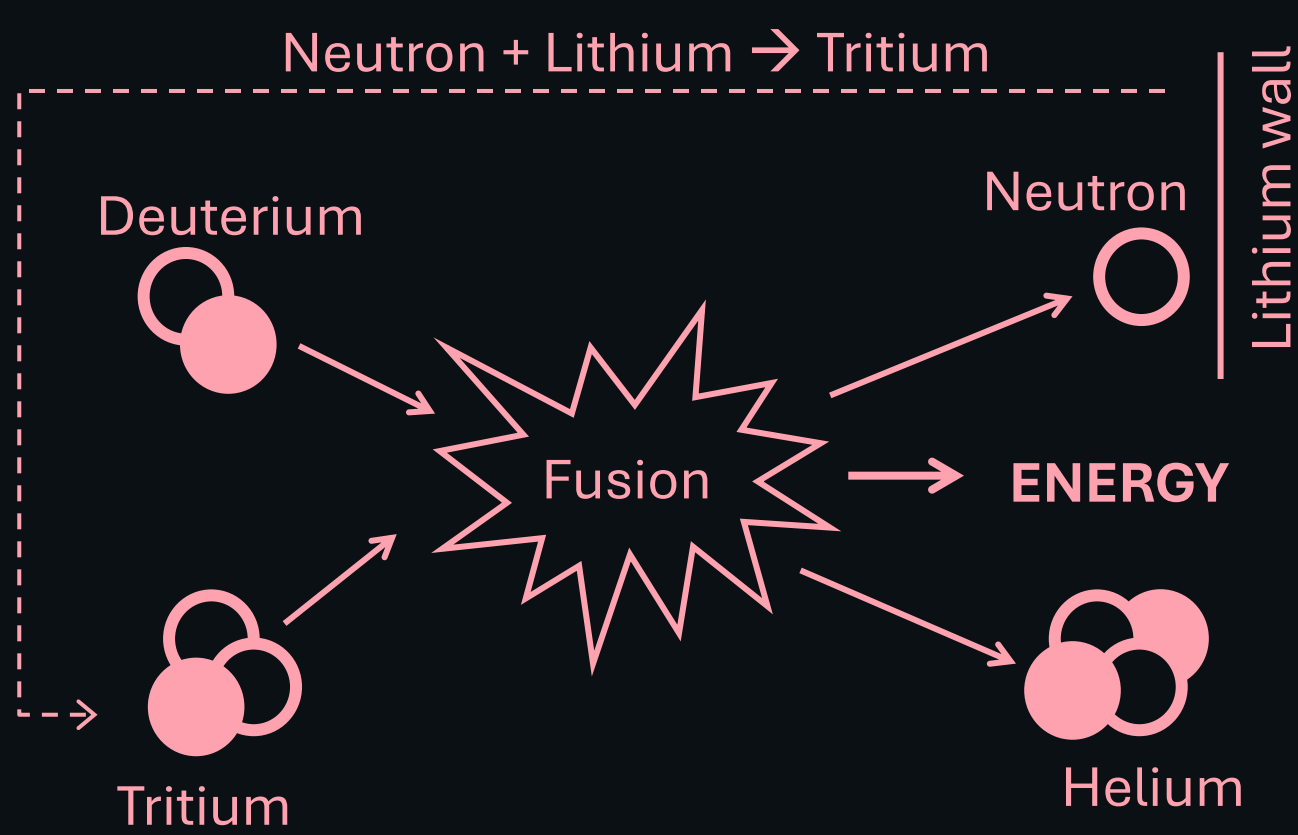


Exploring Plasmas in Switzerland's first Stellarator

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Imagine if we could generate as much energy as today's CO₂-emission free nuclear fission power stations do, but without their drawbacks: almost no radioactive waste, and easy to get fuels. That is the hope of fusion research. It would significantly accelerate the urgently needed energy transition. However, fusion can only take place in the fourth state of matter: plasma. In my internship at the Swiss Plasma Center, I studied the plasma in Polaris, a newly built, small-scale stellarator.

What is Fusion ?



What is Plasma ?

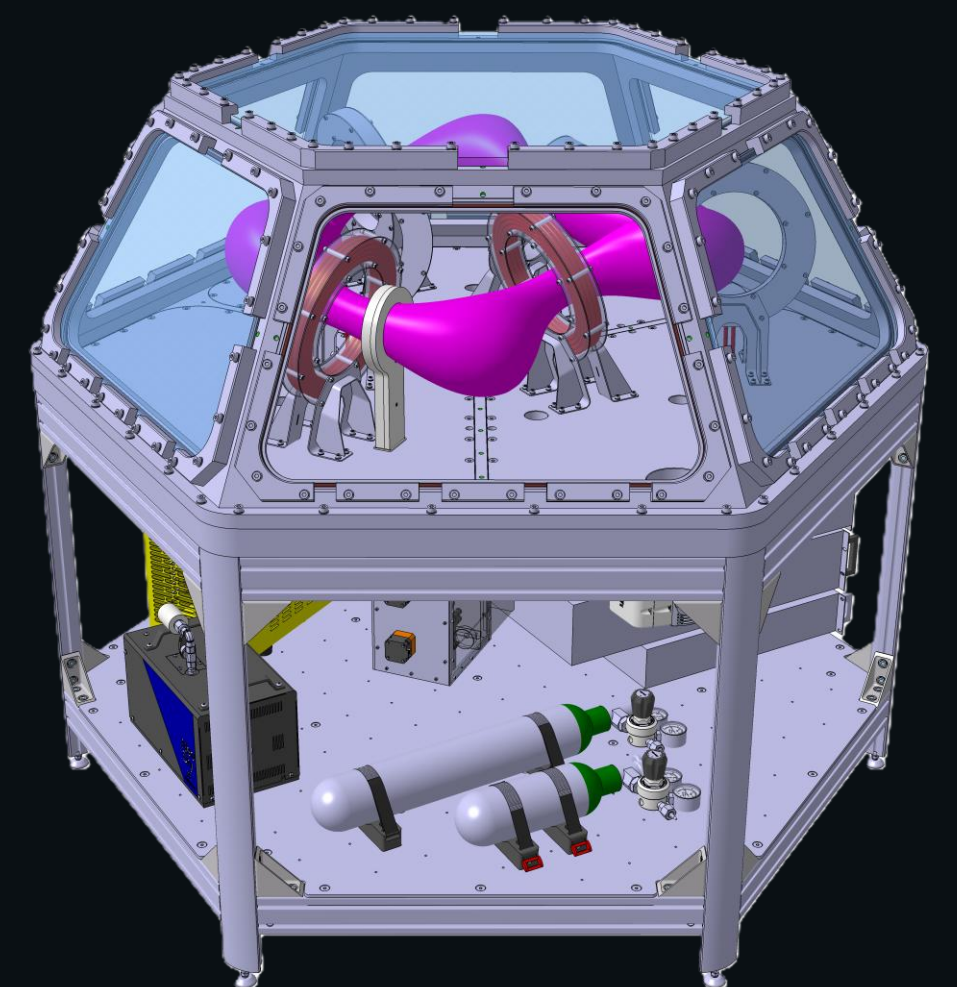
Plasma is a gas that is so hot, that the electrons start shedding from their atoms. So, the gas is constituted of negatively charged electrons and positively charged ions and starts to interact with electromagnetic forces.

Our Stellarator: Polaris

Polaris is a small-scale machine that generates and confines Plasma in an unusual form (called Stellarator).

Goals are:

- Proof of principle that Stellarators have potential
- Exploring plasma in a Stellarator

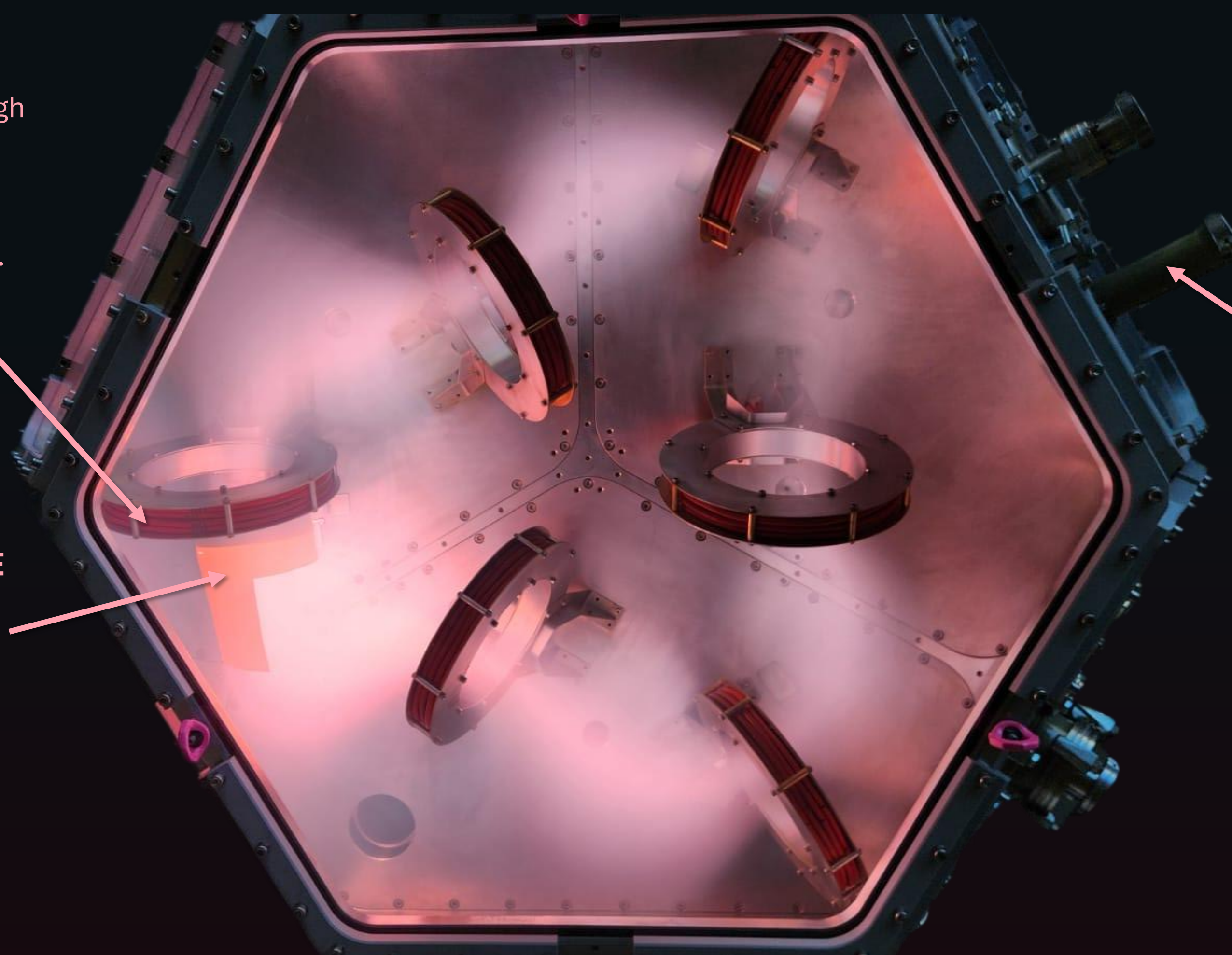


COILS

As a large amount of electricity flows through the coils, a magnetic field is generated that confines the plasma into the correct shape.

RF PLASMA SOURCE

An antenna at radio frequency (13.56 MHz) creates an electric field which accelerates the electrons and thereby heats them up so that they eventually leave their atoms.



LANGMUIR PROBE

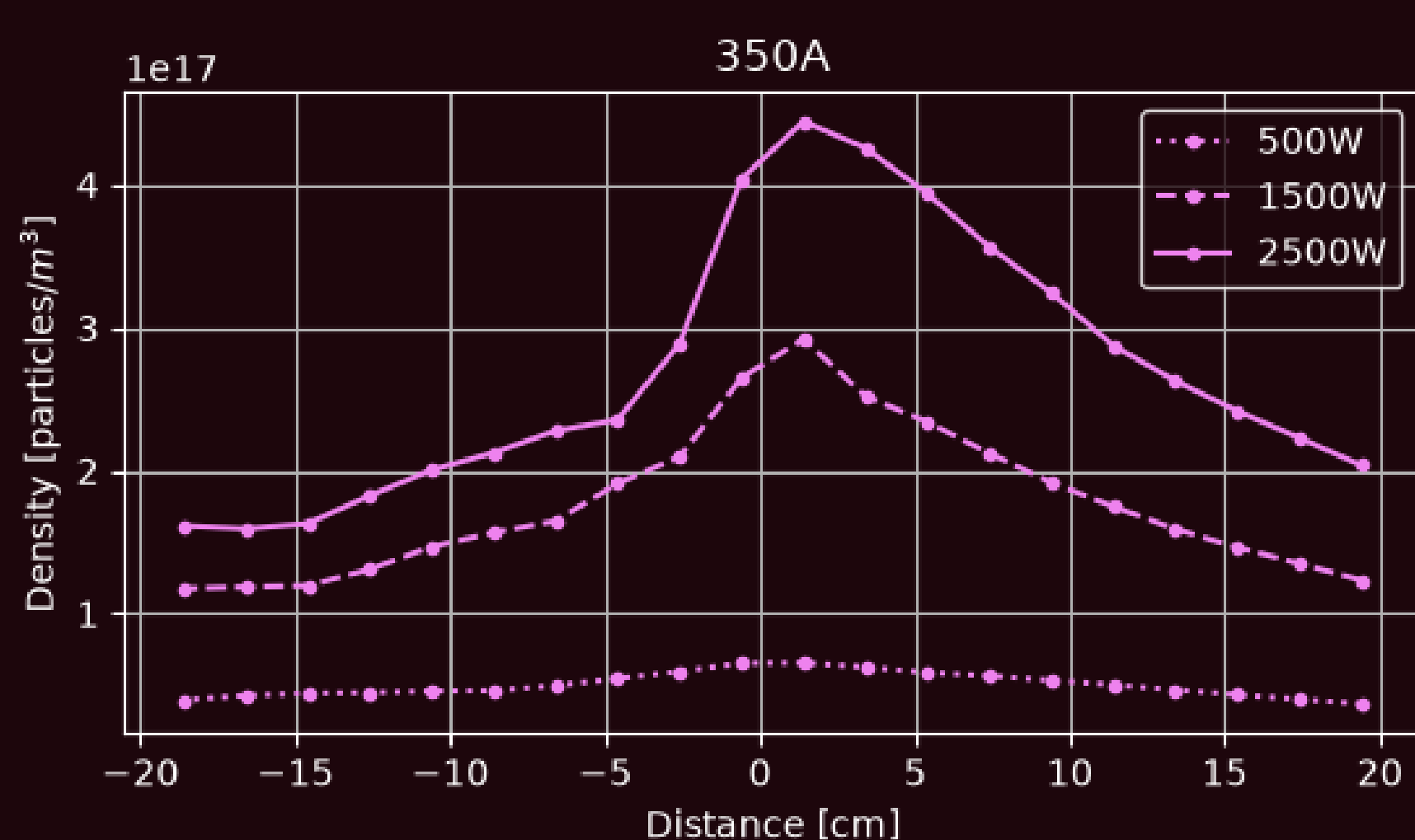
A probe to measure the plasma density: it consists of a polarised electrode put into the plasma, measuring the current (I) of the plasma. This is proportional to the electron density (n) :

$$I = e\alpha_0 n u_B A_{sh}$$

Measurements

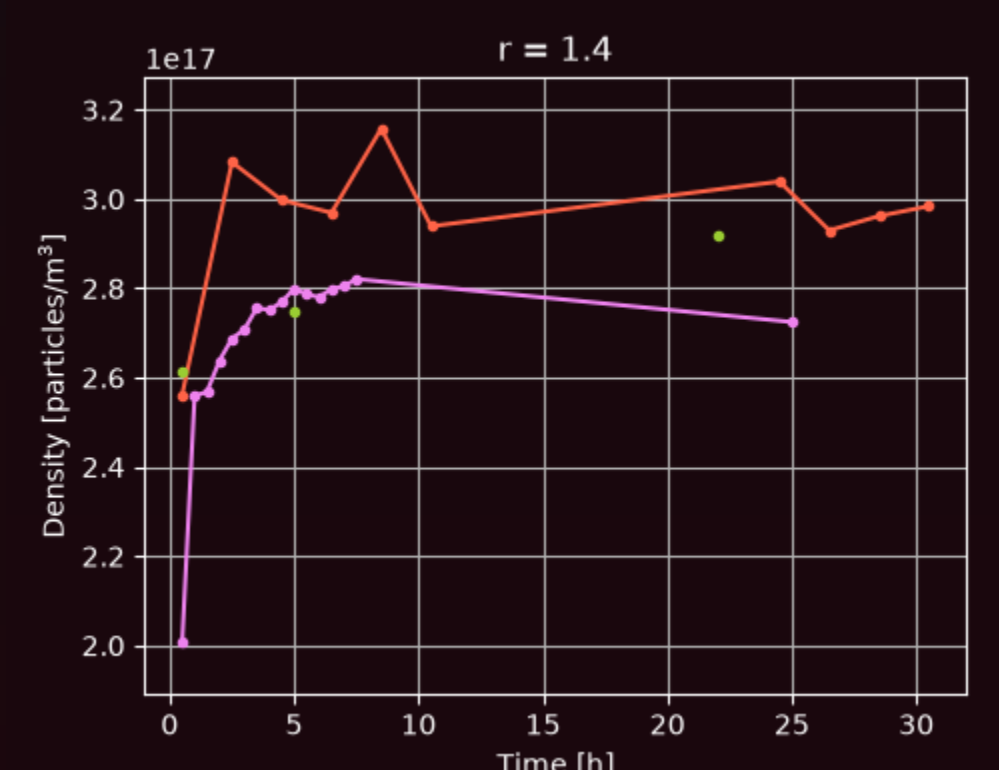
Characterisation of the plasma

Radial profiles were done by varying the magnetic field and antenna power strength and then analysed. Here is an example of a radial profile with 350 A going through the coils.



Exploring reproducibility

Finding out how long it takes, after turning on the pumps, that the plasma density is stable and therefore reproducible measurements can be taken. Then analysing whether igniting the plasma accelerates the process.



Optimise the plasma generation

- Better cooling system
- Better pumping system (with bypass)
- New antenna foot to avoid coating
- Reduce plasma-blob around antenna with teflon tube