Monte Carlo simulation and optimization for the micro-channel target of the HBS project

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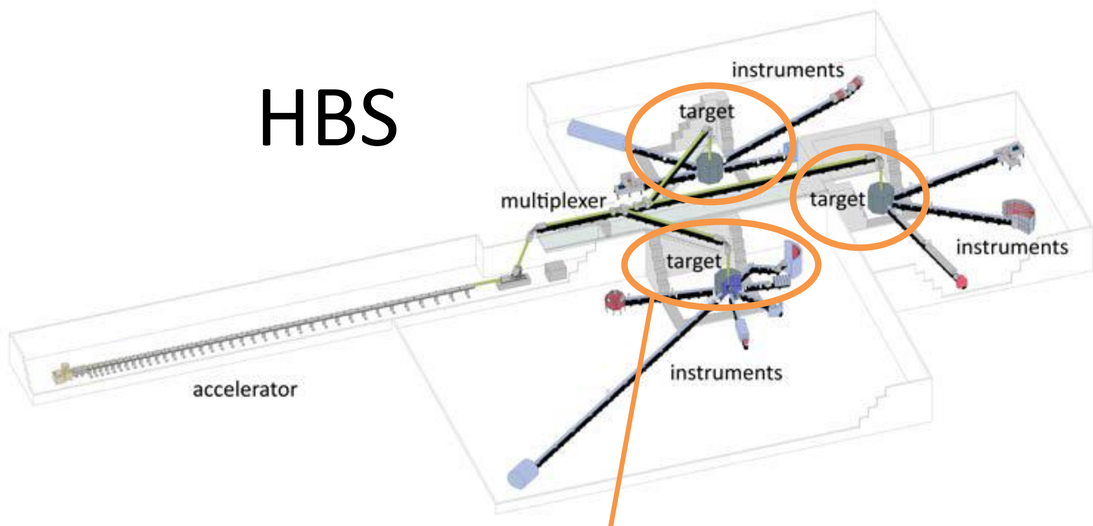
Motivation

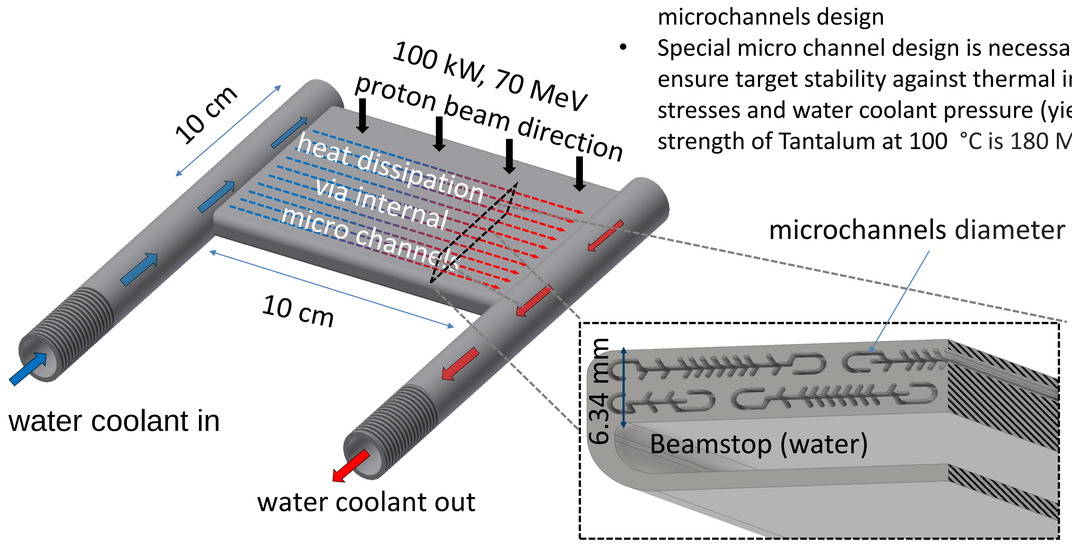
In the framework of HBS project a compact micro channel target was proposed for the powerful high-flux and compact, accelerator-driven neutron sources (CANS). Based on earlier simulations concerning fluid dynamics and structural mechanics, a preliminary design was developed. Due to the required compactness, heat dissipation and mechanical stability are the factors limiting the total neutron yield of the target.

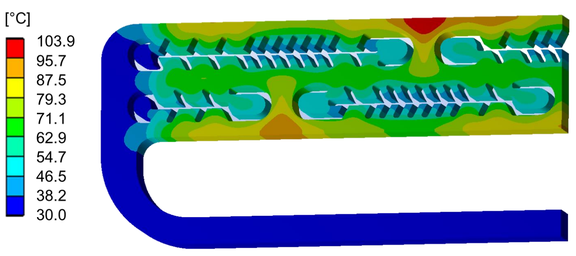
In order to find a compromise solution between high neutron yield and mechanical stability, the energy deposition as well as neutron and proton spectrum in different geometric parameters of the micro-channel target is investigated with the Monte Carlo simulation code FLUKA.



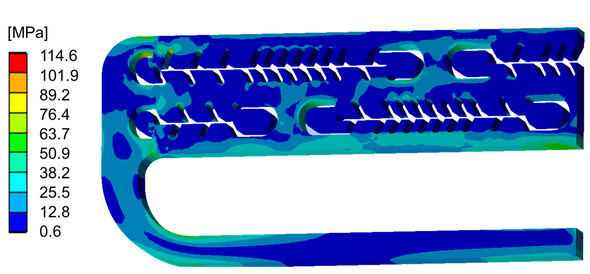
Target design

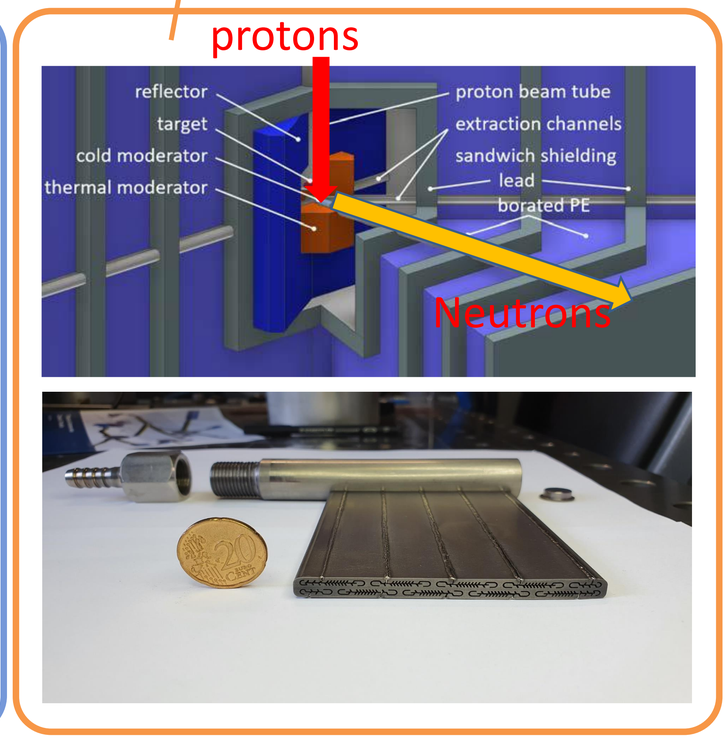
- Size of target should be small to increase brilliance ~ 100 cm²
- Cooling of 1 KW/cm² is achieved with microchannels design
- Special micro channel design is necessary to ensure target stability against thermal induced stresses and water coolant pressure (yield strength of Tantalum at 100 °C is 180 Mpa)



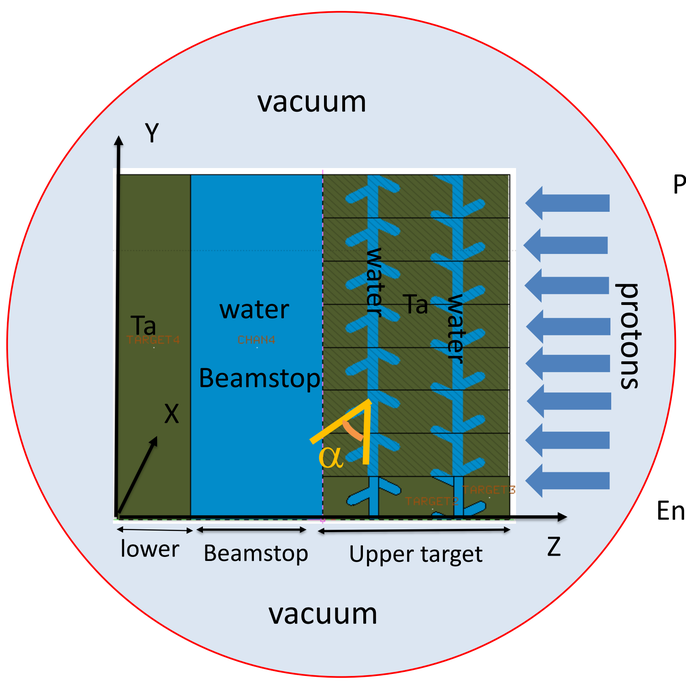


microchannels diameter = 0.35 mm



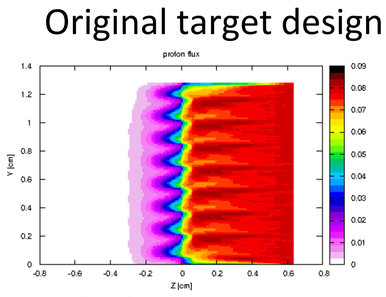


Target optimization

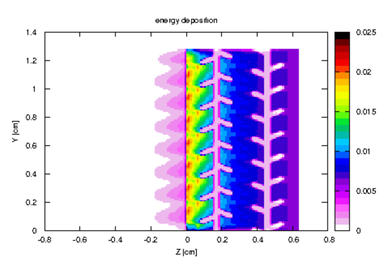


FLUKA model

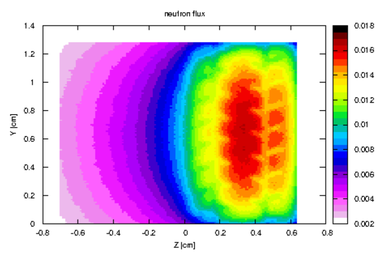
Original target design



Proton flux(1/cm² /primary proton)



Energy deposition(GeV/cm³ /primary proton)



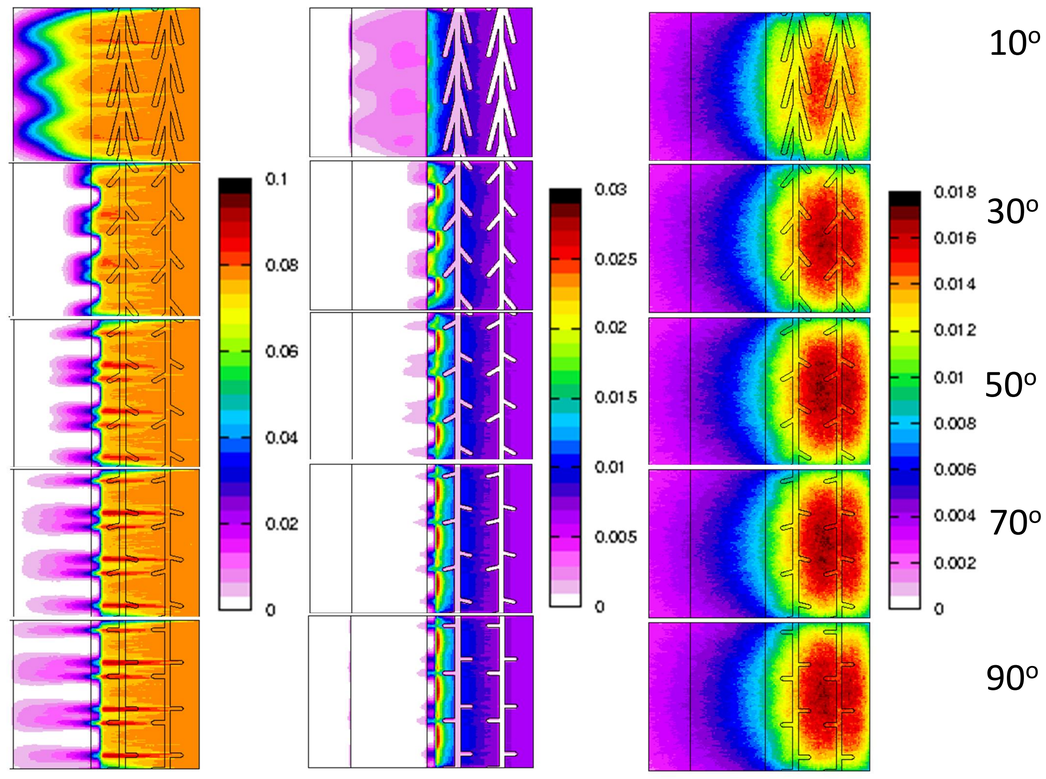
Neutron flux (1/cm² /primary proton)

- Most protons and energy deposited in upper target
  - ➢ Hydrogen implantation
  - ➢ Mechanical stress

Parameters adjustment

- When α= 10°, protons and energy deposition become homogeneous,
  - ➢ α= 10° is the optimal

Optimization of angles of microchannels (10° -- 90°)



Proton flux (1/cm² /primary proton)

Energy deposition (GeV/cm³ /primary proton)

Neutron flux (1/cm² /primary proton)

Conclusion :

- Original target design is not a compromise solution between mechanical stability and high neutron yield
- When angle= 10° , the proton and energy deposition are homogeneous in the beamstop, α= 10° is the optimal value

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