Geant4 Simulations of Recoil Filter Detector Performance in Nuclear Structure Studies with Stable and Radioactive beams

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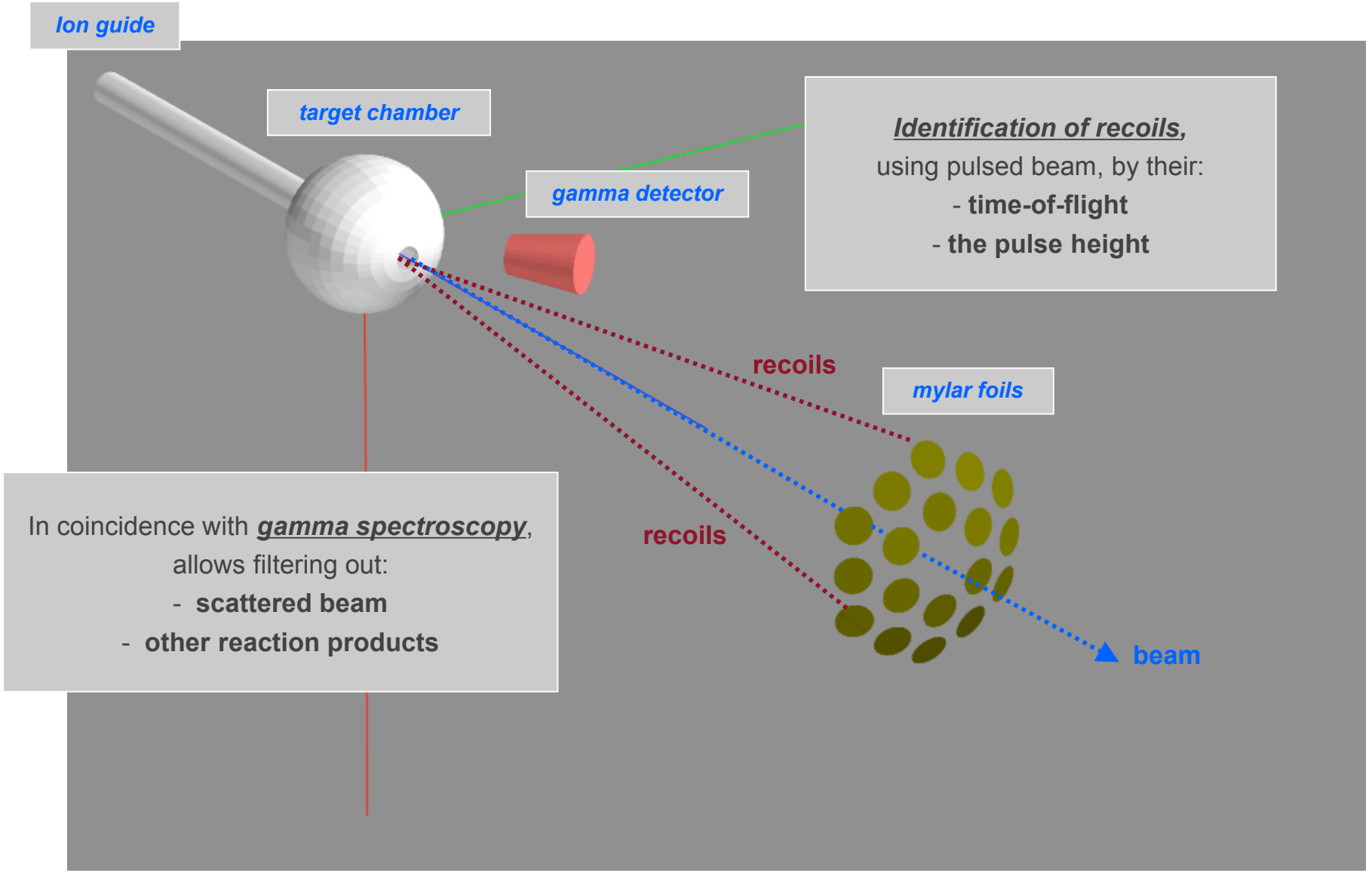
EGAN 2012 Workshop, 25-27 June, Orsay

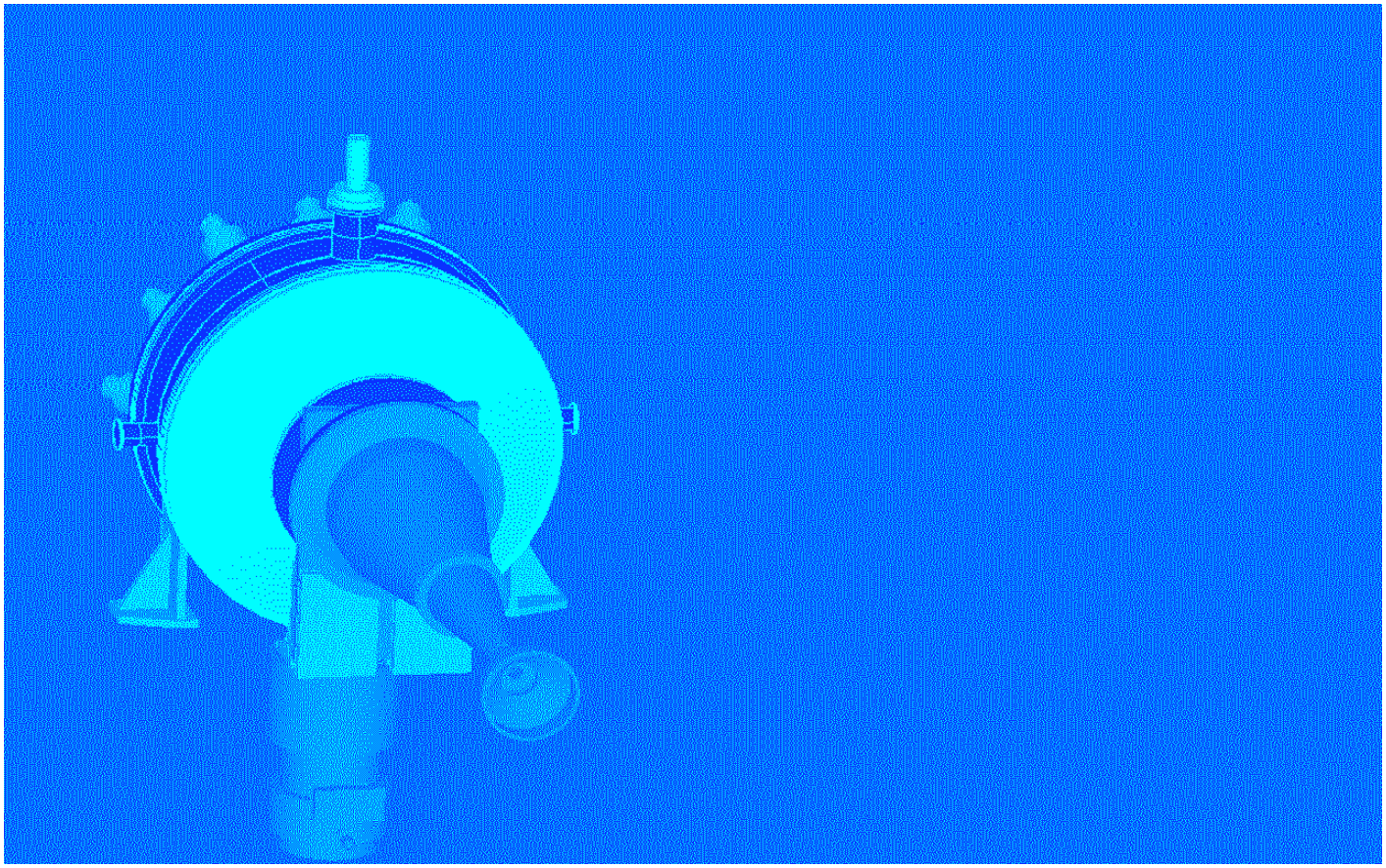
Introduction to RFD

construction and performance



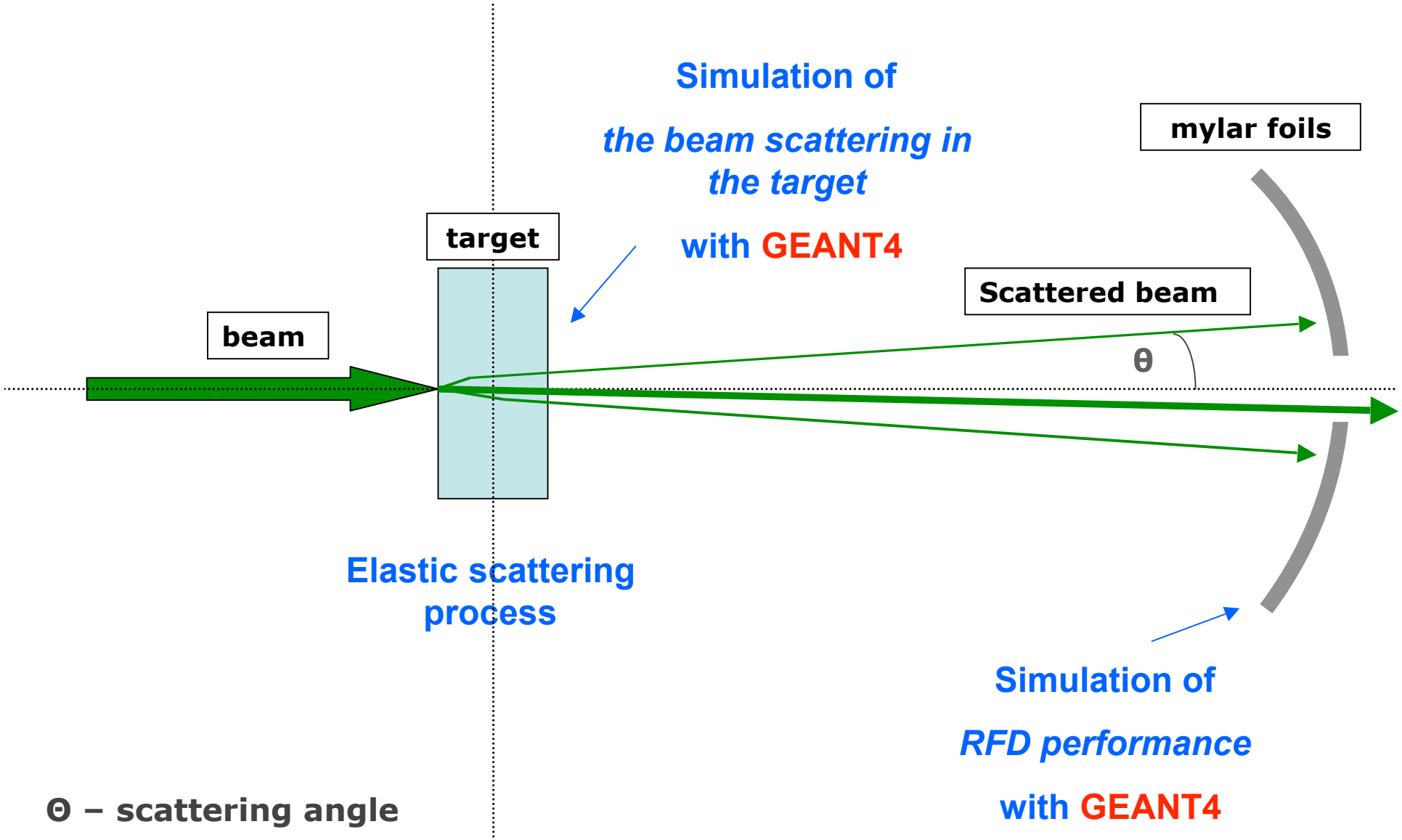
Introduction to RFD

construction and performance



Introduction to simulations

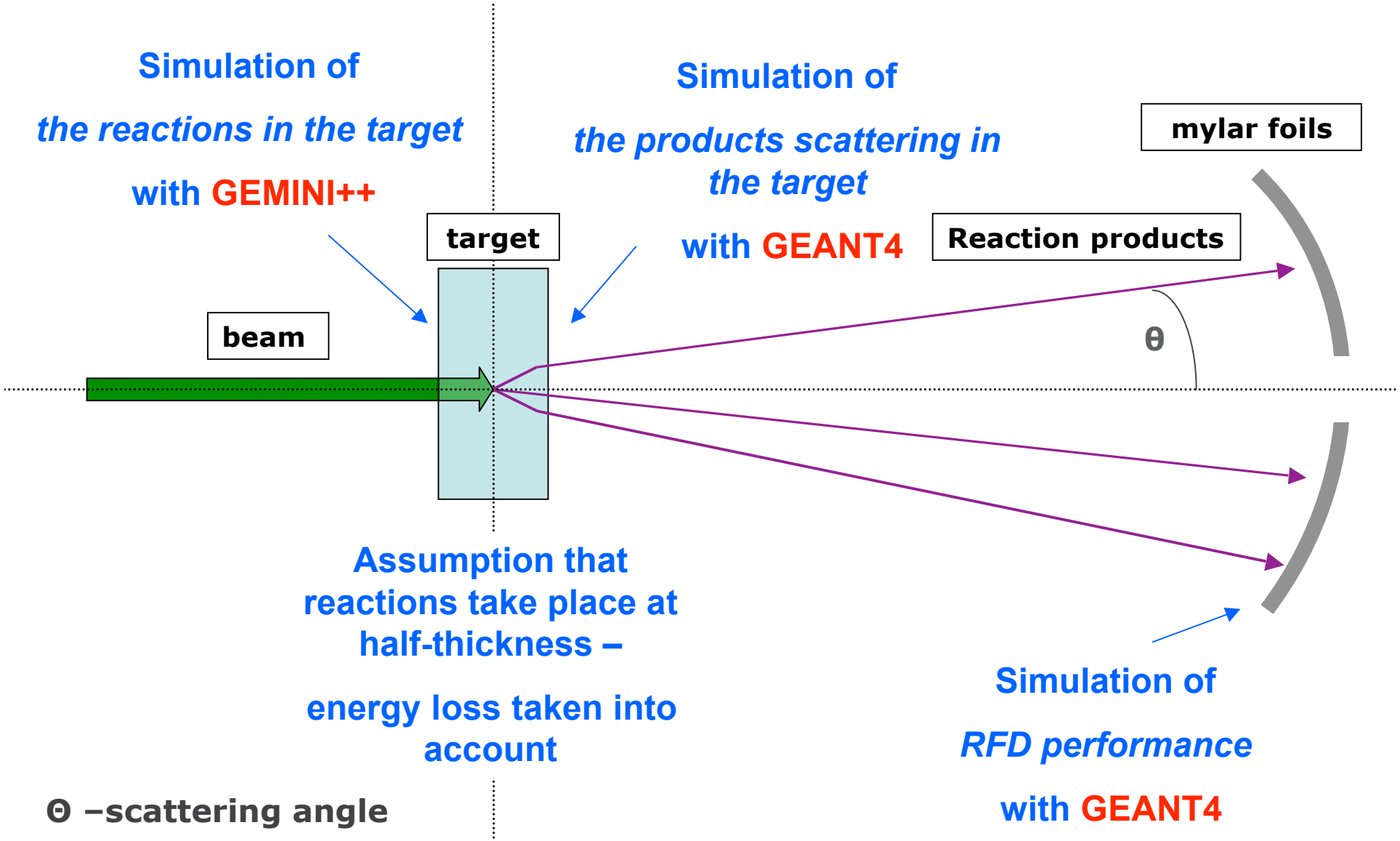
simulation of a beam



Θ – scattering angle

Introduction to simulations

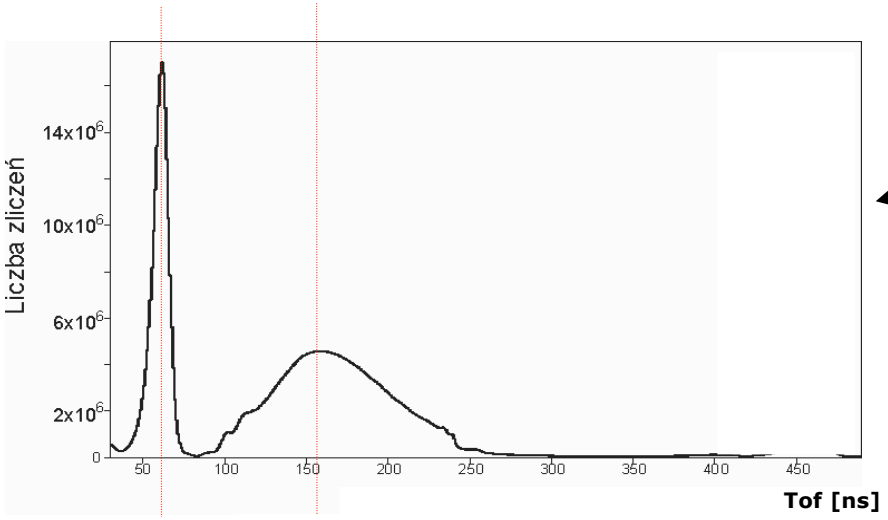
simulation of reaction products



Introduction to simulations

experimental validation of the simulations

95 Mev ^{32}S beam passing 0.8 mg/cm^2 ^{40}Ca target



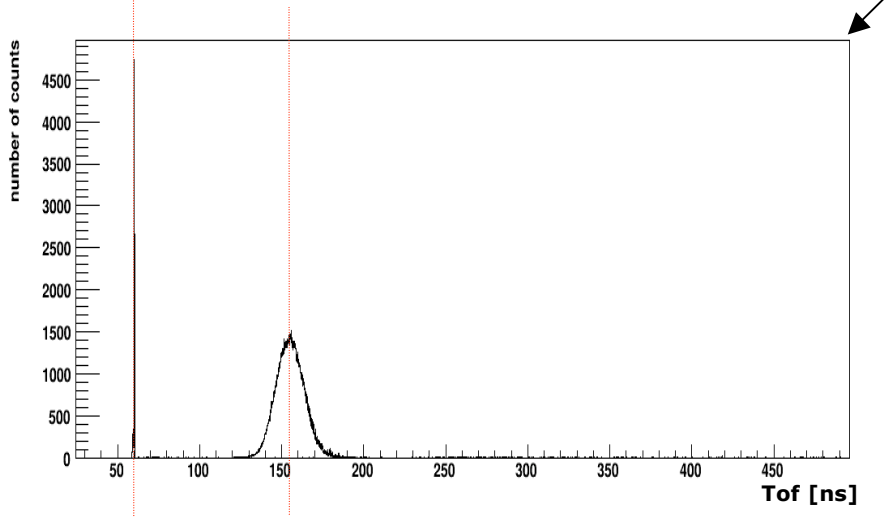
Experimental results

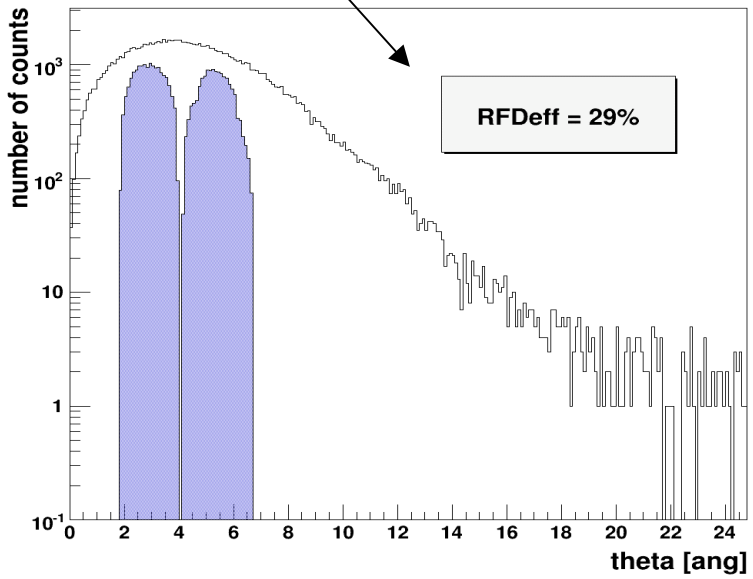
RFDeff ~ 20%

Simulations /punctual beam, „sharp" energy /

60.5 ns +/-3.47

155.9 ns +/-17.66





Aim of simulations

radioactive beams, inverse kinematics

„Study of collective modes of excitations in the neutron-rich Ba region via fusion-evaporation reactions”

Spiral2 Day1 – Phase2 LoI

Adam Maj (Kraków), Silvia Leoni (Milano) – spokespersons
Christell Schmitt – GANIL Liaison et al

Proposed reaction:

- Radioactive beam: ^{90}**Kr**, E = 388 MeV
- Target: ^{48}**Ca**, 1mg/cm^2

Possible application of RFD

- Doppler shift correction
- elimination of fission products – *essential in this kind of reaction*

Results

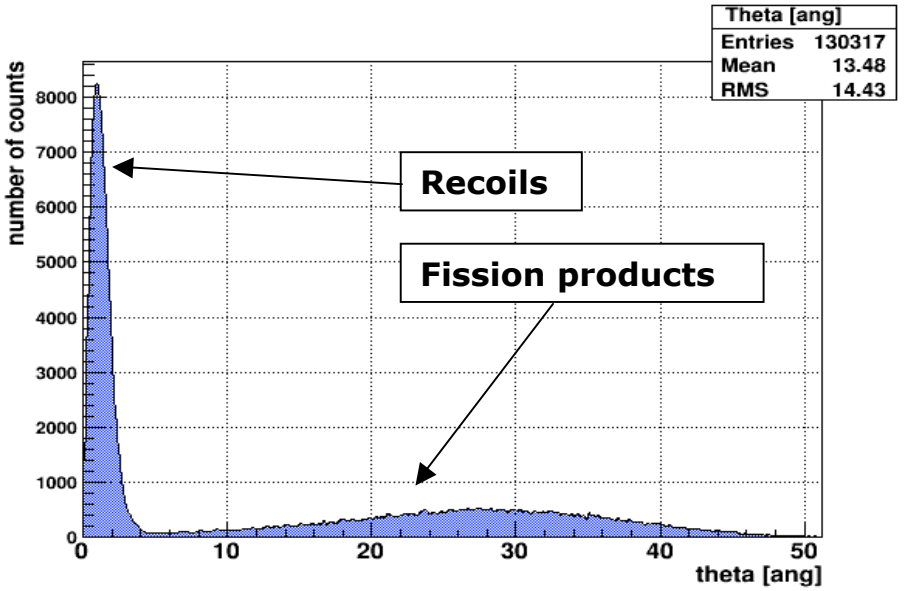
reaction products

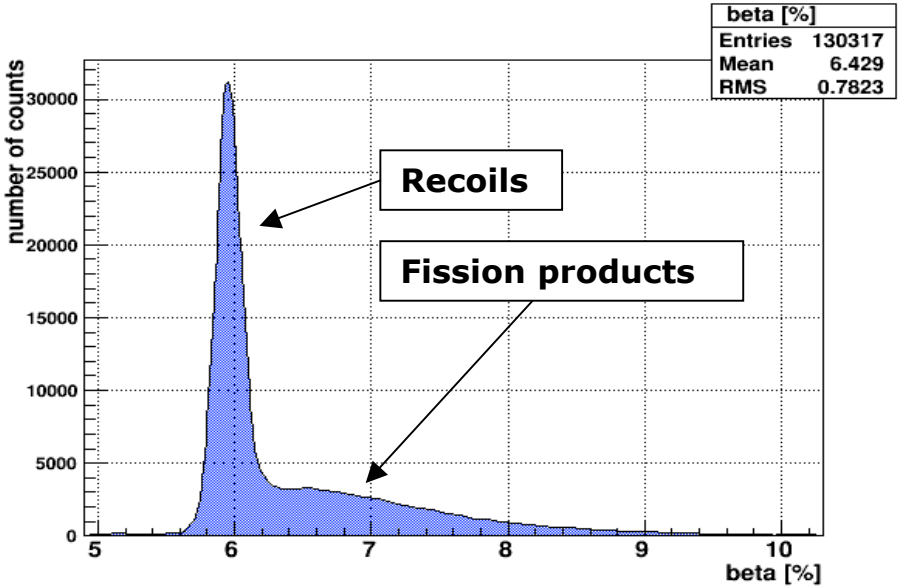
Energy and beta distributions

of

reaction products that leave target

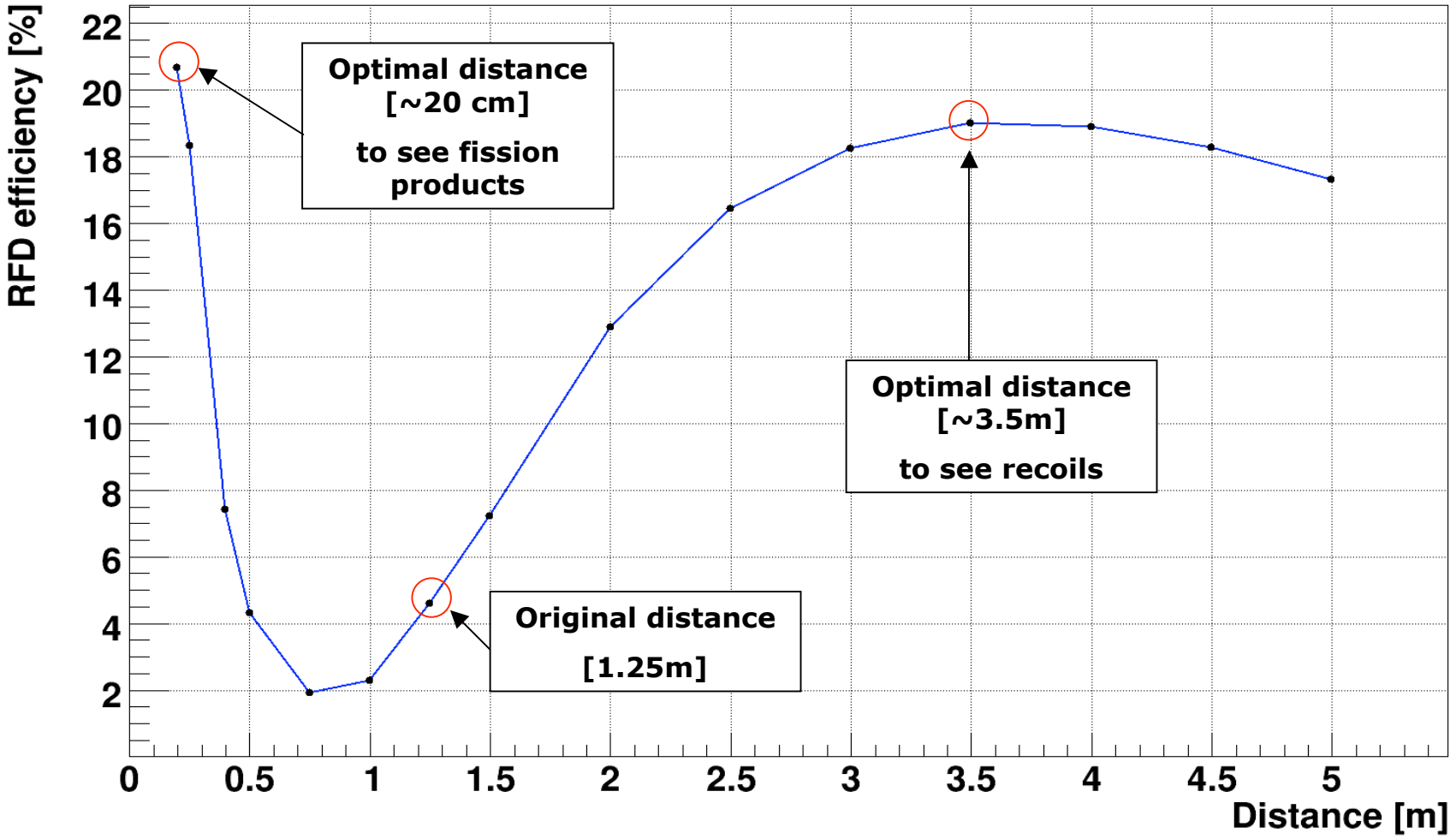
simulated with GEMINI++





Results

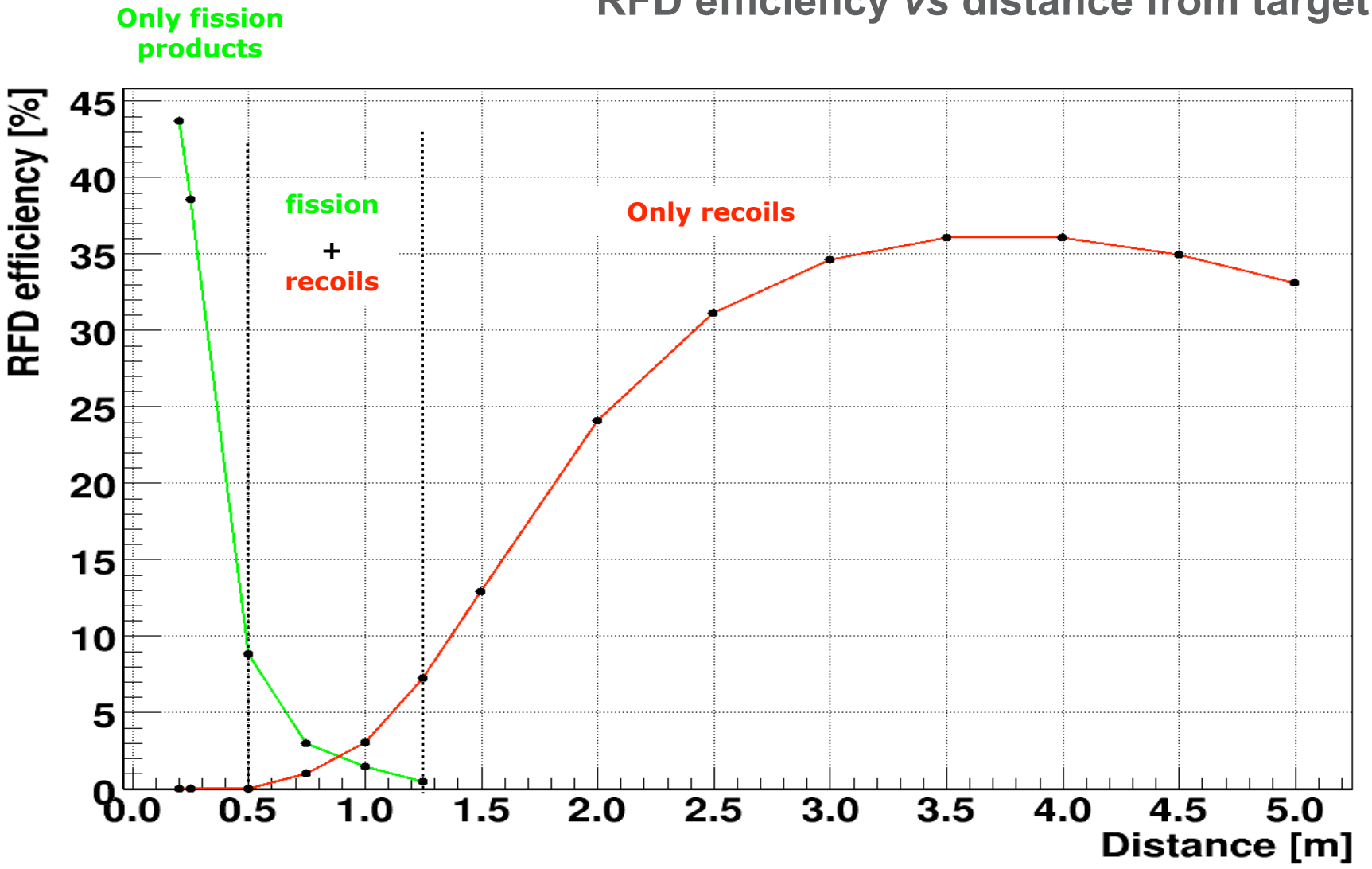
RFD efficiency *vs* distance from target



Strong dependence between distance and what you can detect

Results

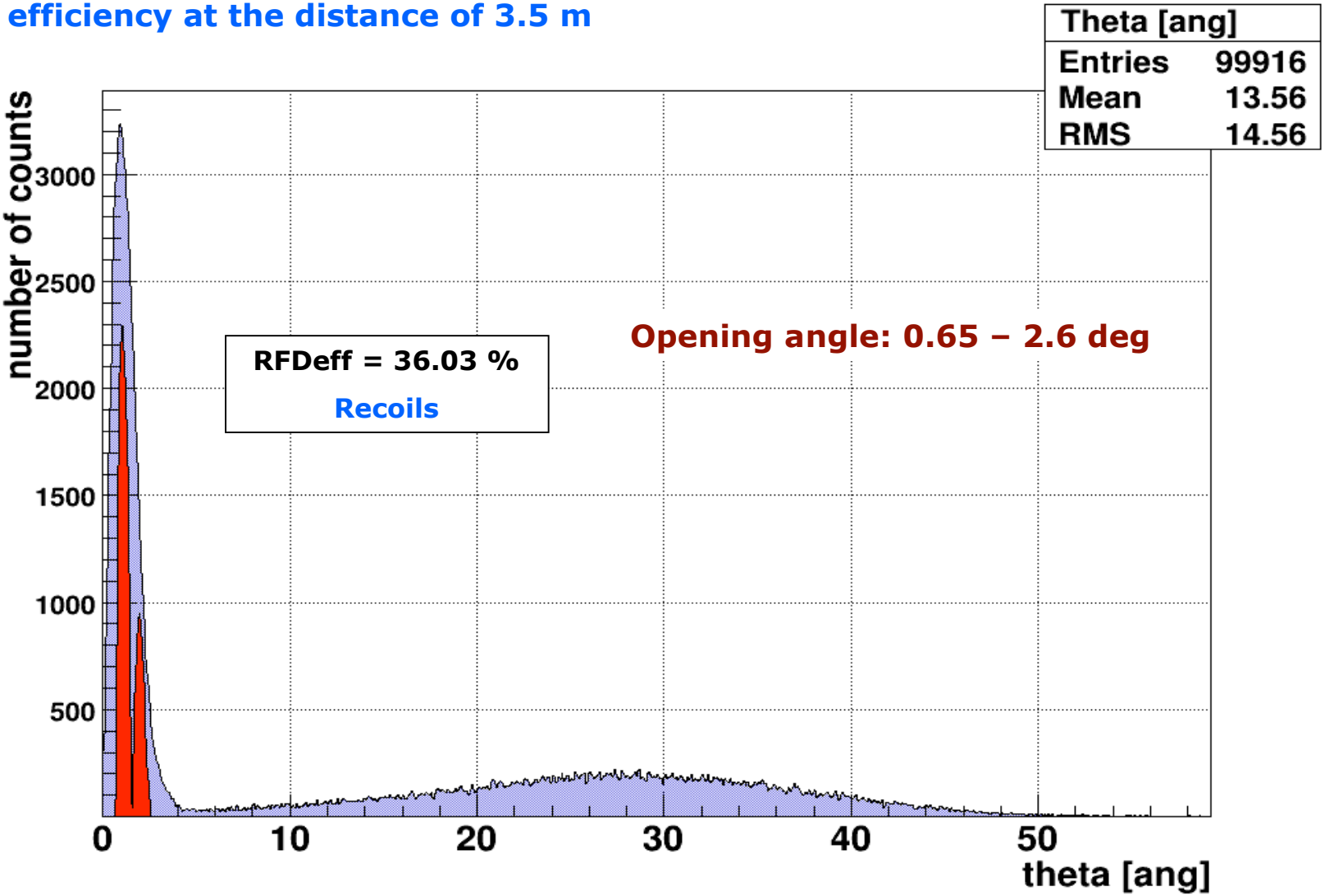
RFD efficiency *vs* distance from target



Results

RFD efficiency *vs* distance

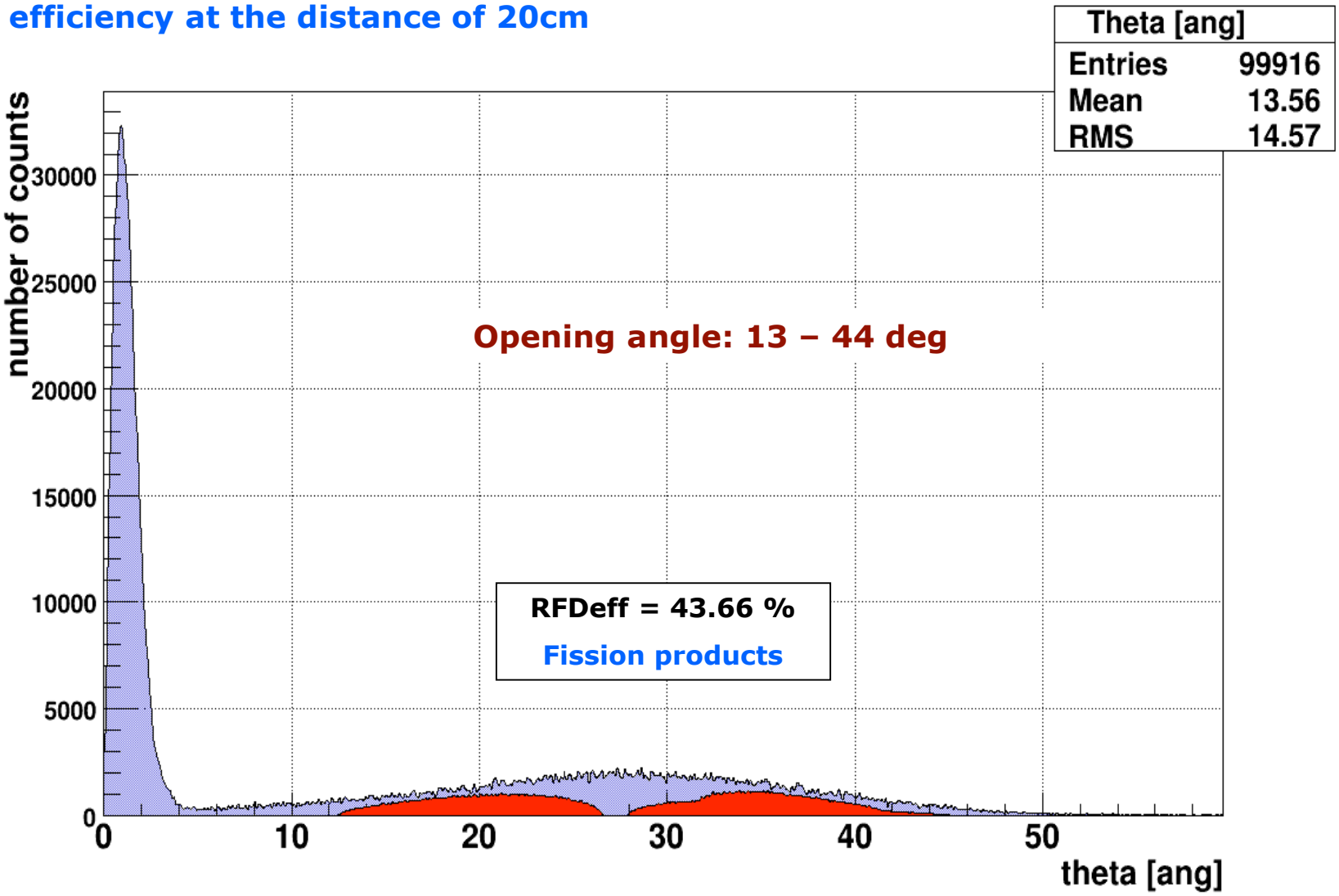
RFD efficiency at the distance of 3.5 m



Results

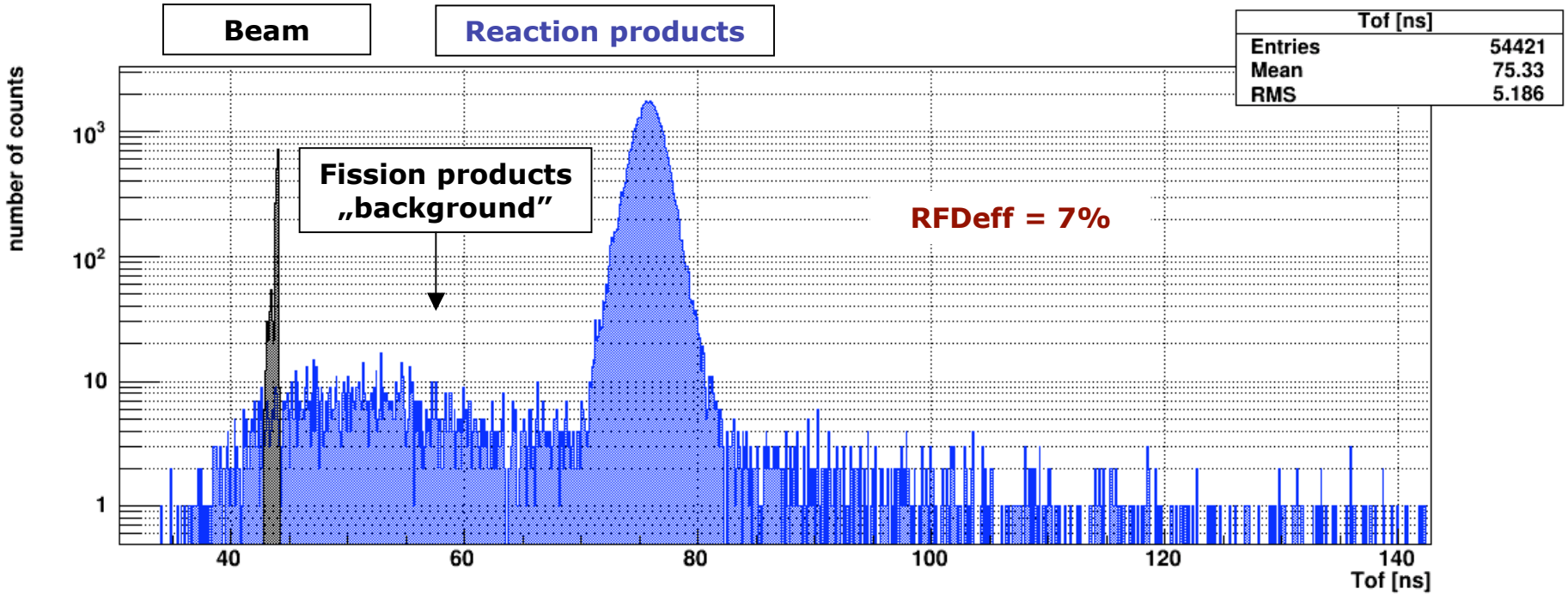
RFD efficiency *vs* distance

RFD efficiency at the distance of 20cm



Results

time-of-flight spectra

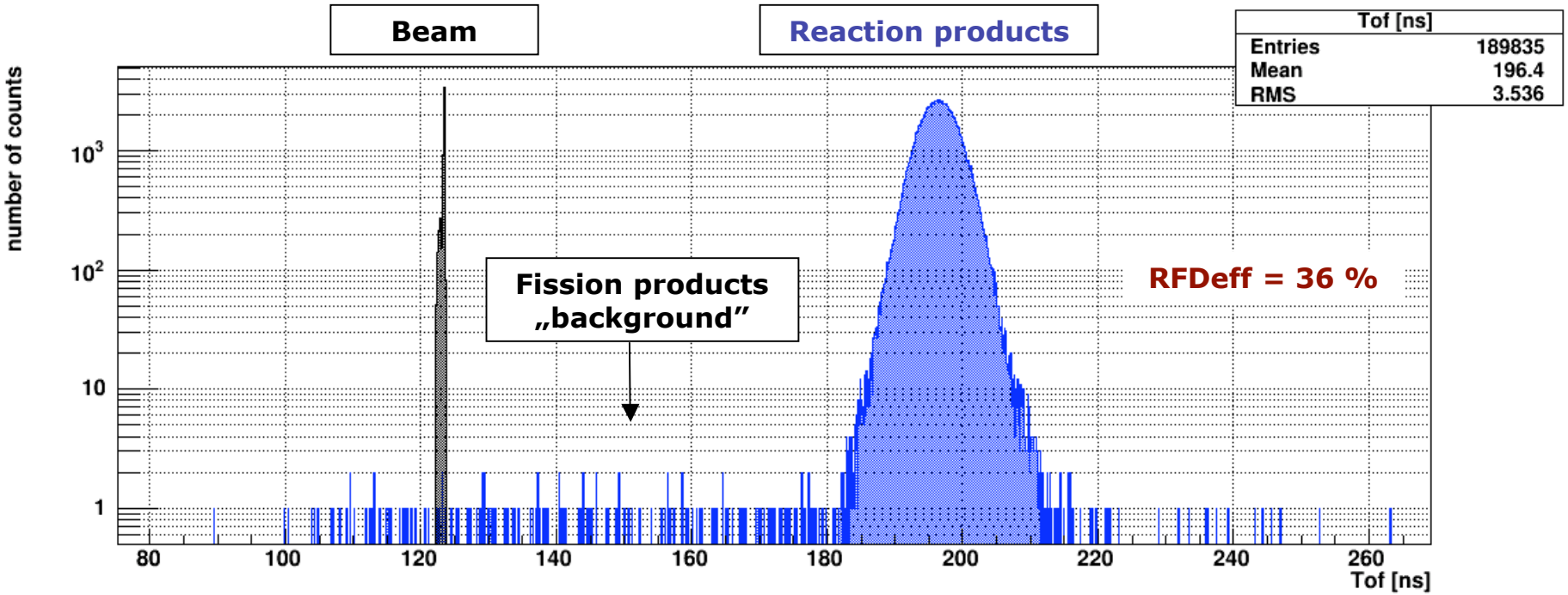


Time-of-flight spectra of beam and reaction products

at the original distance of 1.25 m from target

Results

time-of-flight spectra

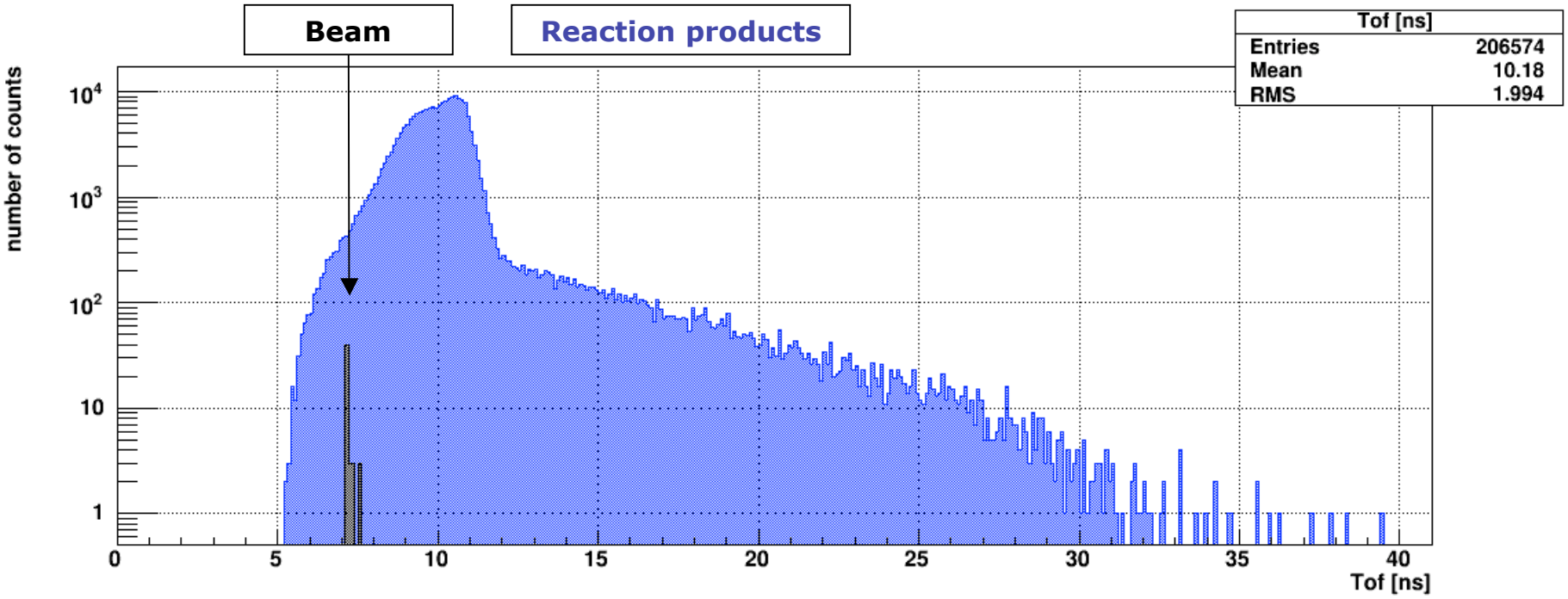


Time-of-flight spectra of beam and reaction products

at the distance of 3.5 m from target

Results

time-of-flight spectra

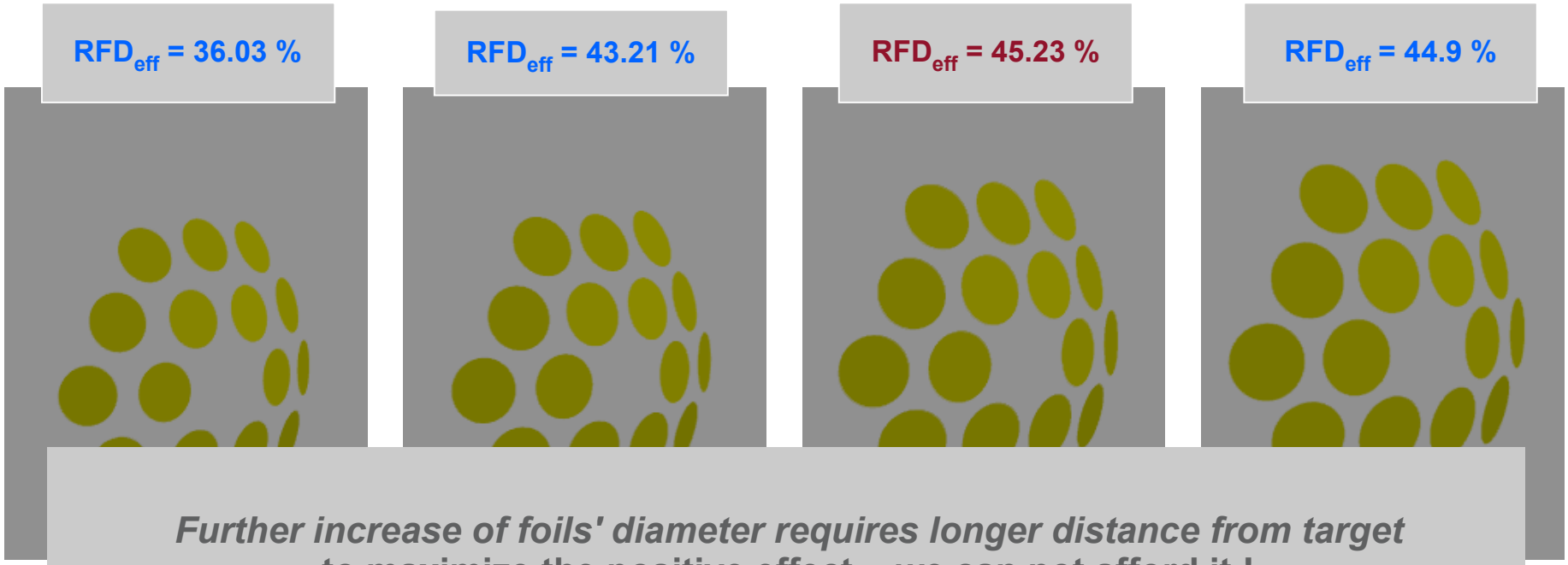


Time-of-flight spectra of beam and reaction products

at the distance of 20 cm from target

Results

different foils' geometry



Further increase of foils' diameter requires longer distance from target
to maximize the positive effect - we can not afford it !

foil
inner ring theta = 2.9 deg
middle ring theta = 5.1 deg
outer ring theta = 5.69 deg
distance from target = 3.5 m

inner ring theta = 2.9 deg
middle ring theta = 5.1 deg
outer ring theta = 5.9 deg
distance from target = 3.5 m

inner ring theta = 3.2 deg
middle ring theta = 5.65 deg
outer ring theta = 6.55 deg
distance from target = 3.5 m

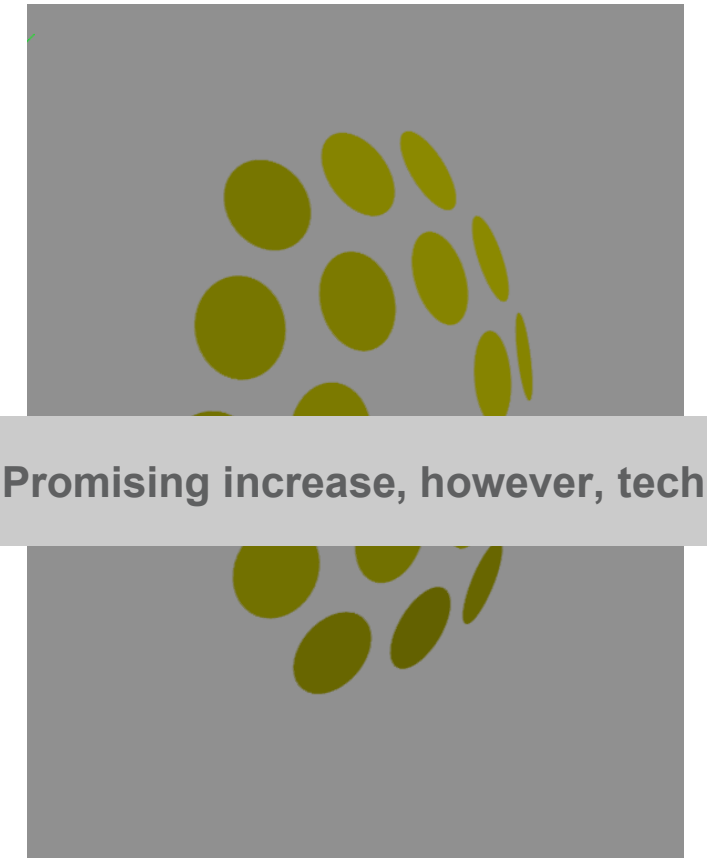
inner ring theta = 3.45 deg
middle ring theta = 6.0 deg
outer ring theta = 7.0 deg
distance from target = 3.5 m

Results

different foils' shape

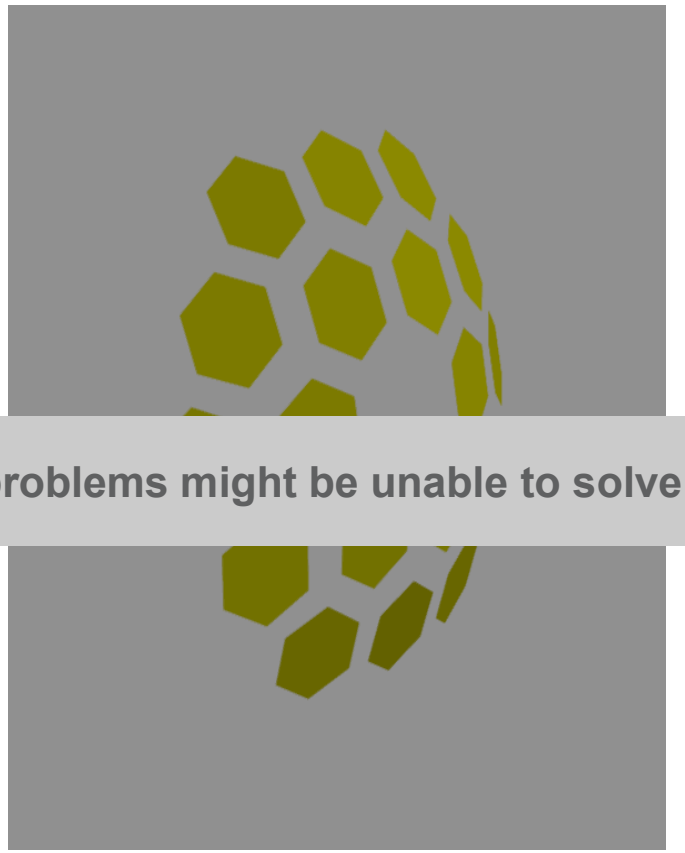
spherical

RFD_{eff} = 36.03 %



hexagonal

RFD_{eff} = 40.01 %

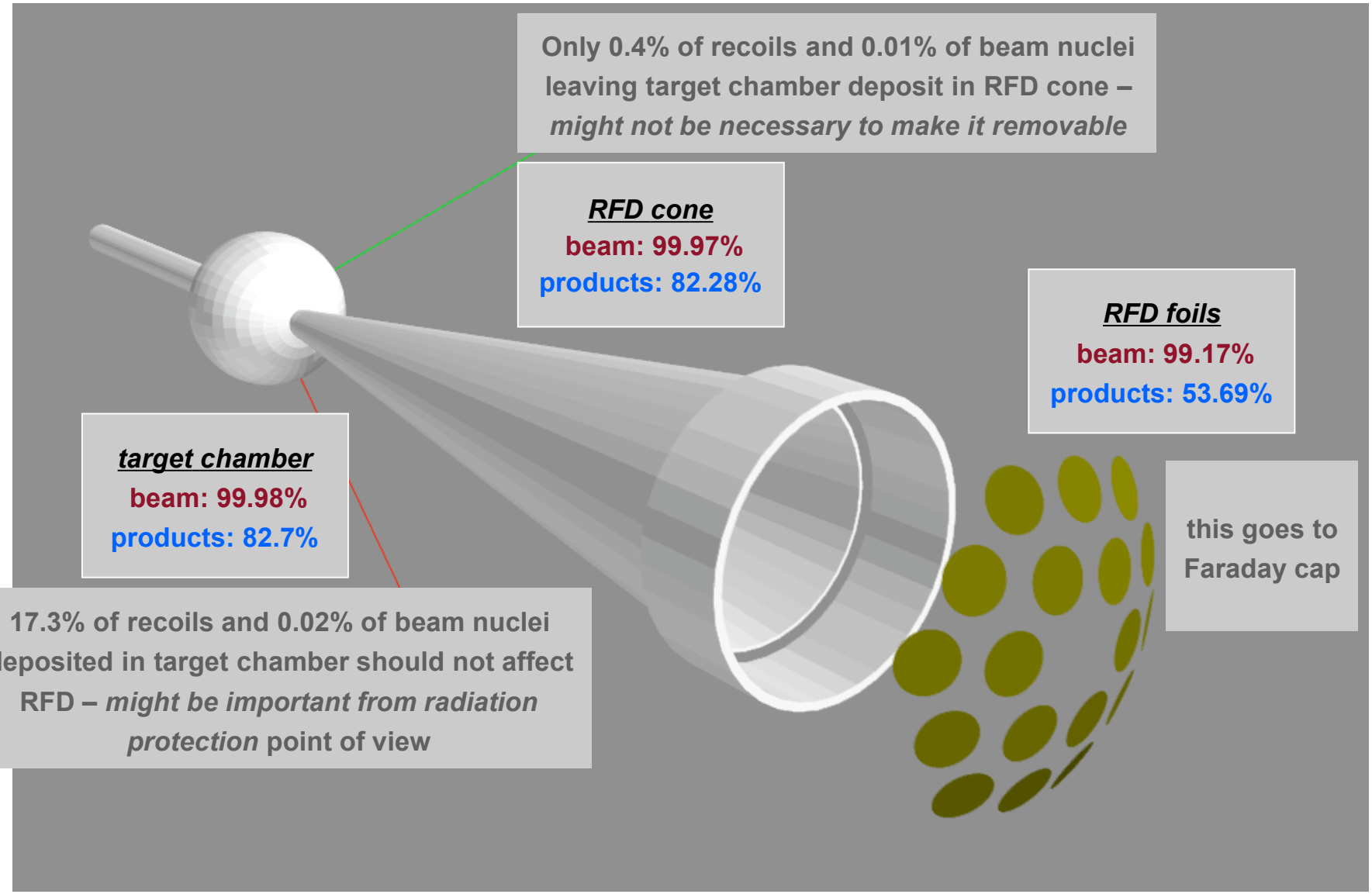


Promising increase, however, technical problems might be unable to solve

present configuration

Results

deposition of nuclei in RFD elements



Simulations

„to do list”

General „improvements”:

Point vs non point-like (finite size of the spot) beam

Realistic broadening of initial beam energy

Further study on possible application to detect fission products:

Angular resolution

Doppler shift correction

Further study on nuclei deposition in RFD construction:

Detailed identification of nuclei and its quantity – estimation of risks