



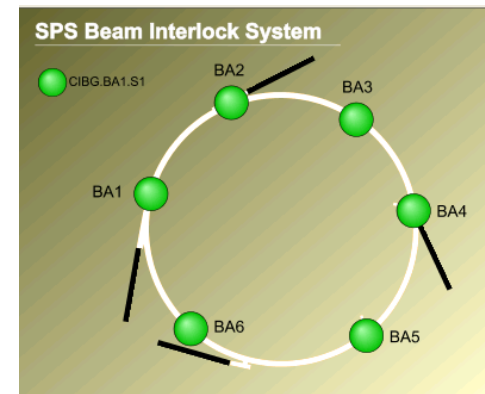
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SPS Injection BIS - Draft requirements

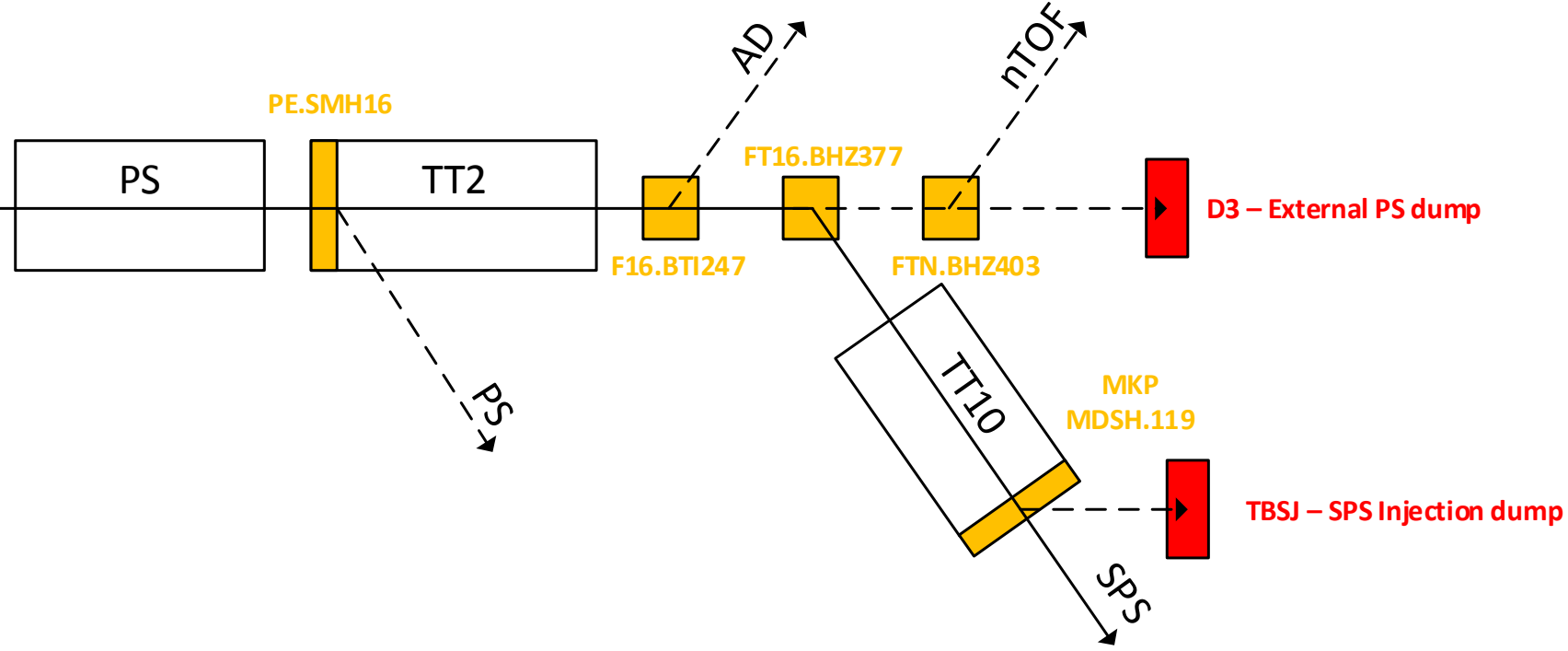
I. Romera on behalf of the BIS team

Motivation

- 1) In view of the SBDS relocation from LSS1 to LSS5 in SPS, **the link between the Beam Dump System and the Injection kicker (MKP) will be removed** => injection inhibit through the SPS-INJ-BIS
- 2) Following the LIU project , **beam luminosity will increase and we need to provide a highly dependable interlock solution** to replace the existing software interlocks => injection inhibit through the SPS-INJ-BIS
- At present, the SPS injection inhibit mechanism relies on the Timing system to interlock the beam at the source (Linac2)
- Three meetings organised to define requirements:
 - 1st: <https://indico.cern.ch/event/623105/>
 - 2nd: <https://indico.cern.ch/event/623122/>
 - 3rd: <https://indico.cern.ch/event/633005/>

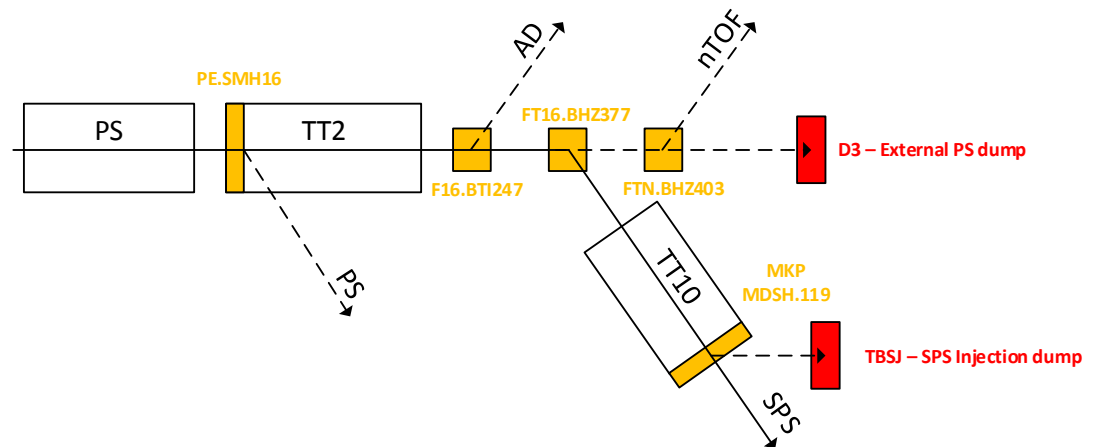


SPS injection layout



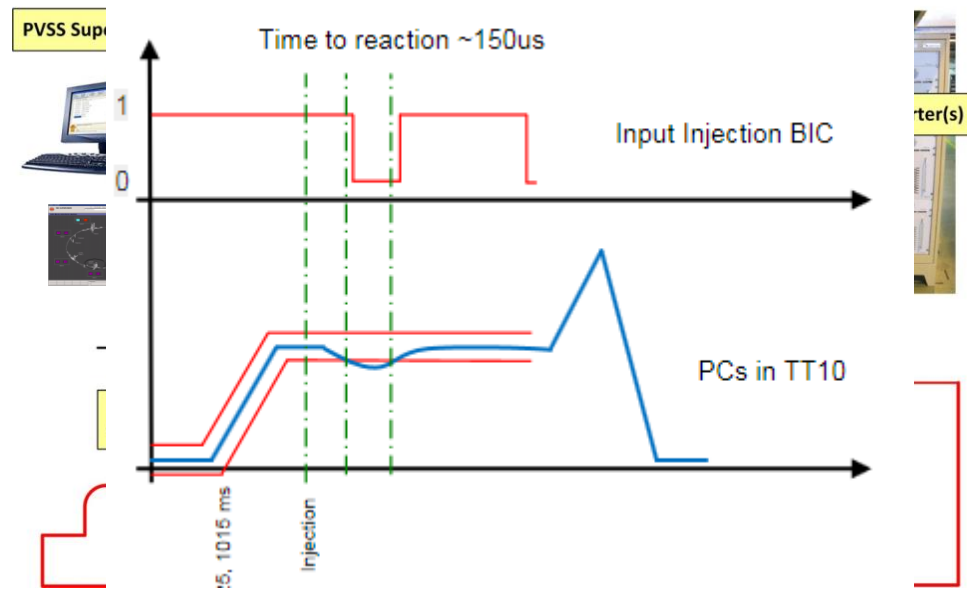
User input connections

- Power converters (Quadrupoles, bending and correctors)
- Power converter **BHZ377** – switching magnet between TT10 and D3
- SPS Injection kicker (MKP)
- BTV screens
- SEM grids
- BLMs
- BQM PS
- Ring BIS
- Safe Beam Flag (SBF) will not be used for SPS-INJ-BIS (always TRUE)



Power converters in TT10

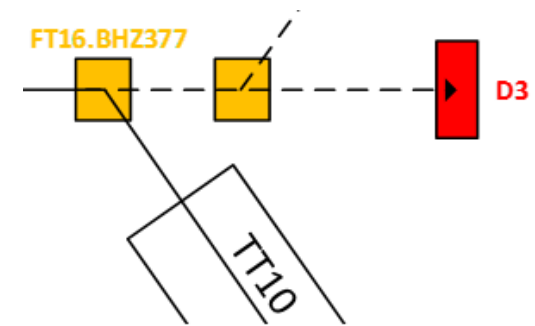
- **Bending (6), quadrupole (11) and corrector (18)**
- Two types of interlocks:
 - **Magnet current interlock (FEI-like, based on MUGEF or FGC3)**
 - **Magnet over-temperature and power converter failures (WIC)**



Power converters in TT10

- **Bending (6), quadrupole (11) and corrector (18)**
- Two types of interlocks:
 - **Magnet current interlock** (FEI-like, based on MUGEF or FGC3)
 - **Magnet over-temperature and power converter failures (WIC)**
- At present, **power converter controls based on MUGEF**. Plan to move to FGC3 during LS2 (not yet confirmed). If so, concentrator to the BIS will be needed
- A **WIC for TT10** will be installed in BA1 either during YETS or LS2
- **2 input channels required** on the SPS-INJ-BIS (from BA1)
- **User_Permit = TRUE if no powering failures and current within range**

Power converter BHZ377

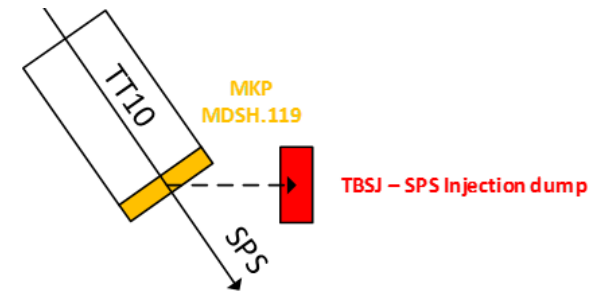


- Responsible for redirecting the beam either to TT10 (SPS) or nTOF/D3 beam dump

| Circuit | 14 GeV | | | 20GeV | | | | 26GeV | | | | | | |
|---------------|--------|------|------------------------------|-------|-------|-------|-------|-------|-------|-------|----------|----------|--------------------|------------------|
| | SFTPRO | CNGS | STFPRO CNGS (with MTE) | TOF | EASTA | EASTB | EASTC | AD | LHC25 | LHC50 | LHCPROBE | LHCINDIV | LHC ION (early) | LHC ION (nom) |
| F16.BHZ377FTS | 222 | 222 | 221 | 0 | 0 | 0 | 0 | 0 | 473 | 473 | 473 | 473 | 274 | 276 |

- Switching time = 1 sec (now) => 500 ms (after LS2)
- This PC is also a BP **destination of the SPS-INJ-BIS** to send the beam to D3 dump in case of SPS injection inhibit
- 1 input channel** to the BIS required (from 269)
- User_Permit = TRUE if power converter current within range**

Injection kicker - MKP



- During injection, the injection kicker pulses to inject the beam into the SPS
- When the kicker is not pulsing, the MDSH.119 must be pulsing to centre the injected beam on the injection dump (TBSJ). The link between the MKP and MDSH is done through the MKP
- With the relocation of the SBDS the propagation time from the SBDS to MKP to inhibit the injection will increase. In order to avoid issues with beams injected after a beam dump, **it was agreed with BE-OP that the SBDS will wait for 1.7 turns before dumping the beam**
- **Also Beam Permit destination!**
- **1 input channel** required (from BA1)
- **User_Permit = TRUE if MKP with no faults**

Beam instrumentation - BTV

- 11 screens in TT10, **not yet interlocked**
- Control racks for TT10 devices in 2 buildings: 269 (PS) and 868 (BA1)**
- Interface to BIS through **BTV interlock boards** (up to 8 channels)
- 3 inputs channels** required
- User_Permit = TRUE** if BTVs to out position

| BTV Devices | | | | | |
|-------------|-------------|-----------|------|--------------|--|
| Line | Name | CTRL Rack | | | Interlock Interface |
| | | Bld | Rack | Crate | |
| TT2 | PE.BTV16 | 269 | 305 | cfv-269-btv1 | Interlock logic to be defined. Need at least 2x BTV Int.Board (EDA-03451) |
| | FT16.BTV107 | 269 | 305 | | |
| | FT16.BTV138 | 269 | 305 | | |
| | FT16.BTV201 | 269 | 305 | | |
| | FT16.BTV218 | 269 | 305 | | |
| | FT16.BTV229 | 269 | 305 | | |
| | FT16.BTV241 | 269 | 305 | cfv-269-btv2 | |
| | FT16.BTV326 | 269 | 304 | | |
| | FT16.BTV352 | 269 | 304 | | |
| | FT16.BTV374 | 269 | 304 | | |
| TT10 | FT16.BTV379 | 269 | 304 | cfv-269-btv3 | Interlock logic to be defined. Need at least 2x BTV Int.Board (EDA-03451) |
| | BTV100123 | 269 | 303 | | |
| | BTV100359 | 269 | 303 | cfv-ba1-btv1 | |
| | BTV101871 | 868 (BA1) | 619 | | |
| | BTV102454 | 868 (BA1) | 619 | | |
| | BTV102541 | 868 (BA1) | 619 | | |
| | BTV102642 | 868 (BA1) | 619 | | |
| | BTV102924 | 868 (BA1) | 621 | cfv-ba1-btv2 | |
| | BTV11860 | 868 (BA1) | 621 | | |
| | BTV11973 | 868 (BA1) | 621 | | |
| BTV11994 | 868 (BA1) | 621 | | | |
| BTV11656 | 868 (BA1) | 621 | | | |

S. Burger

Beam instrumentation - BLM

- **30 monitors will be installed during LS2,** but don't have yet the ok from EN/EL.
Cable passages from surface to tunnel don't have enough capacity...
- **Control racks in bld 269 (PS) and 868 (BA1)**
- **2 input channels to the BIS**
- **User_Permit = TRUE if BLM losses < threshold**

| Element | BLM detectorname | Rack |
|-------------|------------------|-----------------|
| QIID.100100 | BLMIB.100026 | 0303 269-R-0003 |
| QIIF.100200 | BLMIB.100151 | 0303 269-R-0003 |
| QIID.100300 | BLMIB.100327 | 0303 269-R-0003 |
| QIF.100400 | BLMIB.100360 | 0303 269-R-0003 |
| QID.100500 | BLMIB.100473 | 0303 269-R-0003 |
| QIF.100600 | BLMIB.100573 | 0303 269-R-0003 |
| QID.100700 | BLMIB.100673 | 0303 269-R-0003 |
| QIF.100800 | BLMIB.100773 | 0303 269-R-0003 |
| | | |
| QID.100900 | BLMIB.100873 | 0311 868-R-002 |
| QIF.101000 | BLMIB.100973 | 0311 868-R-002 |
| QID.101100 | BLMIB.101057 | 0311 868-R-002 |
| QIF.101200 | BLMIB.101173 | 0311 868-R-002 |
| QID.101300 | BLMIB.101273 | 0311 868-R-002 |
| QIF.101400 | BLMIB.101373 | 0311 868-R-002 |
| QID.101500 | BLMIB.101473 | 0311 868-R-002 |
| QIF.101600 | BLMIB.101574 | 0311 868-R-002 |
| QID.101700 | BLMIB.101674 | 0311 868-R-002 |
| QIF.101800 | BLMIB.101773 | 0311 868-R-002 |
| QID.101900 | BLMIB.101875 | 0311 868-R-002 |
| QIF.102000 | BLMIB.101973 | 0311 868-R-002 |
| QID.102100 | BLMIB.102075 | 0311 868-R-002 |
| QIF.102200 | BLMIB.102174 | 0311 868-R-002 |
| QID.102300 | BLMIB.102273 | 0311 868-R-002 |
| QIF.102400 | BLMIB.102373 | 0311 868-R-002 |
| QID.102500 | BLMIB.102473 | 0311 868-R-002 |
| QIF.102600 | BLMIB.102574 | 0311 868-R-002 |
| QID.102700 | BLMIB.102673 | 0311 868-R-002 |
| QIF.102800 | BLMIB.102773 | 0311 868-R-002 |
| QID.102900 | BLMIB.102873 | 0311 868-R-002 |
| QIF.103000 | BLMIB.102973 | 0311 868-R-002 |

C. Zamantzas

Beam instrumentation – SEM grids

- **SEM:** Secondary emission monitors to measure beam density profile

- **15 grids** already in place

- **Control rack for TT10 devices in BA1**

- **Interface to BIS through PLC**

- **1 input channel** required (from BA1)

| SEM Devices | | | | | |
|-------------|--------------|-----------|------|-------------------|---|
| Line | Name | CTRL Rack | | | Interlock Interface |
| | | Bld | Rack | Crate | |
| TT2 | FT16.MSG 258 | 269 | 304 | cfp-269-bgrid-tt2 | Logic to be defined. Could be implemented inside PLC |
| | FT16.MSG 268 | 269 | 304 | | |
| | FT16.MSG 278 | 269 | 304 | | |
| | FT16.MSF 257 | 269 | 304 | | |
| | FT16.MSF 267 | 269 | 304 | | |
| | FT16.MSF 277 | 269 | 304 | | |
| TT10 | BSPH100405 | 868 | 614 | cfp-ba1-bisemio | Logic to be defined. Could be implemented inside PLC |
| | BSPV100405 | 868 | 614 | | |
| | BSPV100502 | 868 | 614 | | |
| | BSPH100620 | 868 | 614 | | |
| | BSPV100620 | 868 | 614 | | |
| | BSPV102302 | 868 | 614 | | |
| | BSPV10736 | 868 | 614 | | |
| | BSI102736 | 868 | 614 | | |
| | BSGHV102737 | 868 | 614 | | |
| | BSGHV102737 | 868 | 614 | | |
| | BSPV102904 | 868 | 614 | | |
| | BSPH102925 | 868 | 614 | | |
| | BSPV102925 | 868 | 614 | | |
| | BSGHV102937 | 868 | 614 | | |
| BSPV103002 | 868 | 614 | | | |

F. Roncarolo

- **User_Permit = TRUE** if SEMs to out position

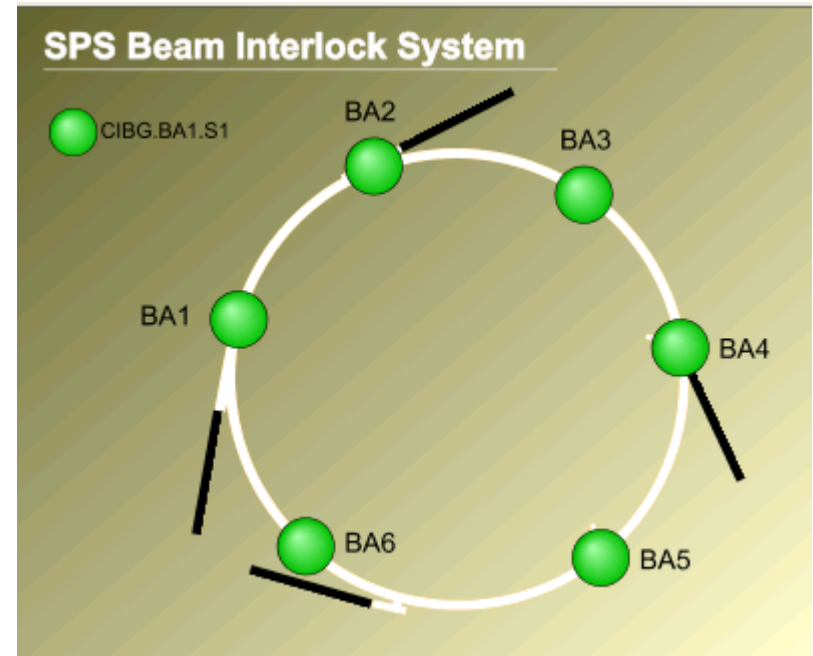
BQM in PS

- **BQM:** Beam Quality Monitor
- **Monitor the quality of the beam:**
 - Azimuthal beam position
 - Longitudinal beam structure and bunch parameters (e.g. if beam unstable or bunches too long)
- **Does not exist in the PS yet**, but can be implemented for LS2
- **1 input channel required** from bld. 269 (PS)
- **User_Permit = TRUE if beam quality is ok**

SPS BIS

- **Status of the SPS-BIS loop** is needed to inhibit injection and send the beam to the injection dump (TBSJ)

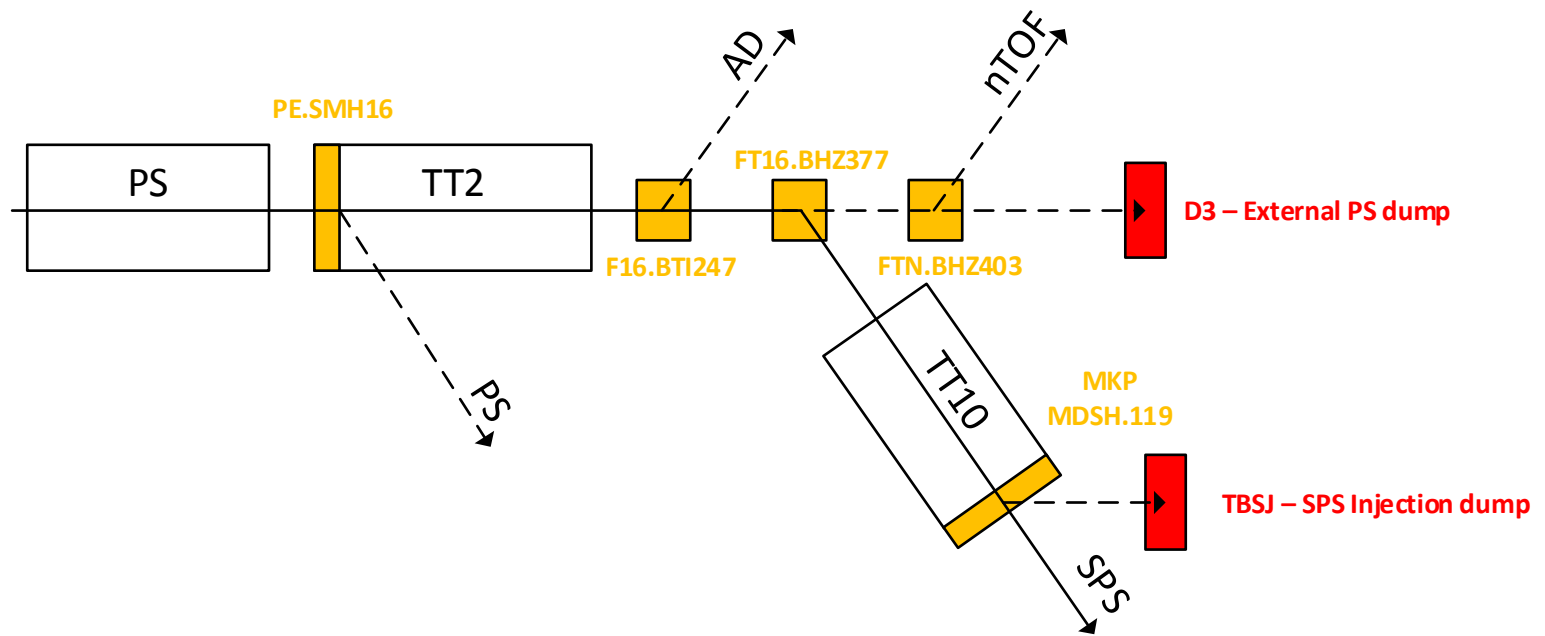
- **1 input channel** required in BA1



- **User_Permit = TRUE** if BPL closed

Beam Permit destinations

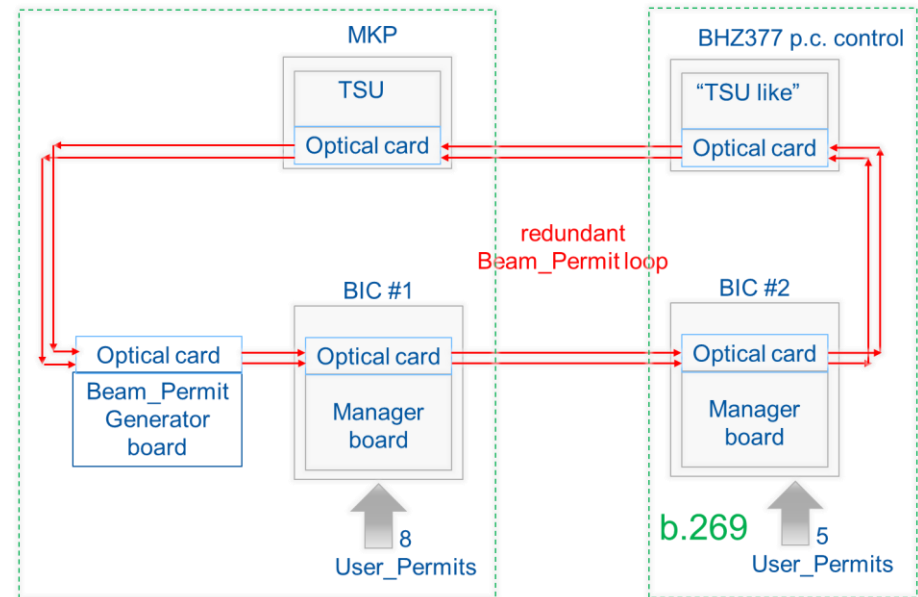
- **Injection kicker (MKP) + MDSH119** to send beam to the TBSJ
 - Both user input and destination
- **BHZ377 power converter – pulse in TT2 D3**
 - Both user input and destination (chicken-egg problem)



Proposed SPS-INJ-BIS architecture

- **13 user inputs** identified (8 from BA1 + 5 from 269)
- **2 Beam Permit destinations** (MKP and BHZ377)

- Distance BA1-269 > **1km**
- 2 BICs in **ring topology**
- 2 **redundant BPLs**
- **CIBG & BICs** in free running



Open questions

- Only systems in **TT10 will be interlocked?** Nothing in TT2
- Why not **stopping the beam at the source?**
- **Is switching time** of MDSH.119 and BHZ377 **a limitation?**
- The SPS-INJ-BIS **will not be timing or cycle-dependent**
- The SPS-INJ-BIS will give its **BEAM_PERMIT only if all user inputs are TRUE** (no equations)
- Both Generator (CIBG) and BIC (CIBM) in free running mode, therefore no BIS arming required => **Arming sequence for MKP and BHZ377 has to be discussed**

Next steps

- Clarify **requirements** with clients (PS BQM, MKP, PCs...)
- Define final SPS-INJ-BIS **architecture**
- Finish **technical specification and launch EDMS approval**
- **Request cabling** for installation during LS2 (Deadline: end of 2017)