Adrian Fabich

High Power Proton Beam Shocks and Magnetohydrodynamics of a Mercury Jet Target for a Neutrino Factory (thesis)

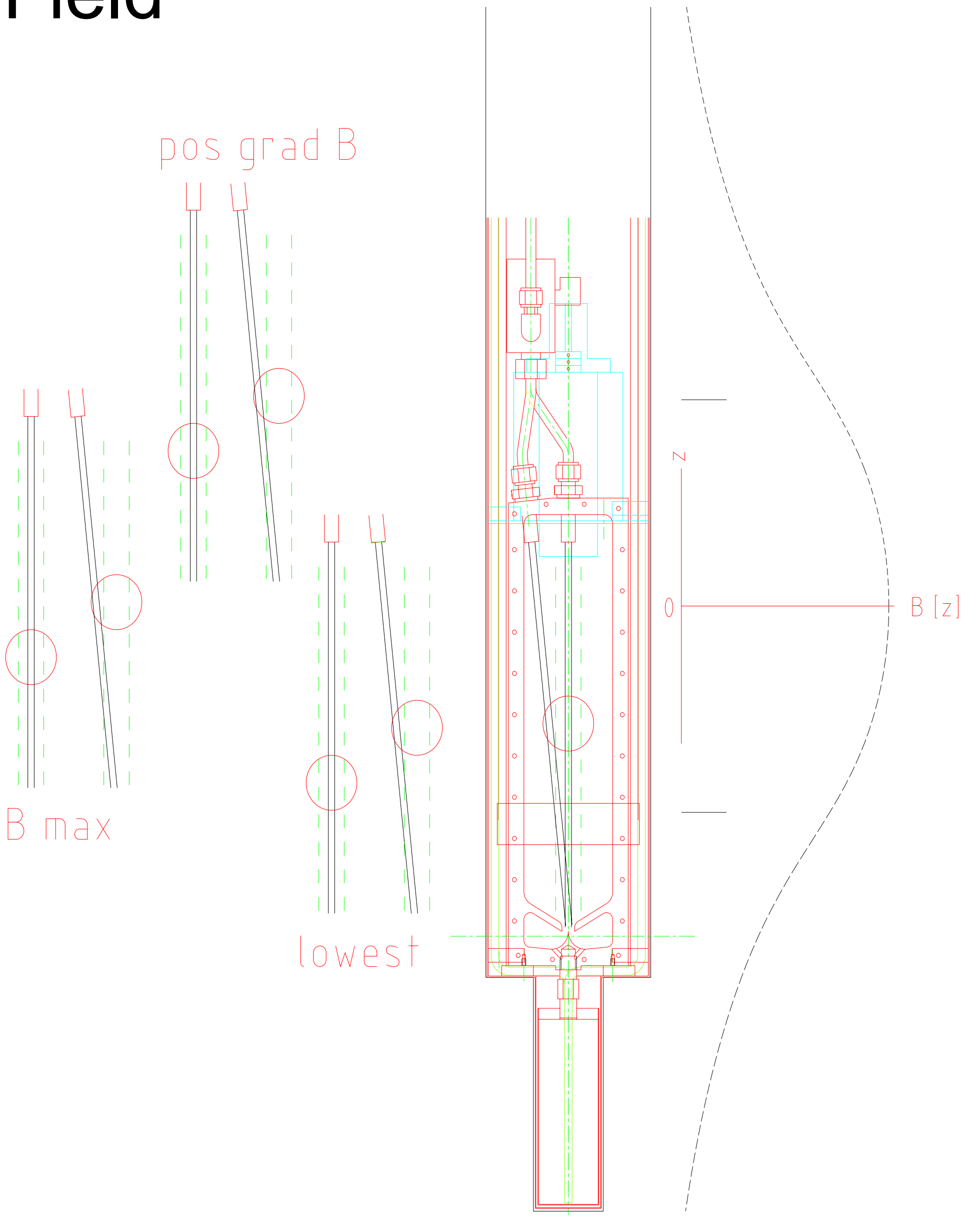
Chapter 4: **MHD**

Contents of Thesis

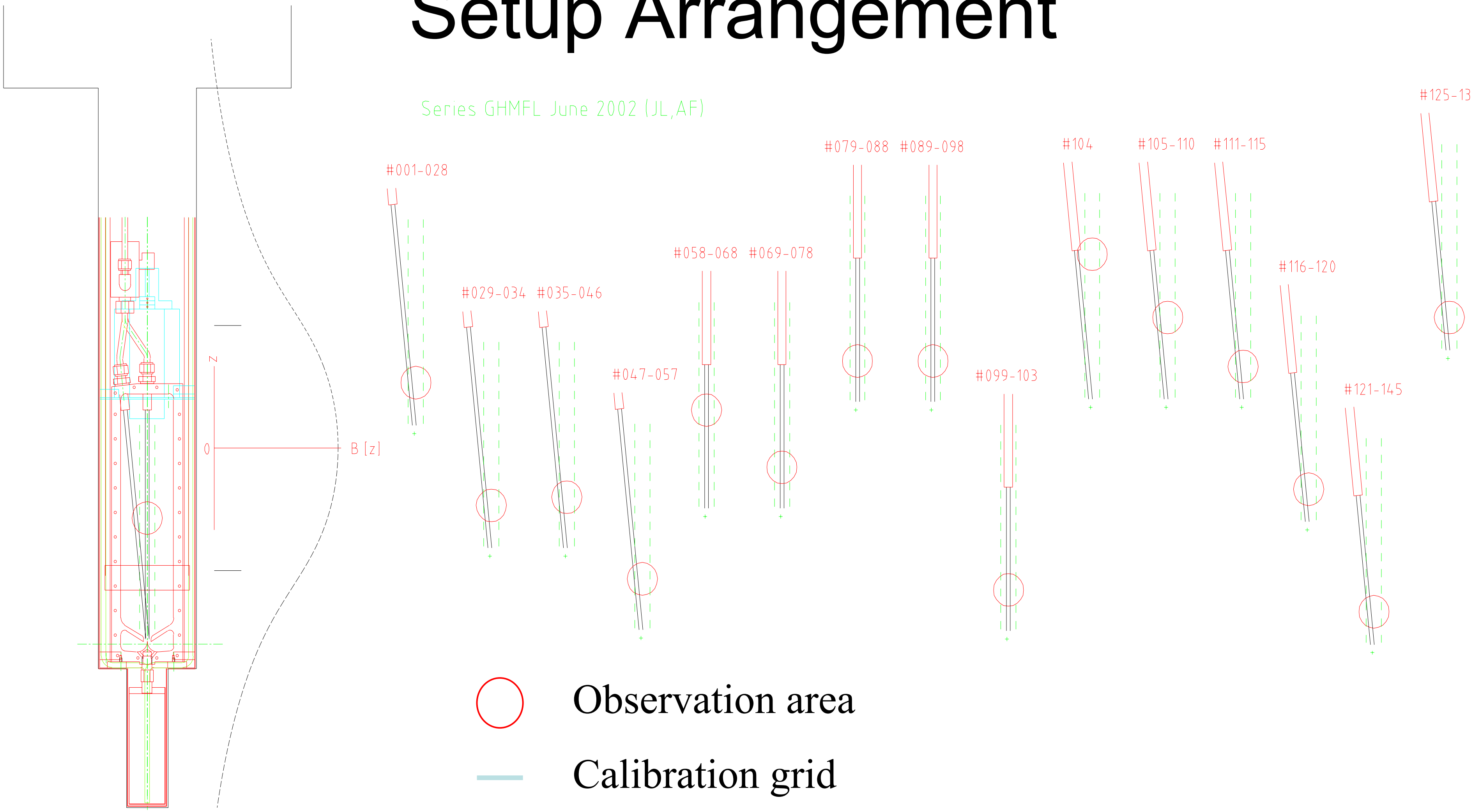
- Introduction
  - application of high power proton beams
  - Neutrino factory
  - layouts for high power beam targets
- Proton induced shocks
  - See previous presentations
- MHD
  - Setup (see also http://puhep1.princeton.edu/mumu/target/, Aug02)
  - Behaviour (v, ∅, α, smoothing) of jet as f(B) $\Rightarrow$

Grenoble High Magnetic Field laboratory (setup)

- mercury jet
- d_{nozzle}=4 mm
- colinear/inclined injection
- $v_{jet} \leq 12$ m/s
- B-field up to 20 Tesla



Setup Arrangement



Observation area

Calibration grid

nozzle

Ideal mercury jet

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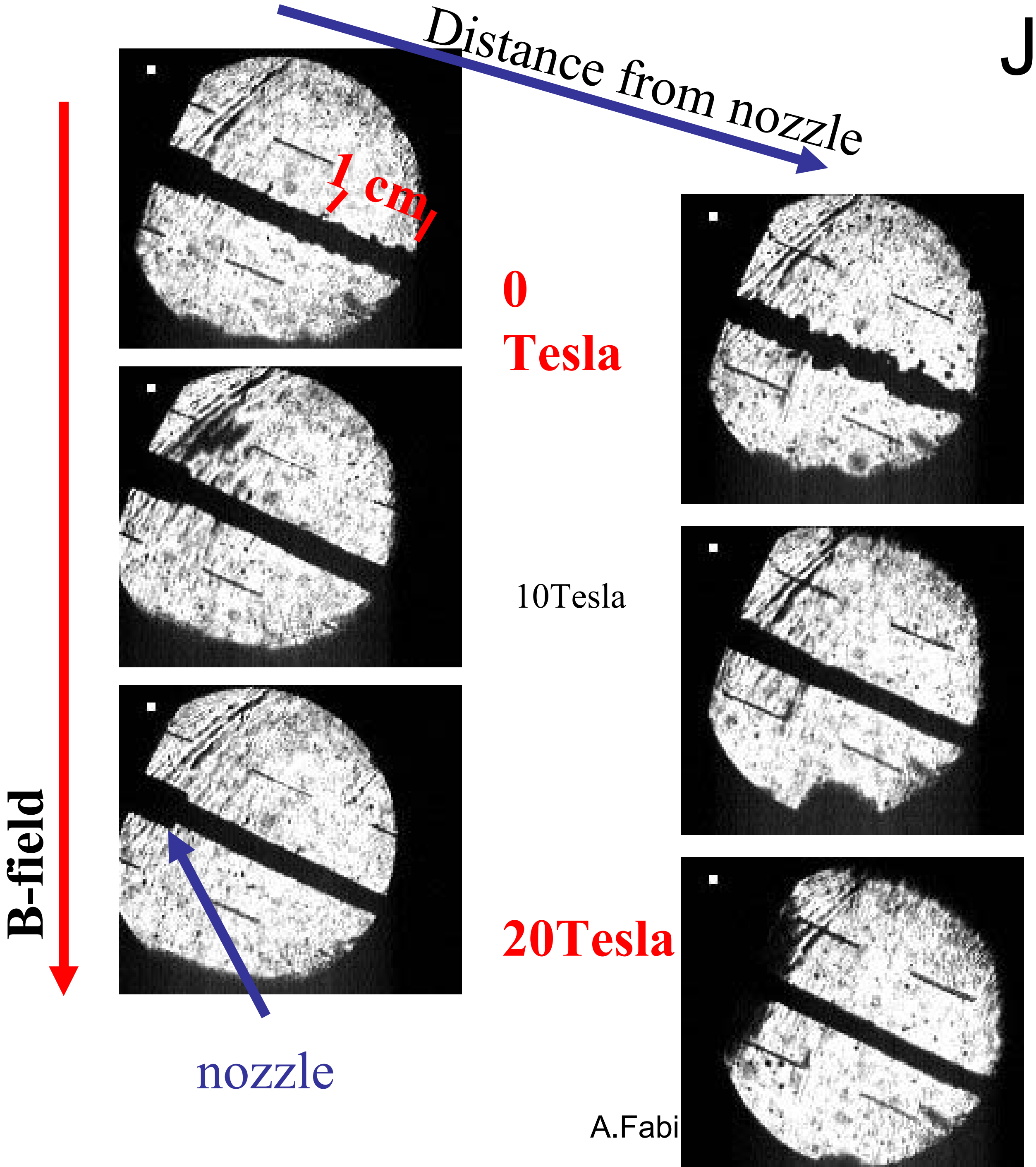
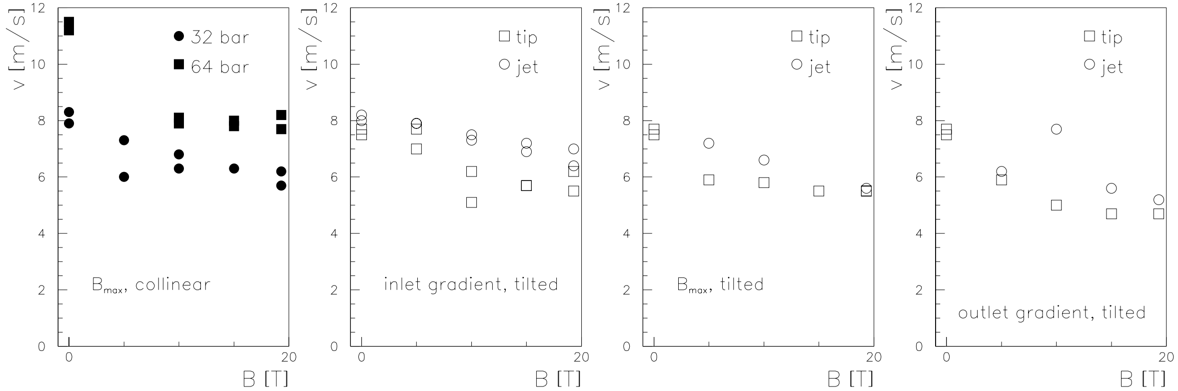
Jet traverses B_{max}



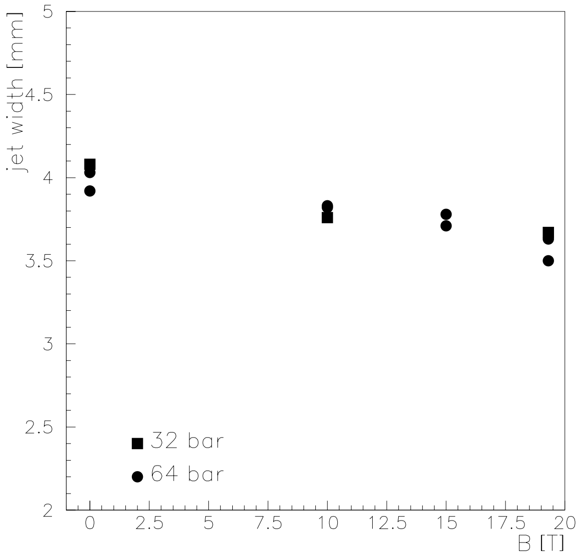
This **qualitative behaviour** can be observed **in all events**.

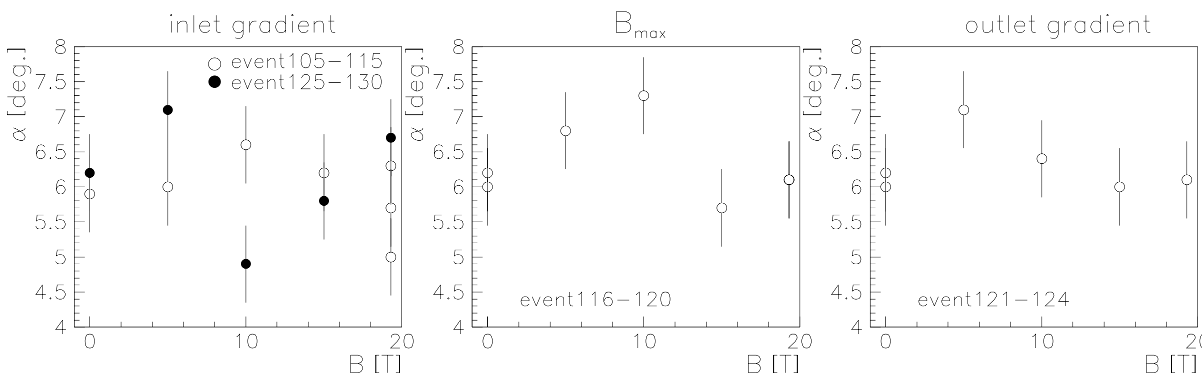
Numerical Results

velocity



Jet diameter





deflection

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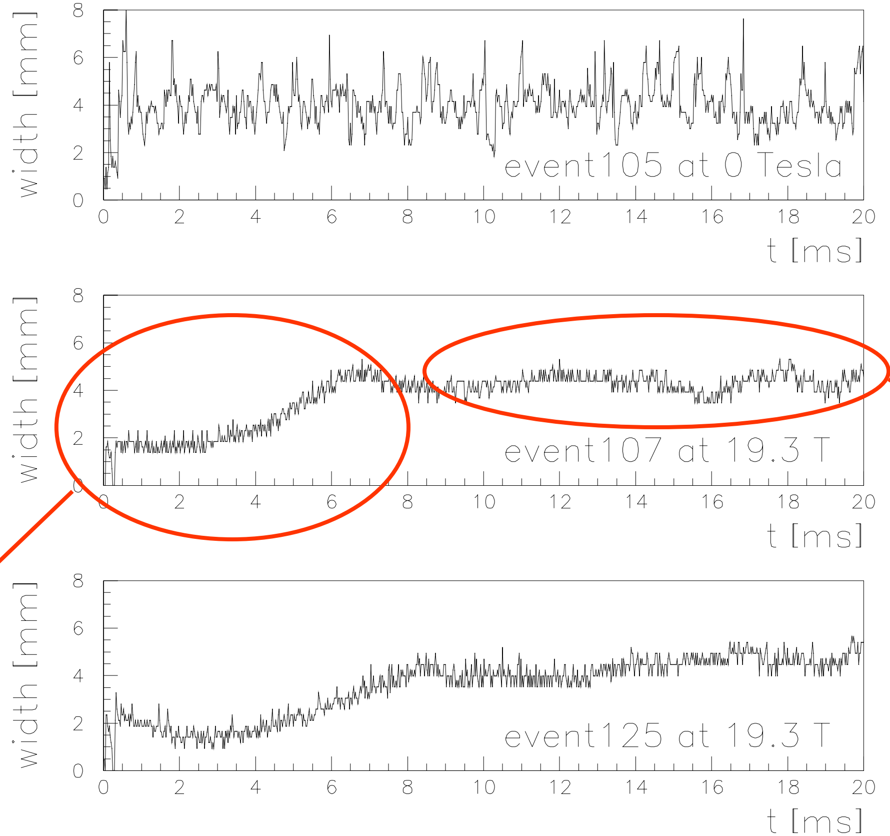
Stabilizing



Jet smoothing

Tip shaping

Variation of amplitude in the order of resolution

$\Rightarrow$ Problem for velocity determination

BUT …

- Effect is somehow correlated with position of valve in magnetic field

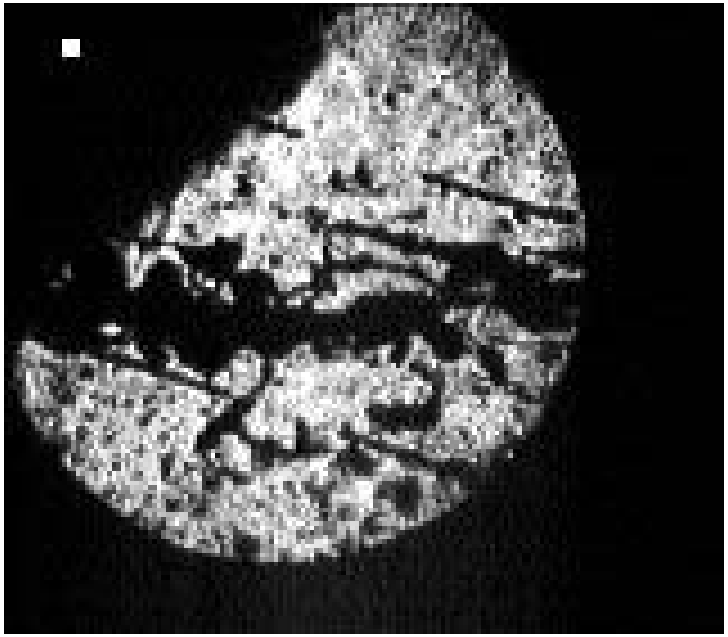
- WIDTH is NOT a function along jet
  - This means already at nozzle the jet is smaller and does not decrease with drift

- Stabilizing did not occur for turbulent simulation with "short" nozzle

- Numerical results larger than MHD of free jet

Turbulent Jet

- Using “short” nozzle
  – Magnetic field could NOT stabilize the jet



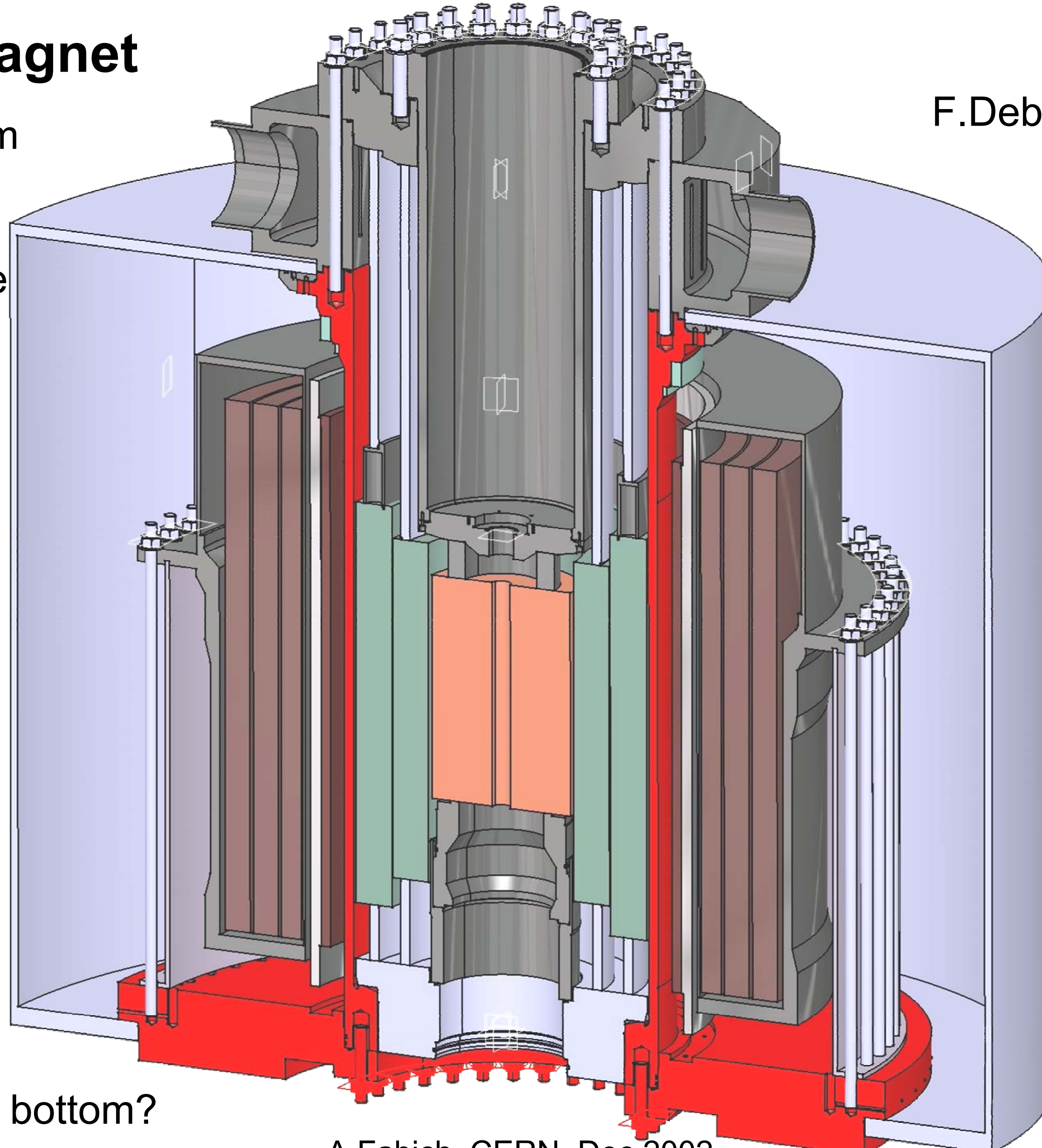
Hybrid Magnet

Available from
spring 2003

40 cm bore

17 Tesla

F.Debray, GHMFL



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Bore:

Vertical

?dead end at bottom?

We need SPACE to put in

- mercury jet (∅ 1cm, v=20m/s)
- mercury loop/reservoir (dead end bore)
- read-out

$$\Rightarrow \quad \varnothing_{\textbf{hybrid magnet}} = \mathbf{2 \times} \varnothing_{\textbf{used M9}}$$

What kind of read-out?

- optical
- radar
- laser vibrometer

Summary

Major MHD effects occur in confined circuit

- Can be overcome by resizing mercury supply

- Who is able to make a nominal jet???
  - Needs money and MAN POWER
    - otherwise it is useless to ask for further magnet time