

# Status report on the FOS environmental monitor.

IFIC, 9<sup>th</sup> PXD Workshop



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# Outline



- PXD mock-up at DESY.
  - \_ FBG validation: Temperature & humidity
  - \_ Issues and lessons.
  - \_ Thermal studies.
- Proposal for April test beam & FANGS

# PXD mockup: FBG distribution

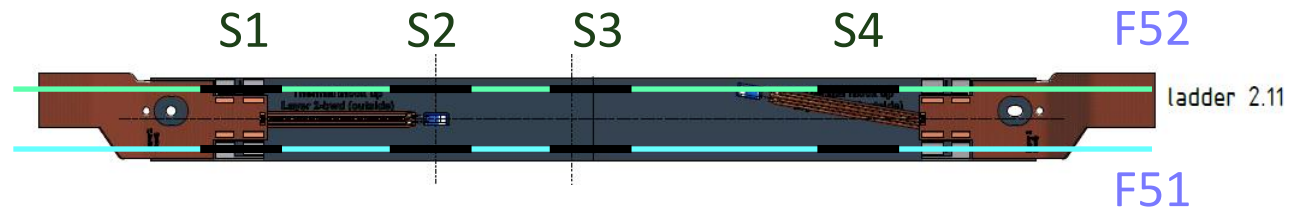
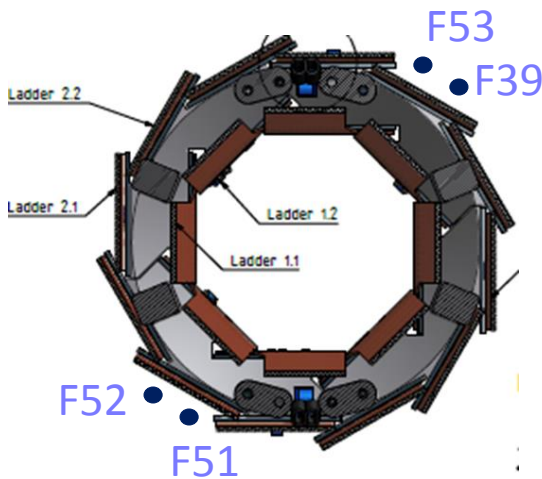


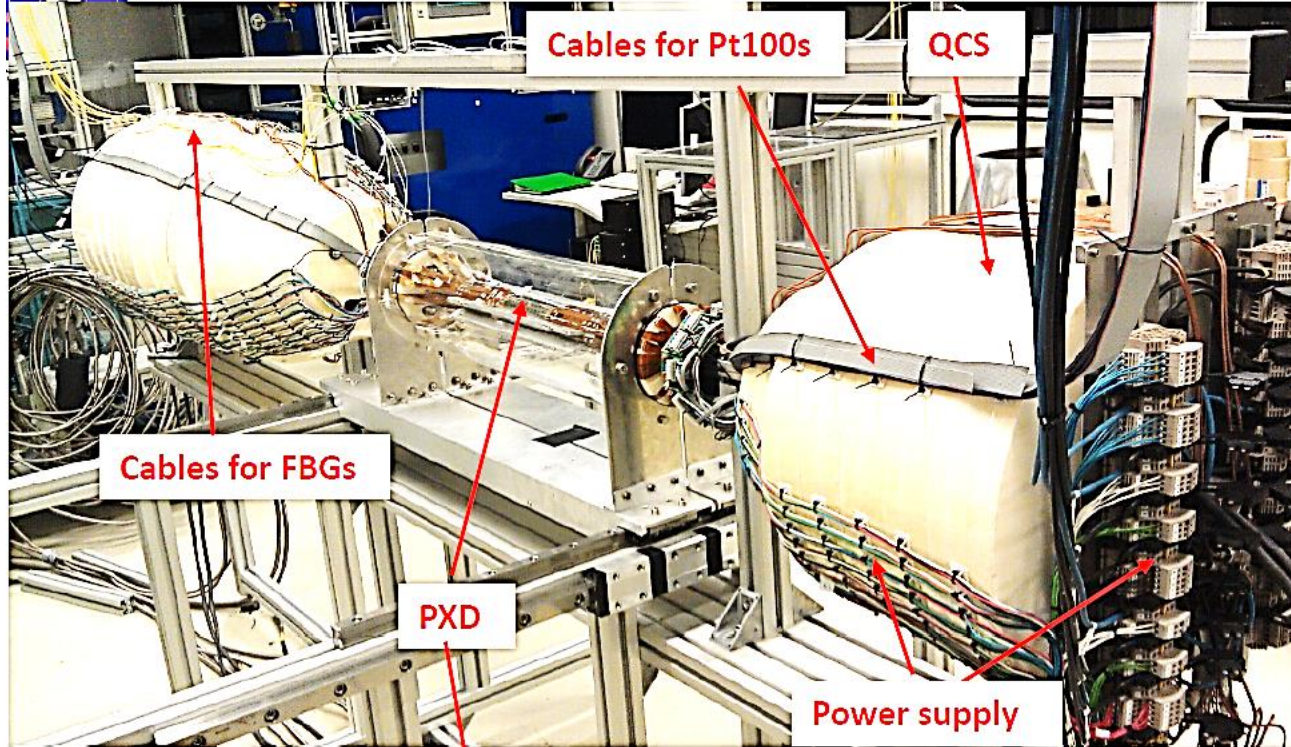
IFCA

A total of 16 FBGs for monitoring the temperature and humidity of the PXD atmosphere

Additionally 6 FBGs for cross validation and one standard humidity sensor

	Fiber ID	FBG#	Tubing	Dominant Sensitivity
Monitoring fibers (accordingly to FOS monitor design)	51	4	Teflon	Temperature
	52	4	Teflon	Temperature
	53	4	Teflon	Temperature
	39	4	none	Temperature + Humidity
Reference fibers (displaceable for ad hoc test)	Ref1	1	Metal	Temperature
	Ref2	1	Metal	Temperature
	F43	2	none	Humidity + Temperature
	F44	2	none	Humidity + Temperature



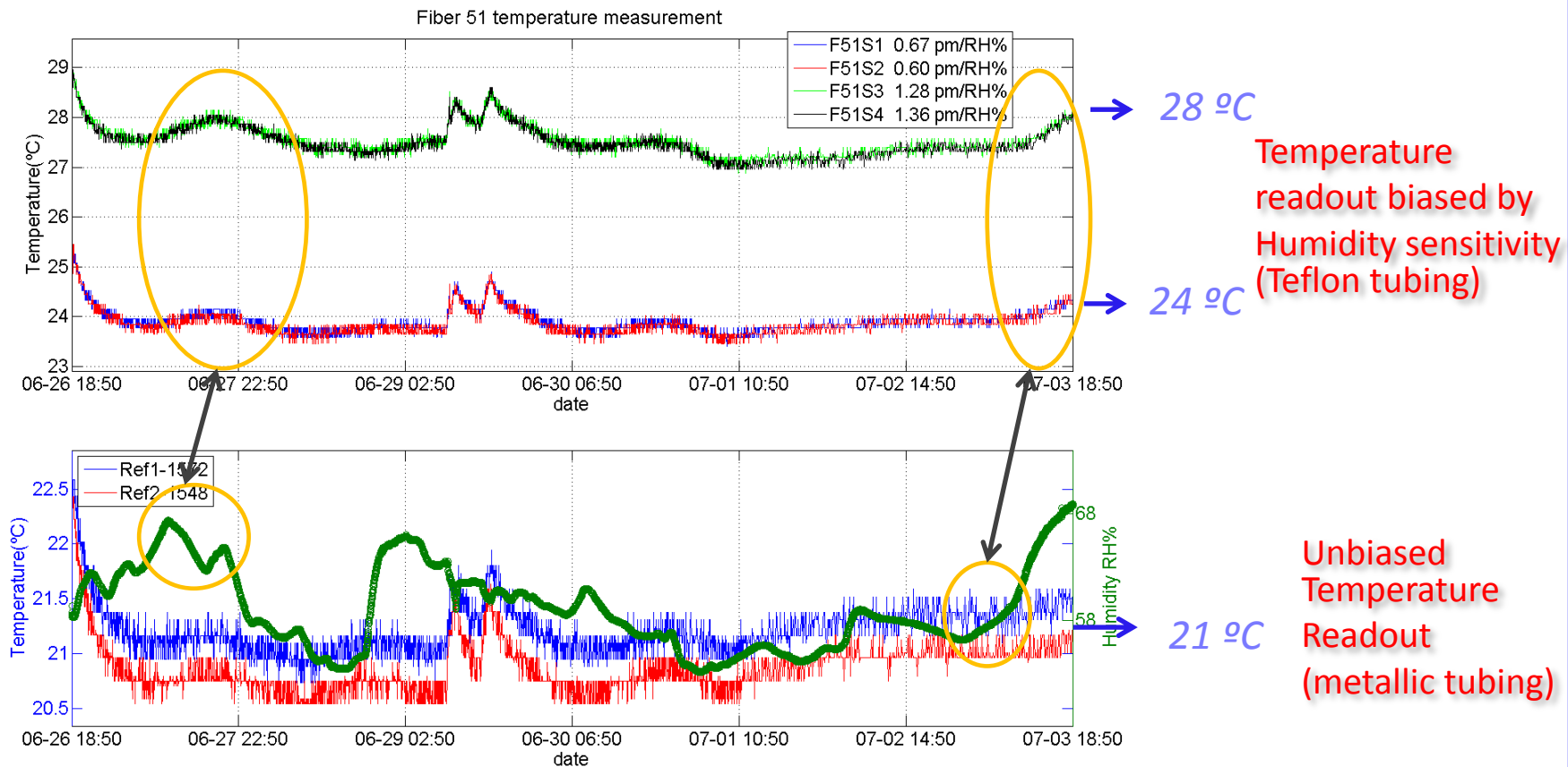


How accurately are FBGs measuring the temperature ?

# PXD Mock: Validation of Temp. Monitoring



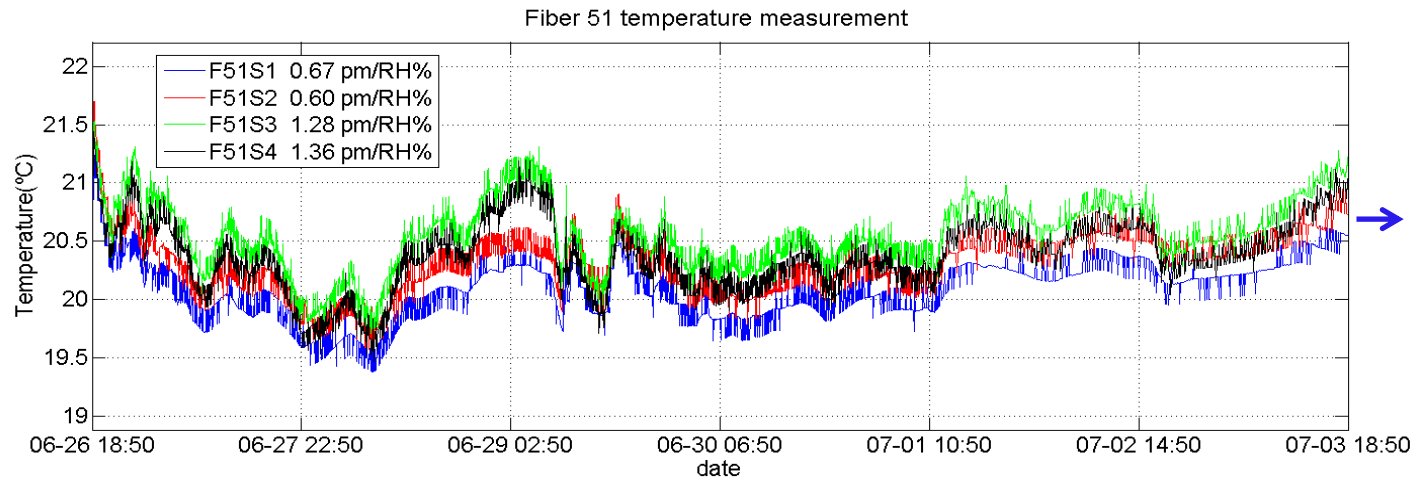
- Temperature monitoring sensors in fibers F51,F52,F53.
- Stable conditions: no heating, no cooling, no N2 blowing.
- Residual sensitivity to humidity observed ( latency response  $\sim$  days)
- Humidity offsets the temperature readout



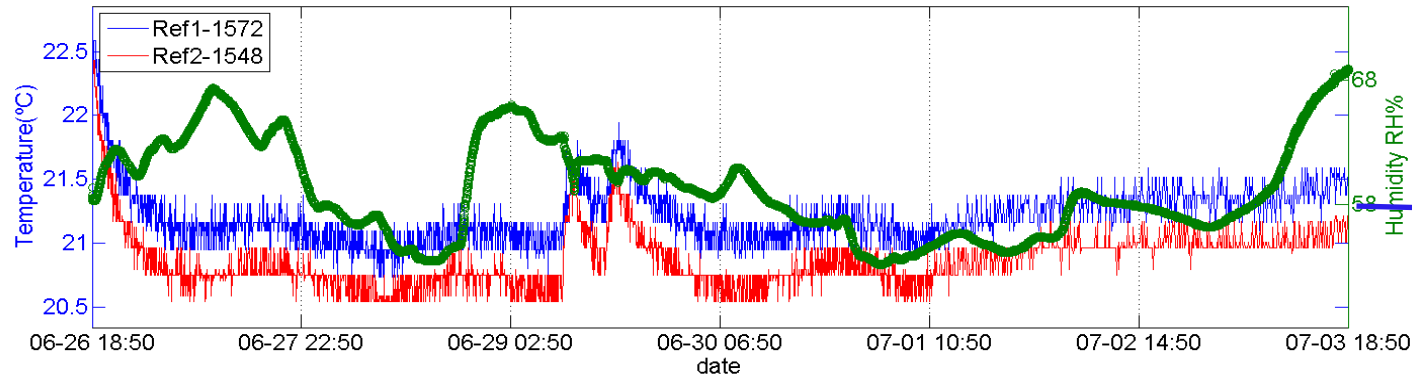
# PXD Mock-up: Validation of Temp. Monitoring (2)

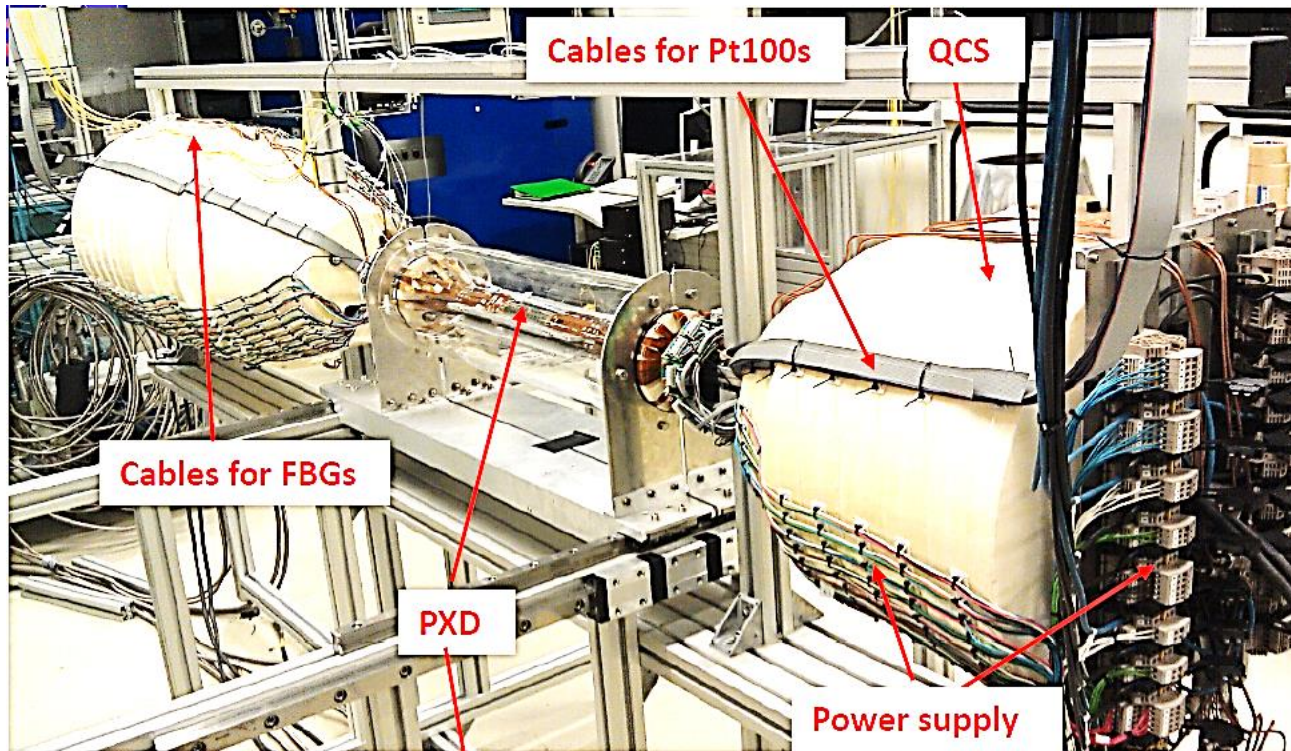


- F51 temperature after humidity bias compensation (coarse correction, latency not considered)



Agreement between reference FBG & Temperature FBG





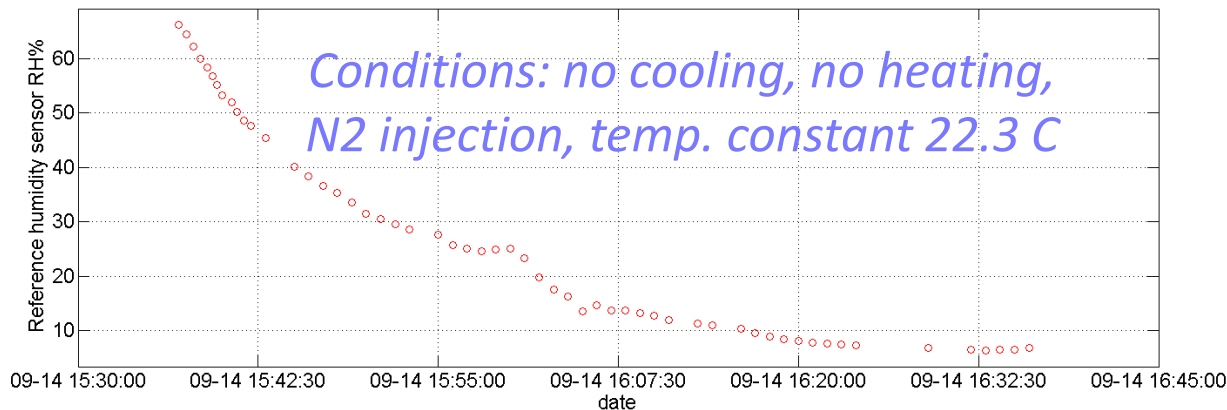
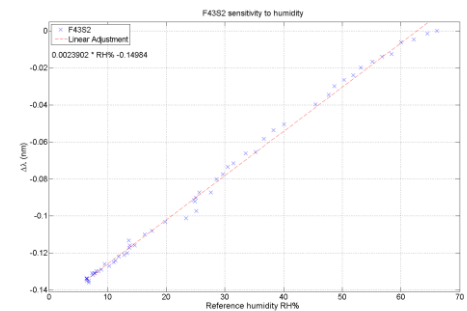
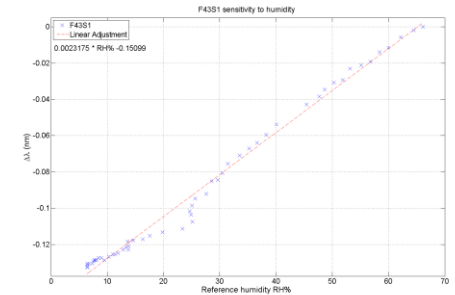
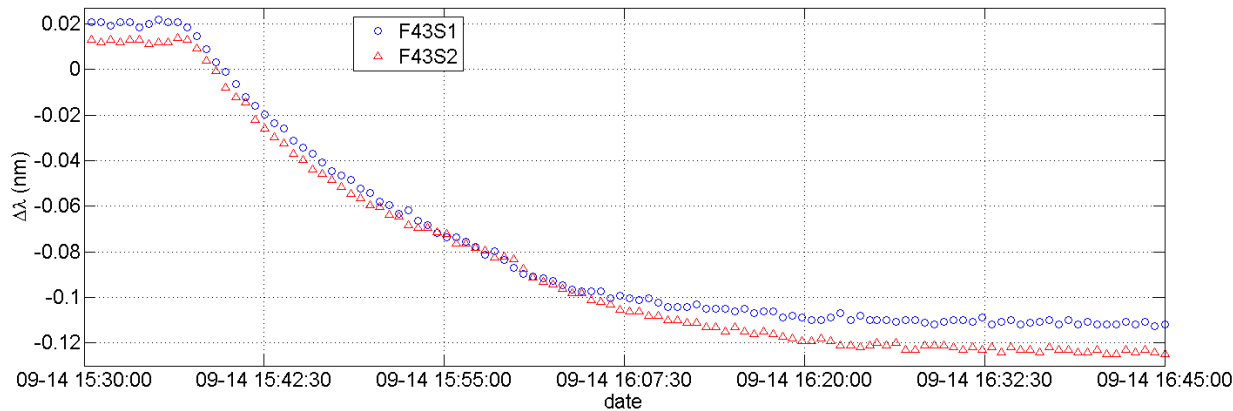
How accurately are FBGs measuring the humidity?

# PXD Mock-up: Validation of Humidity measurements



- FBG sensors in reference fiber F43 (no tubing) similar sensitivity as observed in January 2014 TB

Fiber 43 stability with time



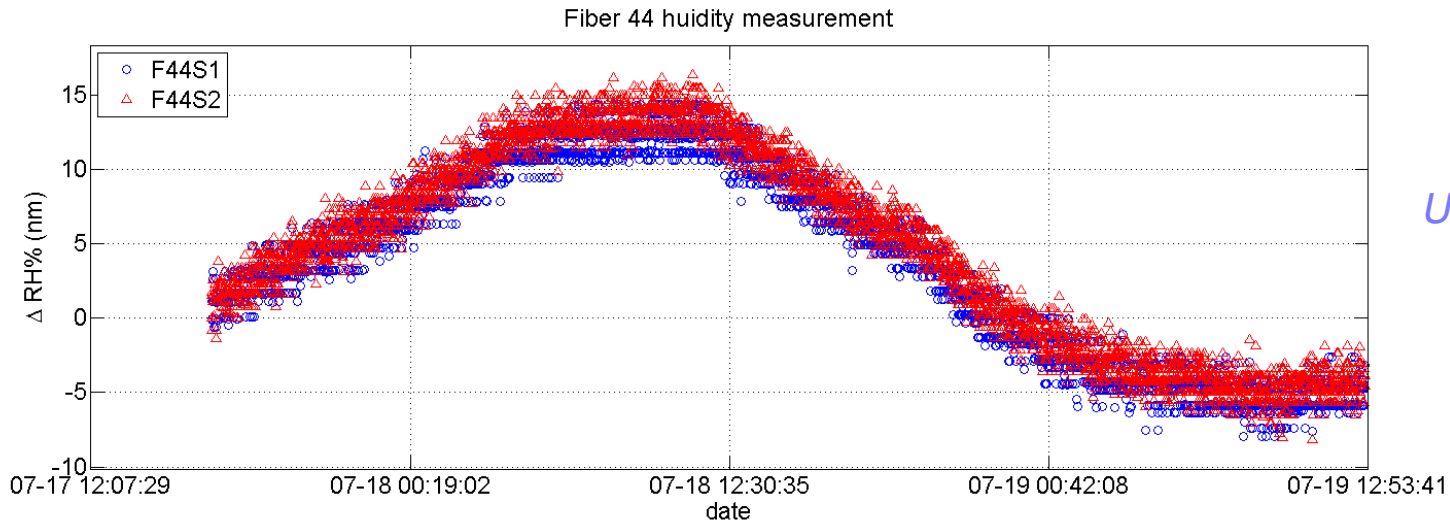
*Conditions: no cooling, no heating,  
N2 injection, temp. constant 22.3 C*



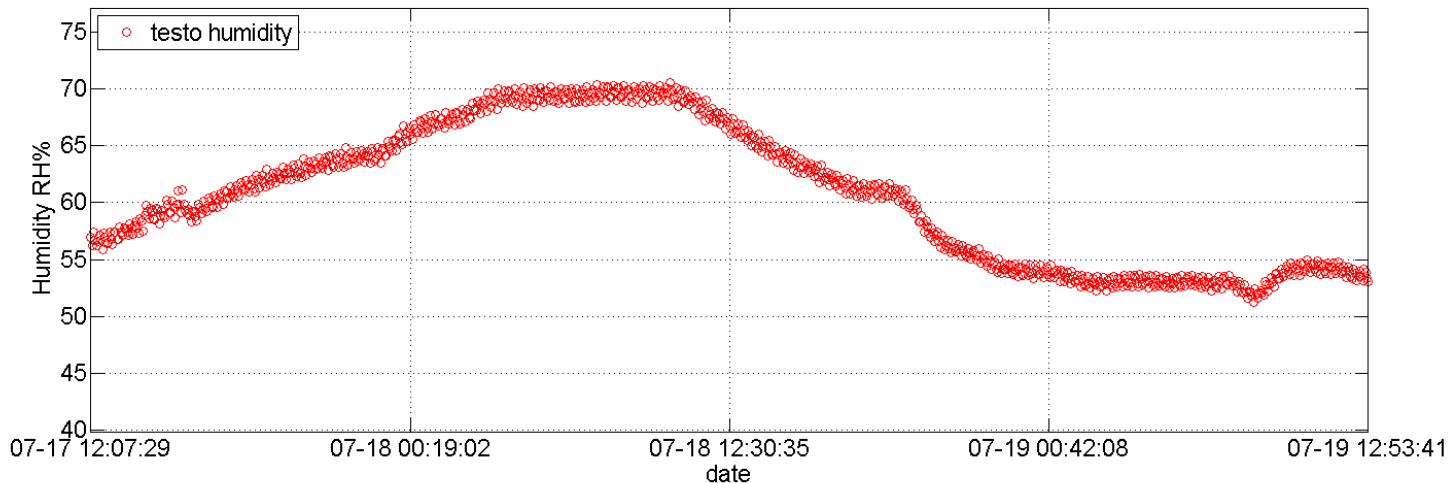
# First results: Humidity Reference Fiber



- Humidity reference sensor measures accurately Humidity change when the dry volume is open after temperature effect compensation

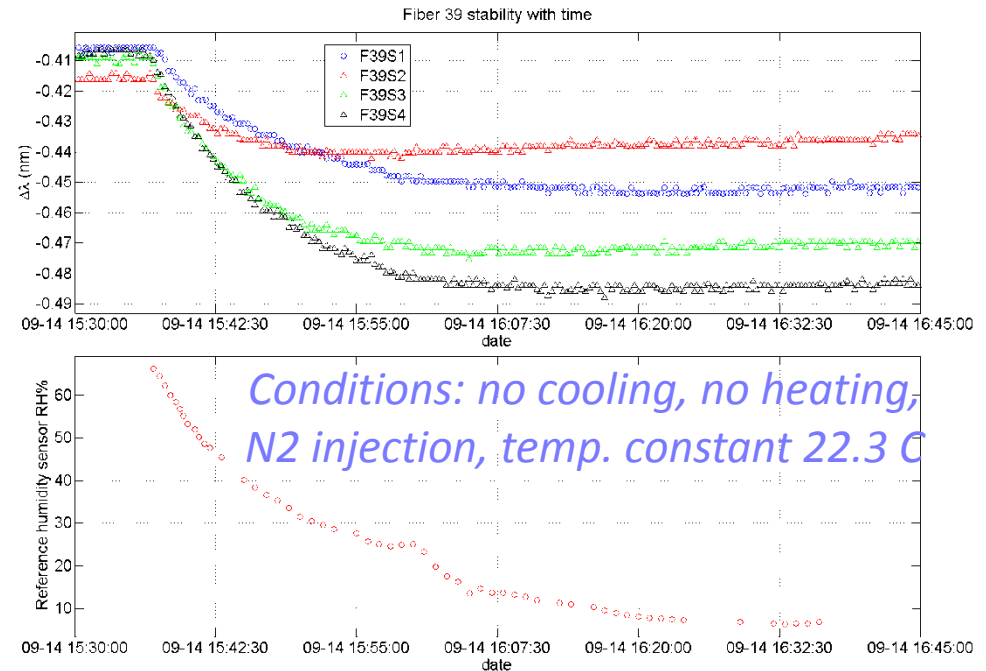
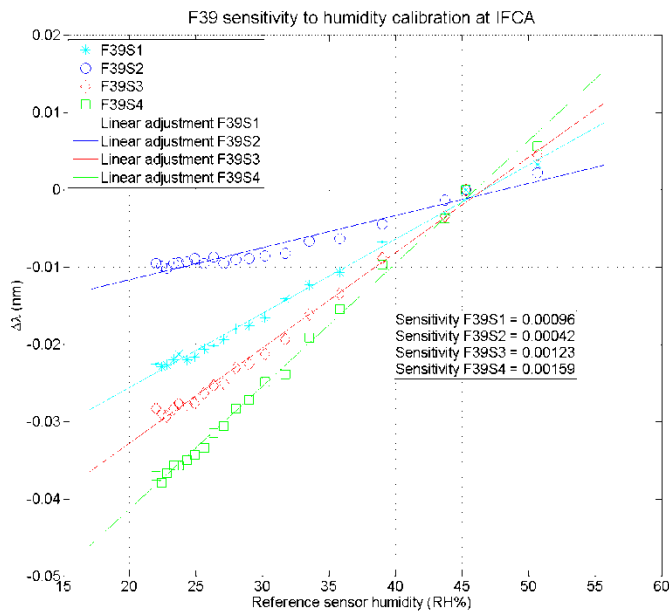


*Under stable thermal conditions*



# PXD Mockup: Validation of Humidity measurements (2)

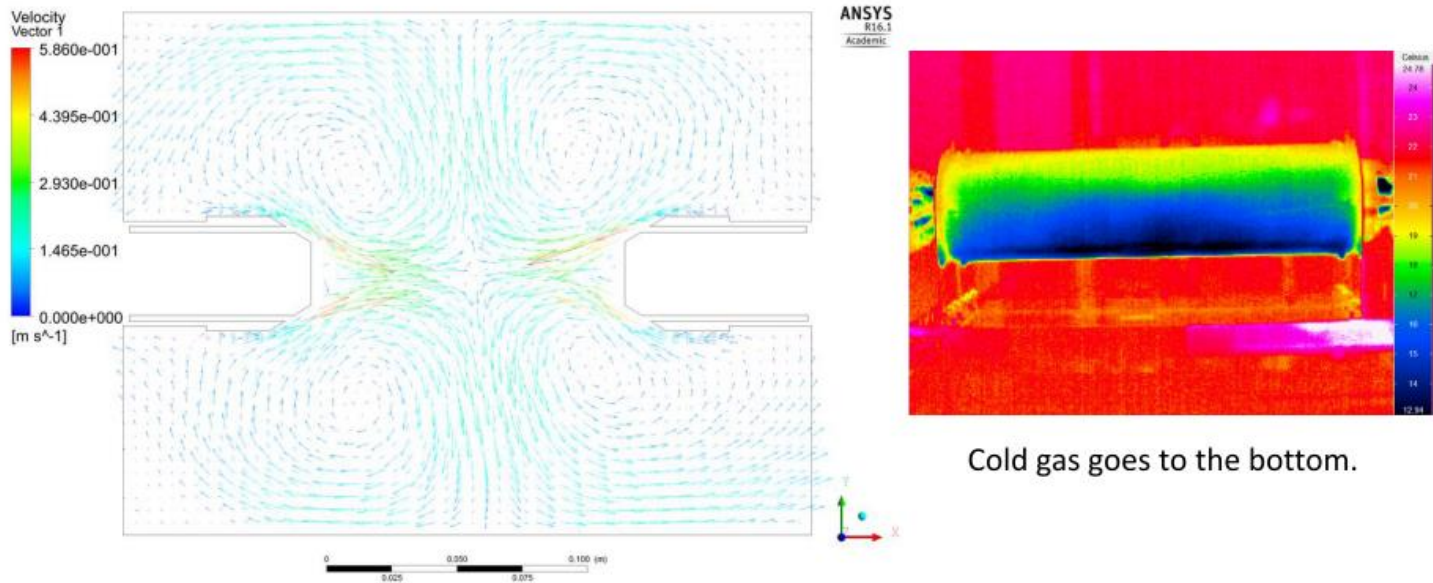
- FBG sensors in Monitoring fiber F39 (hints of humidity-induced mockup deformation).



- Under stable conditions Temperature and Humidity determined accurately.
- Issues to be address:
  - \_ Long latency humidity sensitivity of temperature sensors (observed during sensors calibration). Acrylate coating of fibers should solve this problem (see backup slide).
  - \_ In some cases (F39) fiber mounting induces parasitic strains (readout offset) in the FBG, this strain seems to depend on the humidity. New fiber fixing under design.
- But in real operating ....

# PXD Mockup: Operating Conditions

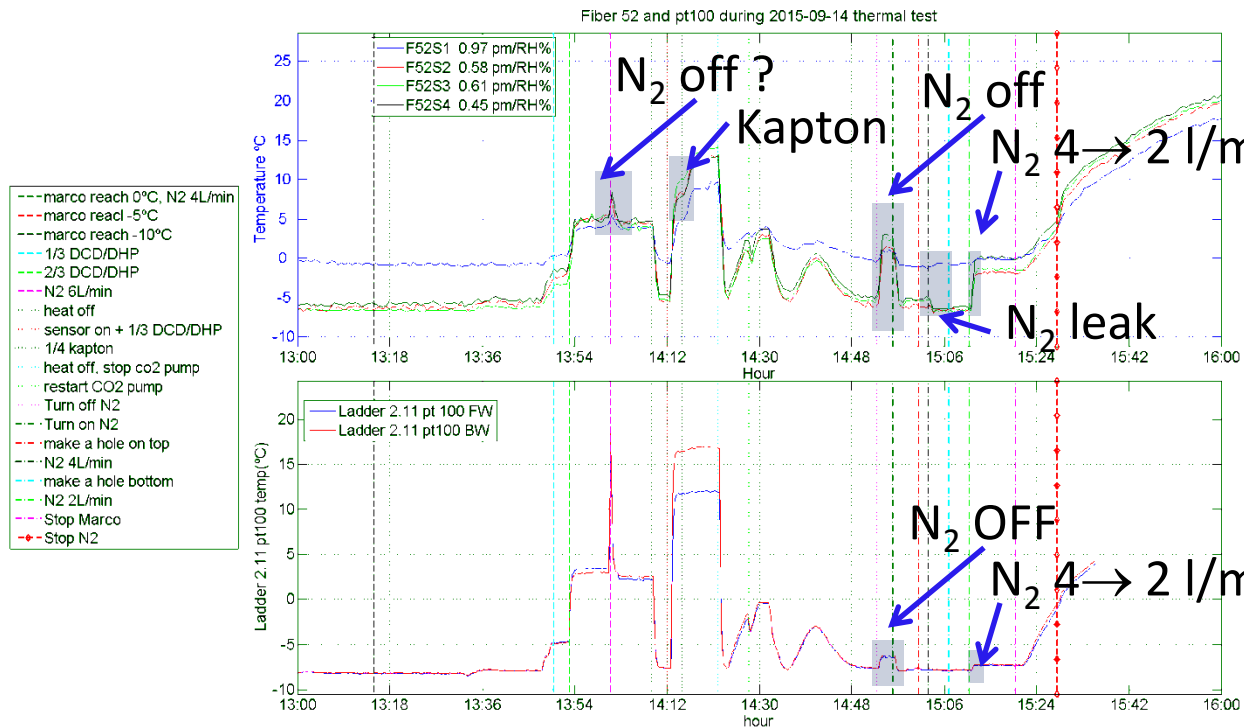
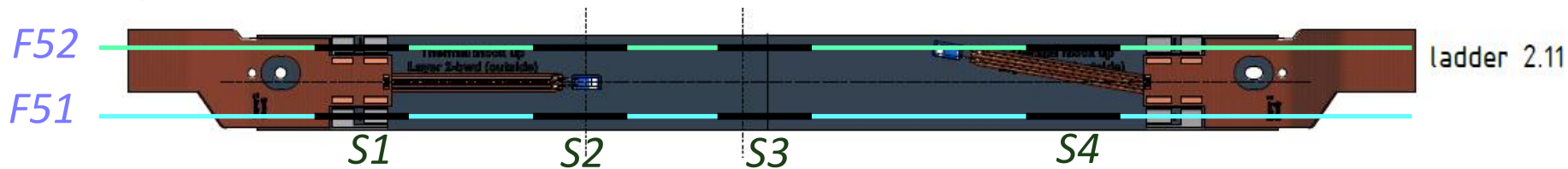
- ... Turbulent highly non-uniform regime inside the PXD envelope.



- Temperature compensation of humidity fiber is not possible with the current FBG distribution.
- Temperature readout accurate as long as temperature fibers F51, F52, F53 are operated long enough in a dry atmosphere.

# Mock-up: Temperature tests (N<sub>2</sub> atmosphere for 3 days)

– Comparison between Pt-100 in the ladder and FBG measurement



*FOS and pt100 very similar behavior.*

*S2-S4 sensing similar temperatures*

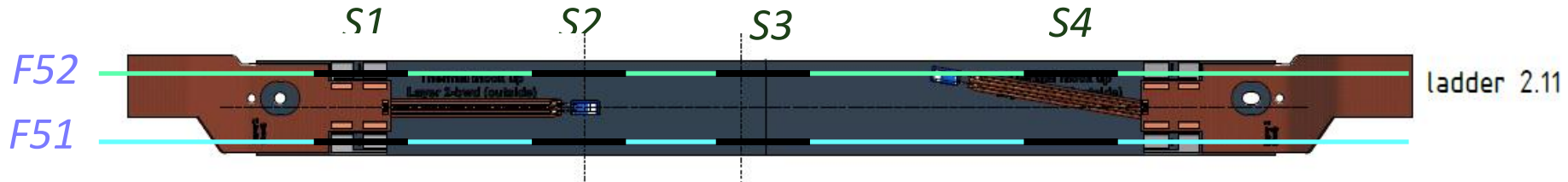
*S1 (outside the direct blow stream different behavior)*

*No effect of N<sub>2</sub> leaks*

*Sensitive to presence and flow of N<sub>2</sub>*

*FBG sensors more sensitive to the N<sub>2</sub> temperature.*

# Mock-up: N<sub>2</sub> Injection at different temperatures

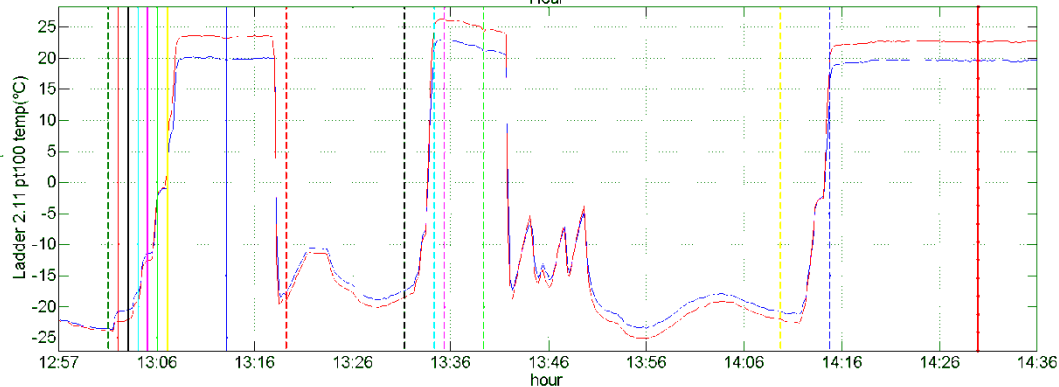
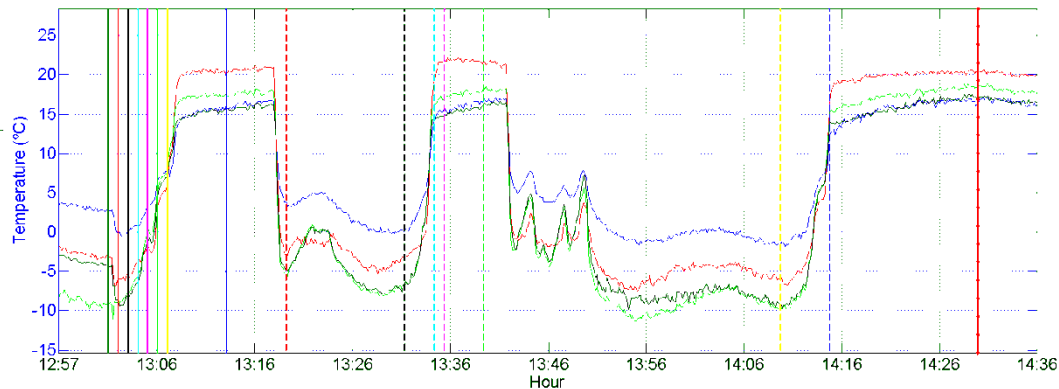


Fiber 52 and pt100 during 2015-11-20 thermal test

- F52S1 0.97 pm/RH%
- F52S2 0.58 pm/RH%
- F52S3 0.61 pm/RH%
- F52S4 0.45 pm/RH%

- N2 12L/min 1.33bar
- give heat: kaacton cable
- +1/3DCD/OHP
- +1/3DCD/OHP
- +1/3DCD/OHP sensor k
- +sensor l
- +S/V/G
- heat N2: 4.7V, 2.5A = 11.75W both side
- - - CO2 pump of Marco stops unexpectedly
- - - start the FXD power supply again
- - - heat N2: 6V, 3A = 18W for both side
- - - heat N2: 7.6V, 4A = 30W for both side
- - - CO2 pump of Marco stops again
- - - start giving heat to FXD
- - - move the thermal camera to the other side
- - - stop heat to N2

- Ladder 2.11 pt 100 FW
- Ladder 2.11 pt100 BW

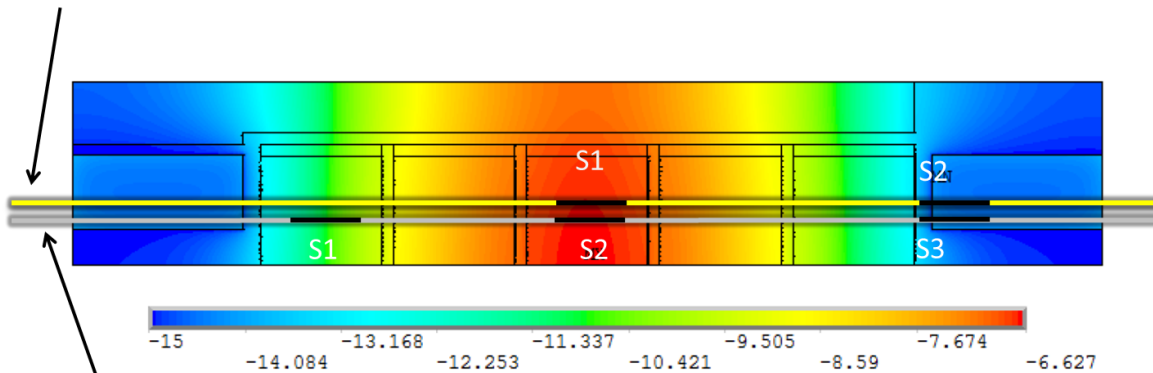


*No Increase on the temperature is observed.  
Is the N2 being really heated?*

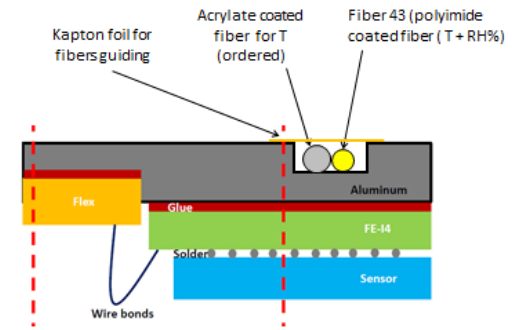
# Test Beam and FANGS proposal

- For April's test beam we could re-use the current system used at DESY mock-up (already employed in January 2014 integrated test beam).
- Additional fibers for FANGS ladders.

Fiber 43 (polyimide coated fiber ( T + RH%))



Acrylate coated fiber for T° (ordered)



# Conclusions



- Under stable environmental conditions: accurate temperature and humidity measurement with fibers (reproducing January 2014 test beam)
- Under mockup operating conditions: accurate temperature measurement mapping pt100 readouts with additional sensitivity on N2 atmosphere conditions.
- Issues to be address:
  - \_ The temperature compensation required for determining the humidity not possible (yet).
  - \_ Residual FBG strains due to fiber fixing.
- Proposal for a test beam and FANGS configuration.



# Conclusions



- Sensible temperature recordings (accuracy  $\sim 1^{\circ}\text{C}$ )
- Accurate Humidity change measurement in stable temperature conditions (reproducing January 2014 test beam results)
- Humidity monitoring during thermal test in progress

# Coatings sensitivity to humidity

