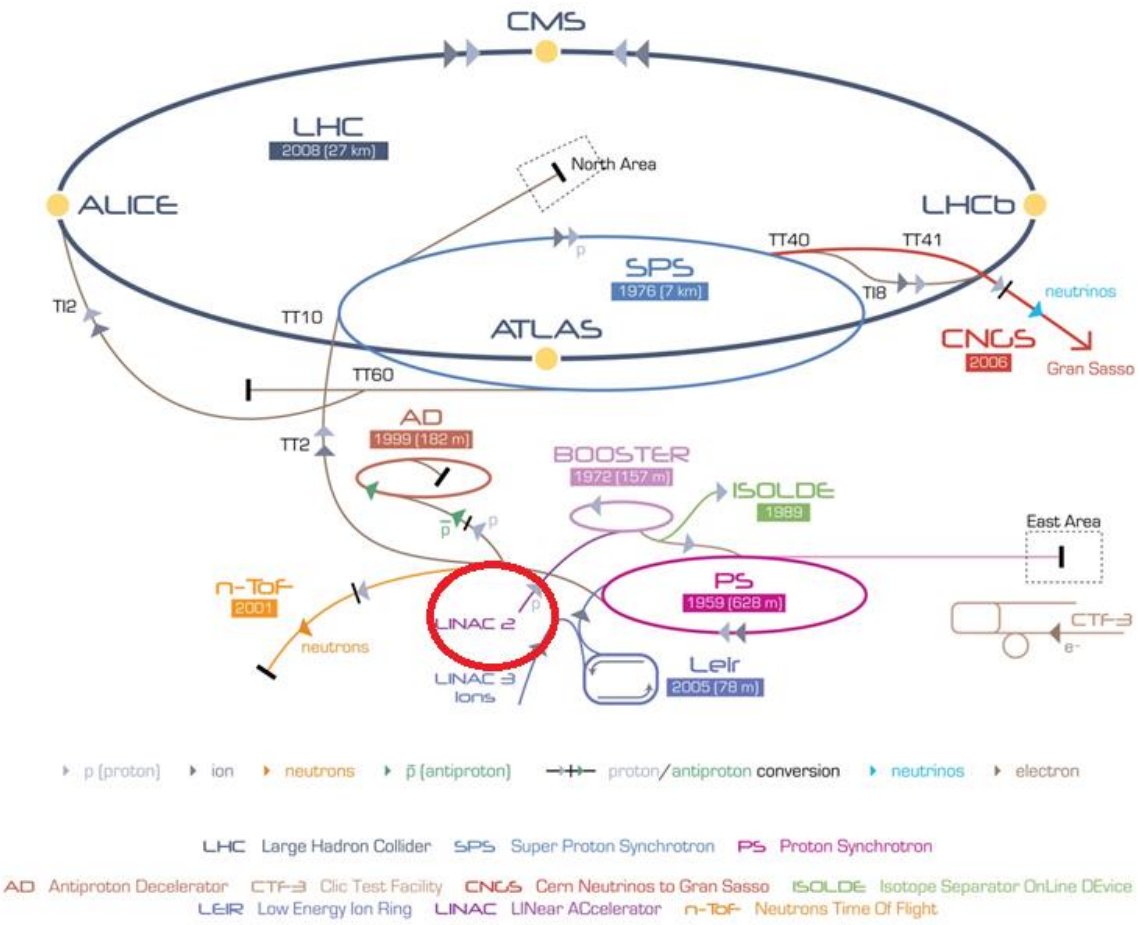
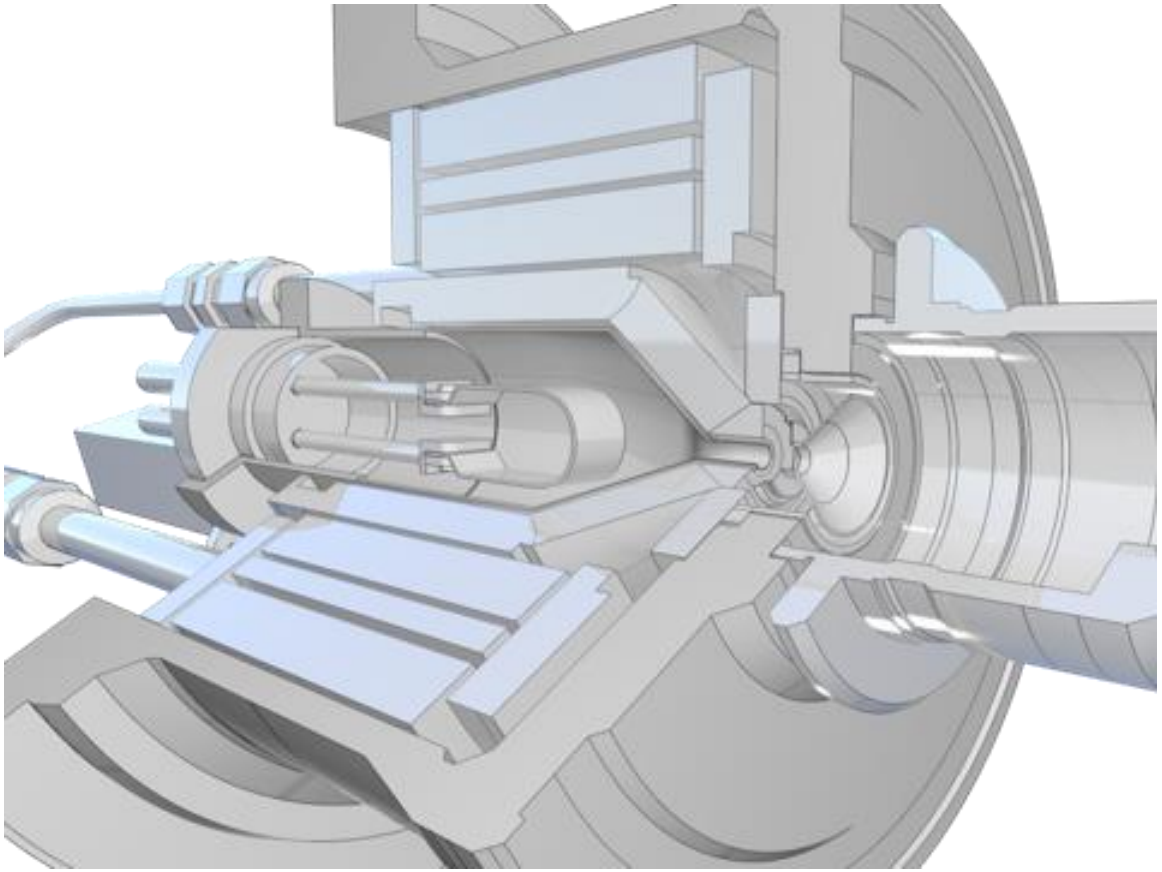
# WHERE IT ALL BEGINS

Where do the protons come from?

Now

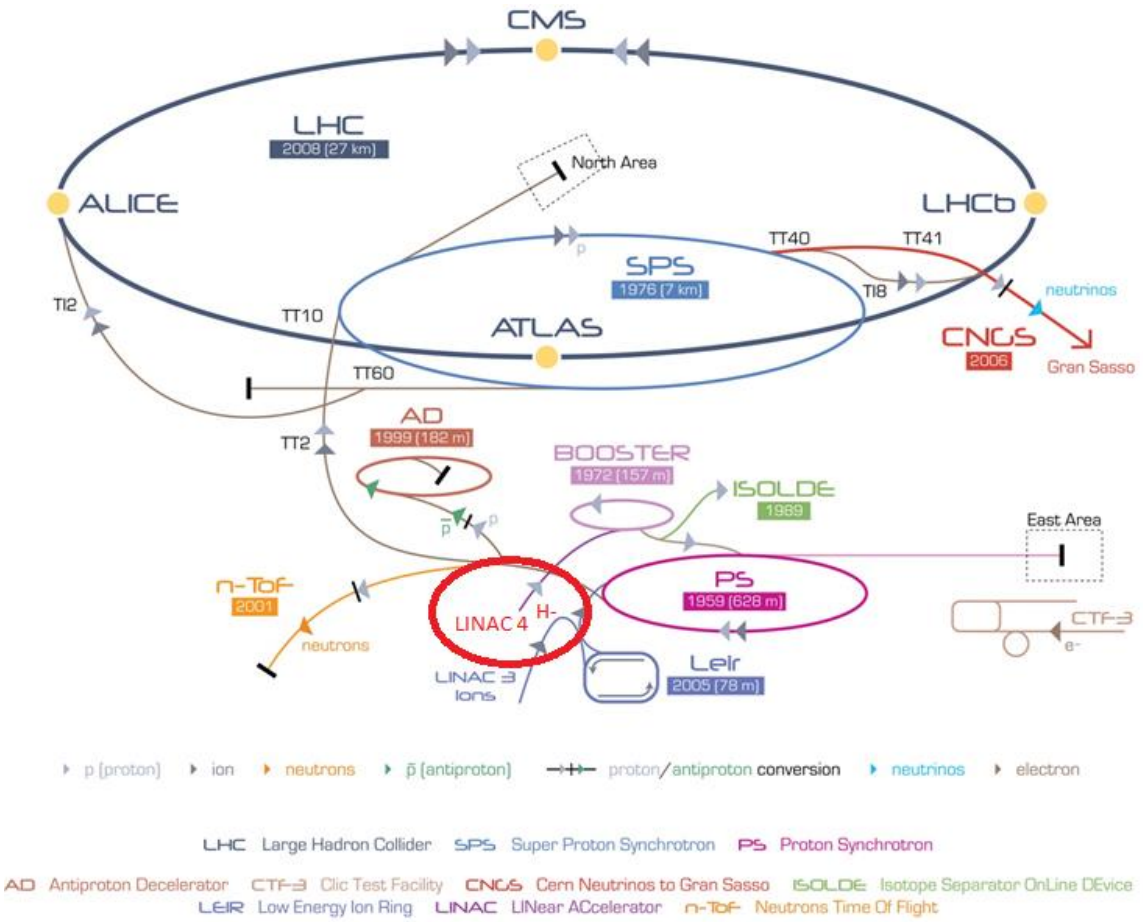

CMS
LHC
2008 (27 km)
North Area
ALICE
LHCb
TT40
TT41
SPS
1976 (7 km)
TI8
neutrinos
TI2
TT10
ATLAS
CNGS
2006
Gran Sasso
TT60
AD
1999 (182 m)
TT2
BOOSTER
1972 (157 m)
ISOLDE
1989
East Area
n-ToF
2001
LINAC 2
PS
1959 (628 m)
CTF-3
neutrons
LINAC 3
Ions
Leir
2005 (78 m)
p (proton)
ion
neutrons
p̄ (antiproton)
proton/antiproton conversion
neutrinos
electron
LHC Large Hadron Collider
SPS Super Proton Synchrotron
PS Proton Synchrotron
AD Antiproton Decelerator
CTF-3 Clic Test Facility
CNGS Cern Neutrinos to Gran Sasso
ISOLDE Isotope Separator OnLine DEvice
LEIR Low Energy Ion Ring
LINAC LINear ACcelerator
n-ToF Neutrons Time Of Flight



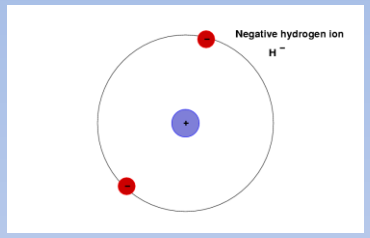
# LINAC 2

Proton beam from hydrogen plasma.
Uses hydrogen gas and an intense electrical discharge.
Electric field that extracts the protons.
In the need of new technology and ideas to increase luminosity and intensity.
Calls for upgrades.

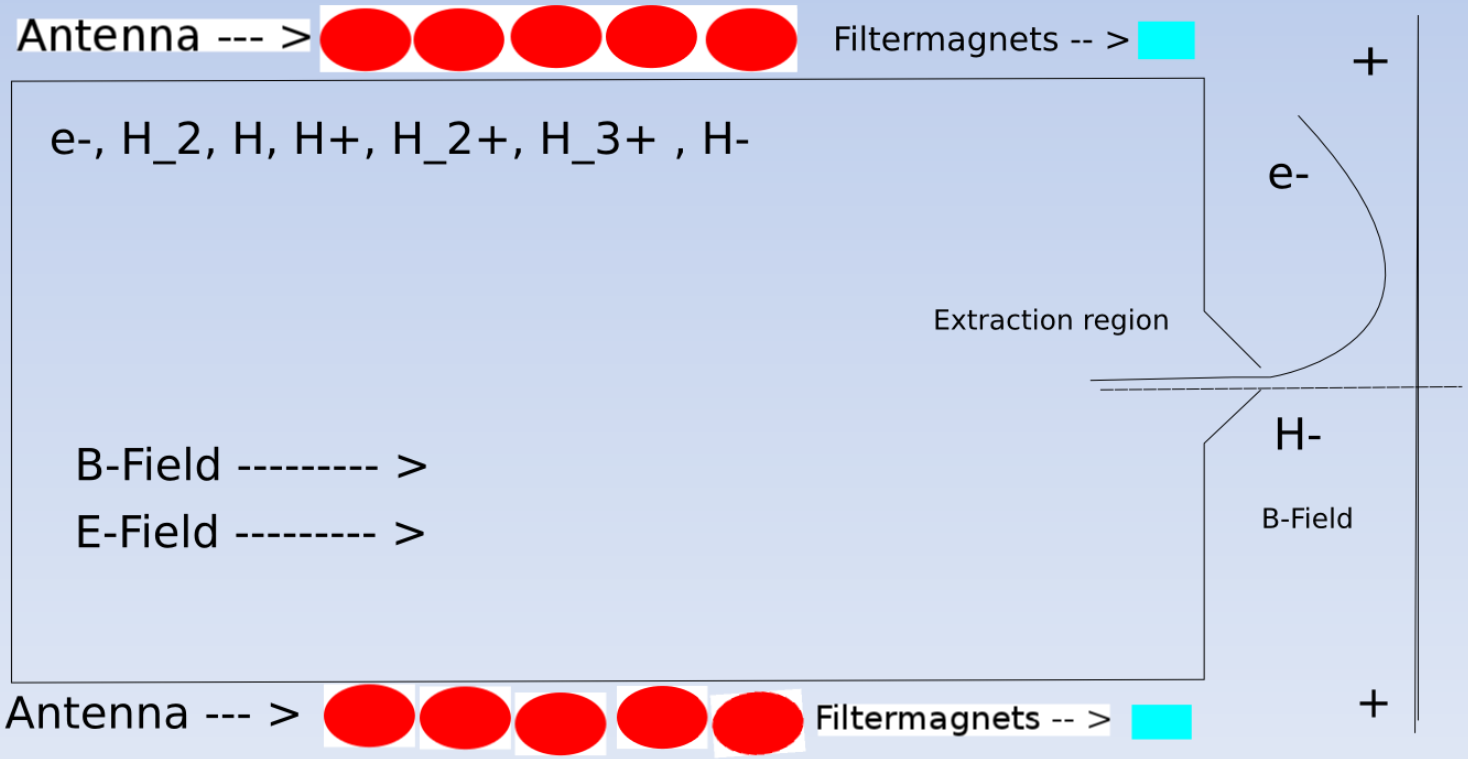
After the installation of the LINAC 4



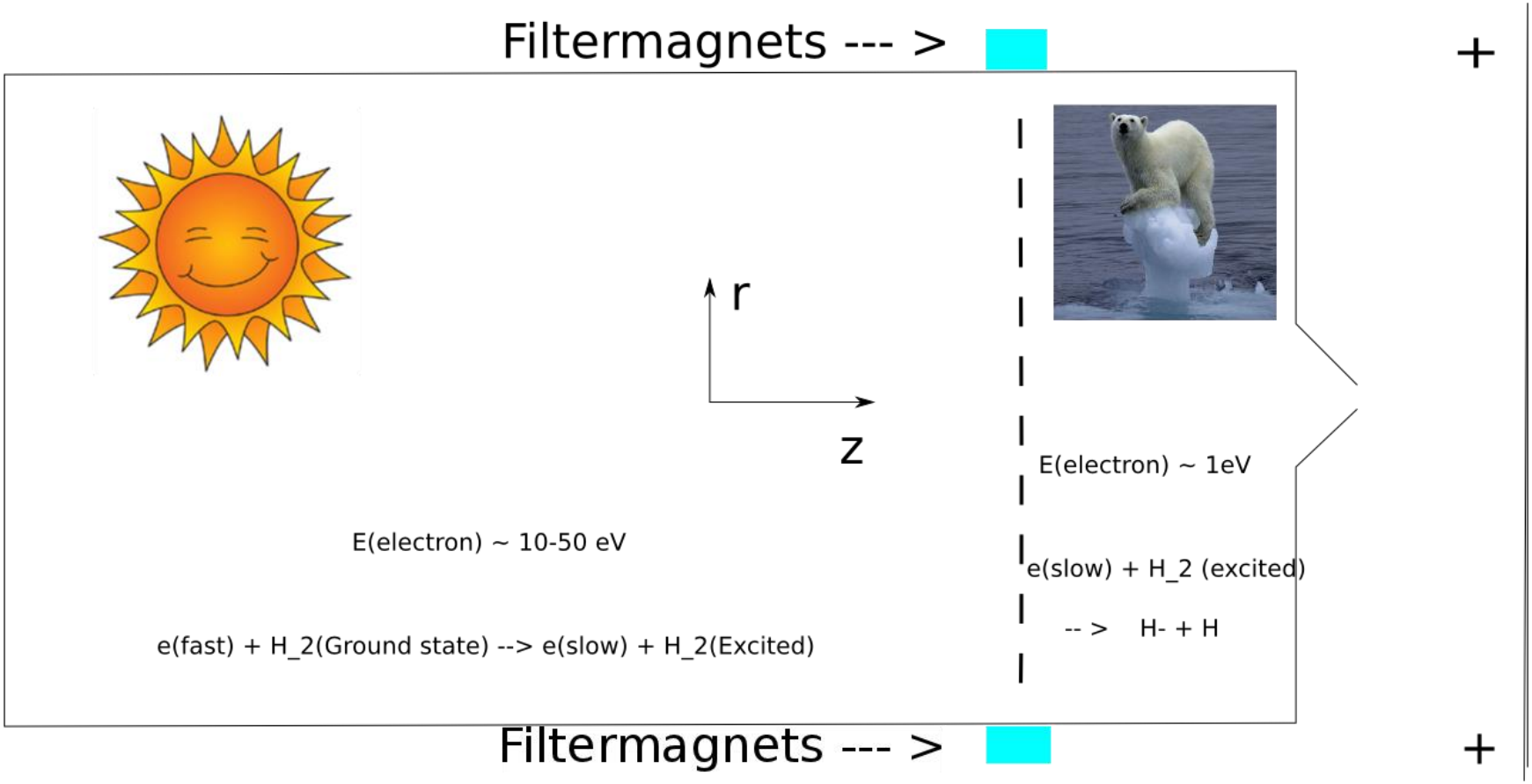
# The ion source - simplified



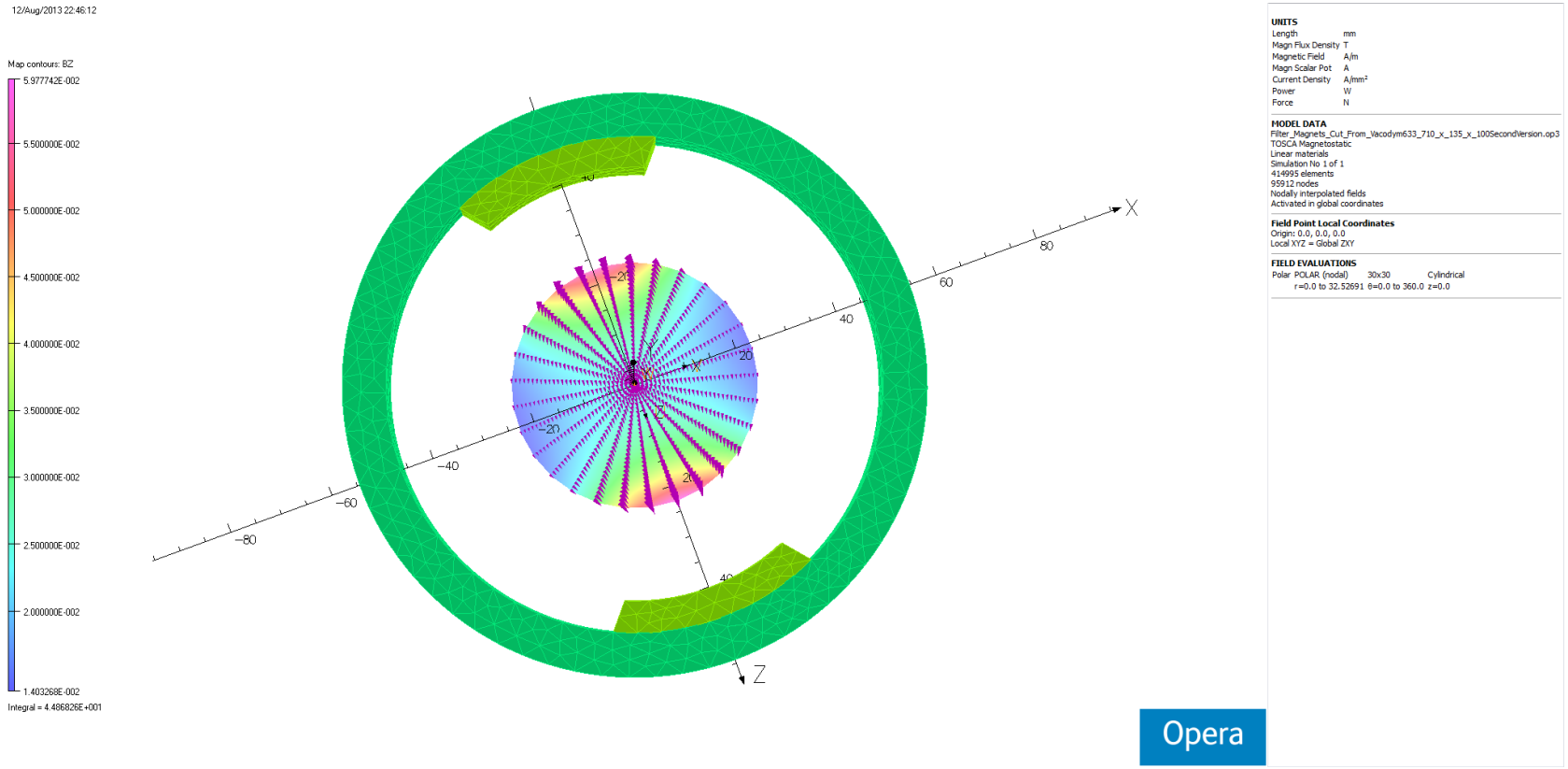

- Here: Simplified overview of the ion source. Antenna (Solenoid), Filtermagnets, Plasma with contents, Extraction area
- What is a plasma? It's contents? Hydrogen plasma created by Antenna. 2 MHz RF current.
- RF current -> E and B fields -> Increase in velocity -> Increase in temperature
- New technology based on the production of H- in the Ion Source. Why?
- H- very unstable compound. Need special environment to live and be created. Filtermagnets one of the keys to this.
- After extraction: Magnetic field to bend the electrons, but not the H-.



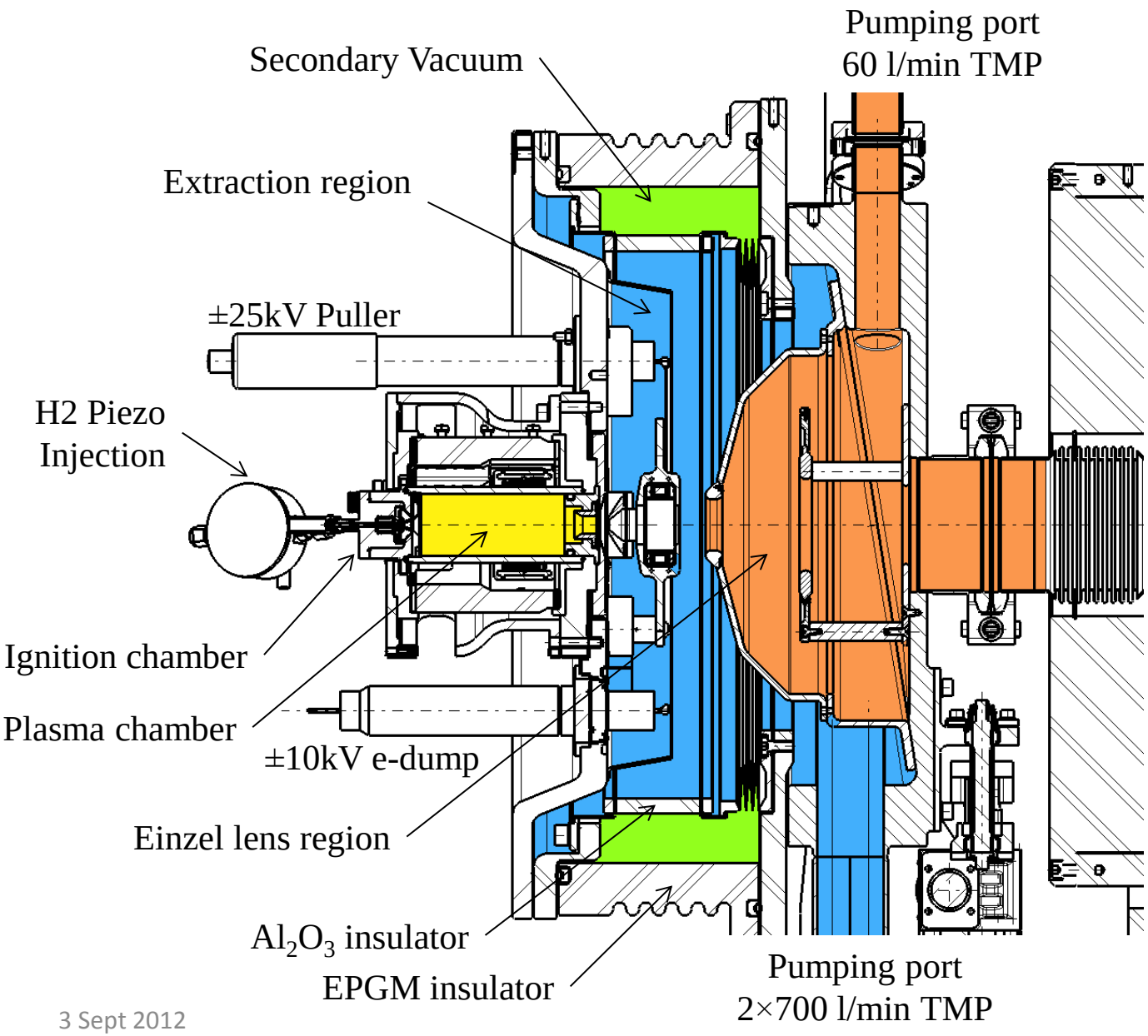
- The filtermagnets splits the plasma in a hot and a cold part.
- All electrons tend to spiral along magnetic field lines.
- High energy electrons collide less, and hence follow B-field into the wall.
- Low energy electrons collide more and make it through to extraction area.

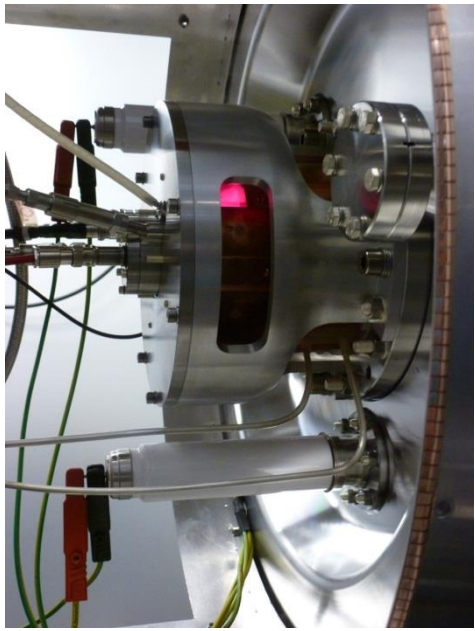


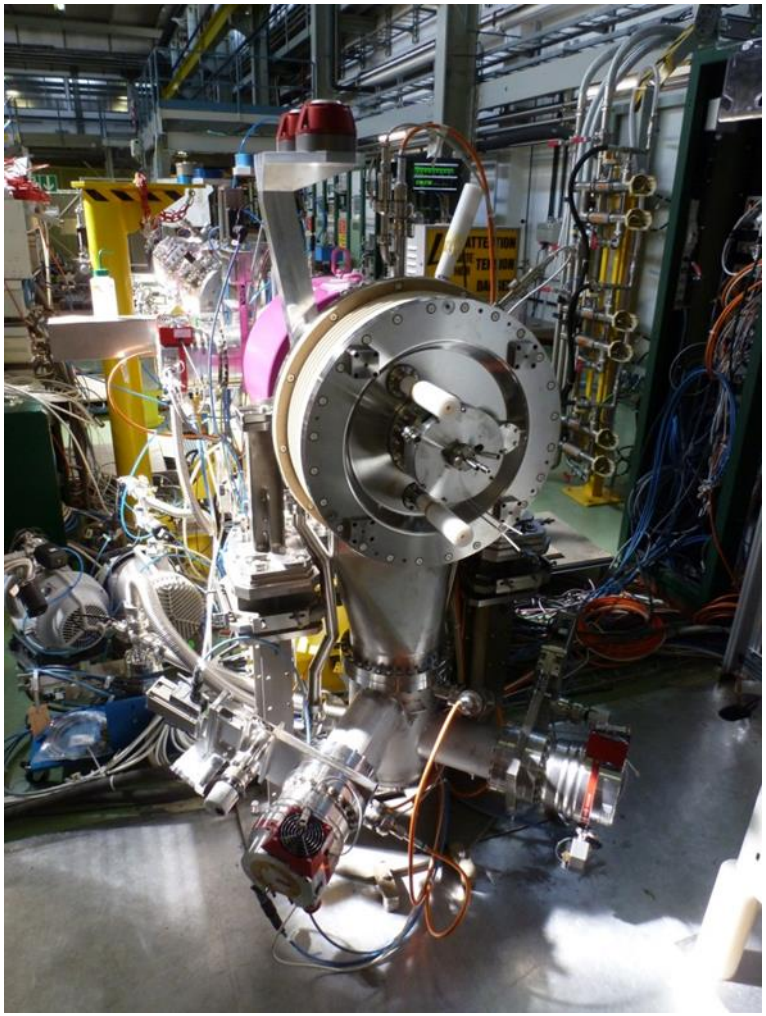
- My first task: To design filtermagnets that creates exactly 25 mT in the center of the plasma. Designed from magnets we already have.
- Know from previous experiments that this creates the necessary conditions.
- Needed to be circular to fit the Ion Source design. Originally cubic.
- Being cut at the moment externally.
- Modeling done in Opera

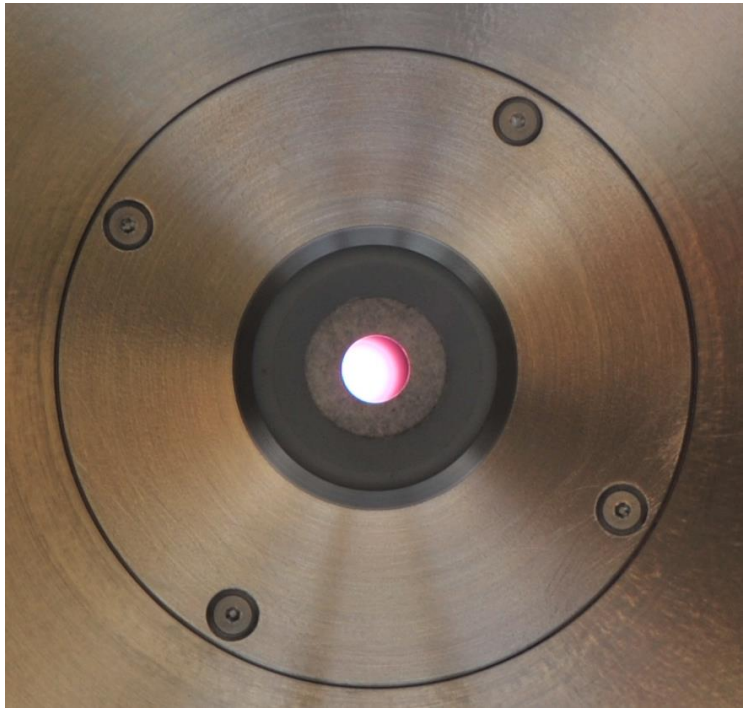


# Plasma Generator and beam formation region







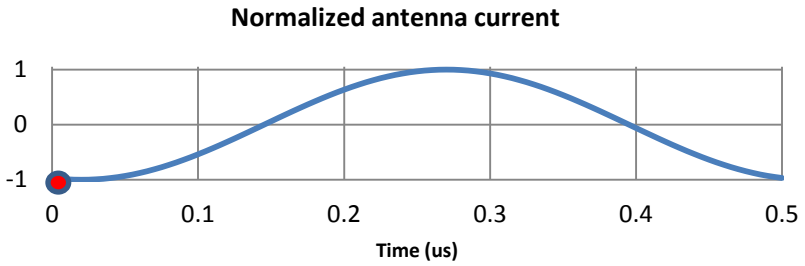
# Densities time evolution

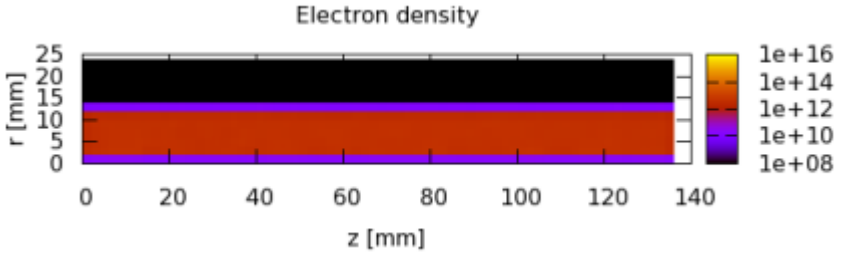
Second project: Simulating the plasma in Fortran. Densities, temperature, Collisions, velocities, coordinates of particles etc.

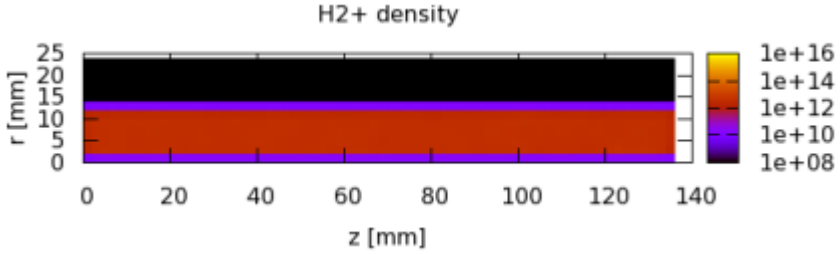
Collisions implemented for electrons.

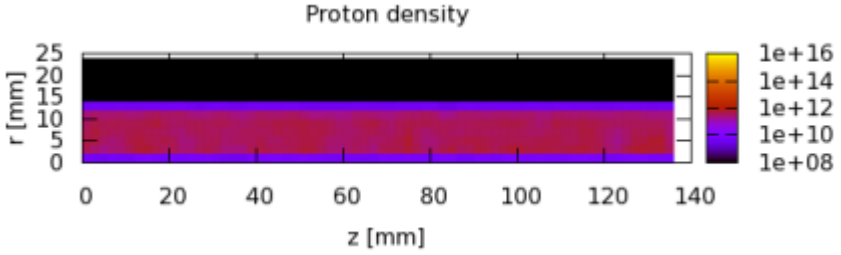
Using Monte Carlo to simulate collisions.

Want to do the same for protons. Why?



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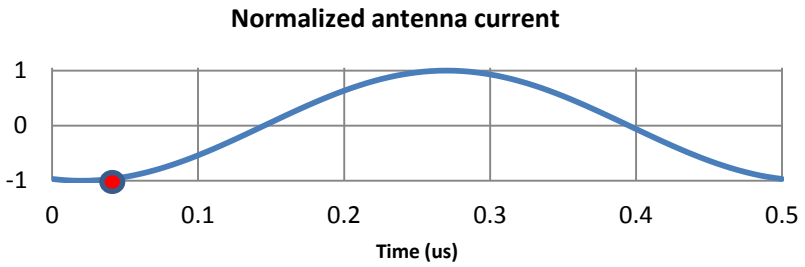


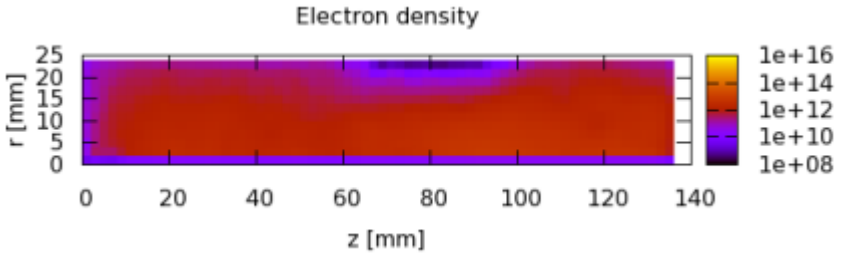


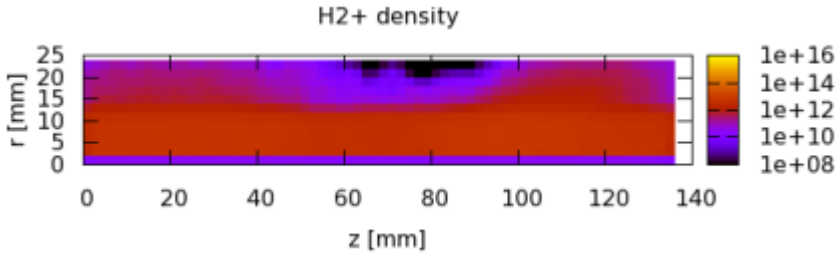


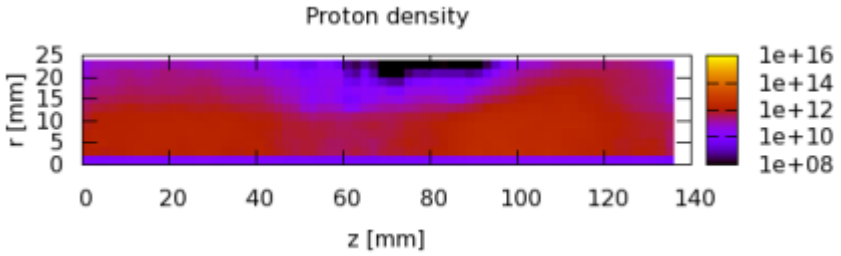

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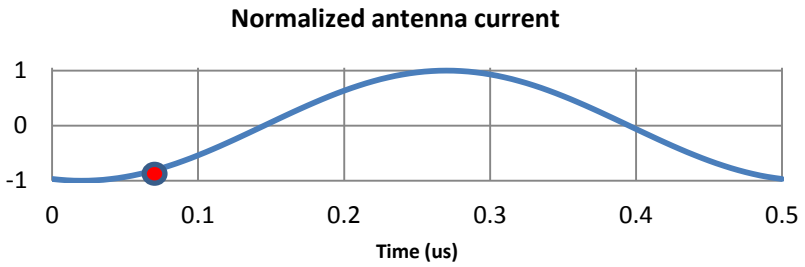


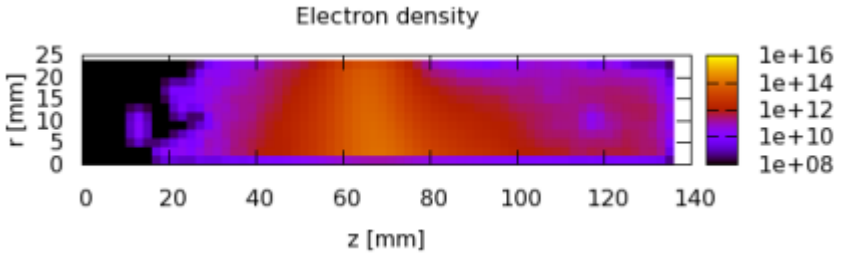


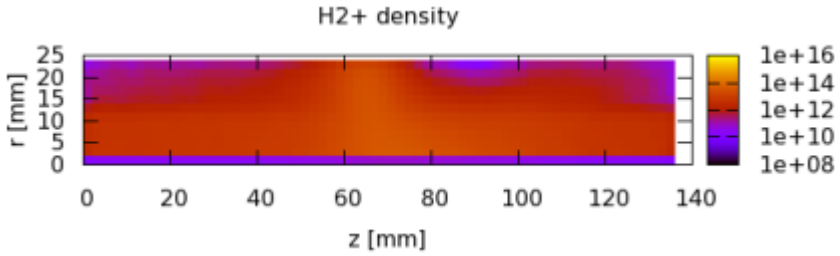


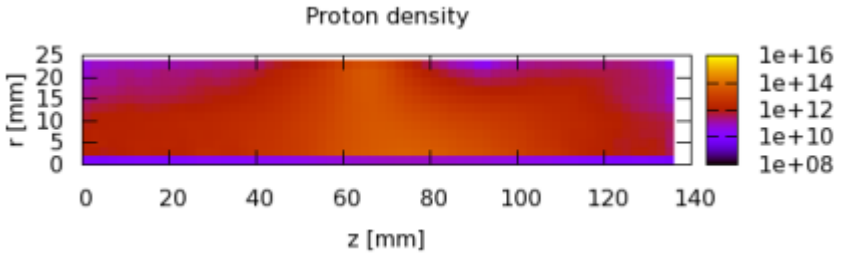

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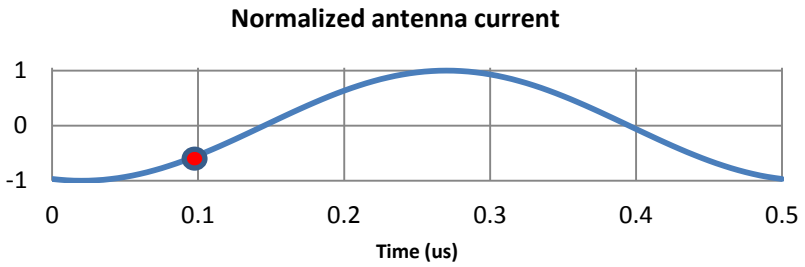


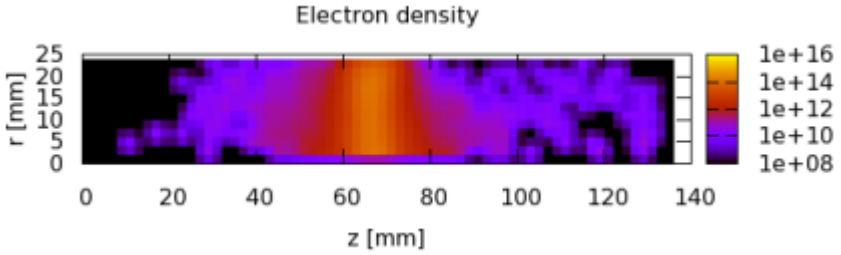


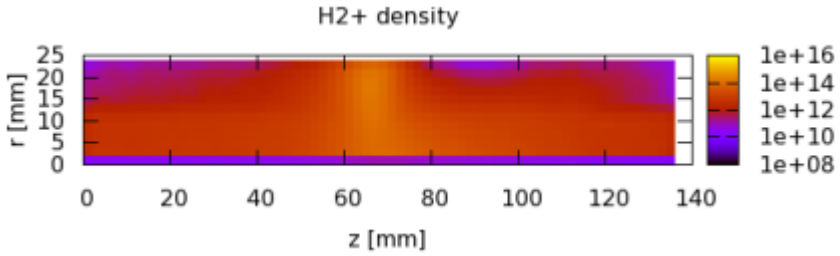


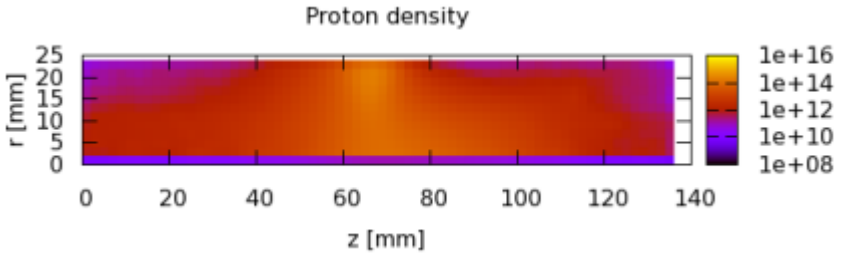

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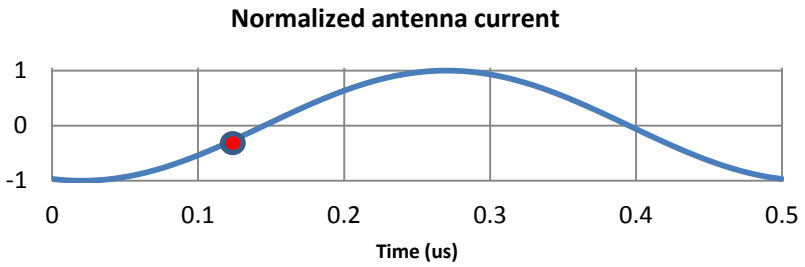


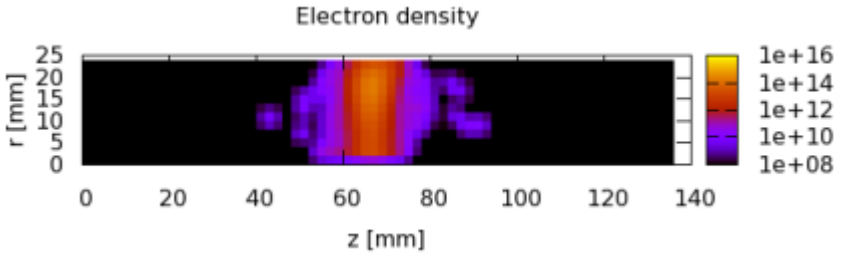


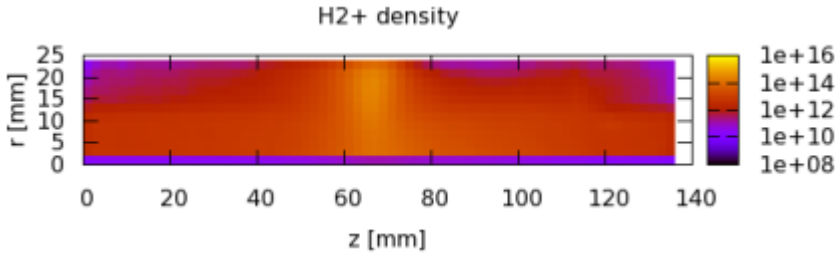


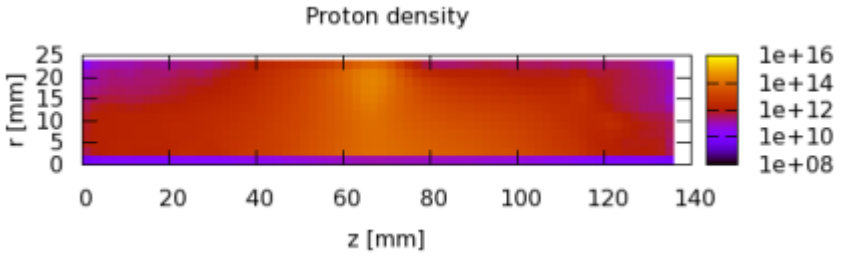

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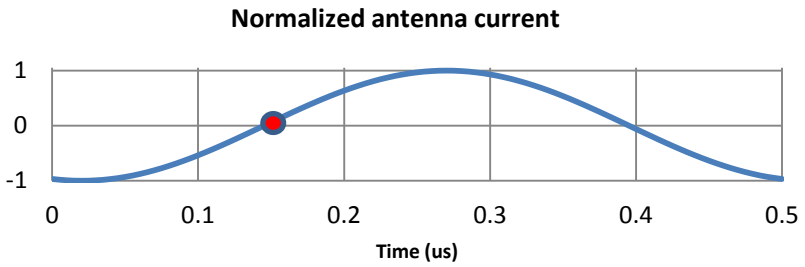


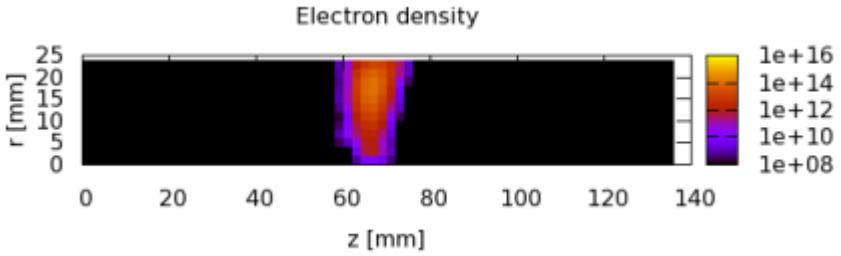


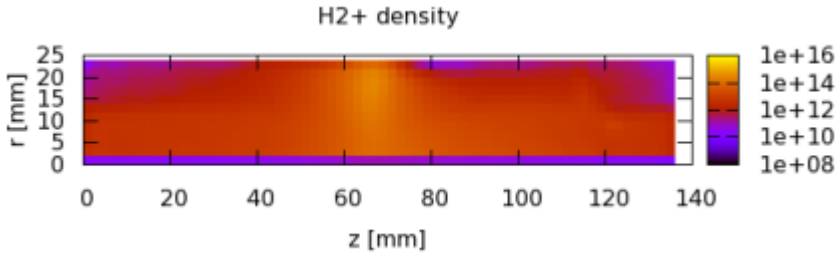


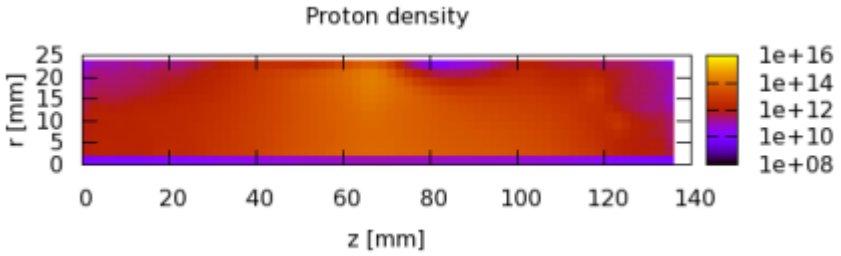

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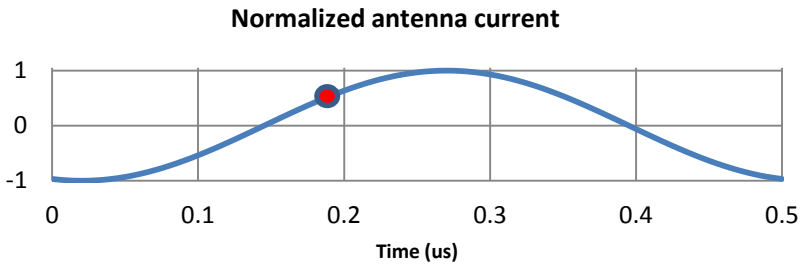


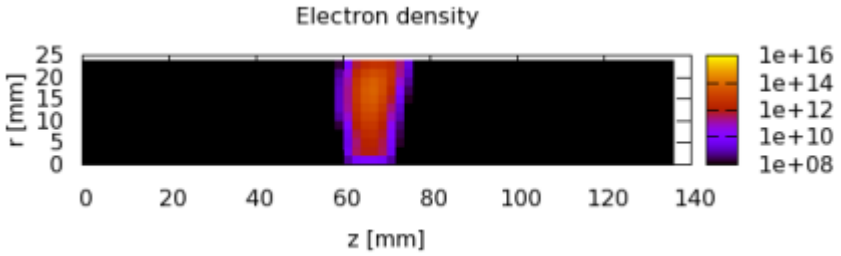


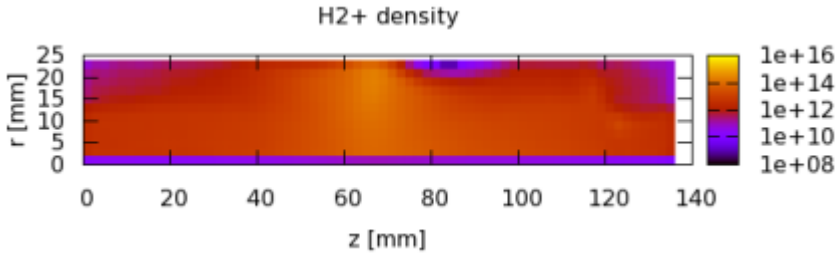


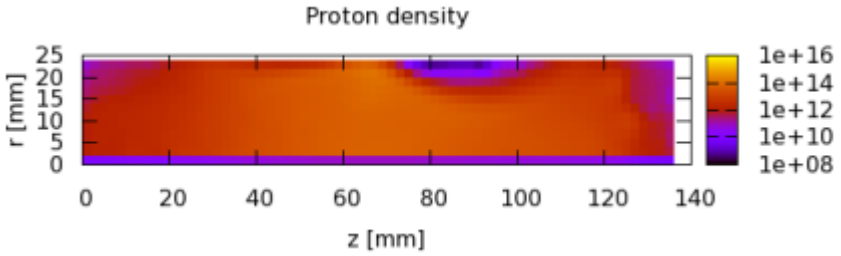

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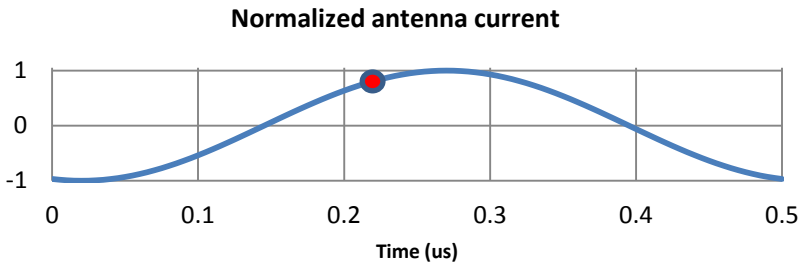


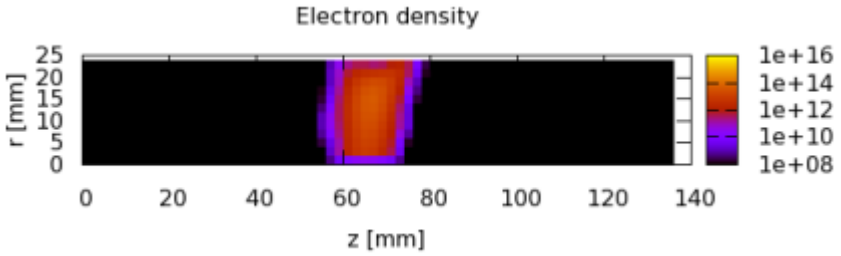


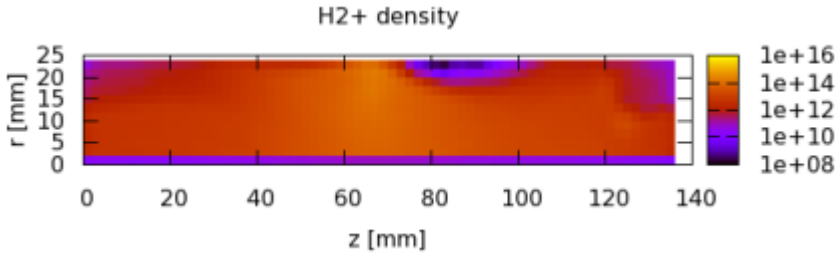


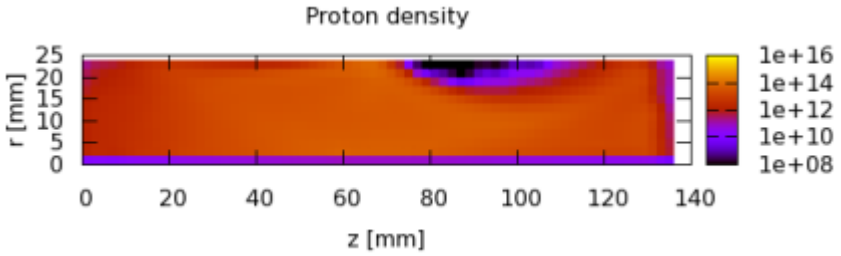

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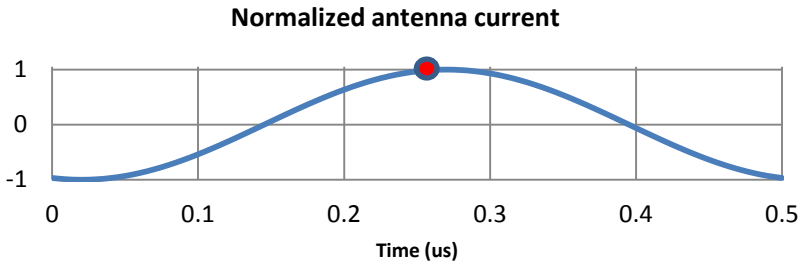


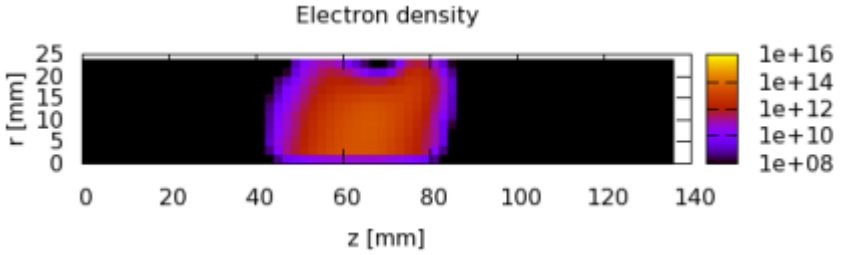


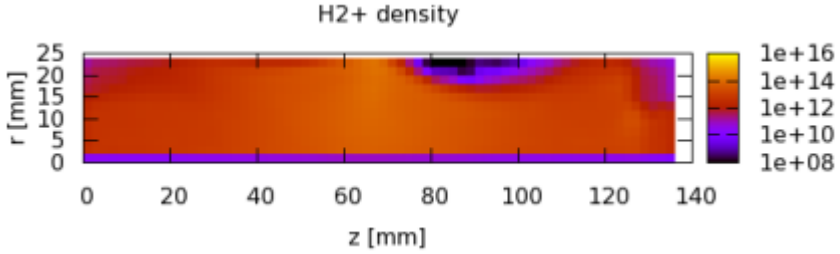


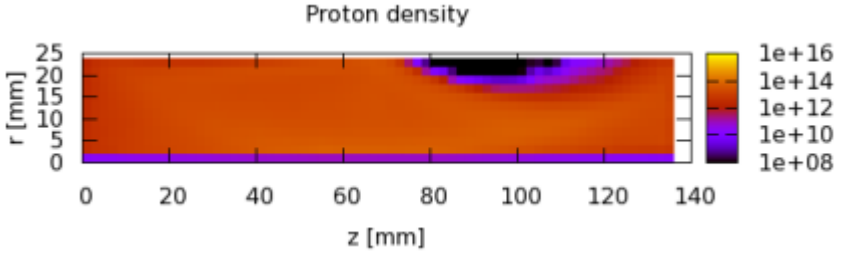

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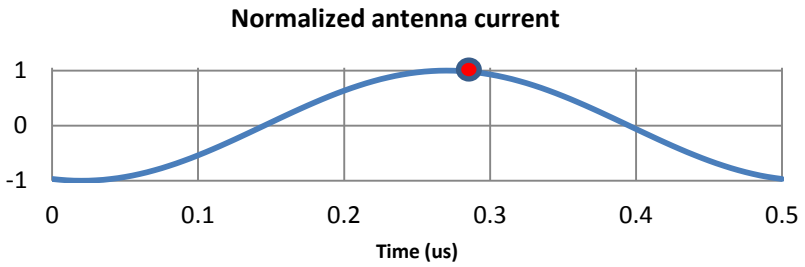


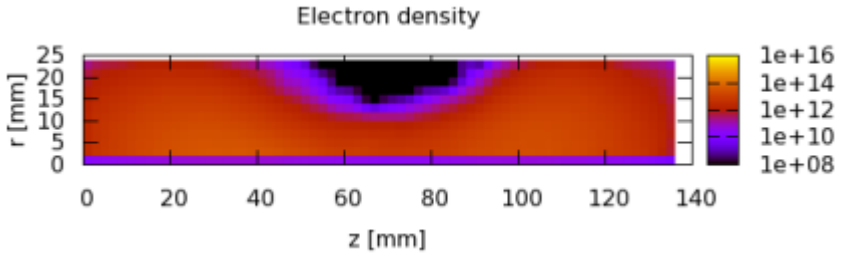


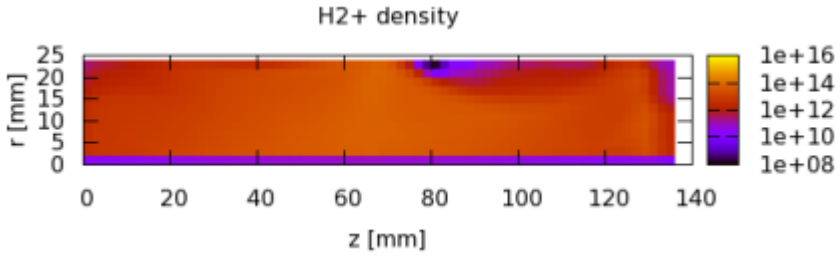


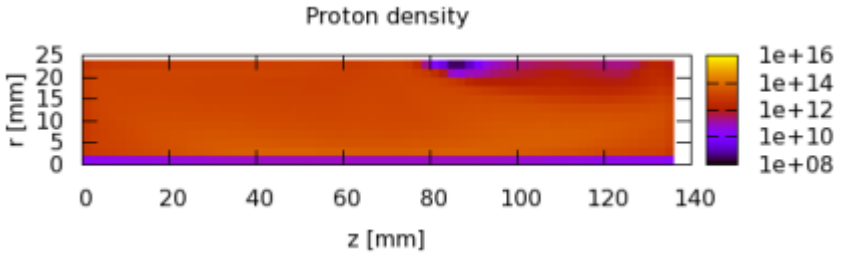

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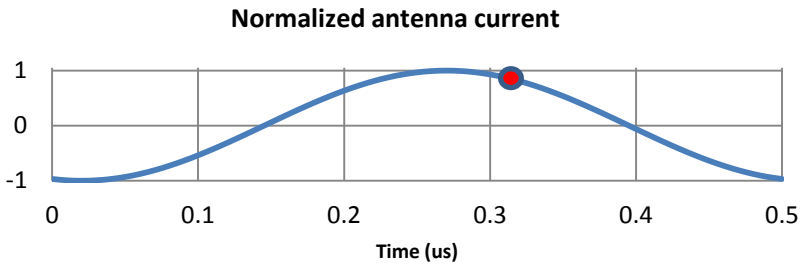
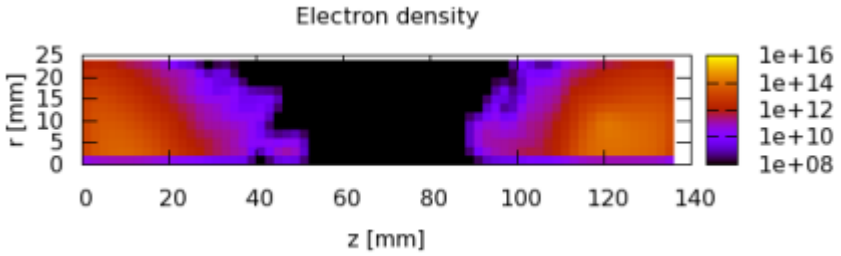
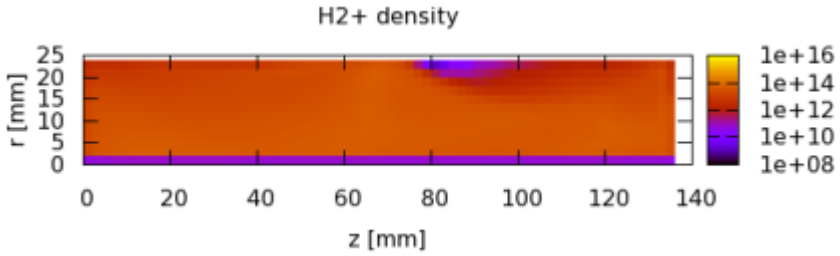
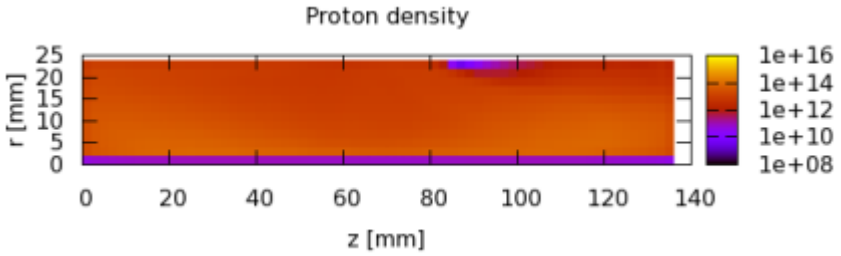
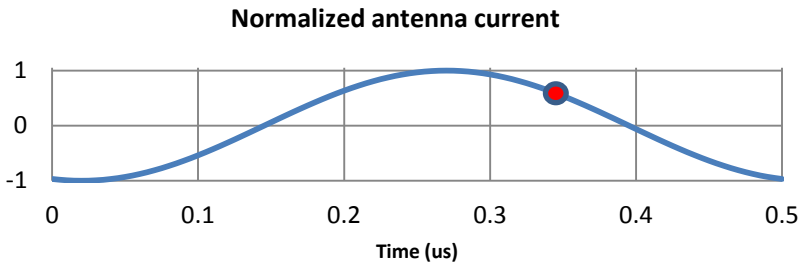


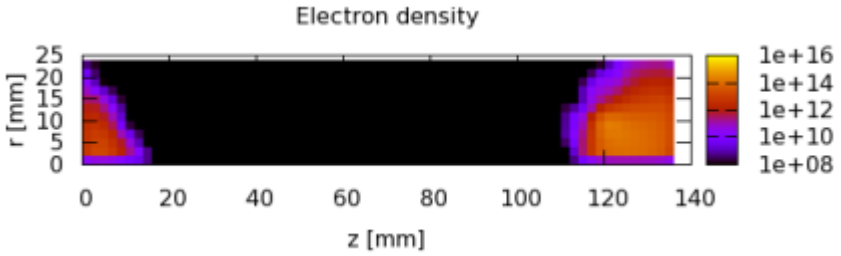



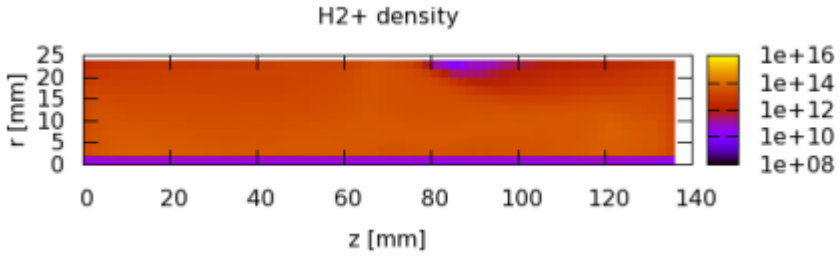



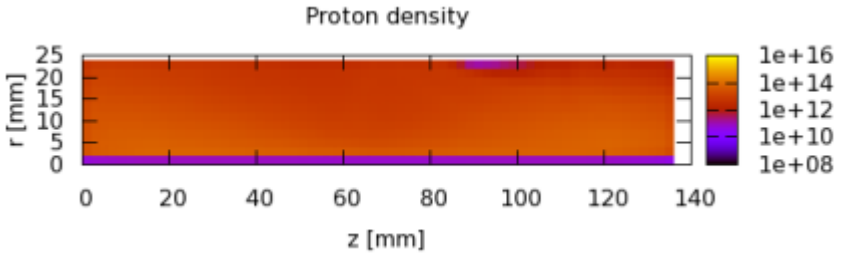



# Densities time evolution

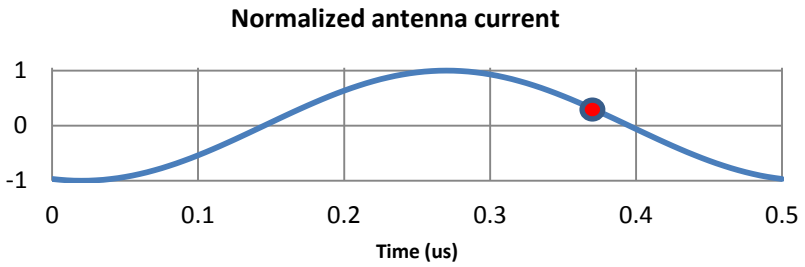


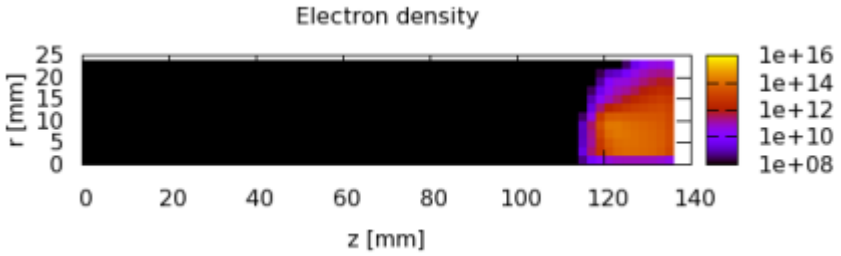



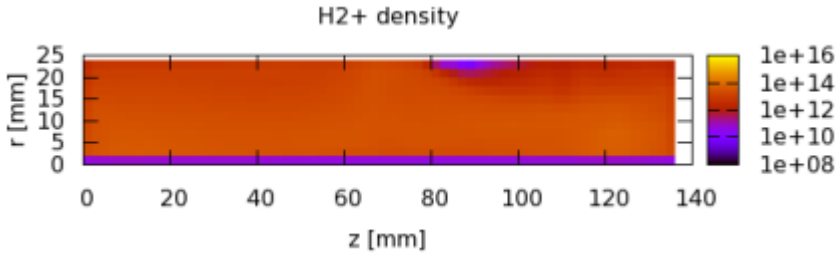



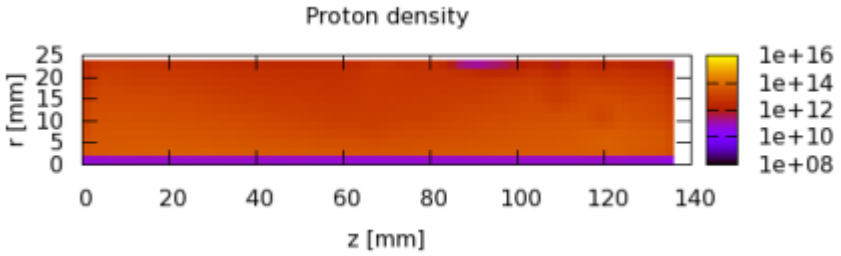



# Densities time evolution

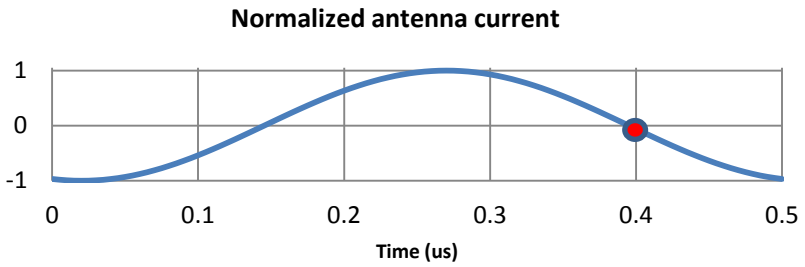


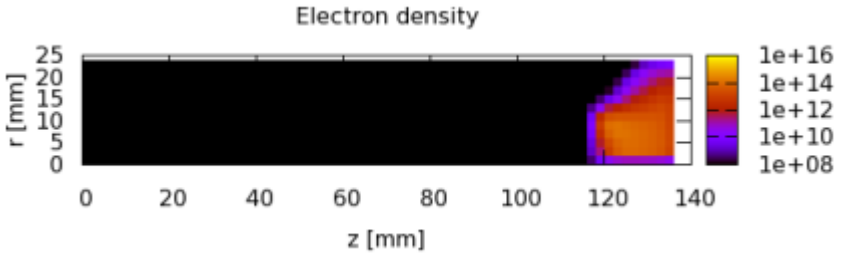



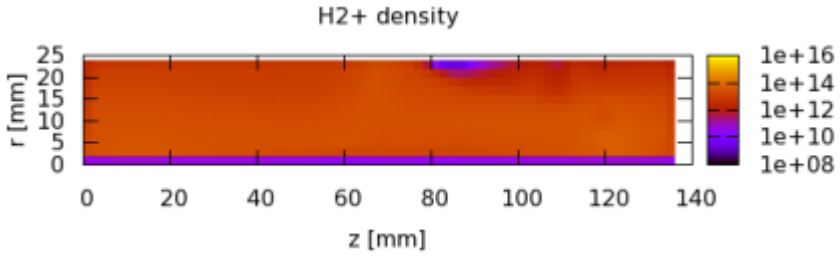



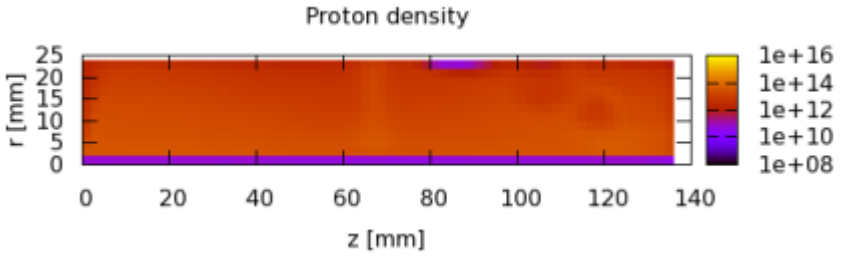



# Densities time evolution



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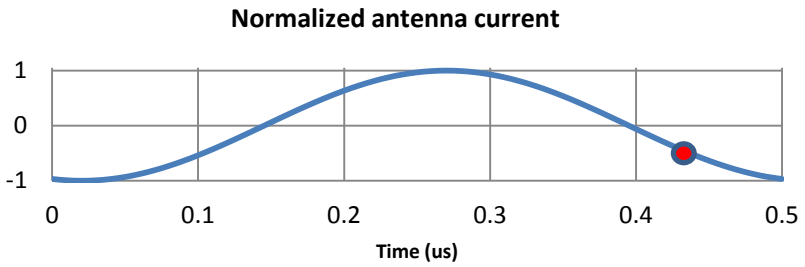


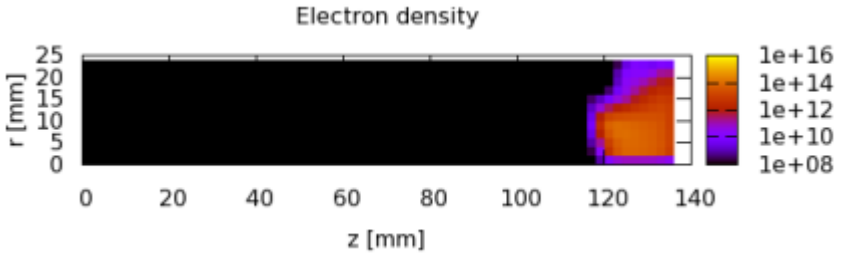


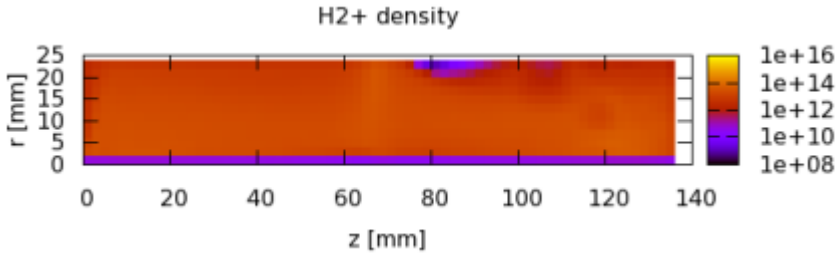


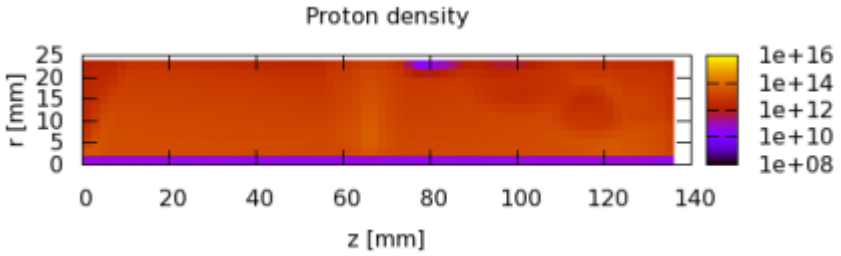

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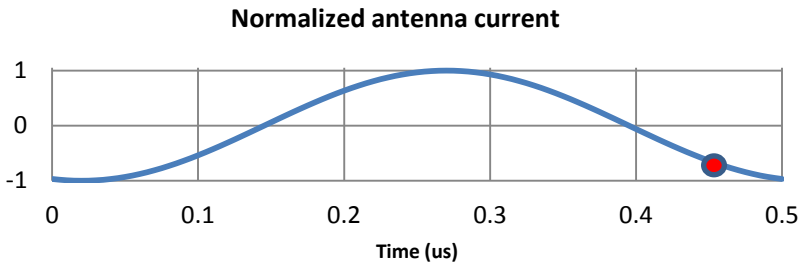


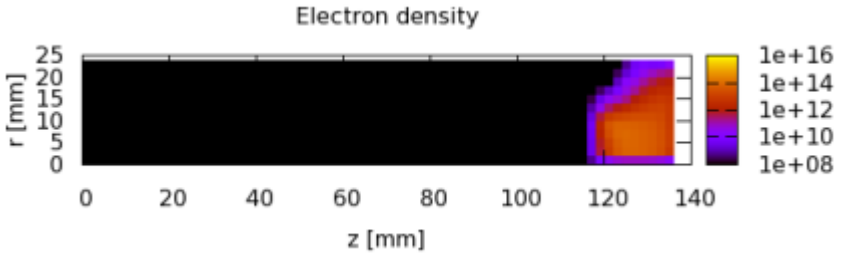


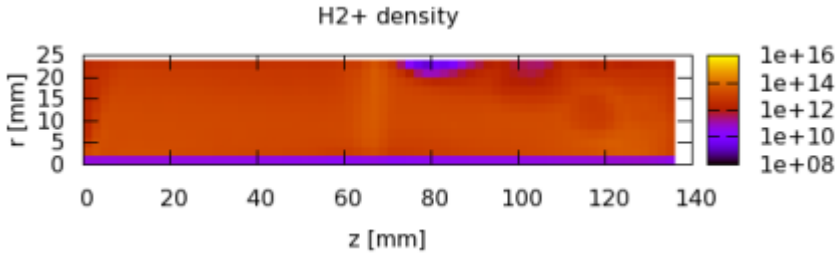


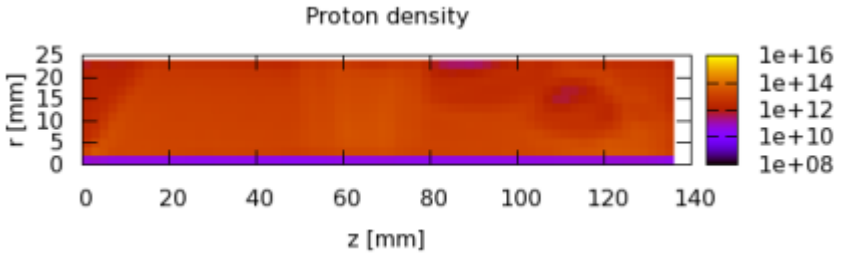

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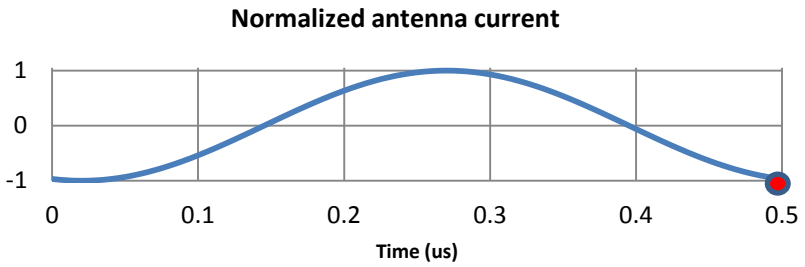


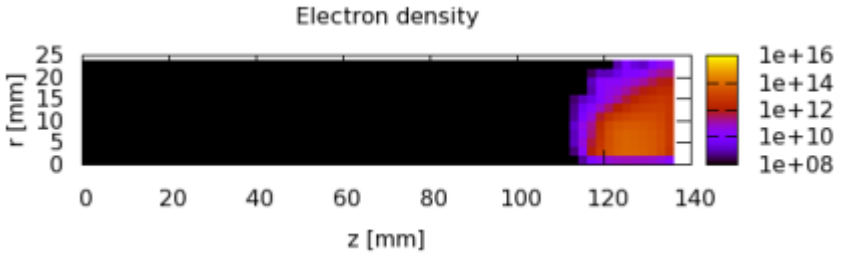


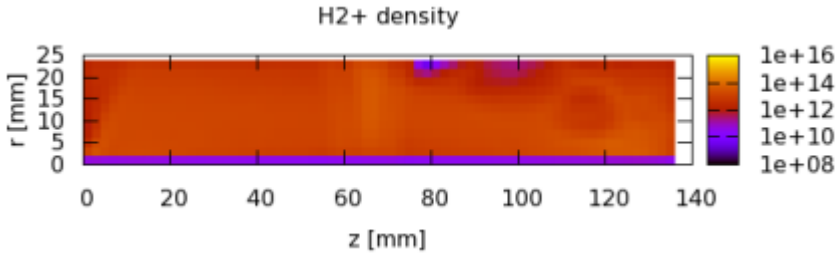


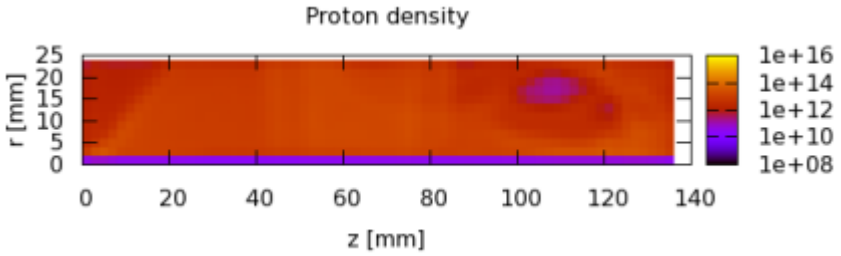

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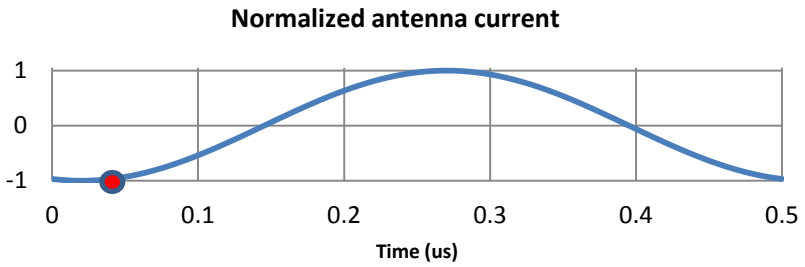


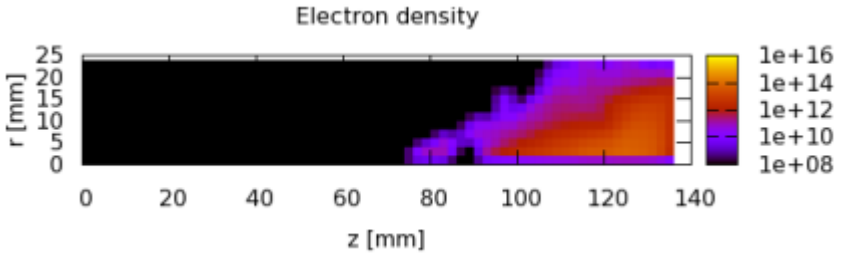


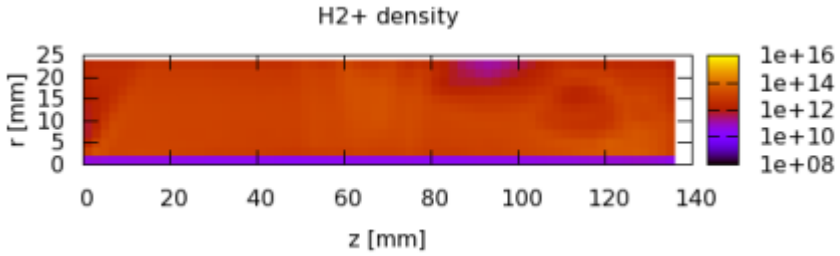


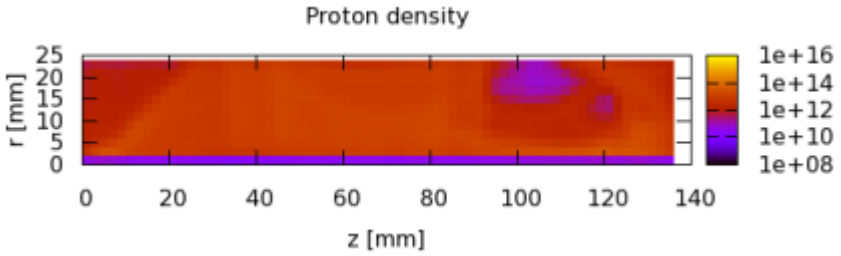

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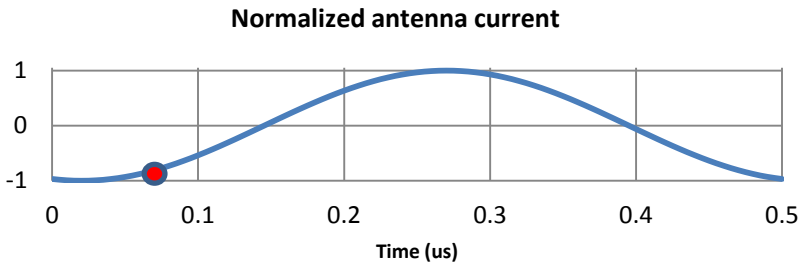


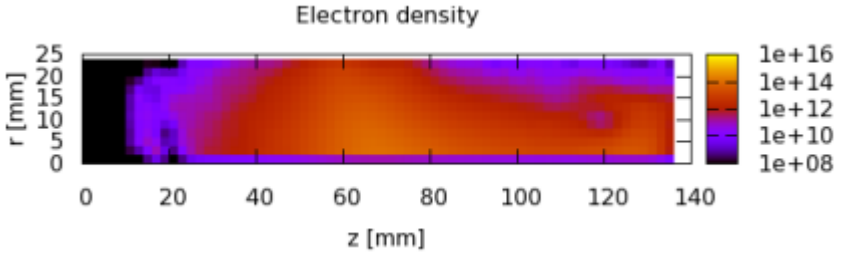


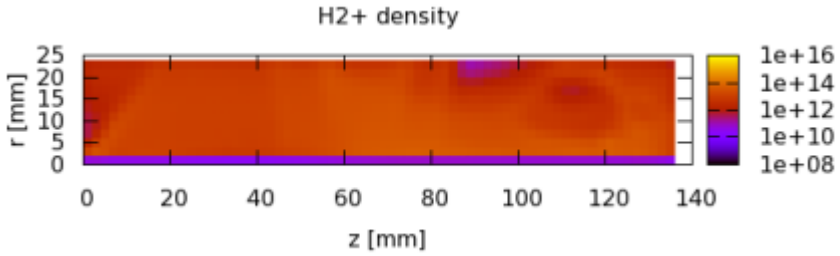


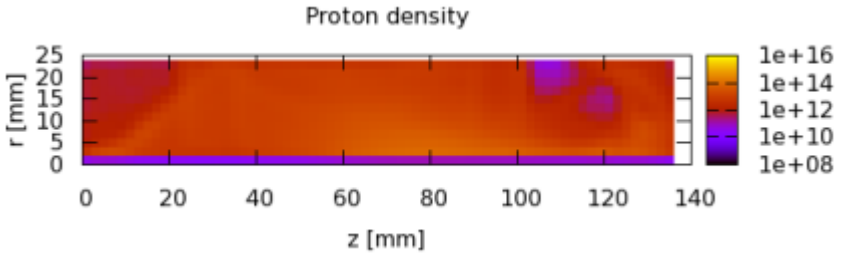

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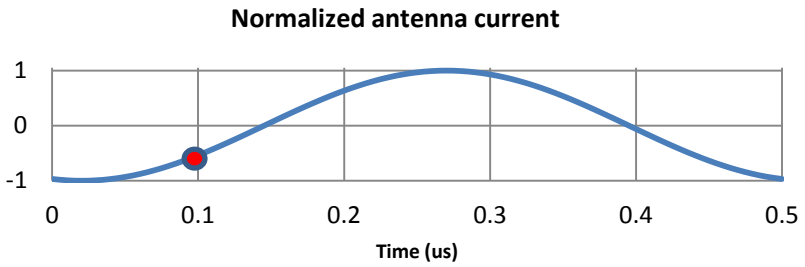
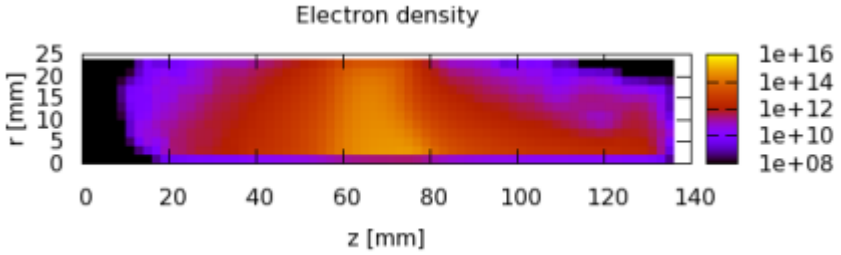
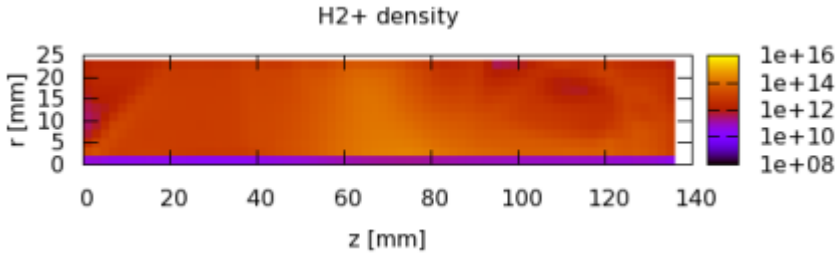
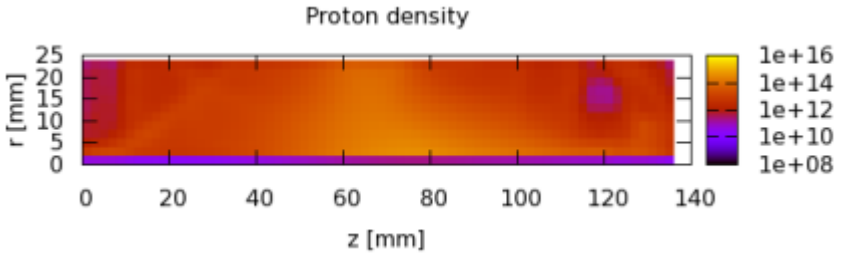


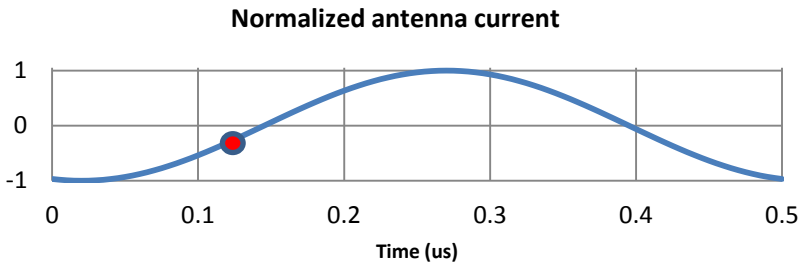



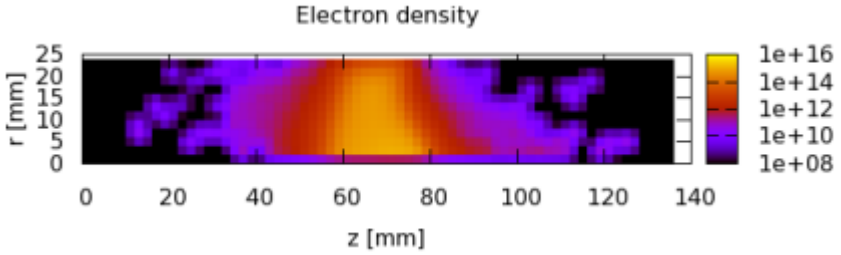



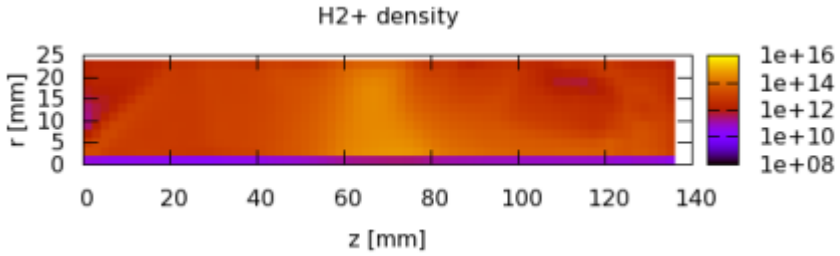



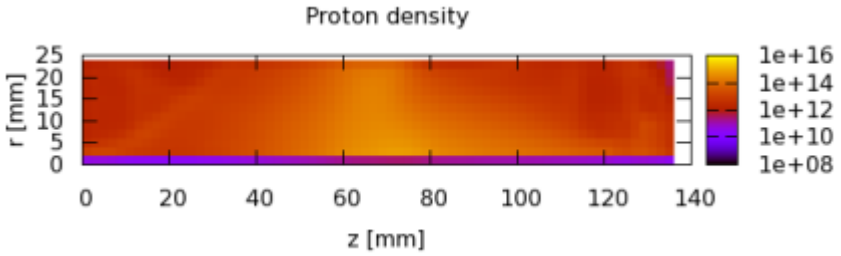
# Densities time evolution

## Simulating one micro second on 48 CPUs = 3 days



# Questions?