



Magnetic measurements for HL-LHC

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Outline

- FAME system
- Short models at cryogenic temperature
- Measurement plan

FAst Measurement Equipment (FAME)

Flexible framework for Magnetic Measurements (FFMM)

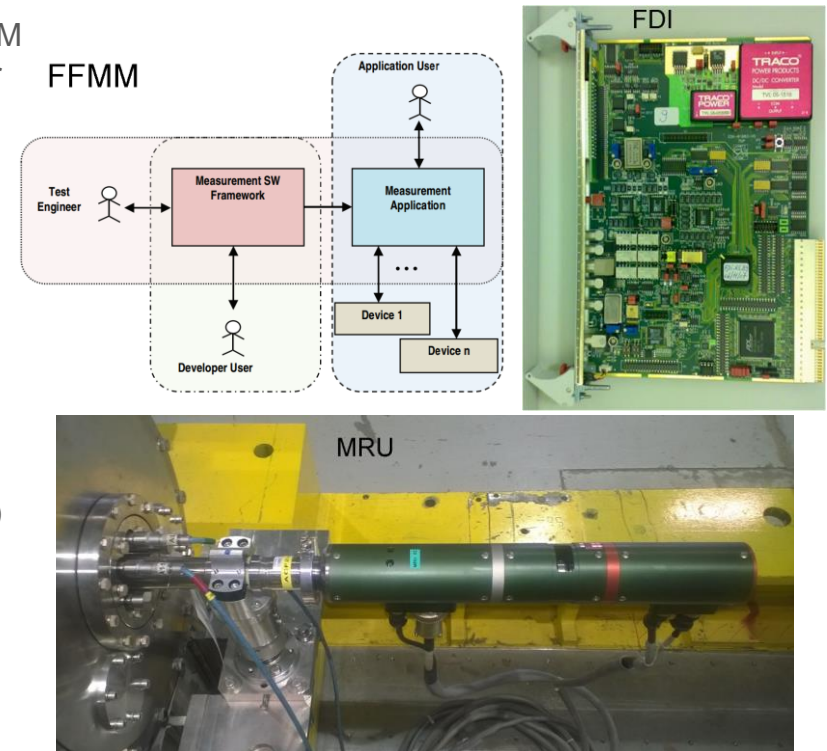
- Library with drivers for common instruments used for MM (such as integrators, acquisition cards, motors, encoder interfaces, DMM's...)
- Measurement procedure condensed in a “short script”
- Run-time generation of GUI for input parameters and data visualization
- Integrated post-processing with Matlab

Fast Digital Integrator (FDI)

- Input range from $\sim \mu\text{V}$ (SC magnets at “warm”) to 30 V (multi-segments at “cold”)
- Fast triggering up to 10 kHz (rotating coils at 10 turns/s)

Micro rotating unit (MRU)

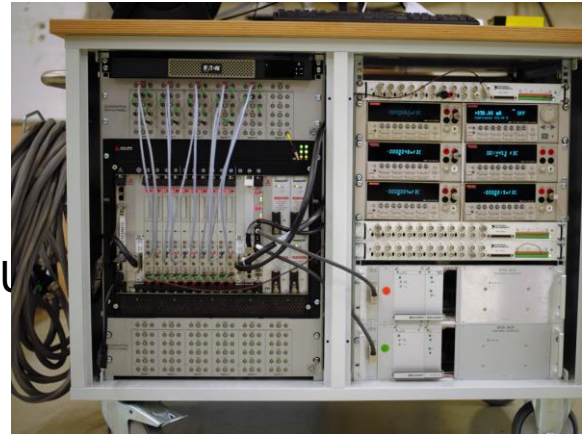
- Angular encoder with 4096 steps
- Slip rings with ~ 50 signals (multi-segment shafts)
- DC motor + reduction for providing high torque (shaft without ball bearings)



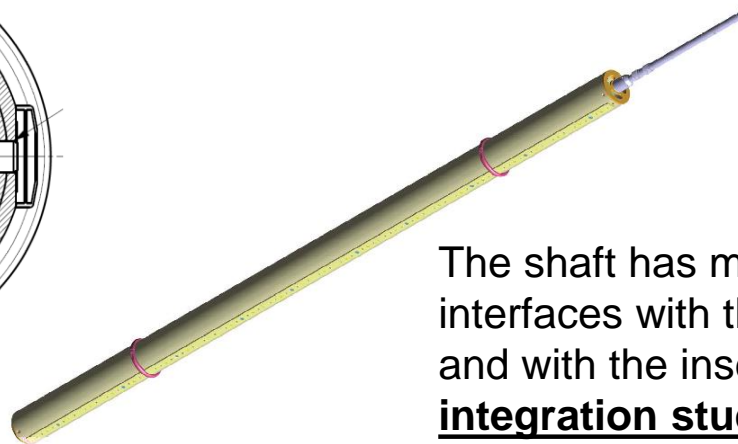
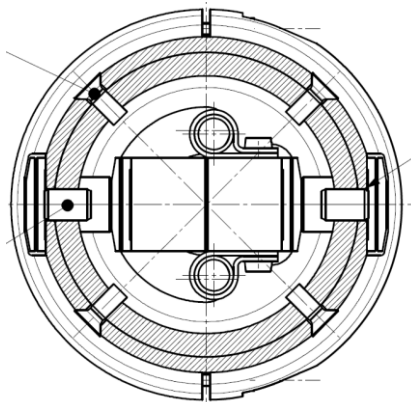
MQXF short models at 1.9 K

FAME for cryogenic temperature in SM18

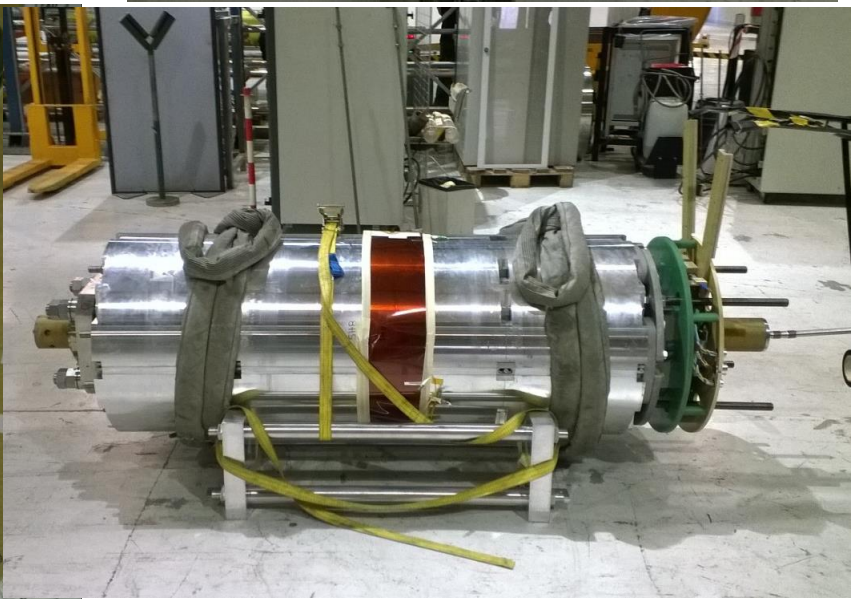
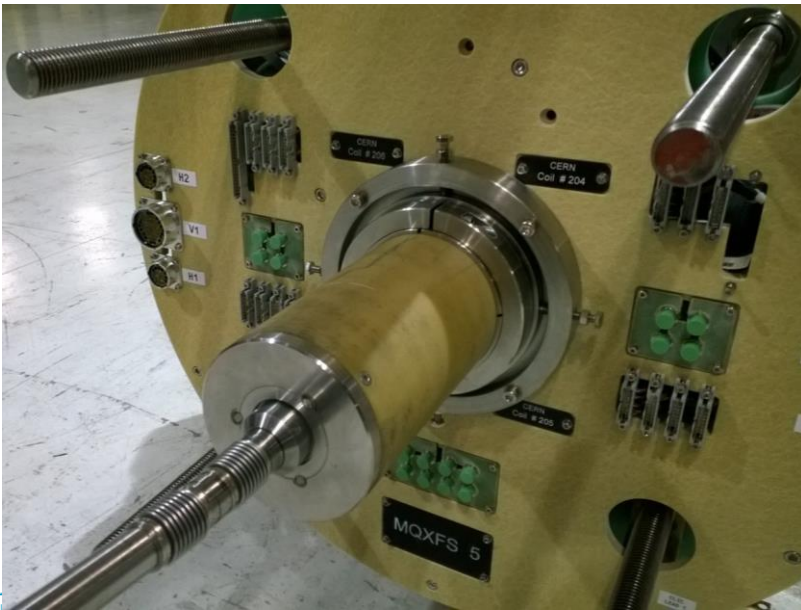
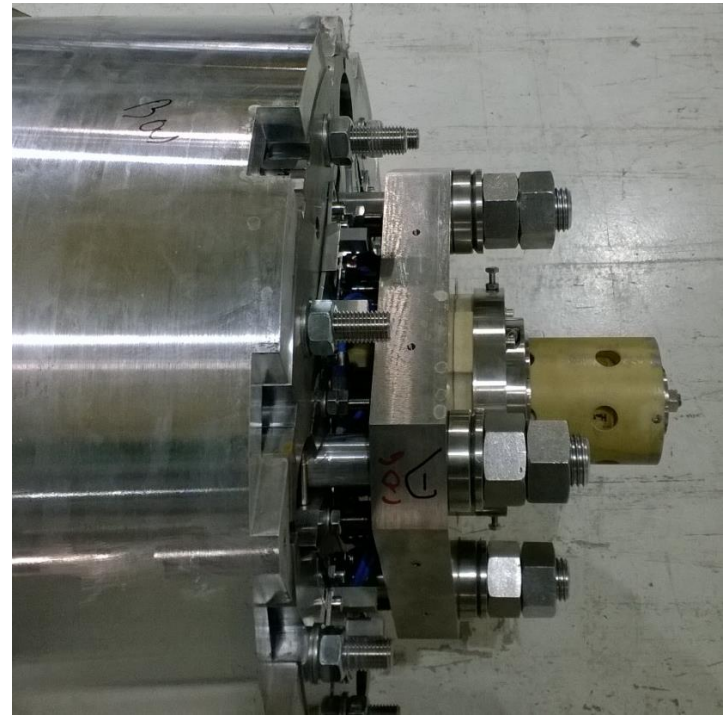
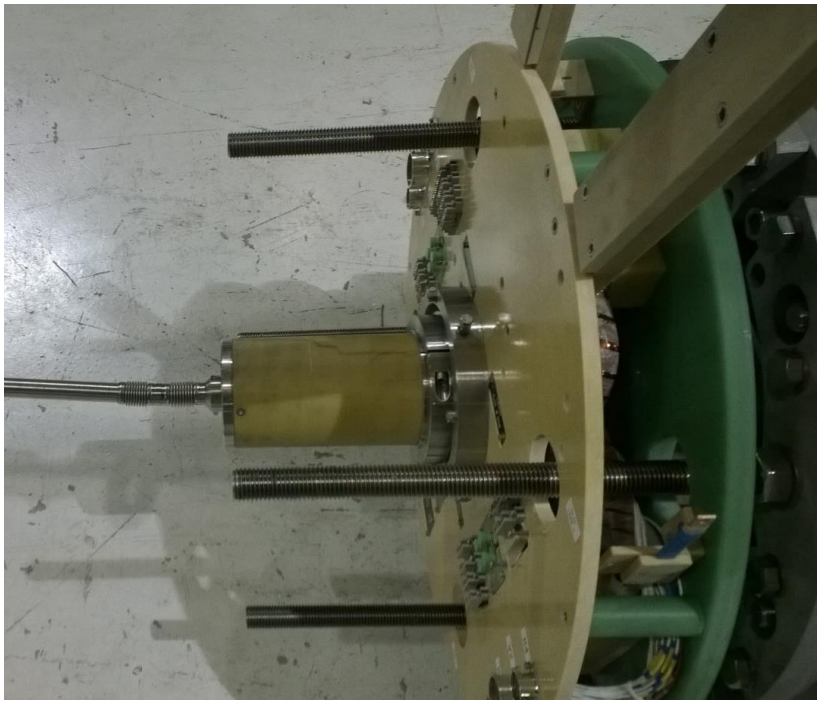
- FFMM software
- Fast Digital Integrators (10x)
- Motor + encoder + slip-ring unit (MRU)
- Vertical rotating shaft
 - L = 420 mm x 5 segments



Coil	unit	A	B	C	D	E
Inner length	mm	420	420	420	420	420
Magnetic surface	m ²	0.36	0.36	0.36	0.36	0.36
Center radius	mm	43.62	19.6	0.03	19.6	43.62



The shaft has mechanical interfaces with the magnet and with the insert:
integration study



Measurement plan

- Ambient temperature, central and integral field at ± 20 A
 - After collaring (CC)
 - After shell welding (CM)
- Cryogenic temperature, central and integral field up to nominal
 - Standard program
 - At 1.9 K
 - Machine simulation cycle after pre-cycling
 - Stair-step cycle
 - Ramp-rate study
 - Extended program
 - Reset current study
 - Pre-cycling study
 - Injection duration study
 - ...