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AMPACITY
Smart grids for the city

Projektträger Jülich
Forschungszentrum Jülich

AmpaCity Project Update
40 MVA HTS Cable and Fault Current Limiter Installation in City Center

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AmpaCity Project Objectives

- Installation of 10 kV, 40 MVA HTS system in the German City of Essen
  - Project started in September 2011
  - Complete system installation in 3rd quarter of 2013
  - Commissioning in 4th quarter of 2013
  - Project duration of 4.5 years
  - Funded by the German Federal Ministry of Economics and Technology
- Investigation of technical feasibility of HTS systems in distribution grids
- Investment comparison of 10 kV HTS systems as alternative to conventional 110 kV systems
- Evaluation of technical operation advantages during demonstration period
- Assessment of further HTS cable and FCL technology applications

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AmpaCity Milestones

- ✓ Project start in September 2011
- ✓ Prototype manufactured in October 2012
- ✓ Type test completed in February 2013
- ✓ Start of component manufacturing in March 2013
- ✓ Groundbreaking ceremony on April 9th, 2013
- ✓ System installation on site Sept. until Dec. 2013
- ✓ Commissioning test on December 16th, 2013
- ✓ System commissioning on March 10th, 2014
- Pilot operation from 2014 until 2016 in progress

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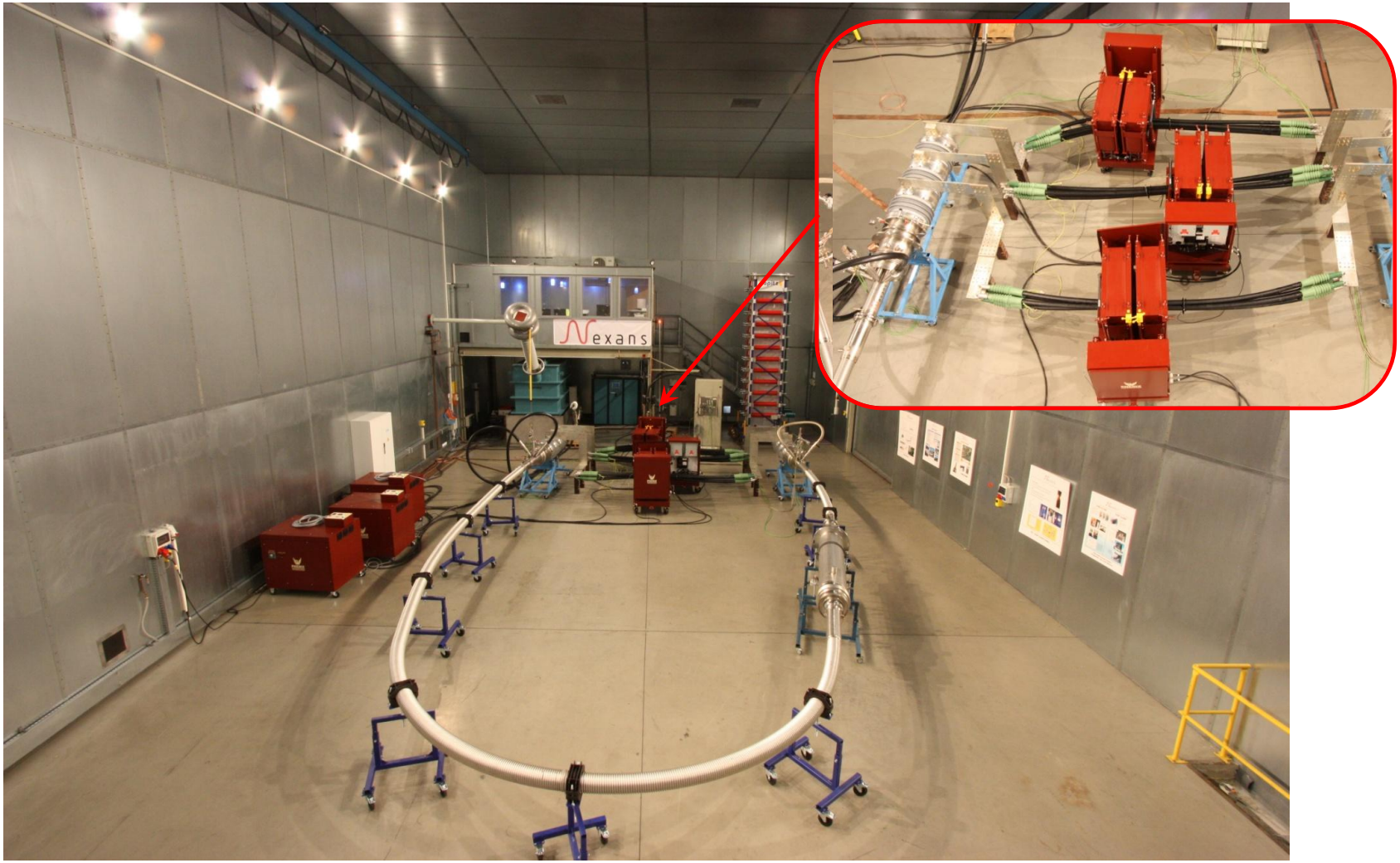
Prototype Setup for Type Test

Prototype Joint and Termination

Type Test Sequence Prototype Setup

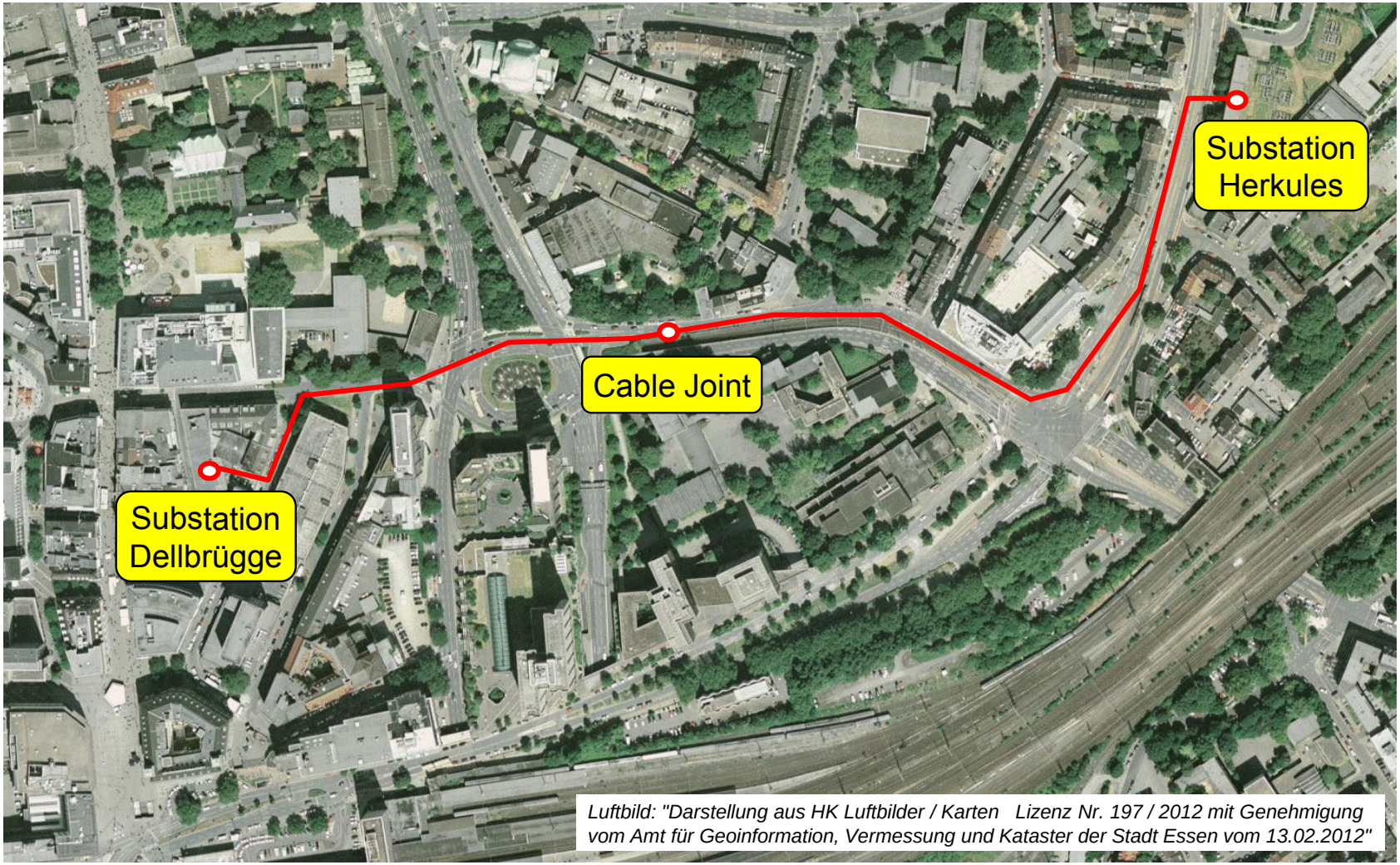
- Testing in accordance to DIN VDE 0276-620
- PD test at 20 kV (after 24 kV for 1 min)
- 20 load cycles with 2.3 kA (3 phase)
- PD test at 20 kV (after 24 kV for 1 min)
- Lightning impulse test at ± 75 kV
- AC voltage withstand test at 30 kV (4 h)

Load Cycle Test Setup



Lightning Impulse Test Setup

AmpaCity Installation in Essen



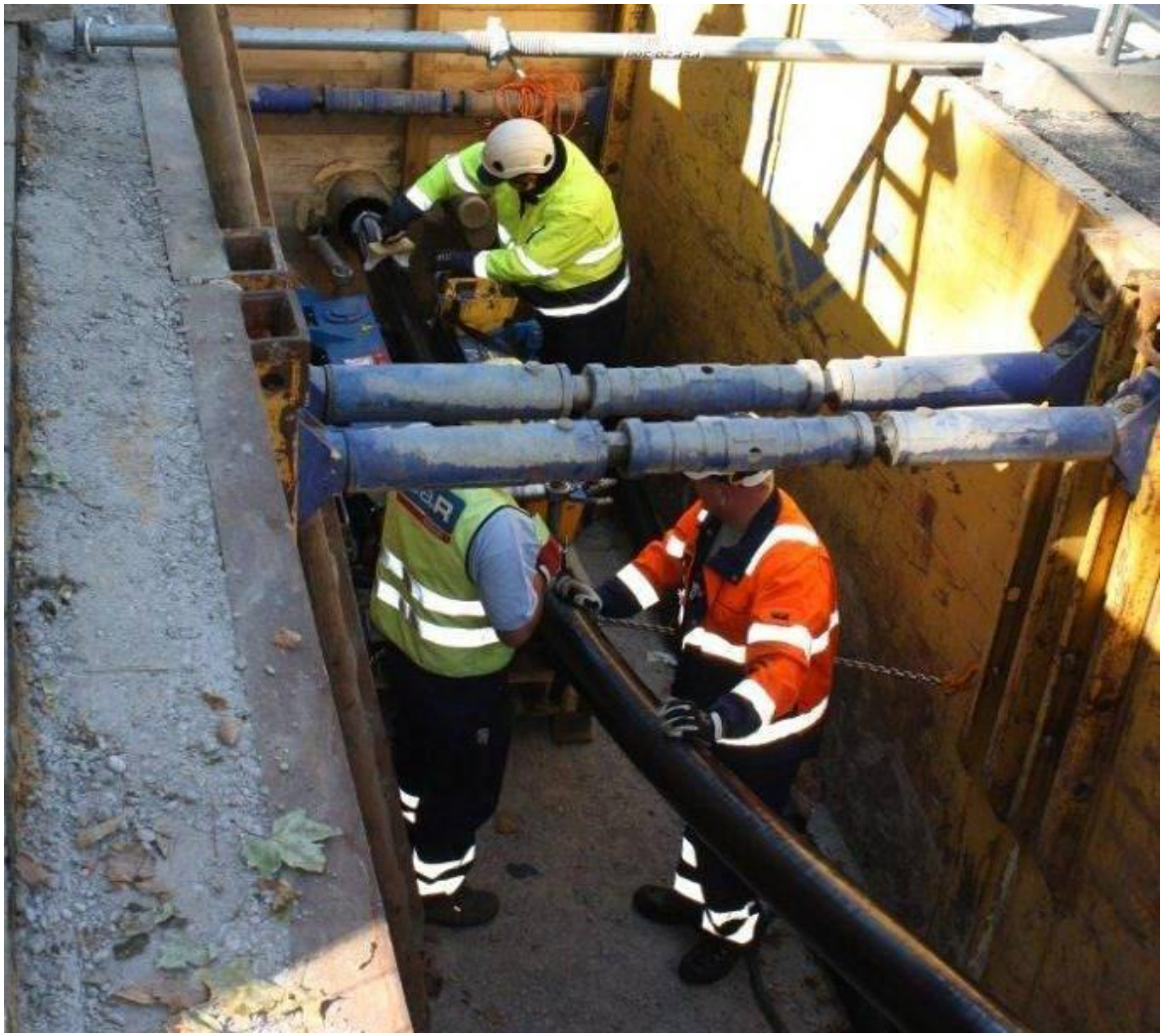
Luftbild: "Darstellung aus HK Luftbilder / Karten Lizenz Nr. 197 / 2012 mit Genehmigung vom Amt für Geoinformation, Vermessung und Kataster der Stadt Essen vom 13.02.2012"

Loading of Cable Drum in Hannover

Cable Drum Trailer at Joint Bay

Preparation of Cable Pulling

Cable Pulling First Length



Installation in Substation Dellbrügge

Termination in Substation Dellbrügge

Installation of Cable Joint

Nitrogen Storage Tank at Substation Herkules

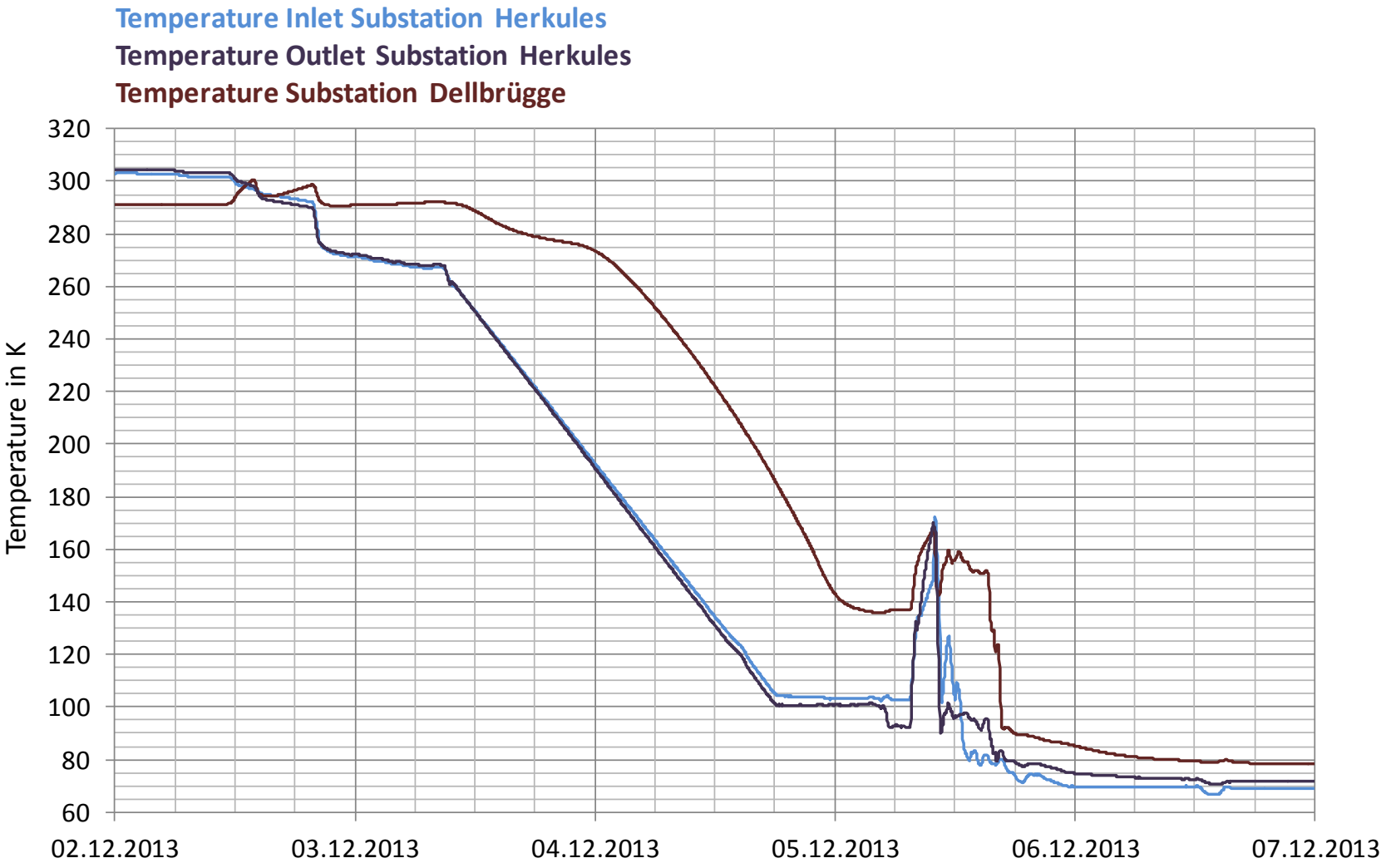
Cooling System Delivery at Substation Herkules

Fault Current Limiter Delivery at Substation Herkules

HTS System Installation at Substation Herkules

Cooling Down of Cable System December 2013

Temperatures During Cooling Down



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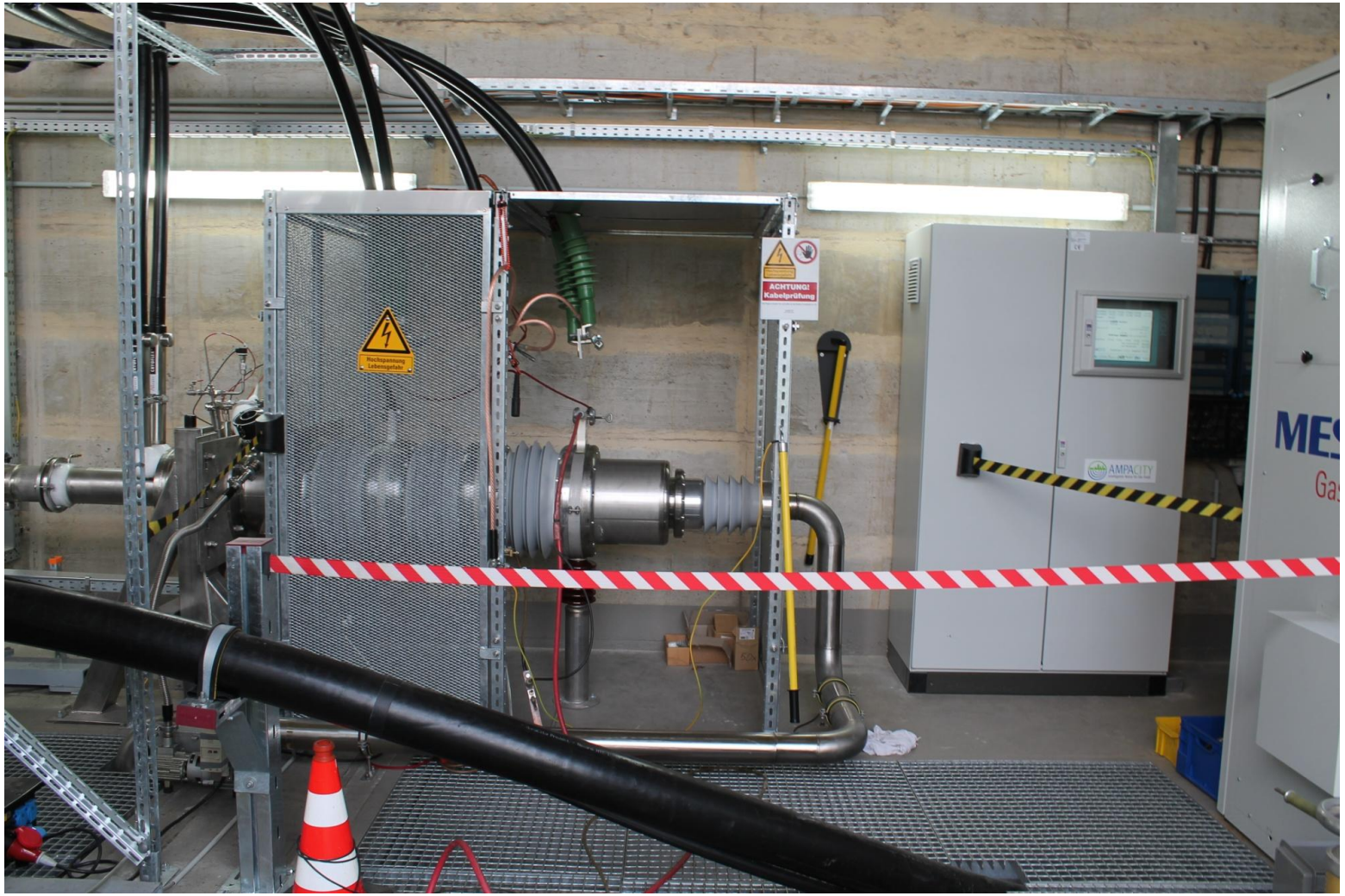
Commissioning Test

- Standard cable testing with cable test van
- PD test of each phase (20 kV at 0,1 Hz)
- Loss factor diagnoses (10 kV, 15 kV, 20 kV at 0,1 Hz)
- AC voltage withstand test (30 kV at 0,1 Hz for 1 h)

Commissioning Test with Cable Test Van

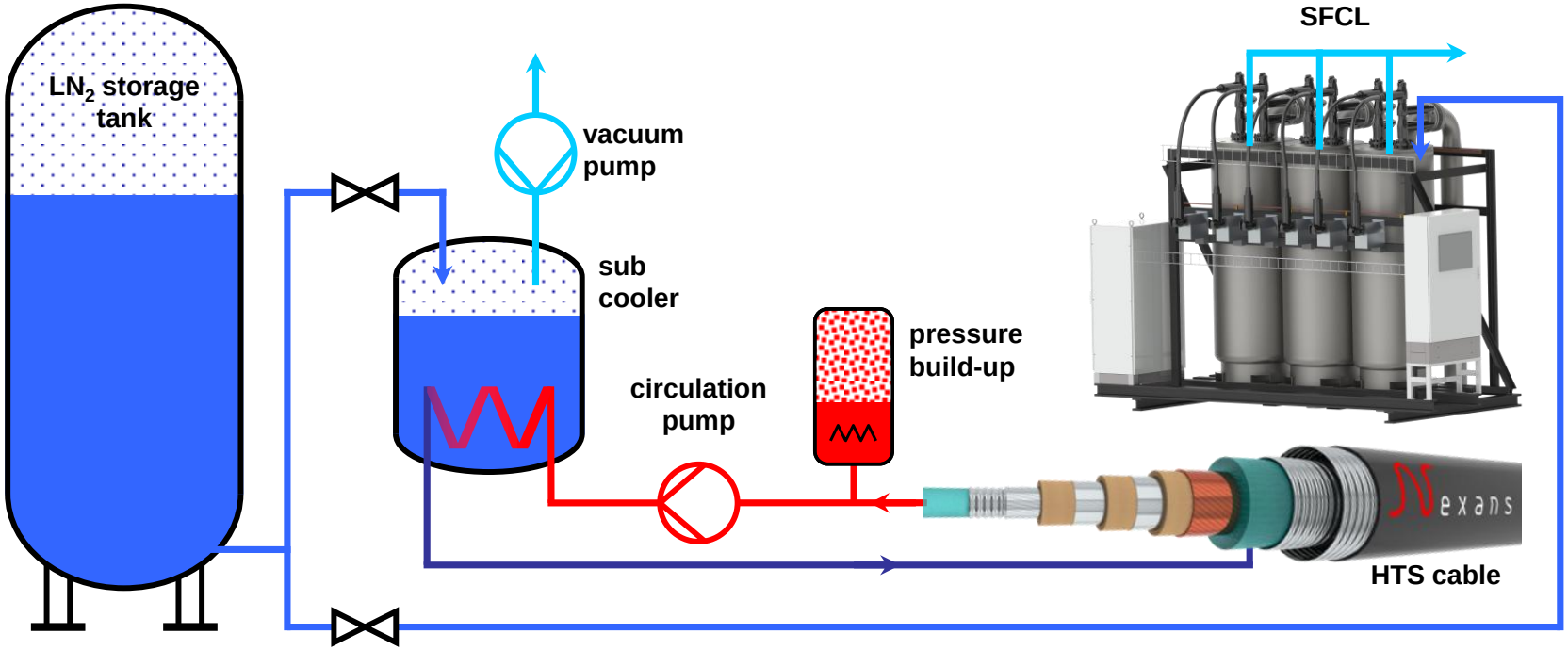


System Commissioning in March 2014

- Voltage test with HTS system connection only in substation Herkules
- Current testing with reactive power transfer between two transformers
- System connection in both substation for test operation in the grid

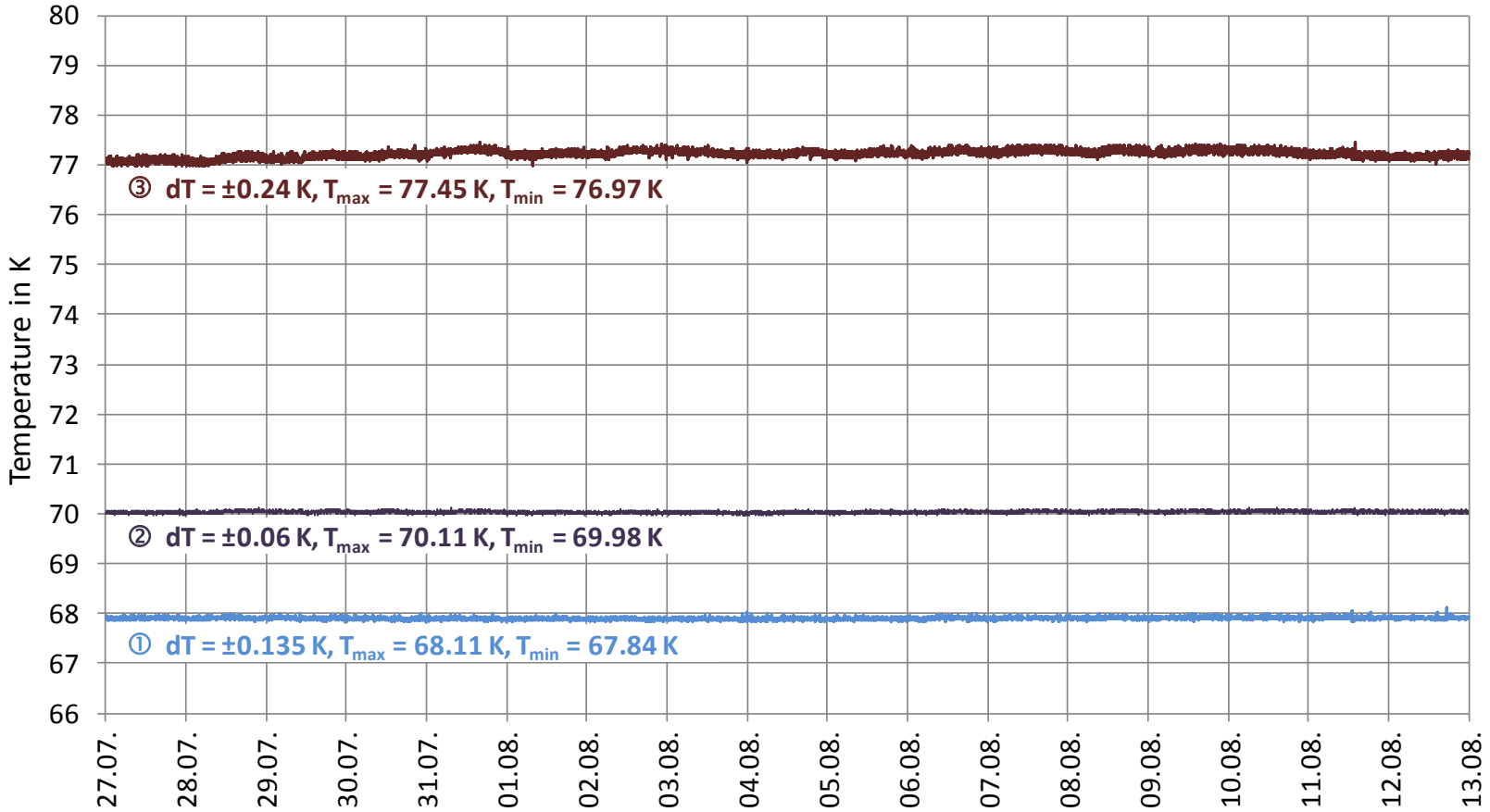
Cooling System

- 4 kW cold power at 67 K
- Subcooled pressurized nitrogen
- Forced flow in closed circuit
- High availability and reliability



Inlet and Outlet Temperatures

① Temperature Inlet Substation Herkules
② Temperature Outlet Substation Herkules
③ Temperature Substation Dellbrügge



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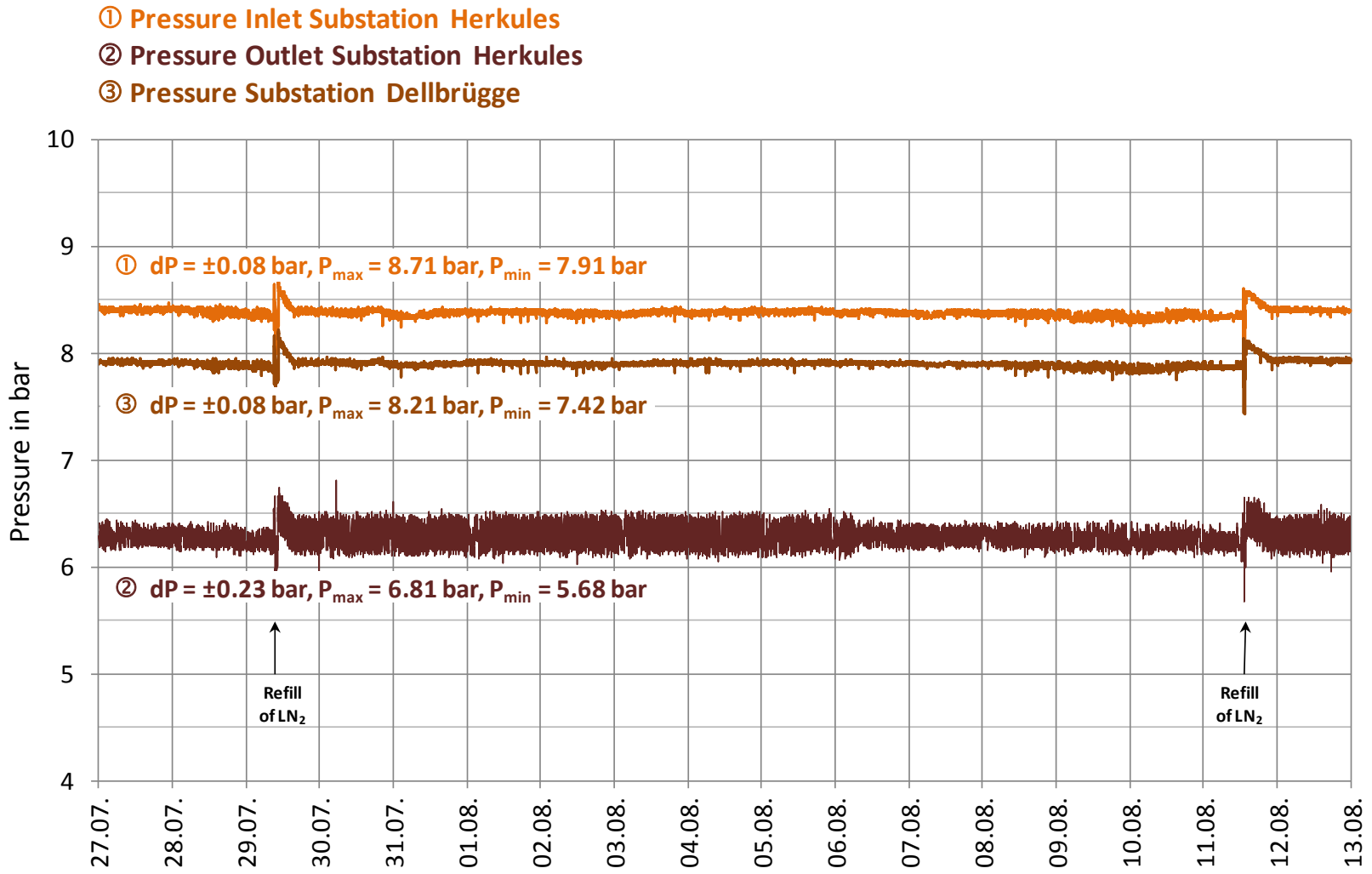
Inlet and Outlet Pressures



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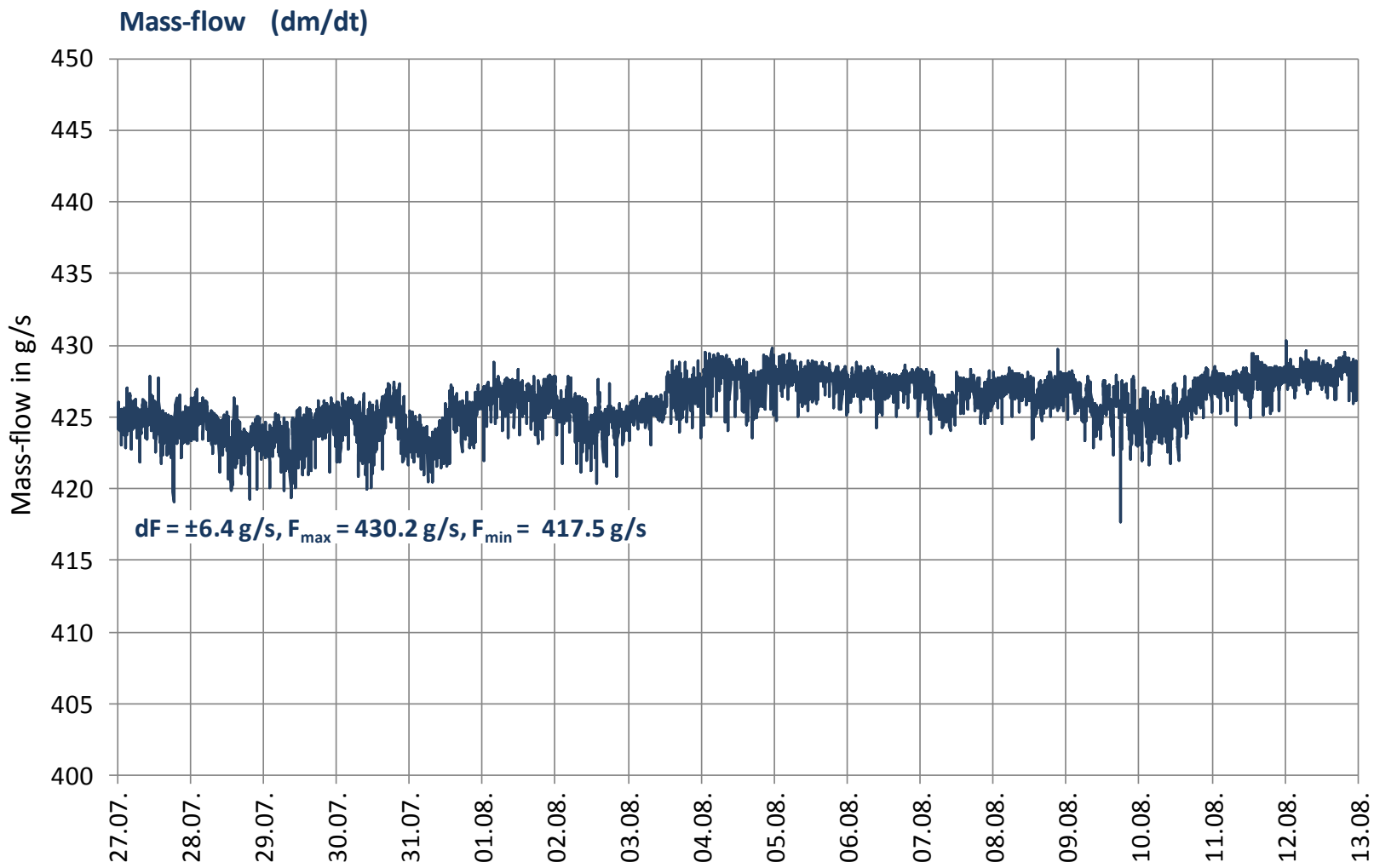
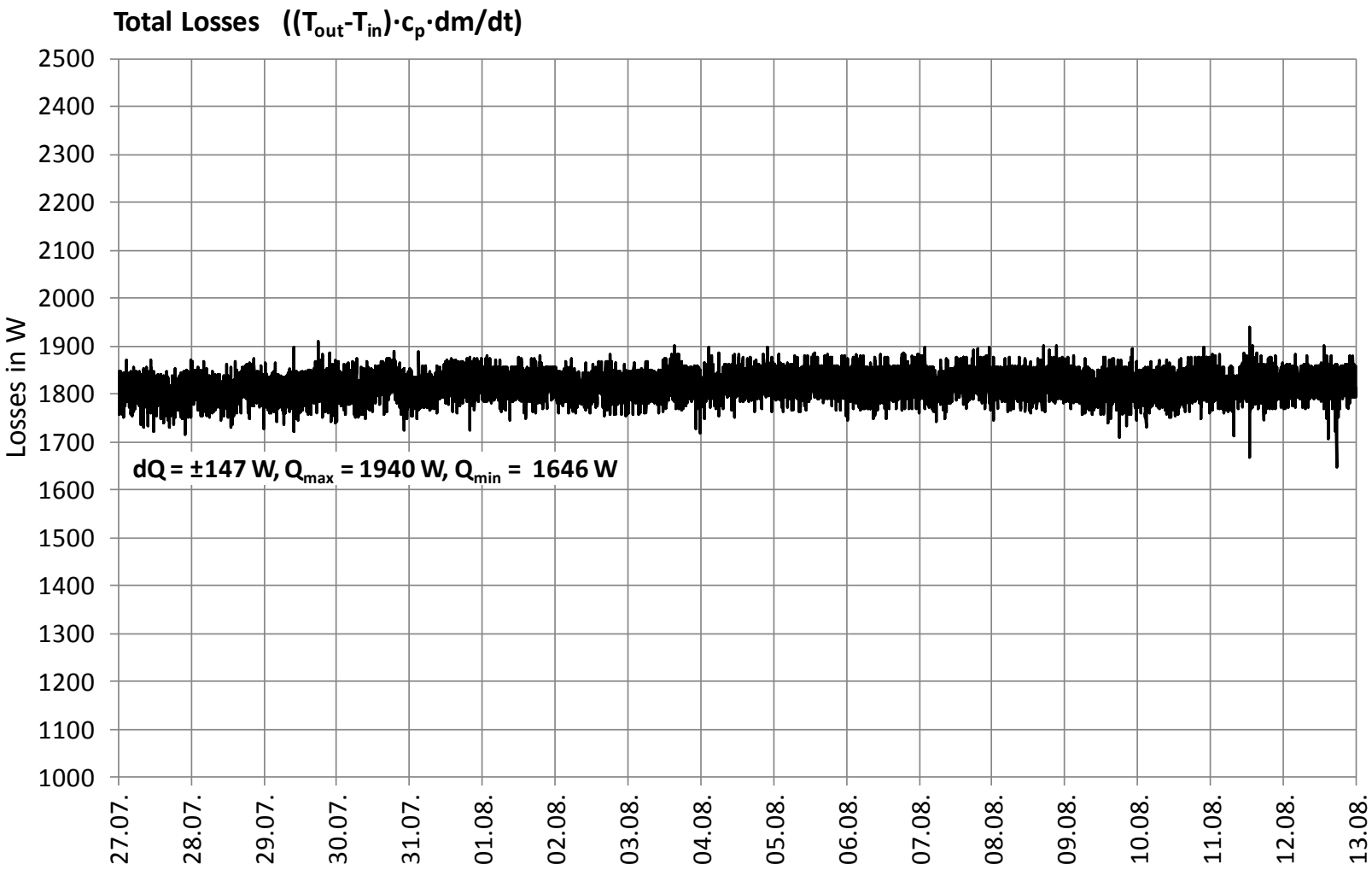
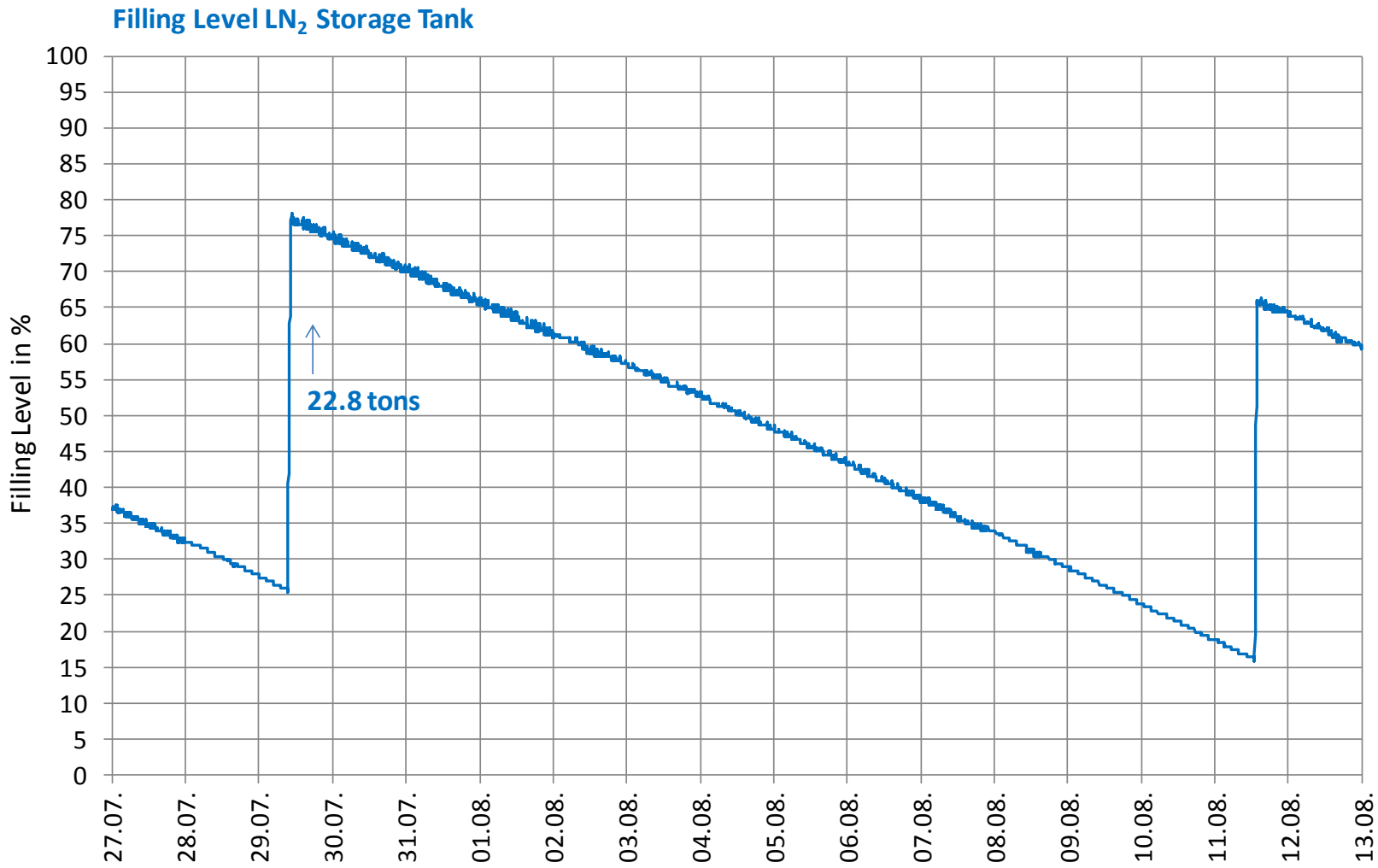
Mass Flow


Mass-flow (dm/dt)
Mass-flow in g/s
450
445
440
435
430
425
420
415
410
405
400
dF = ±6.4 g/s, F max = 430.2 g/s, F min = 417.5 g/s
27.07.
28.07.
29.07.
30.07.
31.07.
01.08.
02.08.
03.08.
04.08.
05.08.
06.08.
07.08.
08.08.
09.08.
10.08.
11.08.
12.08.
13.08.

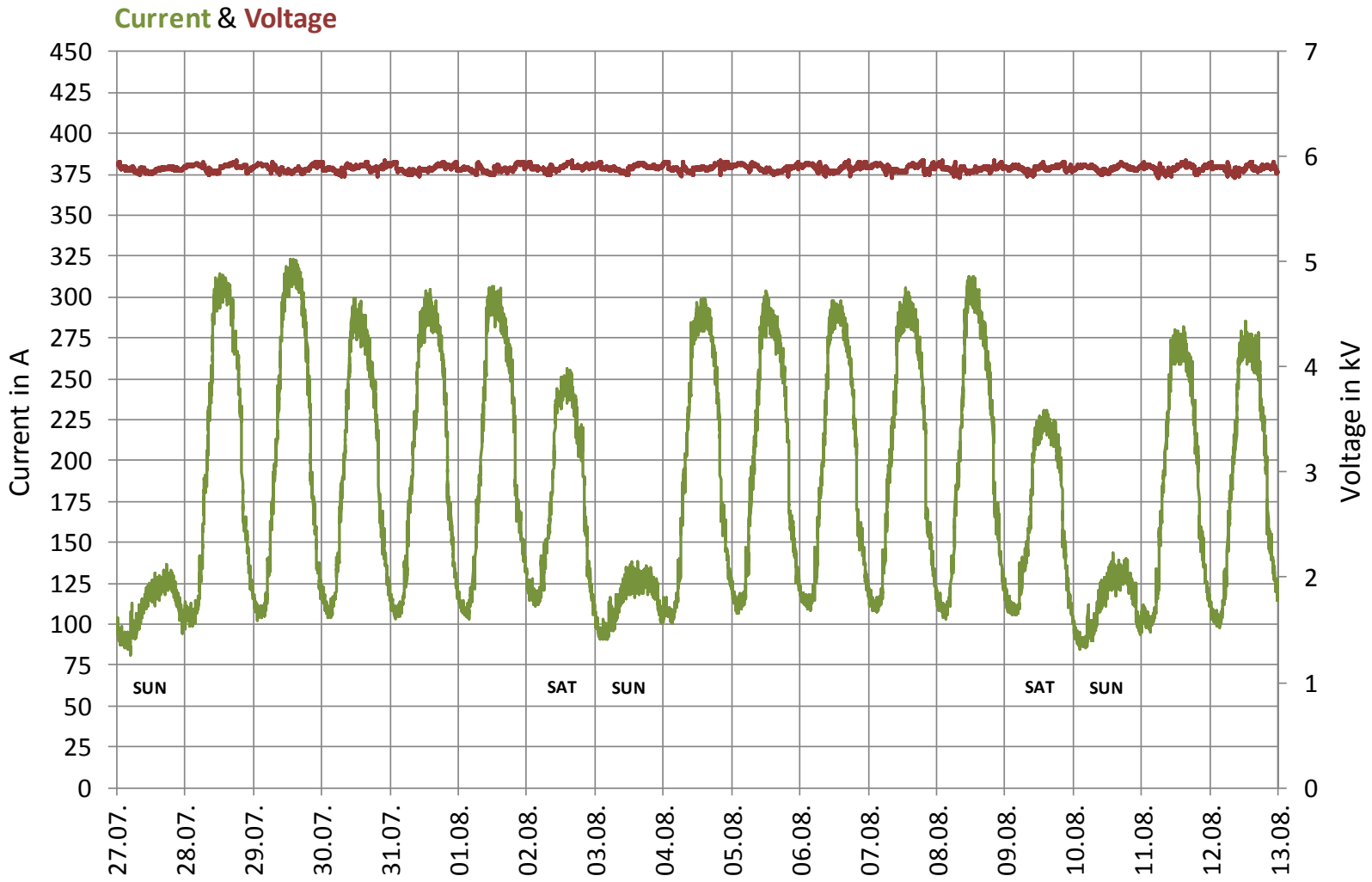
System Losses



LN_2 Level Storage Tank



System Loading



Conclusions

> Type test of Ampacity system was successfully completed

> All system components were manufactured

> System installation was realized in less than 3 month

> HTS System was successfully commissioned

> AmpaCity HTS System is in operation

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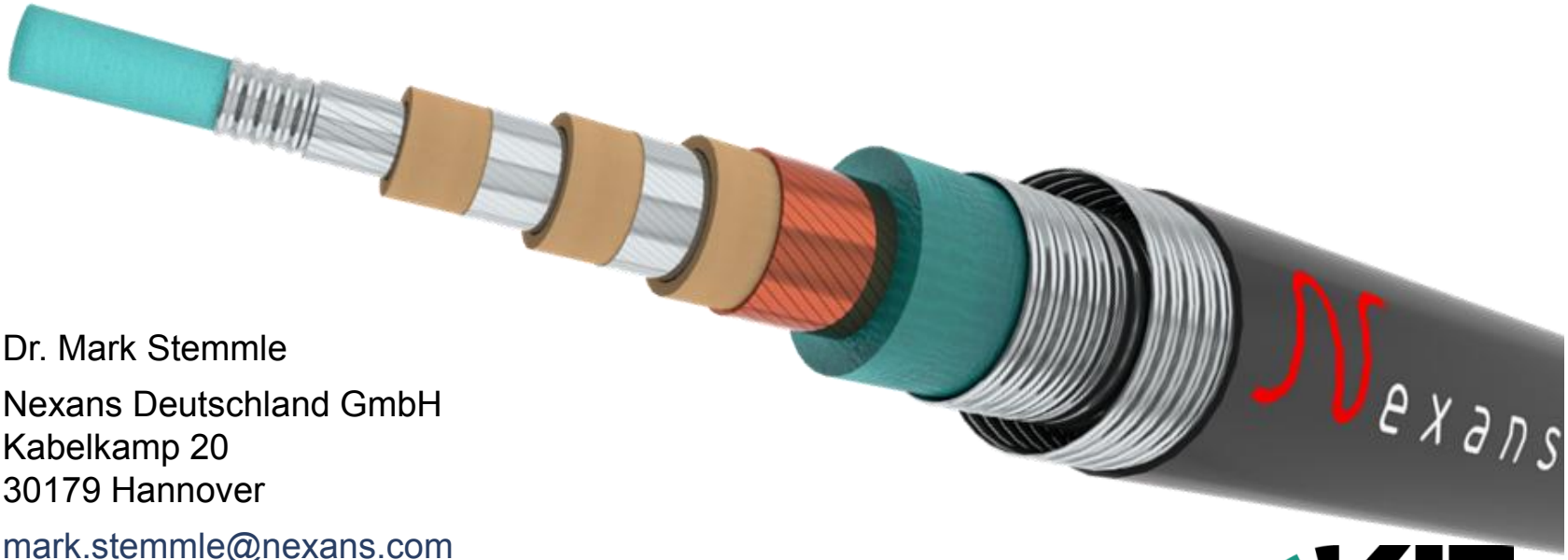
Thank you very much for your attention



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