Movable Collimators System

Piotr Warzybok,

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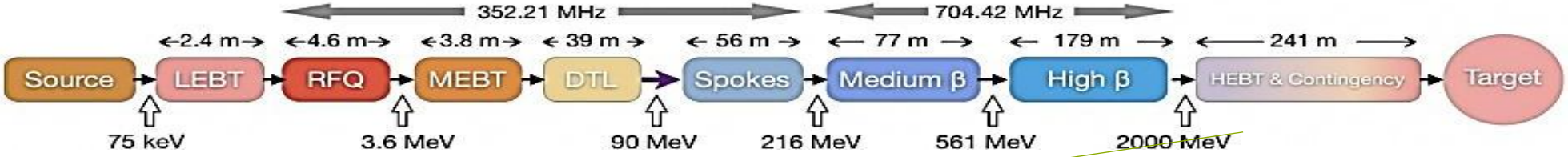
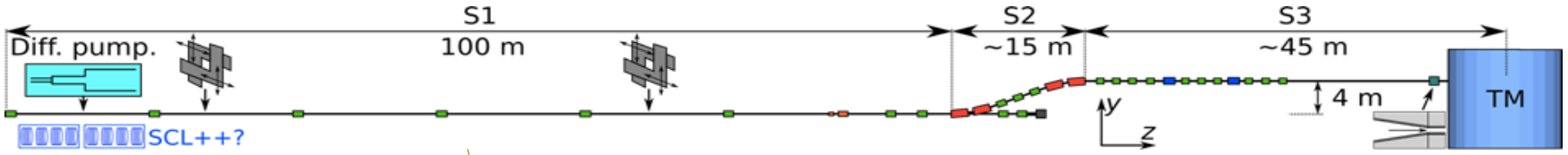
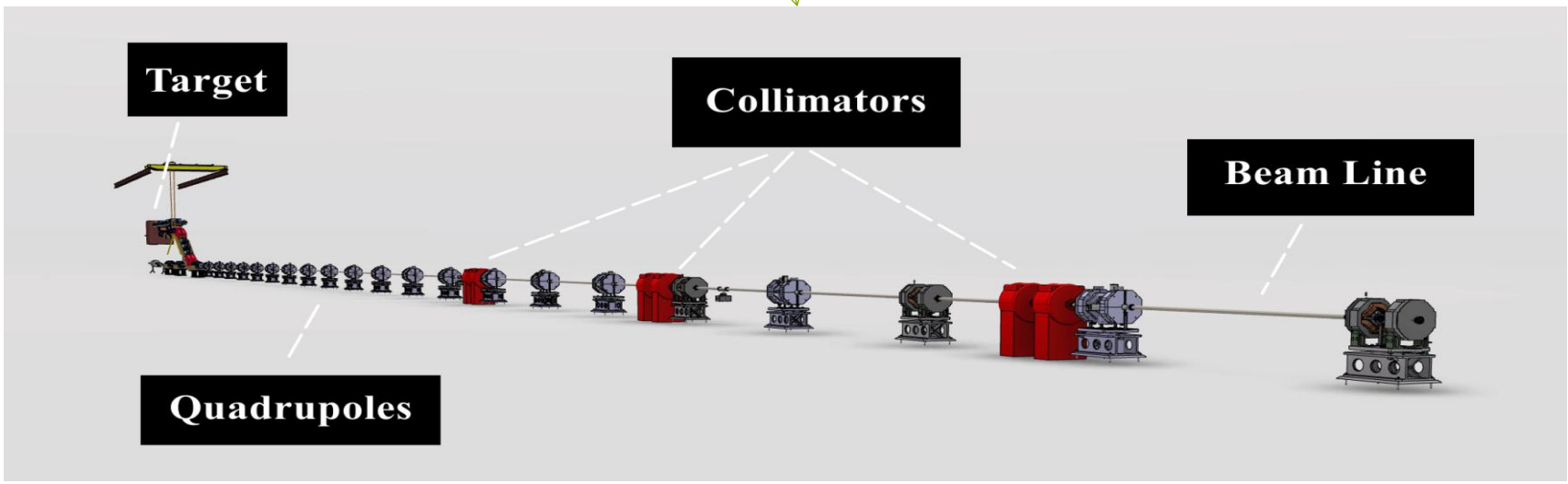
Presentation plan:

1. ESS Project and Collimators
2. Methodology
3. Material studies
4. Shape studies
5. Size studies
6. Normal operation studies
7. Summary

ESS:







	1.	2.	3.	4.	5.	6.
Z[m].	11.32	12.82	36.88	38.38	62.44	63.94

Why do we need collimators?

Function:

- Reduction of the HALO
- Protection of more sensitive linac parts
- Diagnostics – measuring losses and beam deviations

Tools used:

(**FLU**ktuierende **KA**skade)

Engineering simulation software

Few words about my data:

- Most important beam parameters:

E[GeV]:	Duty Cycle [%]:	I(peak) [mA]:	I(avg) [mA]:	P(avg) [MW]:
2.0	4.0	62.5	2.5	5.0

- Simulations were based on the 'special' input file.
- Simulations parameters - sufficient in various simulations
- Design of the liniac is still changing

Additional assumptions:

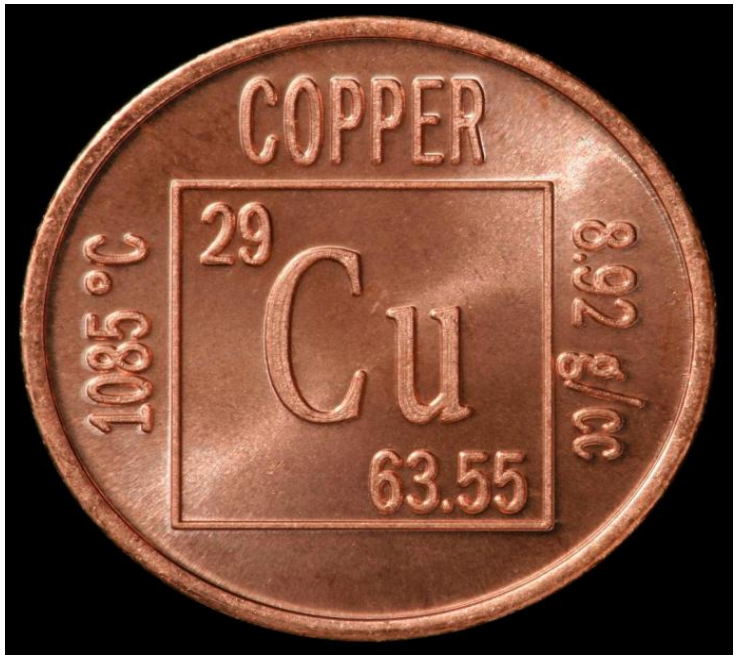
- **each collimation unit is able to accept up to 1kW**
- **direct handling of the collimators - not needed during beam operation**
- collimators should be able to stop 99% of the particles power
- step of the collimator moving system should be not bigger than 0.01mm
- water cooling system should be avoided if possible (tritium production)
- all components of the collimators should be replaceable
- **in case of breakdown, collimators will have some time to cool down**

Material of the collimators – copper:

-Other studied materials: lead, tungsten, steel, concreete.

-Parameters taken into account:

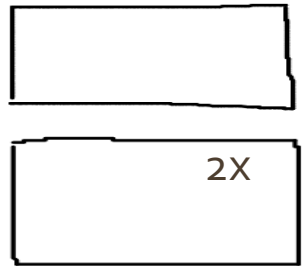
- density
- produced secondaries
- cost
- activation
- thermal conductivity

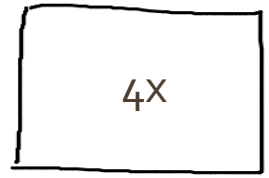


Shape of the collimators:

Shapes which have been analyzed:

- Free Blocks
- Parallel Collimators
- L-shape

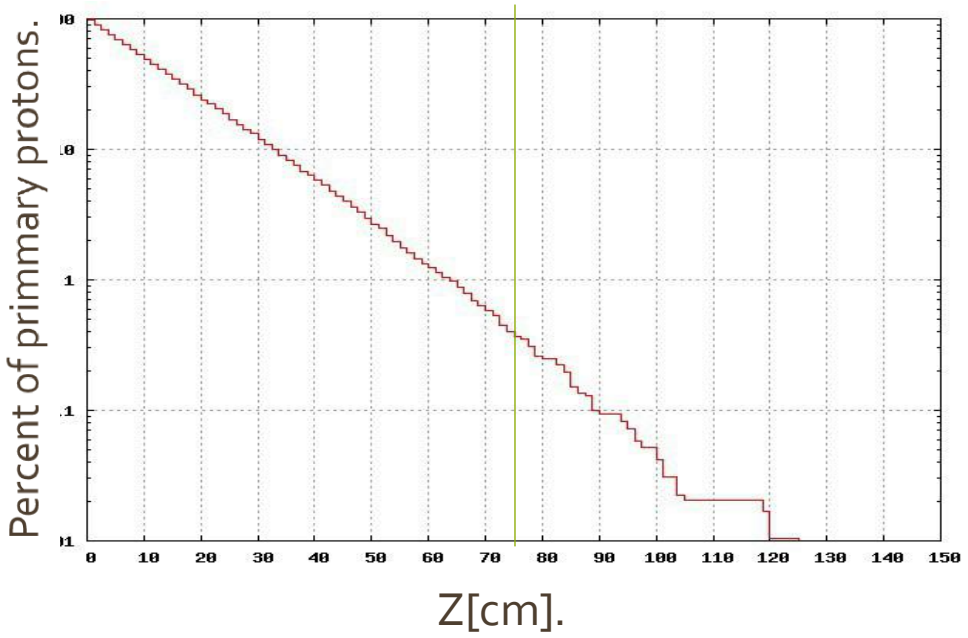




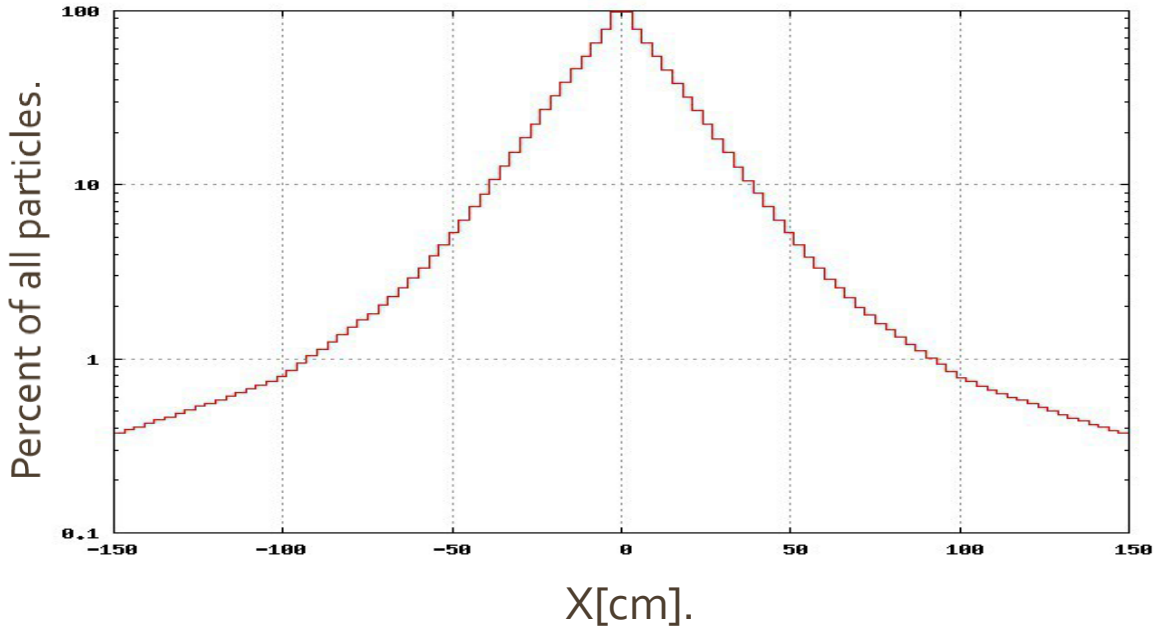
Parameters:

- dose distribution
- operation of collimator unit

Size of each collimator station:



Number of primary protons in function of distance.



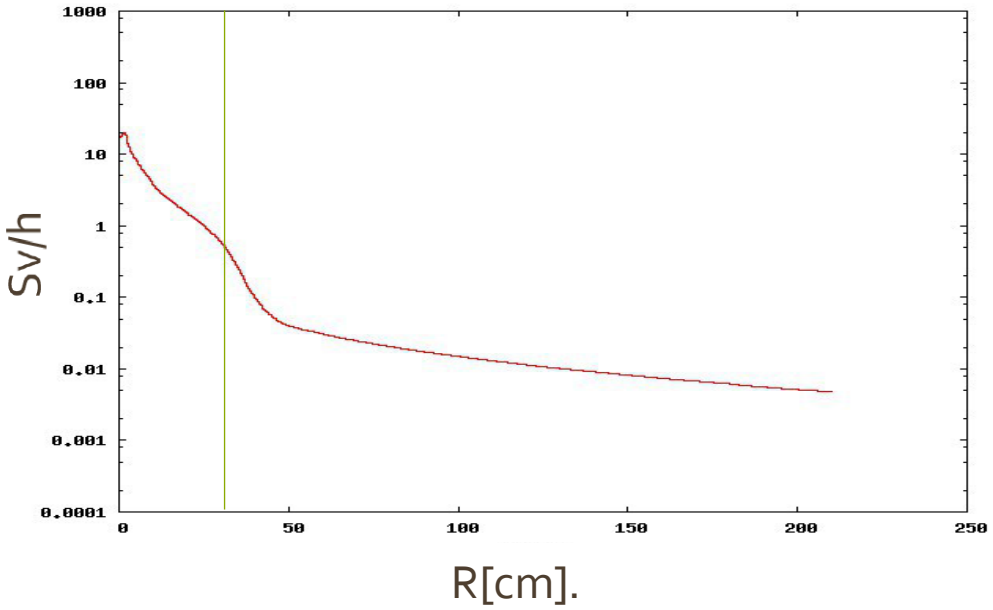
Integral over Secondary particles inside collimator

Activation of material, Size of the tunnel.

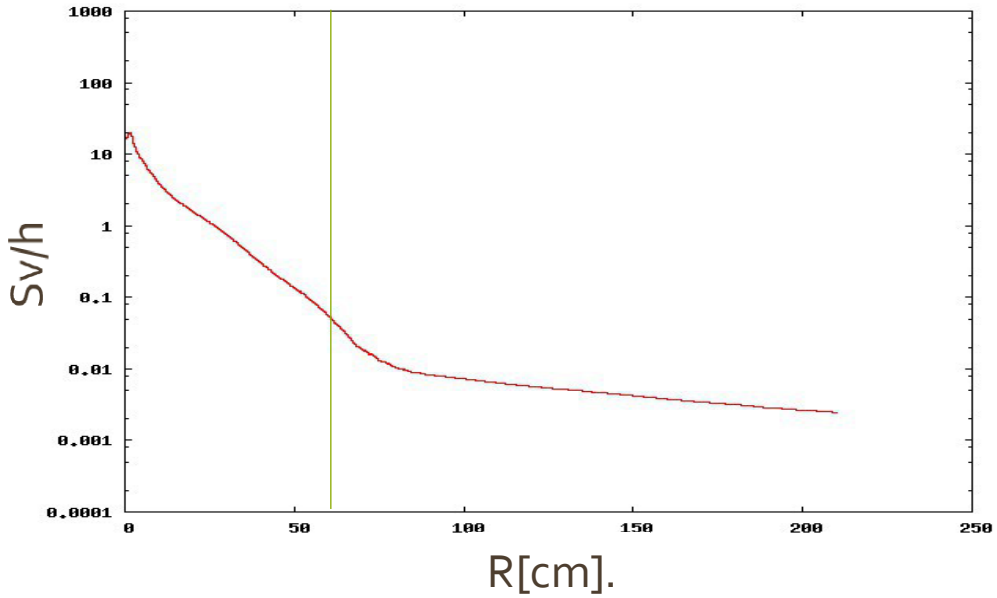
Activation of the collimators:

(after 1 month of operation and 1 h of cooling)

30cm

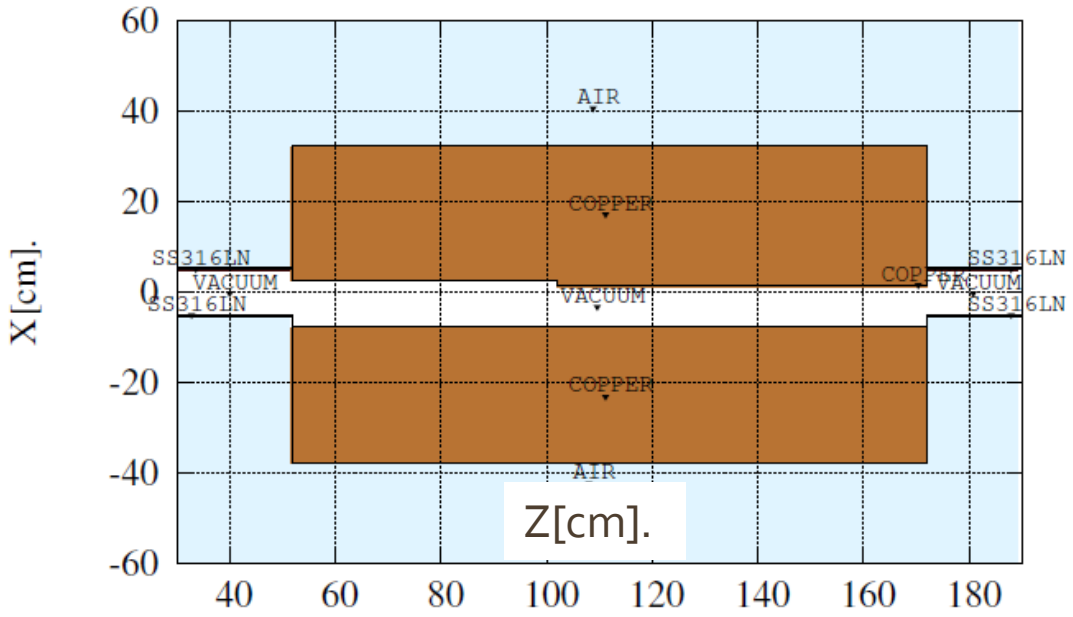


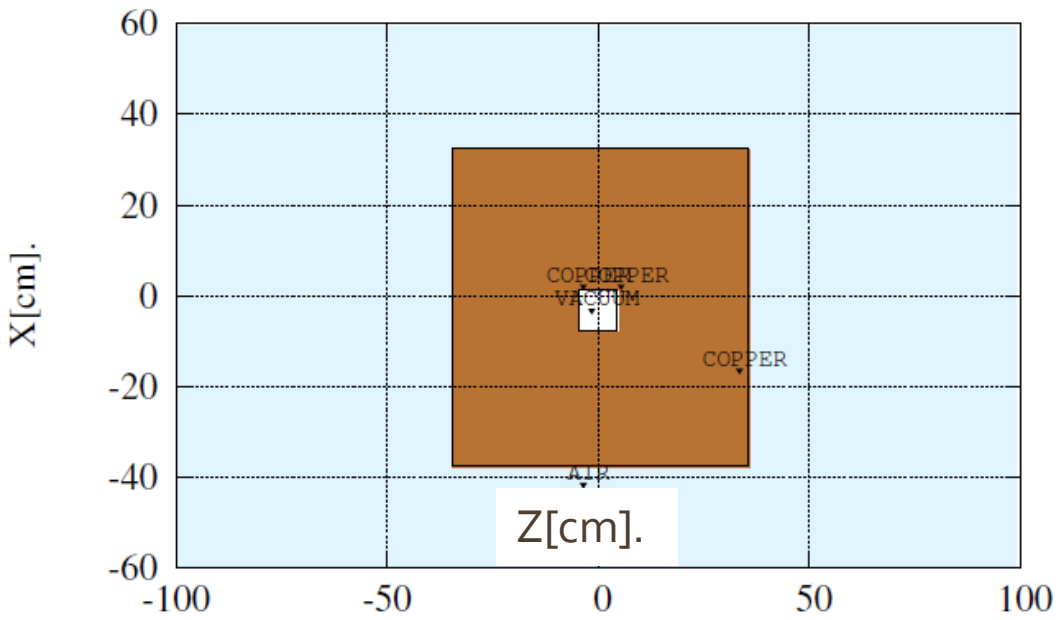
60cm

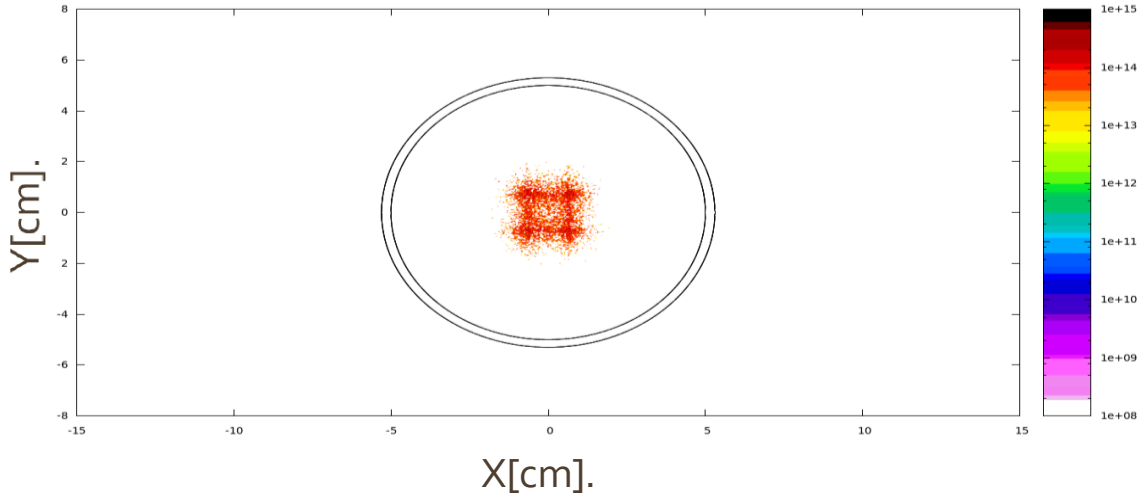


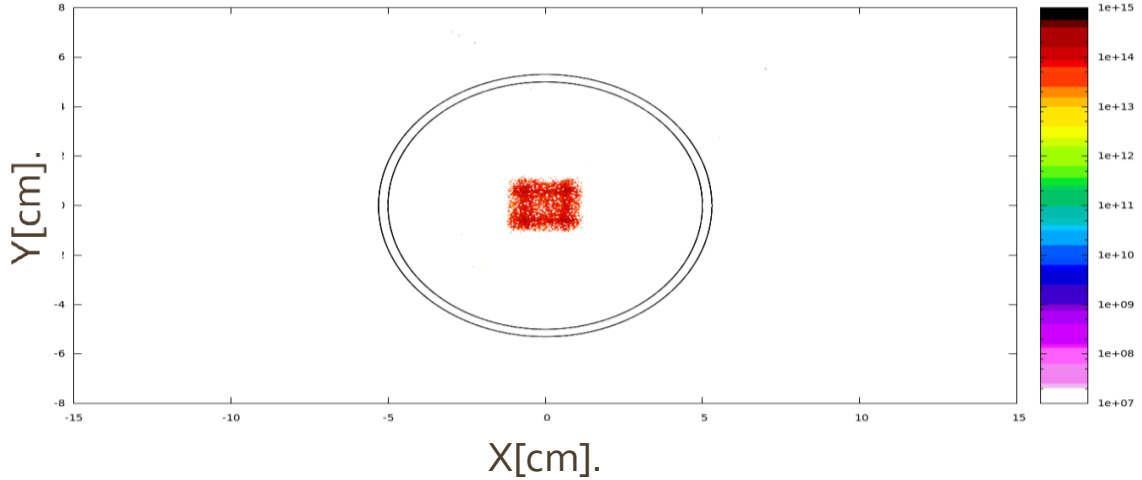
During beam-ON – doses are more than 1000 times higer

Designed collimators sheme:

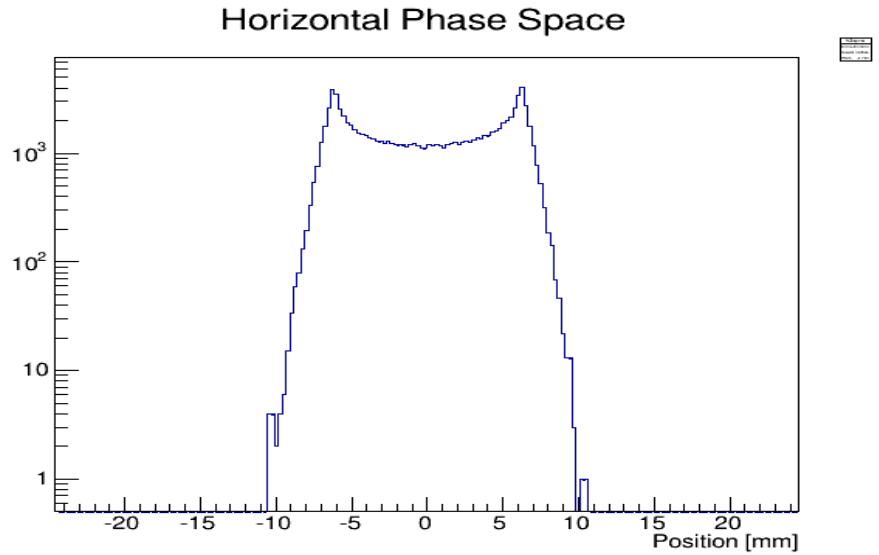


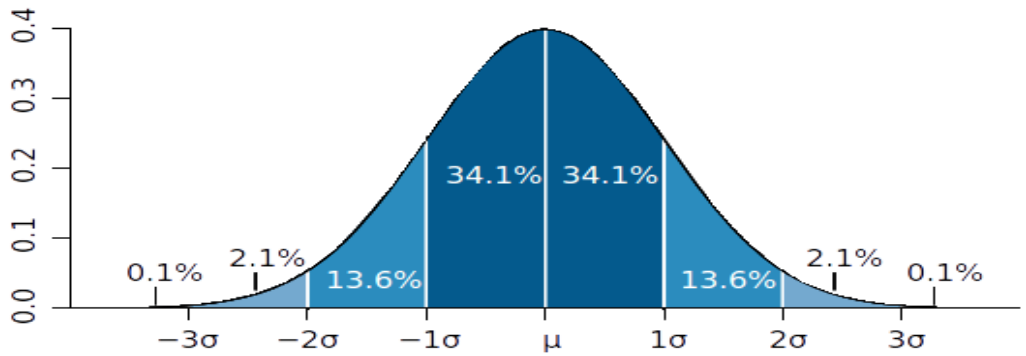






Input Beam – coreless beam:

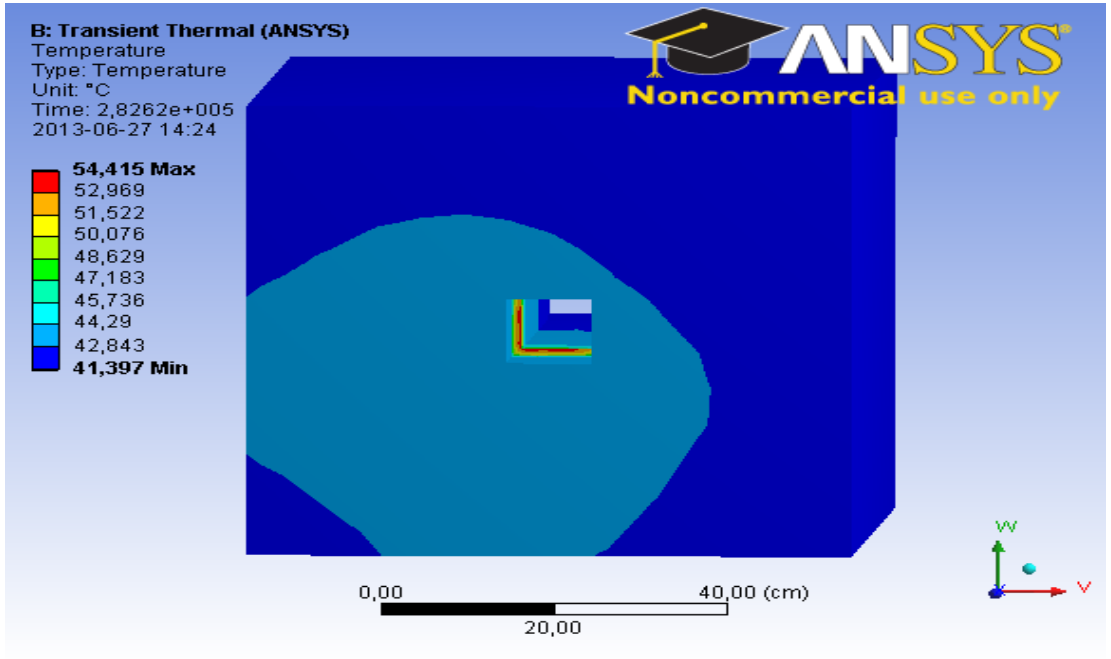




Zσ:	RMS [mm]:	Percent outside (-zσ, zσ):
1.0σ	2.25	68.27
2.0σ	3.50	95.45
3.0σ	6.75	99.73
3.3σ	7.43	99.90

7sigma = 0.000000000256

Normal operation of collimators:

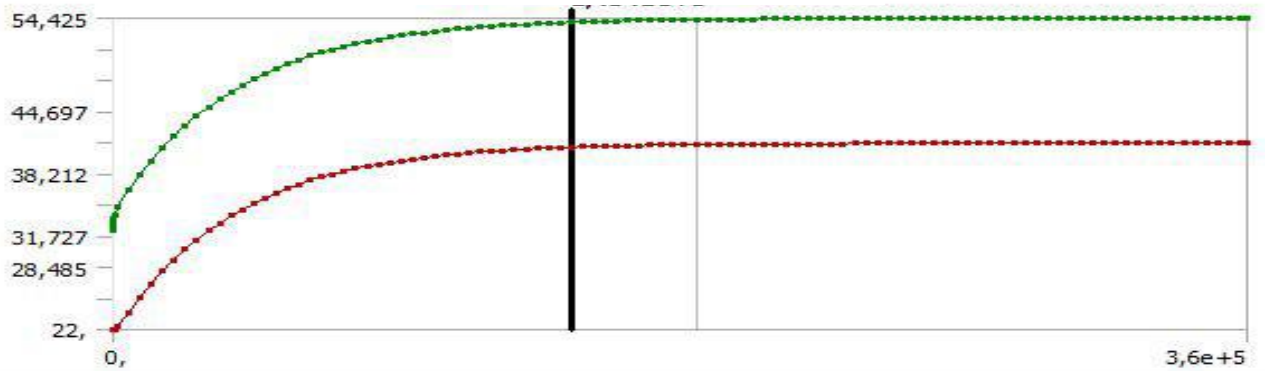


Normal operation = collimationg 1kW

Max. temperature (54.3 Celsius degree) after 72h of operation.

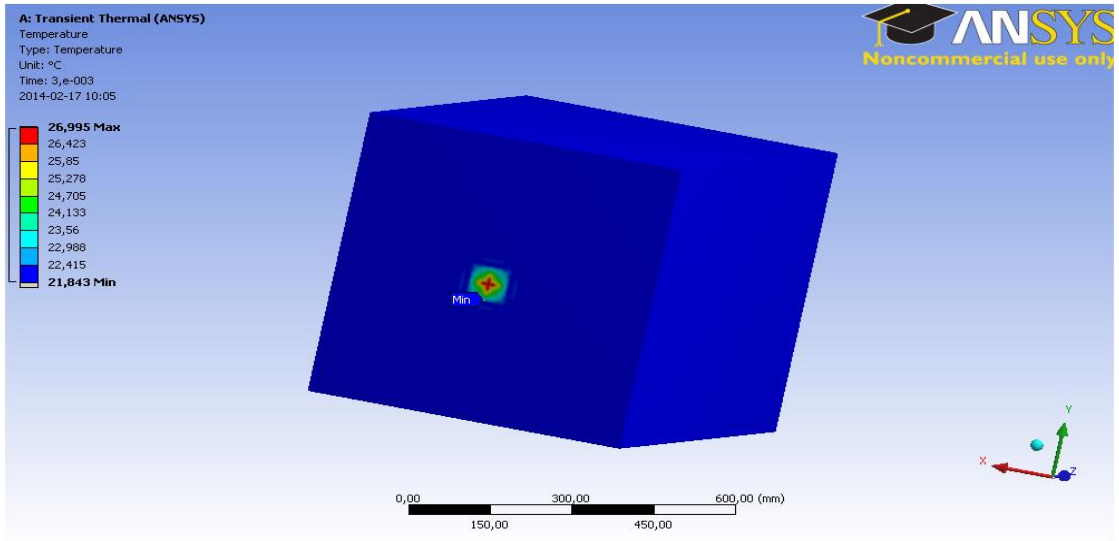
Total thermal deformation: 0.3mm.

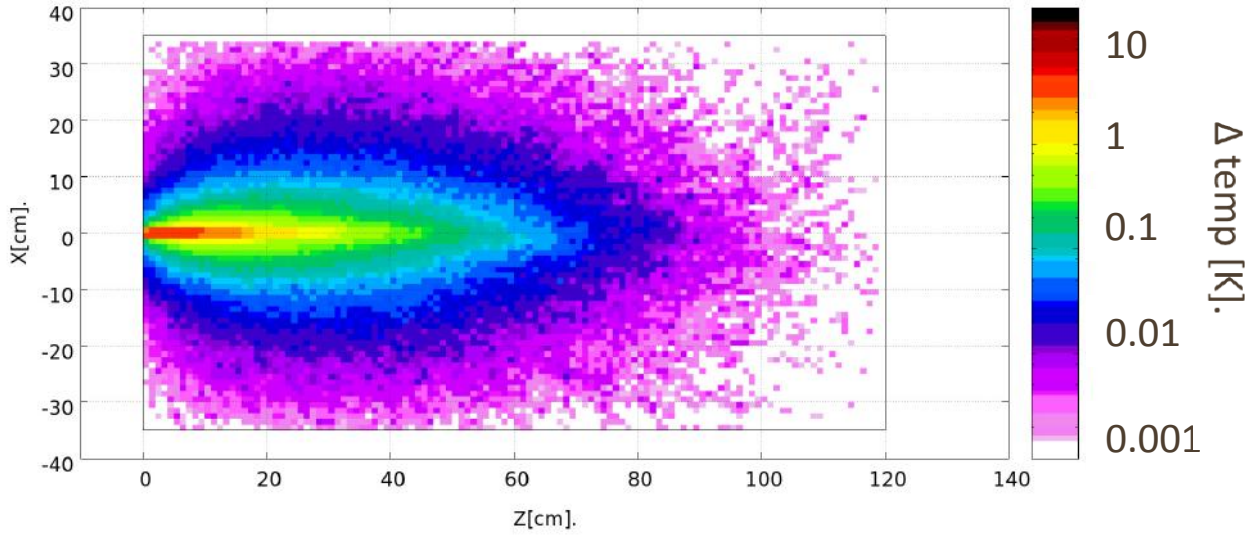
1,4E5 s. = 1.5 day



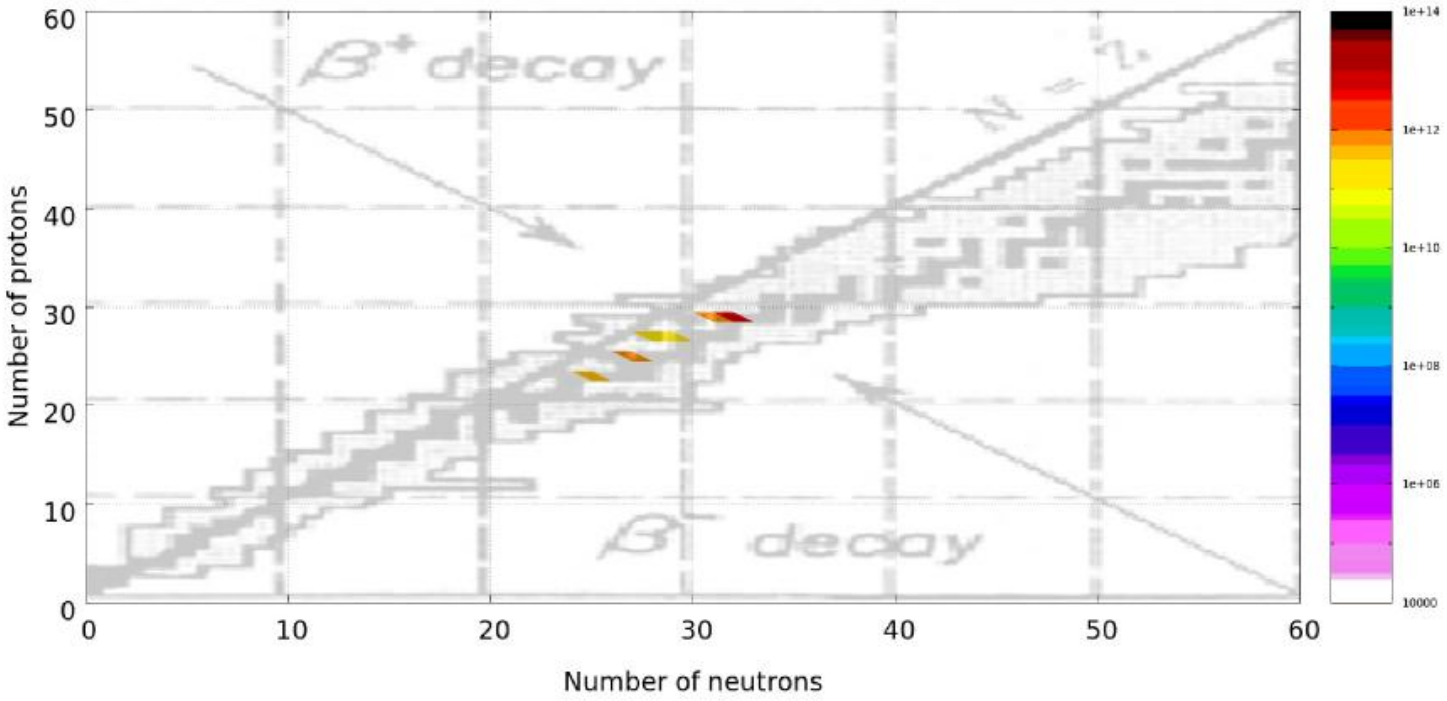
More detailed ANSYS studies:

Max temp. = 26.991 °C



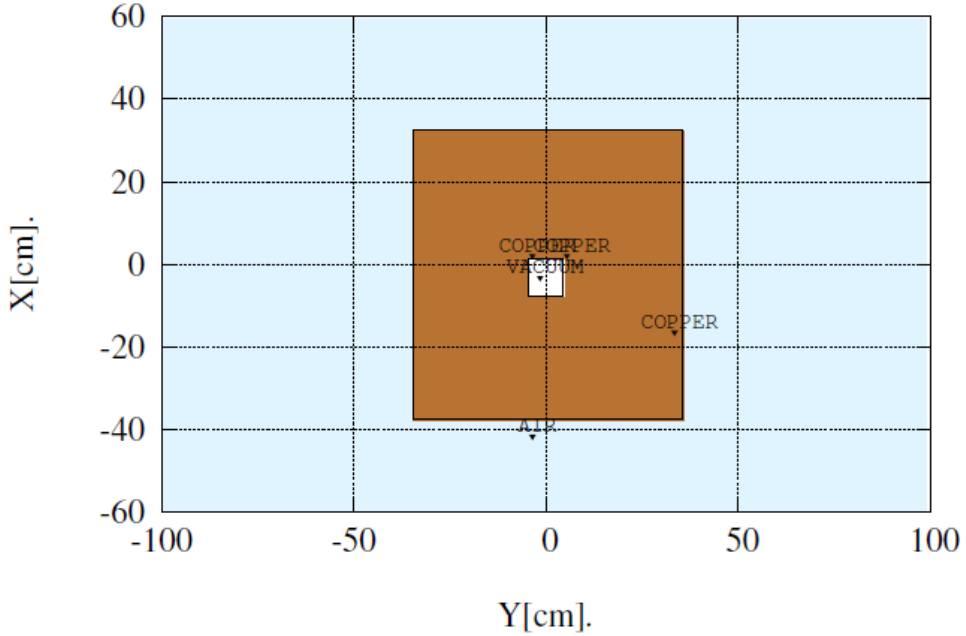


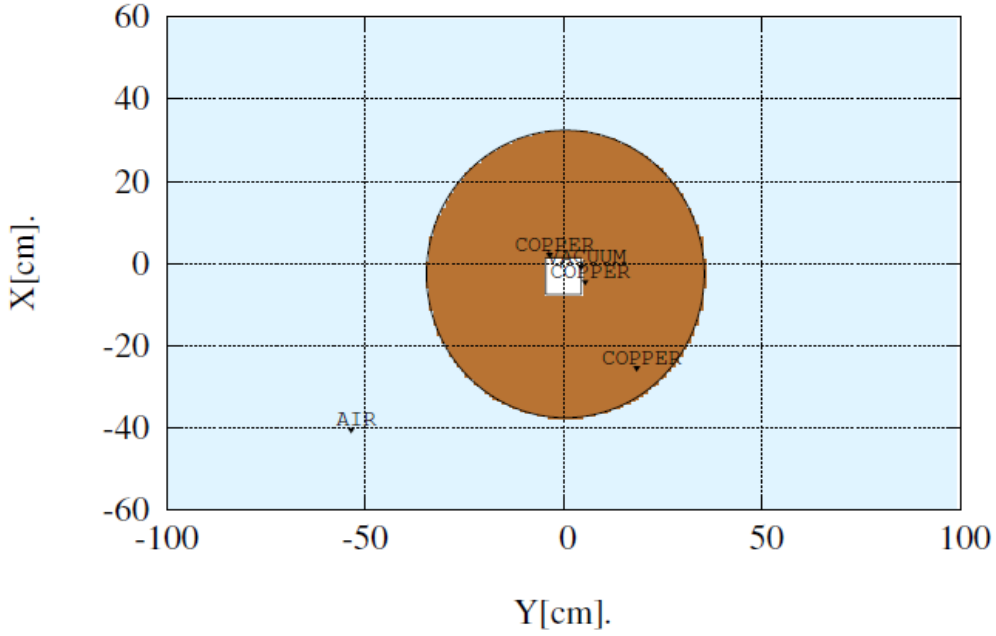
Activation studies:

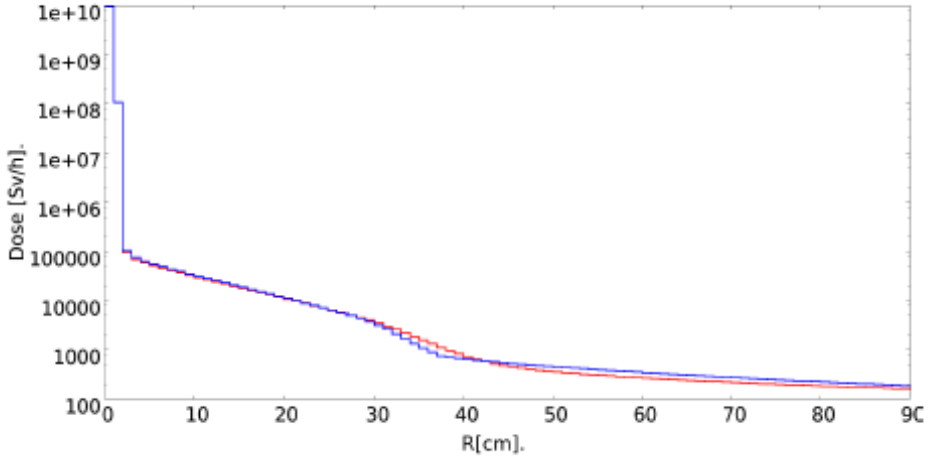


Nuclid	Decay Mode	T(1/2)
48V	ε	15.90d
52Mn	ε	5.58 h
	IT and ε	21.10 m
55Co	ε	17.53 h
56Co	ε	77.23 d
60Cu	ε	23.70 m
61Cu	ε	3.33 h

Shape of the collimator:

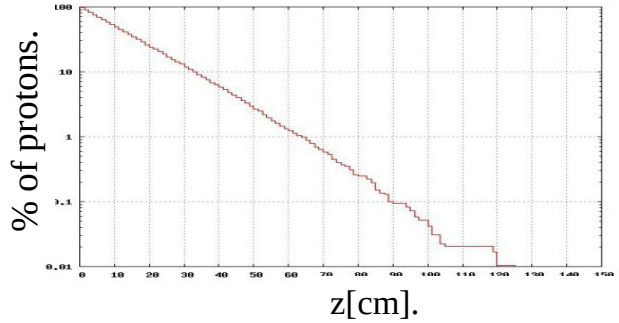


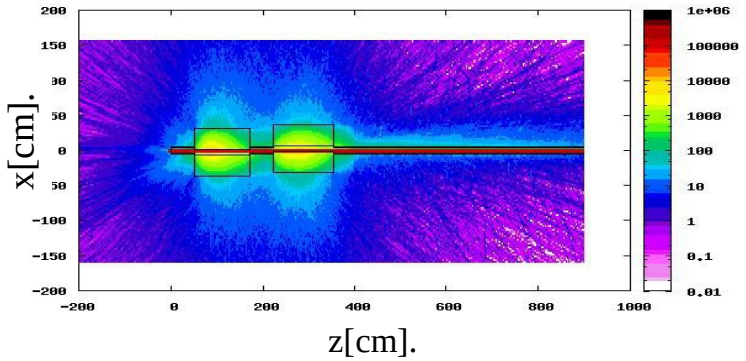


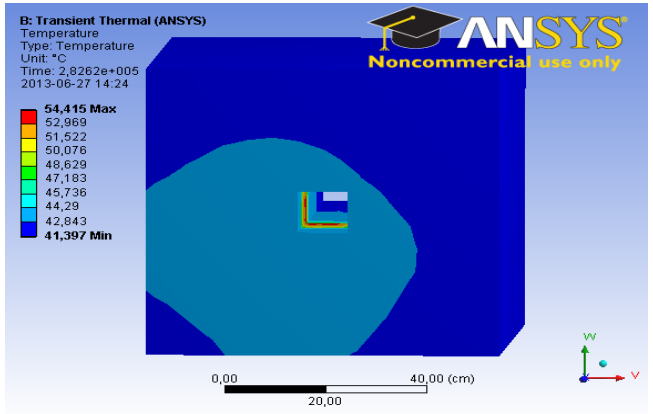


Summary:

Simulations:
- production of secondary particles in function of angle
- 2.0 GeV proton in function of distance inside copper
- dose distribution during collimation
- activation of the collimators, dose distributions after specified time
- energy deposition inside collimator
- heat distribution
- total deformation of collimator's material







Other:
- catastrophically accident analysis
- need of extra shielding around collimators
- cooling system design (in progress)

Future studies:

- Cooling system studies
- Project .cad of collimator unit
- Optimalisation
- Mounting and moving system studies
- Diagnostic

Timetable:

- Material selection studies, radiation protection issues – **Q4 2013**
- INVENTOR CAD design of the movable collimator – **Q2 2014**
- Optimization of the design – **Q3 2014**
- Detailed technical design of collimators finished – **Q4 2014**

- Prototype of movable collimator unit built and tested – **Q4 2015**

Conclusions:

- Complete data analysis has been done!

- Design of the collimators is still in phase of optimization and some of the parameters is changing during subsequent simulations.

- This studies developed a simulation tool – it is possible to obtain new results in reasonably short time with modified beam parameters!