

B-field Measurement Applications of Sensors Based on Optical Fibre Technology.

B-field measurements in HEP detectors.

- Modern HEP detectors feature large bore magnets (e.g. CMS solenoid, 6m bore, 12.5m length, 4T B-field). The measure of the B-field map is done before the magnet being equipped with internal sub-detectors. The resolution, the granularity and the radiation hardness required to the B-field sensors make, at the present, impossible to install them permanently in the detector.

B-field measurements in HEP detectors.

- A possible solution comes from the use of OFT sensors, that would be installed inside the detector volume and would measure the B-field in real time.
- OFT sensors embedded into the magnet coil winding would measure the actual field view from the superconducting cable at cryogenic temperature, along with the mechanical strain. A combination of these three parameters (temperature, strain, field) would give important knowledge on the real working conditions of the magnet.

Development of B-field sensors based on OFT.

- The ideal sensor would have the following characteristics:
 - Radiation hardness/stability up to 100Gy/year.
 - Working temperature between 4K and 450K.
 - Measuring range between 0 and 5T.
 - Precision 10^{-4} at 5T.
 - Compact arrangement for 3-D vectorial measurement.

Results of the measuring campaign on B-field sensors

Terfenol/FBG transducer, B-field up to 5,000 Gauss.

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Norbert Frank (mechanical setup, DAQ)

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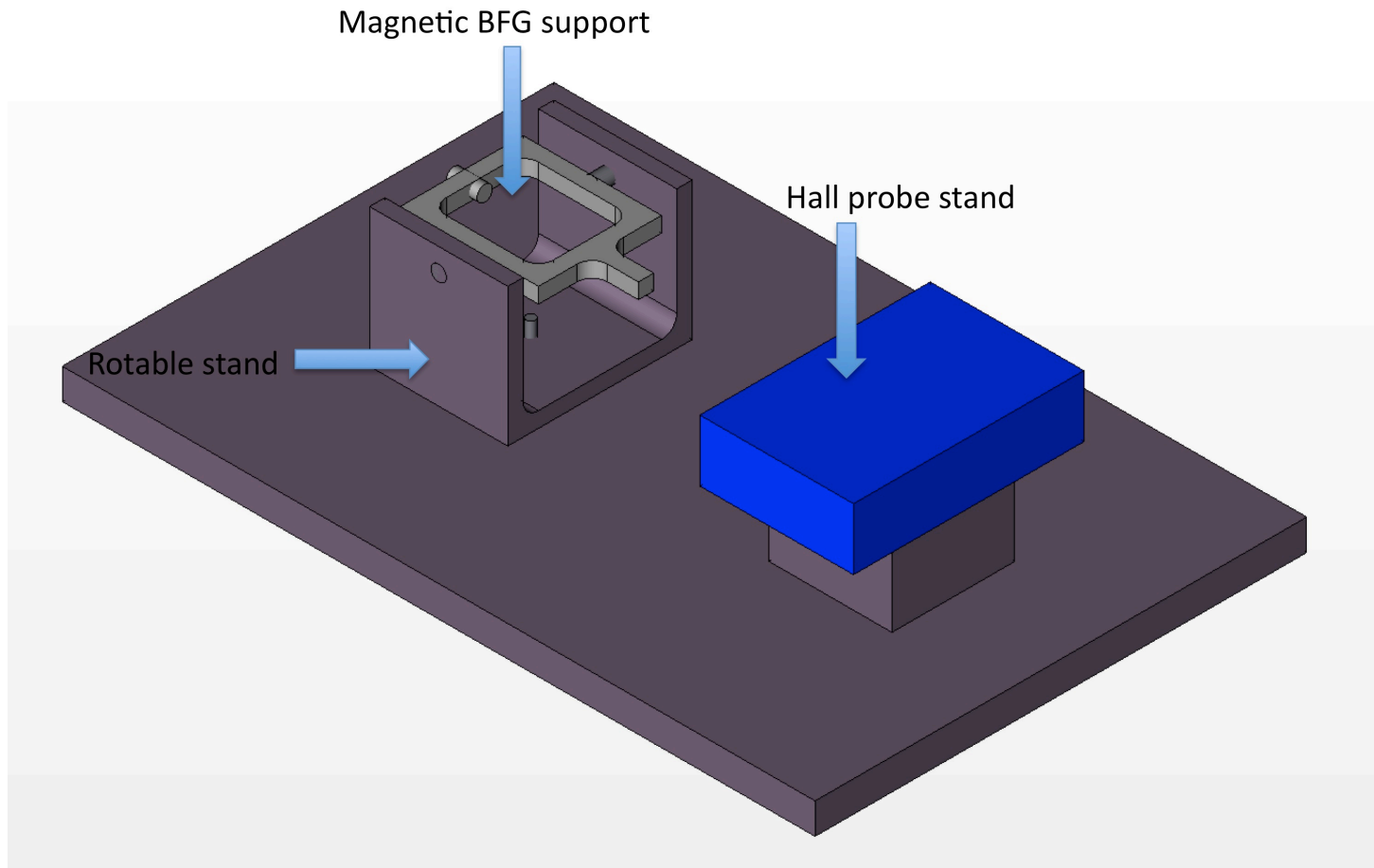
Main scope.

- Terfenol is a nearly single crystal metal alloy that changes its shape when exposed to an external magnetic field (magnetostrictive material).
- Validate the design of B-field sensors (Terfenol + FBG), for mid-range B-fields, up to 5kG (0.5T).
- Measure linearity over the full range, sensitivity to transversal field, hysteresis cycles, temperature drift, pre-stress.
- Compare with actual B-field transducers (3-D Hall probes).

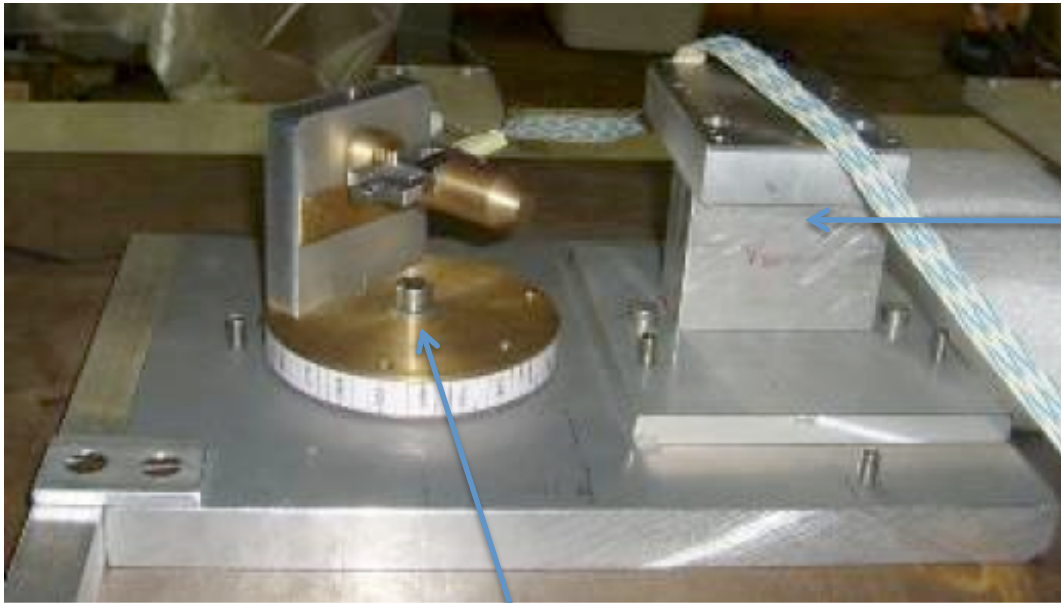
Measuring campaign.

- Each of the 5 FBG sensor has been measured in a static B-field, ranging from 0 to 5,000G
- Different levels of pre-stress have been applied to the Terfenol transducer, from 0 to 50cNm
- The transducers have been measured in different angular positions wrt the main B-field axis (vertical) and compared with the read-out of a 3-D Hall probe.

Experimental setup (1).

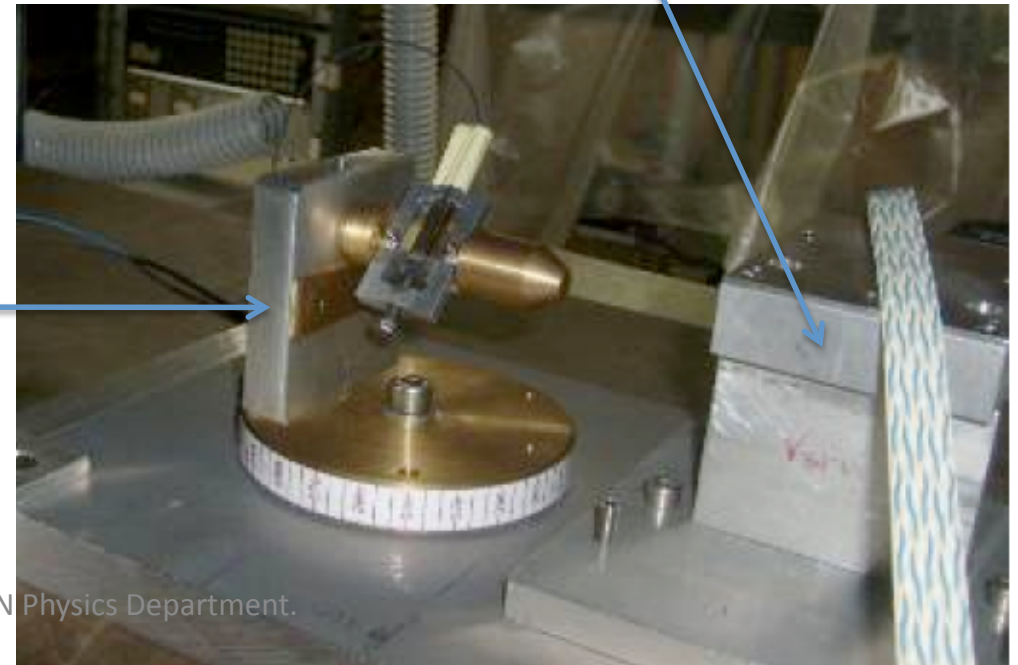


Experimental setup (2).

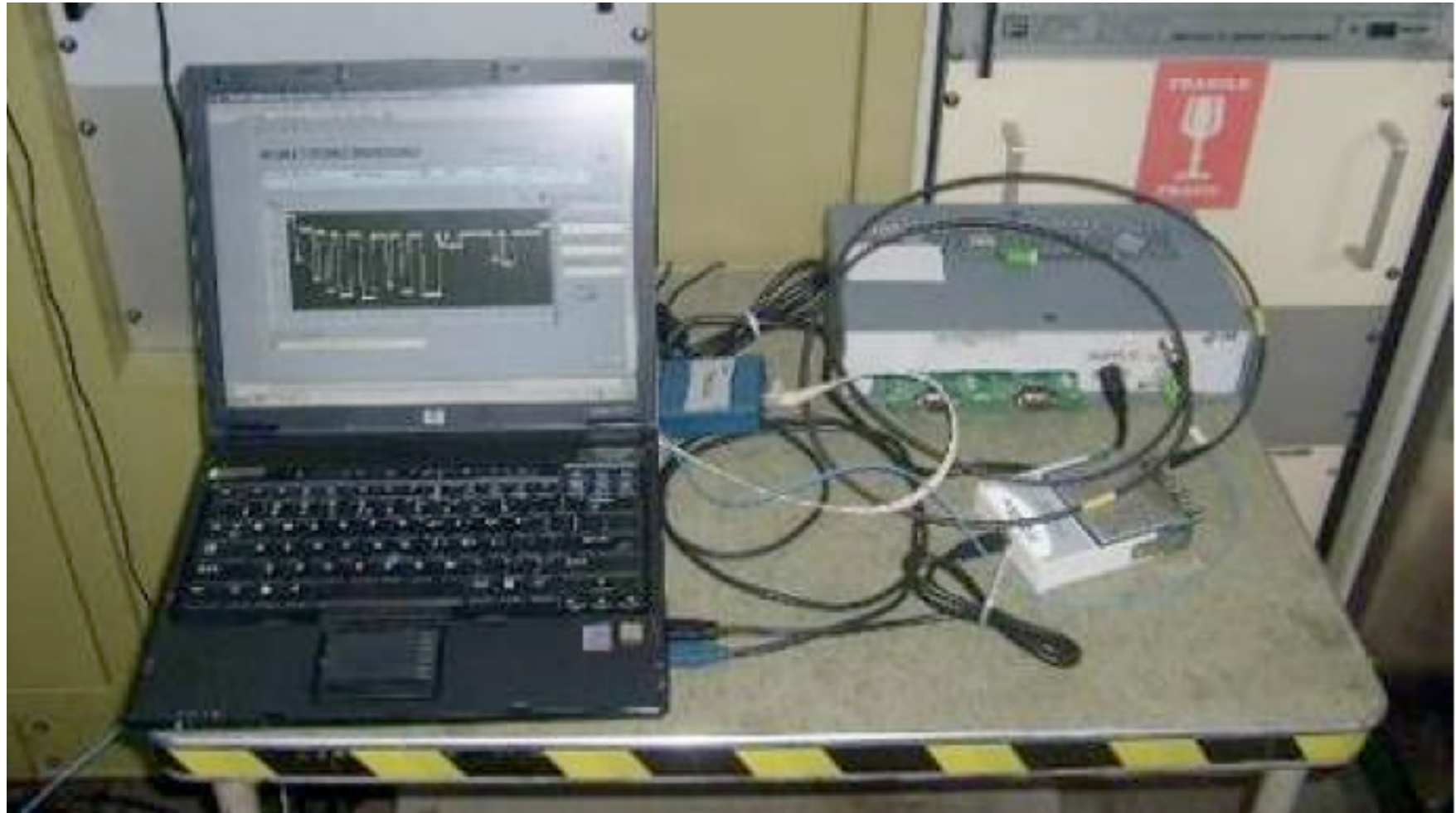


3-D Hall-probe stand

2-axis rotational FBG stand

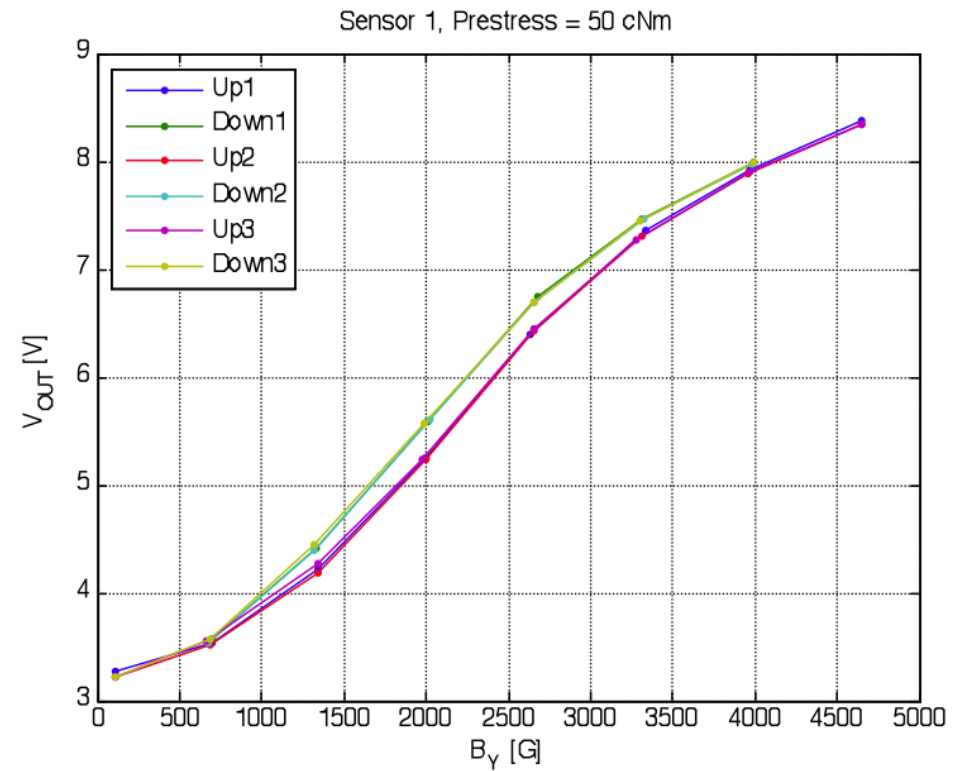
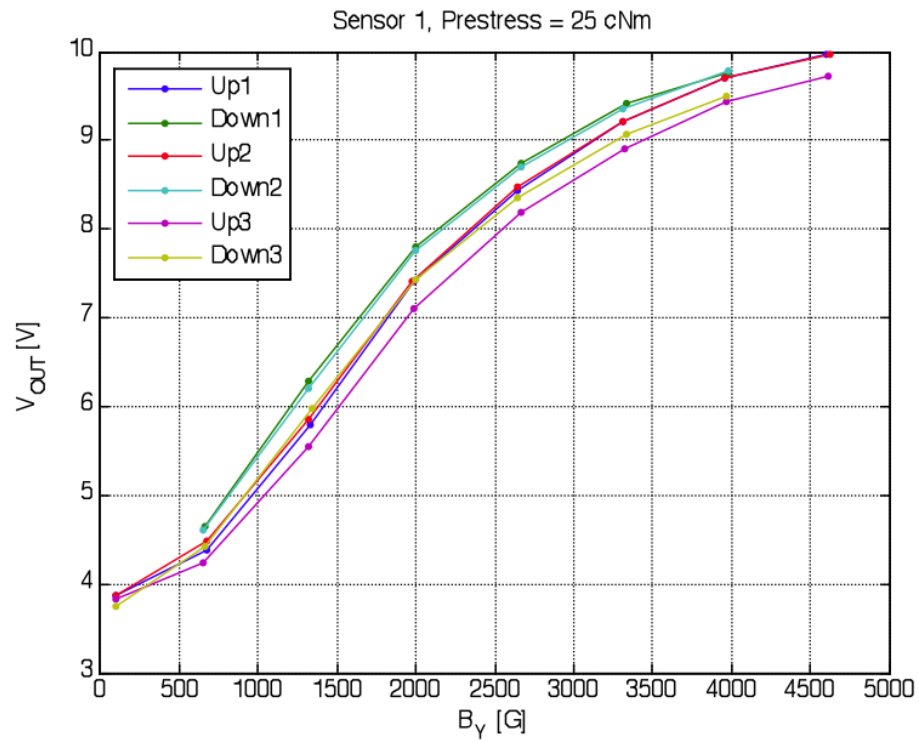


DAQ

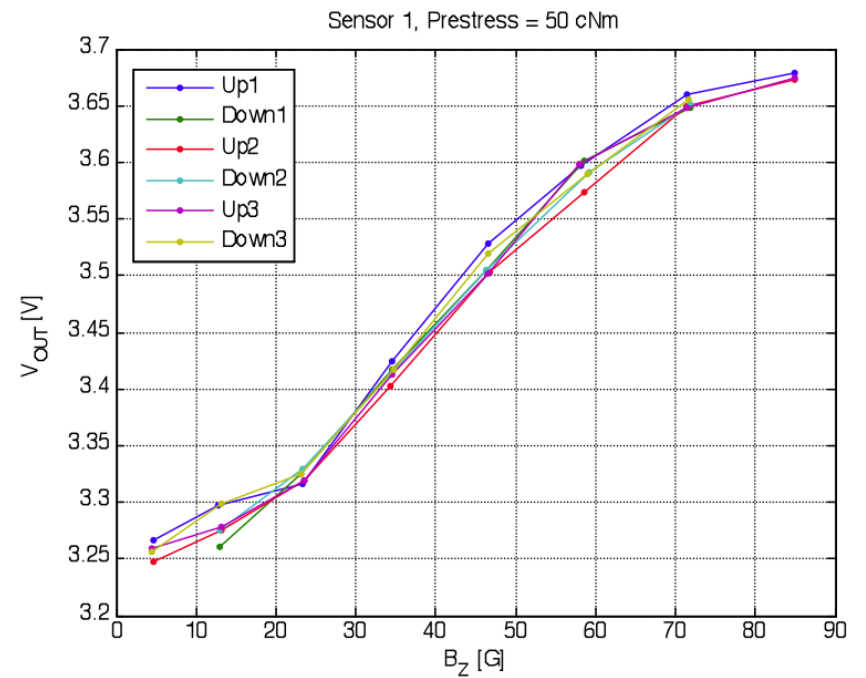
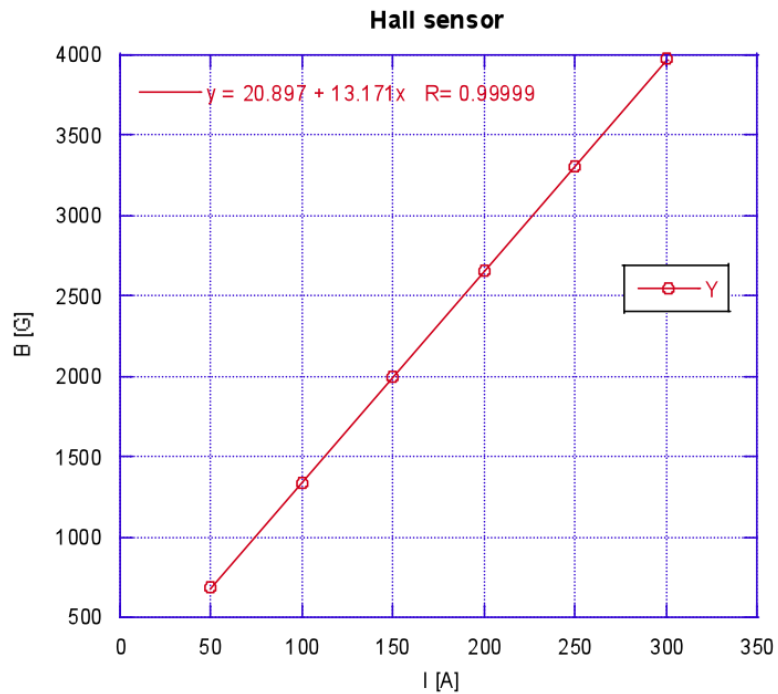
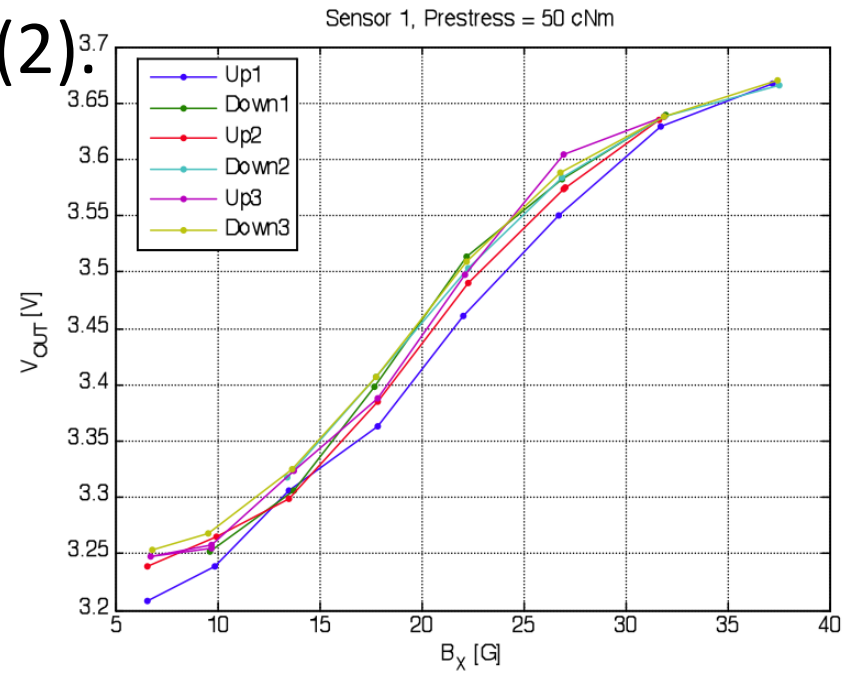
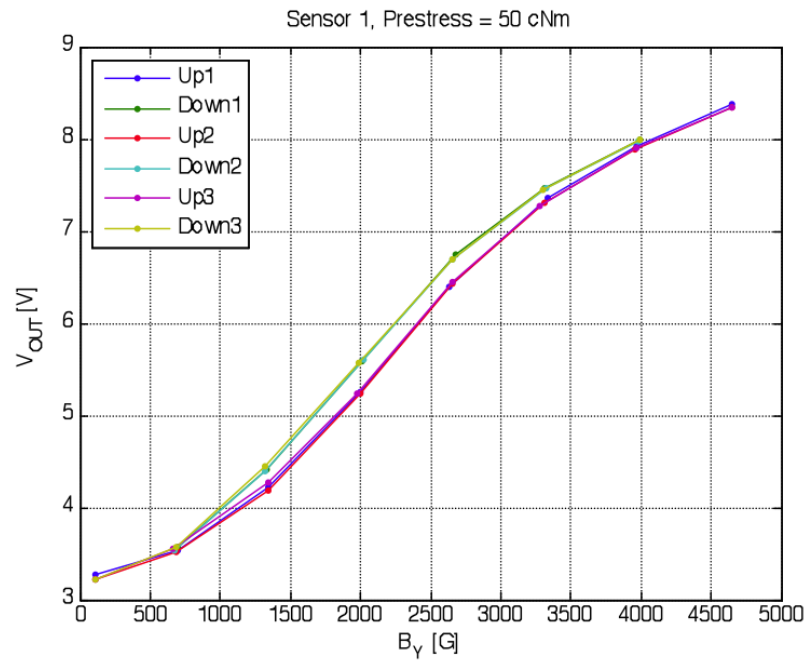


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Results (1).



Results (2).



Preliminary conclusions.

- Importance of the pre-stress on Terfenol
- Small hysteresis cycle when pre-stressed
- Linearity range 400-3000G (in the best case)
- Sensitivity, in the linear range, 2mV/G

Outlook of B-field Measurement Applications of Sensors Based on Optical Fibre Technology. .

- Development of a pre-stress free sensors (cladding).
- Improve the usefull range to 5T and above.
- Study the integration into the superconducting winding pack.
- Develop 3-D sensors arrangement.
- ...
- Application to EU ITN 2011 sent for two fellows for 3 years.