NFOGM Temadag 2016

Ultrasonic Meters
Re-calibrate or Not to re-calibrate

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Agenda

- International practice
- Footprint
- Diagnostics
- Experience
- Traceability
- Summary

Specifications of flow calibrated Ultrasonic Meters

Liquid Meters		
Uncertainty (accuracy)	<± 0.15%	(Lab. ± 0.06%)
Repeatability	<± 0.02%	
Linearity	± 0.10%	

Gas Meters		
Uncertainty	<± 0.1%	(Lab. ± 0.15%)
Repeatability	<± 0.05%	
Linearity	± 0.20%	

Is this correct?
Transferability from lab. calibration to actual conditions ?
Flow meter resilience?

Re-calibration Period of Ultrasonic Gas Meter

- Today there is no international standard or regulation that defines the re-calibration period of ultrasonic gas meters for custody transfer.

- In UK all Custody Transfer meters are be re-calibrated every 2 years (to be agreed with OGA)
- In the Netherlands large ultrasonic meters (≥20”) are re-calibrated every 5 years.
- In gas custody transfer in Canada re-calibrations are mandated every 5 years at a lab.
- In Germany the re-calibration period is 8 years if the meter has not been installed in series with another meter.

- Norway, no required re-calibration period.

Stability

- **Jim Hall et. al, NSFMW 2010:**

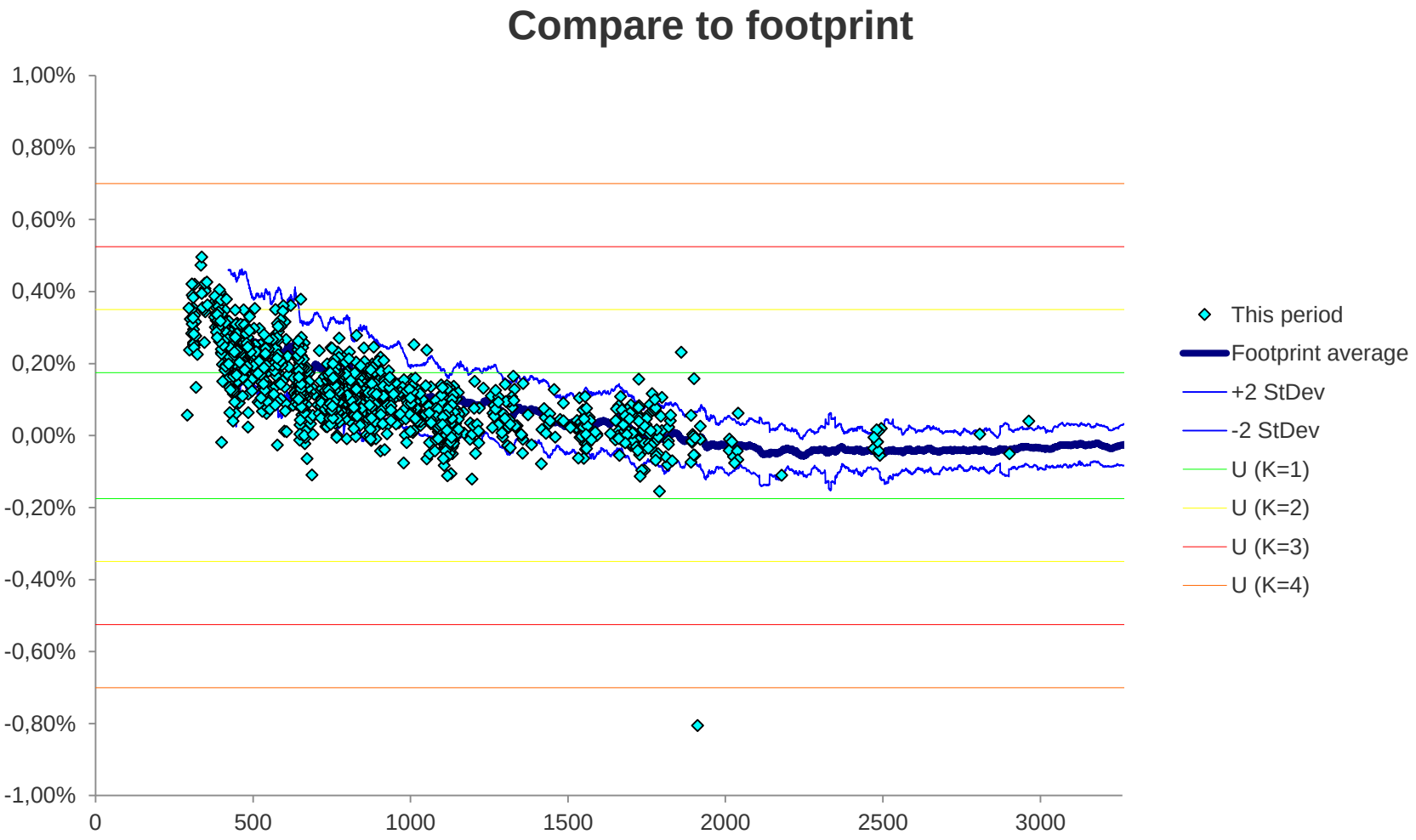
Litterature search on **gas** USM stability concludes that

USM stability over a period of three years appears to be very good (<0.3%) from the limited data available. The primary cause of a shift in a USM's calibration is buildup of a coating in the meter. When meters, flow conditioners and spools were cleaned, the calibration returned very close to the original.

Instead of recalibration, an USM may only need to be cleaned if there is a change in its performance.

Oil&Gas Authority ,UK: *Experience with ultrasonic meters over the past 7 years has shown that meters are likely to show the greatest shifts in the first 6 months of operation. It appears that the meter bore becomes 'conditioned' in-service during this period.* ***Cleaning of the meter bore may therefore be counter-productive and should be avoided whenever possible.***

Gas meters in series on Heimdal
2003 Footprint and last 3 months h-values



Oil & Gas Authority (UK)

6.14 Offshore Loading Systems – Crude Oil Measurement

“Most commonly, oil is exported to market via pipeline. However, in some North Sea applications oil is offloaded to shuttle tankers, which then transport their cargoes to ‘ports of discharge’ in the UK or overseas.

The point of sale in such cases is generally a matter for commercial negotiation. It may either be:

a) at the point of offshore loading, or (more commonly)

b) at the port of discharge.

In the case of a), the fiscal measurement is made during the transfer to the shuttle tanker. This is generally achieved using measurement systems that are designed to custody transfer standards.

In the case of b), the fiscal measurement generally takes place at the port of discharge, which may be beyond the jurisdiction of OGA. It is with this scenario that the present section of the Guidelines is concerned”.

Fiscal Oil Metering Stations

- UK
  - Common to have Offshore Fiscal Oil Metering Stations incl. prover
  - Metering station recommended due to «point of argument» !!!
- Norway
  - Permanent equipment for calibration of the metering device shall be available.
- Cultural differences
  - Sture, Norway: 4-5 claims per year, one accepted in 2012 (water fraction above metering range)
  - Supsa, Georgia: no claims

ISO 12242 Ultrasonic meters for liquid

«The effect of installation conditions and operating conditions on an USM can be reduced by calibrating the meter in field. In general, the electronics used in modern USMs are not subject to significant drift. Moreover, transducers are commonly of the external type or are installed in a housing that isolates the transducer element from the fluid. Therefore, **calibration is not generally required as a function of time** but may be required to reduce other influences on the calibration factor. Such influences can include a) to c):

a) **Installation effects**, i.e. upstream hydraulics
The potential magnitude of installation effects can be determined by performance testing

b) **Fluid properties** and, in particular changing viscosity.
This effect varies with metering design. To estimate the effects of changing viscosity, calibration data may be used …

c) **Corrosion, erosion** and deposition in the upstream pipe or measurement section
The internal surface and wall roughness should therefore be monitored for changes using optical (visual methods) as well as the meter diagnostics

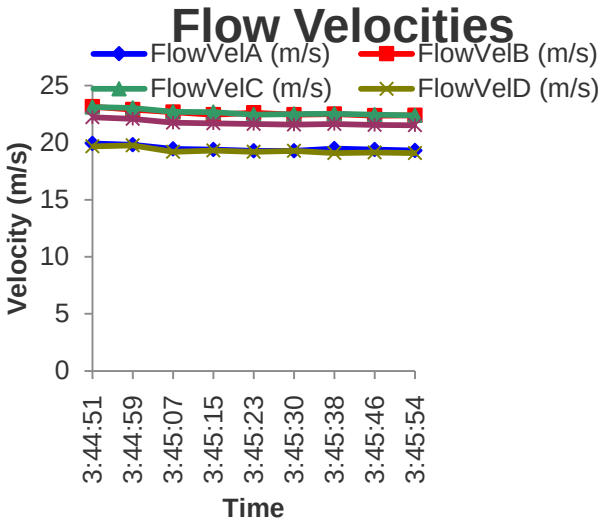
Calibration vs. Installation

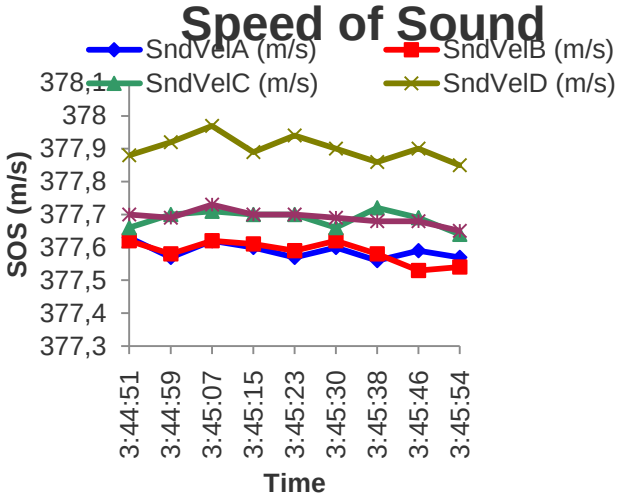
No change in pattern => No change in meter factor

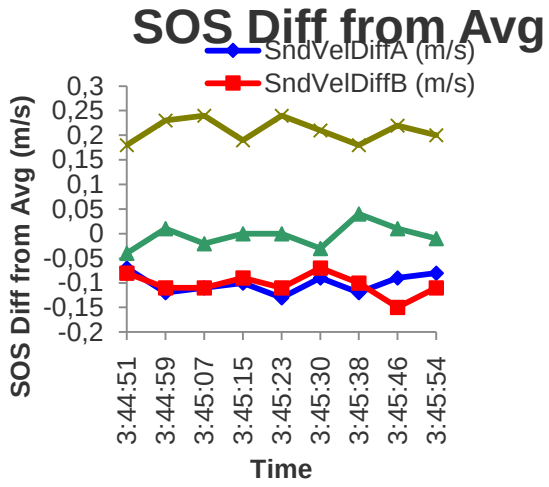
- Footprint is part of gas meter calibration delivery
  - Flow velocities, SOS, profile, gain, performance, turbulence, uncorrected flow
  - **Flow velocity correction file**

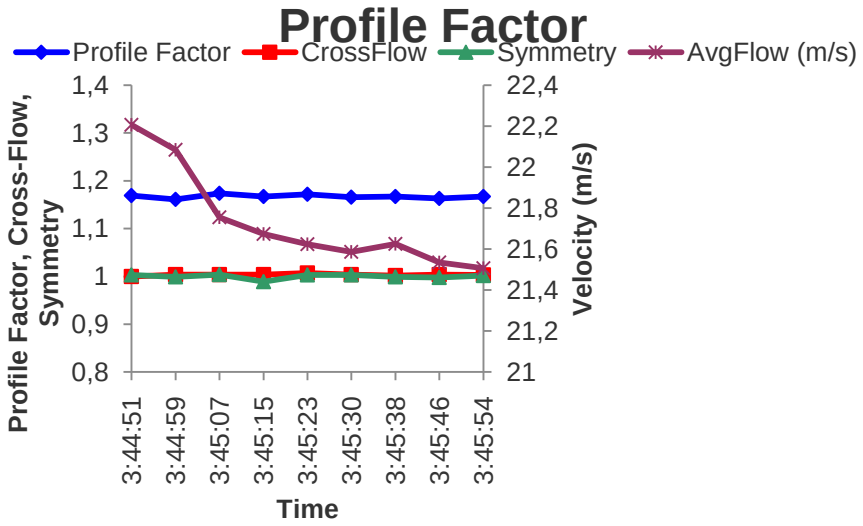
- Typical raw data being part of liquid meter calibration delivery are
  - Flow files
  - **Flow profile (Re number) correction files**
  - Swirl files
- Liquid meter vendors store calibration data, such as k-factor per path, swirl factor, gain, VOS etc, for each liquid meter at each rate. These data are not given to the customer, but vendor can use these data from calibration to verify the meters offshore.

a) Footprint, Gas Meter B









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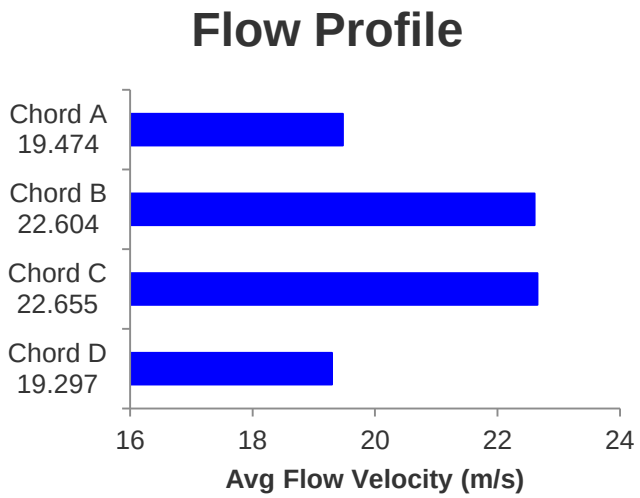
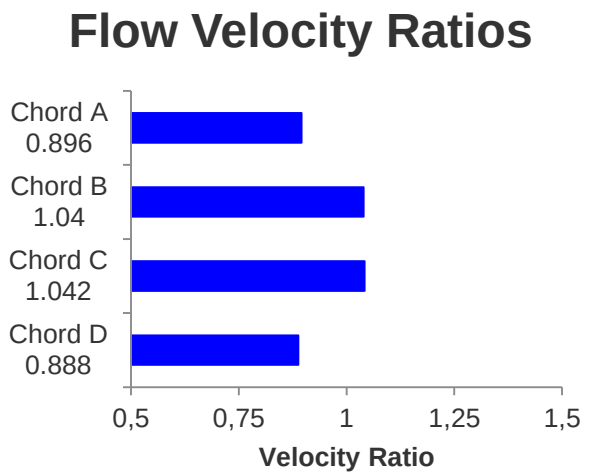
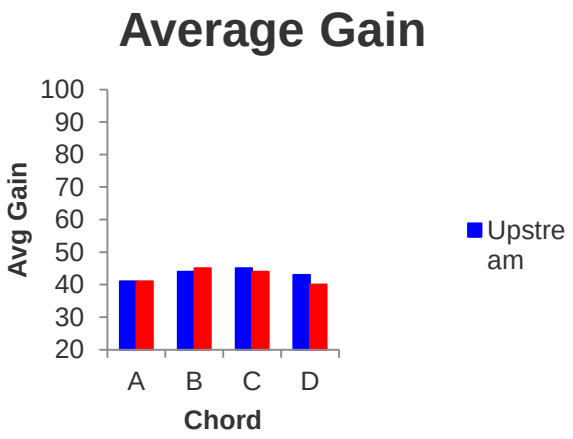
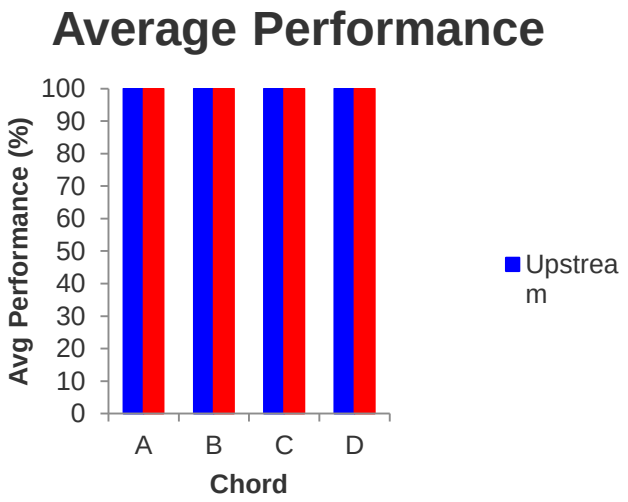
b) Footprint, Gas Meter B









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Condition param. AGA 9 gas / ISO 12242 liquid

As a minimum, the following measurements shall be provided for diagnostic purposes:

a) non-linearized average velocity through the meter;

b) flow velocity for each acoustic path (or equivalent for evaluation of the flowing velocity profile);

c) SOS along each acoustic path;

d) average SOS;

e) velocity sampling interval;

f) averaging time interval;

g) percentage of accepted pulses for each acoustic path;

h) S/N ratio or equivalent (gain control);

i) status and measurement quality indicators;

j) alarm and failure indicator.

Vendor’s Liquid Meter Diagnostic Parameters

- **Transit time depended Parameters**
  - Profile Flatness
  - **Profile Symmetry**
  - **Swirl Flow**
  - **Cross Flow**
  - Turbulence
  - Velocity of Sound (VOS)
- **Signal quality**
  - Gain
  - Signal %
  - Signal to Noise Ratio

Installation effects

- May be minimised by use of upstream spool with flow conditioner and keep spool and meter permanent bolted from calibration to installation.

- Model the installation
  - Common practice in the US nuclear industry is to replicate complex site conditions at the calibration laboratory

Common-mode Errors of Ultrasonic meters

- It is not yet clear how common mode errors will be identified if the ‘master meter’ type principle is utilized with two meters in series

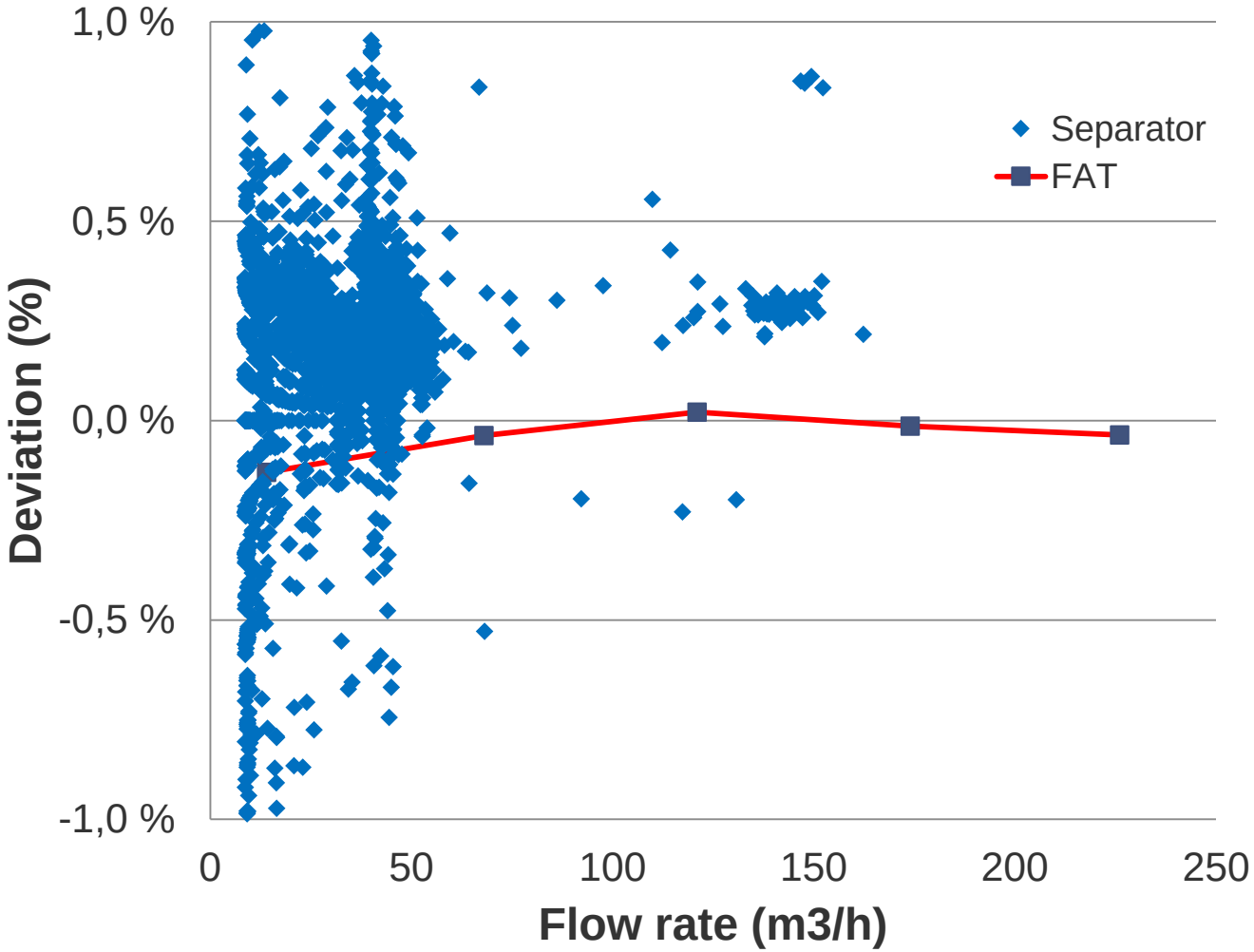
- Per definition the diagnostic parameters cannot detect common mode errors.
  - What is the sensitivity and reliability of diagnostic parameters?
  - What is the relationship between diagnostic parameters and measurement error?

- Has such a “hidden” error ever been reported?

Statoil Ultrasonic Liquid Meters

Innretning	Størrelse	Konfigurasjon	Oppstart	Stedlig kalibrering
Snorre A	8	Serie	1999	Ja
Snorre B	8	Serie	2001	Ja
Fram	6	Serie	2002	Ja
Skirne	4	Serie	2003	Ja
GOSH	12	Parallell	2003	Ja
NOB	6	Serie	2004	Ja
Valemon sep.	**4**	**Serie**	**2015**	**Nei**
Valemon scr.	4	Serie	2015	Nei
Heidrun B	**12**	**Parallell**	**2015**	**Ja**

Valemon 1st stage separator
2 liquid meters in series



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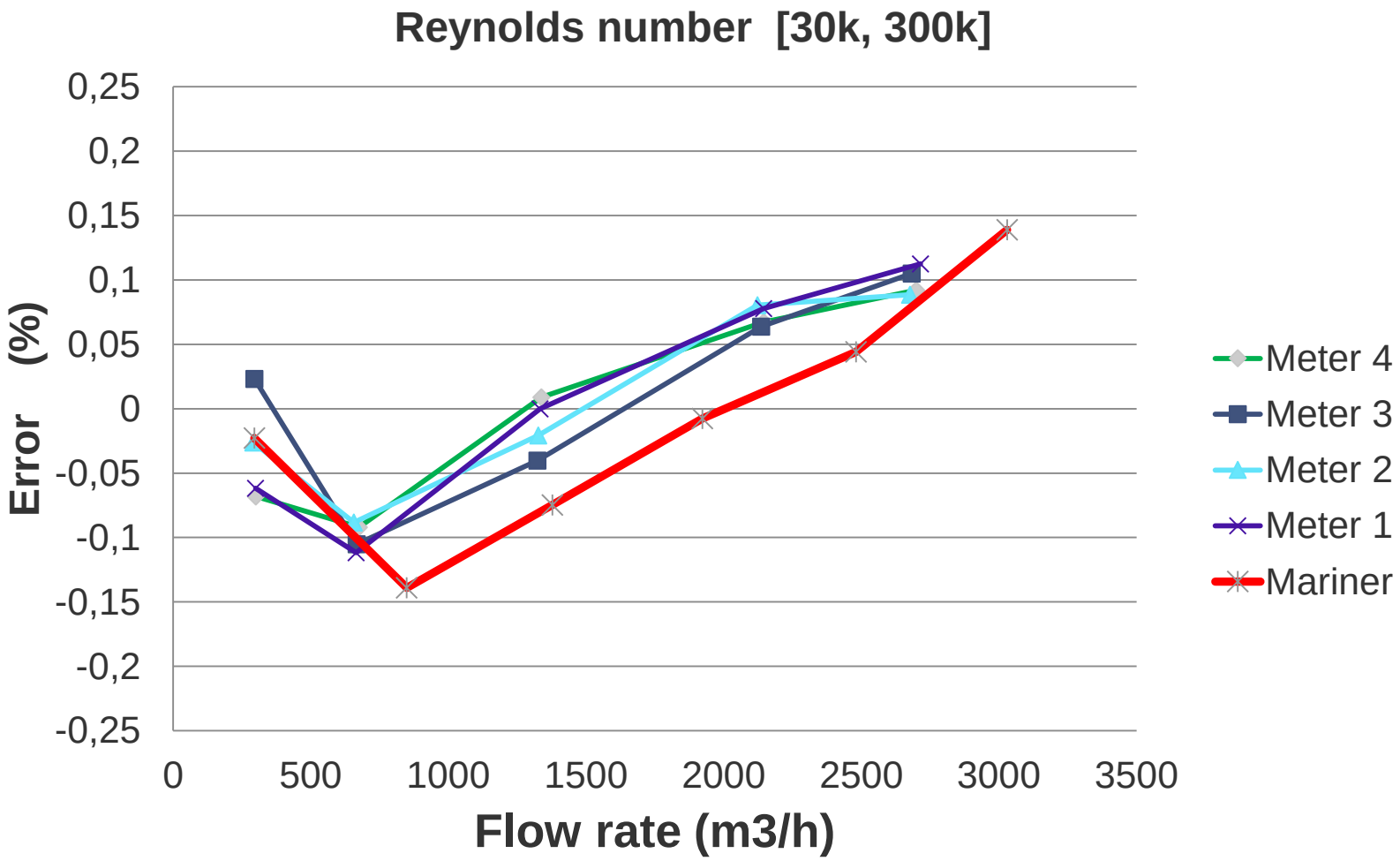
Erie Lab. Calibration of 12’’ Ultra 8



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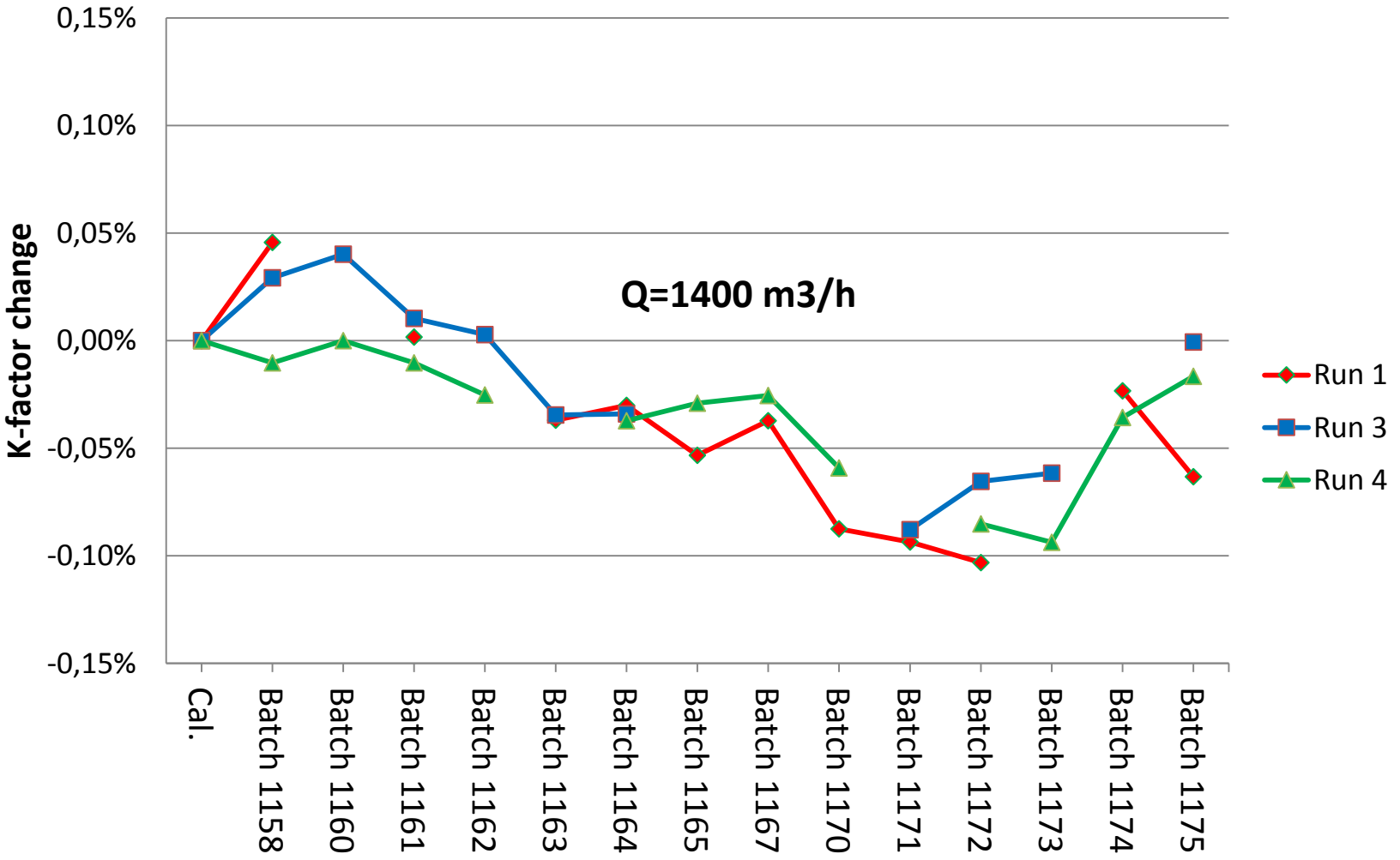
Heidrun B Ultra 8 Proving **rel.** Lab Calibration



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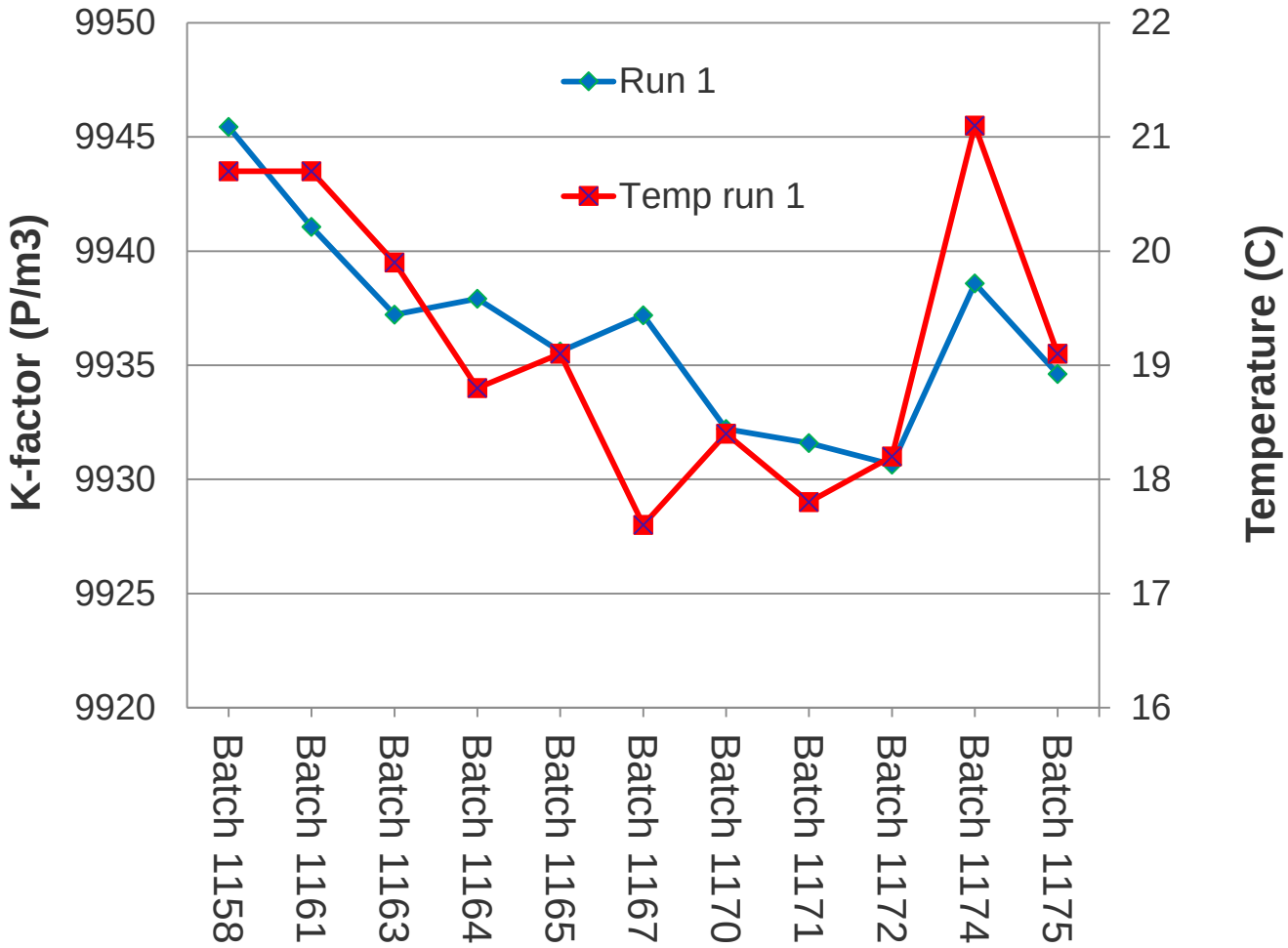
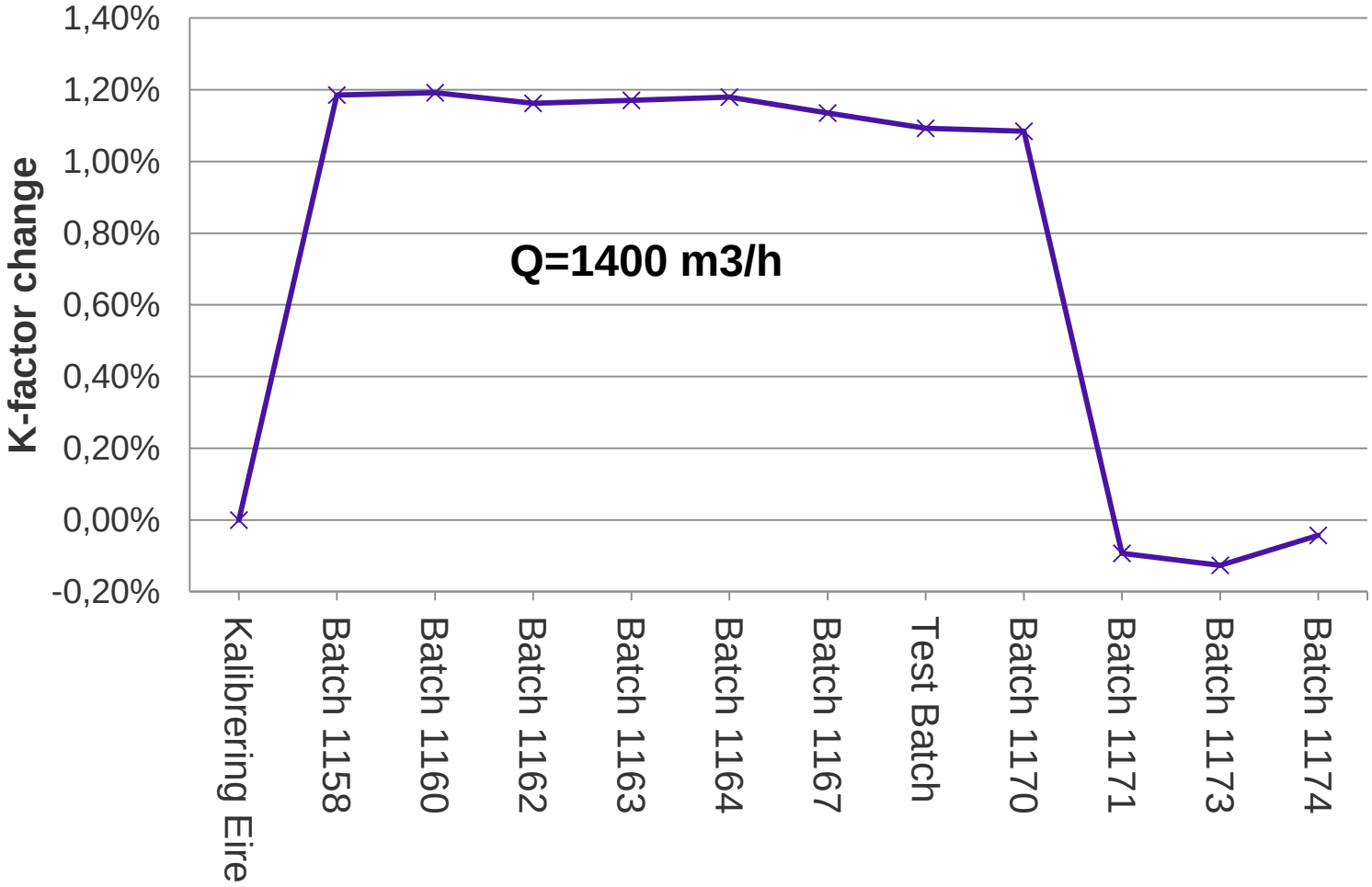
Heidrun B Ultra 8 K-factor and Temperature



Commissioning , «trial and error» Heidrun B run 2



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Meter Traceability calibration to installation

- Applied checksums
  - Software version (changed)
  - Calibration parameters (fixed)
  - IO configuration (changed)
  - Configuration of modbus, frequency output,... (changed)
- Commisioning
  - What is going on?

«ISO 12242: Provisions shall be made to prevent an accidental or undetecthable alteration of those parameters that affect the performance of the meter. Suitable provisions included a sealabel switch or jumper, or a permanent programmable read-only memory chip with verifiable check-sum or event log alarms. For every event with the meter (calibration, repair etc.) a full parameter list before and after the event shall be available at the measuring station.»

Summary

- USM performance is regarded as very reproducible.
- Off-site calibration of USM is more and more considered.
- **Securing transition** from calibration laboratory to field installation is of primary concern.
- Meter diagnostics may be characterized as a passive monitor and data collector
- CBM needs to be more specific and user friendly to ensure validity of the laboratory calibration certificate.
- Any sign of common mode error?

There's never been a better time for good ideas

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