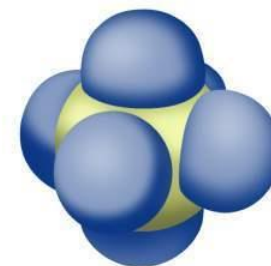


EPA Conference May 2014 Long Beach



Switch gear population

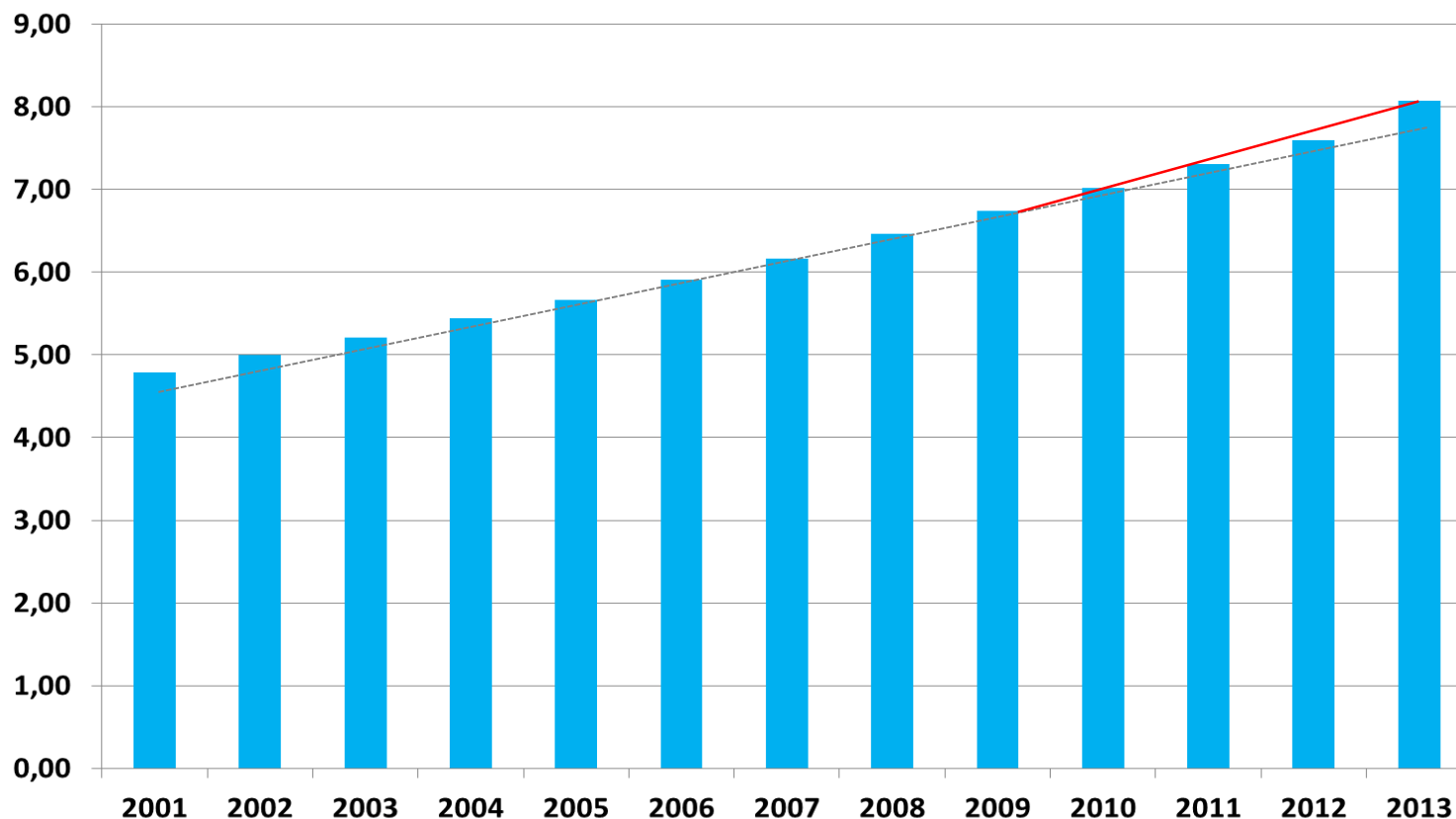
More than 500 utilities operate more than 460.000 substation's



Substation's are filled with more than 60.000 metric tons of SF₆

SF₆ concentration globally

Parts per trillion (ppt)



CAGR %Compound average growth rate 4,3 % 2001 ... 2006 | 4,6 % 2006 ...2013

F-Gas-Regulation 842/2006

16e. *'leakage detection system' means a calibrated mechanical, electrical or electronic device for detecting leakage of fluorinated greenhouse gases which, on detection, alerts the operator;*



- **WIKA introduced a test port in 2009**

- *Test port simplifies calibration of monitoring equipment*

- **F-Gas-Regulation 842/2006 14.04.2014**

- *Leak detection system for detection of F-gases*
- *Effects all new switchgear put in service after 2017*

USED SF₆ is contaminated**Permissible Exposure Limit's (PEL, OSHA US)**

8-hour time weighted average (TWA)

Sulfur dioxide	SO₂	2,00 ppm
Hydrofluoric acid	HF	3,00 ppm
Disulfur decafluoride	S₂F₁₀	0,01 ppm (Very Toxic)



**UNITED STATES
DEPARTMENT OF LABOR**

Occupational Safety & Health Administration

Humidity causes disasters



■ Damage of expensive assets

- *HV substation CAPEX in exceed of ~ 1,0 Mio. €*

■ Power Outages

- *Costs can pile up to many millions*

■ Toxic substances

- *Disulfur decafluoride*
- *Sulfur dioxide*
- *Hydrofluoric acid*

Note: The higher the volume fraction of the water vapour the more de-composition product's you will find.

Analysis of gas quality



GA11 – Gas Analyzer (Field)

- Humidity
- Sulfure Dioxide
- Percentage of SF6

- Hydrofluoric Acid
- Disulfur decafluoride

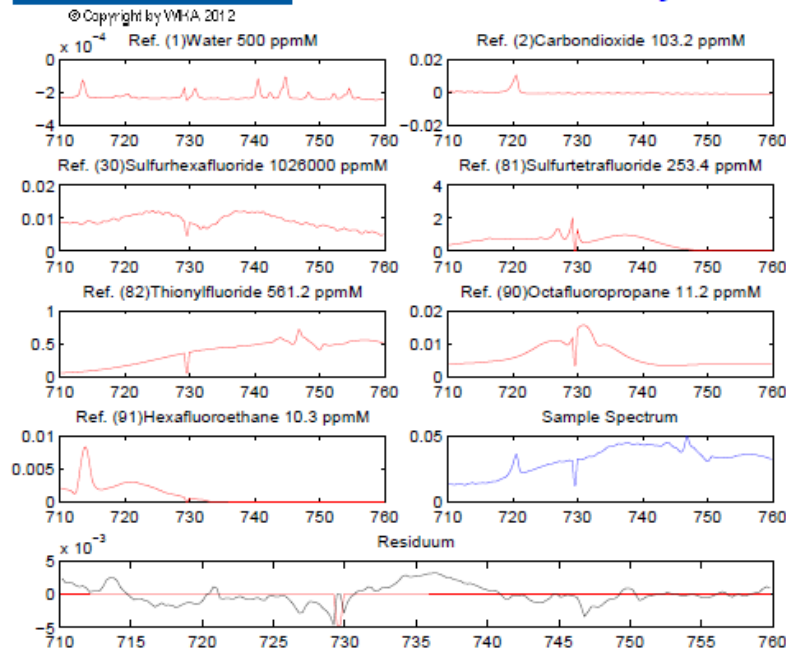


FTIR - Laboratory

FTIR - Gas analysis used SF₆ (Switch gear)



IR-SF₆-Analysis V 3.6



Data saved in: C:\Dokumente und Einstellungen\kurter\Eigene Dateien\Projekte\Software\Update_v36\SF6_111_04.txt

Calibration: default

Insert Sample Pressure for the Spectrum-File in hPa!

Open File

File: SF6 111 04.PRN
 Device: T27.0399.03
 Sample Pressure [hPa]: 1010
 Analysis Date: 07-Apr-2014

Decomposition Products	Concentration [ppmv]	PEL
SO2	165	PEL = 2
HF	0	PEL = 3
SF4	0	
SOF2	338	PEL = 2,5
SOF4	35	
SO2F2	0	PEL = 5
S2F10	44	PEL = 0,01
SiF4	1744	
CO	0	
COS	0	
C3F8	0	
C2F6	0	
CF4	3993	

Impurities	[ppmv]
H2O	128
CO2	1435

Print Report

Quit



Benefits of monitoring of SF₆



- 1 Permanent Measurement
- 2 Data Acquisition & Communication
- 3 Computer Aided Signal Analysis



- Predictive Maintenance
- Simplified emission reporting
- Precise sensors are essential for sound information

WIKAI's online monitoring solution

■ 3 Temperature sensors

- 1 sensor is exposed to the gas
- 1 sensor @ pressure sensor
- 1 sensor is close to ambient

■ Integrated pressure sensor

- Accuracy 0,06 % f.s.d.



■ Calculated density signal

■ Integrated humidity sensor

■ RS485

■ MODBUS

■ DNP3.0 upon request

Density is the ratio of the mass & volume – no direct measurement !

$p \cdot V = n \cdot R \cdot T$ Common Gas Equation, Note: SF6 is not an ideal gas

$$V = \frac{m}{\rho}$$

$$M = \frac{m}{n}$$

p	... pressure
V	... volume
m	... mass
M	... molare mass
n	... amount of substance

$$p = \frac{R \cdot T}{M} \cdot \rho$$

DENSITY IS PROPORTIONAL TO PRESSURE

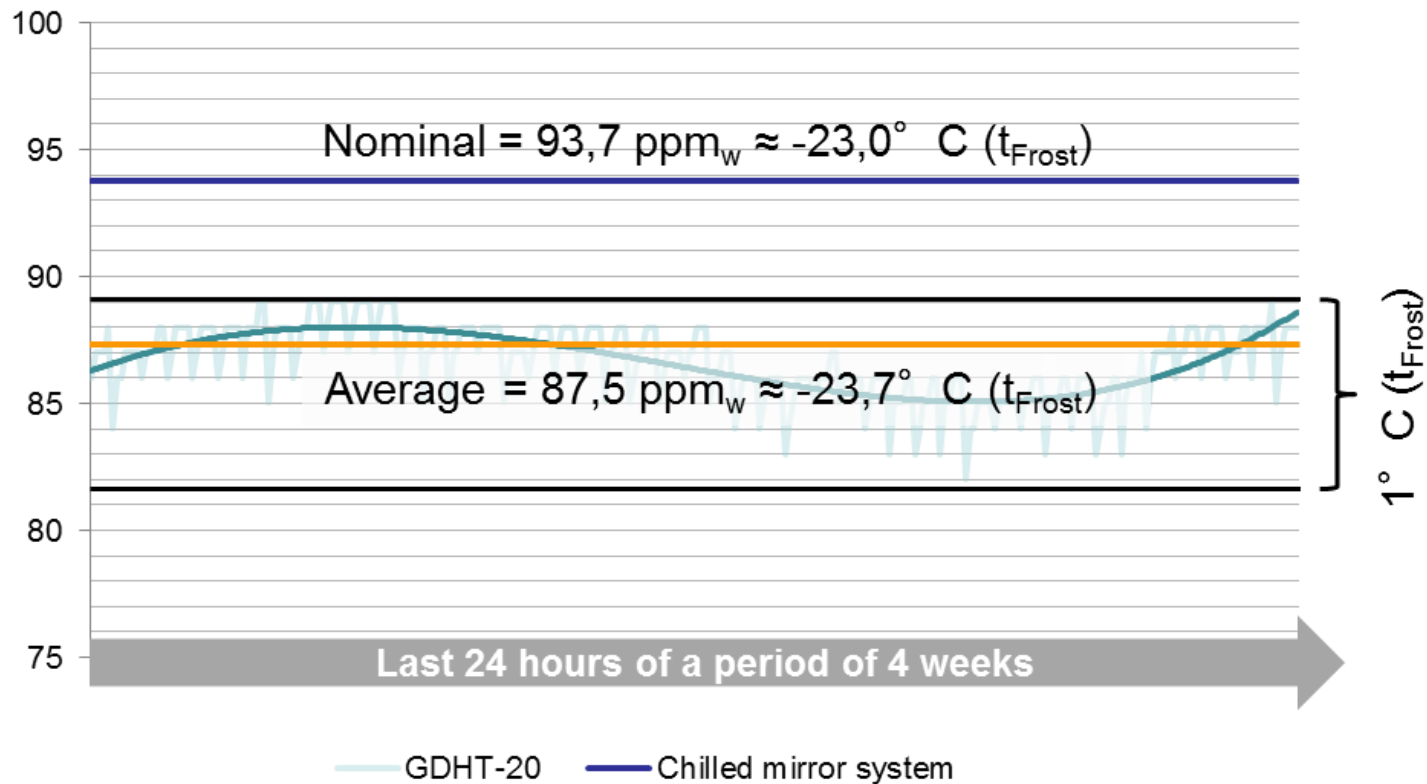
Term is constant

SF₆ Gas Excellence

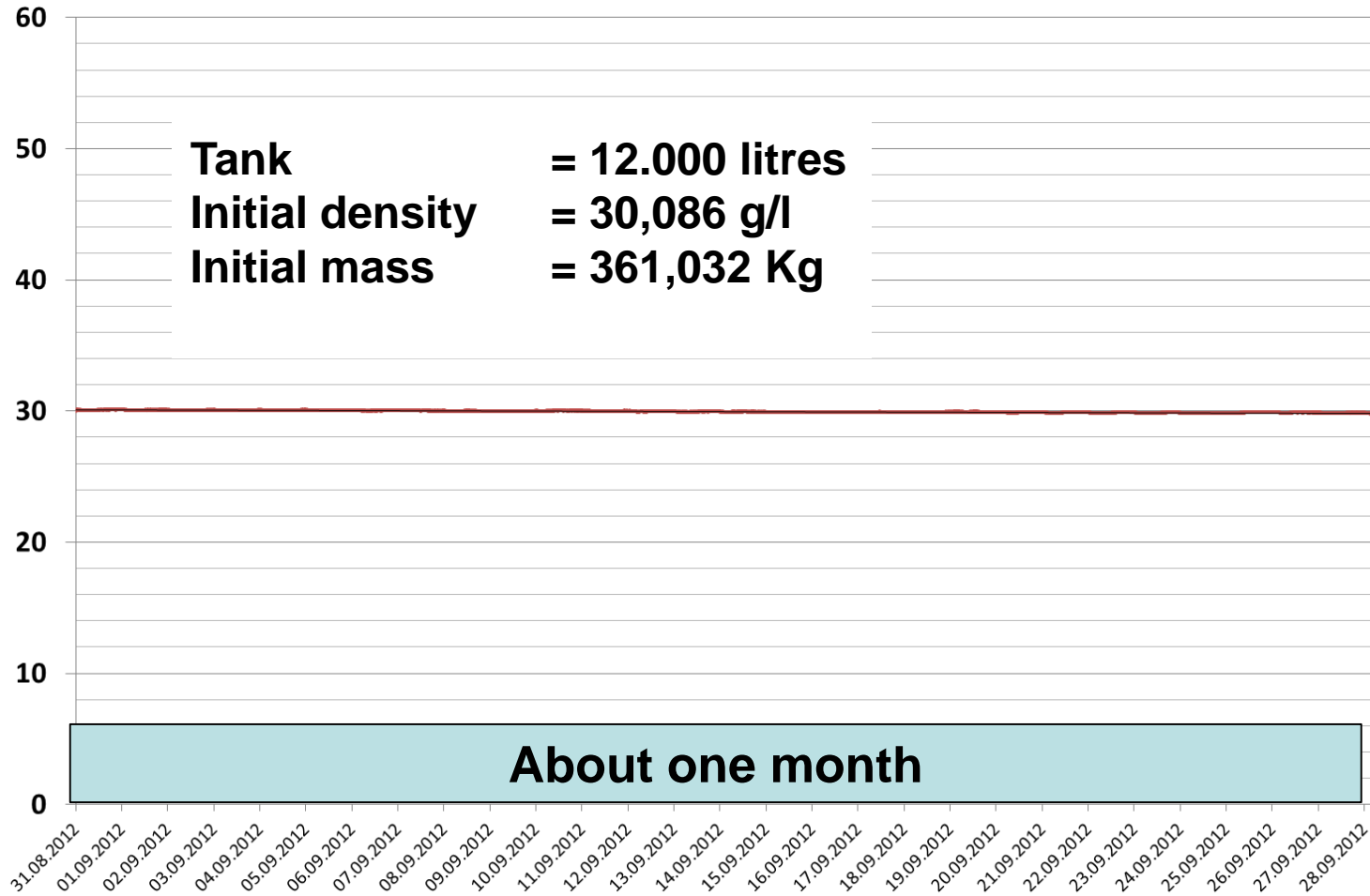
Value of the digital products



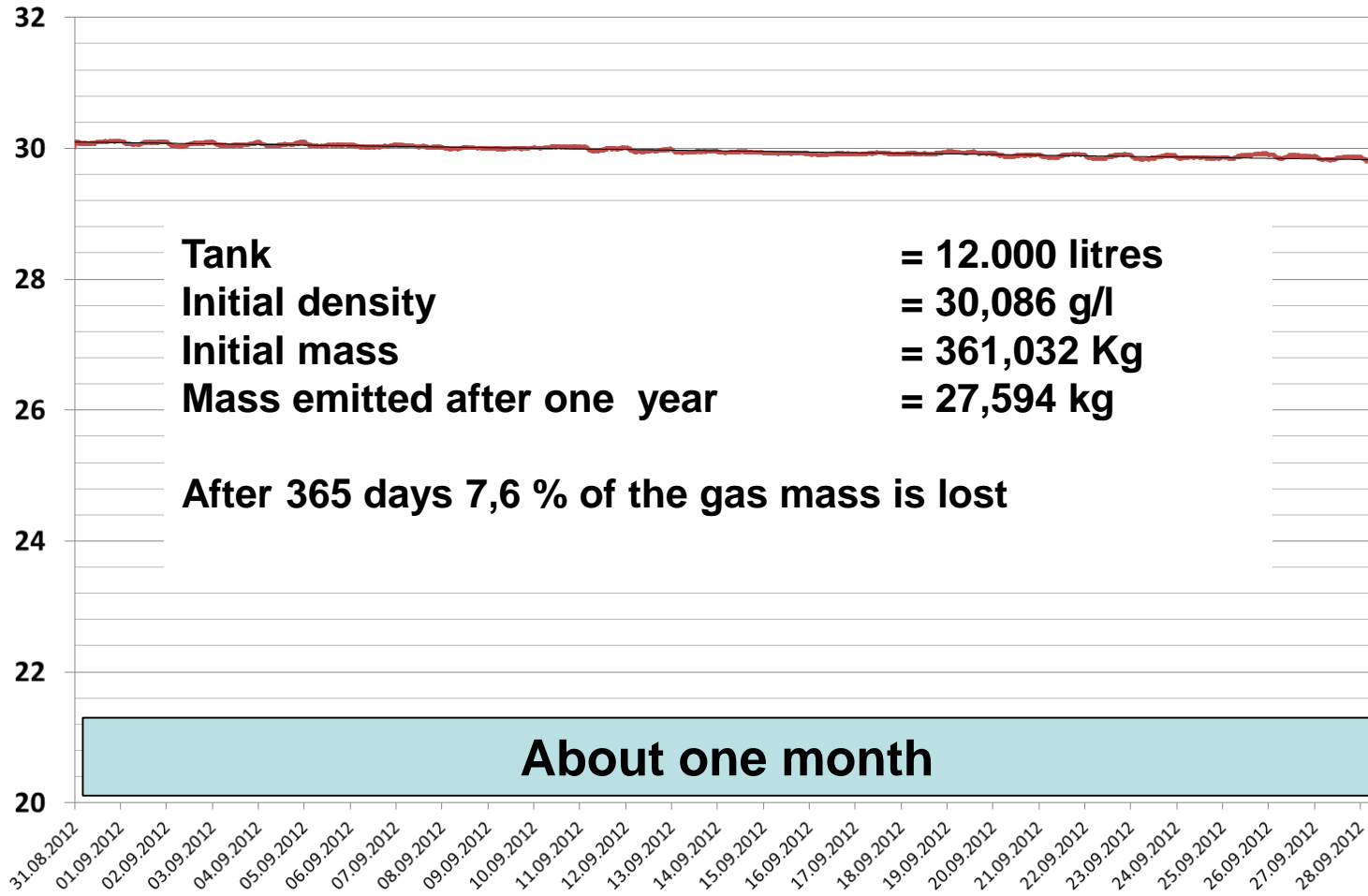
Value of the digital products



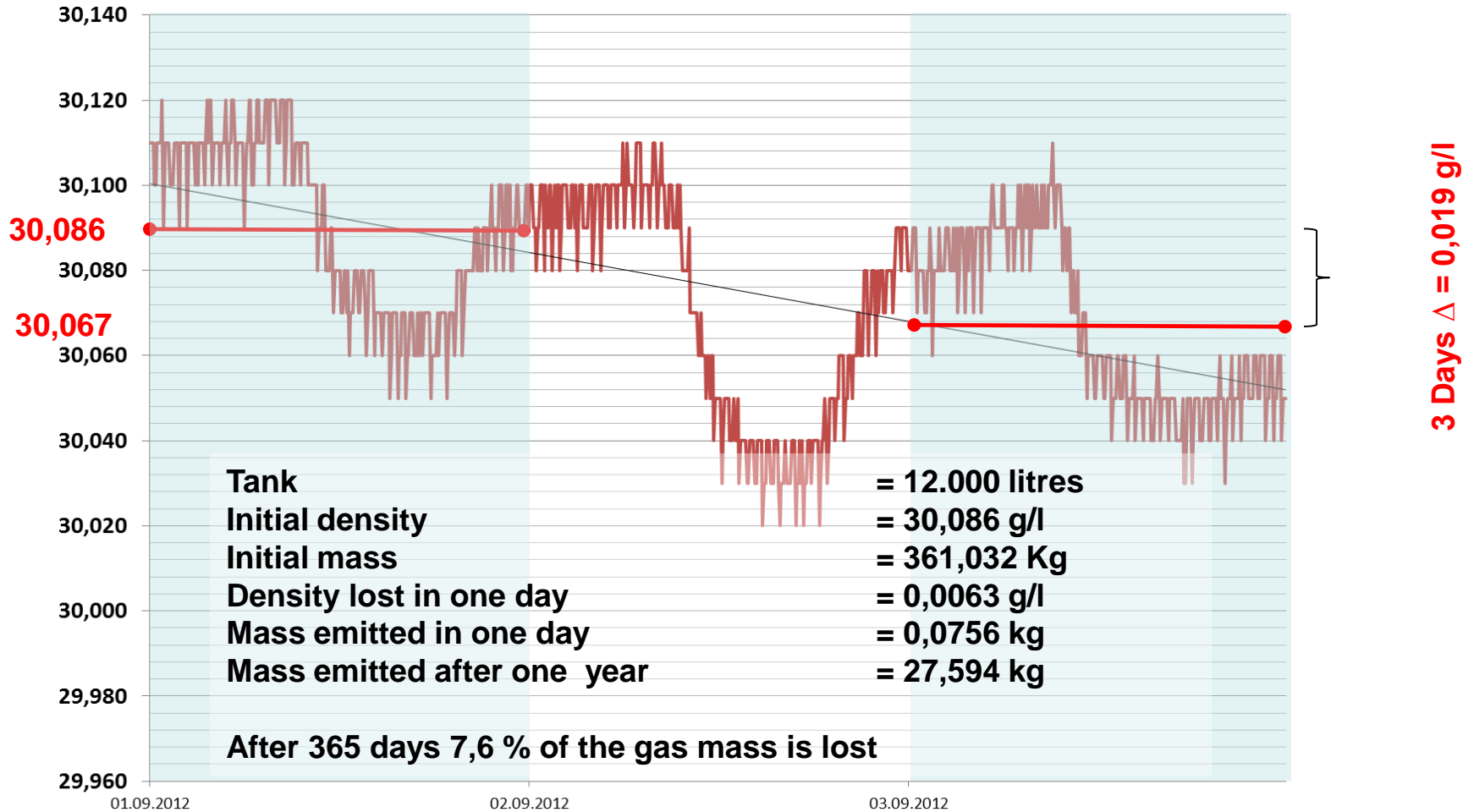
Resolution & flat lines



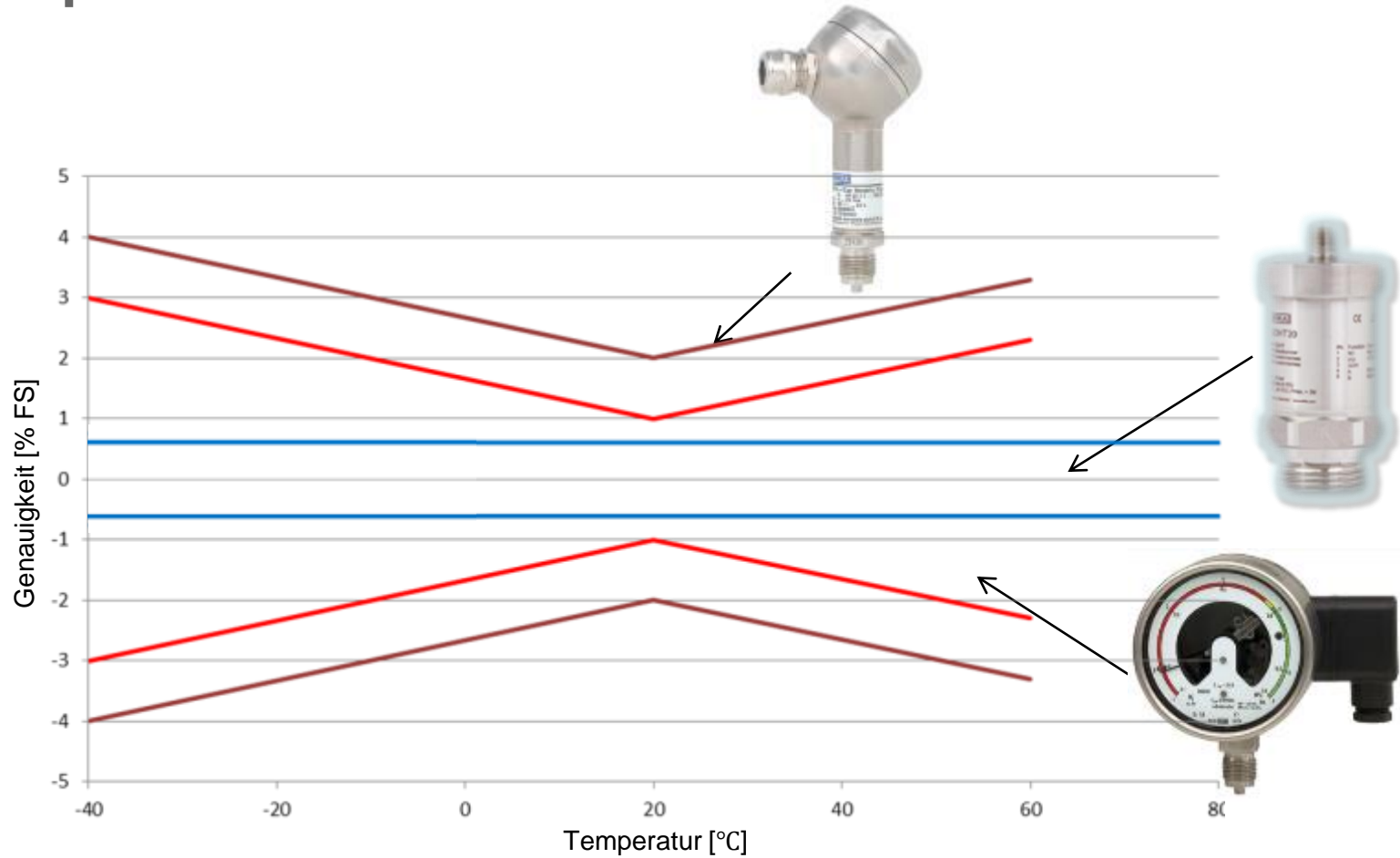
Improve visibility



High resolution = fast information



Comparison of methods



Drivers for online Monitoring

■ Health & Safety

- *De-composition products are toxic*
- *Gas Handling & transportation of aged (used) gas requires gas analysis*

■ Operational Safety

- *Isolation level must be monitored (Density)*
- *Precise sensors allow pro-active monitoring*

■ Emission Control

- *Traditional monitoring is reactive*
- *Digital transmitters allow accurate pro-active maintenance based on the actual condition of the asset*
- *Simplified emission reporting*

■ Regulations

- *EU requires a leak detection system – calibrated mechanical or electronic device of SF6 which alerts the operator*
- *Online monitoring allows fully auditable reporting by third parties*

See us @

Thomas Heckler
Vice President
SF₆ Density Measurement
WIKAL Alexander Wiegand SE & Co. KG
63911 Klingenberg
Germany
Phone +49 9372 132-8970
Fax +49 9372 132-8008970
thomas.heckler@wika.com



Daniel Staiger
Business Development Manager
SF₆ Density Measurement
WIKAL Alexander Wiegand SE & Co. KG
44227 Dortmund
Germany
Phone +49 231 9742-6557
Fax +49 231 9742-6555
daniel.staiger@wika.com

