



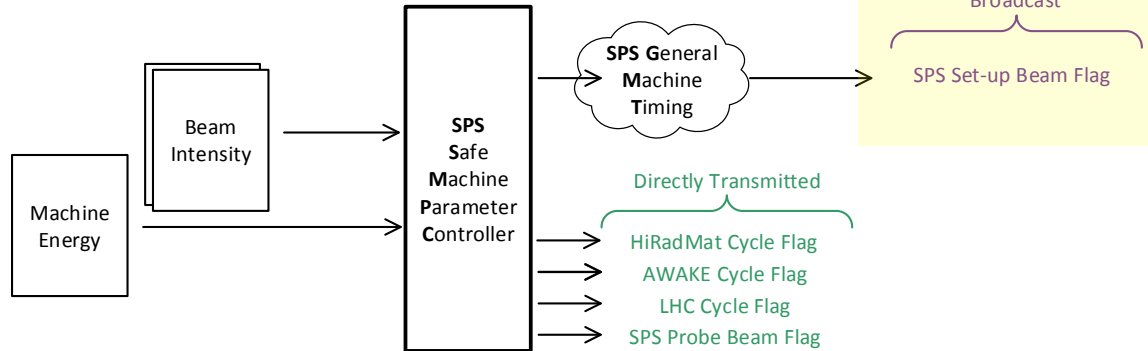
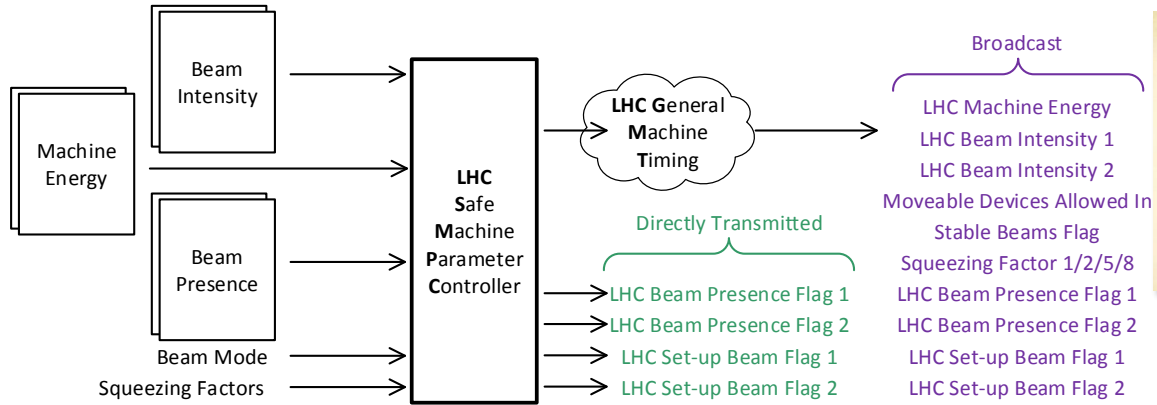
SPS extraction interlock Doubling the SMP connection

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TE-MPE-MI

189th Machine Protection Panel Meeting
8th May 2020

Present Safe Machine Parameters



Extraction Matrix

Signal name	TED TT60/TT40	HRM/CNGS	TED TI2/TI8	LHC PROBE	LHC SETUP	LHC NOMINAL
SOFTWARE_PERMIT	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
E_HRM_CNGS	Don't Care	TRUE	FALSE	FALSE	FALSE	FALSE
E_LHC	Don't Care	FALSE	TRUE	TRUE	TRUE	TRUE
TT60A_TT40A	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
TT60B_TT40B	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
TT60_TT40_TED_IN	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
TT66A_TT41A	Don't Care	TRUE	Don't Care	Don't Care	Don't Care	Don't Care
TT66BTT41B	Don't Care	TRUE	Don't Care	Don't Care	Don't Care	Don't Care
TI2U_TI8U	Don't Care	Don't Care	TRUE	TRUE	TRUE	TRUE
TI2D_TI8D	Don't Care	Don't Care	TRUE	TRUE	TRUE	TRUE
TI2_TI8_TED_IN	Don't Care	Don't Care	TRUE	FALSE	FALSE	FALSE
INJ_PERMIT	Don't Care	Don't Care	Don't Care	TRUE	TRUE	TRUE
SPS_PROBE_BEAM	Don't Care	Don't Care	Don't Care	TRUE	FALSE	FALSE
LHC_BEAM_PRESENCE	Don't Care	Don't Care	Don't Care	Don't Care	TRUE	TRUE
LHC_SETUP_BEAM	Don't Care	Don't Care	Don't Care	Don't Care	Don't Care	FALSE
SPS_SETUP_BEAM	Don't Care	Don't Care	Don't Care	TRUE	TRUE	FALSE

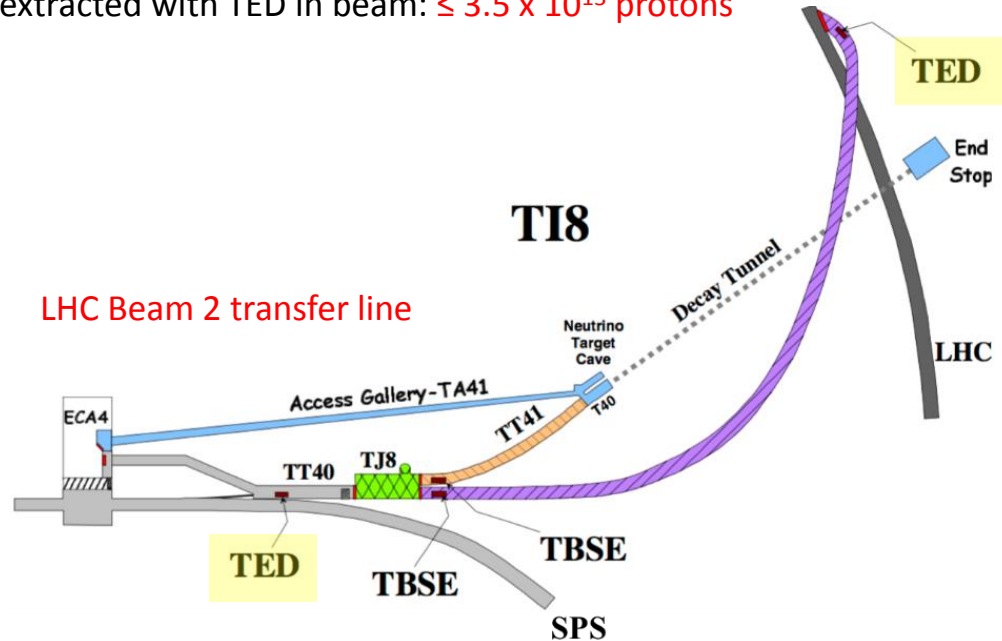
TED Flag Addition

- TEDs will not be able to withstand a full **25 ns LIU batch** consisting of 288b
- **New machine protection** strategy with LHC beams after LS2 ([SPS-OTH-ES-0001](#))
- Beam **intensity** that can to be extracted with TED in beam: $\leq 3.5 \times 10^{13}$ protons

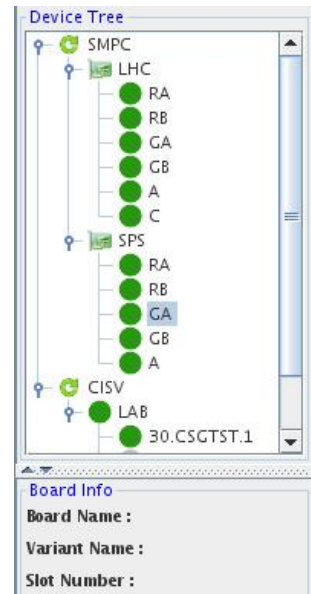
4 x ELMA CRATE 3U



Description	Place
LHC injection Dump	T18
LHC injection Dump	T12
SPS Dump	TT60
TT40 extraction Dump	TT40



TED Flag Addition - II



From Sources

BCT4/40S Intensity A

BCT4/40S Intensity B

BCT3/30S Intensity A

BCT5/50S Intensity B

Generation

1 out of 2 :
Select A then B

BCT4/40S Intensity

Operator Probe Beam Limit

Probe Beam Limit

\leq $=$

1 out of 2 :
Select A then B

BCT3/BCT5 Intensity

Setup Beam Limit

TED Beam Limit

\leq $=$

To Arbiter & Extraction BIS

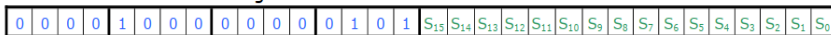
SPS Probe Beam Flag

SPS Setup Beam Flag

TED Beam Flag

SPS Flags on GMT

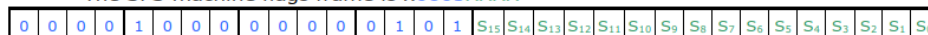
The SPS machine flags frame is x0805XXXX



Bit	Description	Logic
S ₁₅	Reserved	Always '0'
S ₁₄	Reserved	Always '0'
S ₁₃	Reserved	Always '0'
S ₁₂	SPS Setup Beam Flag A	'1' = TRUE, '0' = FALSE
S ₁₁	Reserved	Always '0'
S ₁₀	Reserved	Always '0'
S ₉	Reserved	Always '0'
S ₈	SPS Setup Beam Flag B	'1' = TRUE, '0' = FALSE
S ₇	Reserved	Always '0'
S ₆	Reserved	Always '0'
S ₅	Reserved	Always '0'
S ₄	Reserved	Always '0'
S ₃	Reserved	Always '0'
S ₂	Reserved	Always '0'
S ₁	Reserved	Always '0'
S ₀	SPS Setup Beam Flag	'1' = TRUE, '0' = FALSE



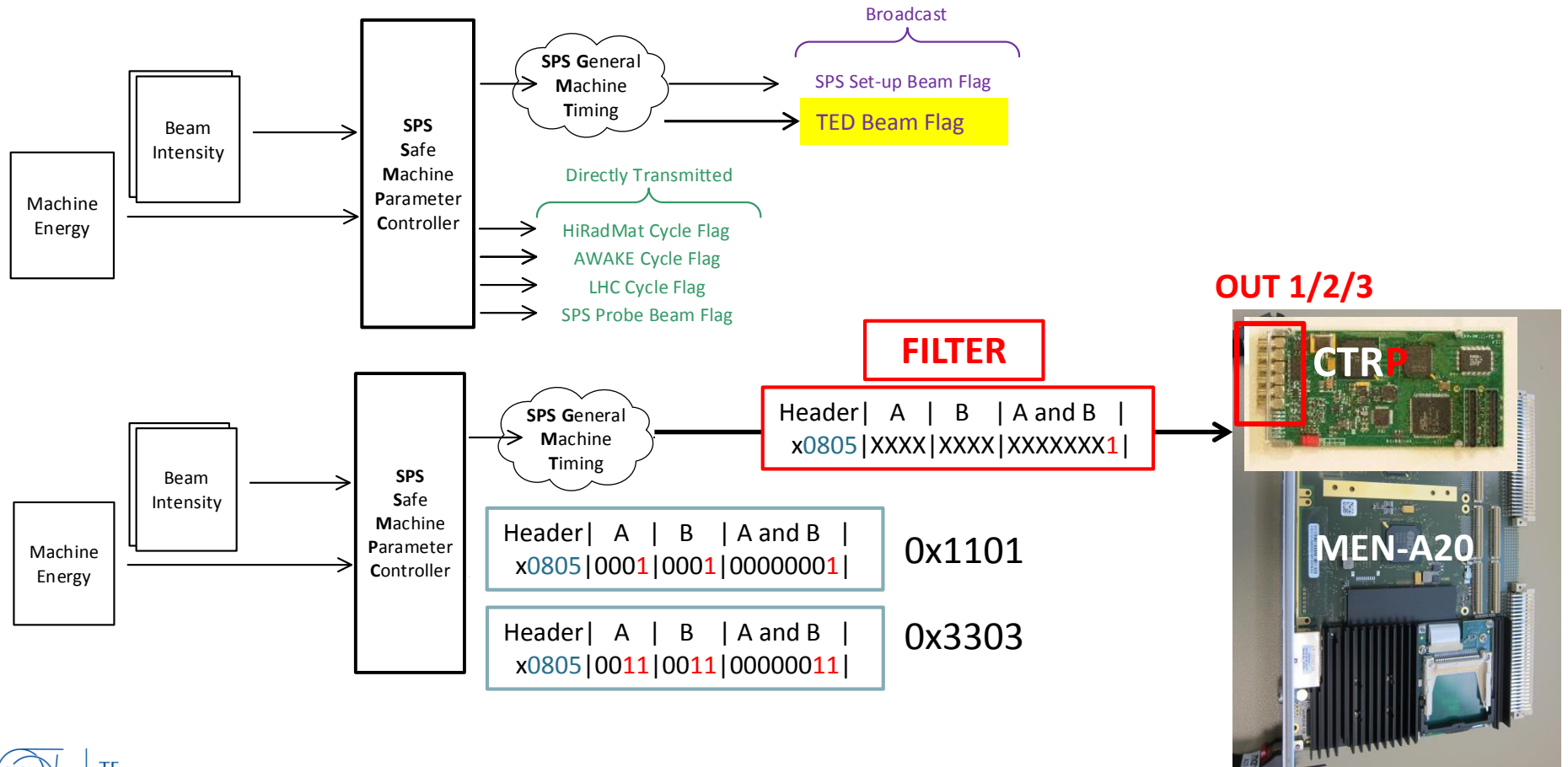
The SPS machine flags frame is x0805XXXX



Bit	Description	Logic
S ₁₅	Reserved	Always '0'
S ₁₄	Reserved	Always '0'
S ₁₃	TED Beam Flag A	'1' = TRUE, '0' = FALSE
S ₁₂	SPS Setup Beam Flag A	'1' = TRUE, '0' = FALSE
S ₁₁	Reserved	Always '0'
S ₁₀	Reserved	Always '0'
S ₉	TED Beam Flag B	'1' = TRUE, '0' = FALSE
S ₈	SPS Setup Beam Flag B	'1' = TRUE, '0' = FALSE
S ₇	Reserved	Always '0'
S ₆	Reserved	Always '0'
S ₅	Reserved	Always '0'
S ₄	Reserved	Always '0'
S ₃	Reserved	Always '0'
S ₂	Reserved	Always '0'
S ₁	TED Beam Flag	'1' = TRUE, '0' = FALSE
S ₀	SPS Setup Beam Flag	'1' = TRUE, '0' = FALSE

SMP – Interface to general Machine timing EDMS 901688

SPS Flags Transmission



OUT 1/2/3

Extraction BIS - I

SMP sends:

0x1101 or 0x0000

Extraction receives

0x0001 or 0x0000

After TED implementation

SBF **TRUE** and TBF **TRUE**: 0x3303

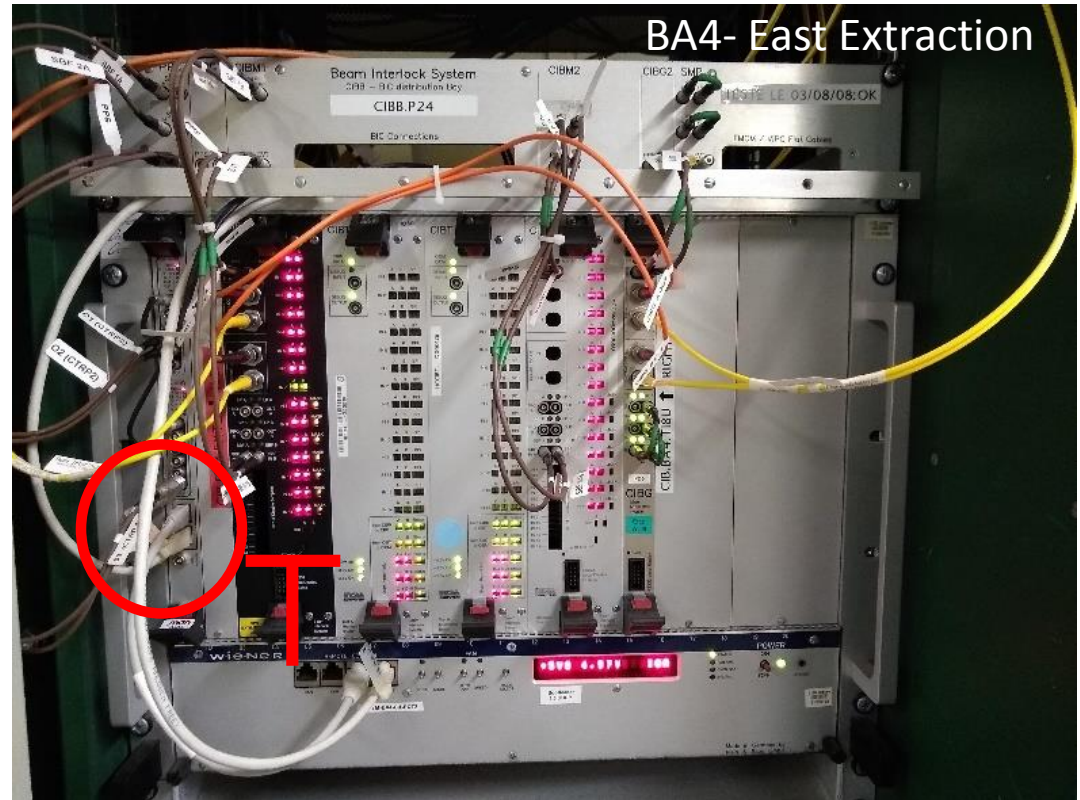
SBF **FALSE** and TBF **TRUE**: 0x2202

SBF **FALSE** and TBF **FALSE**: 0x0000

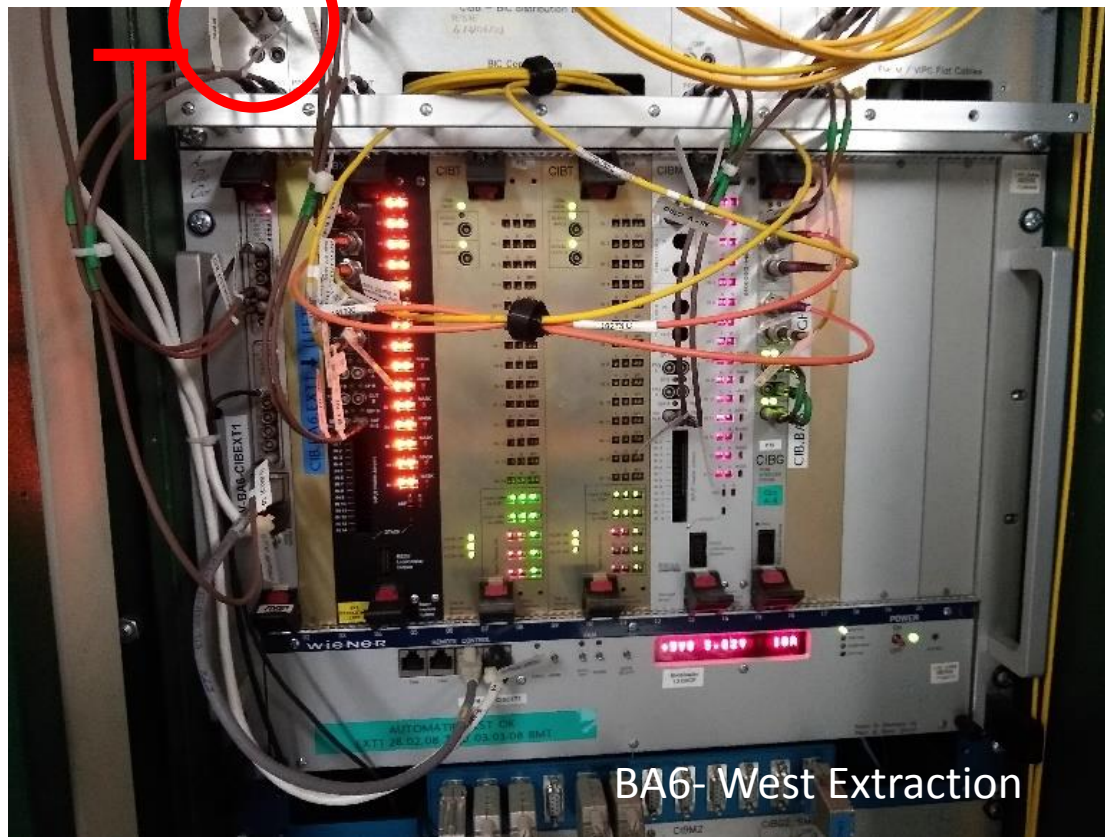
SBF **TRUE** and TBF **FALSE**: **NO**

Extraction (BA4 and BA6) must decode
the SBF **ONLY**

The 4 TED crates must decode
the TBF **ONLY**



Extraction BIS - II



HARDWARE and LTIM CONFIGURATION CHANGES

1) As present

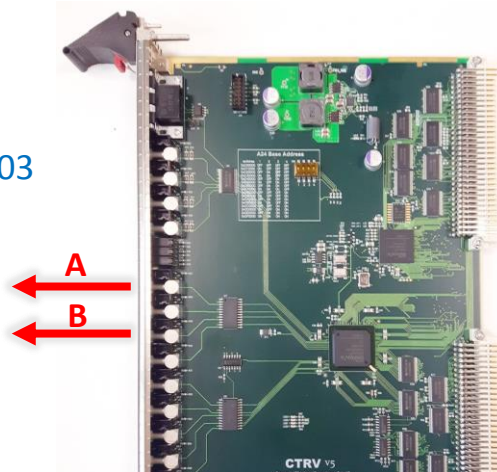
- **NO REDUNDANCY A and B**
- Decode logical **AND** (A and B)
- Use one **CTRP** and a T
- **Remove the Filter**
- No extra costs
- LTIM configurations:
 - **SBF: LTIM decodes 0x3303**
 - **TBF:**
 - **LTIM1 decodes 0x3303**
 - **LTIM2 decodes 0x2202**

2) 1x CTRV

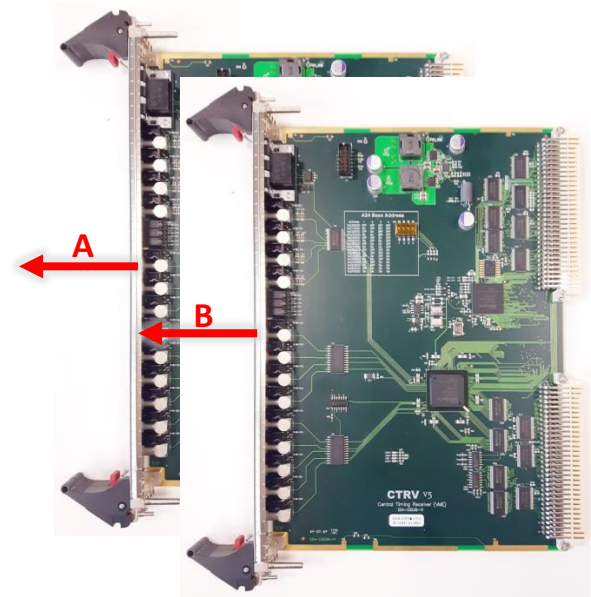
- Remove the GMT filter
- Remove the "T"

3) 2x CTRV

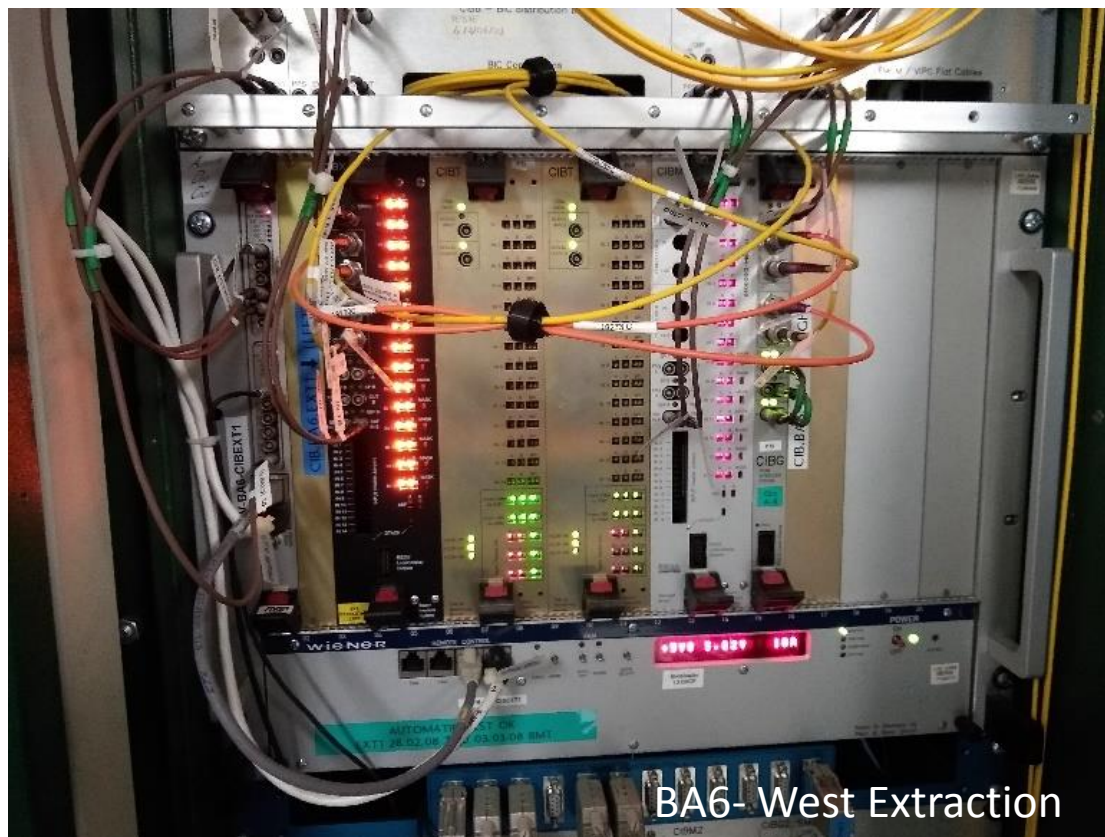
- Remove 2x CTRP, GMT Filter and "T"
- 2xLTIM configurations:
 - **SBF-A: LTIM-CTRVA decodes 0x3303**
 - **SBF-B: LTIM-CTRV-B decodes 0x3303**



Not OK for the present LTIM devices
and cannot have CTRP and CTRV
together



Extraction BIS



Conclusions

- **SMP** sends **2 SPS Flags**: Setup Beam Flag and TED Beam Flag
- **TBF** less critical than **SBF** (used at commissioning), **SBF** is critical for Extraction
- GMT filters out the redundant part of the SMP SPS Flags.
 - This seems to be not necessary and needs to be changed/removed to allow transmission of **TED FLAGS**
- The SPS-SBF **logical AND** (A and B) is received and then transmitted through a **Lemo 'T'**
- **Proposal:**
 - Replace 2xCTRP → 2xCTRV in 2x Extraction BIS (~3kCHF)
 - Signal split in 2 separate boards
 - Remove T connector
 - Still **decode from the full payload**, not single Bits
 - EDMS 901688: <https://edms.cern.ch/document/901688/2.4>
- **Lesson learned**: **CTRP** OK for a quick and easy solution to decode ONE specific payload
→ **SMP v2**: need a **board** for SPS (such as present CISV) to generate interlock from timing

