

Joint Universities Accelerator School

JUAS 2019

Practical Works at CERN - Magnet Measurements

28th February – 1st March 2019

Lucio Fiscarelli & Thomas Zickler

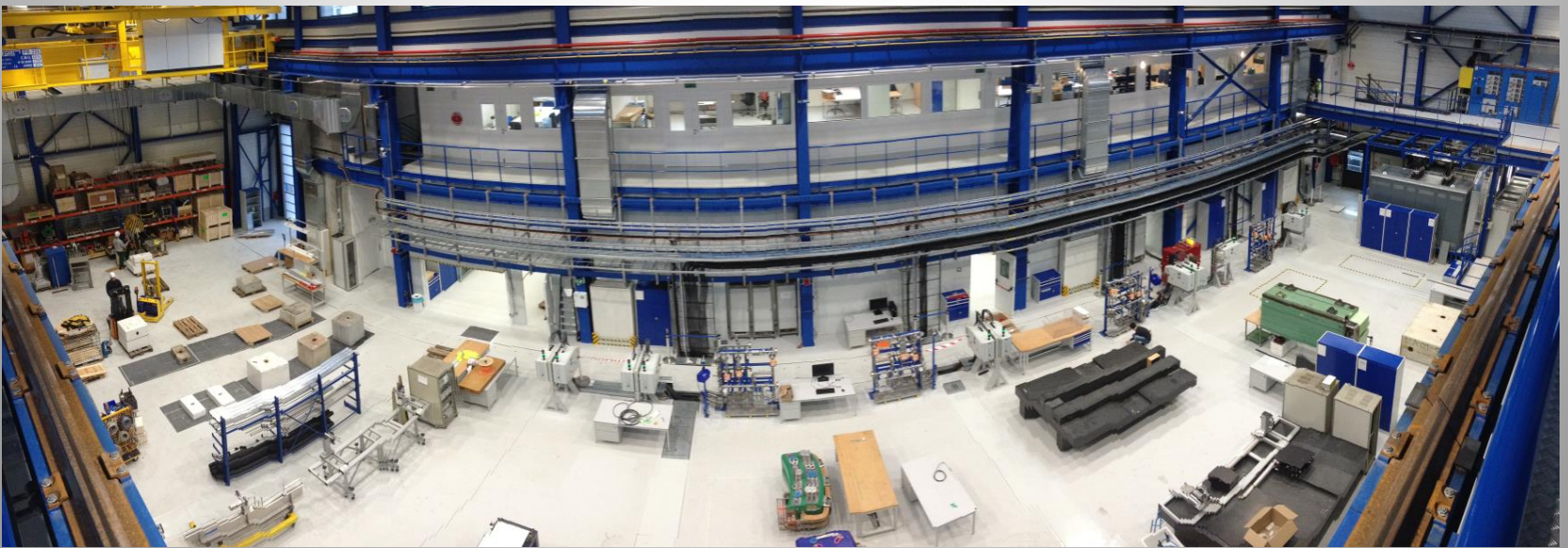
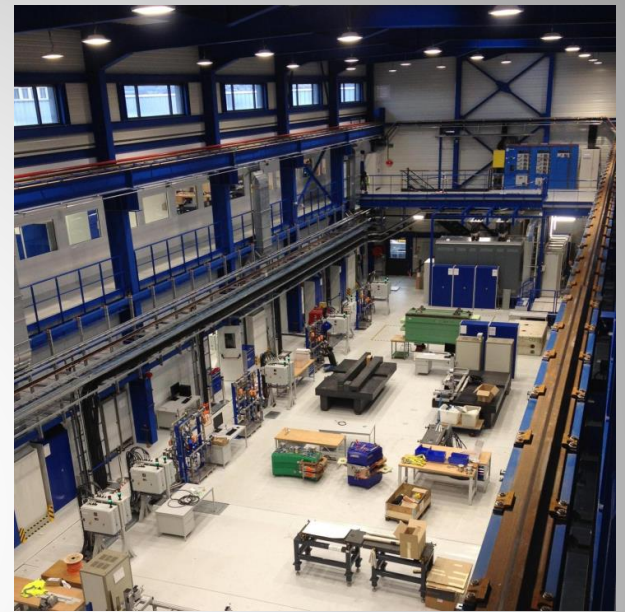
CERN



Visit our Magnet Measurement Lab



New lab constructed in 2017

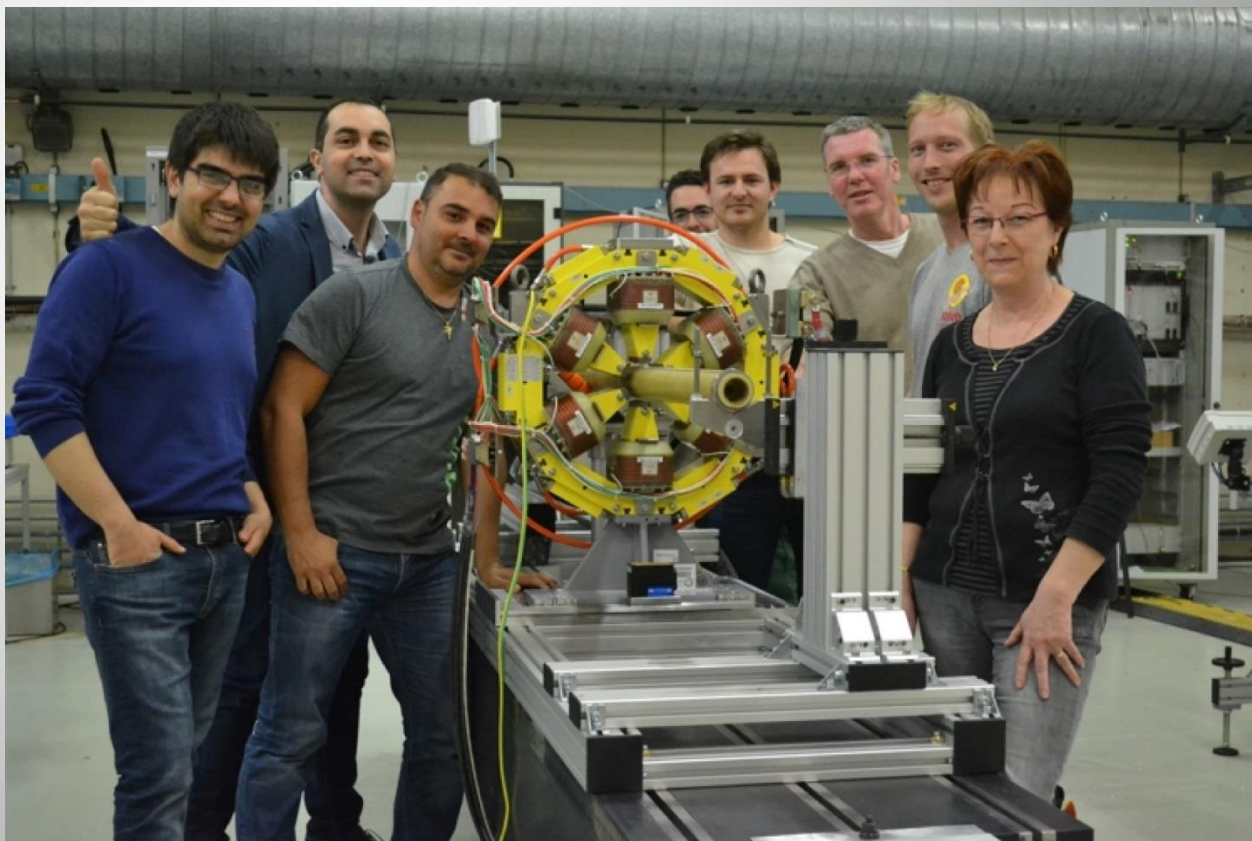




Meet the experts

Strong team consisting of **+30 experts** (physicists, engineers, technicians and students):

- In charge of testing **all** of CERN's **17000 magnets**
- Magnetic characterization of materials
- R&D of **specialized** equipment
- **60+ years** experience

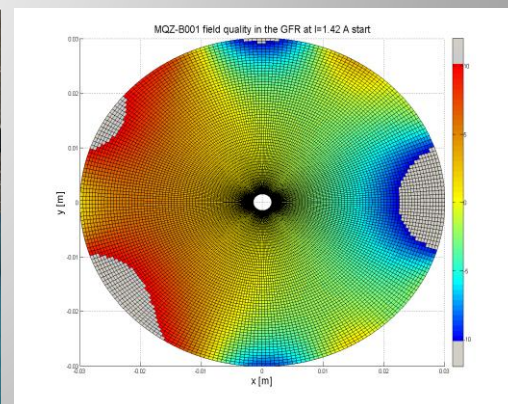
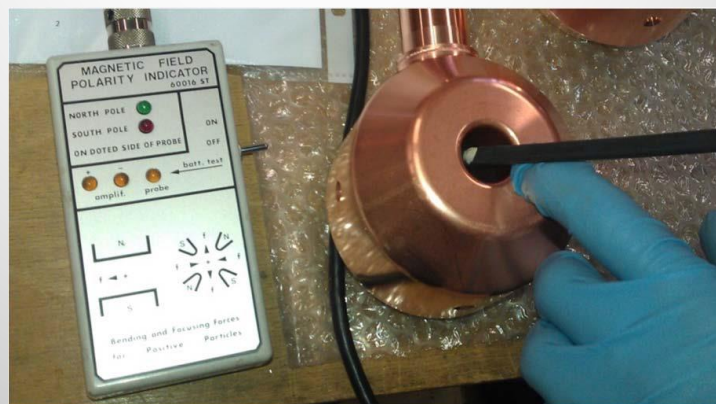
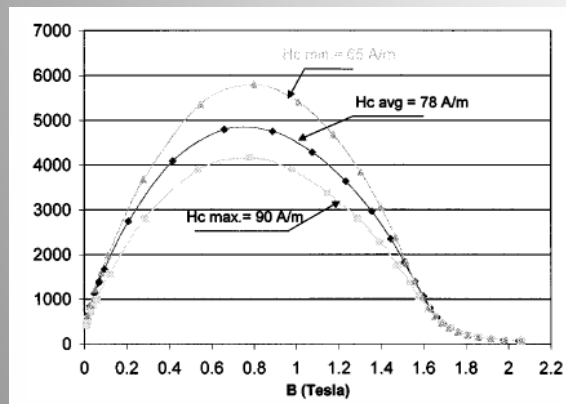




Understand the motivation for MM

Magnetic measurements are performed to:

- characterize soft (iron) and hard (permanent magnets) ferromagnetic materials
- prove that the electro-magnetic design is correct
- monitor production quality and steer manufacturing
- collect information and data for operation: polarity, transfer function, field uniformity, magnetic axis, dynamic effects (eddy currents) and magnetic cycling effects (hysteresis)
- characterize magnets after repairs or to use in different operational ranges





Explore different MM techniques

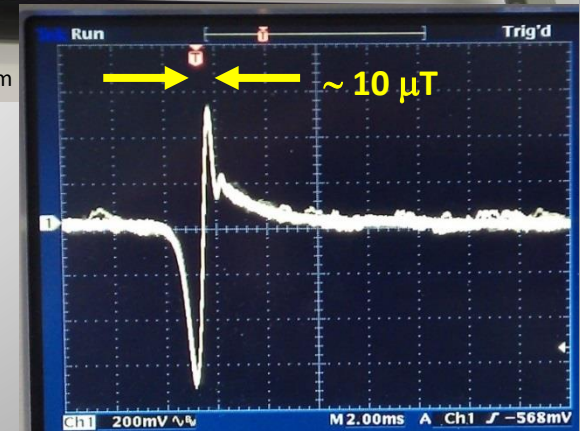


No single instrument or method can cover all requirements

- Multiple instruments are complementary
- Overlaps provide estimation of absolute uncertainty and error correction



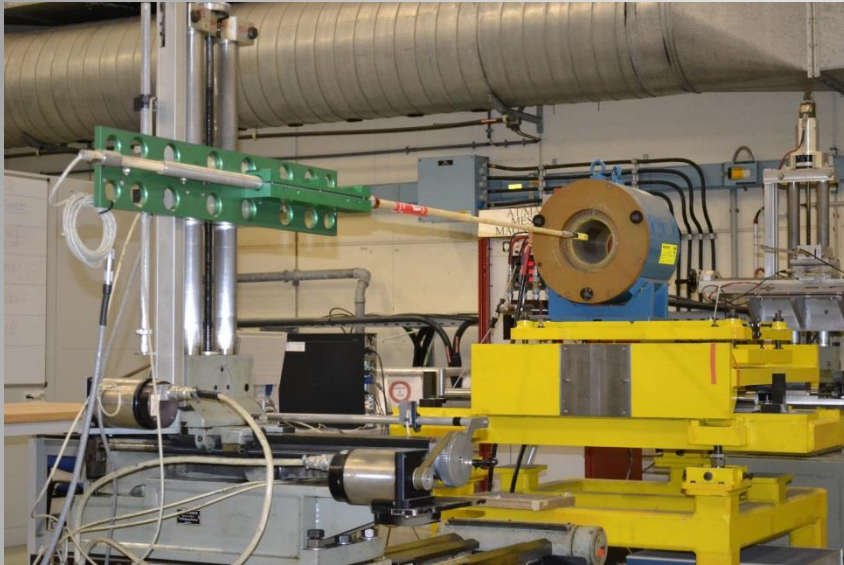
Courtesy www.metrolab.com



demodulated RF output in "marker mode"



Explore different MM techniques



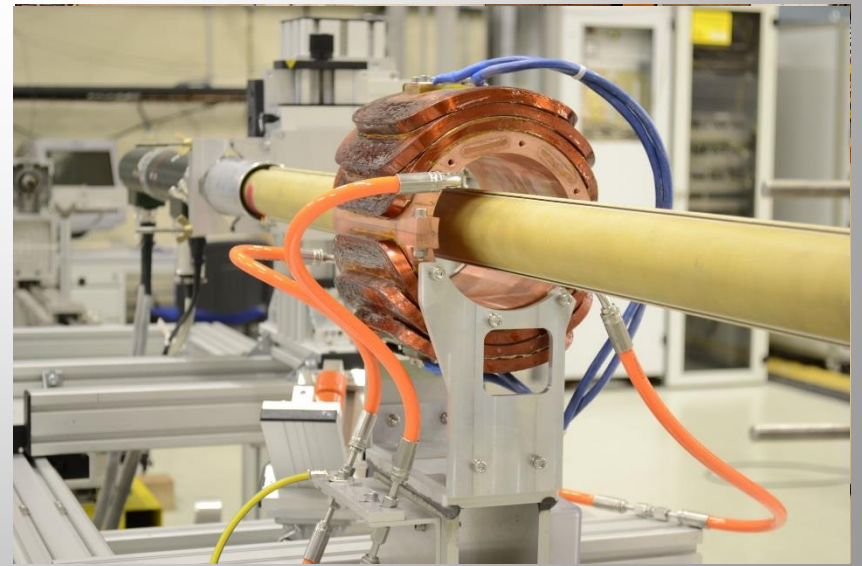
Hall probe mapper



Single stretched wire bench



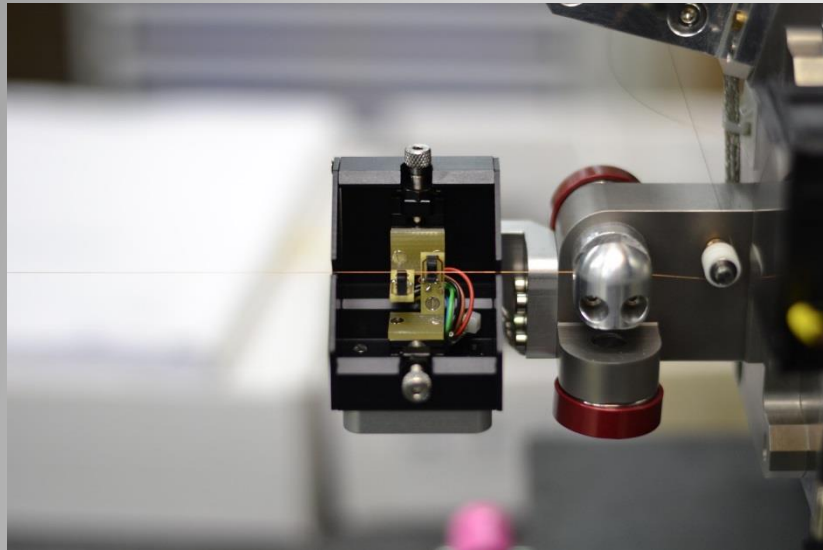
Induction coil magnetometer ("Fluxmeter")



Rotating coil magnetometer



Find out about latest developments



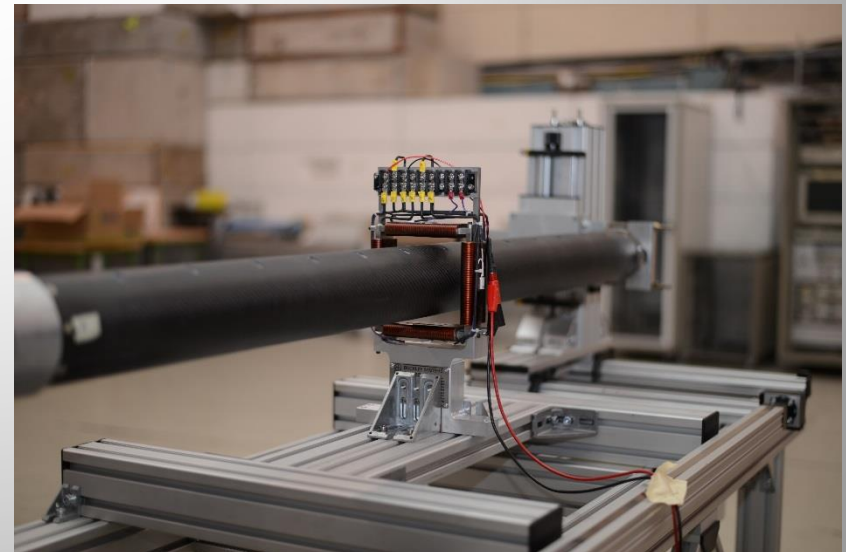
Photodetectors in the vibrating wire system



Fast digital integrator module



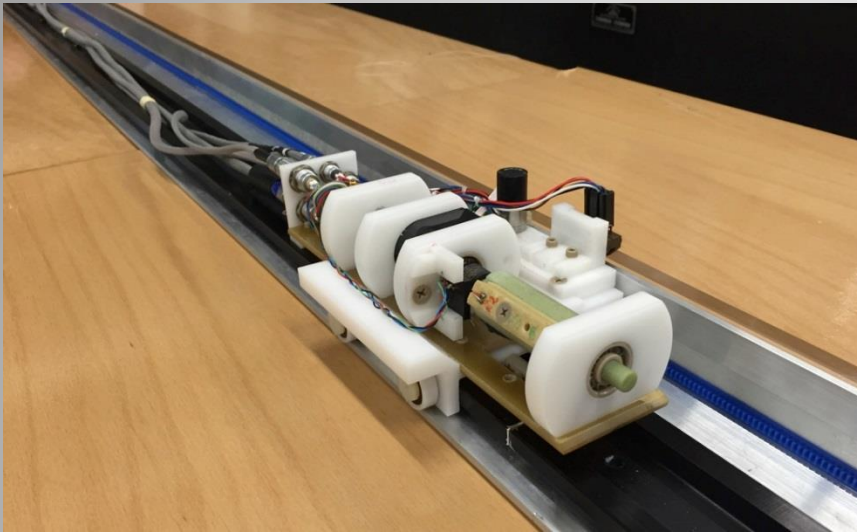
Nine-coil fluxmeter for the ELENA B-Train



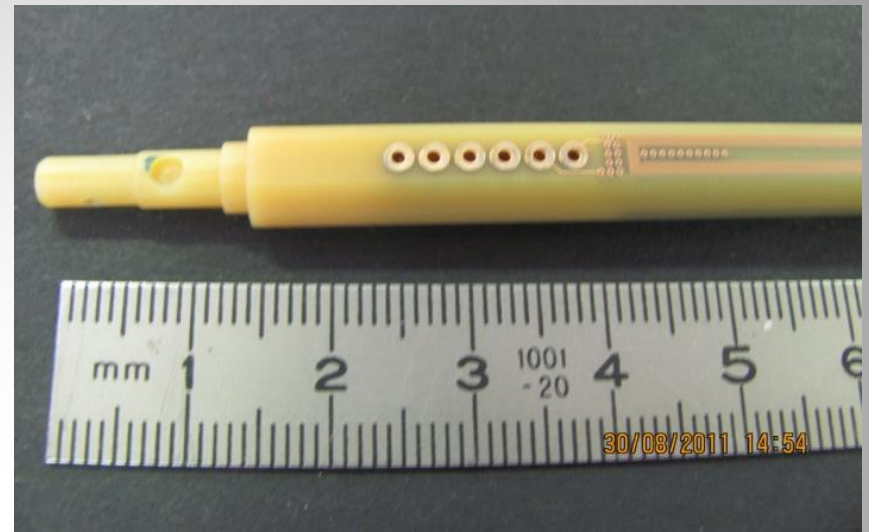
Large-diameter carbon fibre shaft



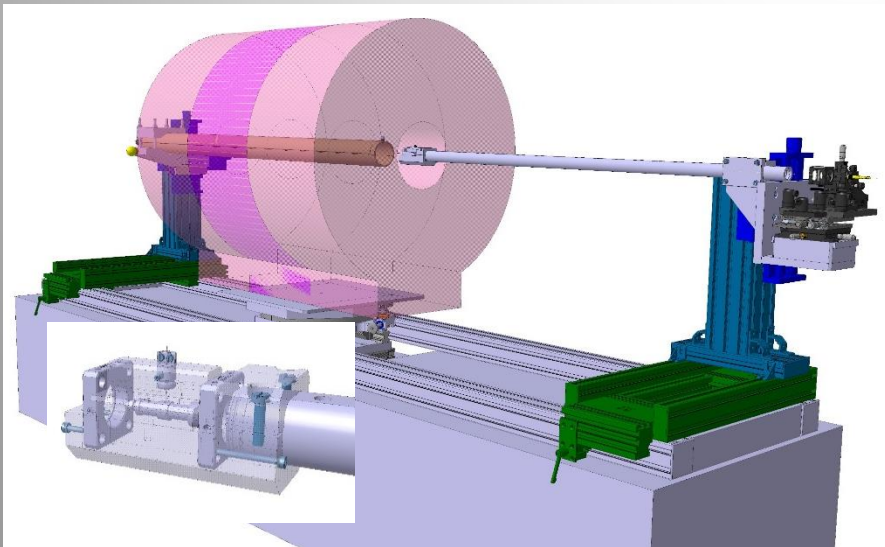
Find out about latest developments



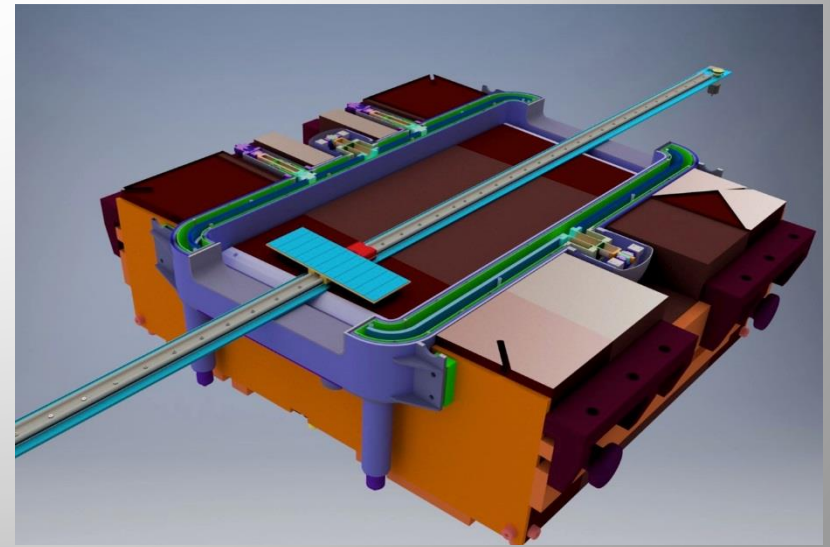
Rotating Coil Mapper (alias 'Toy Train')



Miniature rotating coil using PCB technology



Compass-Laser probe for Solenoids



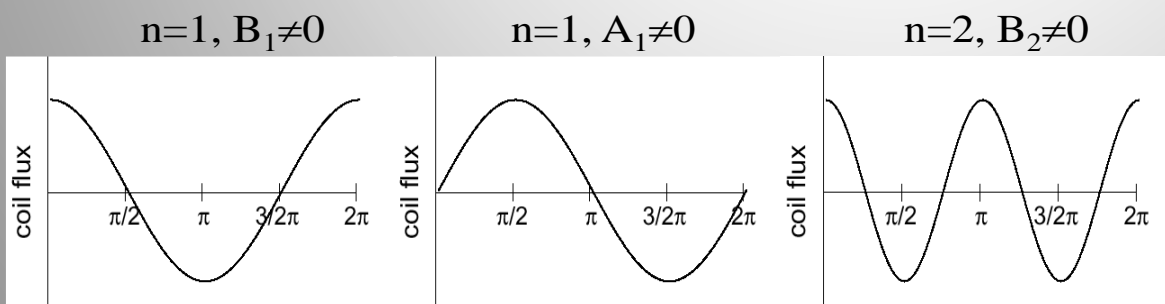
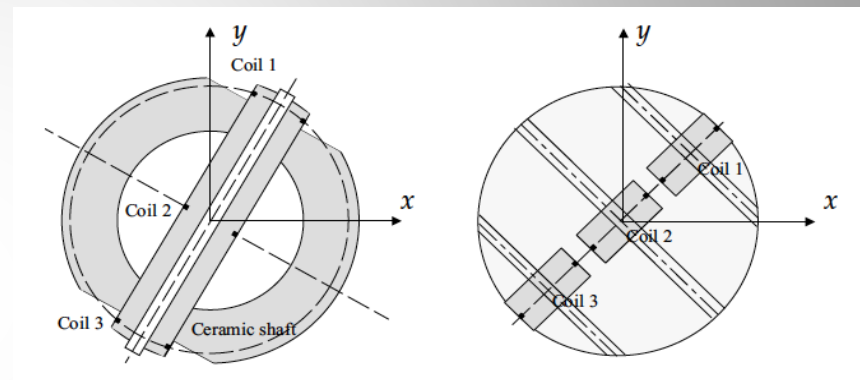
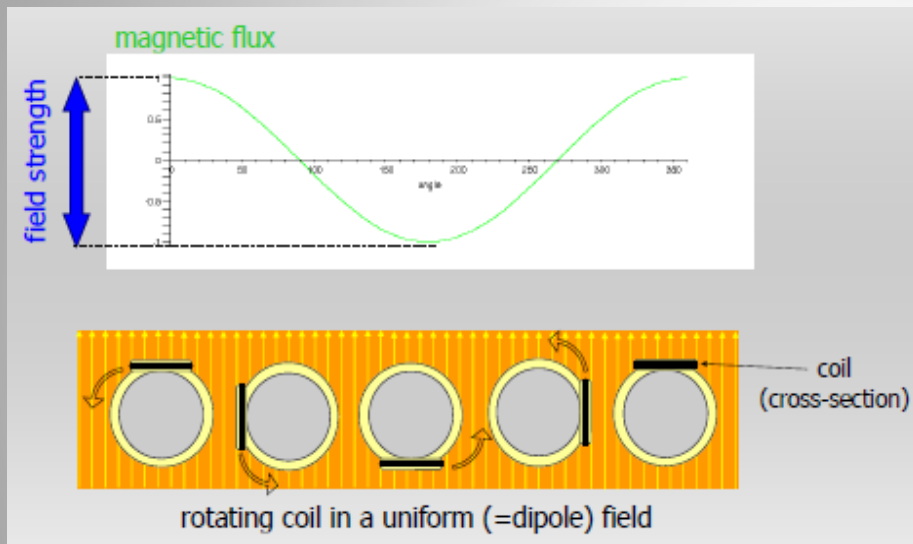
Translating Fluxmeter for the FAIR project



Learn...



... how a rotating coil system works in detail

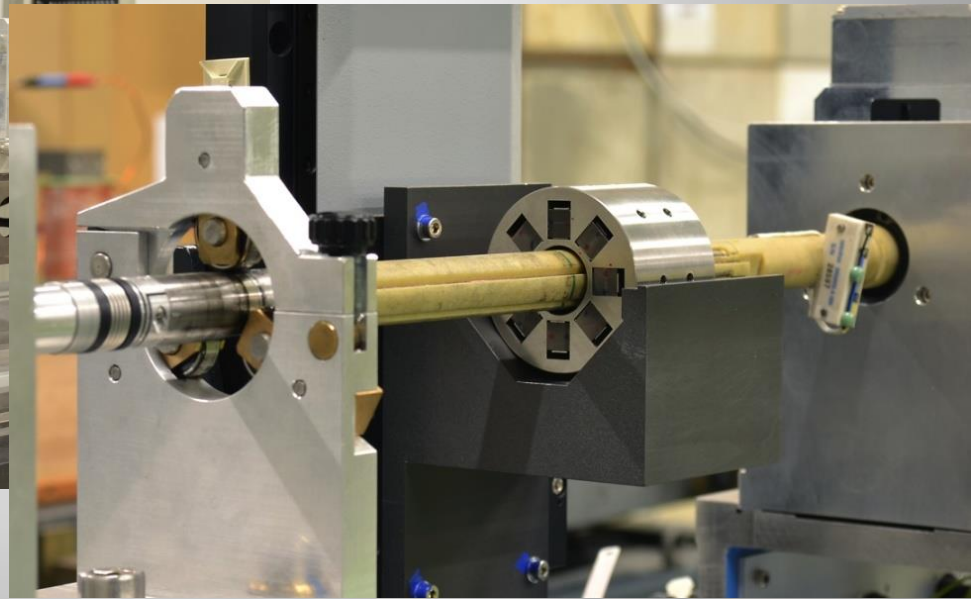
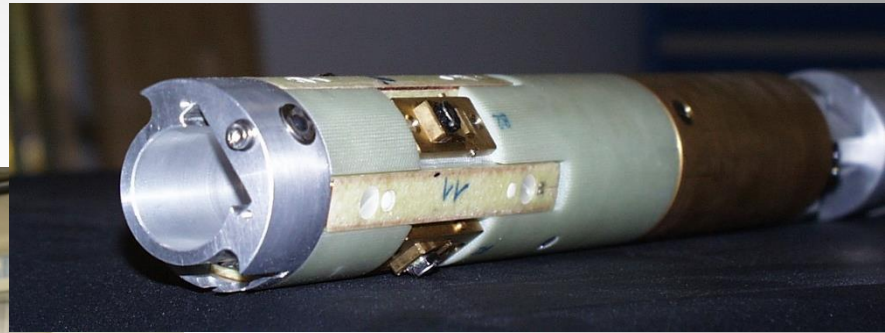
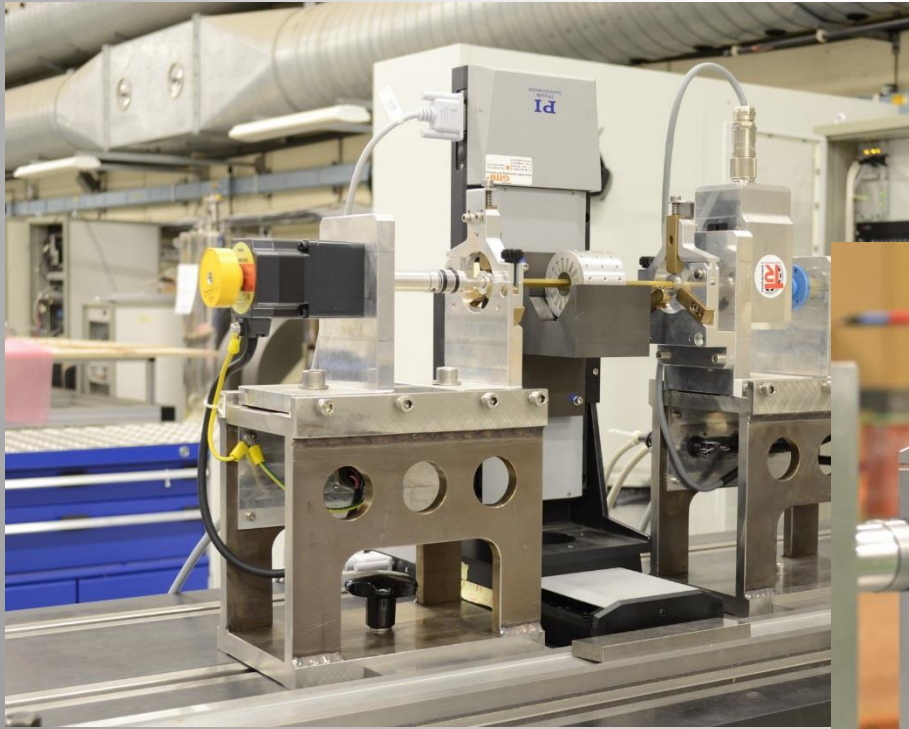




Learn...



... how to prepare and run the system to measure a quadrupole magnet yourself

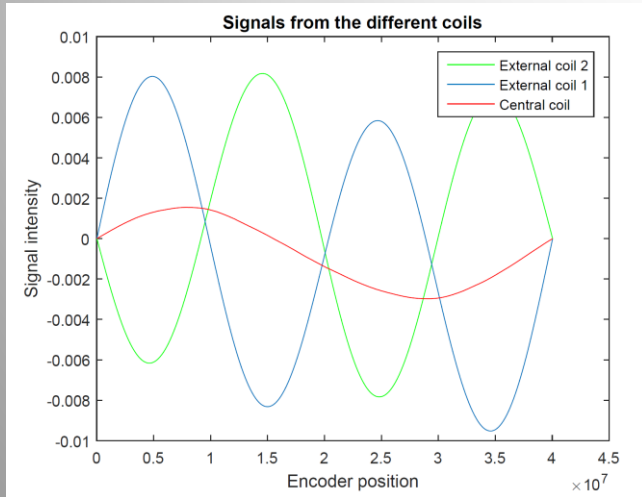
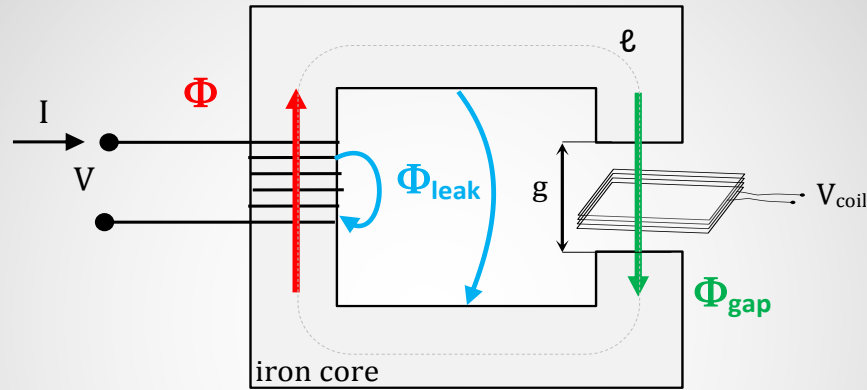




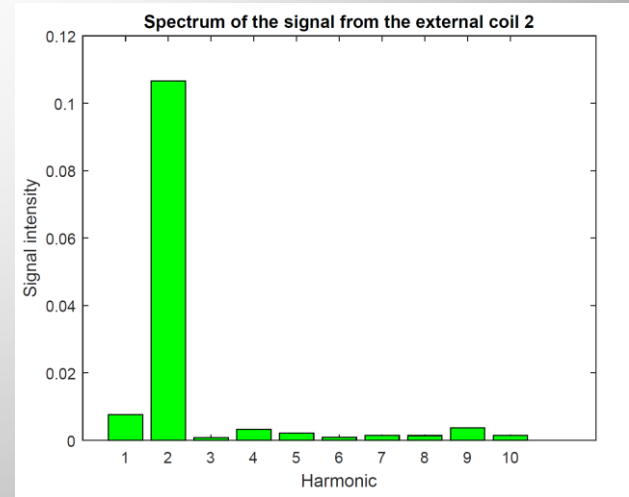
Learn...



... how to analyse and interpret the results



Fourier transform





Safety remarks

- ⚠ The laboratory is a workplace with associated hazards
- ⚠ Wear closed, flat or block-heel shoes
- ⚠ Eating, drinking and smoking are forbidden during the visit
- ⚠ Always follow the instructions of the guide
- ⚠ Don't touch any equipment unless explicitly asked by the guide
- ⚠ Never get away from the guide
- ⚠ No pacemakers allowed!





Additional references



- L . Bottura, K. N. Henrichsen, “Field Measurements”, Proceeding of CAS - CERN Accelerator School on Superconductivity and Cryogenics for Accelerators and Detectors, 2002
- A.K. Jain, “Measurements of Field Quality Using Harmonic Coils”, US Particle Accelerator School (USPAS) on "Superconducting Accelerator Magnets“, 2001
- M. Buzio, “Fabrication and calibration of search coils”, Proceedings of CAS - CERN Accelerator School on Magnets, 2009
- L. Walckiers, “Magnetic measurement with coils and wires”, Proceedings of CAS - CERN Accelerator School on Magnets, 2009



We are looking forward to
welcome you at CERN!

Special thanks to my colleagues for providing the nice material and pictures