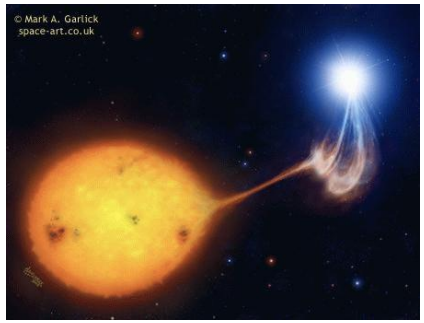


Generation of strong external magnetic field at LULI

Albertazzi Bruno

Magnetic meeting 23-24 April, Rochester

Outline

- Pulsed power system
- Coil able to generate up to 40 T B-field (two 5 mm diameter access)
- Coil able to generate up to 15 T B-field (three 1.1 cm diameter access)
- Perspectives

Motivation

Build a plateform able to generate **<u>strong external magnetic field (> 10 T)</u>**

Huge volume ($\geq cm^3$), constant over long time ($\geq \mu s$)

Motivation

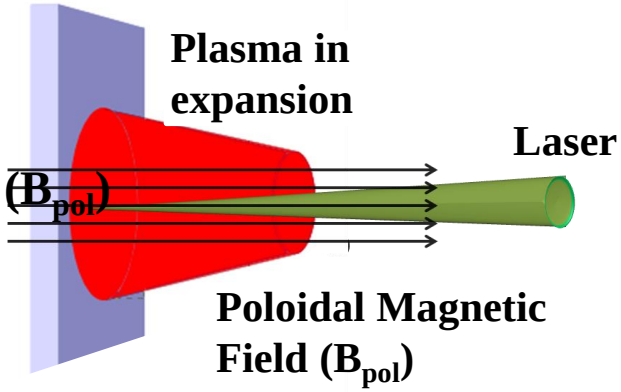
Build a plateform able to generate **strong external magnetic field (> 10 T)**

Huge volume ($\geq$ cm^3), constant over long time ($\geq$ µs)

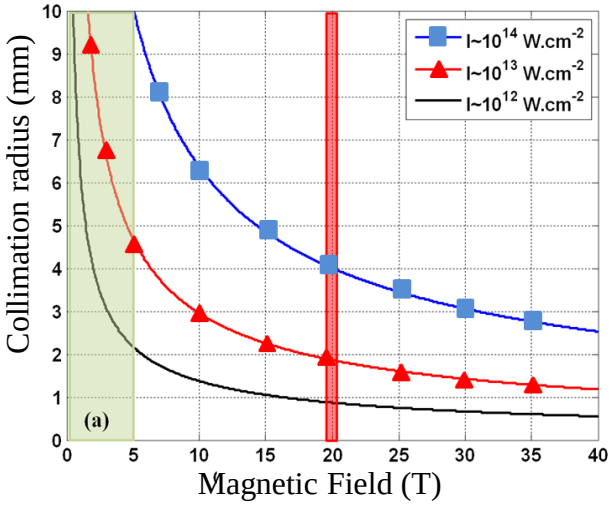
Spherical expansion stopped when σ ~ 1

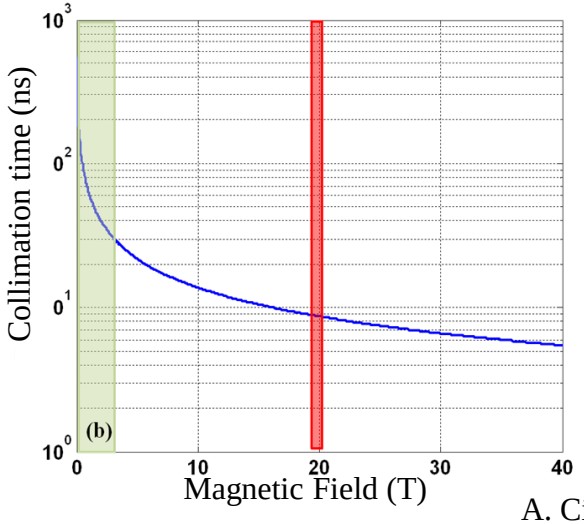
Collimation radius

$$R_{coll}(cm) \sim 0{,}8[f E_L / B_0^2]^{1/3}$$



Collimation time given by : $\tau_{coll} \sim R_{coll}/v_{exp}$ with $v_{exp} = 4{,}6.10^7\, I_{14}^{1/3} \lambda_{\mu m}^{2/3}\ (cm.s^{-1})$





To magnetically collimate a jetlike flow with radius of few mm, B > 10 T applied for t > 10 ns

A. Ciardi et al., Phys. Rev. Lett 110, 025002 (2013)

Our method

High current Generation :

- Build by HZDR

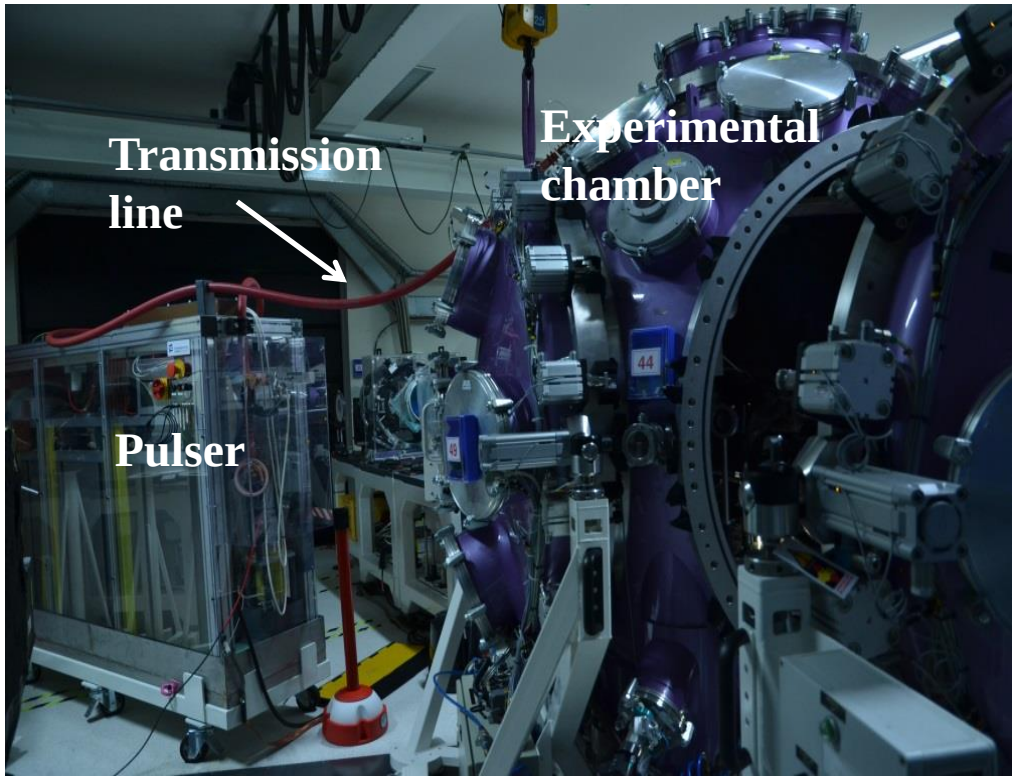
- 250 kA maximum

- Available energy : 32 kJ

- Short rise time(~µs)

- Ignitron switch

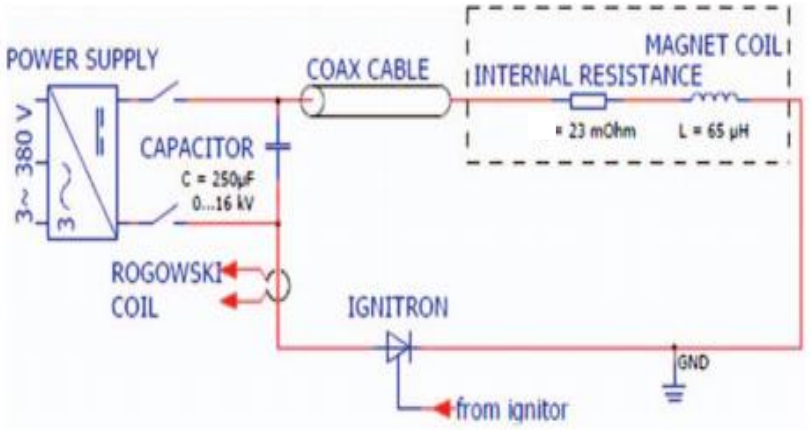
Pulsed power system @ LULI



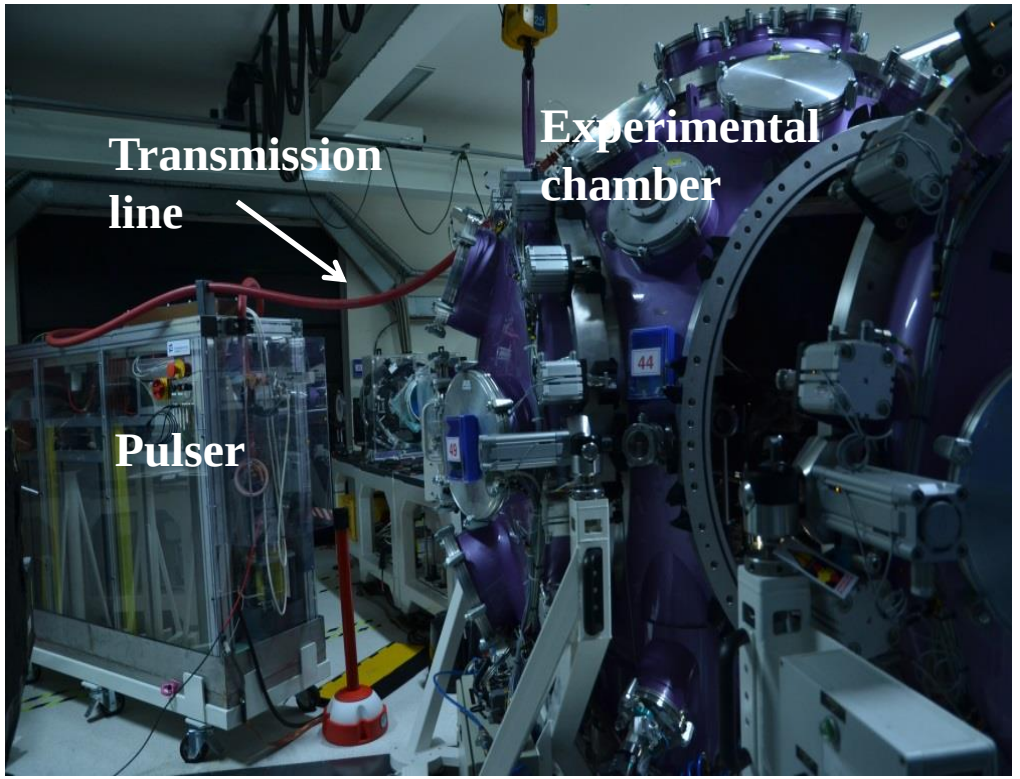
[B. Albertazzi et al., Rev. Sci. Instru 84, 043505 (2013)]

Patent: Device for magnetising laser plasma by means of a pulsed magnetic field

Our method



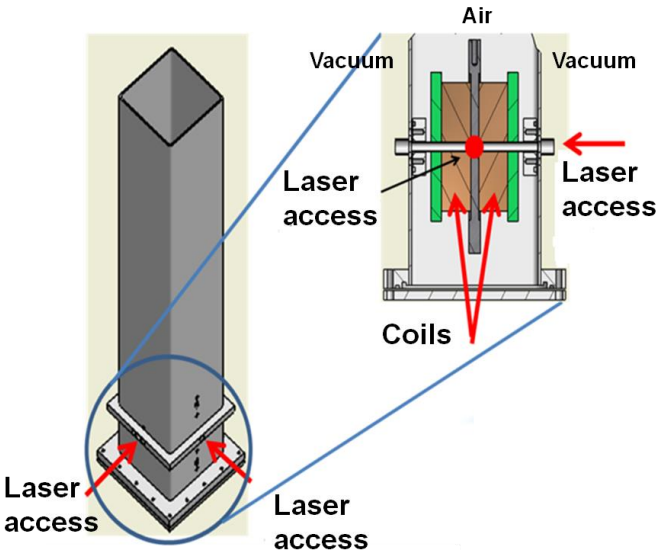
Pulsed power system @ LULI

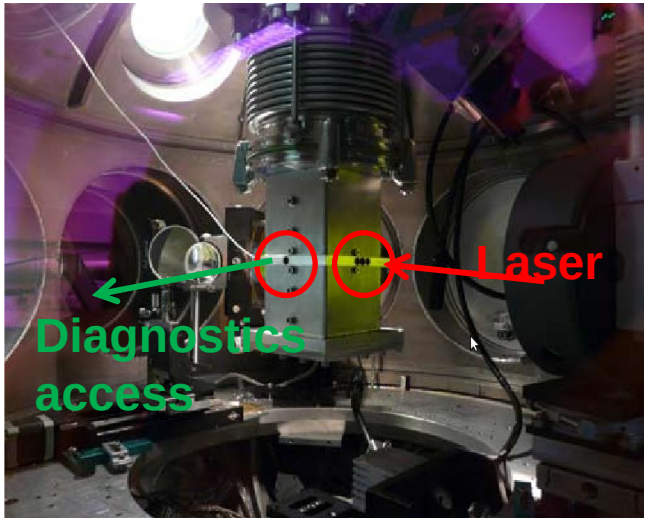


[B. Albertazzi et al., Rev. Sci. Instru 84, 043505 (2013)]

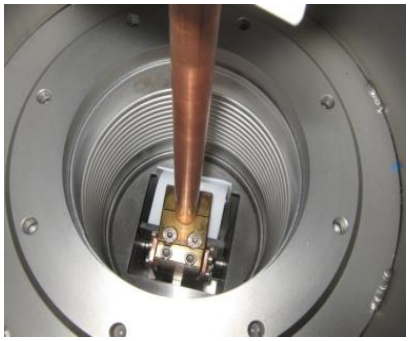
Patent: Device for magnetising laser plasma by means of a pulsed magnetic field

Coil developed by the LNCMI





Top view



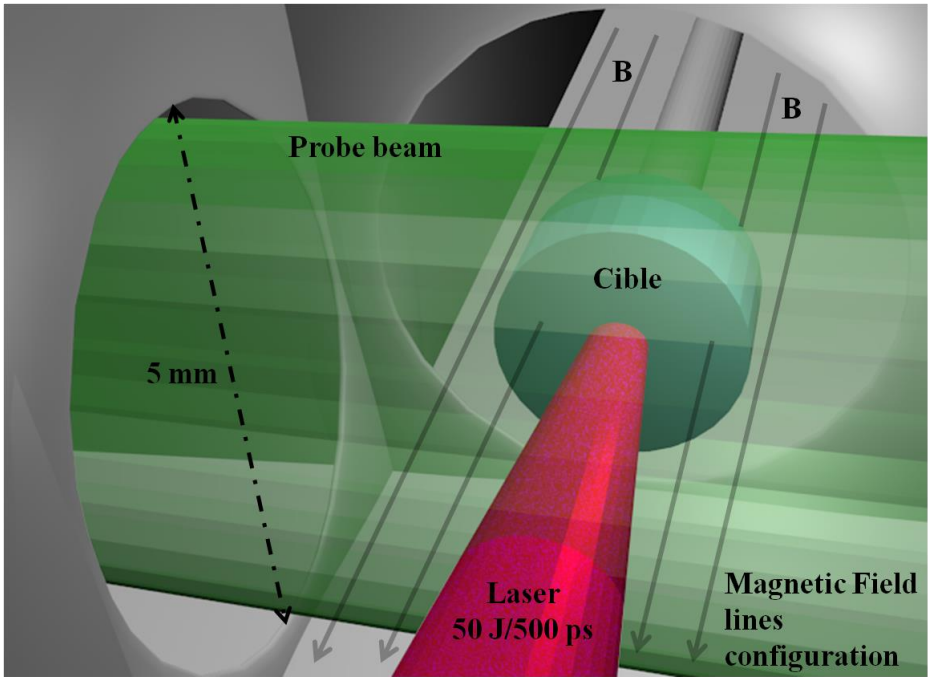
Our Method implies :

- **Coil in air : NO DEBRIS**
- **Reduced thermal load**
- **Drastic diminution of risks of arcing between experimental chamber and transmission line**

[B. Albertazzi et al., Rev. Sci. Instru 84, 043505 (2013)]

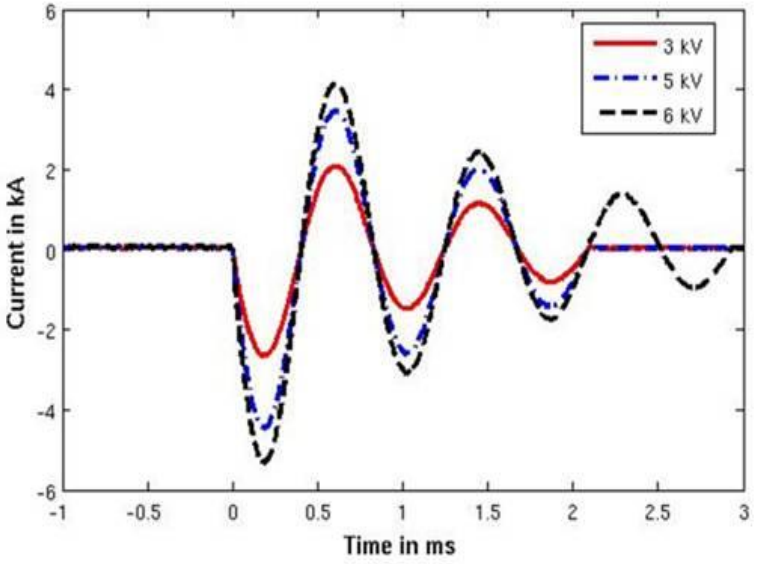
Coil developed by the LNCMI

- 2 access of 5 mm diameter:
  Laser and diagnostics
- Magnetic field up to 40 T
- Constant in a huge volume (cm^3)
- Easily synchronisable with the laser

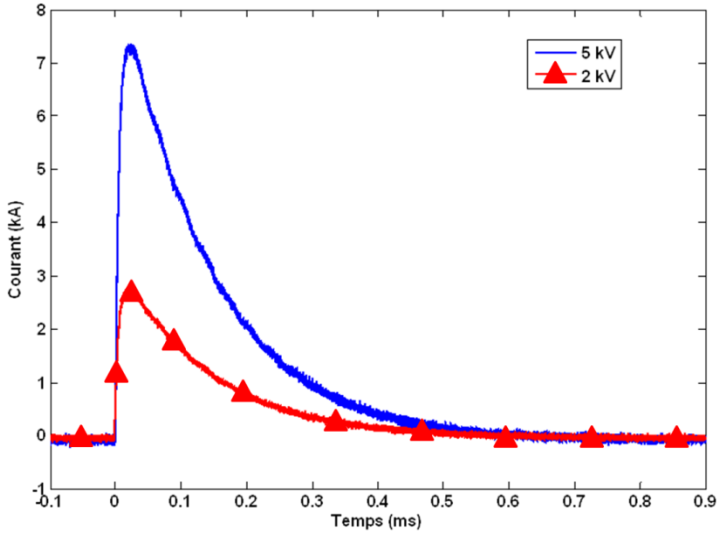


Coil developed by the LNCMI

Discharge without current limiter

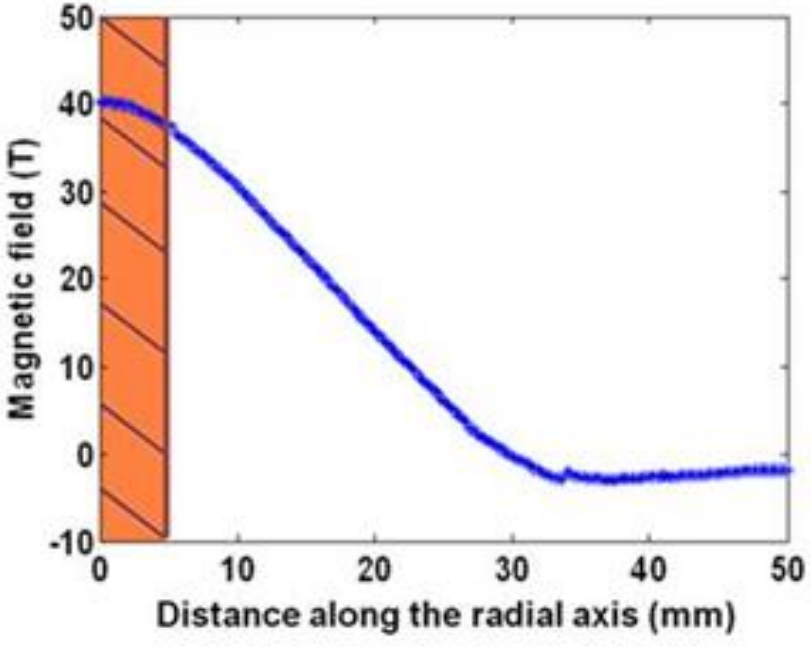


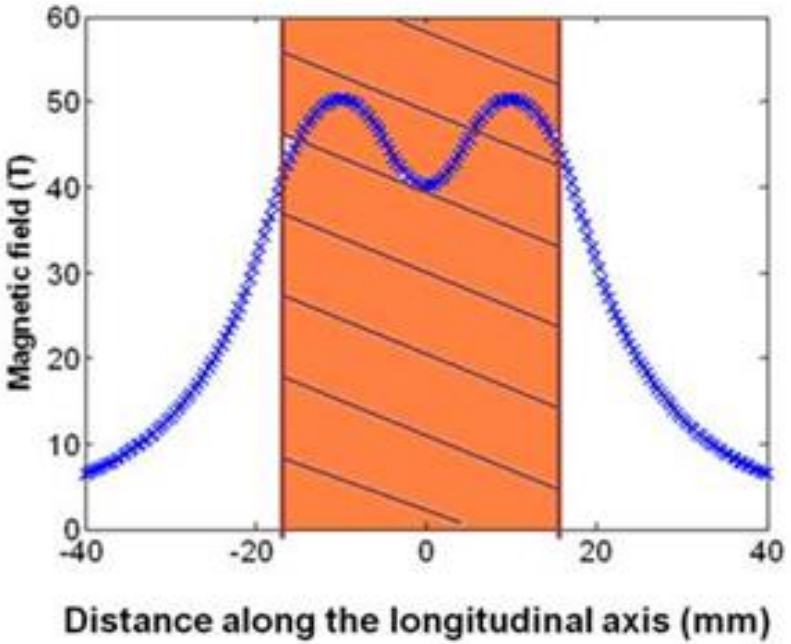
Discharge with current limiter



Rise time to first peak : ~ 176 µs
I/B~300 A/T, for 40 T ➔ I_{max}~ 12 kA

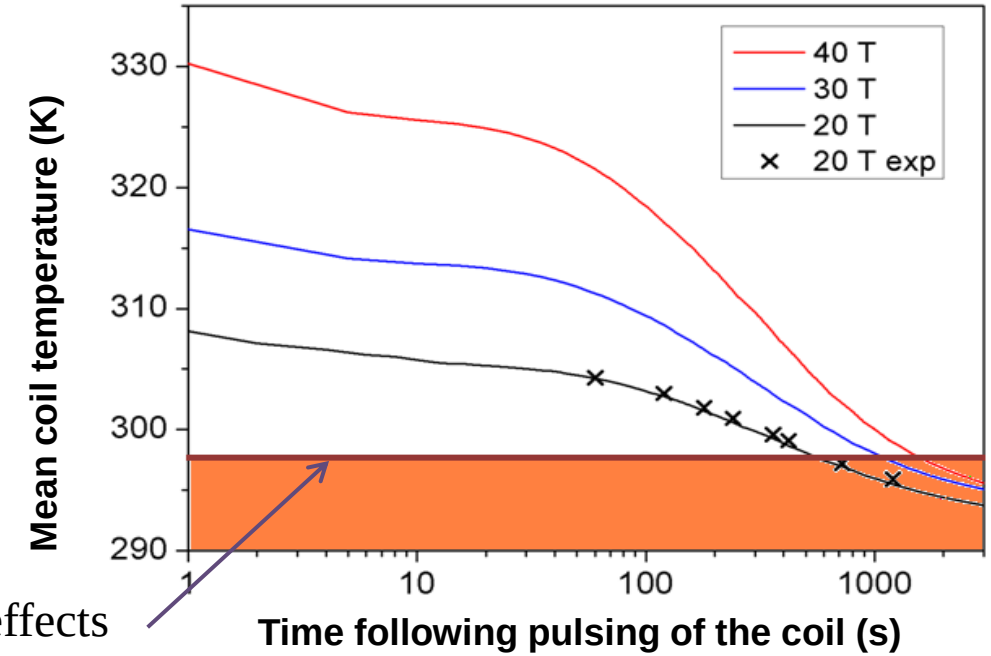
Coil developed by the LNCMI





Coil developed by the LNCMI

Evaluation of the repetition rate in an experimental manner at 20 T and comparison with theoretical calculations :



avoid cumulative effects

Repetion rate of the order of 10-15 min at 20 T and of 30-45 min at 40 T : compatible with High powers Laser Facility

Conclusion

- Magnetic field up to 40 T
- Constant in a huge volume (cm^3)
- Constant in time (> 5 μs), with less than 2% variation

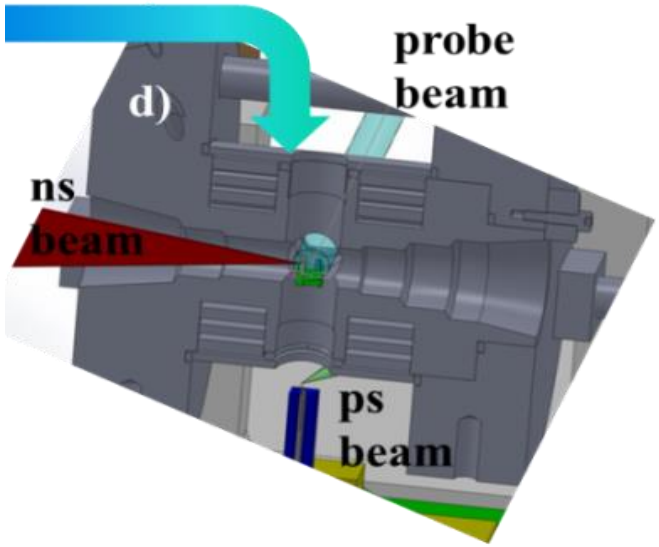
However:

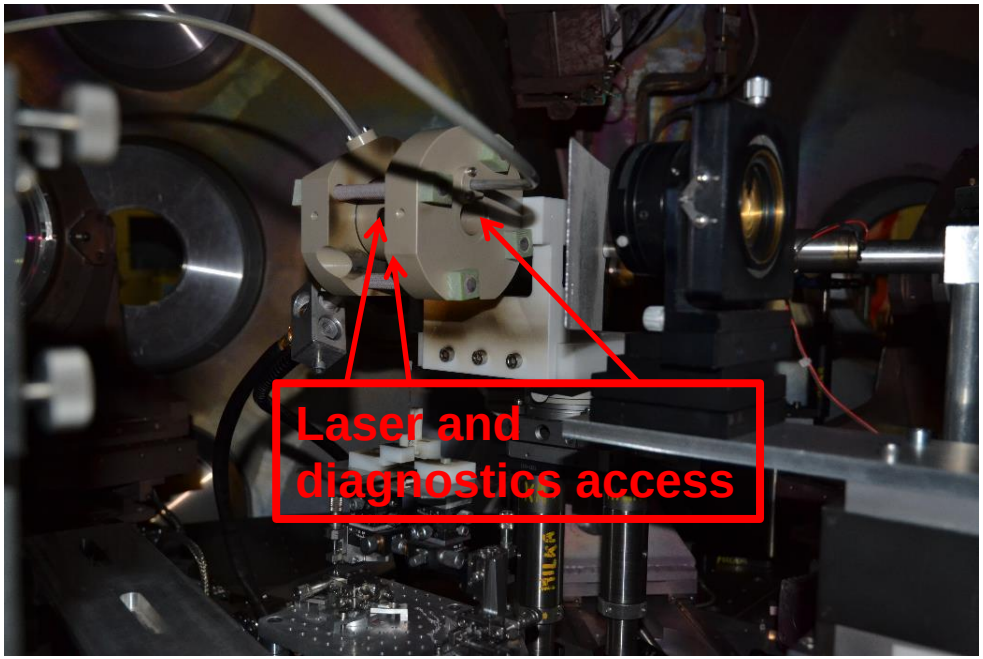
Restriction about access to the plasma

Coil developed by the HZDR

HZDR
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

Inside the coil



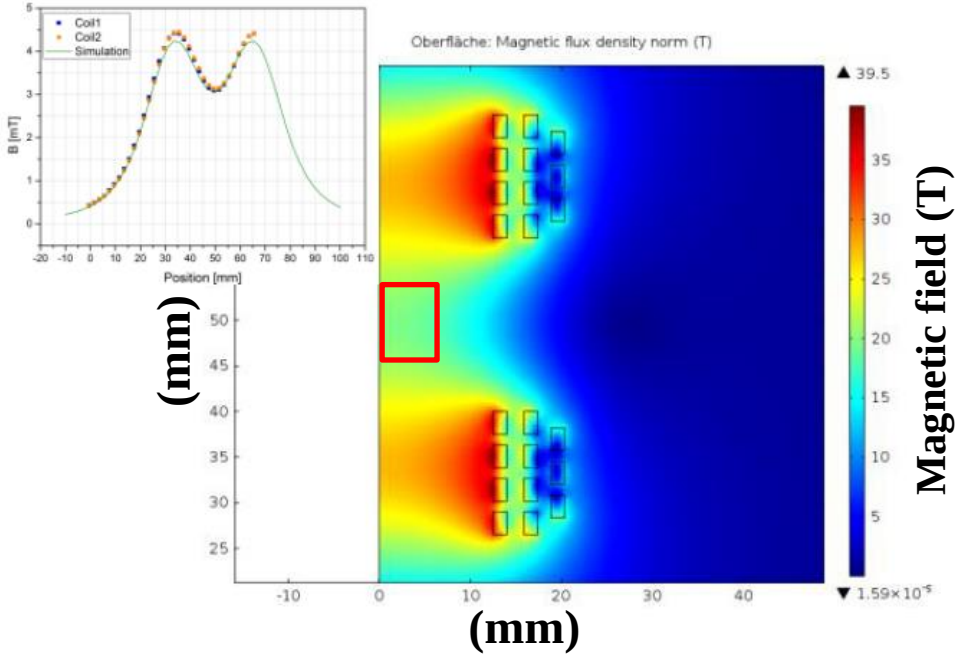


- 3 access of 1 cm diameter
- Magnetic field up to 15 T (will be improved for future experiments)
- Constant in a huge volume (> cm^3)
- Easily synchronisable with the laser

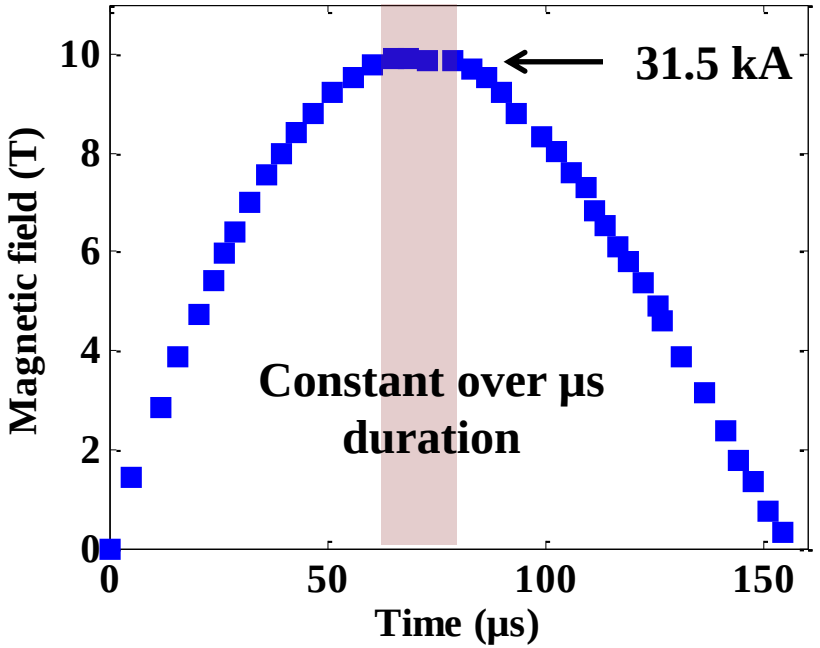
Coil developed by the HZDR

HZDR
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

Simulation of the coil



Rogowski measurement



Constant volume > 1cm^3
Constant over 10s of µs duration

Conclusion

- Magnetic field up to 15 T (will be improved)
- Constant in a huge volume (cm^3)
- Constant in time (> 20 µs), with less than 2% variation
- More access for laser and diagnostics ➔ X-ray radiography coupled with optical diagnostics

Perspectives

- Increase the available energy of the pulse power system:
  - ➔ Design of the coil less restrictive

- Developmnent of a coil allowing to have a transverse magnetic field (20 T) compared to the drive laser axis together with the x-ray radiography (HZDR collaboration)

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