CERN

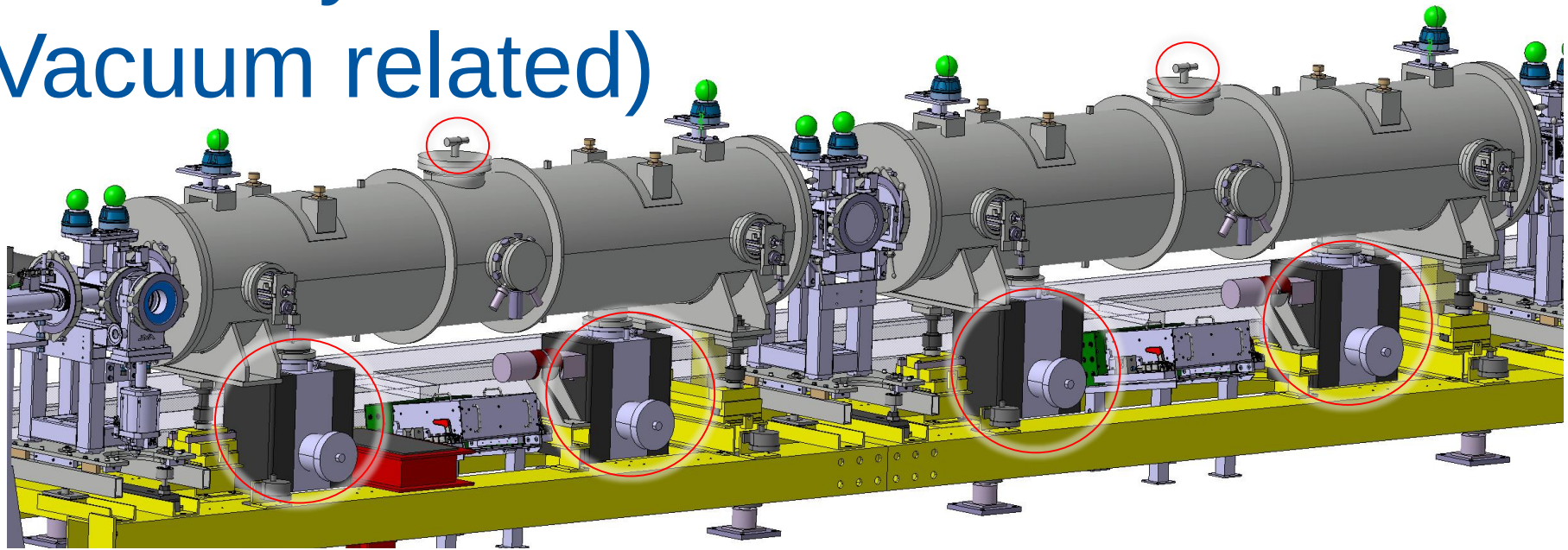
ZS recommissioning strategy for the 2021 start up of the SPS

B.BALHAN for TE-AB-SE

Outline

- *Systems overview, LIU Upgrade*
- *Vacuum levels, temperature limits, ZS sparking rate, related interlocks...*
- *Required OP procedures and actions, expert contact persons during beam commissioning*
- *Beam commissioning for ZS*

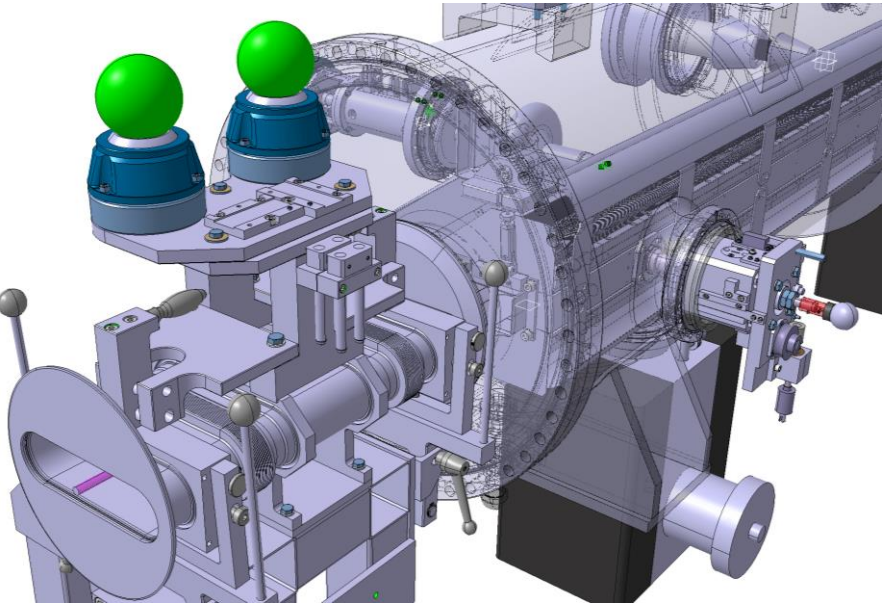
ZS-LIU system overview (Vacuum related)

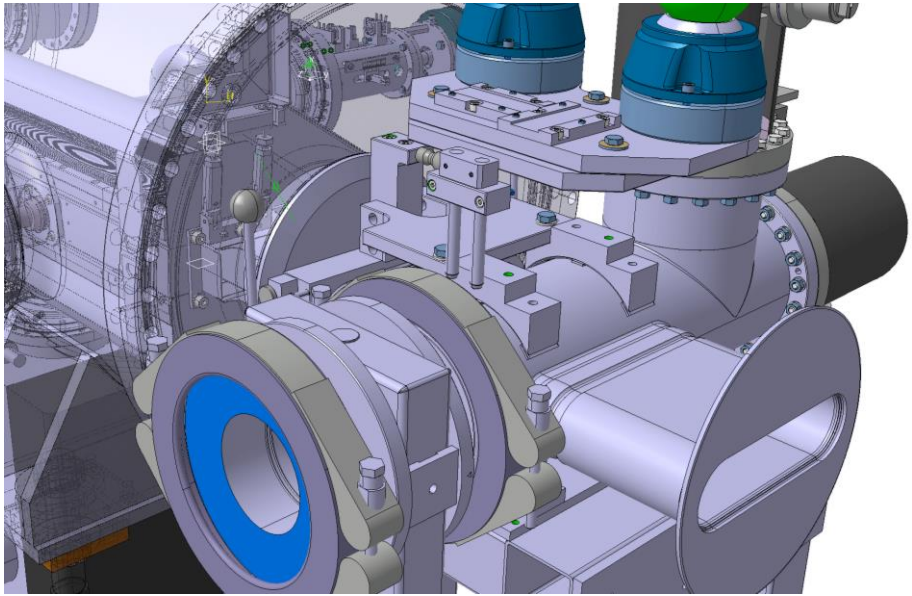


Modifications with respect to pre-LS2:

- ZS equipped with vacuum pumping directly on tanks (VPI and NEG)
- Individual vacuum gauges for each ZS (previously installed on PMs).

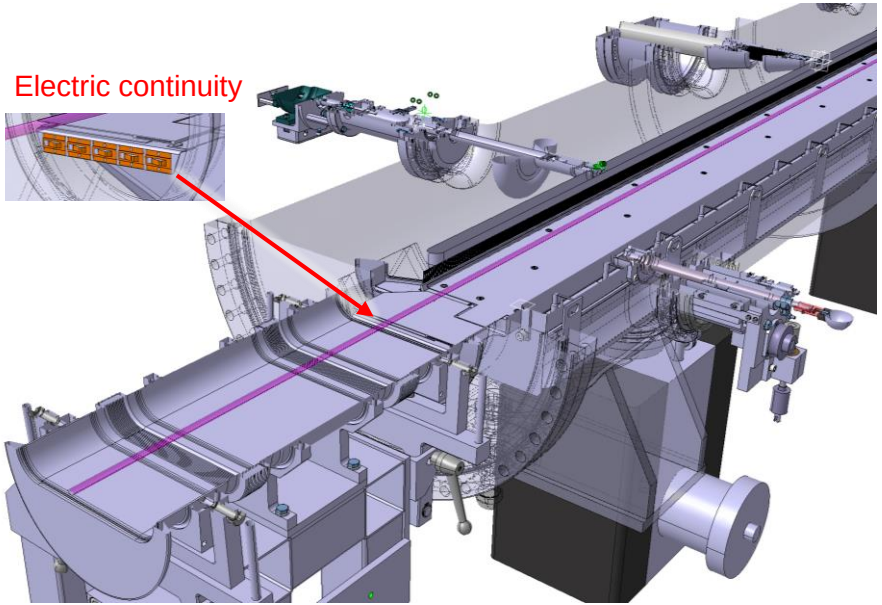
System Overview (Impedance reduction related)

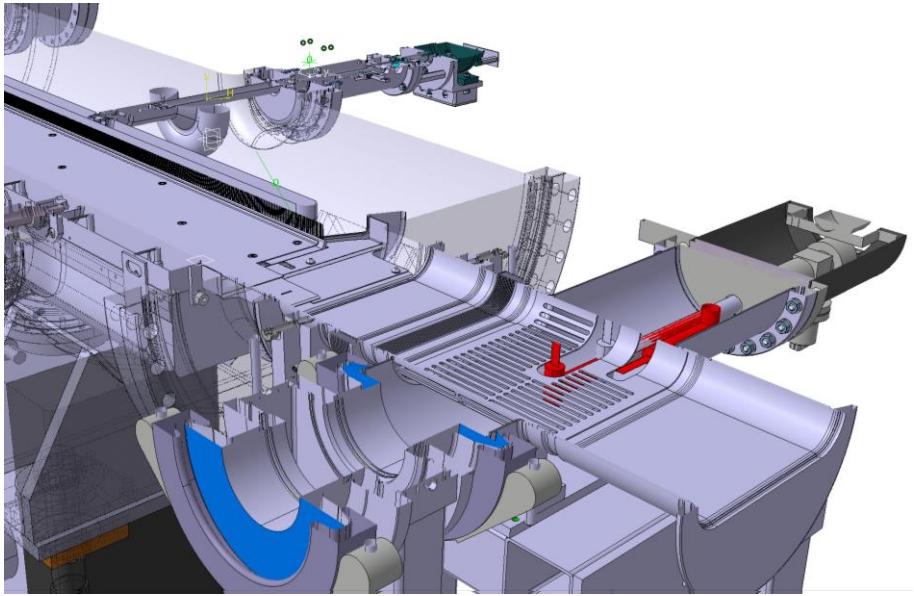




- Beam impedance reduction: all ZS equipped with RF Shielding upstream and downstream
- Redesign ZS interconnect using elliptical bellows/chambers and RF shielding
- BI fully refurbished, new stepping motors.

System Overview (Impedance reduction related)





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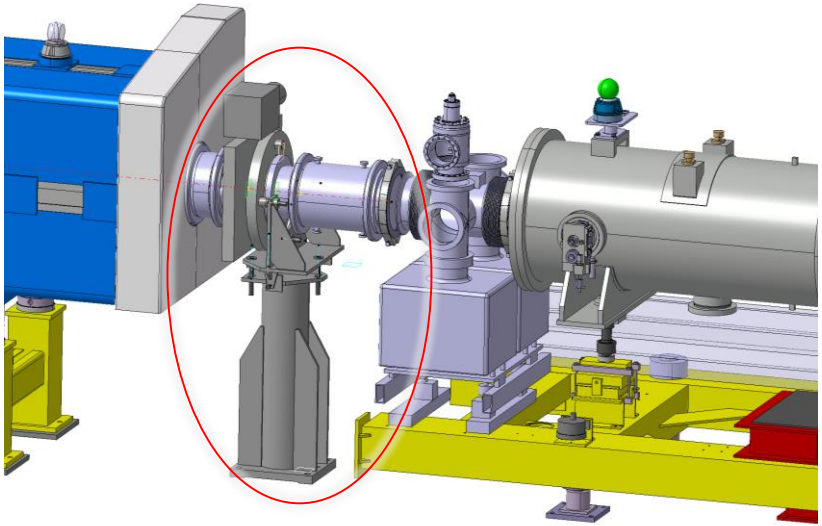
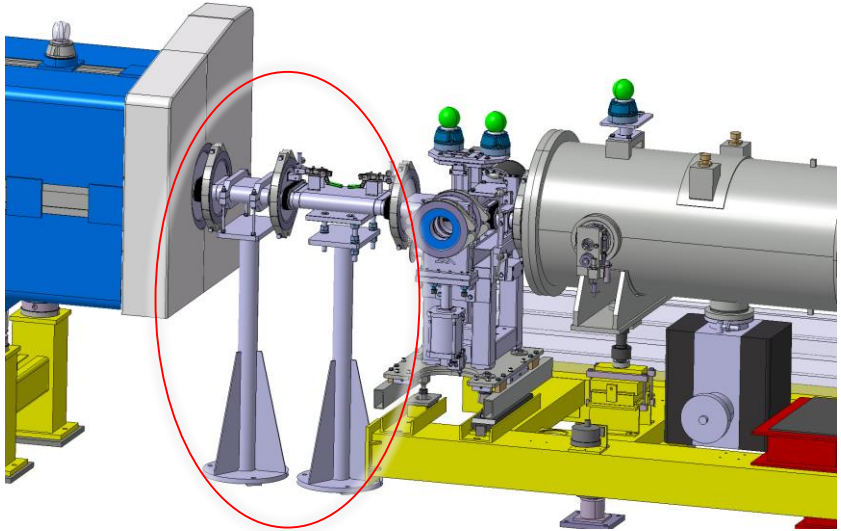
System Overview (Layout and Impedance reduction related)

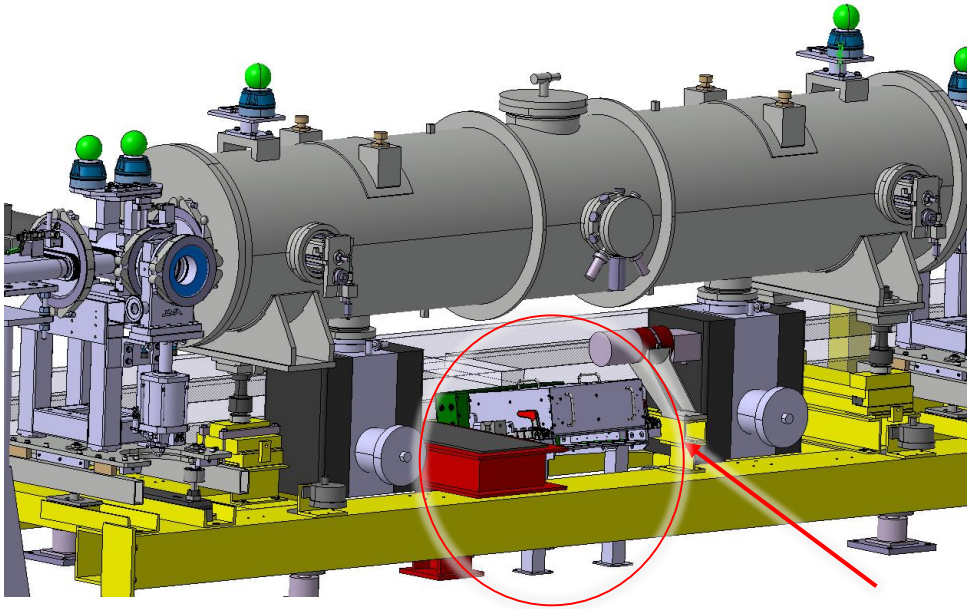




Simplified vacuum layout and impedance reduction:

- Removal of the “ghost vacuum valve” between QFA216 and ZS1 (obsolete)
- Use of elliptical chambers and bellows
  (beam impedance reduction, potentially reduction of e-cloud)
- Removal of HV feedthrough lead shielding (source of residual activation).

ZS-LIU system overview (HV circuit related)



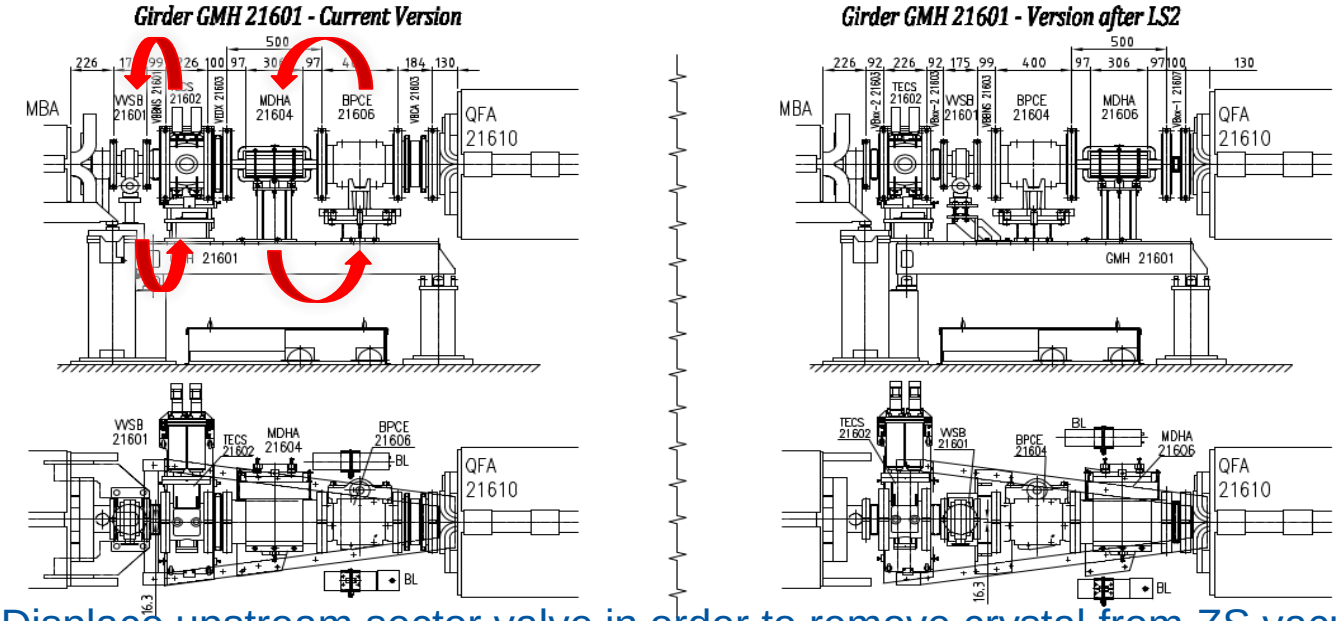
Improved diagnostics by:

- Separate measurement of Anode sparking
- Separate measurement of Ion Trap top and bottom electrode sparking
- Voltage measurement of the Ion Trap electrodes (measurement of beam induced voltage variations)
- Electrical Ion Trap impedance reduction (faster recharging)
- Temperature sensors (PT100) installed on each ZS anode.

New Ion trap connection boxes. Improvements w.r.t. pre-LS2:

- ZS anodes firmly grounded inside tank (to reduce beam induced sparking)
- Rapid plug-in and plug-out (ALARA, no individual cables to (dis)connect)
- Air insulation (supressed oil isolation and need for regular maintenance)

System Overview (crystal related)



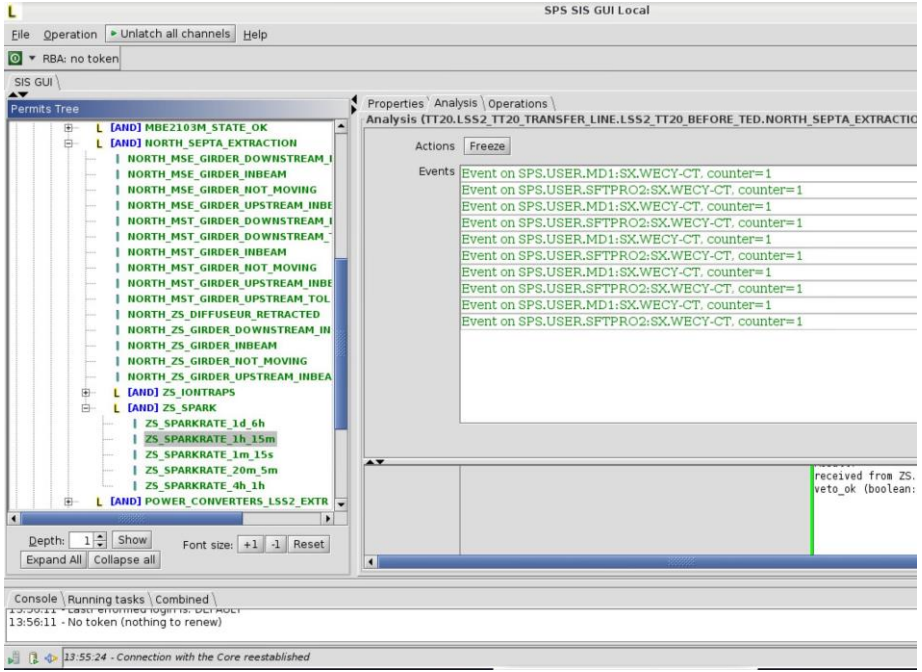
- Displace upstream sector valve in order to remove crystal from ZS vacuum sector.
- Improve impedance by swapping BPCE.21606 and MDHA.21604, replace standard bellows by ecliptics one. *Edms 2026650*, differential layout *SPSLNINS0152*.
- Offset for crystal displacement 16.3mm

Interlocks / limits

- Vacuum interlock set to 1.00E-07, =>HV switch off, main and Itraps, global off (earth switch)
- Spark rate interlocks;
  - Hardware High Spark rate 9 Spark / 6 sec
    ⇒ HV switch off, Spark timer for 10 min
  - Software (medium and low) Spark rate limits
    ⇒ SIS interlock, ZS expert acknowledge required
- Anodes temperature for measurement only.

ZS spark Fixed Display and interlocks

Global and individuals interlock thresholds with different rate and time base



SPS SIS implementation / reset by experts only

Restart considerations

- 5 upgraded ZS installed,
- Re-used Anodes for ZS1-3
- New Anode (wire never saw beam) in ZS 4 & ZS5
- When LHC beam:
  - ZS main generator need to be ON >30 kV
  - Ions trap ON need to be ON >1 kV
- Maintain possibility cycle by cycle modulation (PPM) of main and Itrap voltages (SIS interlock need to be adapted)
- Alignment of ZS anodes to be set-up using low intensity beam starting from 0 position (automated algorithm can be used).

Beam commissioning

- Electrode surface conditioning need to be assessed. Gradually increase LHC beam intensity and batches, observe vacuum activity.

  Expect to be more robust with new system
- Spark rate to be monitored and followed carefully: Fixed Display page to be set up in CCC.
- Need BI expert around during Slow extraction setting up.

Equipment expert list (best effort)

- Antoine Prost (equipment responsible)
- Bruno Balhan (expert)
- Jan Borburgh (SL)
- Roger Barlow for control issues
- Matthew Fraser for beam optics issues.