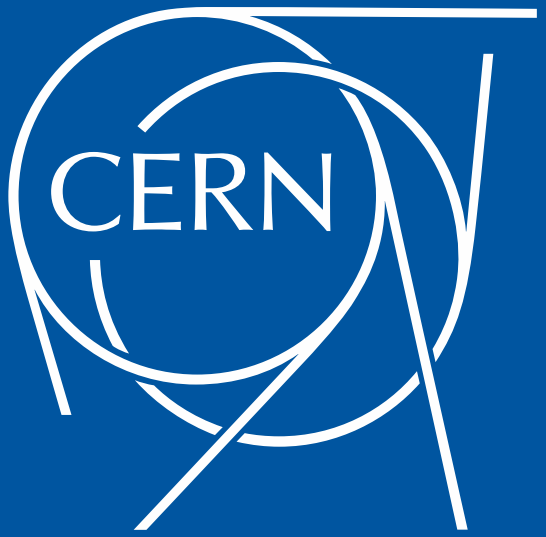
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MD#3205 Beam screen shielding of Quench Heater discharge with warmer beam screen

LSWG 4th of December

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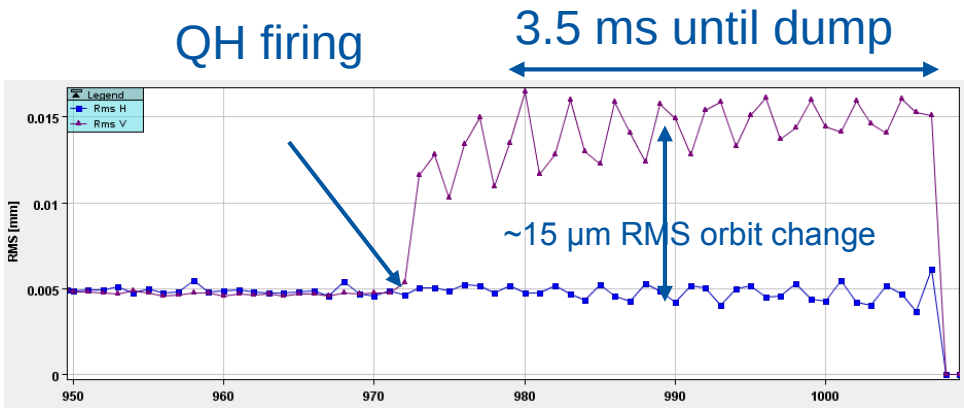
C. Wiesner, D. Wollmann

With special thanks to: G. Ferlin and the Cryo OP team,
the LHC EICs and operators and MP3, D. Valuch

Re-cap motivation and plan

- Very **fast effect** on the circulating beam has been observed during dipole quenches due to quench heater firing. Effect was confirmed in MD at injection
- Rise time of current in quench heater **~30 us**.
- The rise time of observed kick (~200 μs) is **faster than expected** from beam screen shielding effects ($\tau \propto 1/\rho$)
- For the **HL-LHC triplets**, kicks from single quench heater firing are expected to **reach critical levels**



Quench of MB.C28L5 on July 12th 2016

- QH firing with beam screen at ~70 K and two different currents with three circulating bunches
- Dedicated measurements with MQXFS4b in SM18 → not part of this talk

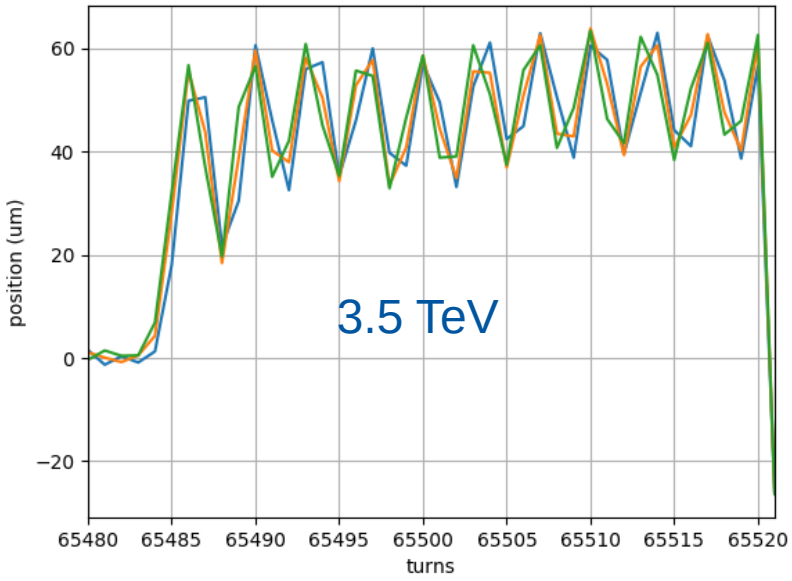
Magnet	L (m)	I_{QH} (A)	B (μT)	Kick (σ)
MB	14.3	80	450	0.4
MQXF	7.15	200	472	**1.28**

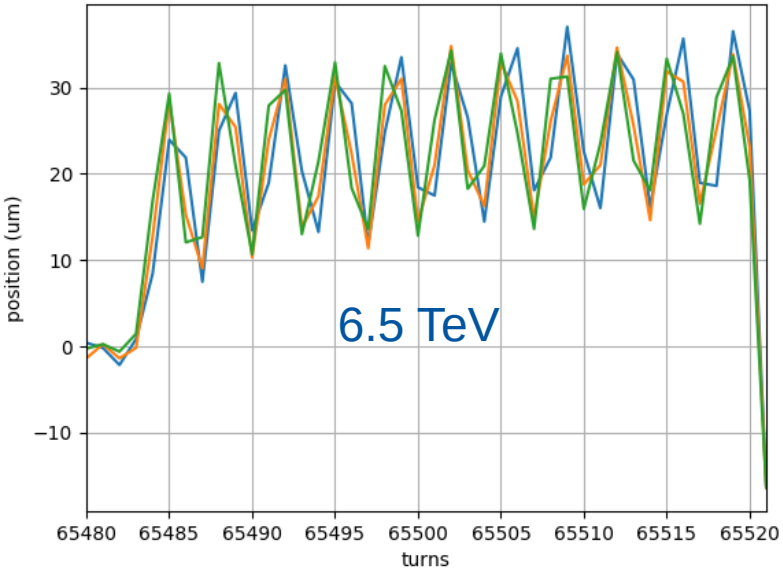
HL-LHC: QH parameters and expected kick

MD#3205

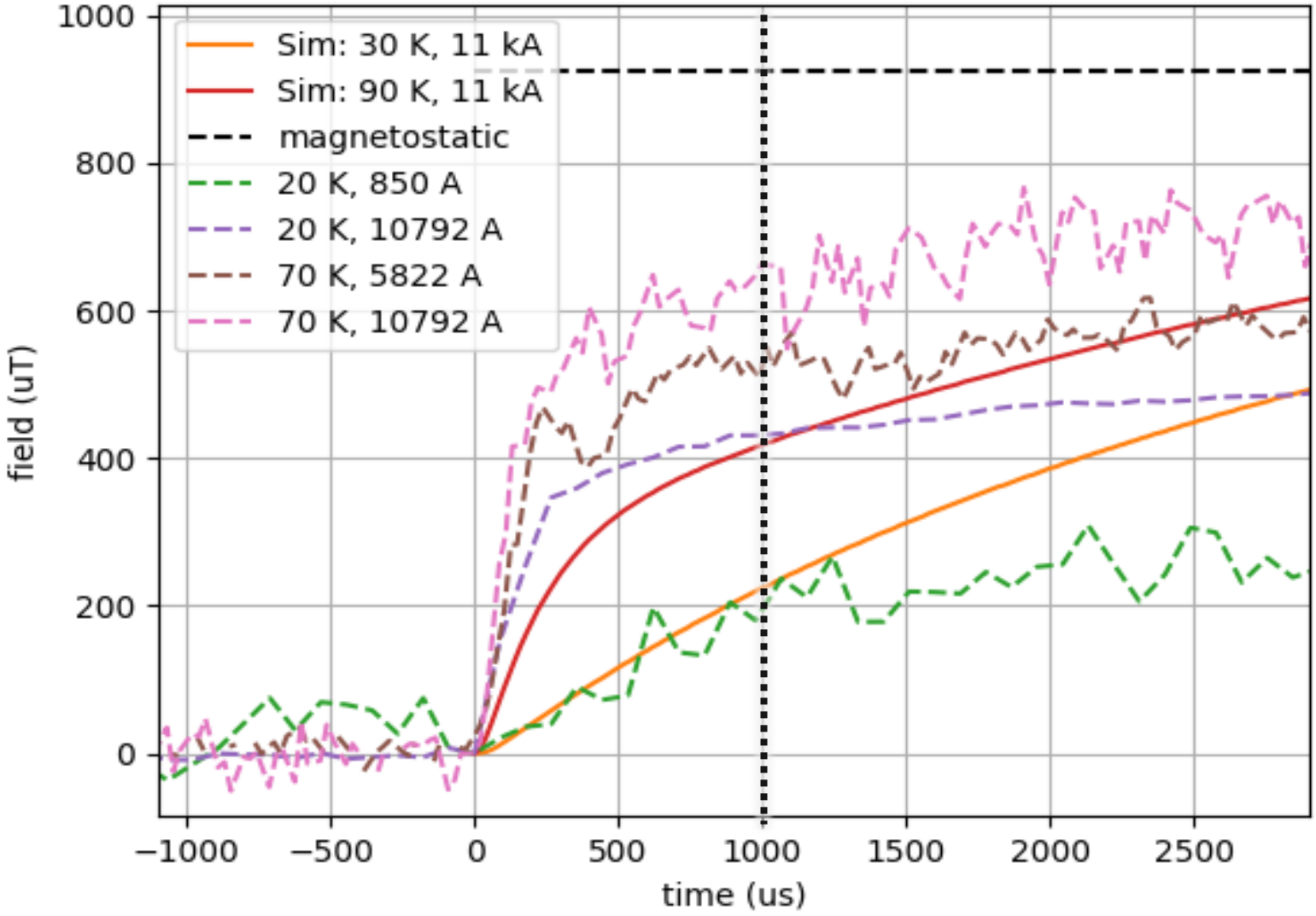
- MB.C28L5
- Beam screen temperature ~70 K
- Three nominal bunches circulating
- Quench heaters fired at 5822 A (3.5 TeV) and 10792 A (6.5 TeV)
- Kick & magnetic field from quench heaters reconstructed from ADTObsBOX

Measured beam excursion at ADT pick-up (Q7R5)

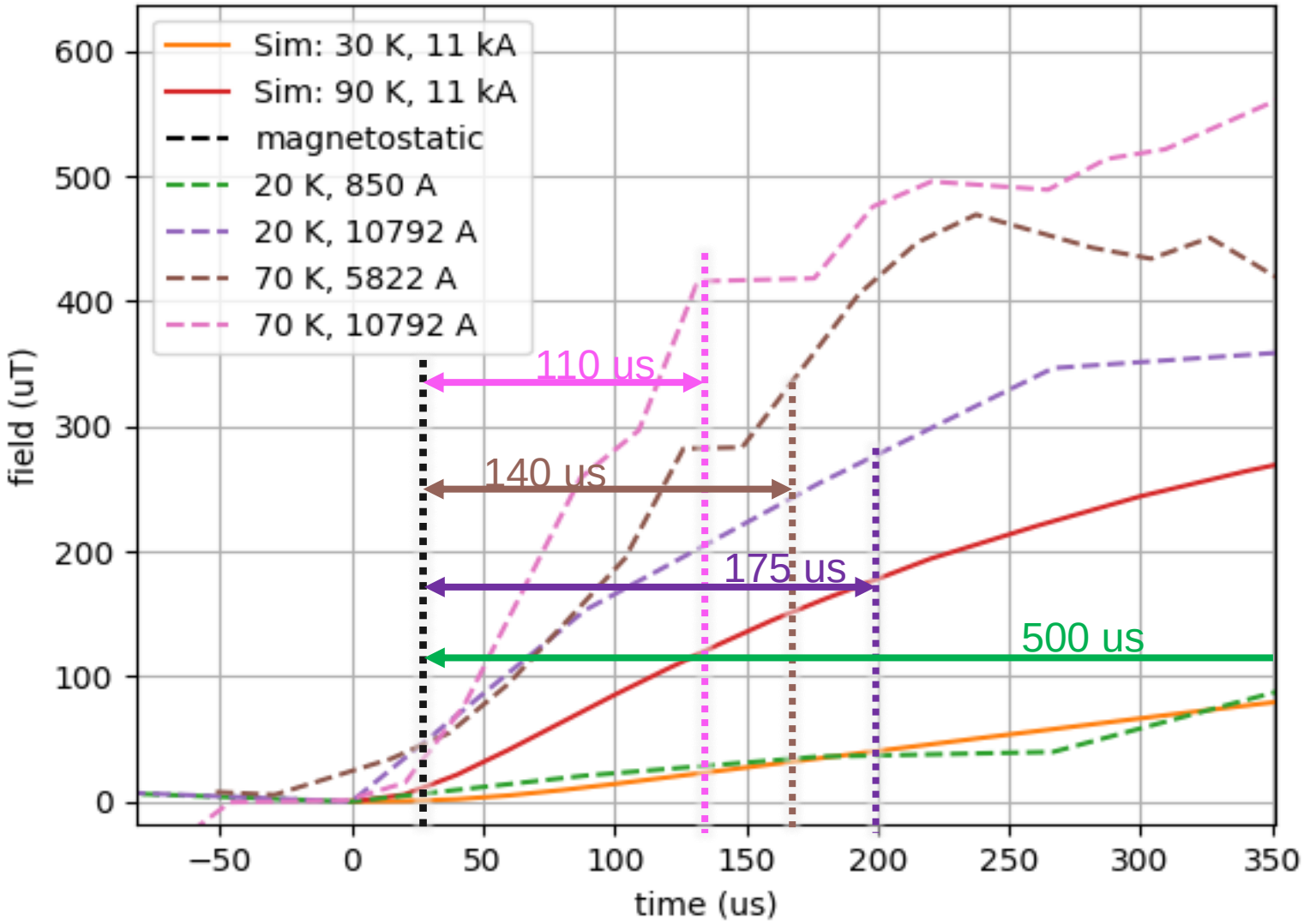




Magnetic field 1 ms after QH firing



Rise time of magnetic field (10 % → 65 % at 1 ms)



Summary of Observations

- Effect of **beam screen** temperature increase from **20 K → 70 K**:
  - Faster rise time and higher magnetic field reached **as expected**
  - Quantitative **changes not reproduced** by models
- Effect of **increased main field** with beam screen at **70 K**:
  - Faster rise time and higher magnetic field reached **as expected**
  - **Quantitative order** of change **correct**, details to be understood
- Effect of **increased main field** with beam screen at **20 K**:
  - Much faster rise time and significantly higher magnetic field reached
  - **Relative change in good agreement** with models

Energy (TeV)	I (A)	T (K)	ρ (10^{-10}Ω.m)	QH field rise time (10% → 65% at 1ms) (μs)	fraction of magnetostatic field after 1 ms
0.45	850	20	2.5	500	0.22
6.5	10792	20	5.22	175	0.47
3.5	5822	70	17.4	140	0.57
6.5	10792	70	18.52	110	0.69

Conclusion and Outlook

- Measurements agree **qualitatively** with expectations
- Nevertheless, **discrepancies between simulation** models and beam observations in respect to effect of beam screen resistance remain
  - Measurements with changed beam screen temperature are an essential input to adapt the transient field effect simulations in STEAM, especially focussing on the effect of the main coil on the quench heater field seen by the beam
- SM18 measurements with MQXFS4b and **beam screen are currently** being analysed and will be compared to STEAM simulations
- Further experiments in SM18 with final beam screen design are under preparation

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Zoomed Window: _6_DynamicTrend
Time Range
Y Axes
Save
Other
1:1
log
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Trend Ruler Values
Ruler
1
Date
Time
10/31/2018
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Automatic Resize
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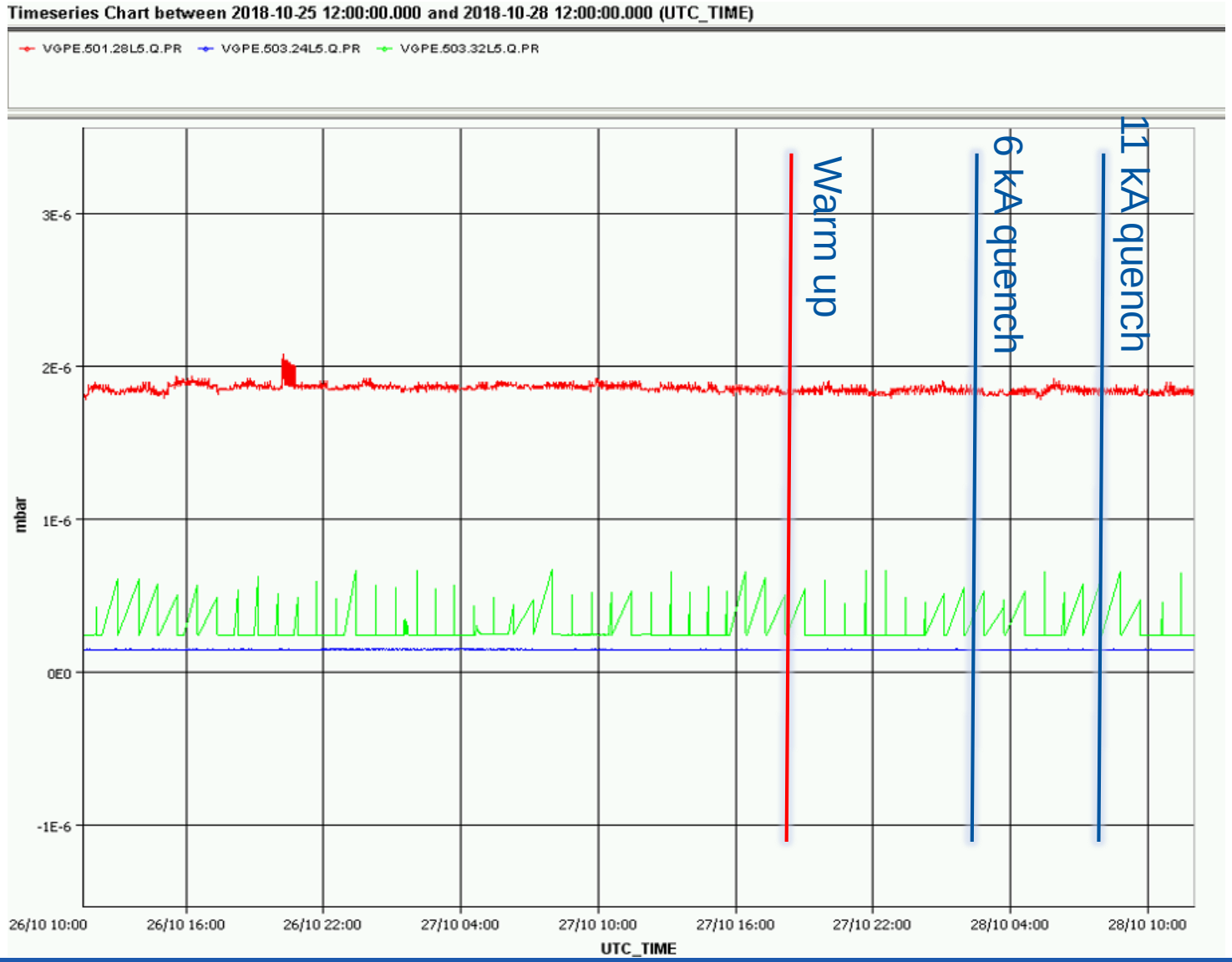
Timeseries Chart between 2018-10-25 12:00:00.000 and 2018-10-28 12:00:00.000 (UTC_TIME)
VGPE.501.28L5.Q.PR
VGPE.503.24L5.Q.PR
VGPE.503.32L5.Q.PR
Warm up
6 kA quench
11 kA quench
3E-6
2E-6
1E-6
0E0
-1E-6
mbar
26/10 10:00
26/10 16:00
26/10 22:00
27/10 04:00
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27/10 16:00
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UTC_TIME