

Simulations of Possible Application of Recoil Filter Detector in Nuclear Structure's Studies with Radioactive Beams

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Introduction to RFD

construction and performance

Ion guide

target chamber

gamma detector

Identification of recoils,
using pulsed beam, by their:

- time-of-flight
- the pulse height

In coincidence with gamma spectroscopy,
filtering out:

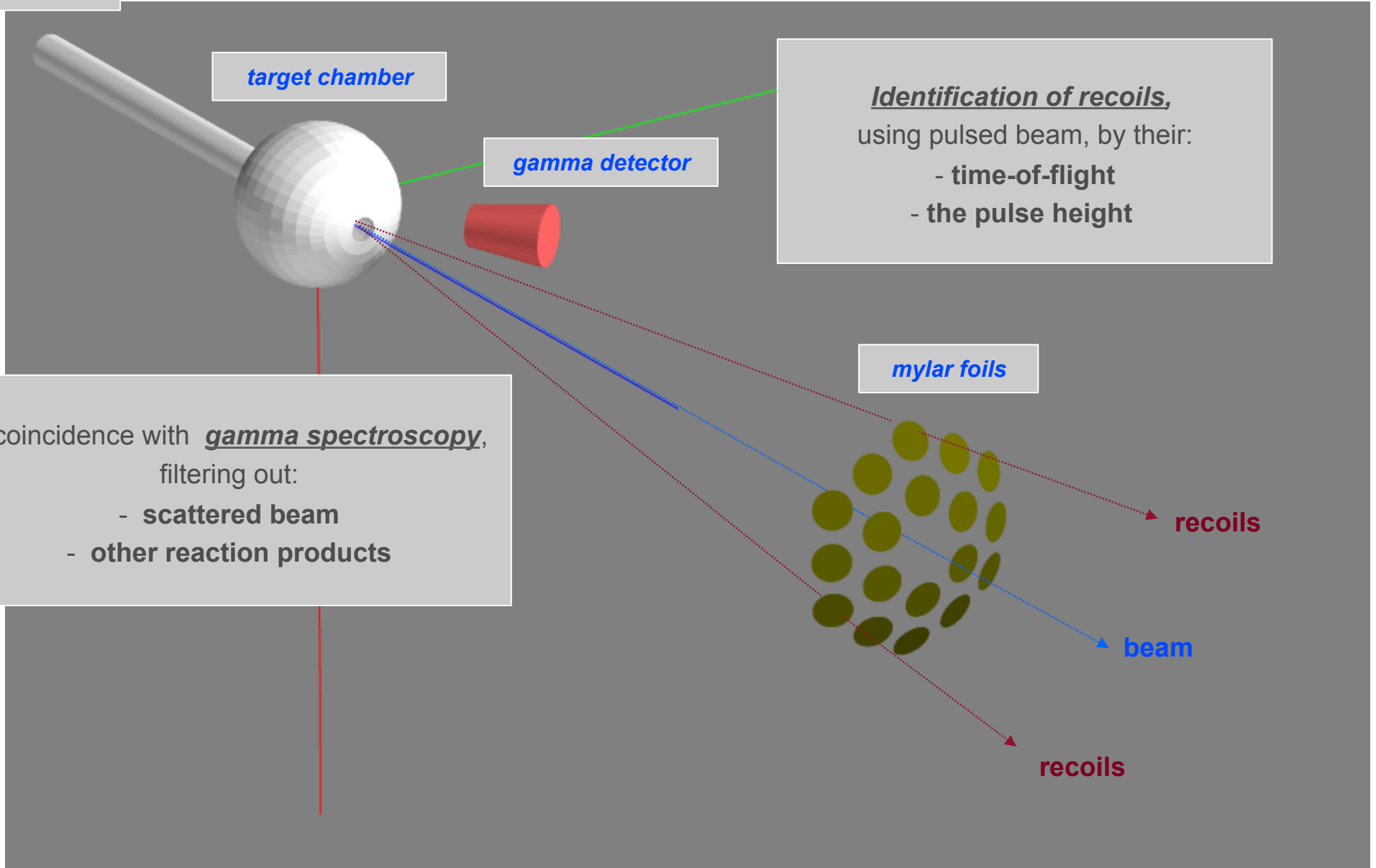
- scattered beam
- other reaction products

mylar foils

recoils

beam

recoils



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

Spiral2 Day1 – Phase2 Lol

Adam Maj (Kraków), Silvia Leoni (Milano) – spokespersons

Christell Schmitt – GANIL Liaison et al

Proposed reaction:

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

Application of RFD

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

Results

RFD efficiency as a function of distance from target

General remarks on simulations

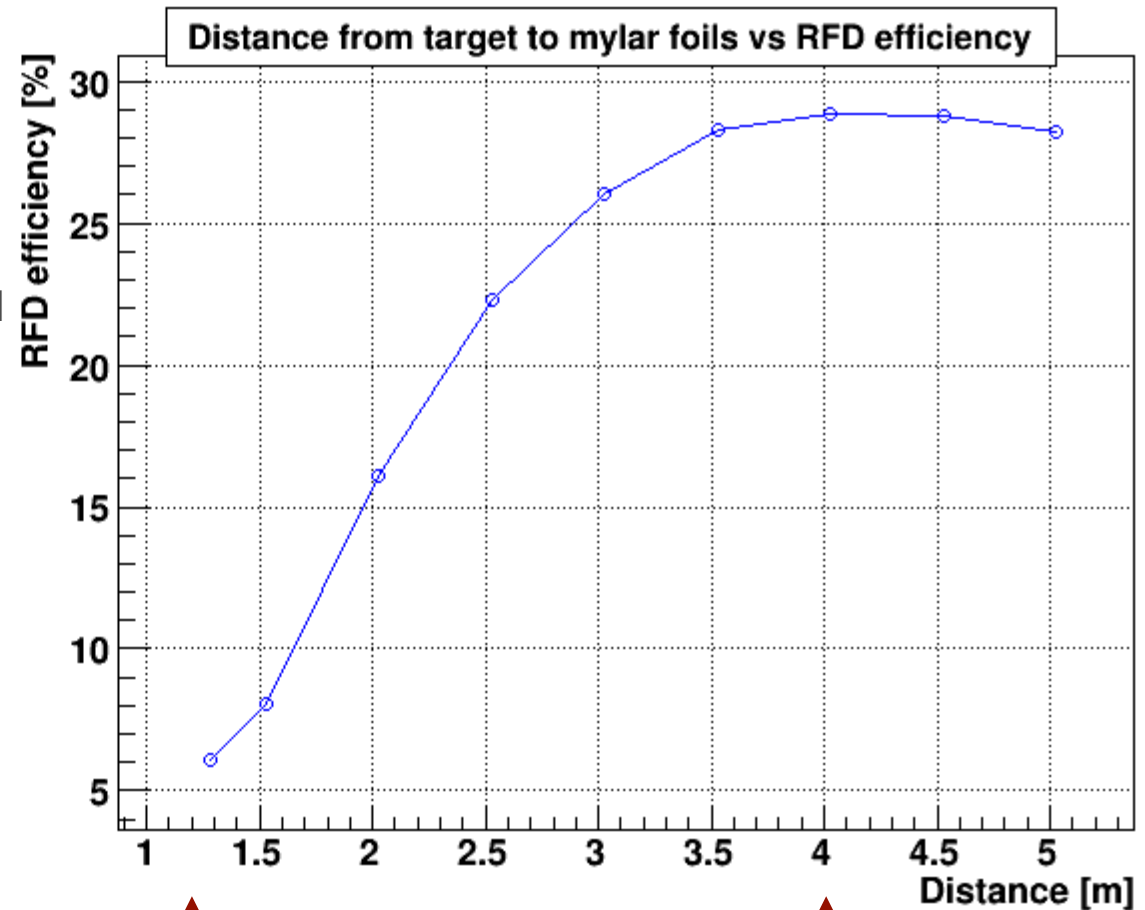
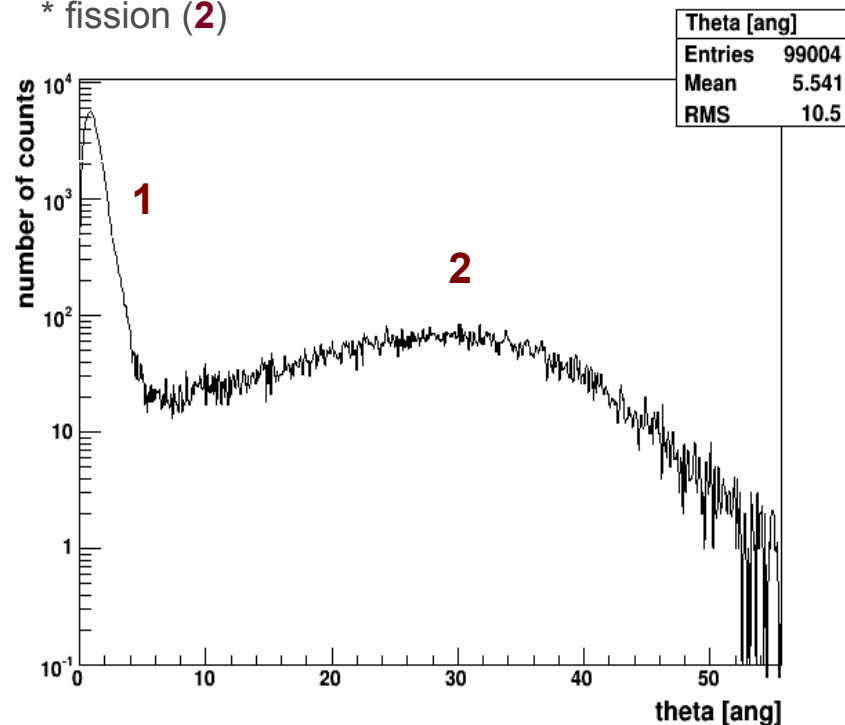
Simulations **started** by *G.Jaworski* using Geant4:

* one reaction channel: $^{90}\text{Kr}(^{48}\text{Ca}, 8n)^{130}\text{Ba}$

Then, **products of reactions** were simulated with *Cascade* (*M. Ciemala*) including:

* fusion-evaporation (**1**)

* fission (**2**)

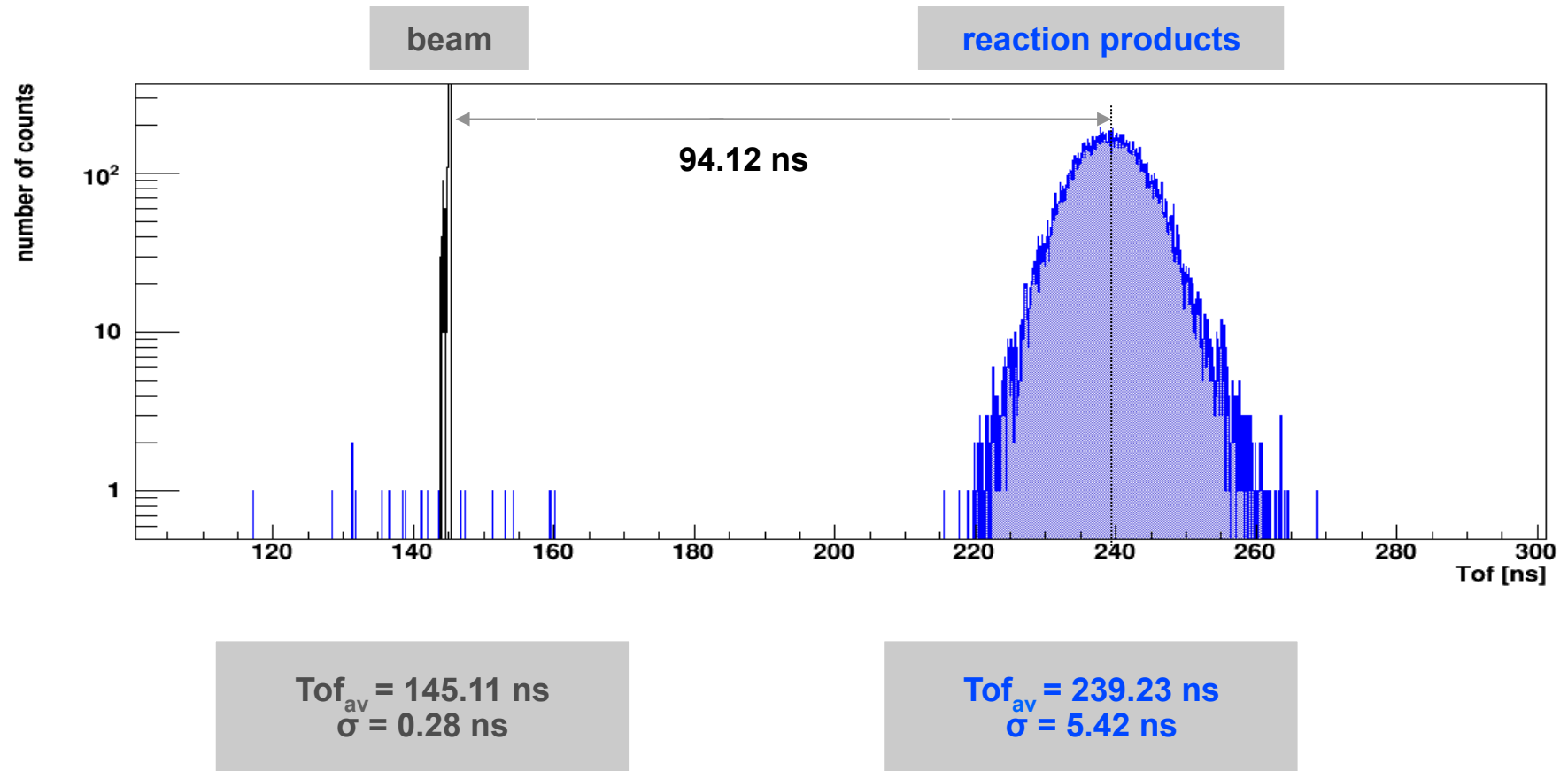


original distance [1.25m]

optimal distance

Results

Time-of-flight separation



Possible separation of beam and reaction products with this setup

Results

different foils' geometry

$RFD_{eff} = 28.59 \%$

$RFD_{eff} = 34.29 \%$

$RFD_{eff} = 35.89 \%$

$RFD_{eff} = 35.63 \%$

Further increase of foils' diameter requires longer distance from target

to maximize the positive effect - we can not afford it ! 4 m is already long

foil

inner ring theta = 2.9 deg
middle ring theta = 5.1 deg
outer ring theta = 5.69 deg
distance from target = 4 m

inner ring theta = 2.9 deg
middle ring theta = 5.1 deg
outer ring theta = 5.9 deg
distance from target = 4 m

inner ring theta = 3.2 deg
middle ring theta = 5.65 deg
outer ring theta = 6.55 deg
distance from target = 4 m

inner ring theta = 3.45 deg
middle ring theta = 6.0 deg
outer ring theta = 7.0 deg
distance from target = 4 m

Results

different foils' shape

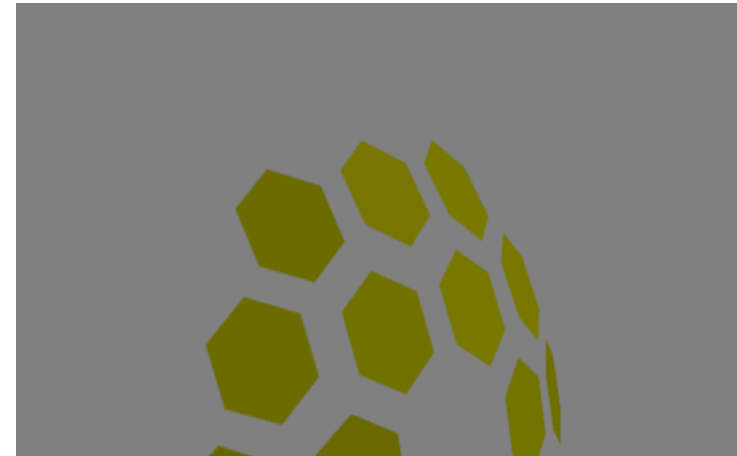
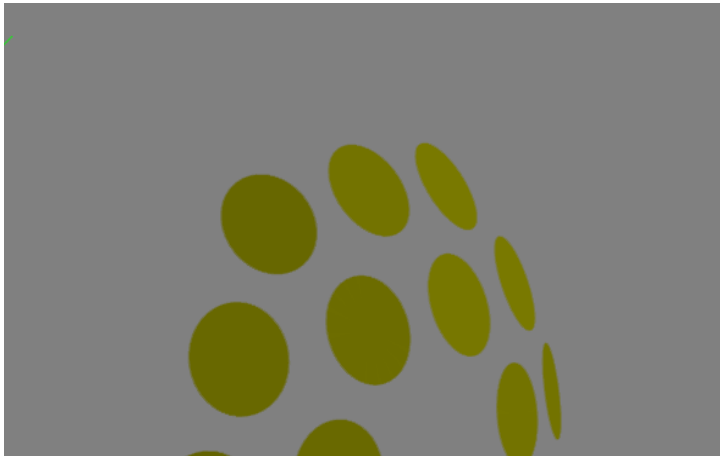
spherical

$RFD_{\text{eff}} = 28.59 \%$

vs

hexagonal

$RFD_{\text{eff}} = 31.75\%$



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



present configuration

Results

deposition of nuclei in RFD elements

Initial
beam: 100%
recoils: 100%

Only 0.4% of recoils and 0.01% of beam nuclei leaving target chamber deposit in RFD cone –
might not be necessary to make it removable

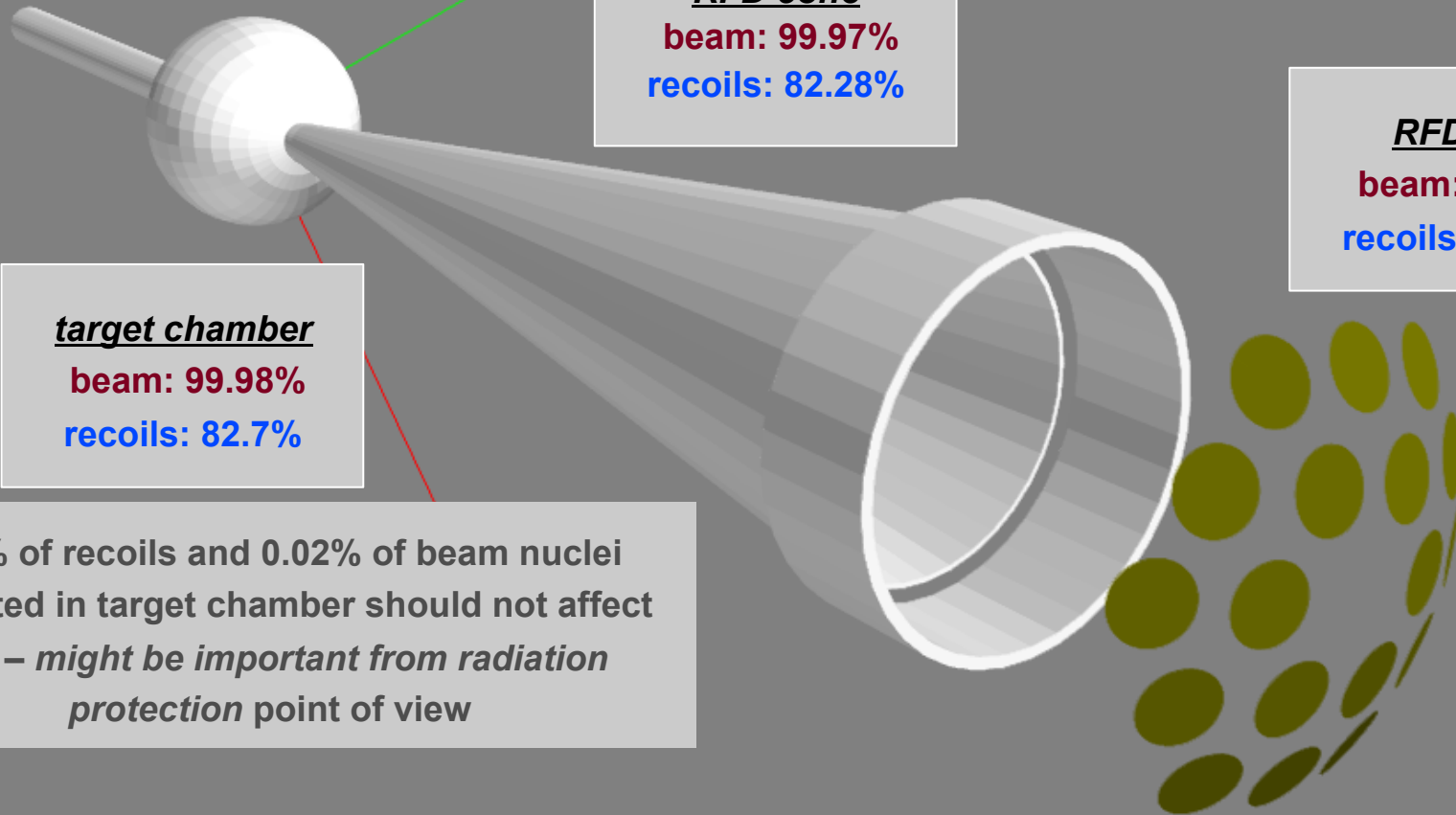
RFD cone
beam: 99.97%
recoils: 82.28%

target chamber
beam: 99.98%
recoils: 82.7%

RFD foils
beam: 99.17%
recoils: 53.69%

this goes to
Faraday cap

17.3% of recoils and 0.02% of beam nuclei deposited in target chamber should not affect RFD – *might be important from radiation protection point of view*



Summary

„to do” list:

- * **simulation of realistic reaction products** – *done with Cascade* 😊
- * **beam separation** – *theoretically possible !* 😊
- * **searching for optimal foils configuration** – *in progress, with some promising results*
- * **simulation of nuclei deposition in RFD elements** – *in progress, first step has been done*
- *

... any suggestions are very welcome !