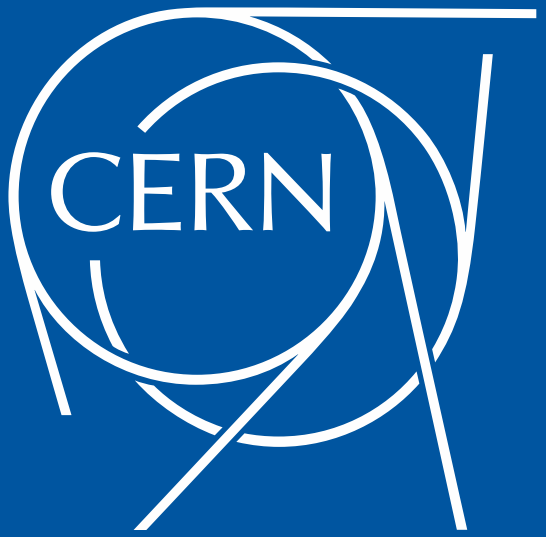
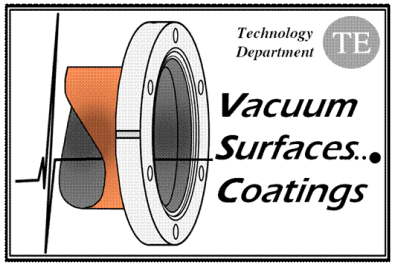

CERN



R. Salemme

SPS East Extraction bump inhibit during COLDEX operation

on behalf of TE-VSC group

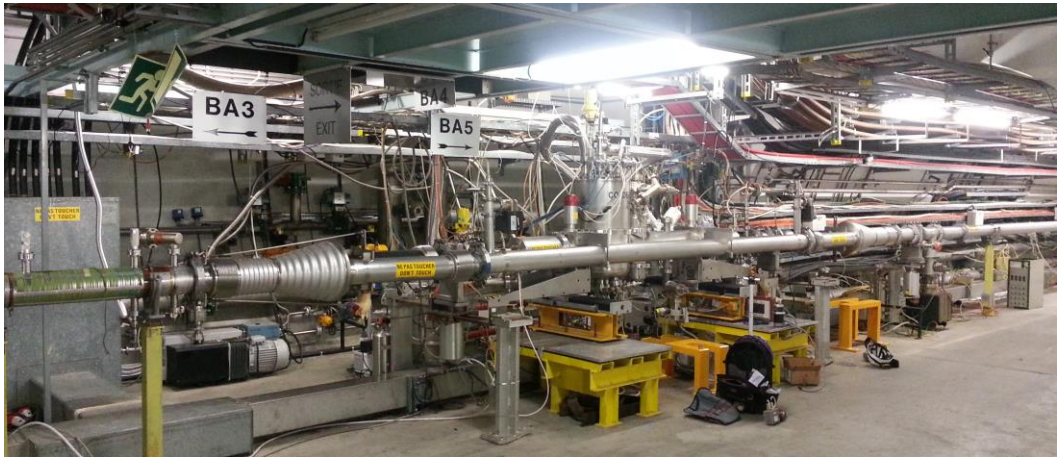
104th SPS and LHC Machine Protection Panel Meeting

CERN, March 13th 2015

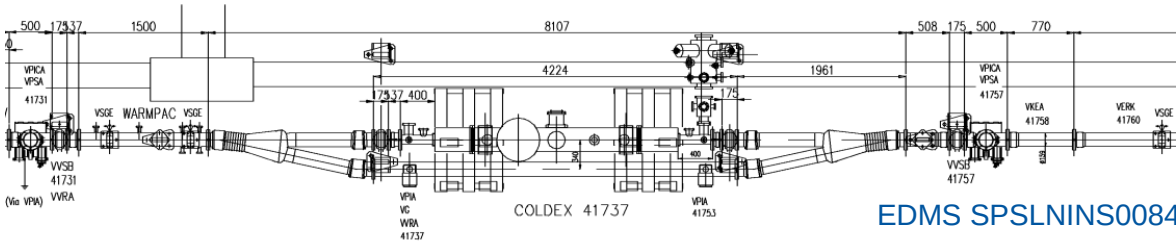
COLDEX

- Already installed in SPS/LSS4 for electron cloud studies
- Mimics the LHC cold bore (CB) and beam screen (BS) cryogenic vacuum system
- Installed on a by-pass line, it is inserted in SPS ring during experimental runs
- Recommissioned in 2014 for HL-LHC studies

- Performance qualification with LHC type beams of a-C coatings at cryogenic temperature
- Operation of the BS in the 10K to 60 K temperature range
- Reduction of background to LHC experiments

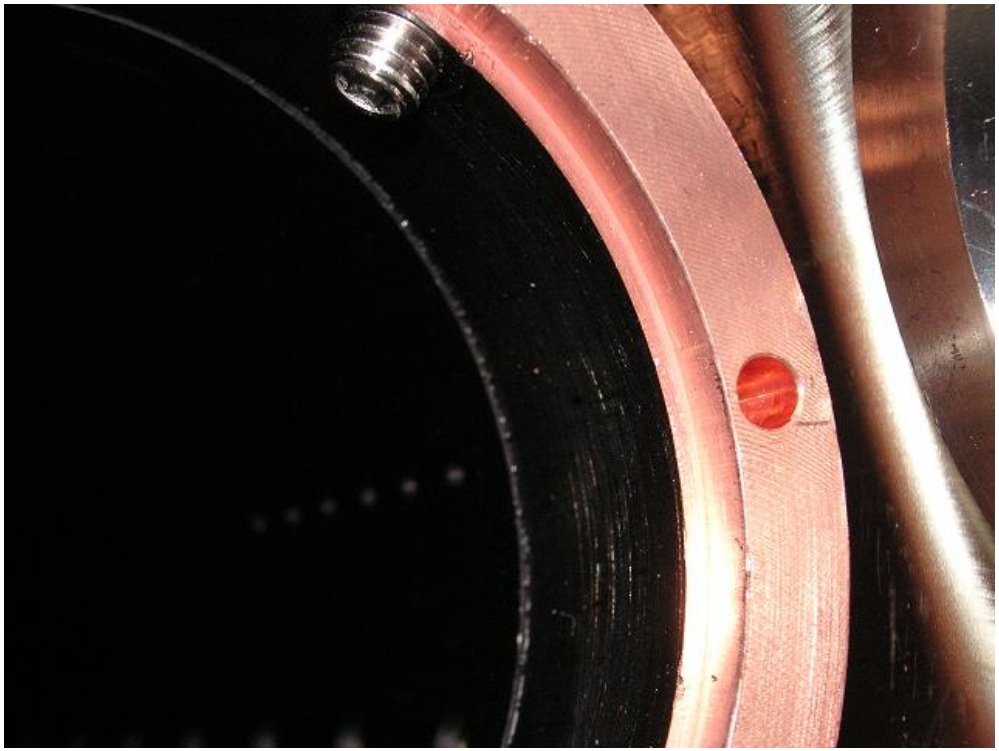


High Luminosity LHC



EDMS SPSLNINS0084

COLDEX a-C coated BS



Picture and detail of the a-C coated Beam Screen during re-installation in COLDEX on February 11th 2014 (G. Bregliozzi)

Experimental runs

- COLDEX experimental runs are placed in well defined periods, normally planned during:
  - SPS Scrubbing Runs: long studies, e.g. pressure evolution, gas composition, heat load, electron activity, scrubbing conditioning
  - Dedicated SPS Machine Development (MD) periods: specific studies *e.g.* gas accumulation, different BS temperature ranges, impact of temperature oscillations

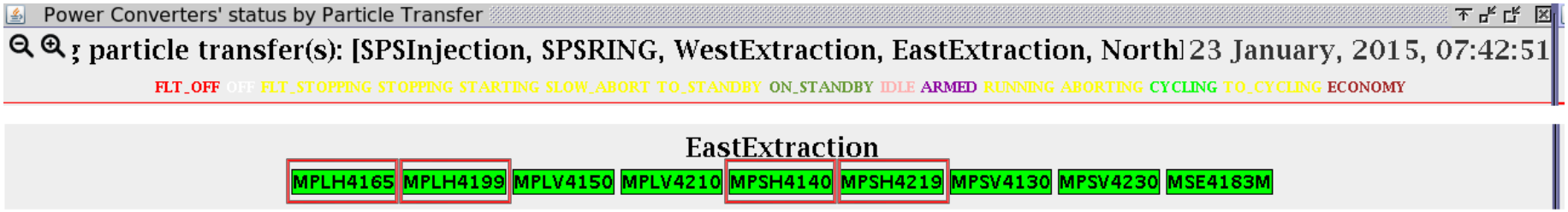
- In 2014, COLDEX run:
  - SPS Scrubbing Run 1: 3rd-9th November (7 days)
  - SPS Scrubbing Run 2: 8th-10th December (3 days)

Inhibit motivation

- COLDEX sits between the SPS LSS4 kickers and the septa (East Extr.)
- Due to aperture restriction (67 mm), COLDEX operation is not compatible with the **horizontal orbit bump** generated to extract the beam toward SPS East transfer lines (from LSS4 to TI8, TT40) with the kickers MKE416xxx (V. Kain, BE-OP, 10/09/14, private communication).

→ **Inhibit SPS beam East Extraction bump if COLDEX is IN**

- **Four power converters** are in charge of supplying the four bumper magnets generating the orbit bump (S. Cettour-Cave, BE-OP, 06/10/14):
  - **MPLH4165**
  - **MPLH4199**
  - **MPSH4140**
  - **MPSH4219**



Implementation

Inhibit SPS beam east extraction bump if COLDEX is IN

- Neither an interlock to the SPS-ring BIS nor an interlock to LSS4 Extraction BIS can help (B. Puccio, TE-MPE, 12/11/2014, private communication)

- Discussion with the SPS power converters responsibles: G. Le Godec, L. De Oliveira, E. Coulot (TE-EPC) (07/10/2014)

→ **Implementation of a hardware inhibit logic sent to the tripping auxiliaries of Main Circuit Breakers of the bumpers (five) Power Converters**

- **RPPBY.BA4.MPLH4165**
- **RPPBY.BA4.MPLH4199**
- **RPPBY.BA4.MPSH4140**
- **RPPBY.BA4.MPSH4219**

- **+ 1 spare!: RPPGR.BA4.NO2.SPARE**

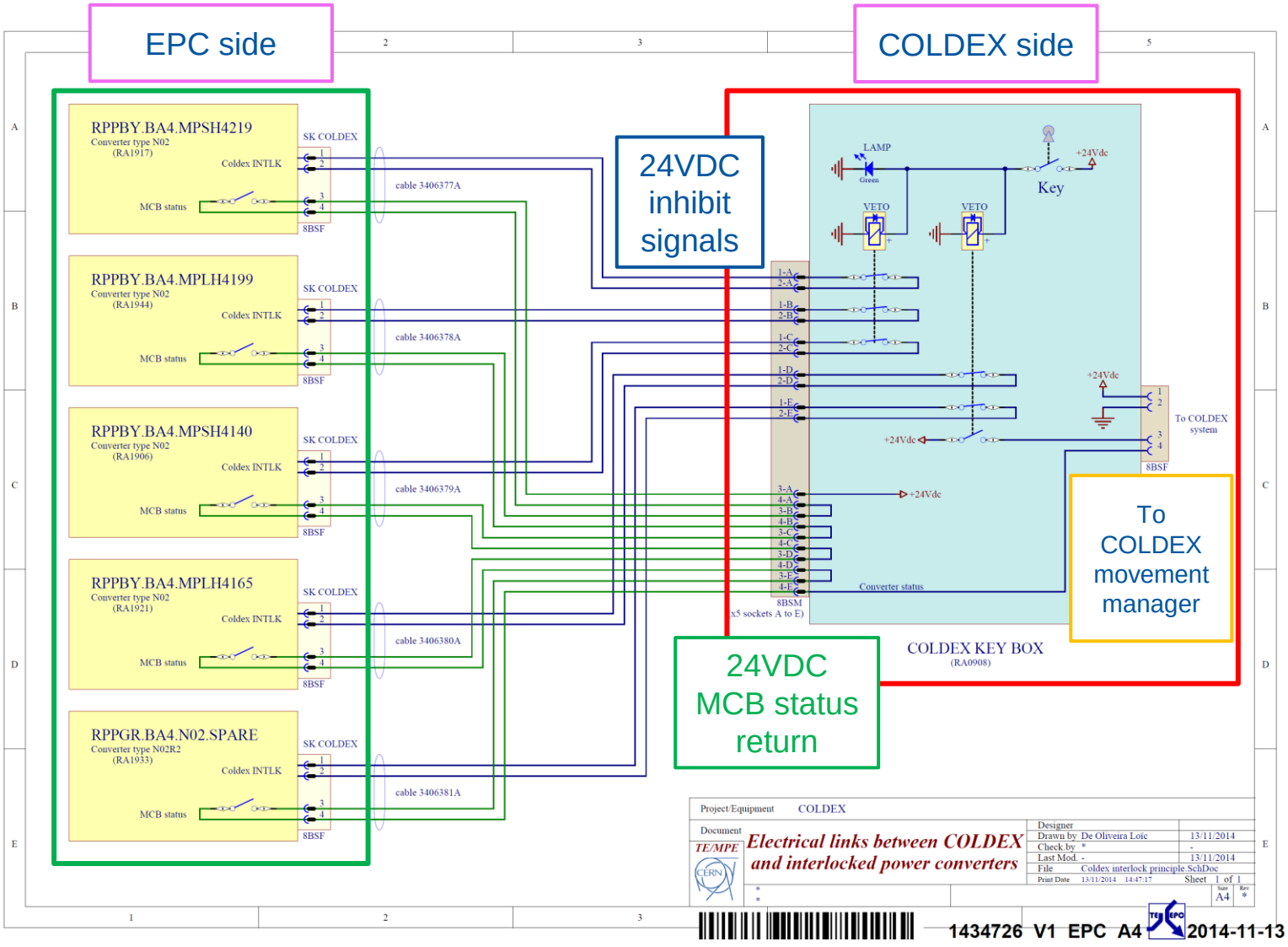
Logic

- From COLDEX side:
  - Reliable inhibition signal based on a hardware, non-glitching, device (to avoid spurious inhibition during normal SPS operation): 24VDC under hard key
  - Clear visualization on COLDEX racks («Inhibit» box)

- From MCBs side:
  - As soon as the inhibit signal is sent to the five converters, their breakers cannot close until the inhibition signal is gone
  - Acknowledgement and MCBs status signal: 24VDC return signal if MCBs are OFF
  - Clear visualization on Power Converters (control card)

- The MCBs status is used in the movement management (PLC) of COLDEX. If the MCBs have not been inhibited before, we are not allowed to move COLDEX from its garage position.

Schematics


EPC side
COLDEX side
24VDC inhibit signals
24VDC MCB status return
To COLDEX movement manager
RPPBY.BA4.MPSH4219
Converter type N02
(RA1917)
RPPBY.BA4.MPLH4199
Converter type N02
(RA1944)
RPPBY.BA4.MPSH4140
Converter type N02
(RA1906)
RPPBY.BA4.MPLH4165
Converter type N02
(RA1921)
RPPGR.BA4.N02.SPARE
Converter type N02R2
(RA1933)
SK COLDEX
Coldex INTLK
MCB status
8BSF
cable 3406377A
cable 3406378A
cable 3406379A
cable 3406380A
cable 3406381A
LAMP
Green
+24Vdc
Key
VETO
VETO
To COLDEX system
Converter status
8BSM
(x5 sockets A to E)
COLDEX KEY BOX
(RA0908)
Project/Equipment COLDEX
Document
TE/MPE
Electrical links between COLDEX and interlocked power converters
Designer
Drawn by De Oliveira Loïc 13/11/2014
Check by * -
Last Mod. - 13/11/2014
File Coldex interlock principle.SchDoc
Print Date 13/11/2014 14:47:17
Sheet 1 of 1
Size A4
Rev *
1434726 V1 EPC A4 2014-11-13

Realization

- Implementation planned and executed during SPS TS1/2014 (29/10/2014)

- Coordinated, executed, tested and validated on the same day (R. Salemme, A. Gutierrez (TE-VSC), L. De Oliveira, E.Coulot (TE-EPC), S. Cettour-Cave (BE-OP))
- Cabling infrastructure (5 cables) provided and installed by EN-EL
- Upgraded and re-tested with the spare converter MCB (26/11/2014)

Modus operandi during agreed periods

At the beginning of a COLDEX experimental run:

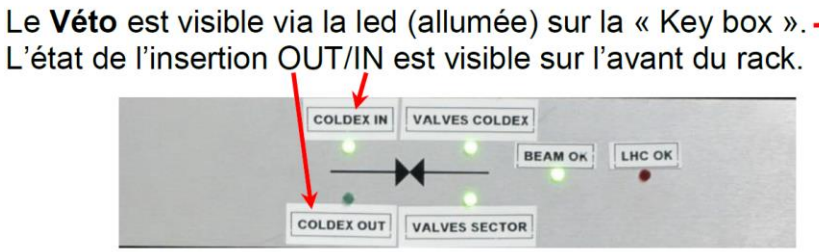
1. Before using this inhibit, previously **check in CCC** with the SPS operator if the MCBs are OFF from their console
2. Then, go to SPS/BA4 and **VISUALLY check** on the five physical Power Converters (red status LED off)
3. Finally, the **inhibit key** is turned.
    - The **MCBs status signal** is received from the MCBs
4. Now COLDEX can be operated. Access the SPS tunnel for COLDEX movement (on-site operation)

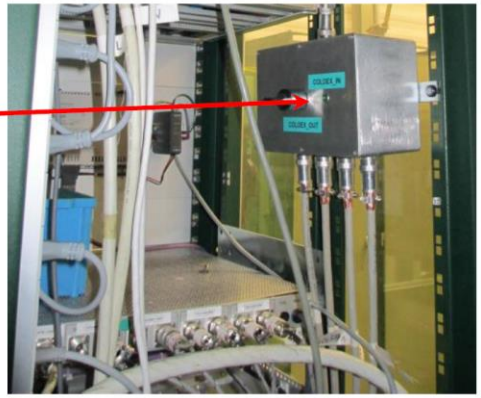
- At the end of a COLDEX run, the inhibit is removed (key turned back)
- Both TE-VSC and TE-EPC have a copy of the inhibit key

Signalization

- **On the COLDEX control racks**:

  (BA4, 871-R-15)





- **On the 5 Power Convertes control cards**:

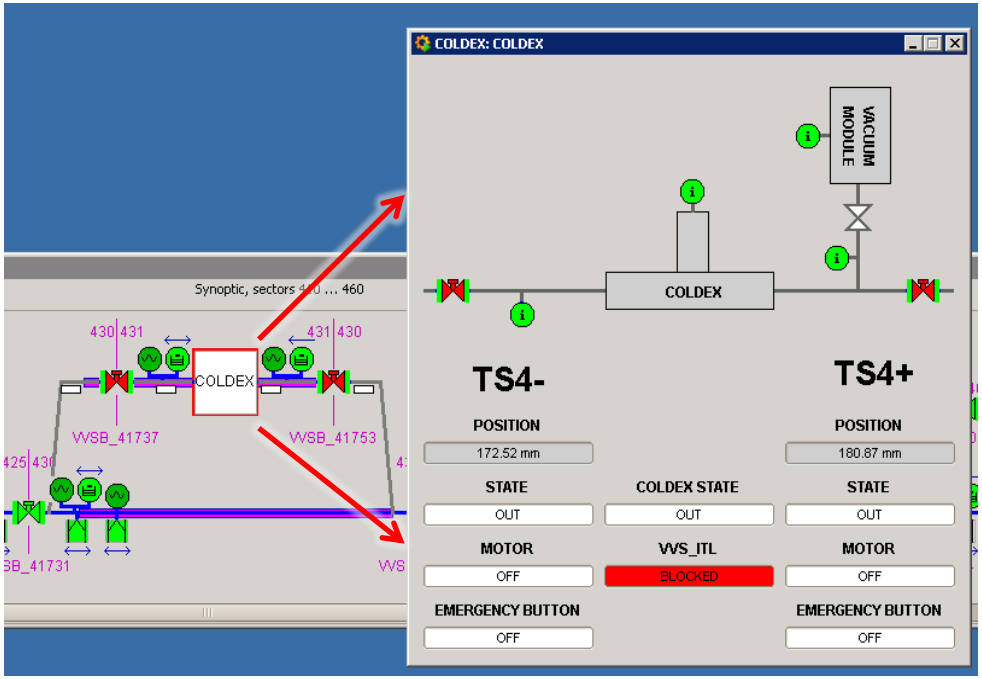
  (BA4, 871)

Signalization

- **Vacuum SCADA application** (PVSS)

  Monitoring of COLDEX status:

  - State
  - Position
  - Motors operating mode
  - Emergency stop button



- **CERN controls Middleware** (CMW)

  2 Classes are publised on CMW

  - "CDX_CTRL_KEY": ON if the inhibit key is turned
  - "CDX_MCB_ST": OFF if the MCBs are off

```
10:49:24:970 RDA  Getting VAC.COLDEX/CDX_CTRL_KEY on ASYNC.PERIODIC.1200
10:49:24:985 [ Name : value
Type : bool
Value: false

Name : acqStamp
Type : double
Value: 1.421336212062E12
 ]
```

```
10:51:17:692 RDA  Getting VAC.COLDEX/CDX_MCB_ST on ASYNC.PERIODIC.1200
10:51:17:692 [ Name : value
Type : bool
Value: true

Name : acqStamp
Type : double
Value: 1.425913806704E12
 ]
```

Documentation

- «Note d'opération spécifique pour les convertisseurs interlockés pour COLDEX», L. De Oliveira (TE-EPC), R. Salemme (TE-VSC), EDMS 1432933

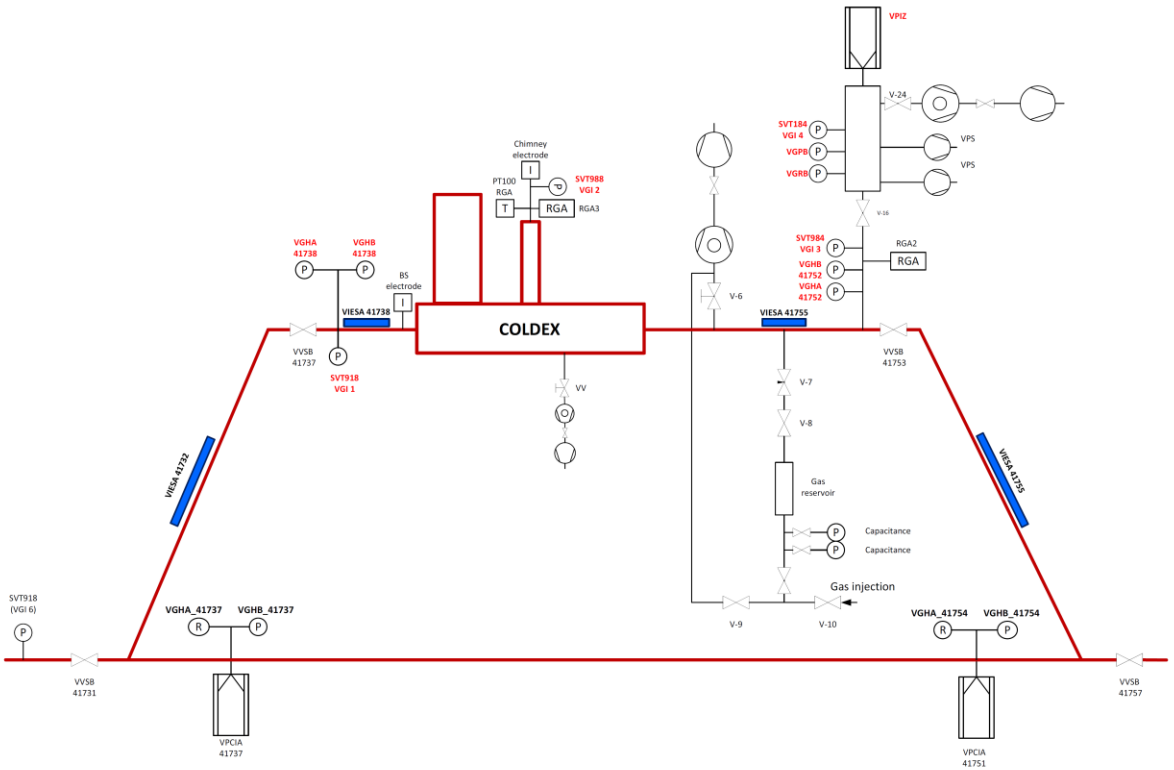
- «COLDEX experiment to qualify the performances of a-C coatings at cryogenic temperature with LHC type beams», Engineering Specification, under release

Acknowledgements

- G. Le Godec, L. De Oliveira, E. Coulot (TE-EPC)
- A. Gutierrez, B. Rio, F. Bellorini, P. Gomes (TE-VSC)
- V. Kain, S. Cettour-Cave (BE-OP)
- EN-EL for cabling at SPS-BA4

www.cern.ch

COLDEX: measurements



- Total pressures along the vacuum system
- Partial pressures in the RT and cryogenic parts
- Electrons activity and integrated dose
- BS and CB temperatures
- Heat load on the beam screen

Interlocks, inhibit, safety

- Interlock Vacuum
  - Sector of COLDEX closed if pressure is higher $1 \cdot 10^{-5}$ mbar:

→ BA4 vacuum valves controller

- Machine Protection
  - A. Avoid COLDEX movement if sector valves are open

→ COLDEX movement manager (PLC)

  - B. Avoid beam injection into SPS if COLDEX is being inserted (position status: neither IN, nor OUT)
    → automatically implemented on LSS4 Vacuum BIC with previous interlock

→ LSS4 Vacuum BIC

  - C. Avoid SPS beam east extraction bump if COLDEX is IN
    - COLDEX is not compatible with the horizontal orbit bump generated to extract beam toward SPS east transfer lines (TI8, TT40) with the kickers MKE416xxx
    - Hardware inhibit sent to the main circuit breakers of the four bumpers Power Converters

→ RPPBY.BA4.MPLH4165
RPPBY.BA4.MPLH4199
RPPBY.BA4.MPSH4140
RPPBY.BA4.MPSH4219
RPPGR.BA4.NO2.SPARE
MCBs inhibit

- Cryogenics
  - Reviewed in “SPS BA4 cryogenics for COLDEX and Crab Cavities, K. Brodzinski, SPS-CSAP, 3th April 2014”

SPS Power Converters