Induction in the VKS2 experiment

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VK dynamos

VKS1

VKS2

Setup

Uniform B_0

Localized B_0

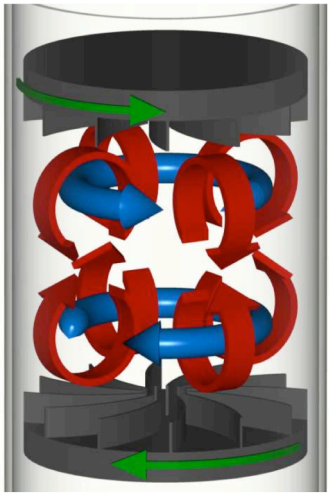
Conclusions

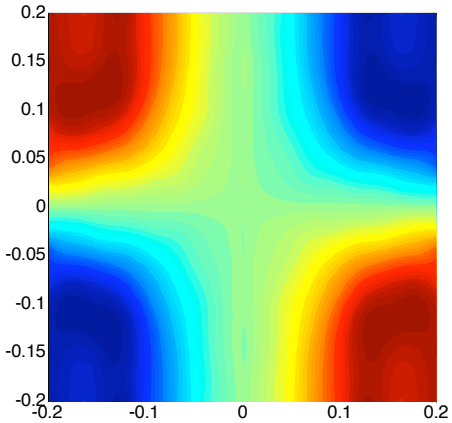
Fluctuations

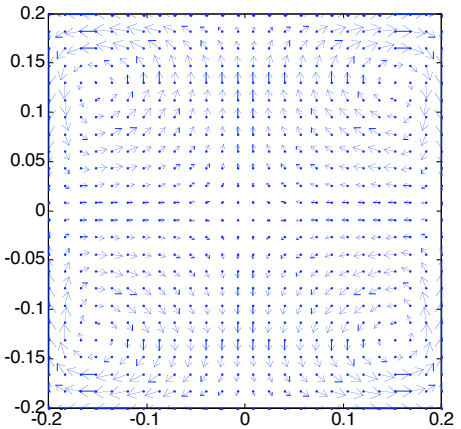
α and β

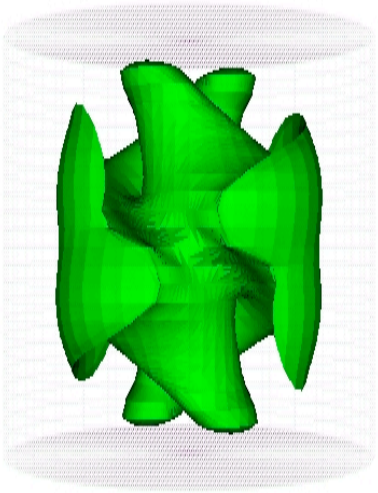
Next step

Dynamo and VK-flow









- Inductions ingredients: diff Rot, helicity
  Moffat, Cambridge UP, (1978)
- Kinematic dynamo simulation
  Duddley James, Proc. R. Soc. Lond. **A425** (1989)
  Marié et al., *Eur. Phys. J* **B33** (2003)
- DNS (P_m=1 down to 0.01)
  Nore et al., *Phys. Plasmas*, **4**, (1997)
  Ponty et al., *PRL* **94** (2005)

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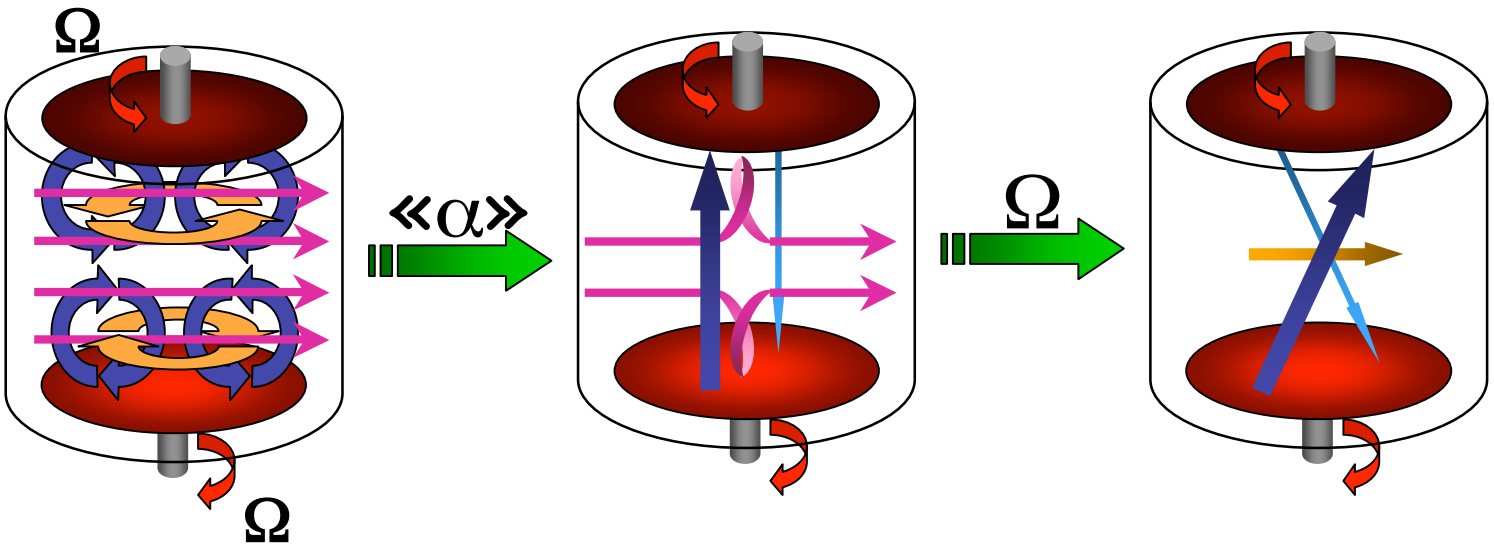
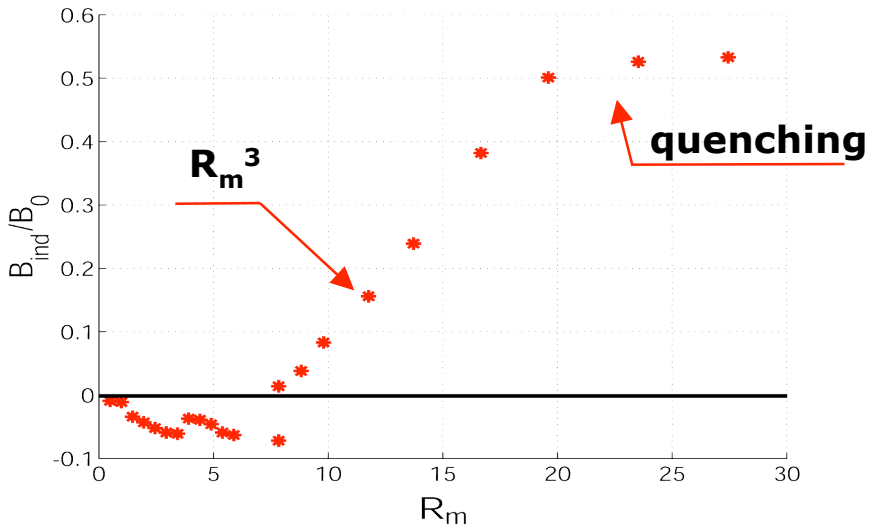
VKS1 induction mechanisms



Phys. Fluids **16**, 2529 (2004)
Phys. Rev. Lett. **90**, 174501, (2003)
Phys. Fluids **14**, 3046 (2001).

B_i // B_0



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VKS1 to VKS2

- Induction engineering

  Mean flow strategy
  Water prototype measurements
  Kinematic simulation

- Turbulence

  Help from numerics (cf. Y. Ponty's talk)

- Experiment

  Redesign inner vessel
  Increase volume and cooling capacity
  Increase power input

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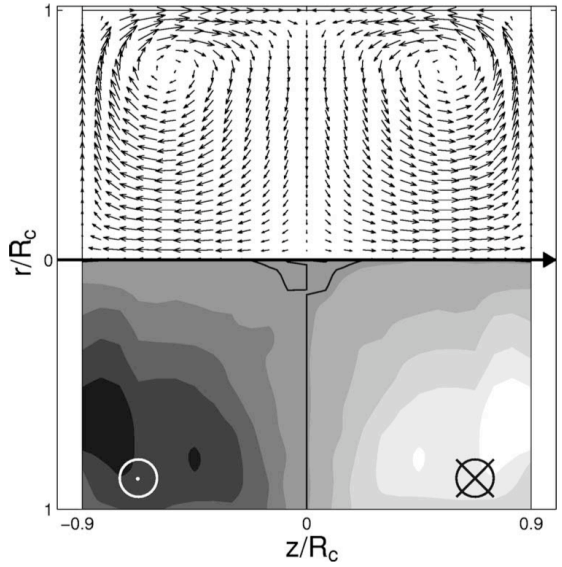
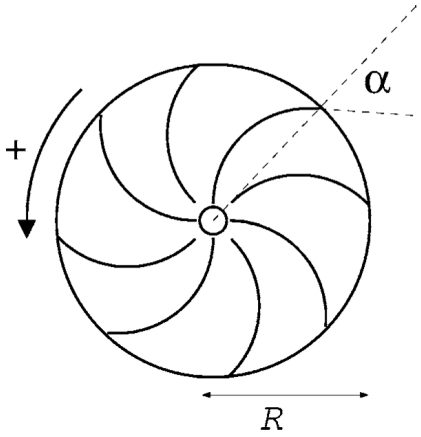
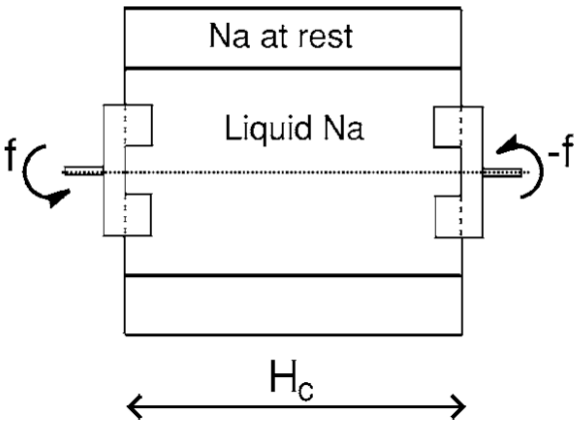
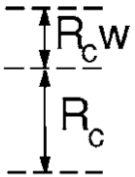
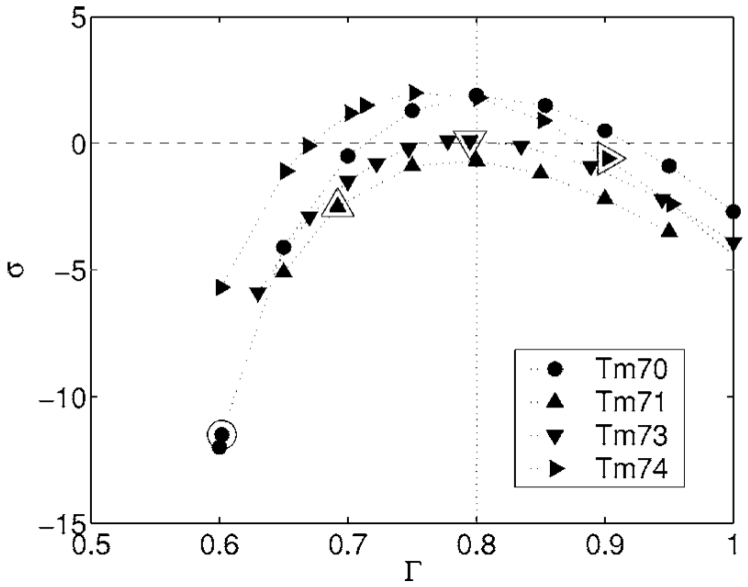
Induction - engineering / optimization











Ravelet et al., *Phys. Fludis* **17**, 117104 (2005)

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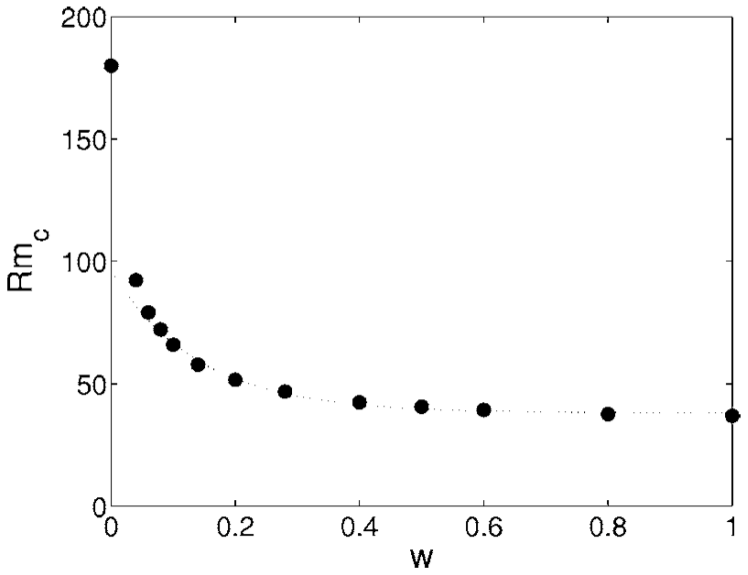

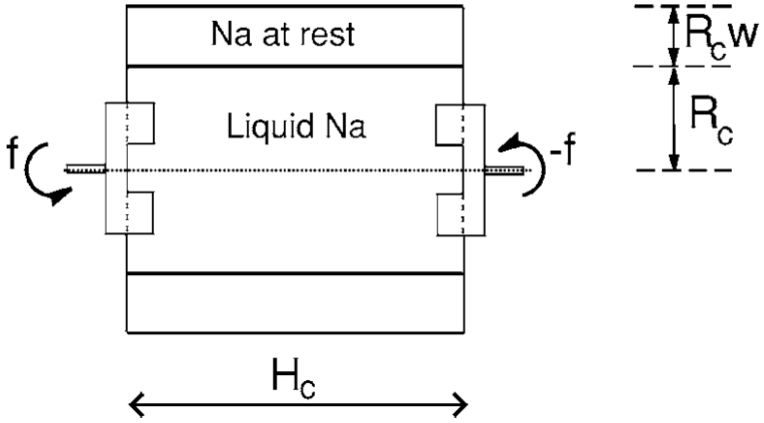

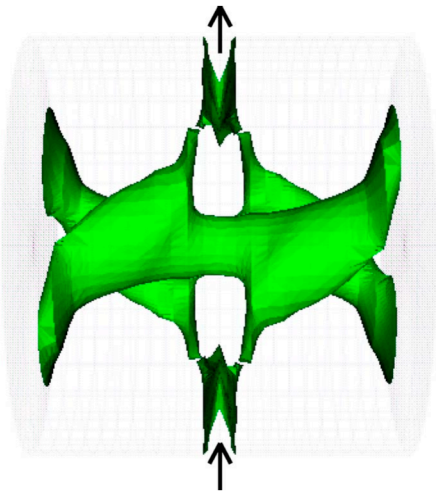

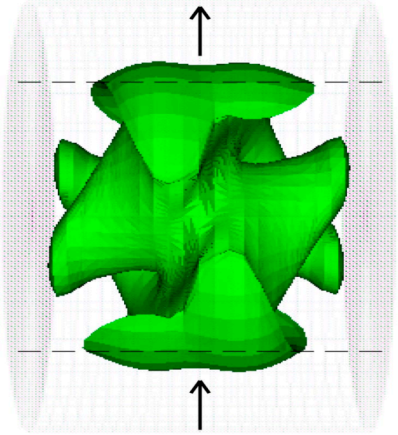

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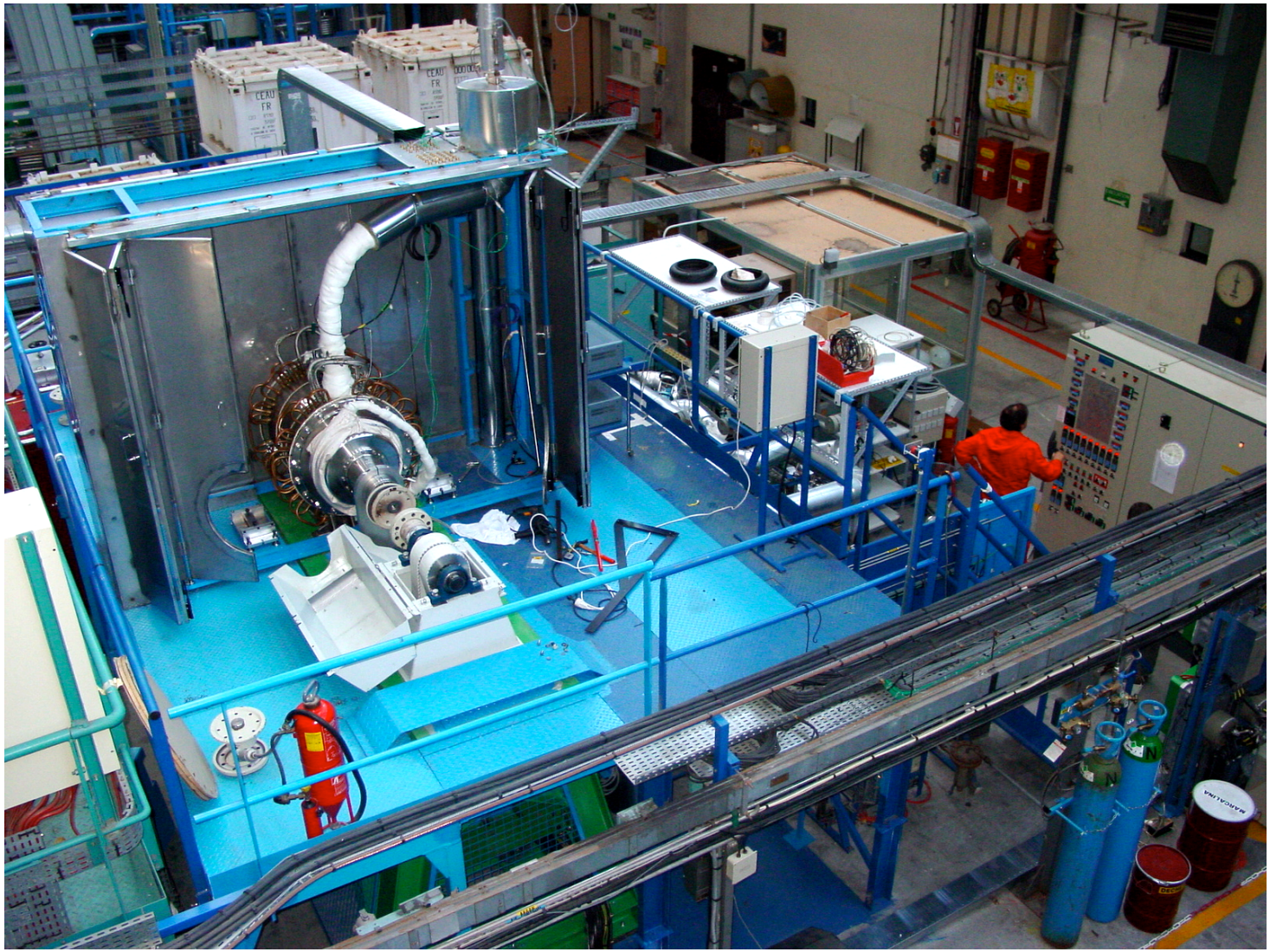

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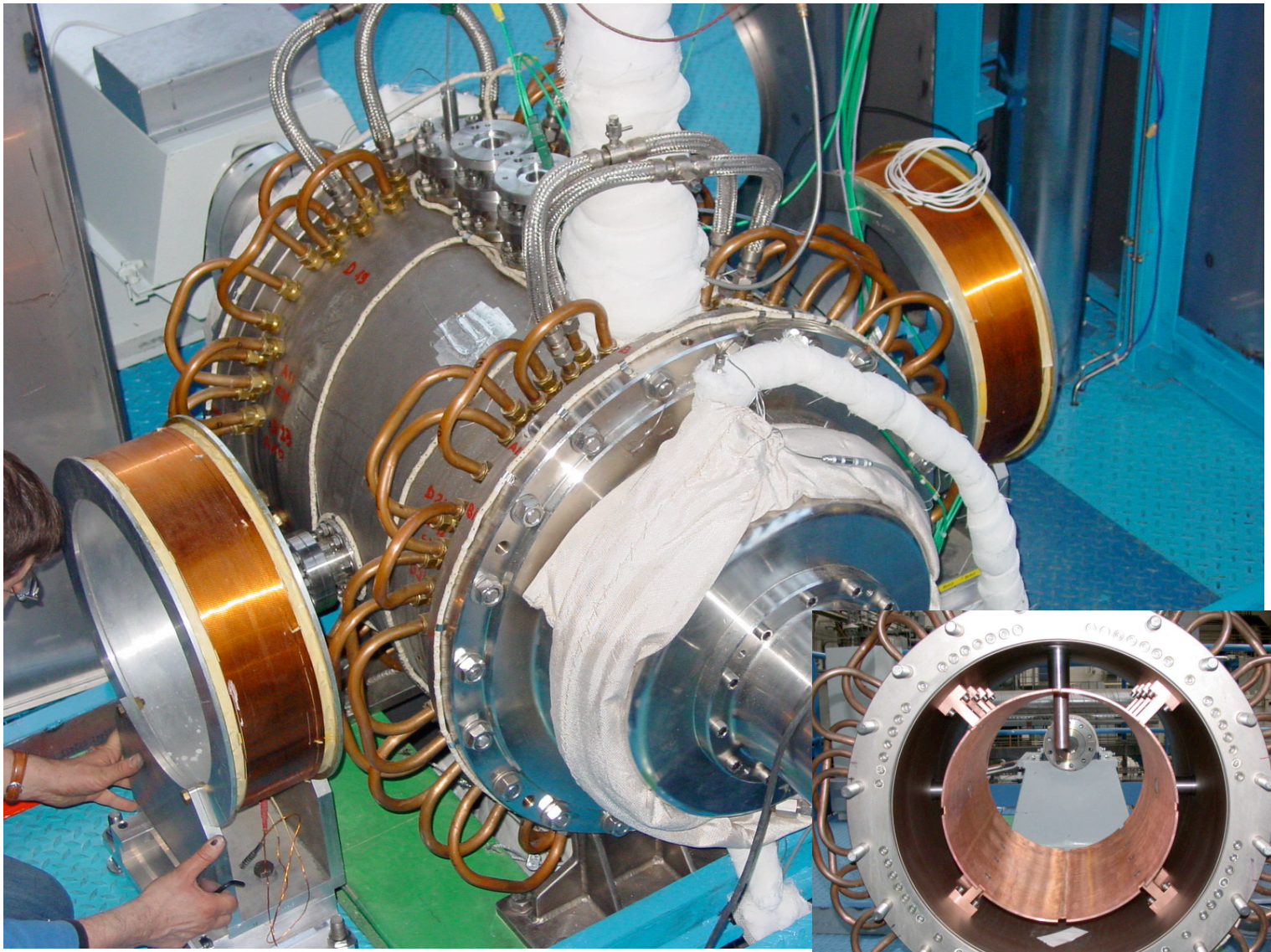

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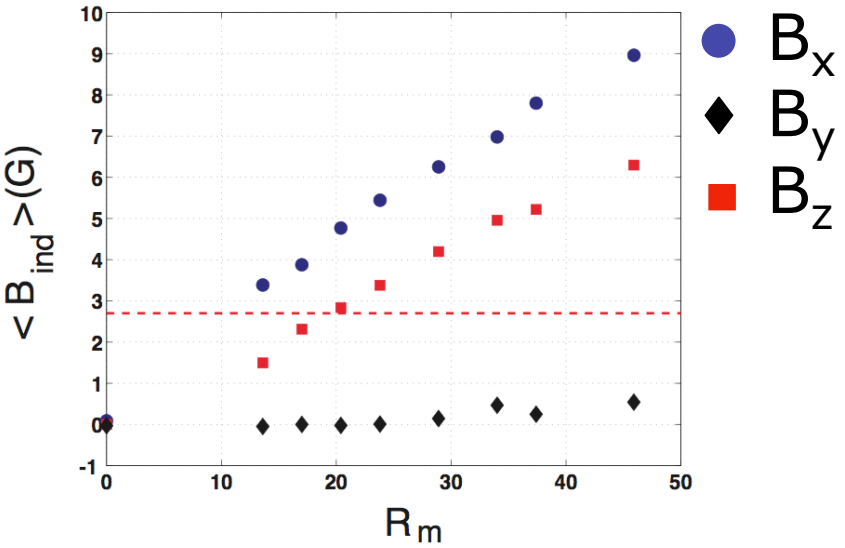
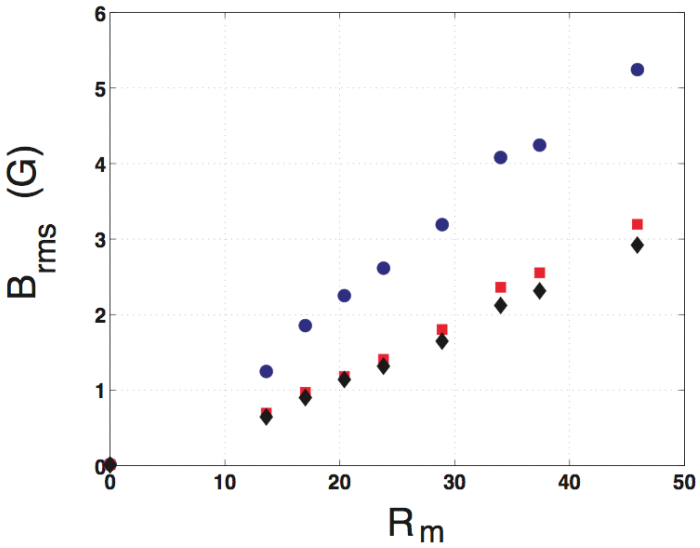
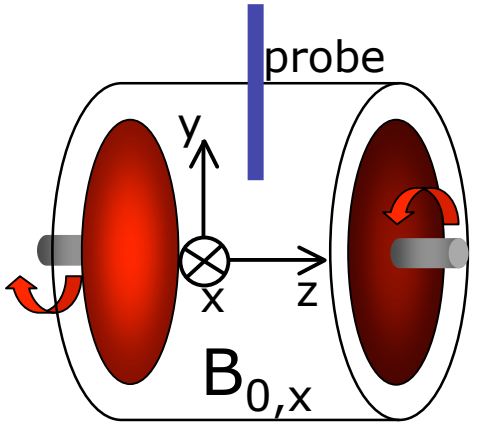
VKS2a : response to a transverse applied field





- linear …
- $\langle B_{\text{induced}} \rangle > B_0$
- $B_{rms} \simeq \langle B_{\text{induced}} \rangle$



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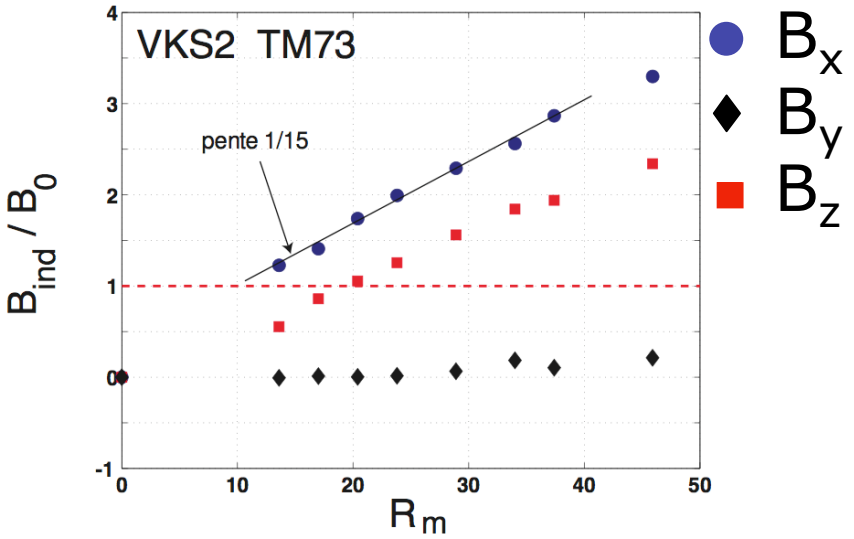
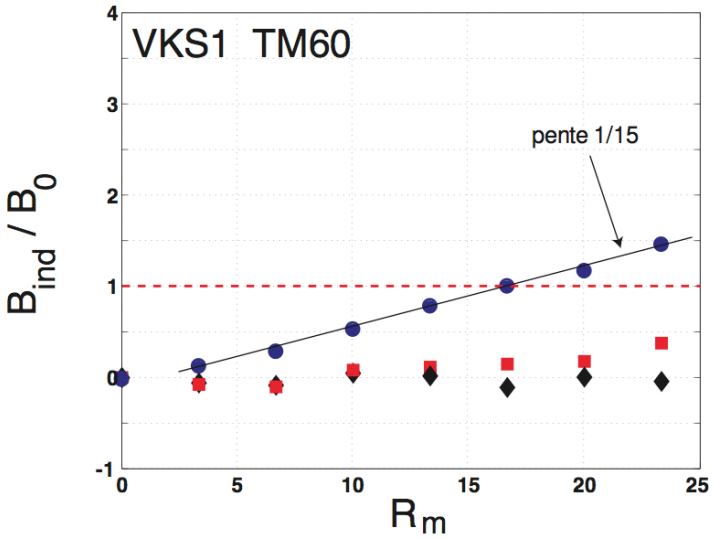
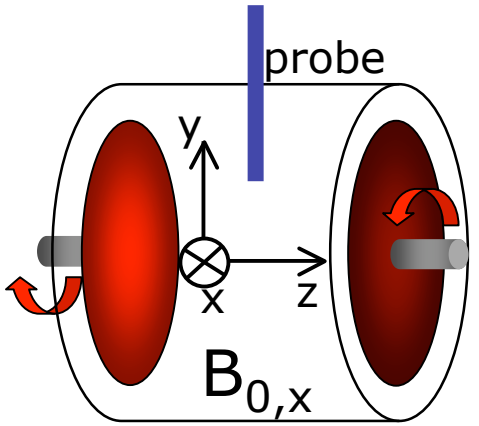


(a) VKS2 : TM73



(b) VKS1 : TM60

- consistent with VKS1



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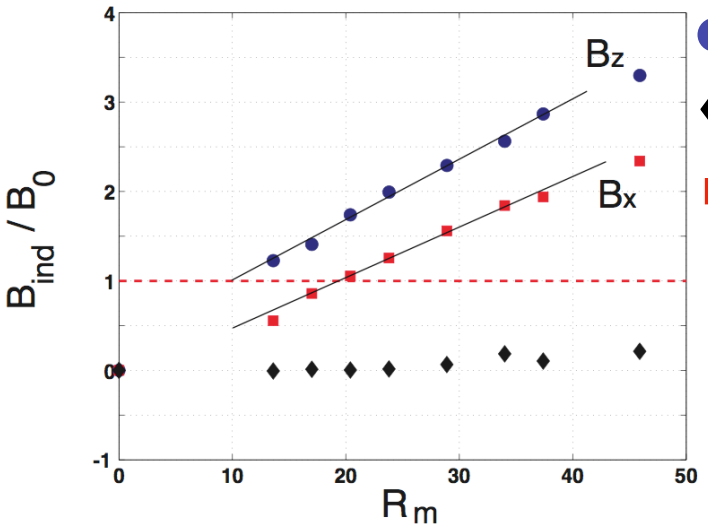
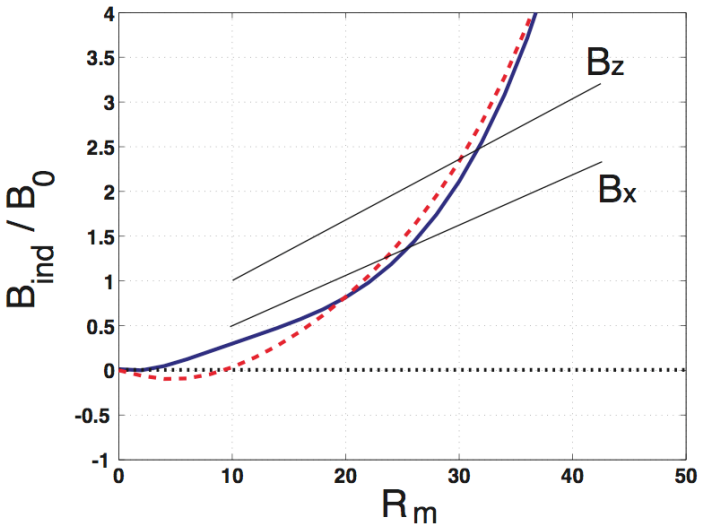


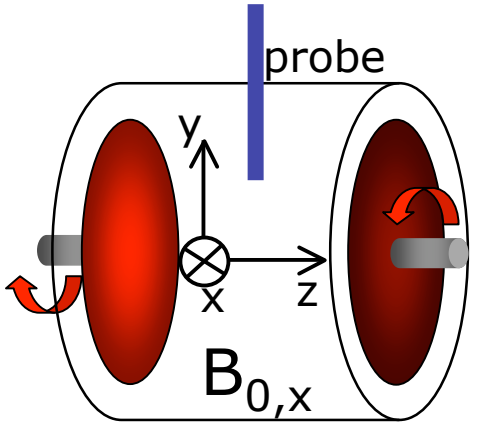
(a) Expériences



(b) Simulations

B_x
B_y
B_z

- $\langle B \rangle \neq B$ from $\langle v \rangle$



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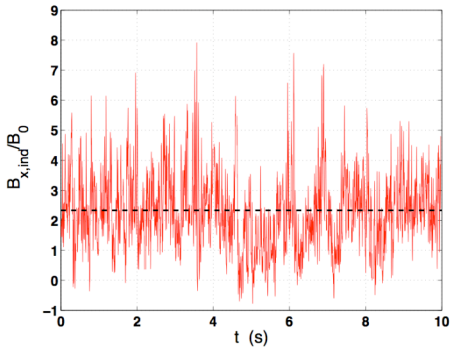
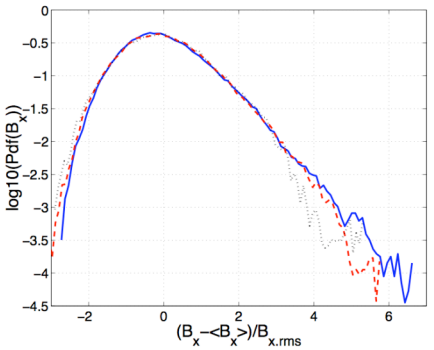
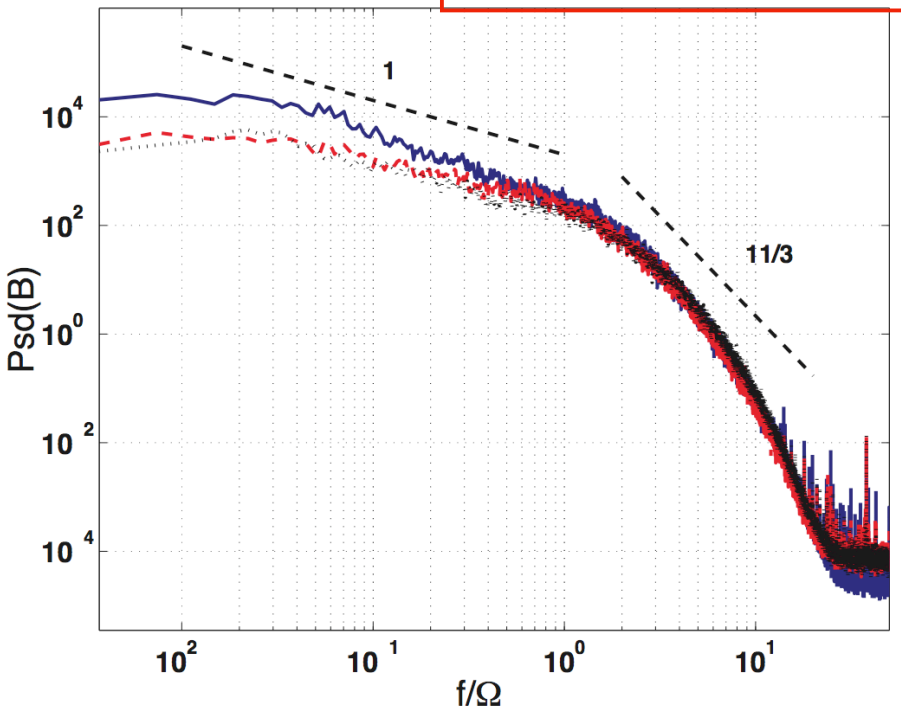
VKS2a : fluctuations



(a) $B_x(t)$, $\Omega = 27$ Hz



(d) Pdf centrées réduites



$\mathrm{Psd}(B_{ind})$, $\Omega = 27$ Hz

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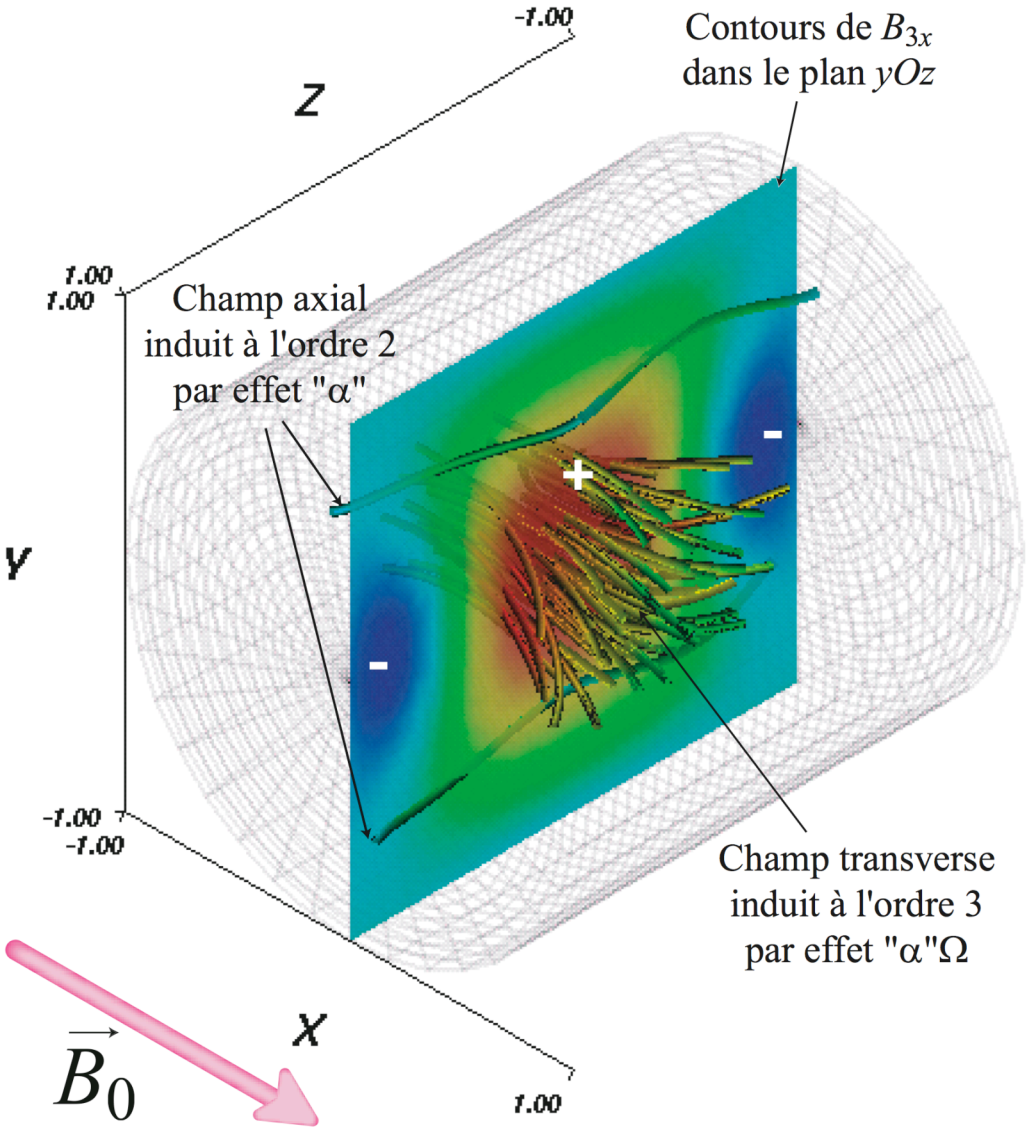
VKS2b : transport of a localized B-field



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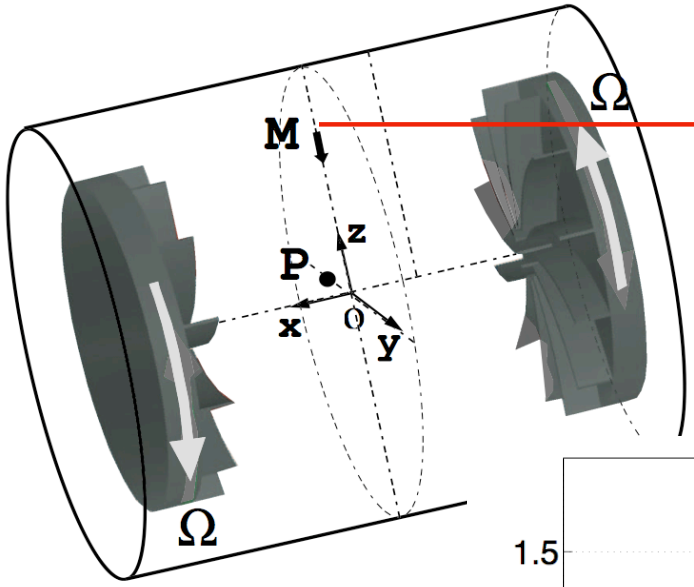
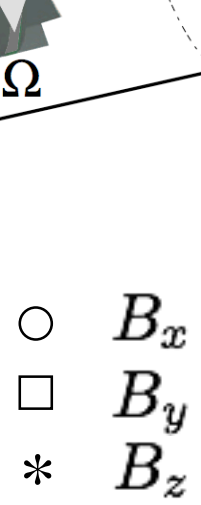
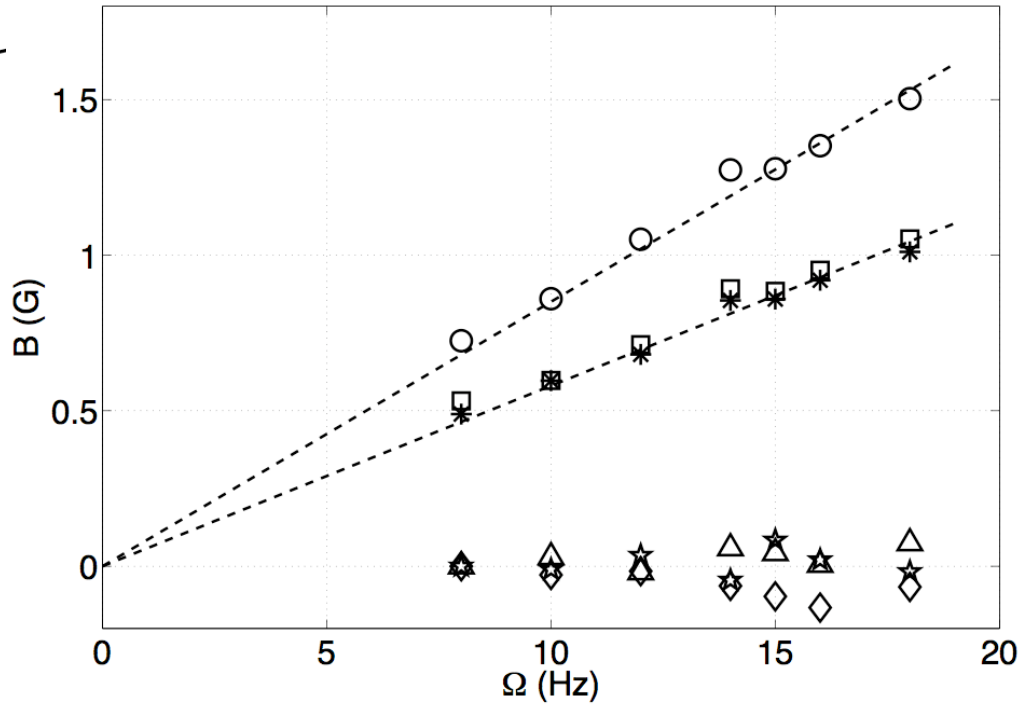


NdFeB magnet
(22mm x 10mm)
Bs ≈ 500 G





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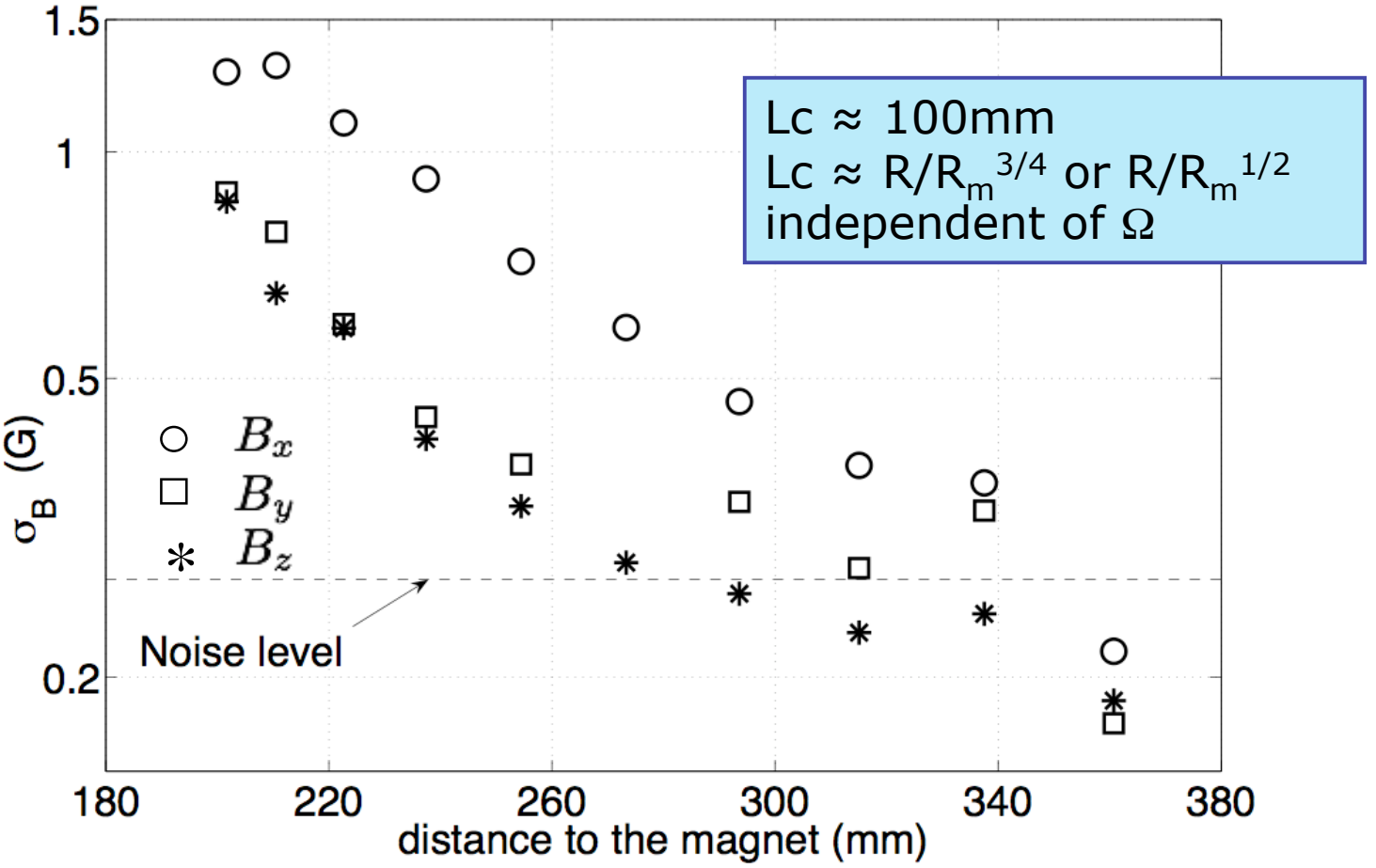

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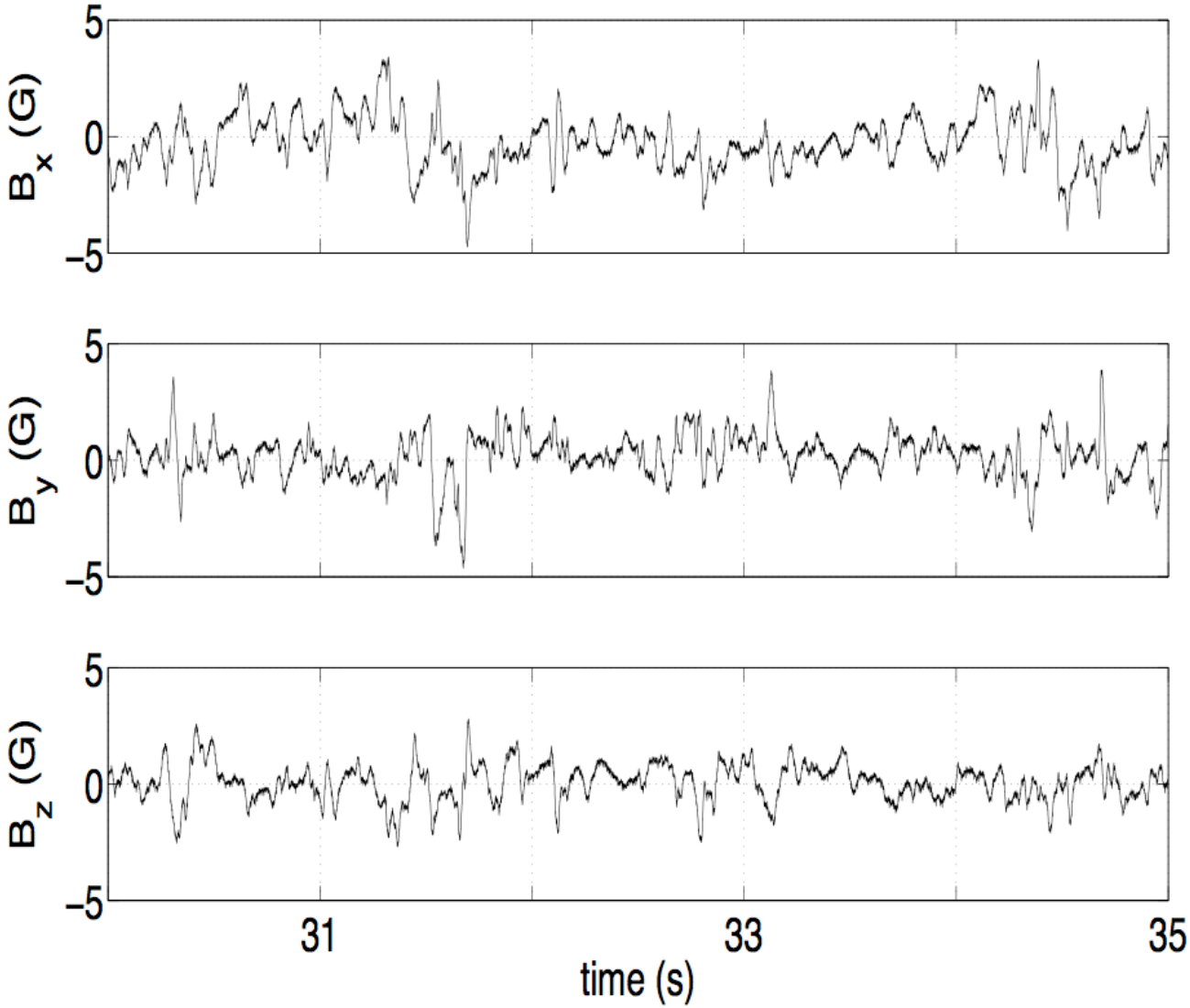

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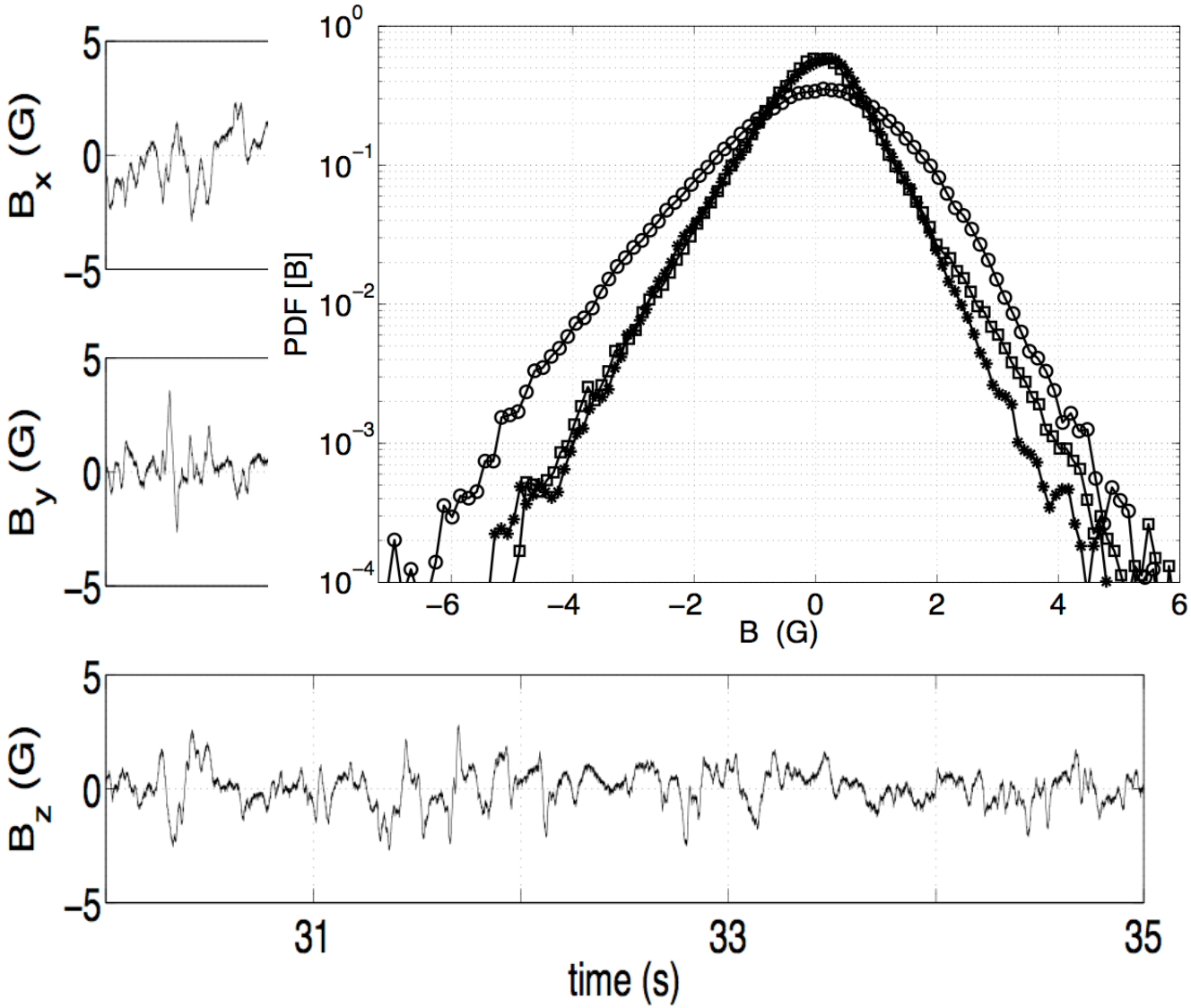

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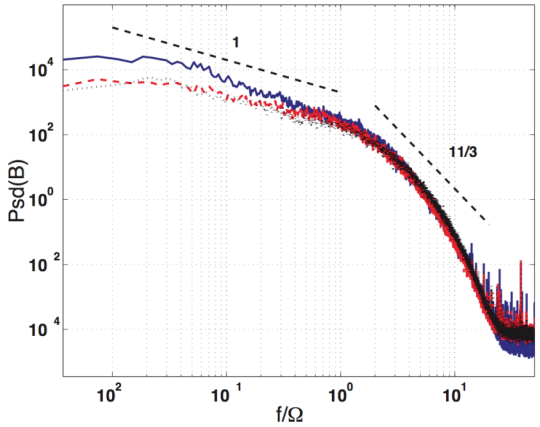
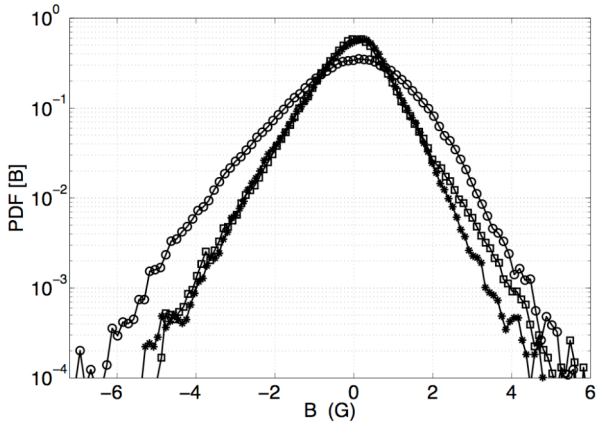
VKS2 : current thoughts about dynamo generation

- Fluctuations (cf. Odier's talk)

VKS2 : slow dynamics, intermittent transport



$\mathrm{Psd}(B_{ind})$, $\Omega = 27$ Hz



VKG : 50% of time away from <VK> geometry

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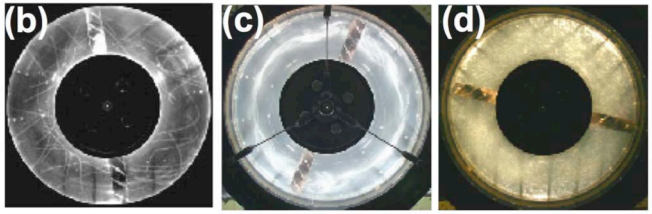
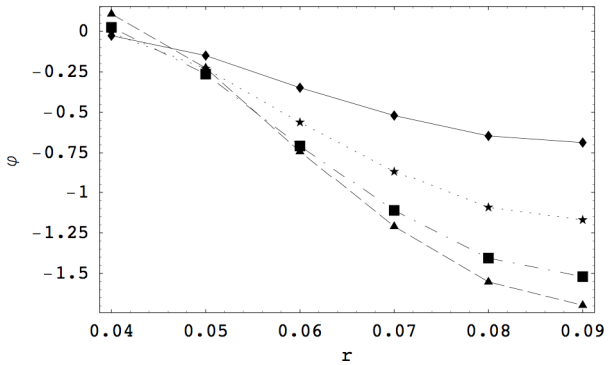
- Fluctuations (cf. Odier's talk)
- Small scale contributions : alpha and beta effect

alpha measurements in the Perm screw flow (Ga)



$$\alpha/U \leq 10^{-4}$$

beta measurements in VKG : phase of skin effect



$$\beta/\lambda_0 \sim 2-4\%$$

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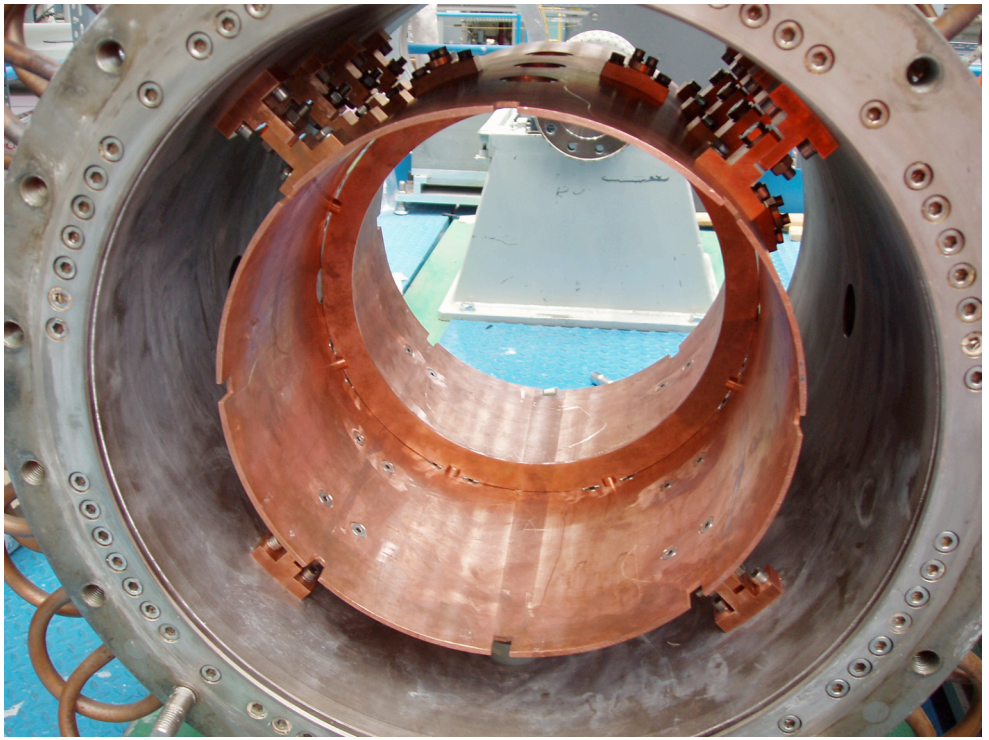
- Fluctuations cf. Odier
- Small scale contributions : alpha and beta effect
- Next step : VKS2c

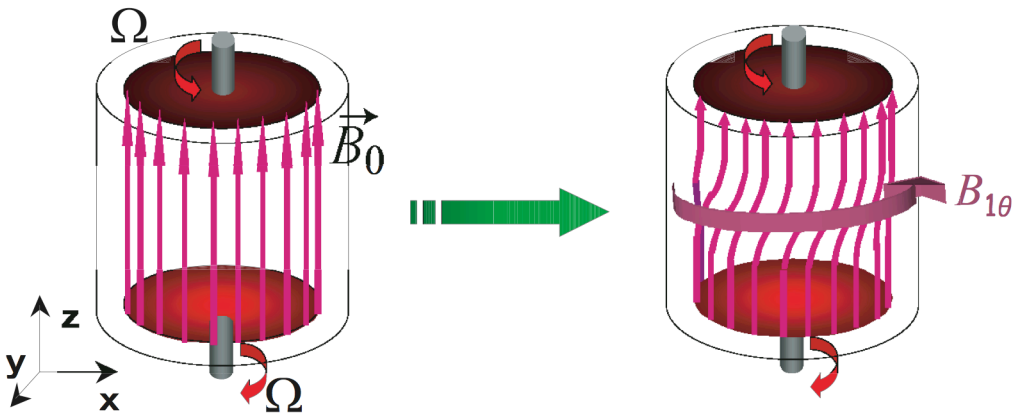


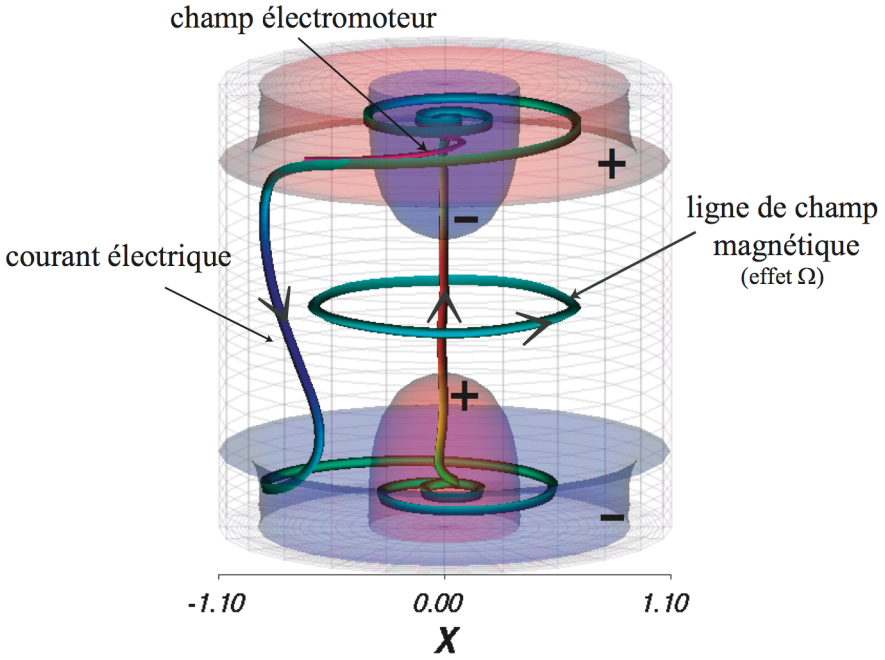
Also with

Mickael Bourgoin
LEGI, Grenoble

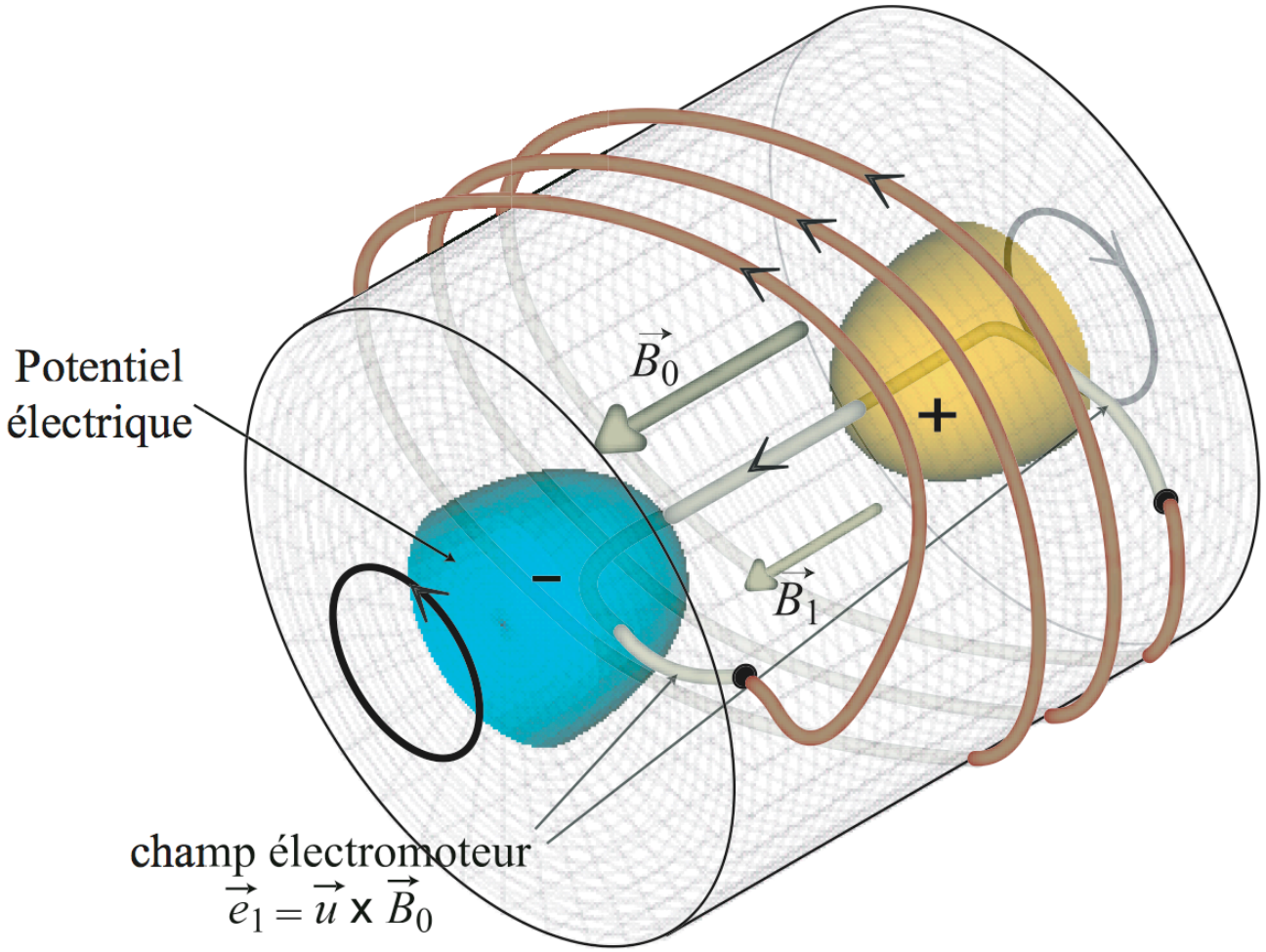
Pierre Augier
ENS-Lyon

A Bullard - Von Karman Dynamo





A Bullard - Von Karman Dynamo



A Bullard - Von Karman Dynamo