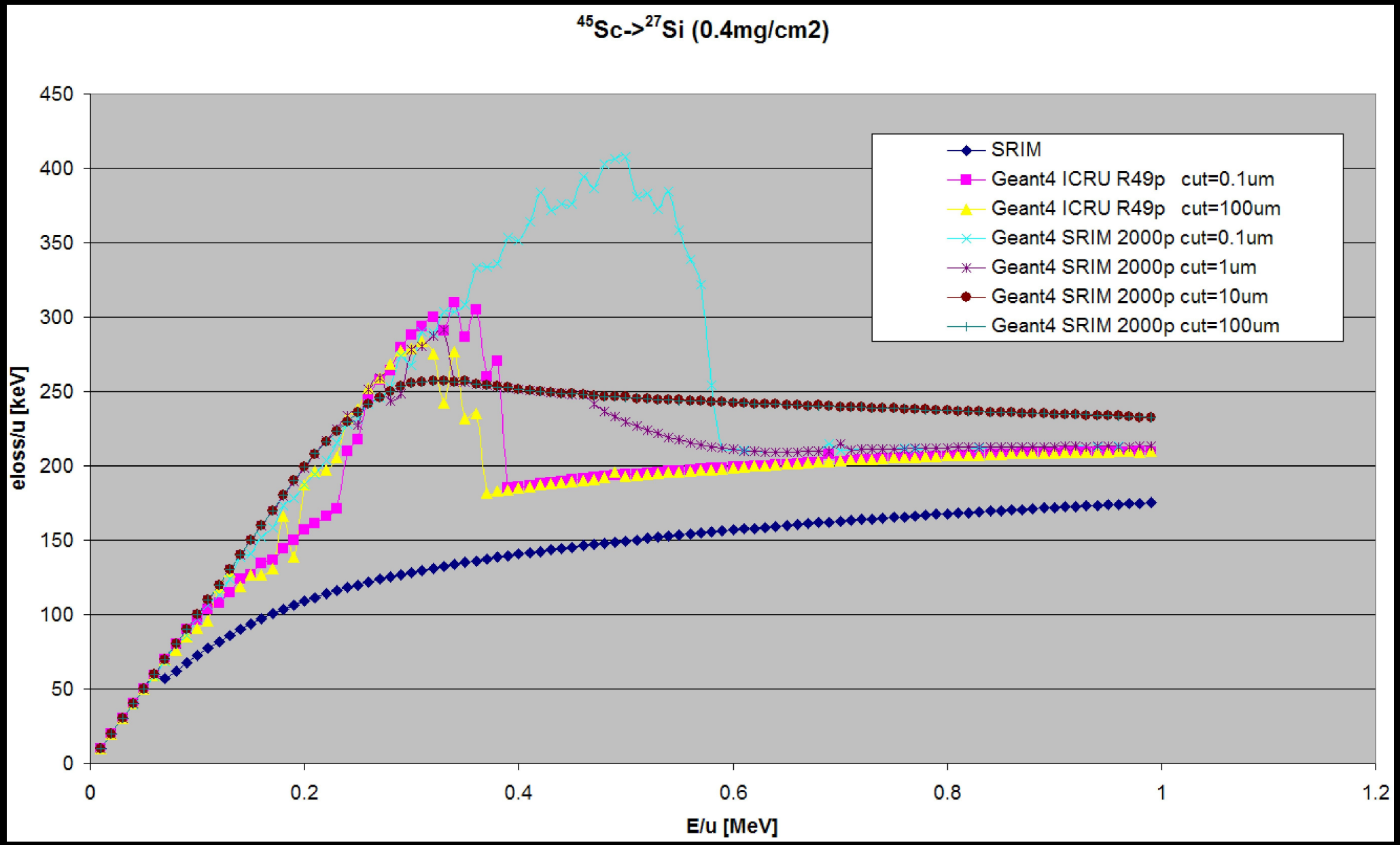

Ring 120 deg
Entries 1170
Mean 120.6
RMS 3.357


Ring 145 deg
Entries 1130
Mean 145.1
RMS 3.704

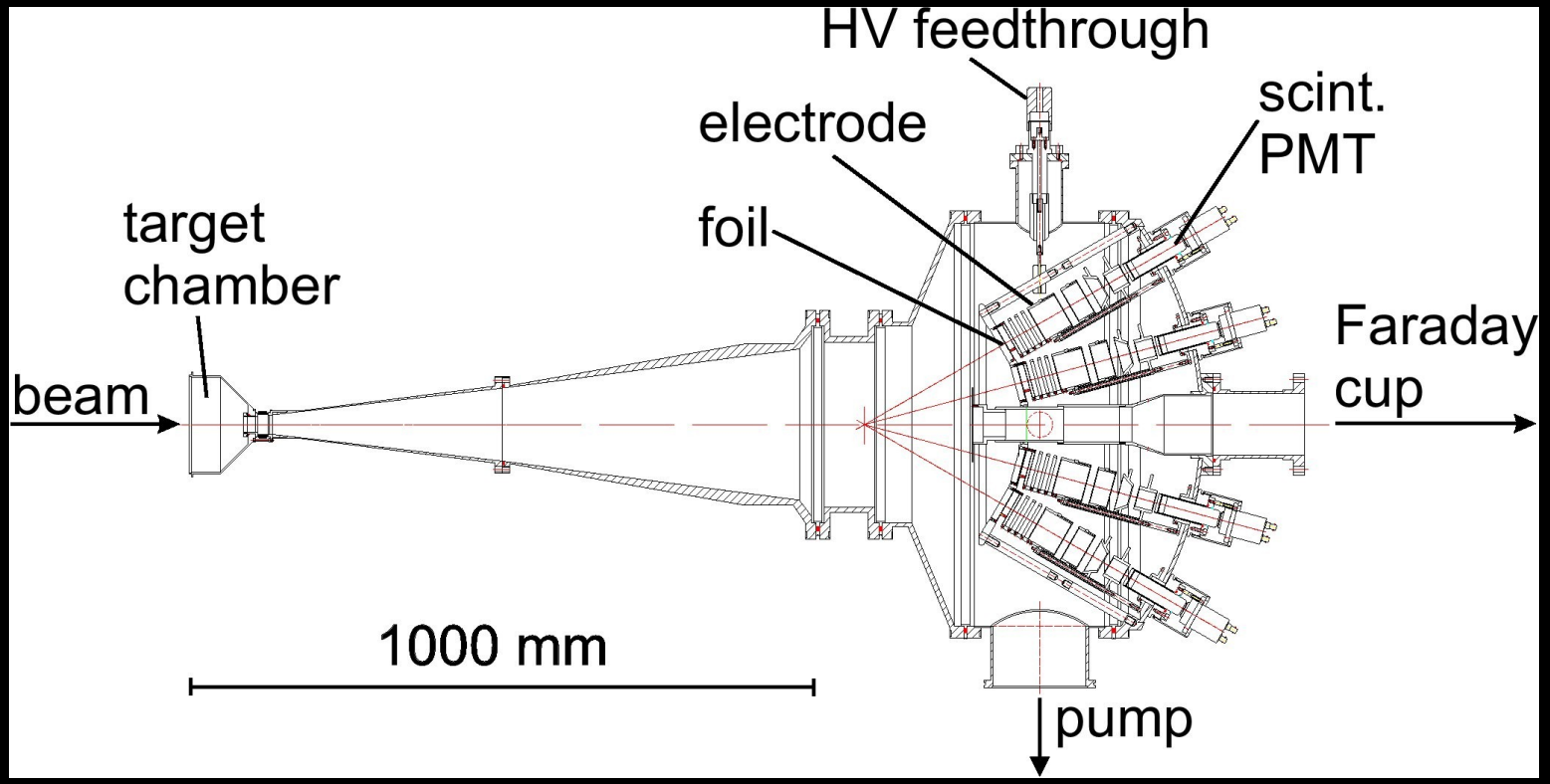

Ring 60 deg
Entries 1260
Mean 59.6
RMS 3.326
number of counts
0
10
20
30
40
50
60
70
52
54
56
58
60
62
64
66
68
GASP-RFD angle [deg]


AGATA-RFD angles
Entries 38224
Mean 106.8
RMS 28.43
number of counts
0
10
20
30
40
50
60
70
0
20
40
60
80
100
120
140
160
180
AGATA-RFD angle [deg]

Problems with Geant4 stopping powers calculations

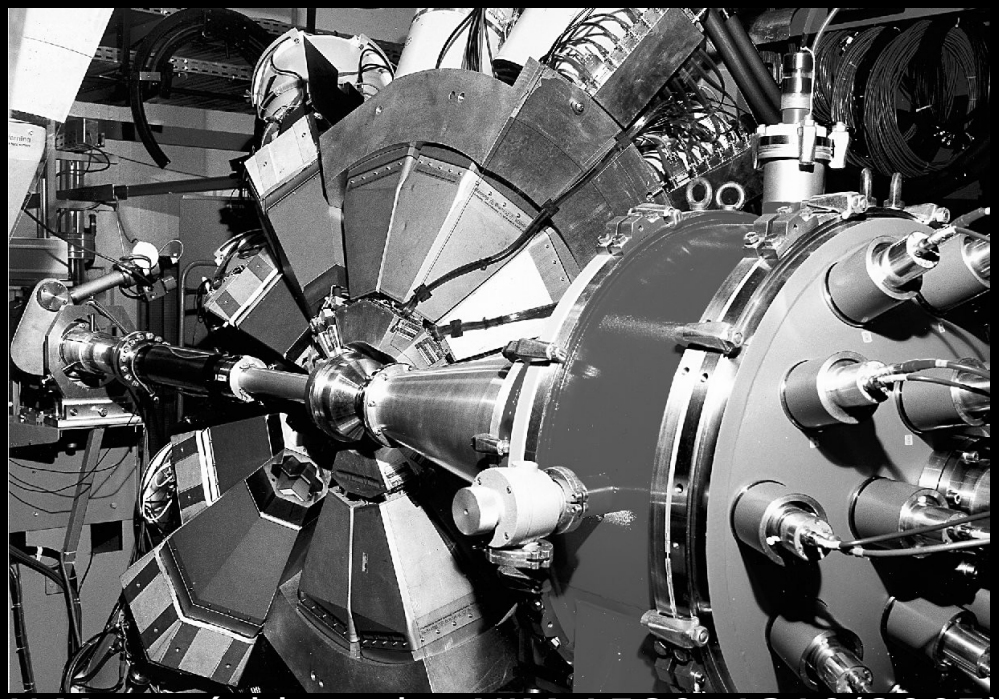


The RFD detector

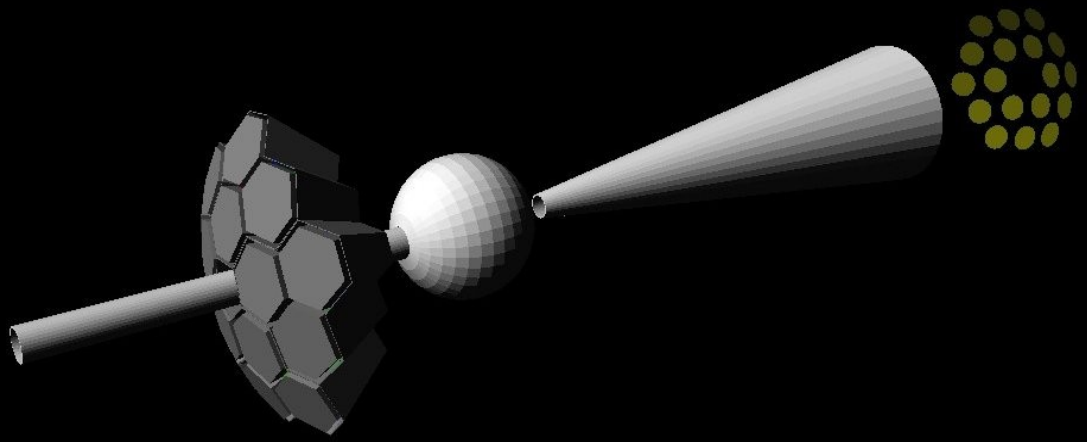


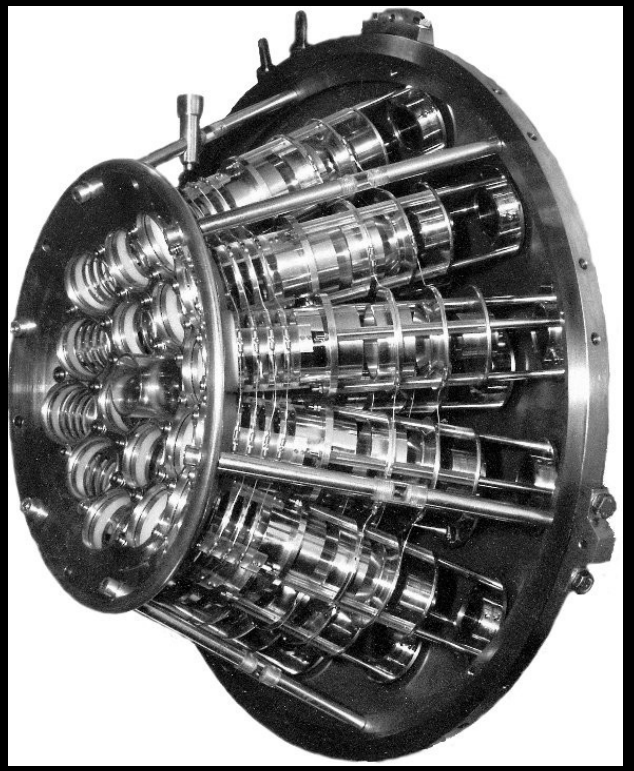
W.Męczyński et al. - NIM A580, 1310(2007)

The RFD detector



W.Męczyński et al. - NIM A580, 1310(2007)





W.Męczyński et al.
NIM A580, 1310(2007)