

High-pressure transducers as transfer pressure standards evaluated by a 1 GPa pressure comparison

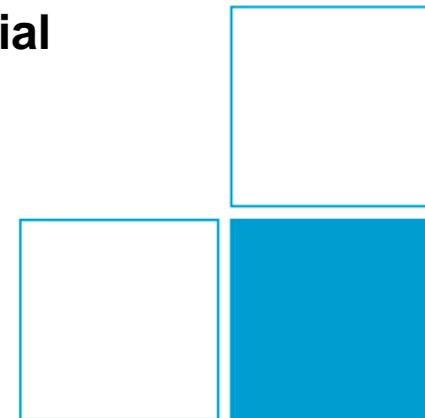
Dr. Jens Könemann / OE 3.33 „Pressure“

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Workshop on
High-pressure Metrology for Industrial Applications
PTB, Braunschweig, Germany
September 17, 2014



Background

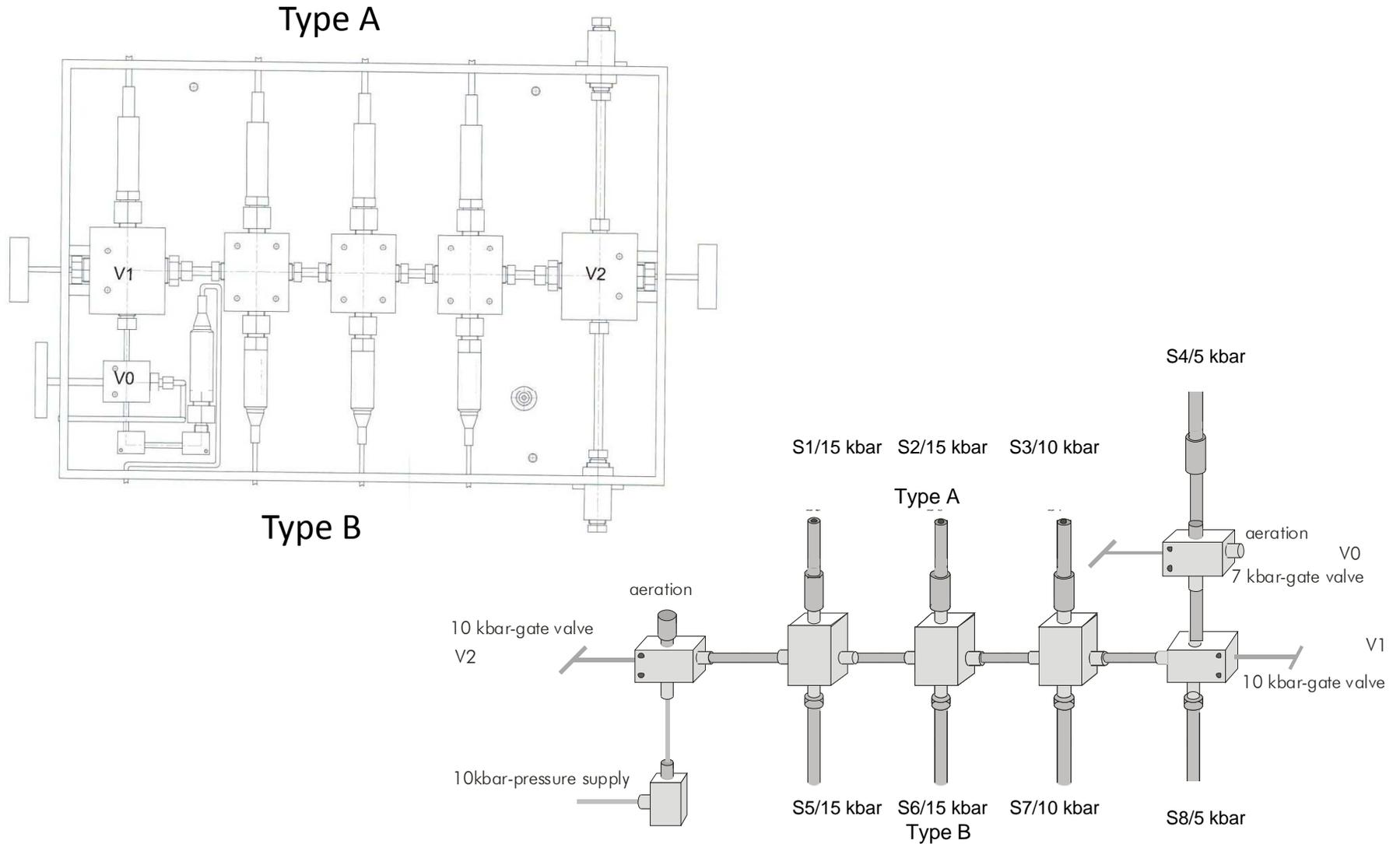
- Project: IND03 HighPRES „High pressure metrology for industrial applications”
 - Task 5.4: Characterisation and optimisation of modern 1.5 GPa pressure transducers. Investigation of their drift, hysteresis, sensitivity, repeatability, long-term stability and load cycling effects.
 - Task 5.5 Development and testing of 1.5 GPa transfer standards realised on the basis of high-precision pressure transducers. Verification of the transfer standards, application in comparison measurements in the range from 0.1 GPa to 1.5 GPa
- Registration as supplementary comparison EURAMET 1306

Comparison: general remarks

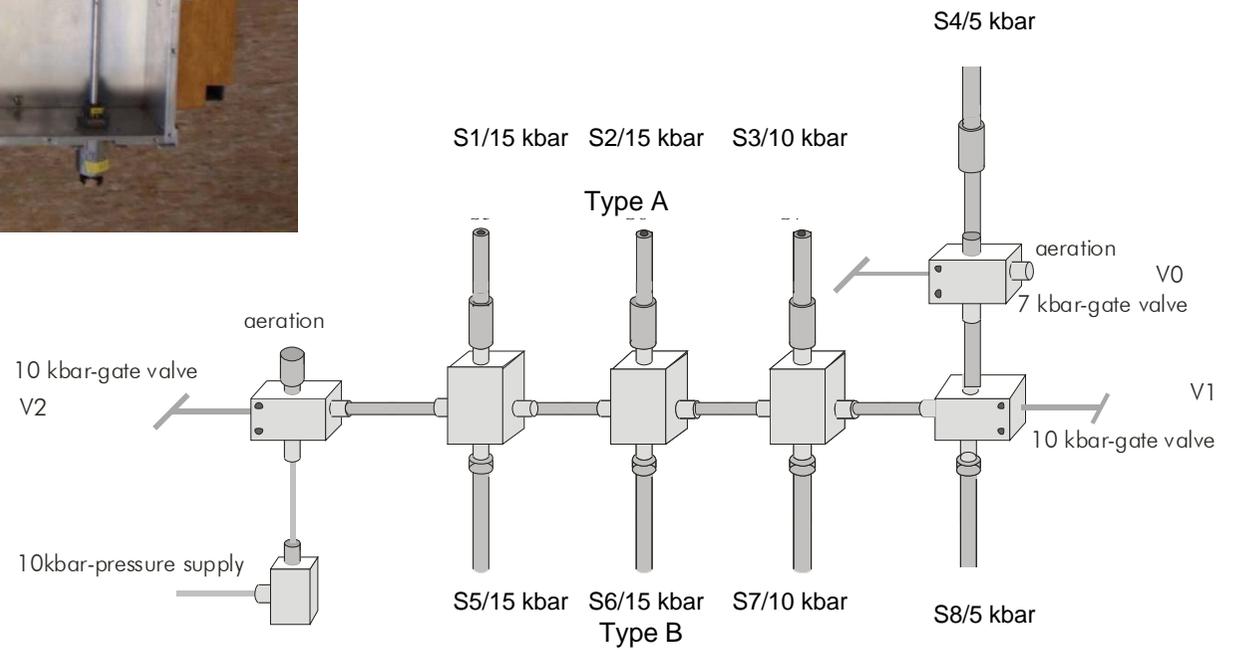
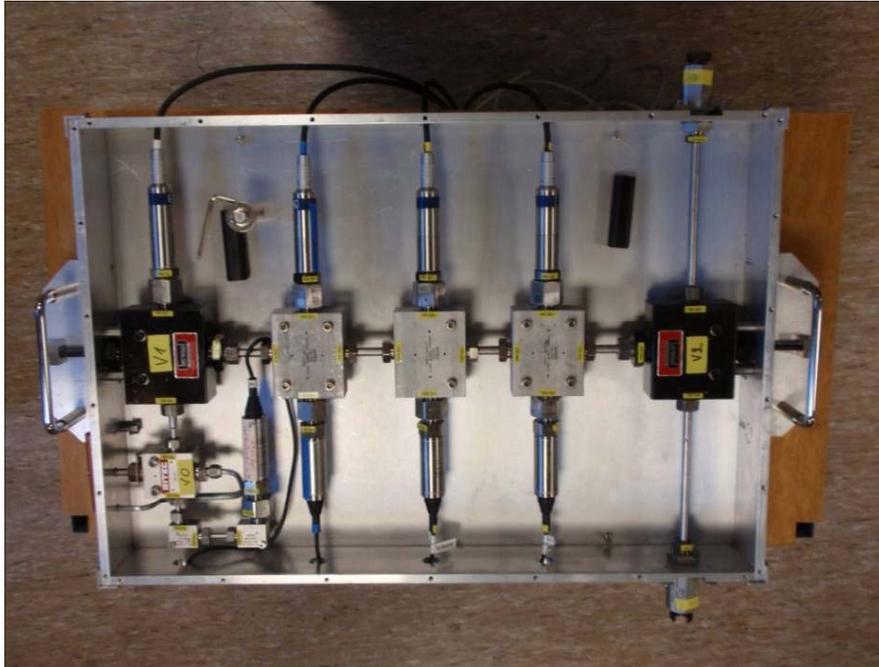
Measurement time	Institute
until 26.04.2013	PTB, initial investigation of TS
29.04. – 31.05.2013	CMI
03.06. – 12.07.2013	SMU
02.09. – 10.11.2013	LNE
27.11. – 28.02.2014	METAS
01.05. – 21.05.2014	PTB, final investigation

- Two measurement ranges: CMI & SMU 0.5 GPa, PTB, METAS, LNE 0.5 & 1.0 GPa
- Two types of absolute pressure transducers with three ranges and four individuals each under investigation:
 - Type A: foil strain gauge with RS-232 interface
 - Type B: thin-layer strain gauge with USB connector
- Due to delays LNE and METAS interchanged positions in time table
- SMU deviated from technical protocol: only two runs
- One participant had problems with pressure generation: only 8 kbar reached
- Transfer standard „survived“/ no leakages etc...

Layout of transfer standard

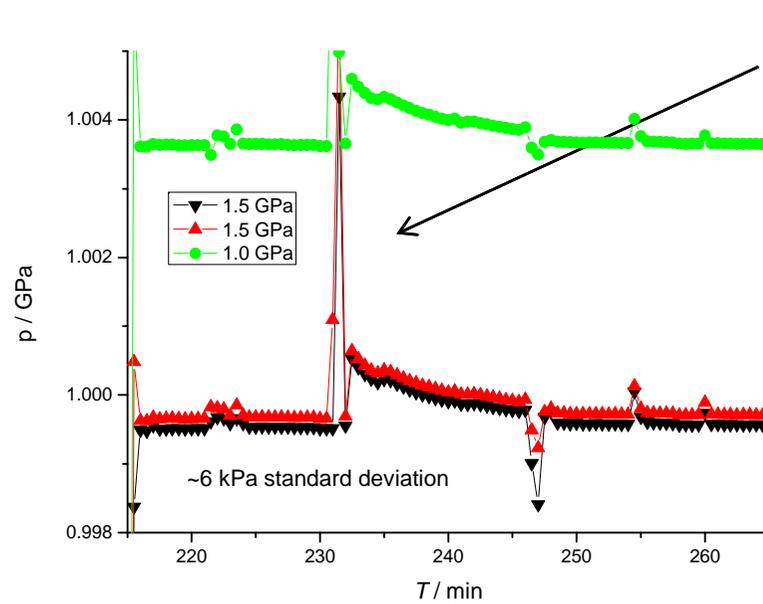


„Insight“

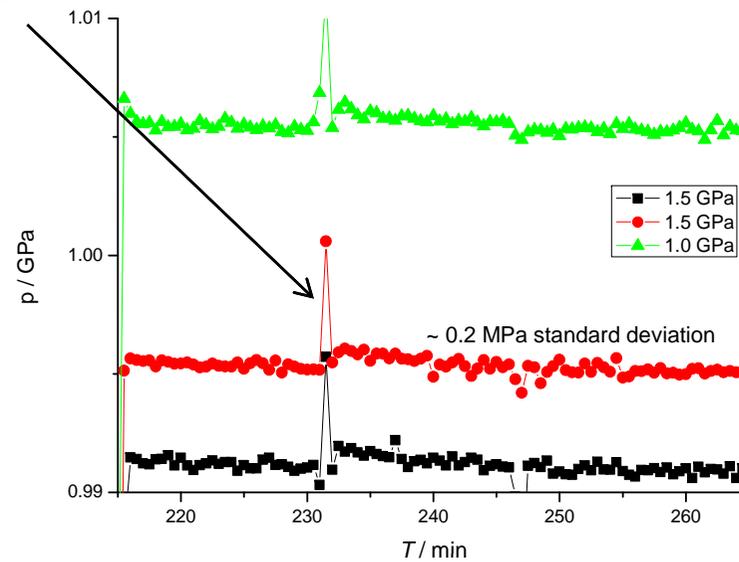


Transducer characteristics

Load: 1.0 GPa



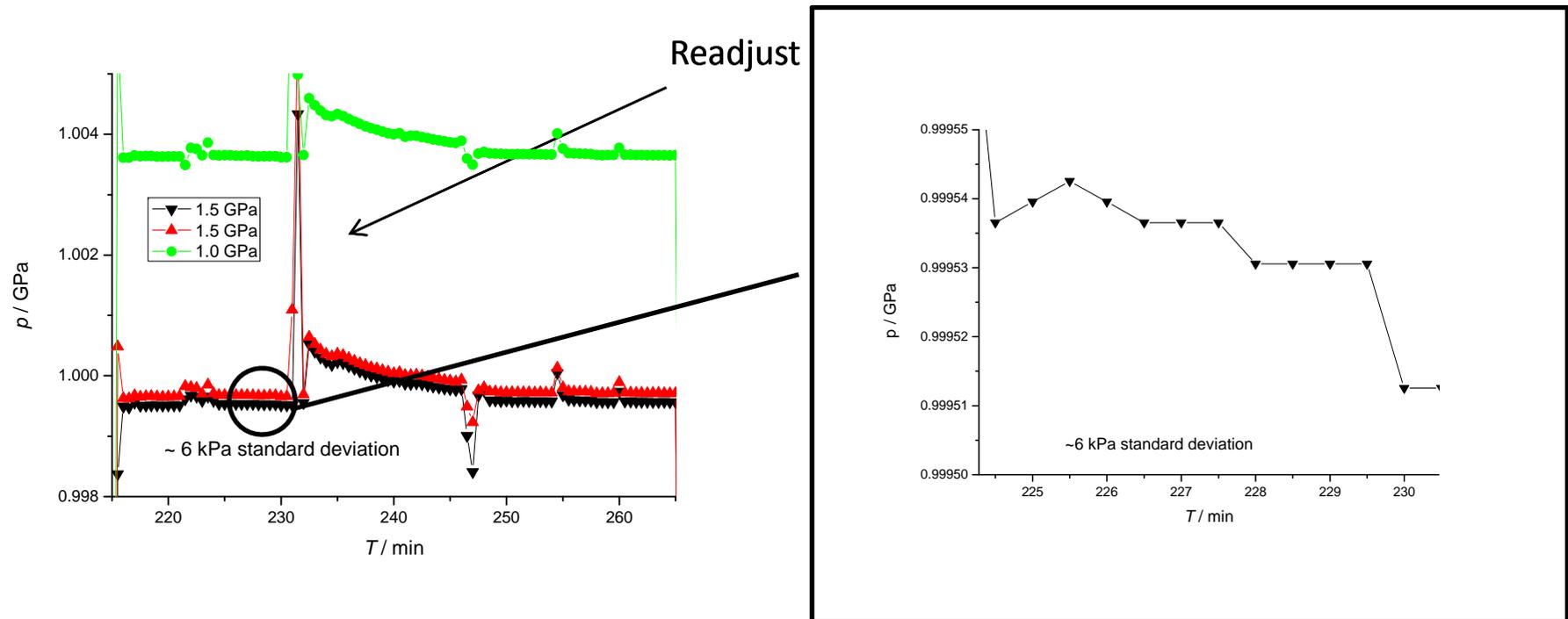
Type A (S1 – S3)



Type B (S5 – S7)

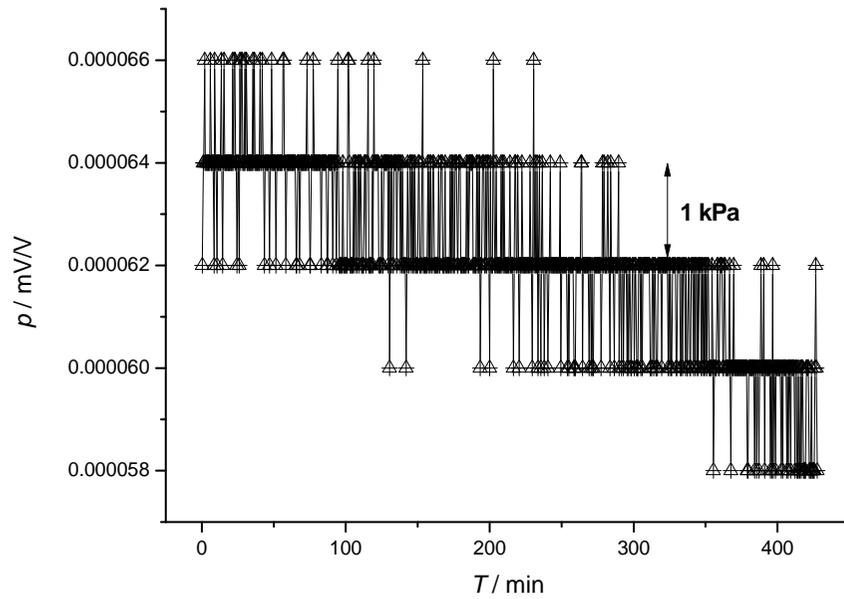
Transducer characteristics

Load: 1.0 GPa

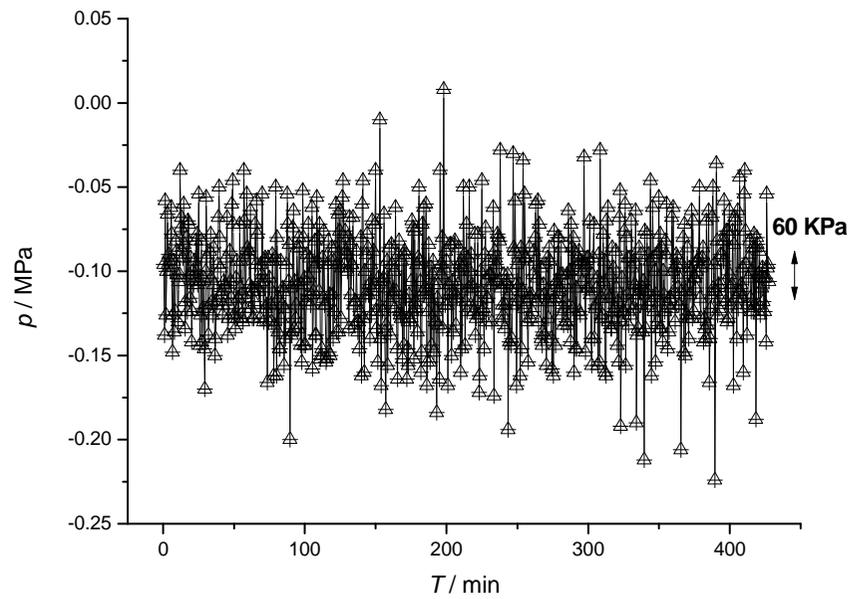


Index stability

7 hours, no load



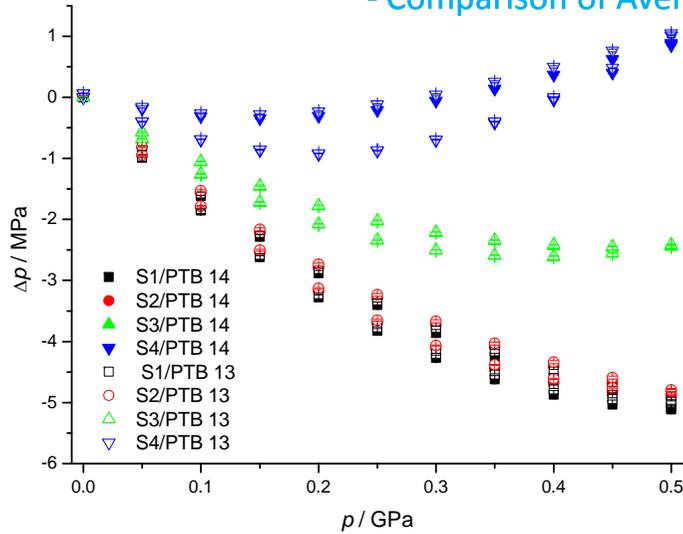
(S4: 0.5 GPa)



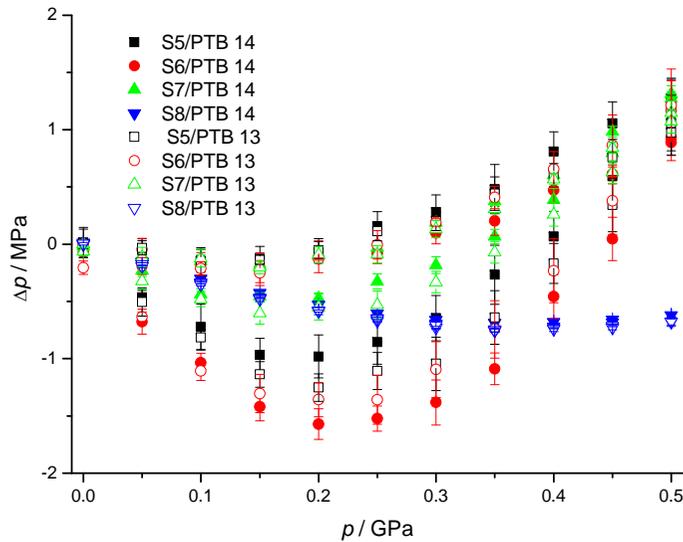
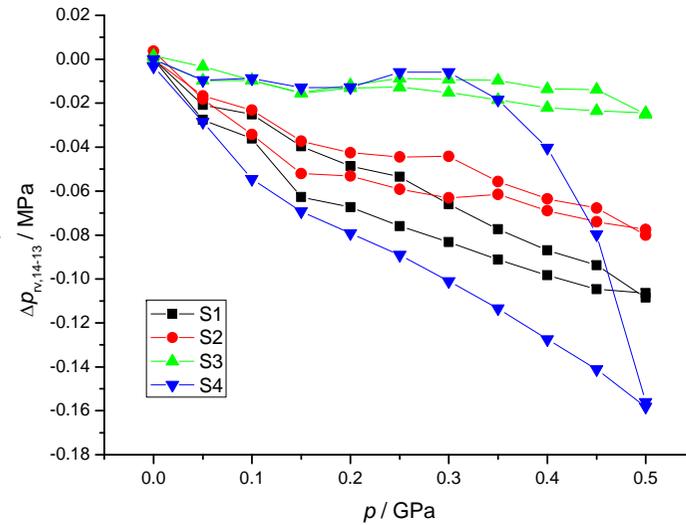
(S8: 0.5 GPa)

Determination of TS stability, 0.5 GPa

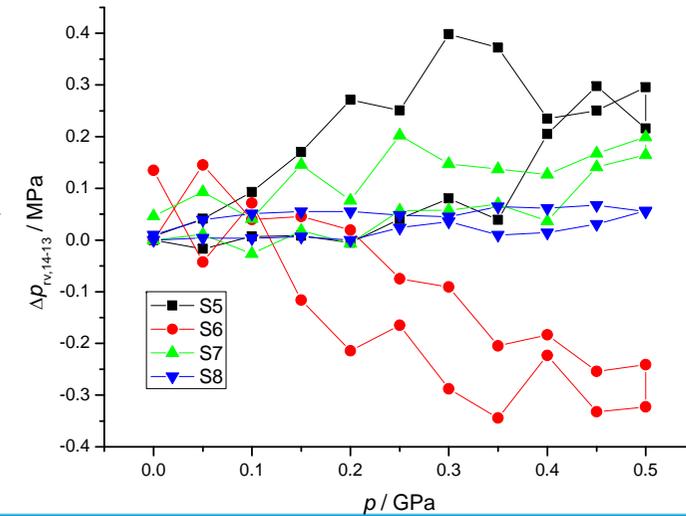
- Comparison of Averages of PTB 2014 to PTB 2013 measurements -



Type A

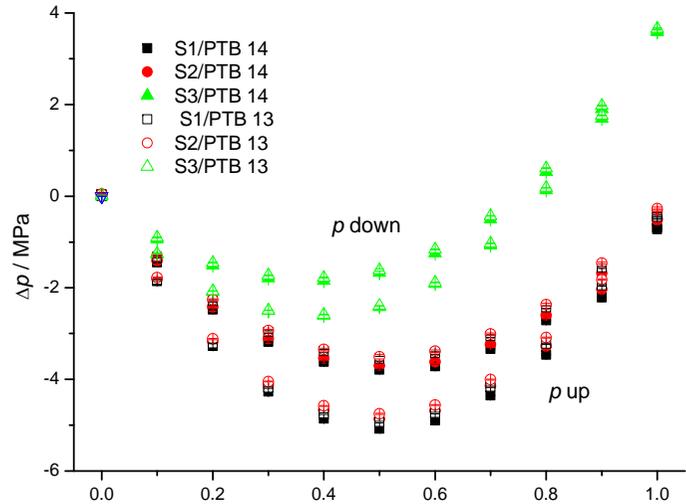


Type B

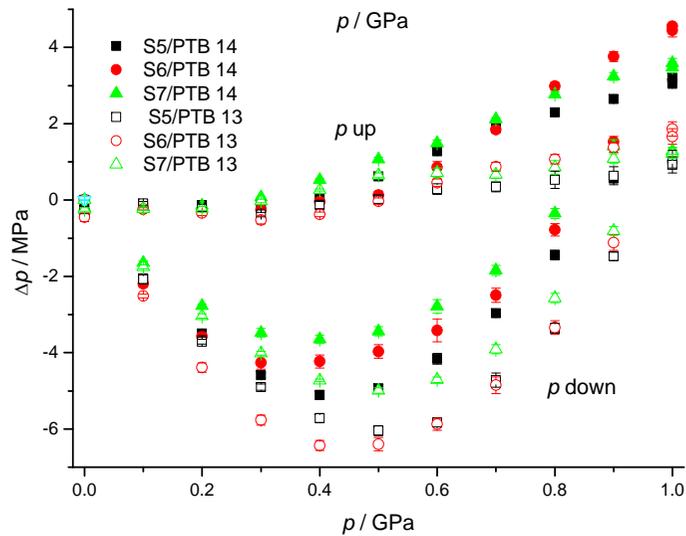
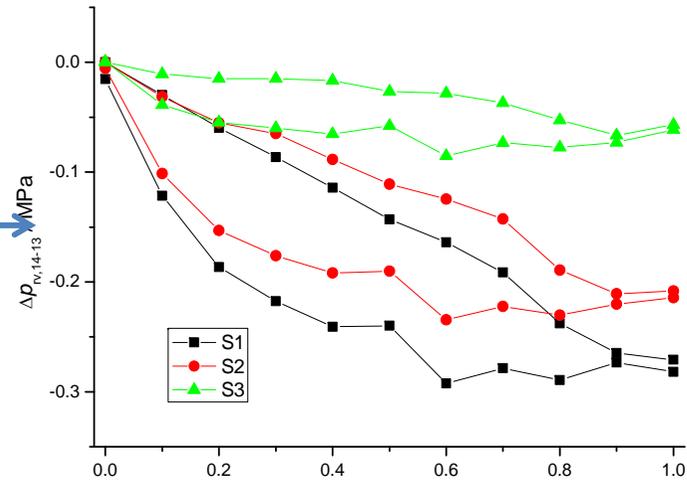


Determination of TS stability, 1.0 GPa

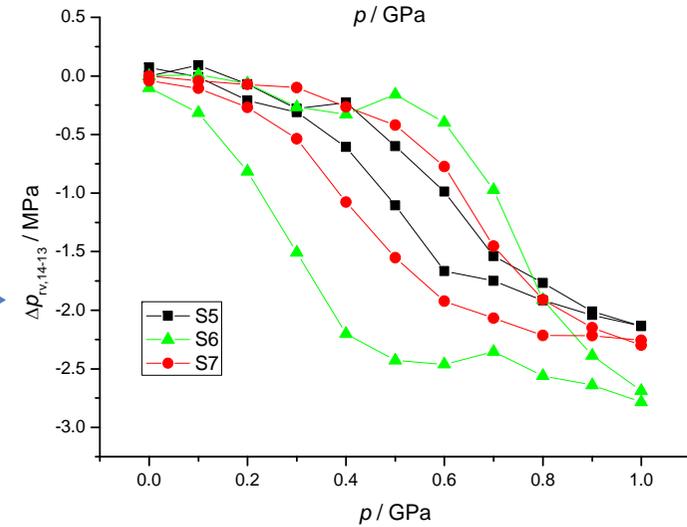
- Comparison of Averages of PTB 2014 to PTB 2013 measurements -



Type A



Type B



Determination of TS stability

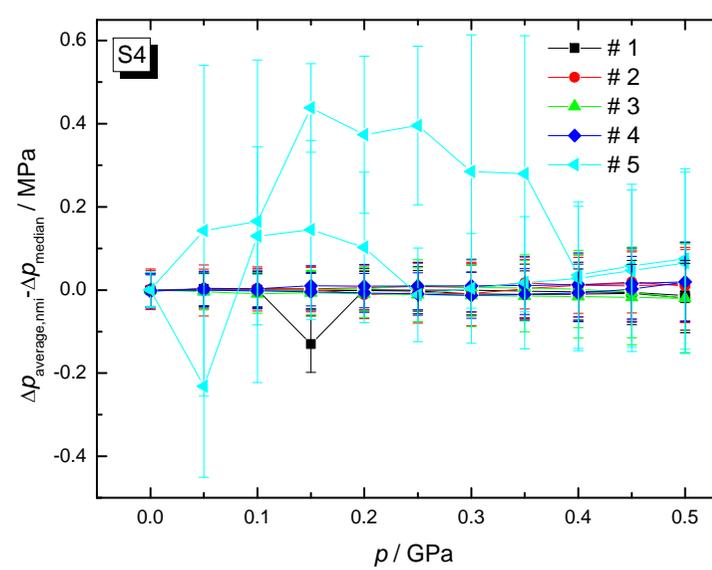
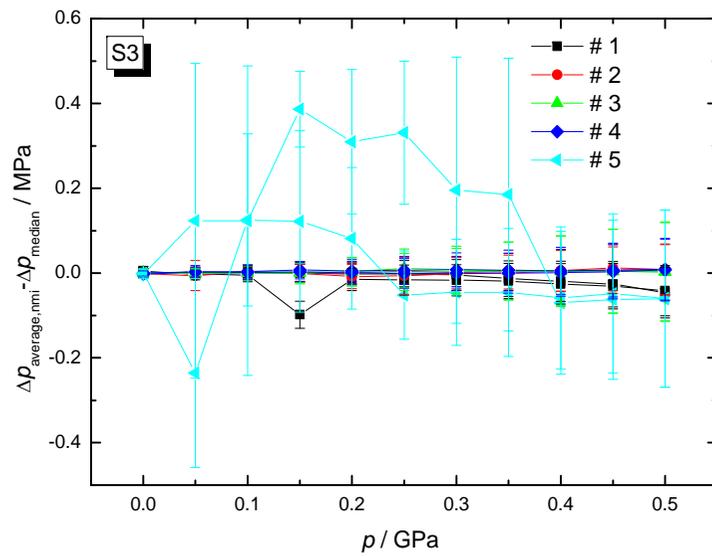
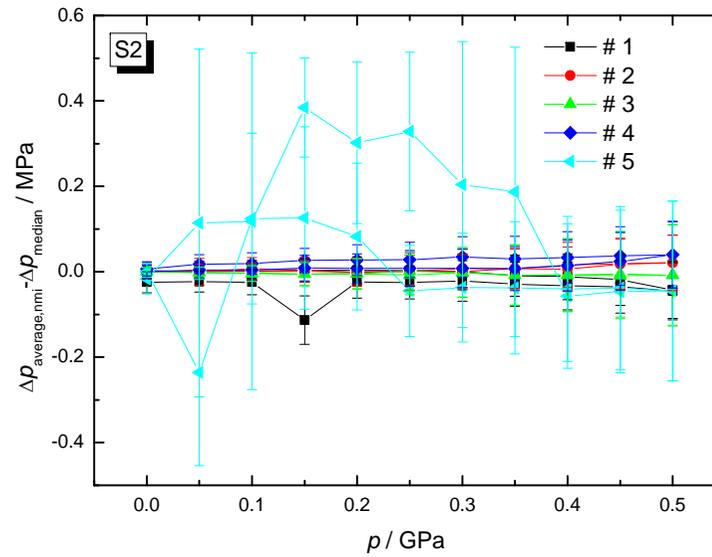
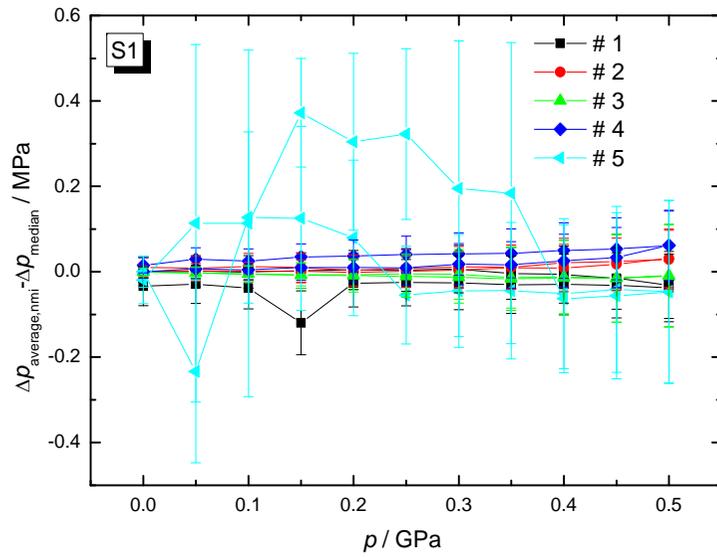
- Comparison of PTB 2014 to PTB 2013 measurement -

- incomparable behaviour of sensors of same type A or B
- Long-term (in)stability orders of magnitude „worse“ than standard deviations of individual measurement
- preliminary result: S3 (type A, 1.0 GPa) most stable

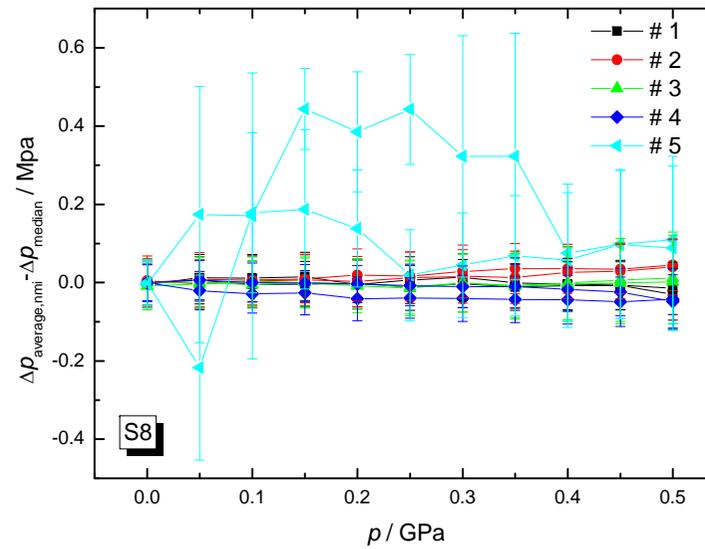
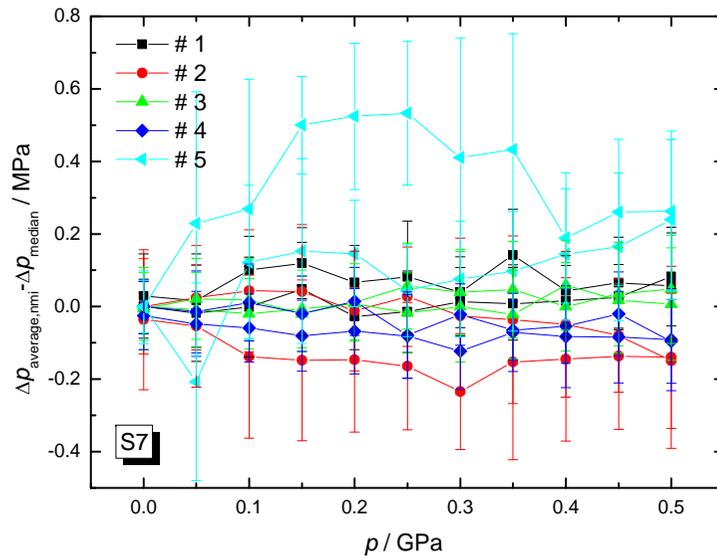
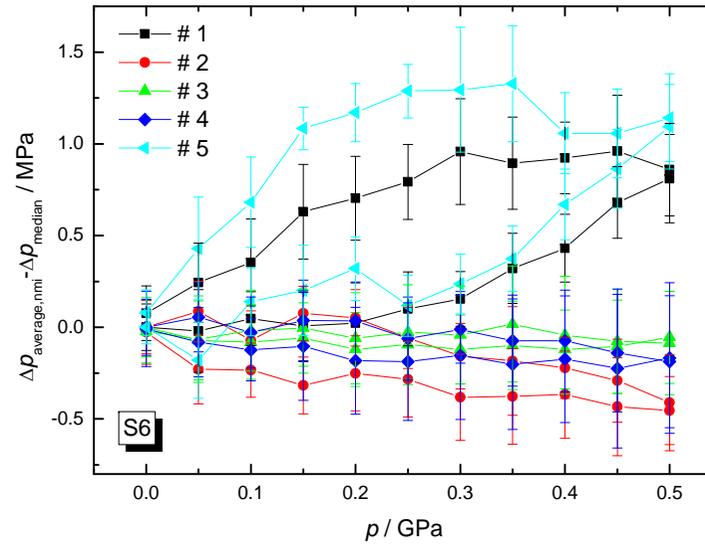
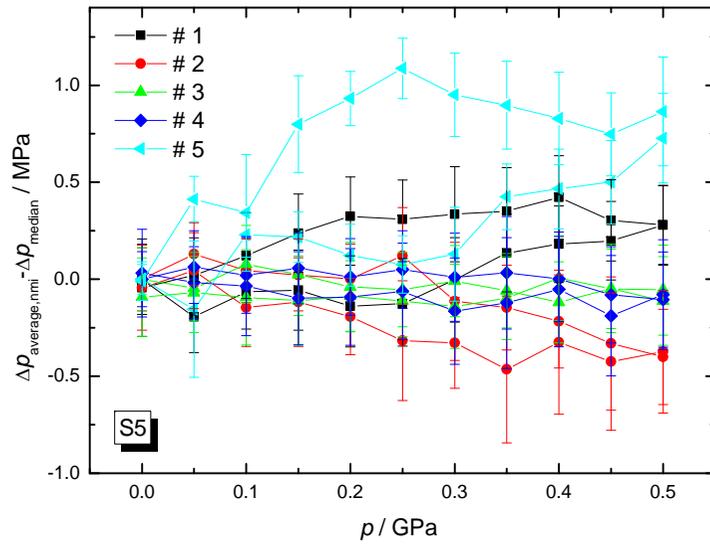
Intermediate remarks

- Type A transducers appear quite stable (reproducible, repeatable zero-point deviation) in 0.5 GPa-range, indication of slowly decreasing hysteresis with load cycles
- Type B transducers in 0.5 GPa-range reproducible within „scattering“
- at 1.0 GPa-range type A transducers still „stable“, decrease of hysteresis more pronounced
- Change of transducers characteristics for type B in 1.0 GPa-range!
No load (0.5 GPa-transducers): slow drift for type A (less than 10 kPa in 7 hours), not resolvable for type B due to „noise“ (order of 60 kPa)

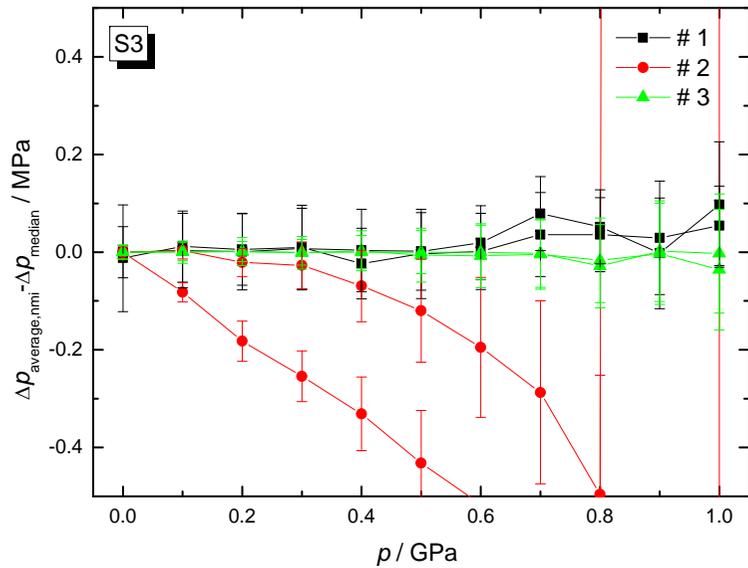
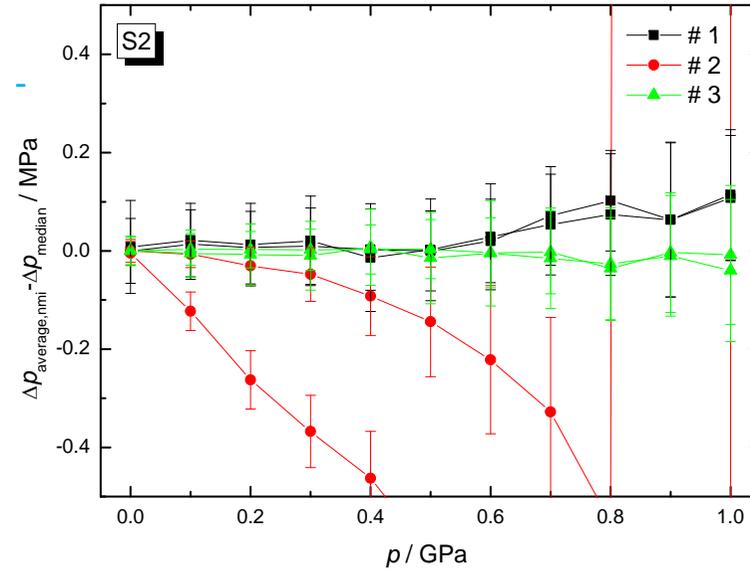
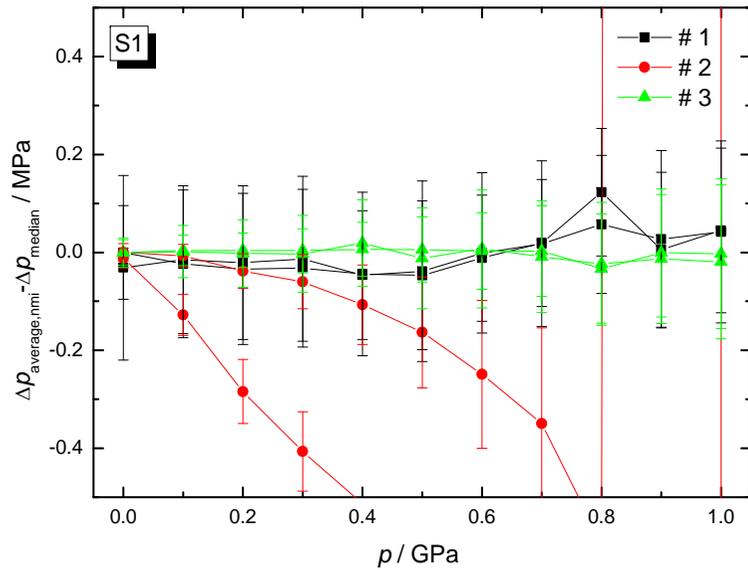
NMI comparison, 0.5 GPa (type A)



NMI comparison, 0.5 GPa (type B)

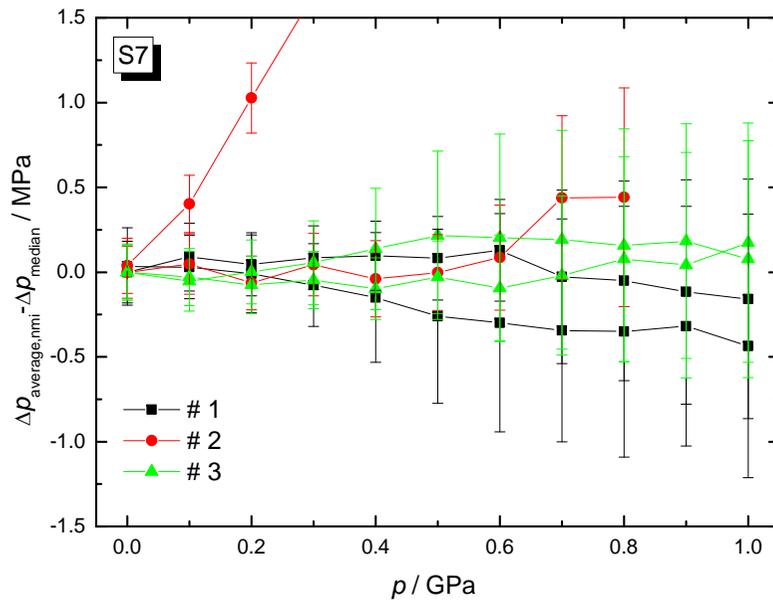
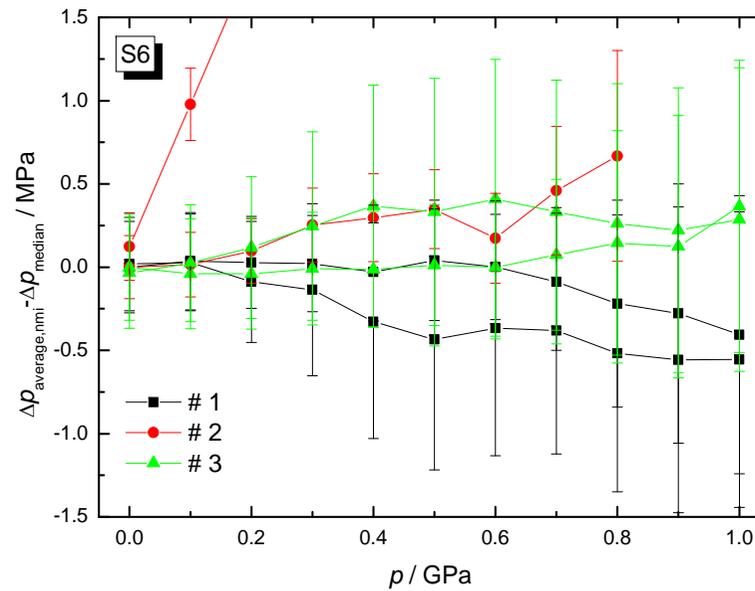
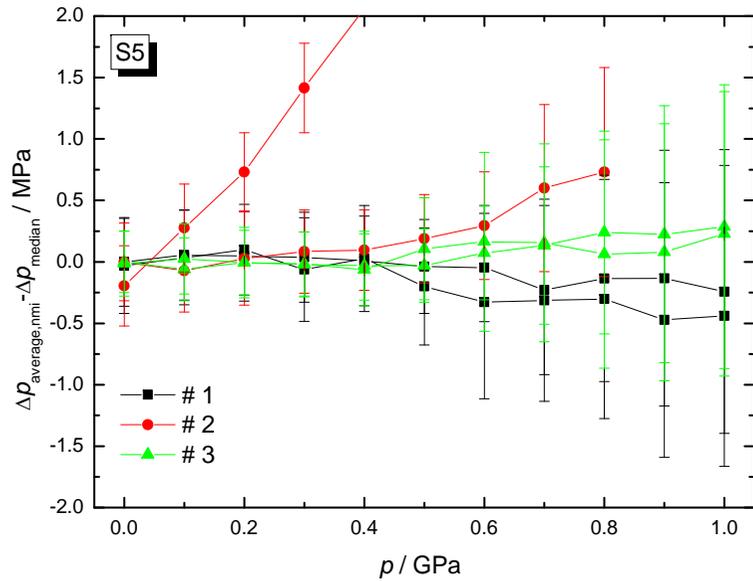


NMI comparison, 1.0 GPa (type A)



Transducer S4 operates
in 0.5 GPa-range

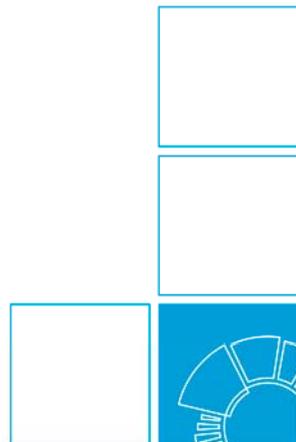
NMI comparison, 1.0 GPa (type B)



Transducer S8 operates
in 0.5 GPa-range

Summary

- Presentation of high-pressure supplementary comparison EURAMET 1306 based on modern high-pressure transducers as transfer standard
- Two types of transducers with significantly different properties
- Individual transducers behave very stable and accurate
- Most participants with „promising“ results
- Open question: Long-term stability in metrological applications



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