Vacuum Status for RFD-SPS & series

C. Pasquino on behalf of TE-VSC contributors to WP4

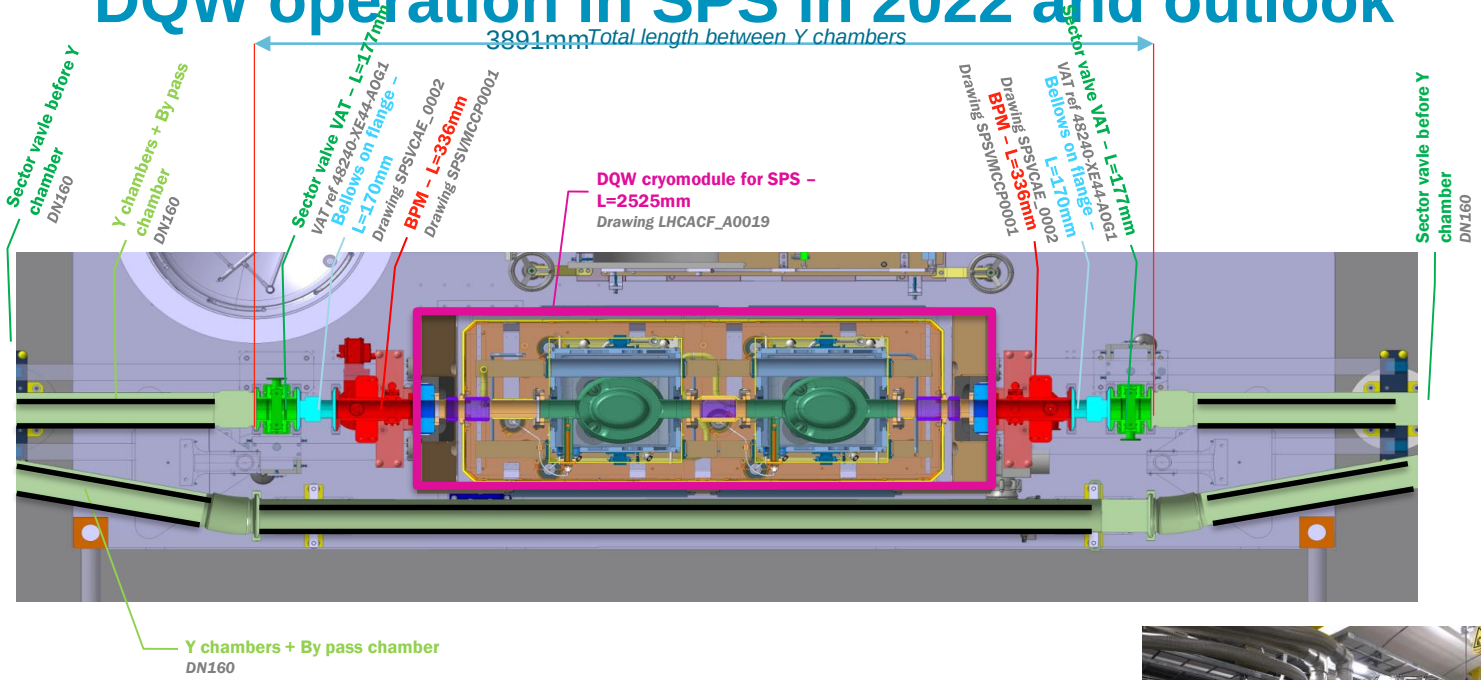
12th HL-LHC Collaboration Meeting – Uppsala University, 19th – 22nd October 2021

Outline

- DQW operation in SPS in 2022 and outlook
- SPS-RFD vacuum tests @ CERN
- TE-VSC to WP4 contributions:
  - Overview
  - Status of the contributions for RFD @ UK, STFC
  - Status of the series production
  - LHC integration layout

DQW operation in SPS in 2022

DQW operation in SPS in 2022 and outlook

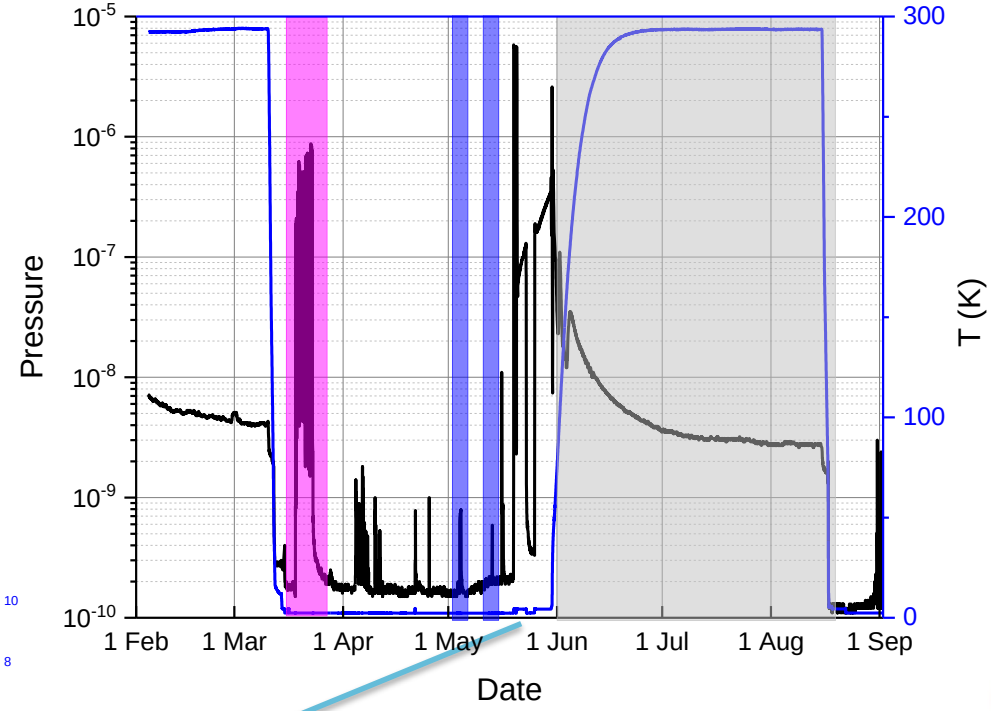


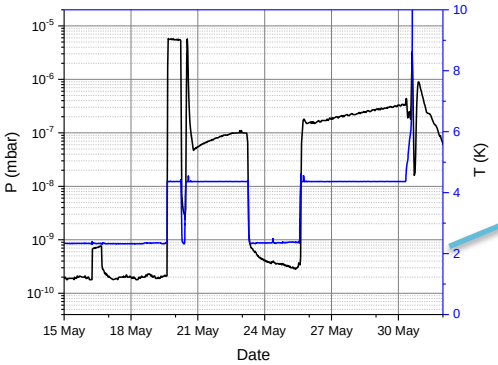
Reminder:

- Y chamber and pumping units are aC coated;
- BPMs and CWT are not;
- Vacuum conditioning shall be expected due to the presence of unconditioned surfaces;
- Penning gauges are located on the BPM modules upstream and downstream.

DQW operation in SPS in 2022 and outlook

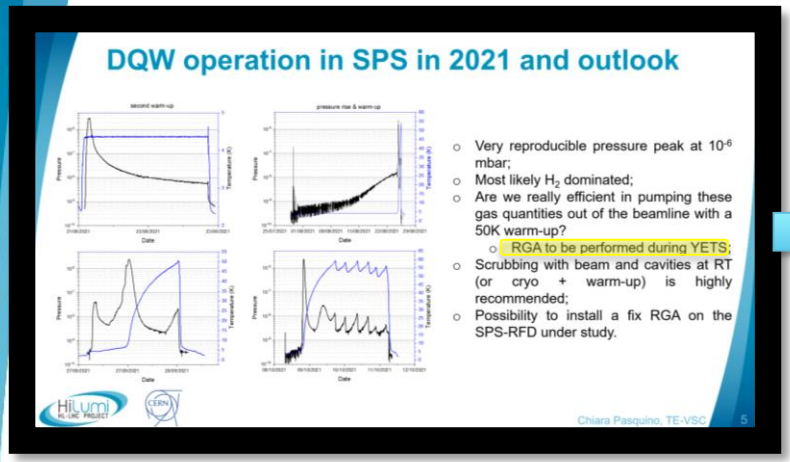
YETS (Year End Technical Stop) + Cooldown	Dec-Feb (w11-w12)
Scrubbing	March 18
RF Conditioning & LLRF setup	Week 13-16
MD 1 – emittance growth, 270 GeV	May 4
MD 2 – emittance growth, 270 GeV*	May 16
Warm-up, standby	Jun 25 - Aug 23
MD 3 – Emittance & high intensity test	Week 37
MD 4/5 – high intensity + MP	Week 37 & 39

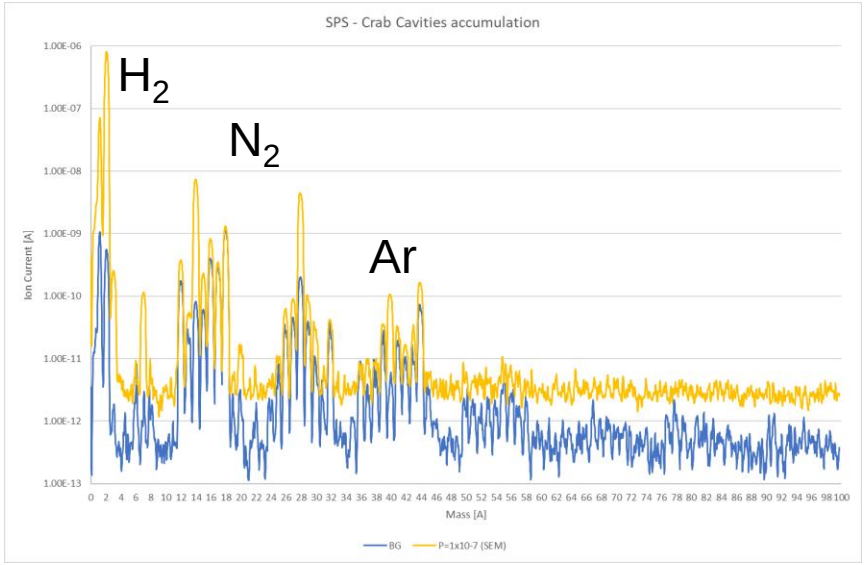




Cavities at 4.5K

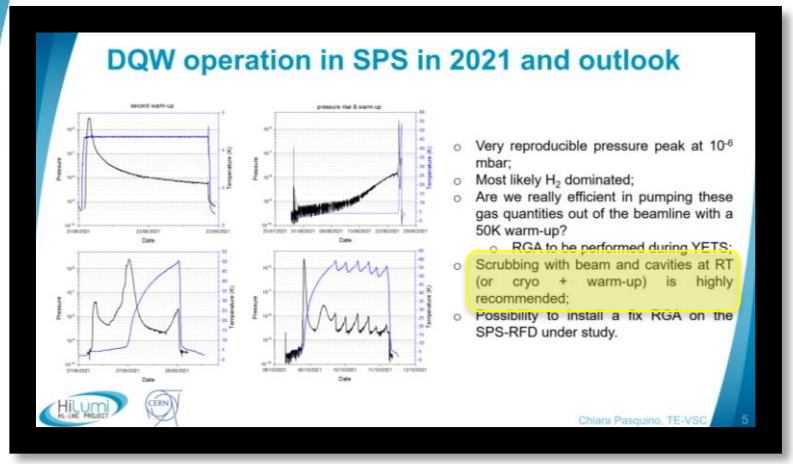
DQW operation in SPS in 2022 and outlook: YETS interventions

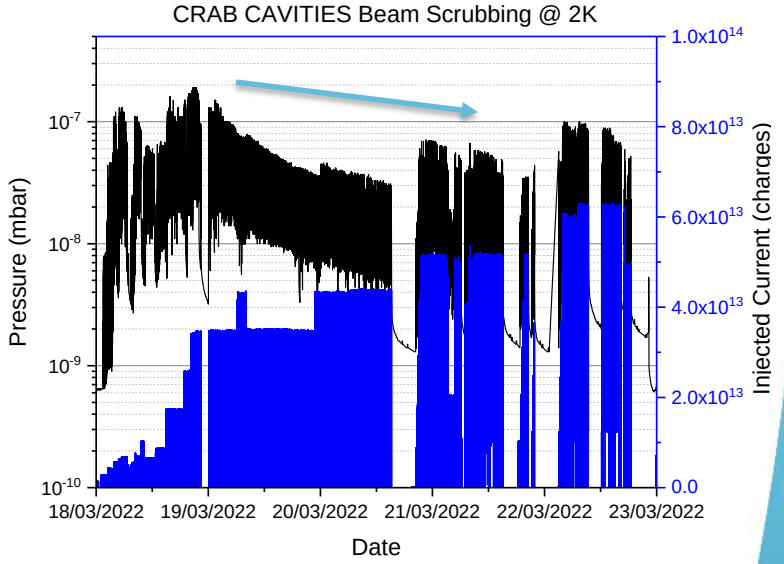




- Gas spilled from the beam line is H_2 dominated
- RGA analysis showed the presence of air peaks. A leak detection of the beam vacuum line revealed a leak in the 10^{-9} mbar l/s range on a collar (now solved).

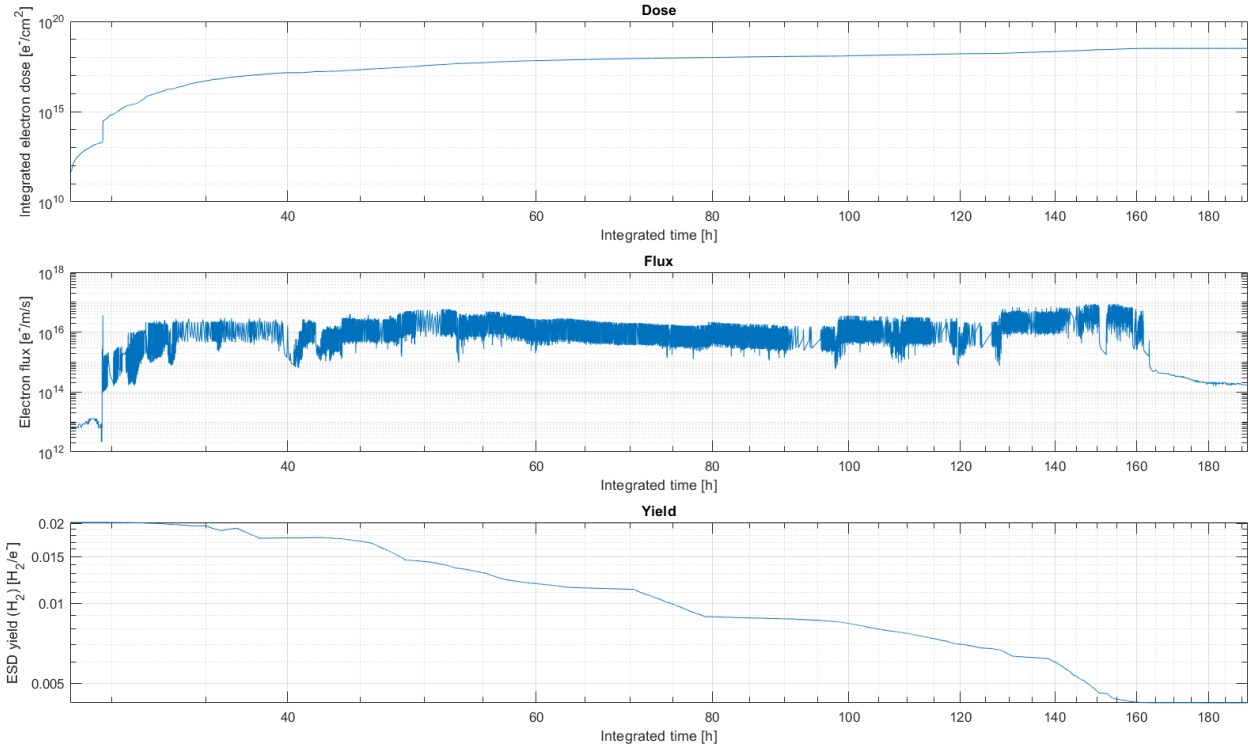
DQW operation in SPS in 2022 and outlook: Beam Scrubbing





- Scrubbing performed with few hours of exposure to 5 batches of 72 bunches, 25ns bunch spacing and 1.7*10+11 ppb!
- Cavities at 2K (schedule clashing to perform it at RT)
- Very stable operation after this, no pressure drifts experienced so far.

DQW operation in SPS in 2022 and outlook: Beam Scrubbing

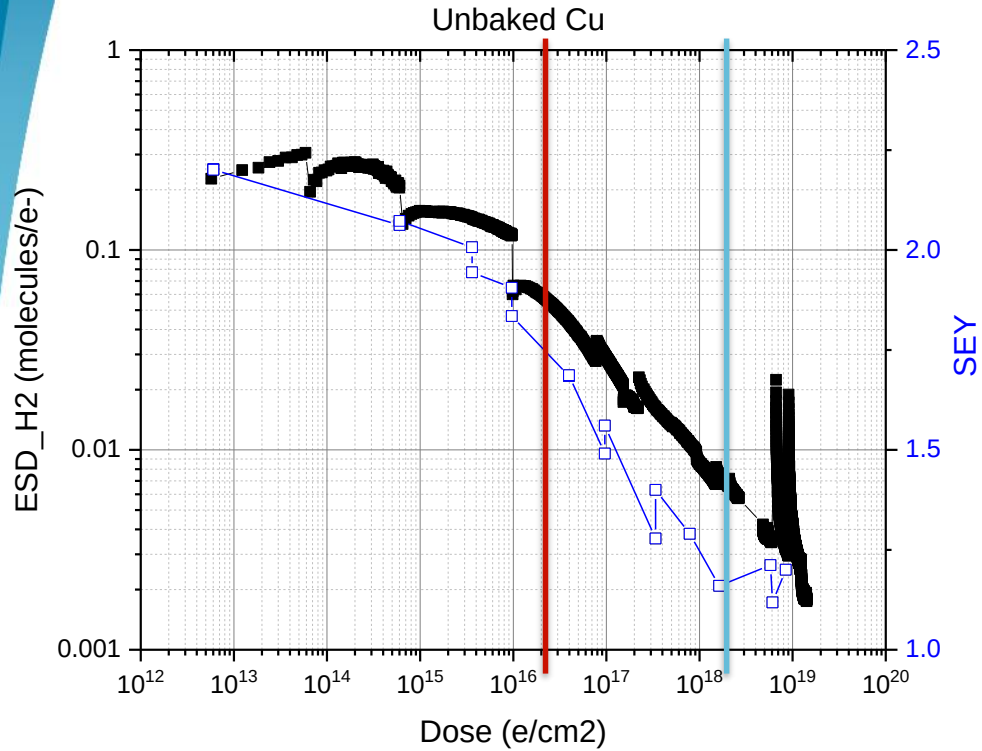


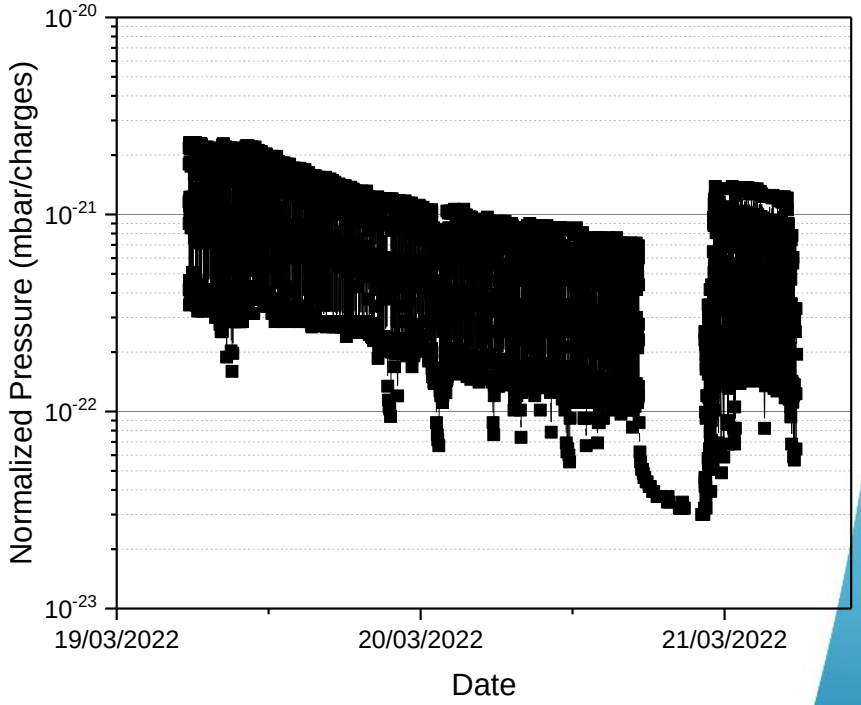
$$P_{tot} \approx \sum \frac{\eta_{gas} \cdot \dot{\Gamma}}{S_{gas}} = \sum P_{gas}$$

- ESD is dominating the pressure dinamyc;
- Integrated dose to decrease the ESD by 1 order of magnitude;
- Only possibility to suppress this is to coat the PIMS on the cavity sides as well.

A. Galloro

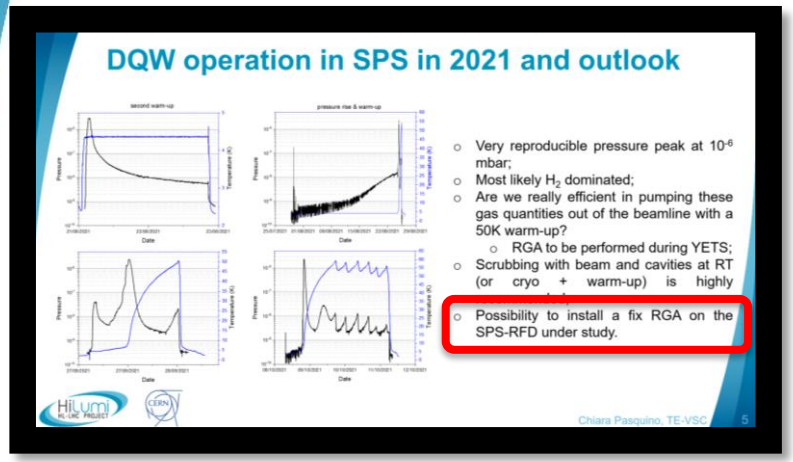
DQW operation in SPS in 2022 and outlook: Beam Scrubbing





A factor 3 / 4 gained during conditioning, not matching with the expected e- dose.

DQW operation in SPS in 2022 and outlook



- ❑ Cable will be pulled in YETS22/23;
- ❑ RGA bought and delivered;
- ❑ Follow-up of gas composition during warm-up could be part of the tests that can be performed on the SPS-RFD, once at CERN (M7).

SPS-RFD tests @ CERN

SPS-RFD tests @ CERN (SM18-M7)

Goals:

- Assess the leak tightness both of insulation and beam vacuum (cavity & secondary line) @ room temperature;
- Assess the cleanliness of the beam vacuum lines (RGA) @ room temperature;
- Assess the functioning of the vacuum equipment (gauges, ion pumps, gate valves);
- Assess the leak tightness at 2K (followup of mass 4 during cooldown);
- Assess the gas evolution during a warm-up and assess the effective pumping speed is correctly sized.
- EDMS 2756481

TE-VSC contributions to WP4:STATUS

TE-VSC to WP4 contributions

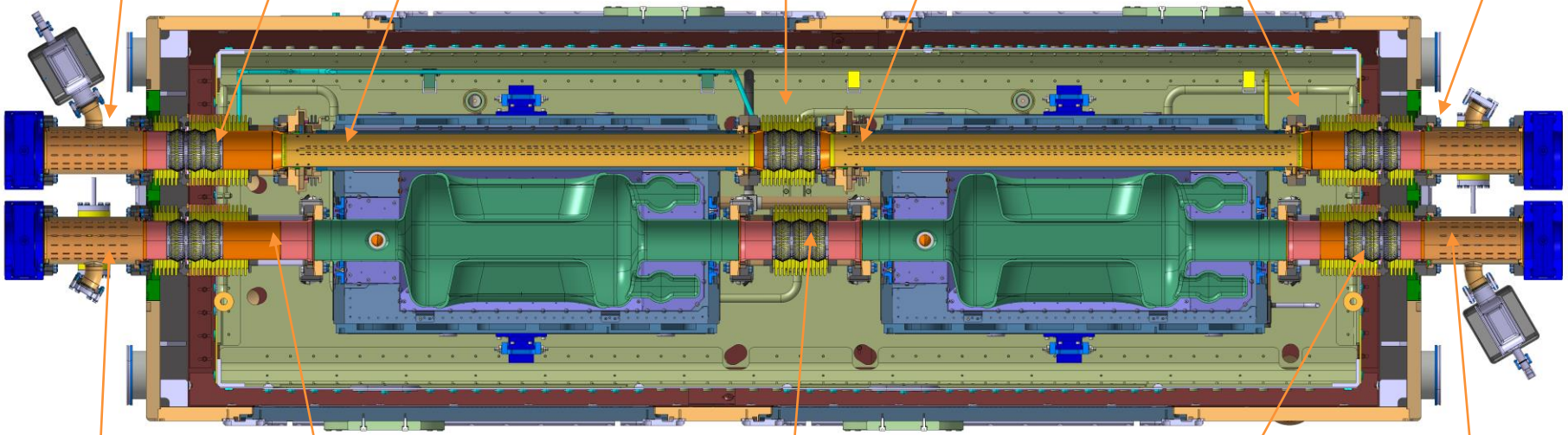
What is planned to be installed:

- SPS – LSS6 : 1 X RFD – LHC type cryomodule;
- LHC – LSS1 (L+R) : 4 (2 + 2) DQW cryomodules;
- LHC – LSS5 (L+R) : 4 (2 + 2) RFD cryomodules;

What is planned for production:

- SPS – LSS6 : 1X RFD;
- LHC: 5 (4 + 1 spare) DQW; 5 (4 + 1 spare) RFD;
- Spares: 6 Plug In Modules, 2 vacuum modules, 2 beam screens;

TE-VSC to WP4 contributions



Courtesy of T. Capelli

Project & quality management

- TE-VSC WP4 Contributions EDMS node:
  - TE-VSC production Plan
  - Spending Profile
  - Long Term Planning (WP4 planning)
  - List of Assets
  - Monthly reports

TE-VSC to WP4 contributions: status

2022 – Q1/2023 most of the production should be concluded

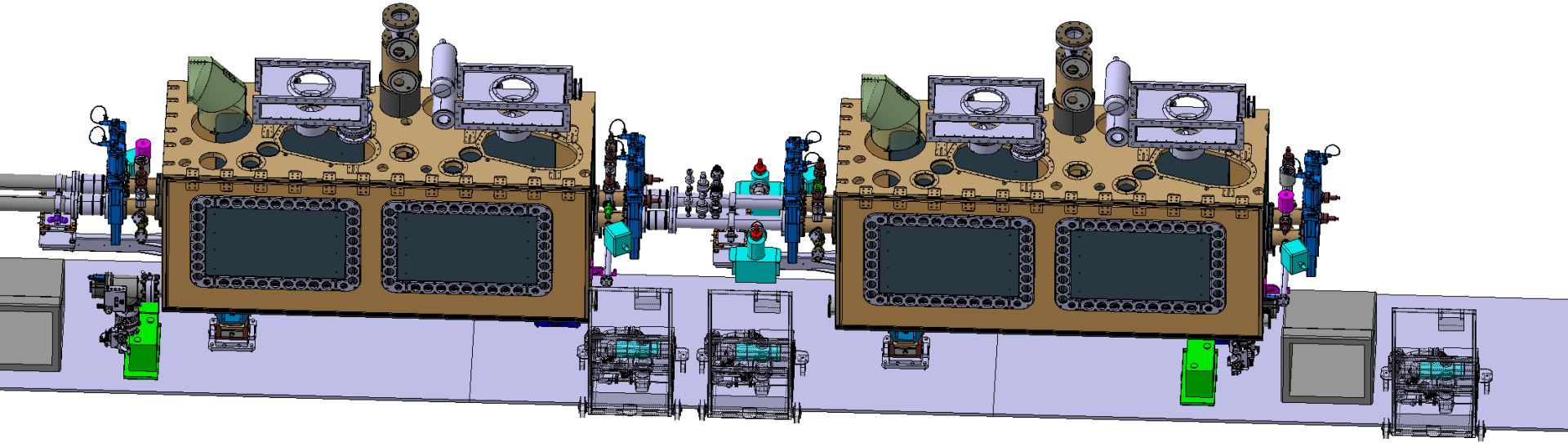
- Beam screen production:
  - 14 RFD beam screens produced and pressure tested;
  - 6/14 RFD beam screens tested for vacuum acceptance and are ready for aC coating.
  - 2/14 carbon coated and inserted in RFD1 and RFD2 cavities;
  - 14 DQW beam screens produced and pressure tested
  - 6/14 DQW beam screens tested for vacuum acceptance and are ready for aC coating.
- Bellows procurement for HL-LHC:
  - Blanket contract is in place, and PIMs for DQW @ CERN are being produced, expected delivery date Nov2022.

TE-VSC to WP4 contributions: status

- Vacuum Modules:
  - 10 pieces produced
  - 34 remaining pieces will be completed by December 2022
  - The vacuum modules for the non-crabbed line will be aC-Coated
- Standard components:
  - Gauges manifolds and Tees all produced;
  - Rupture disks being purchased;
  - 2X gauges assembly + flap valve (insulation vacuum) completed;
- Support to SRF in SMA18:
  - Validation of leak detection and RGA analysis for the cavities.
  - Acceptance criteria : EDMS Crab Cavities Vacuum Acceptance Criteria
- Plasma Cleaning: knowledge transfert could be organised at CERN

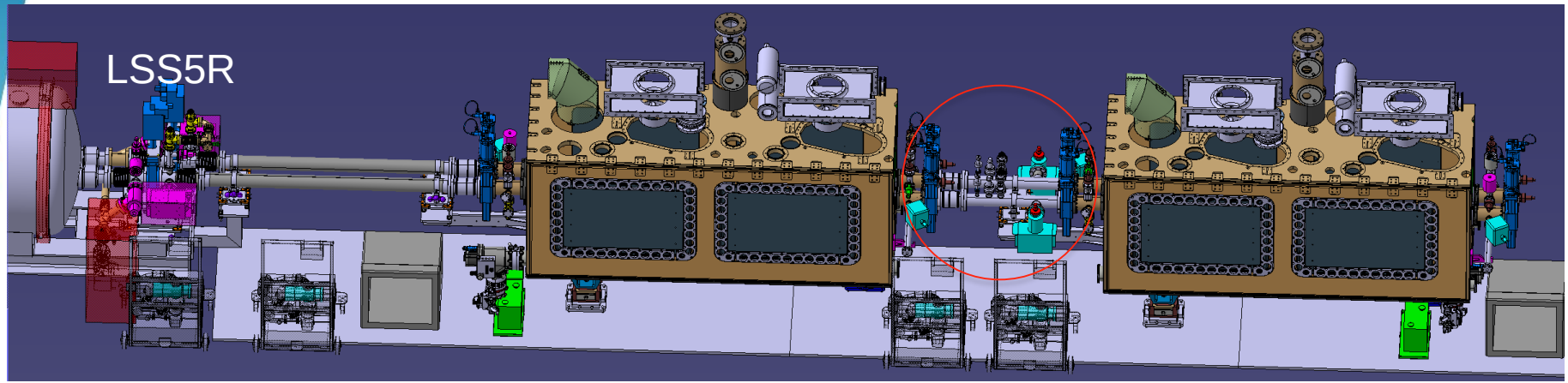
TE-VSC to WP4 contributions: IN-KINDs procured by CERN

- Sector Valves:
  - DN80 Vacuum sector valves have been procured through CERN B-Contract. First delivery of 5 expected by Dec2022.→ **savings of about 800 KCHF**.
- Standard components:
  - Rupture disks;
  - 9X gauges assembly + flap valve (insulation vacuum) completed;
  - Tees and gauges manifolds;



LHC Integration Layout

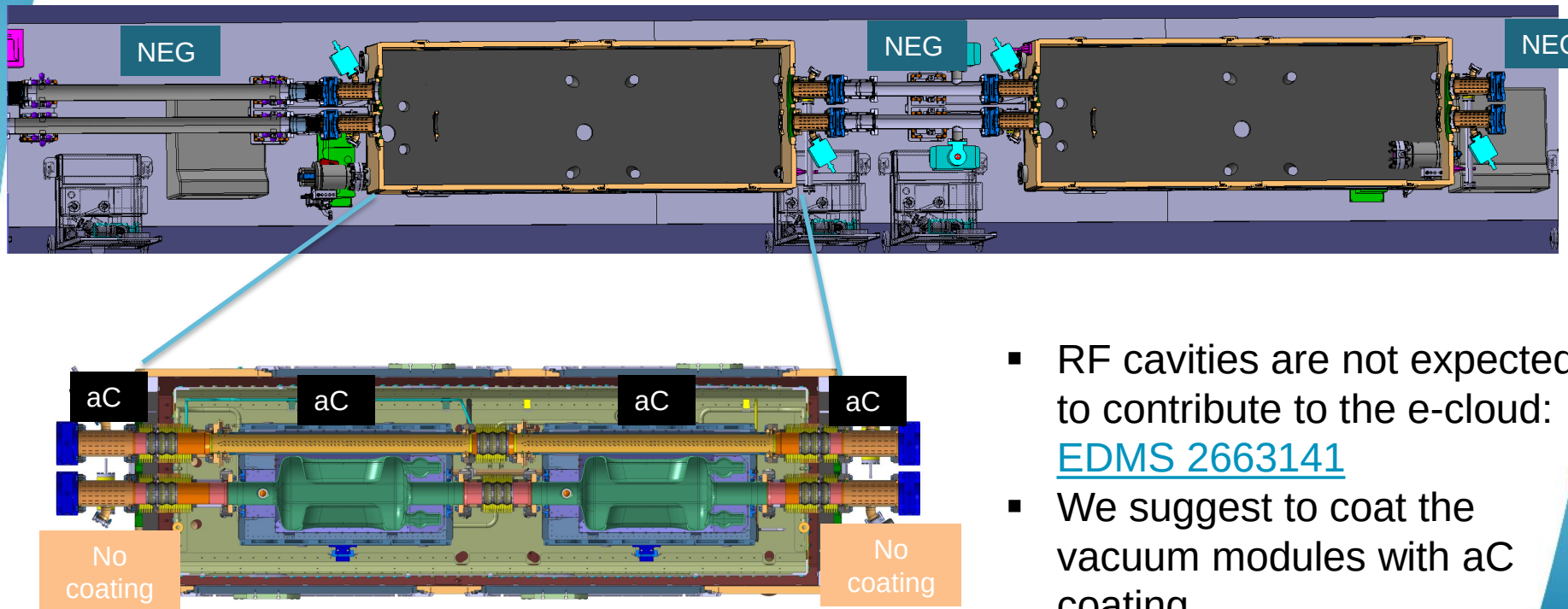
LHC integration



Optics v1.6

- Intertanks cryomodules design is evolving toward a simpler design (work in progress);
- NEG coating and aC coating are used to suppress e-cloud;
- Integration checks ongoing to assess the accessibility to the line during future interventions or maintenance.

LHC integration: e- cloud suppression



- RF cavities are not expected to contribute to the e-cloud: EDMS 2663141
- We suggest to coat the vacuum modules with aC coating.

Next Steps

- Follow up on production & procurement:
  - PIMS production, with priority on the DQW@CERN;
  - Vacuum modules production;
  - Beam screen and vacuum modules aC coating;
- Vacuum acceptance tests at M7:
  - Crucial for assessing the vacuum performance of the first LHC-type cryomodule;

Thanks for your attention!

Vacuum dynamics Vs beam intensity