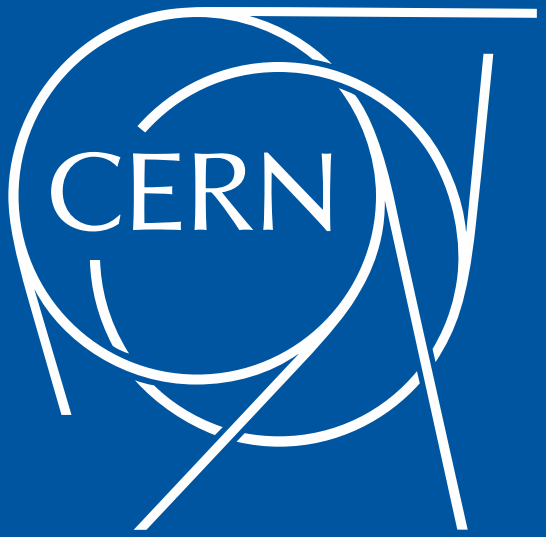

CERN

MPP recommendation – TDE pressure interlock

Action from LMC #263

J.Uythoven, J.Wenninger D.Wollmann, M.Zerlauth, W. Bartmann, A.Siemko, M.J. Jimenez, S.Gilardoni, M.Calviani, G. Bregliozzi, G. Pigny, P.Chiggiato et al for the MPP members

Recall of 2016 operation

- During beam operation in 2016, small leaks were detected on the (upstream) gaskets of the beam dump blocks (TDE)
- Verified by eXternal Post Operational Check (XPOC), inhibiting injection via SIS and BIS in case of pressure < 1.1bar (or > 1.4 bar)
  - XPOC warnings were overlooked in the past due to other repetitive warnings
- Additional mitigation measures were deployed, allowing continuing operation under non-nominal conditions
  - Installation of additional N_2 bottles
  - Deployment of SIS dump interlock in case N_2 pressure <1.1 bar (allowing 1 minute of 'non-valid data' to overcome communication issues)
    - Worked perfectly without false dump in 2016

EYETS activities

- VSC installed a 2nd piezo gauge, with direct reading on the dump volume, connected to the (same) VSC signal acquisition chains (MPP #140)
- Several consolidation interventions on the TDE took place, nevertheless minor leaks persist at the downstream gaskets of the TDE
- During LMC #292 (minutes) and LMC #295, 2017 operation with the present LHC beam dump block was approved
- Nominal pressure in TDE volume proposed to be as of now 1.05-1.08 bar (G.Bregliozzi), with 1.3 bar maximum pressure limited by safety release valves and 0.96-0.98 bar in tunnel
- Today the leaks are small, however their evolution in time cannot be reliably predicted

MPP meetings and follow-up actions

- The damage limit in case of a (simultaneous) kicker dilution failure as simulated by EN/STI (and presented in MPP on 22/04/2016 and MPP on 19/02/2017) is conservatively estimated at ~ 20 nominal bunches in case of (considerable) oxygen presence in the dump volume

- Define the maximum temperature the TDE core is allowed to reach, if it would be surrounded by air, and what is the maximum number of bunches we are allowed to dump at top energy assuming the dump core resides in air – Action EN/STI (studies done, experimental verification ongoing)

- How fast can the air penetrate into the dump volume, assuming a worst case leak (without and during/after a beam dump)? The underlying question here is, how fast do we need to react in case of a new leak developing - Action VSC (M.Sitko, J.A. Ferreira Somoza).

MPP meetings and follow-up actions

- Based on results of the above simulations, specify the appropriate reliability of the interlock function (for long term operation) and follow up definition (ECR), implementation and validation – Action MPP et al

- Awaiting the results of actions 1 and 2 and in an effort to further improve risk mitigation while preparing for a long-term solution or an eventual degradation of the situation in 2017, MPP recommends an adaption of the 2016 interlock strategy for 2017 operation as follows

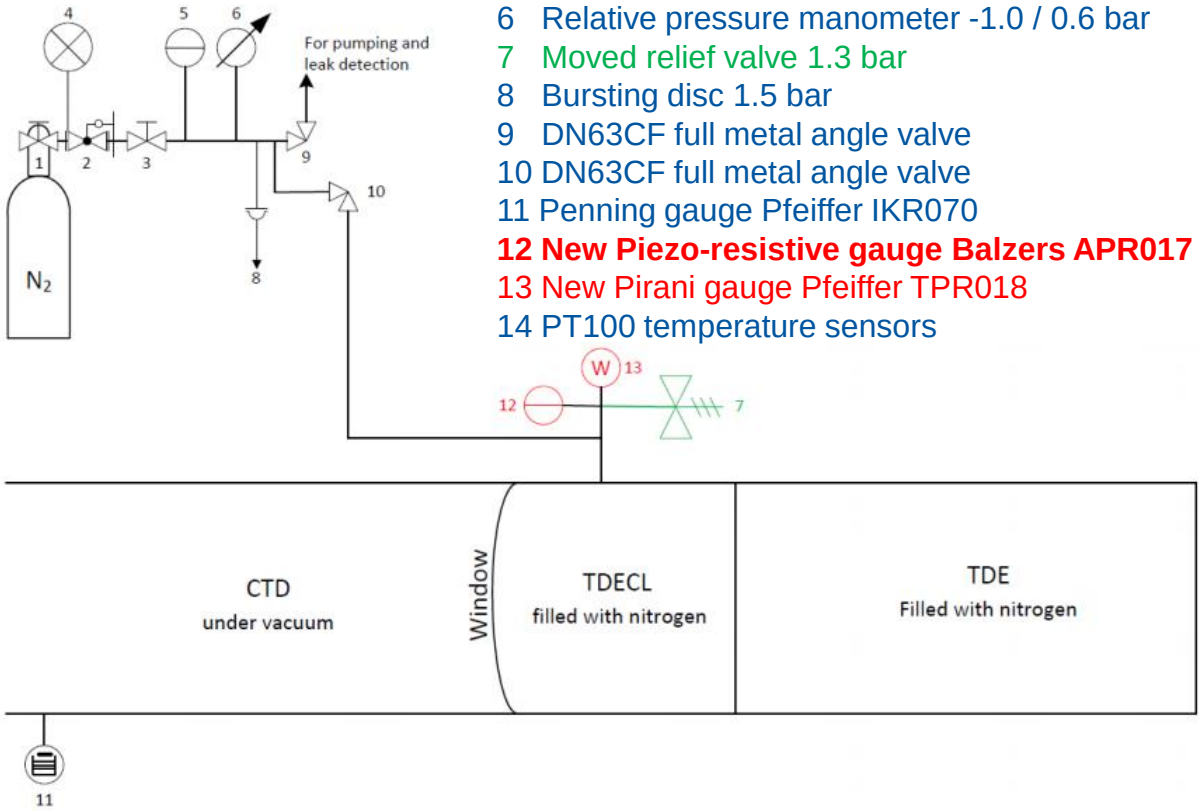
Recommendation for 2017 operation

- As before: XPOC injection inhibit
  - Update to new operational range
    XPOC limit at 1.025 bar instead of previous 1.1 bar
  - Change to newly installed gauge at the dump volume
- SIS interlock:
  - New: Injection inhibit if either of the two pressure readings is < 1.025 bar OR if pressure readings diverge by >=0.1 bar (temporization by 1 min, allowing for bad readings + communication loss)
  - As before: Beam dump if pressure reading on piezo gauge on dump volume is <1 bar (1min temporization for bad readings + communication loss)
- New: Hardware channel from newly installed piezo gauge connected for additional diagnostic (using 2 controllers and locally programmable thresholds)
  - Warning/Alarm if pressure reading on piezo gauge on dump volume is <1 bar
  - Following outcome of studies this channel might be consolidated for appropriate reliability (detailed via ECR) to become an active interlock channel (beam inhibit or dump)

Fin

Questions?

TDE pressure measurements



1 Bottle and tap
2 Reducer from 200 bar to 0.05 / 1 bar
3 Isolation valve (reducer-injection line)
4 Bottle high pressure transmitter WIKA S-10 0-250 bar (active 0-10V; DC 10..30V)
5 Piezo-resistive gauge Balzers APR017 0-2000 mbar (passive)
6 Relative pressure manometer -1.0 / 0.6 bar
7 Moved relief valve 1.3 bar
8 Bursting disc 1.5 bar
9 DN63CF full metal angle valve
10 DN63CF full metal angle valve
11 Penning gauge Pfeiffer IKR070
12 New Piezo-resistive gauge Balzers APR017 0-2000 mbar (passive)
13 New Pirani gauge Pfeiffer TPR018
14 PT100 temperature sensors

Proposed architecture TDE6x