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Neutronics Model for the Stellarator Power Reactor HELIAS

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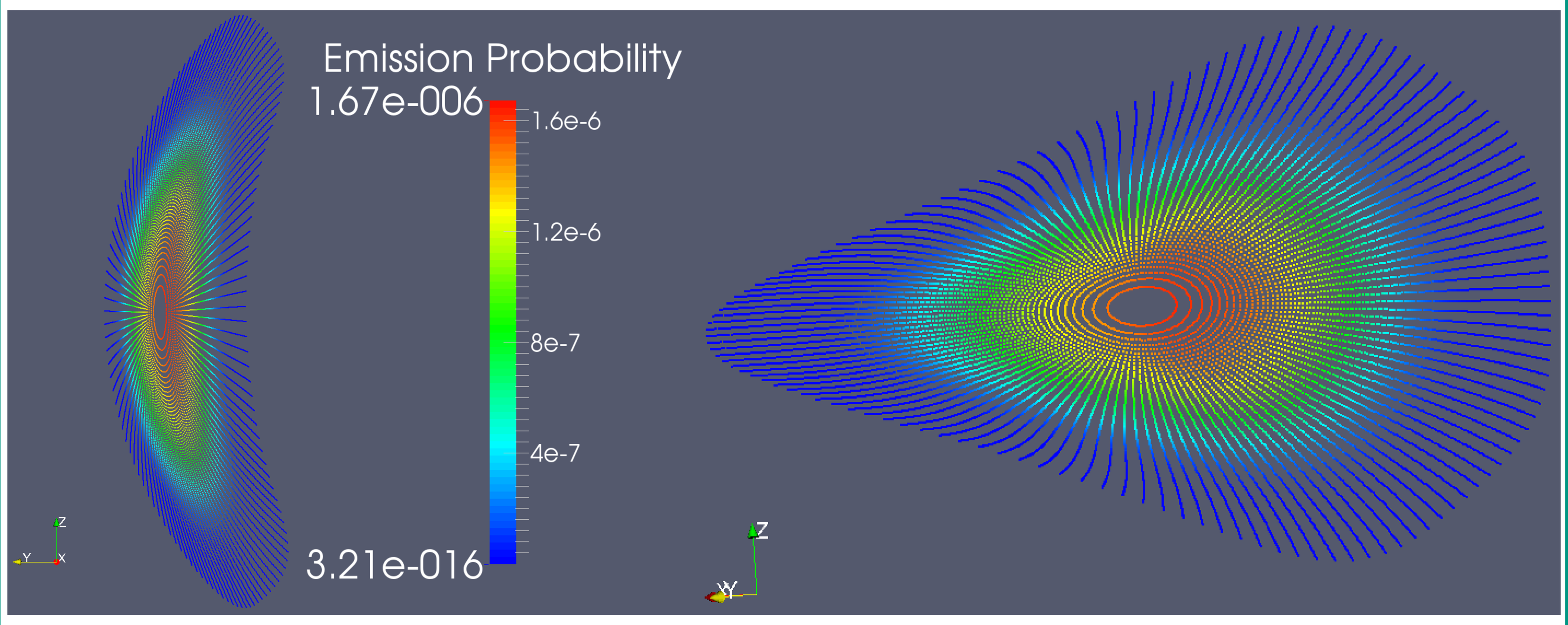
Objective

The objective is to develop a suitable computational approach for neutronic analysis, with the Monte Carlo n-particle transport code MCNP, of a stellarator type fusion power reactor and apply it to the design analysis of the Helical Advanced Stellarator (HELIAS) demonstration power reactor with D-T fusion and 3000 MW fusion power.

Data

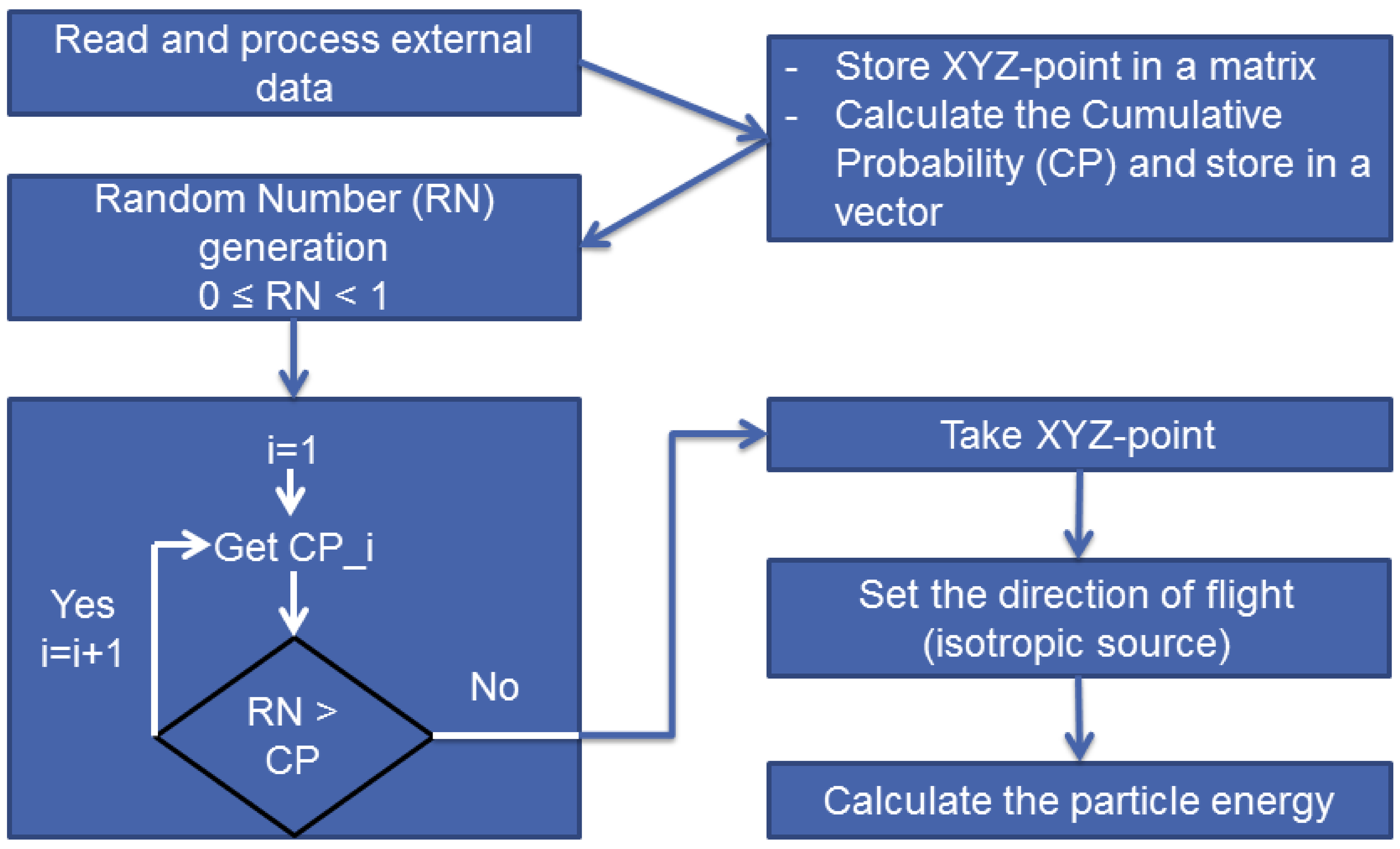
- Based upon a plasma physics calculation at Institute for Plasma Physics, Greifswald (IPP Greifswald).
- Input Data: Plasma density distribution inside the stellarator linked with a specific neutron emission probability.



Emission probability of the source perpendicular to the main axis

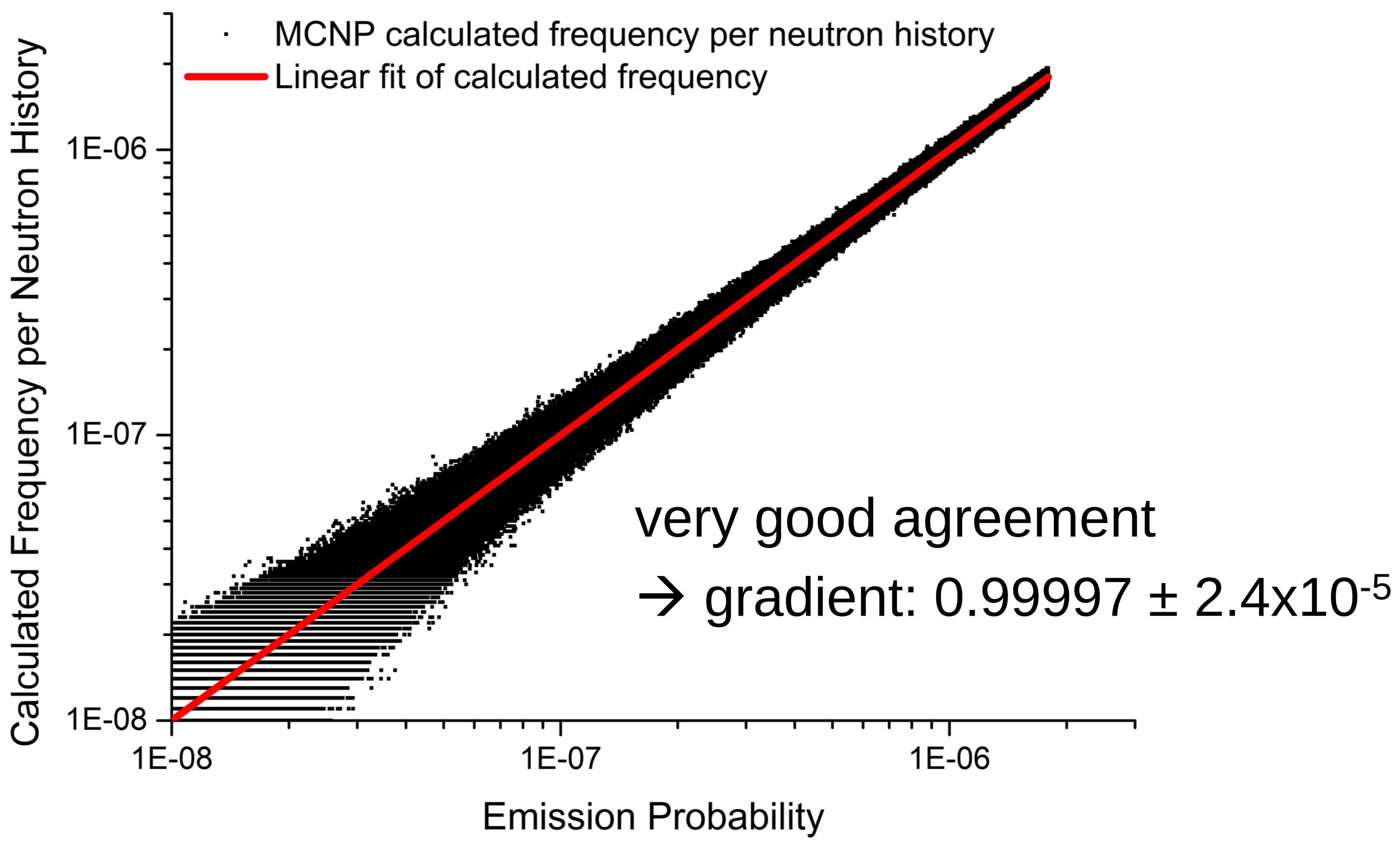
Method

Data from plasma physics calculation is stored in an external file, which can be read and processed by the MCNP source subroutine developed in this work.



Results

Verification the source point sampling of the developed source subroutine.

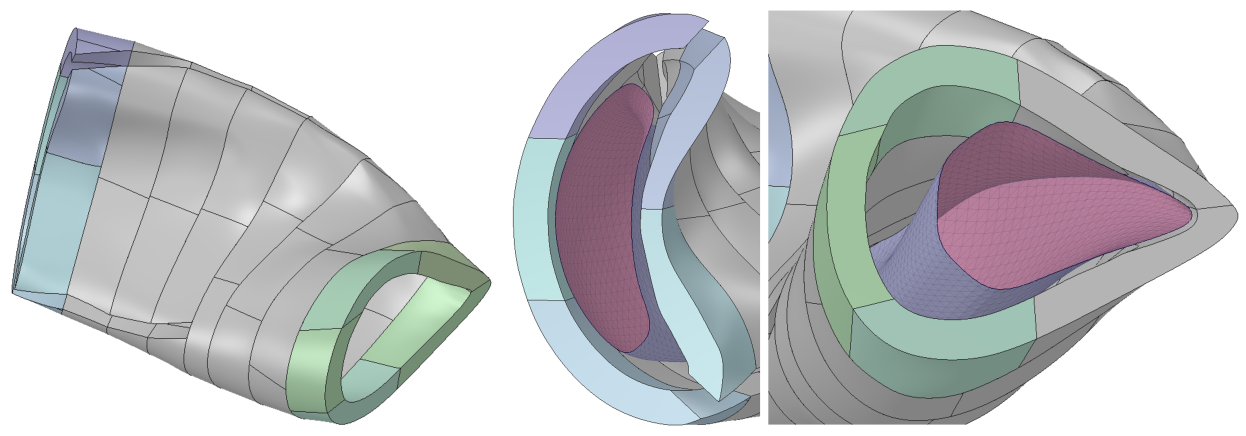


Calculated frequency of the source positions compared with the original intensity

CAD Geometry

Three different approaches will be investigated to create a CAD based MCNP geometry:

1. Traditional CSG: "Geometry translation approach" with KIT's CAD to MCNP conversion tool McCad → fully developed procedure for Tokamak reactors
2. Faceted Solid: Direct tracking of particles in CAD geometry by using DAG-MCNP (DAG = Direct Accelerated Geometry)
3. Unstructured Mesh: Tracking of particles in MCNP6



Blanket envelope model provided by IPP Greifswald, including last closed flux surface

Conclusion and Outlook

- 3-D Stellarator neutron source: development and testing have been successfully achieved.
- Geometry modelling: preliminary model needs further development (first wall, breeding zone, manifolds etc. are currently missing).
- Nuclear design analyses: neutron wall loading, nuclear heating, neutron flux distribution, shielding performance, tritium breeding performance, radiation damage.