

R. Salemme

SPS East Extraction bump inhibit during COLDEX operation

on behalf of TE-VSC group

104th SPS and LHC Machine Protection Panel Meeting

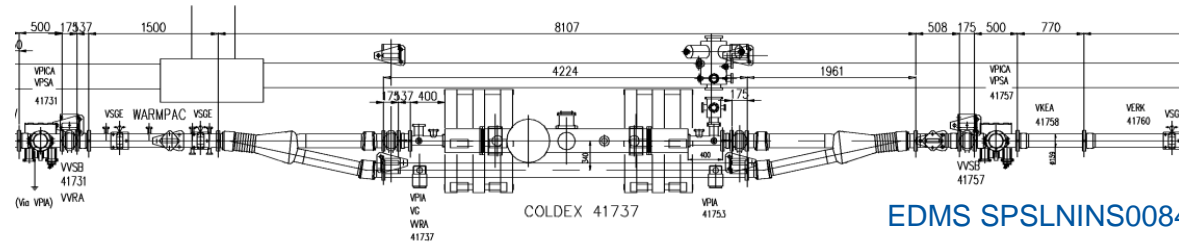
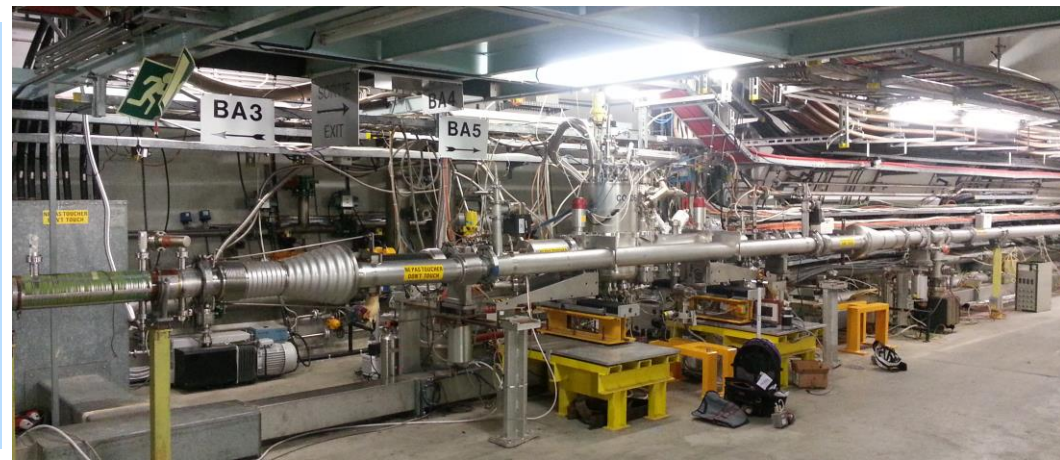
CERN, March 13th 2015



COLDEX

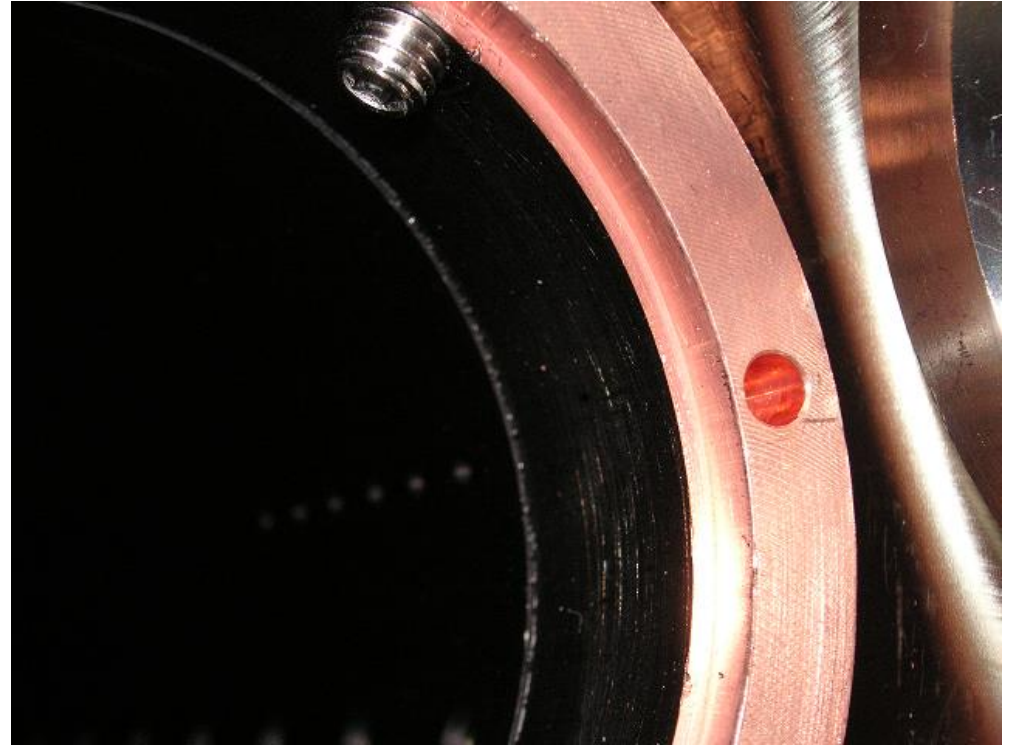
- **Already** installed in SPS/LSS4 for electron cloud studies
- Mimics the LHC **cold bore (CB)** and **beam screen (BS)** cryogenic vacuum system
- Installed on a by-pass line, it is inserted in SPS ring during experimental runs
- Recommissioned in 2014 for HL-LHC studies

- 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



EDMS SPLNINS0084

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

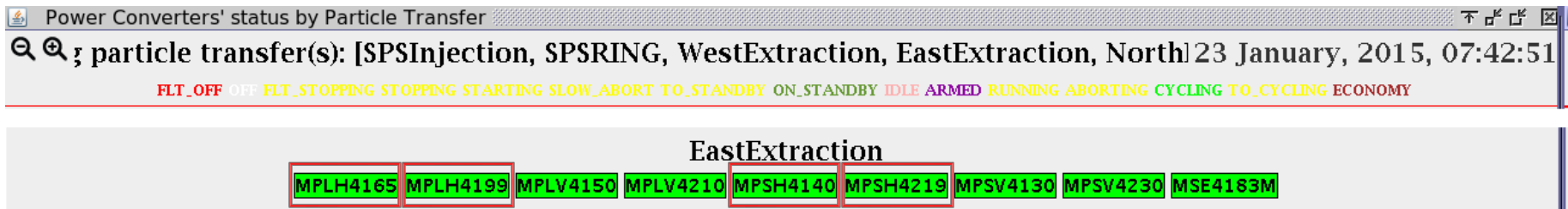
- COLDEX experimental runs are placed in **well defined periods**, normally planned during:
 - **SPS Scrubbing Runs**: long studies, e.g. pressure evolution, gas composition, heat load, electron activity, scrubbing conditioning
 - **Dedicated SPS Machine Development (MD) periods**: specific studies e.g.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

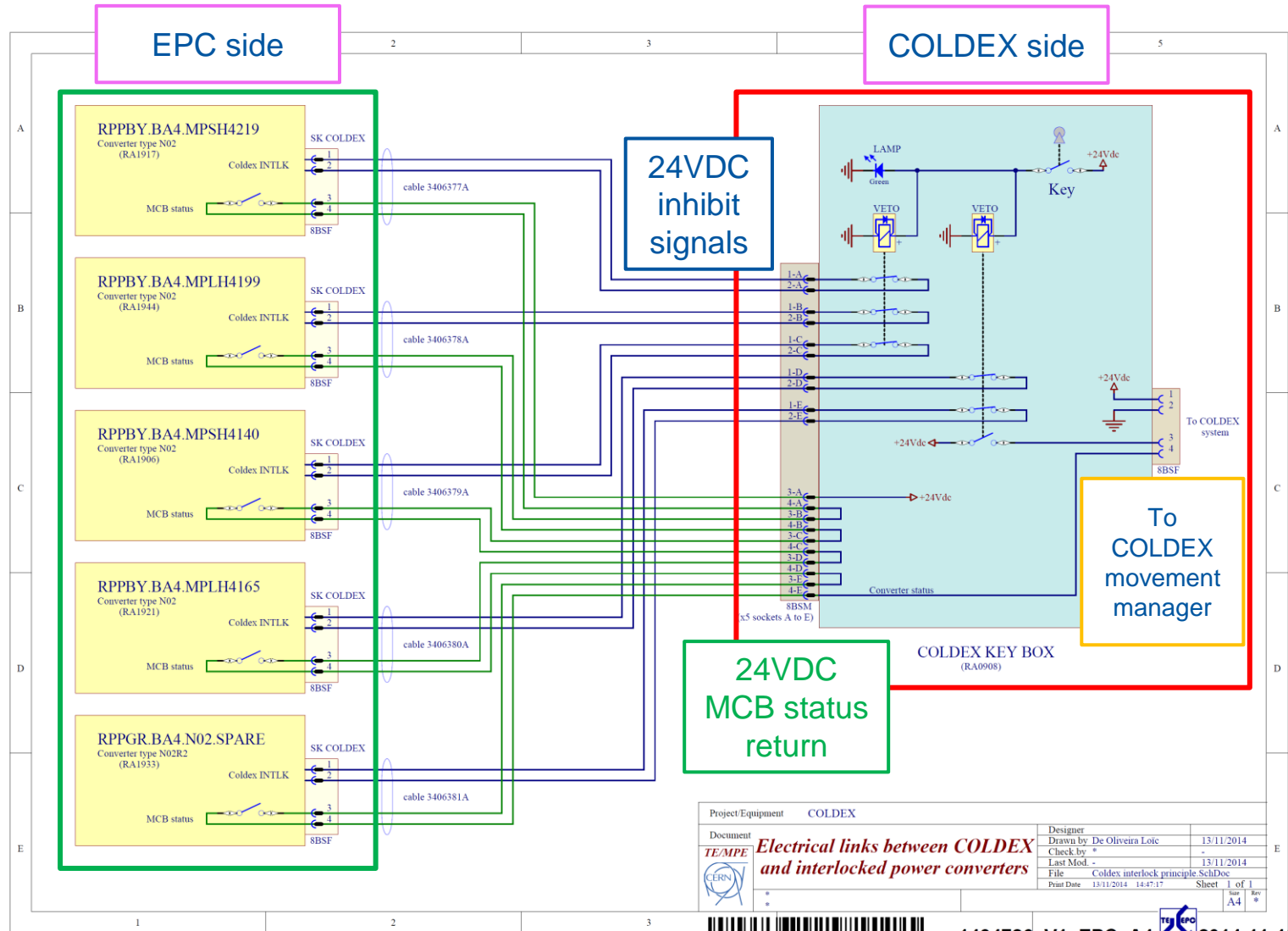
- **RPPBY.BA4.MPLH4165**
- **RPPBY.BA4.MPLH4199**
- **RPPBY.BA4.MPSH4140**
- **RPPBY.BA4.MPSH4219**

- **+ 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



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

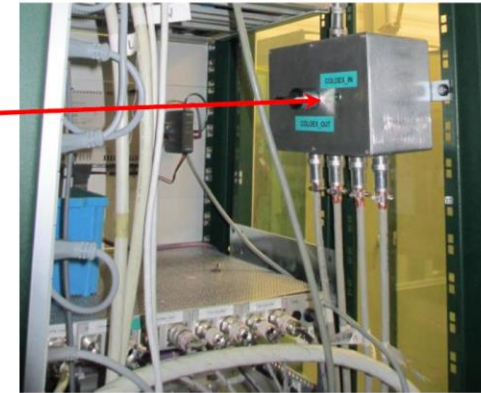
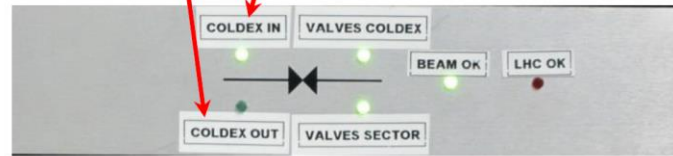
At the beginning of a COLDEX experimental run:

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)

Le **Véto** est visible via la led (allumée) sur la « Key box ». L'état de l'insertion OUT/IN est visible sur l'avant du rack.



- On the 5 Power Converters control cards:
(BA4, 871)

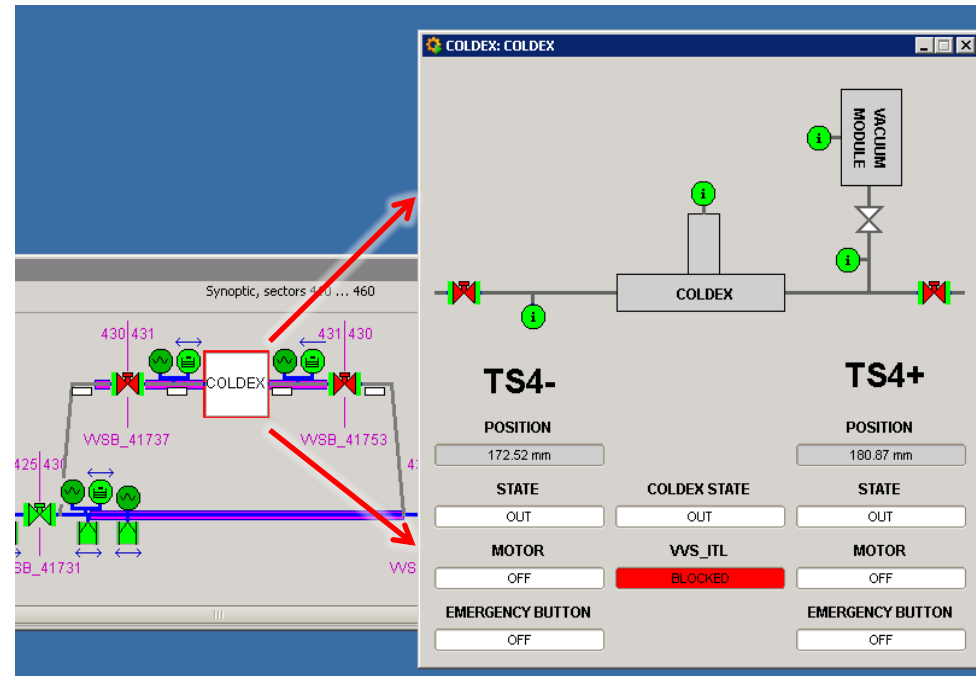


Signalization

- **Vacuum SCADA application (PVSS)**

Monitoring of COLDEX status:

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



- **CERN controls Middleware (CMW)**

2 Classes are published 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. Salemmé (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

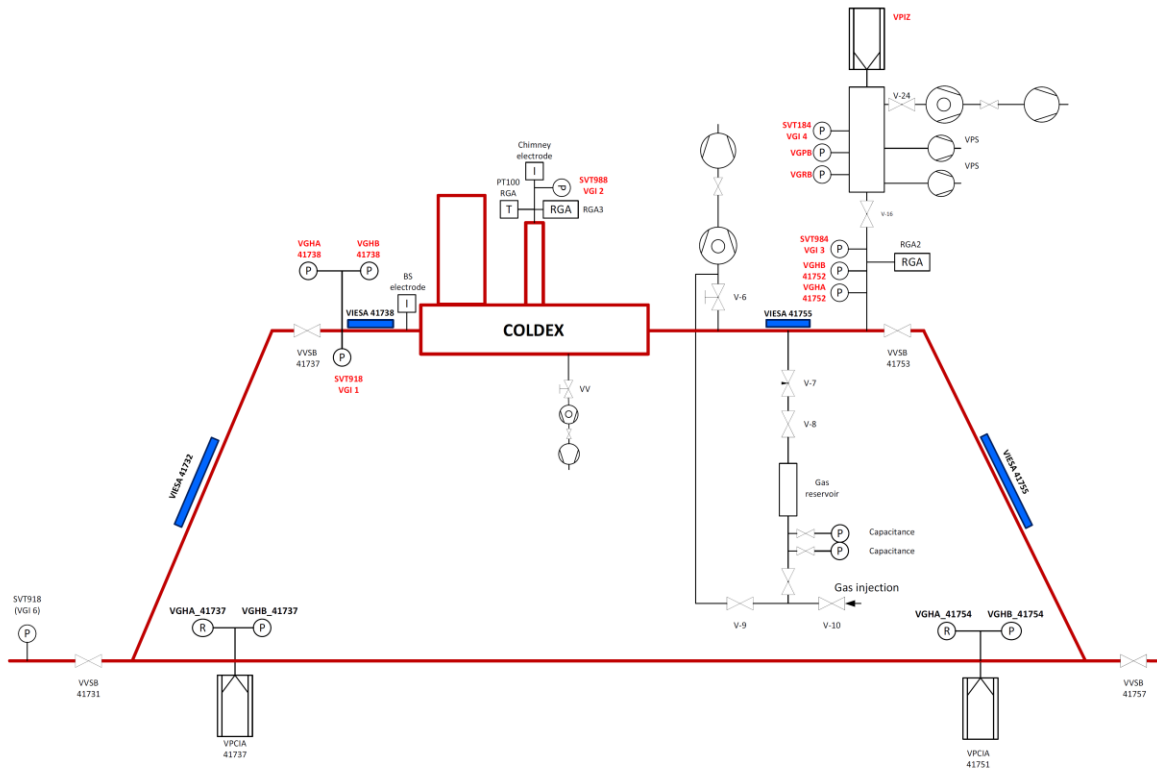
Acknowledgements

- 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



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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
- 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
- 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

COLDEX movement manager (PLC)

LSS4 Vacuum BIC

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

Power Converters' status by Particle Transfer

particle transfer(s): [SPSInjection, SPSRING, WestExtraction, EastExtraction, North] 23 January, 2015, 07:42:51

FLT_OFF FLT_STOPPING STOPPING STARTING SLOW_ABORT TO_STANDBY ON_STANDBY IDLE ARMED RUNNING ABORTING CYCLING TO_CYCLING ECONOMY

SPSInjection

MAL1001M MAL1029 MBIV1003M MDCA1030 MDCV1029 MDHI1015 MDHI1021 MDHI1004A MDHI1004B MDHI1026A MDHI1026B MDIV1005A MDIV1005B MDIV1021A MDIV1021B MDIV1025A MDIV1025B MDIV1027A MDIV1027B MDLH1028 MDSH1197 MDVI1001 MDVI1016 MSI1183M QID1005 QID1007M QID1011M QIF1004 QIF1006 QIF1008M QIF1012M QIID1001 QIID1003 QIIF1002 QISK1006M

SPSRING

BA3MD01 BA3MD01SR BA3MD02 BA3MD02SR BA3MD03 BA3MD03SR BA3MD04 BA3MD04SR BA3MD05SR FFA-AUX FFA-CORR FFA-FTW LFGTWCAV1 LFGTWCAV2 LFGTWCAV3 LFGTWCAV4 LOD LOF LSDA **LSDB** LSFA LSFB LSFC MBI NOISE-CF QD QF RADSTESER SL-GAIN STABLE_PHASE SYNCHROP TWC800-A1 TWC800-A2 TWC800-PH TWC800-PH-SR TWCAV1AMP TWCAV2AMP TWCAV3AMP TWCAV4AMP TWCOUNTER TWLANDAU TWPBASELO TWRADIALS VCOMP-CORR MDV10107 MDH10207 MDV10307 MDH10407 MDV10507 MDH10607 MDV10707 MDH10807 MDV10907 MDH11007 MDV11107 MDH11207 MDV11307 MDH11407 **LQE1143M** MDV11507 MDH11605 MDV11705 MDHD11832 MDVA11904 MDH12007 MDV12107 MDH12207 MDV12307 MDH12407 MDV12507 MDH12607 MDV12707 MDH12807 MDV12907 MDH13007 MDV13107 MDH13207 MDV13307 MDH13407 MDV13507 MDH13607 MDV20107 MDH20207 MDV20307 MDH20407 MDV20507 MDH20607 MDV20707 MDH20807 MDV20907 MDH21007 MDV21107 MDH21207 MDV21307 MDH21407 MDV21507 MDHA21604 MDVA21703 MDHA21804 MDVA21932 MDH22007 MDV22107 MDH22207 MDV22307 MDH22407 MDV22507 MDH22607 MDV22707 MDH22807 MDV22907 MDH23007 MDV23107 MDH23207 MDV23307 MDH23407 MDV23507 MDH23607 MDV30107 MDH30207 MDV30307 MDH30407 MDV30507 MDH30607 MDV30707 **MDH30807** MDV30907 MDH31007 MDV31107 MDH31207 MDV31307 MDH31407 MDV31507 MDH31607 MDV31707 MDH31807 MDV31907 MDH32007 MDV32107 MDH32207 MDV32307 MDH32407 MDV32507 MDH32607 MDV32707 MDH32807 MDV32907 MDH33007 MDV33107 MDH33207 MDV33307 MDH33407 MDV33507 MDH33607 MDV40107 MDH40207 MDV40307 MDH40407 MDV40507 MDH40607 MDV40707 MDH40807 MDV40907 MDH41007 MDV41107 MDH41207 MDV41307 MDH41407 MDV41507 MDH41607 MDVA41703 MDHA41804 MDVA41932 MDH42007 MDV42107 MDH42207 MDV42307 MDH42407 MDV42507 MDH42607 MDV42707 MDH42807 MDV42907 MDH43007 MDV43107 MDH43207 MDV43307 MDH43407 MDV43507 MDH43607 MDV50107 MDH50207 MDV50307 MDH50407 MDV50507 MDH50607 MDV50707 MDH50807 MDV50907 MDH51007 MDV51107 MDH51207 MDV51307 MDH51407 MDV51507 MDH51607 MDHW51634M MDHW51634S MDV51707 MDVW51734S MDVW51734M MDPH51753 BBLR5176M BBLR5177M MDV5177 MDH51807 MDHW5183M MDV51907 MDH52007 MDV52107 MDH52207 MDV52307 MDH52407 MDV52507 MDH52607 MDV52707 MDH52807 MDV52907 MDH53007 MDV53107 MDH53207 MDV53307 MDH53407 MDV53507 MDH53607 MDV60107 MDH60207 **QBM603.04** MDV60307 MDH60407 **QBM605.06** MDV60507 MDH60607 MDV60707 MDH60807 MDV60907 MDH61007 MDV61107 MDH61207 MDV61307 MDH61407 MDV61507 MDHA61604 MDVA61703 MDH61804 MDVA61932 MDH62007 MDV62107 MDH62207 MDV62307 MDH62407 MDV62507 MDH62607 MDV62707 MDH62807 MDV62907 MDH63007 MDV63107 MDH63207 MDV63307 MDH63407 MDV63507 MDH63607

WestExtraction

MPLH616S MPLH6199 MPSH6140 MPSH6219 MPSV6130 MPSV6150 MPSV6210 MPSV6230 MSE6183M MST6177M

EastExtraction

MPLH416S MPLH4199 MPLV4150 MPLV4210 MPSH4140 MPSH4219 MPSV4130 MPSV4230 MSE4183M

NorthExtraction

LSE1060 LSE1240 LSE2060 **LSE2240** LSE4060 LSE4240 LSE5060 **LSE5240** LSE6240 MPLH2142 MPLH2199 MPLH2219 MPNH2173 MPSH2120 MPSV2130 MPSV2150 MPSV2210 MPSV2230 MSE2183M MST2177M