Safe Machine Parameters – Status and future requirements

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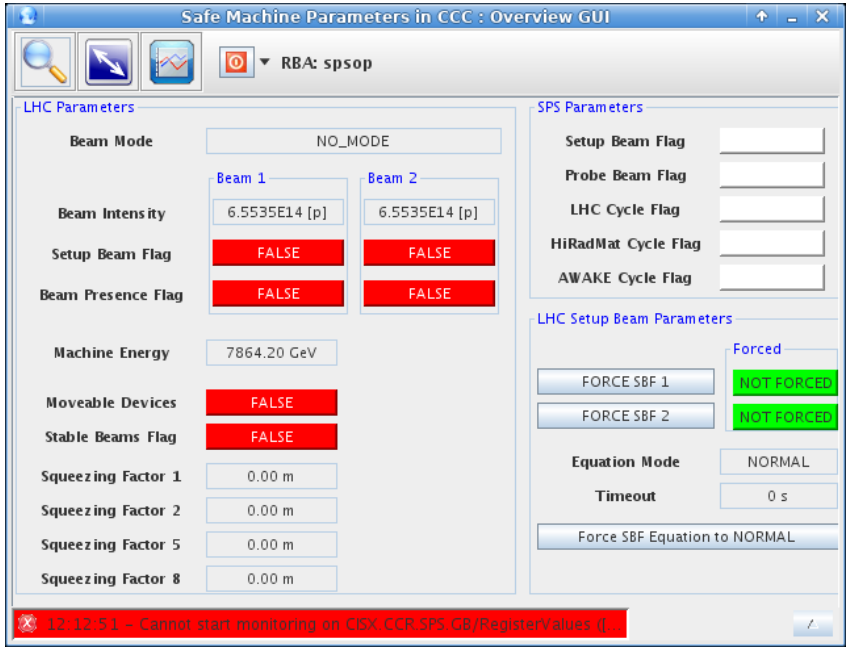
Status

- SPS safe machine parameters
  - Energy and intensity related flags



Sources:

Setup beam flag: high intensity BCTs 3 and 5

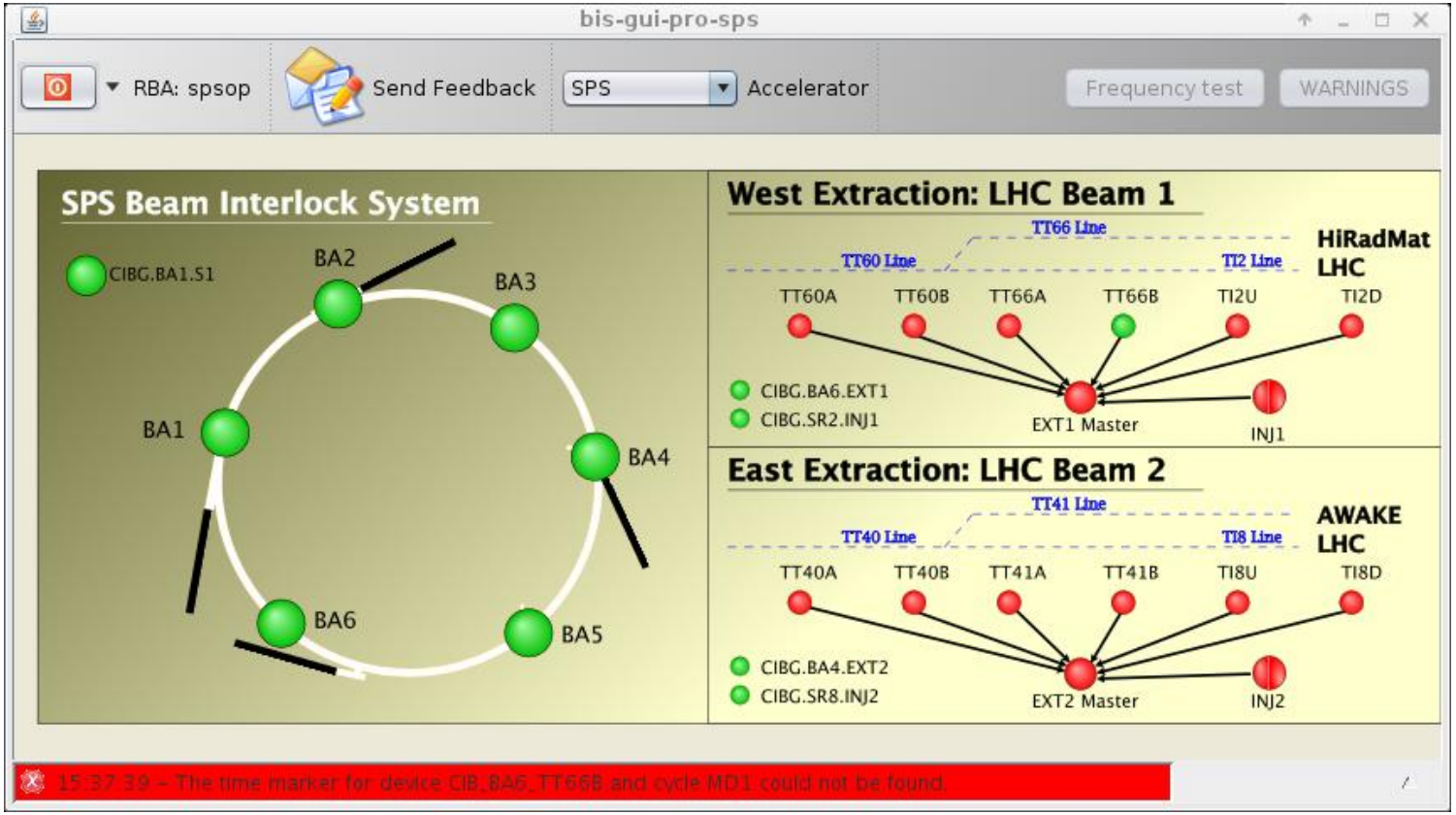
Probe beam flag: low intensity BCT 4 (single source)

Energy flags: BETS system
→ High availability logic: “1 out of 4” ((BEM4-A, BEM4-B, BEM6-A, BEM6-B)

- Only SPS SBF is distributed over timing
  - Others directly fed to extraction BIS through optical fibers
  - No cross-check on SPS SBF timing distribution

SPS hardwired interlock systems – SMP?

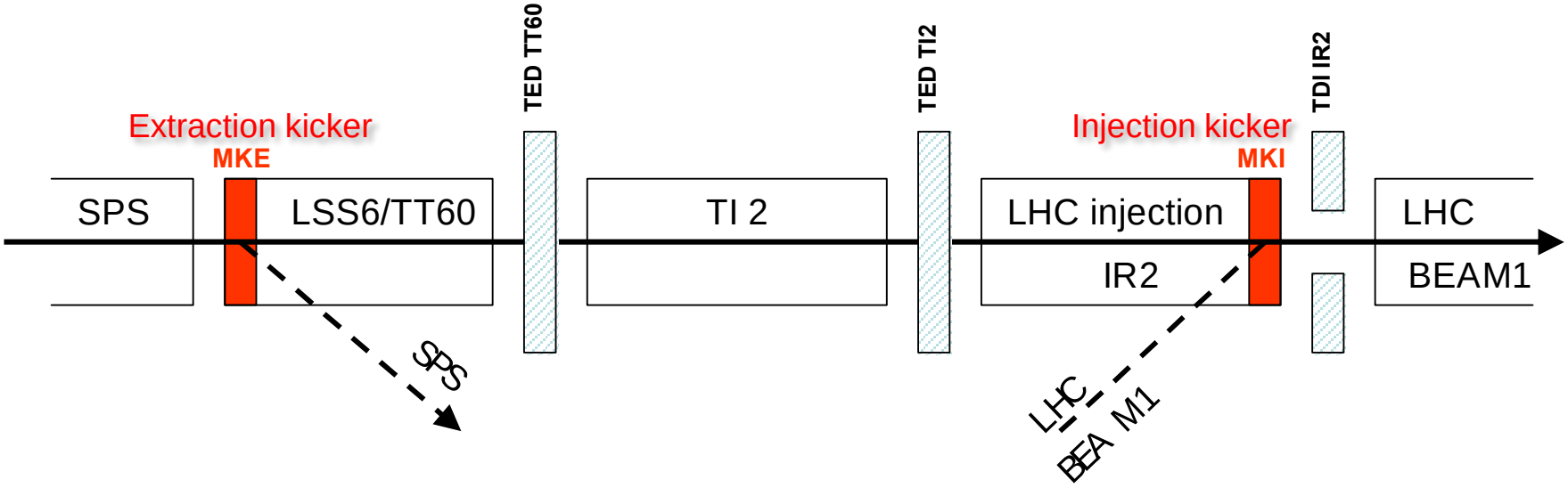
- Beam permit → SPS beam dump
- Extraction permits → extraction kickers



→ SPS setup beam flag (SPS SBF) not used in ring BICs

Addition to current paradigm – SPS TED Beam Flag (SPS_TBF)

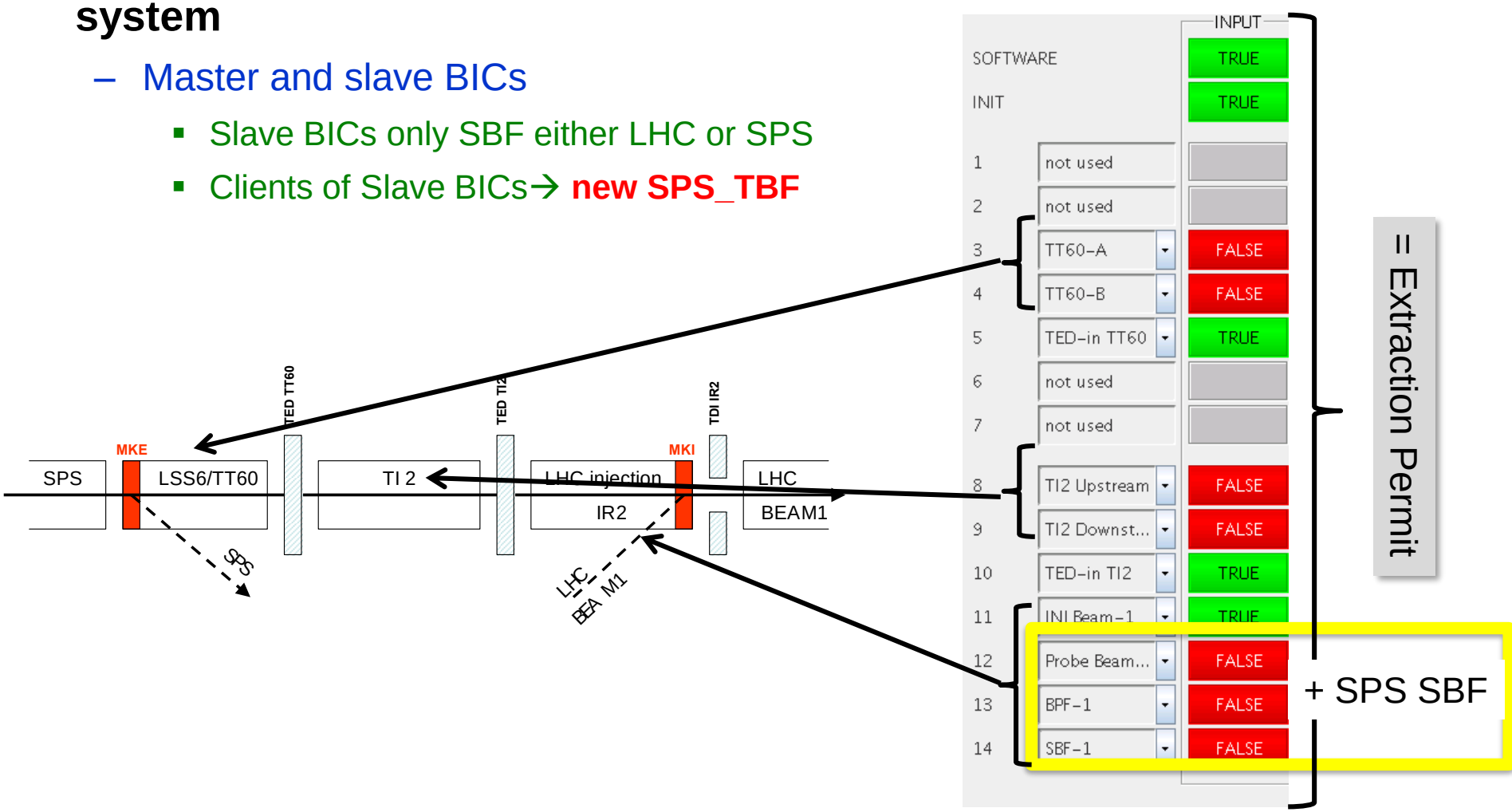
- With the TEDs, part of the line can be studied without the downstream part necessarily available



- Interlocking philosophy: If a TED is in beam the interlocks of the downstream equipment are ignored.
  - The **maximum allowed intensity** with TED is 2.3e+11 x 144: 3.5 x 10^{13} p^{+}
  - → **additional interlocking required for LIU**
  - The slave BIC TED input will take this into account exploiting the **new SPS TED Beam Flag**

Safe machine parameters → only used for the SPS fast extractions

- SPS and LHC SMP flags are used in the **extraction interlock system**
  - Master and slave BICs
    - Slave BICs only SBF either LHC or SPS
    - Clients of Slave BICs→ **new SPS_TBF**

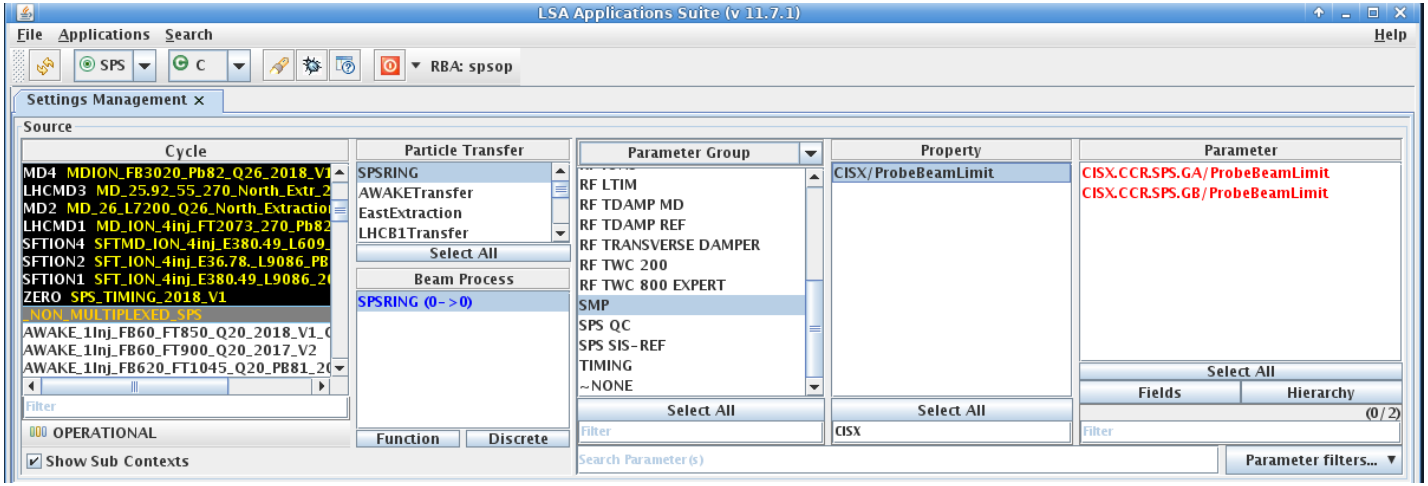


Example: LSS6, idem for LSS4 extraction

Management of threshold for flags

- Most are hardcoded
- For operational flexibility and commissioning some need to be adjustable
  - Probe beam flag
  - TED beam flag

- Use Management of Critical Settings in this context

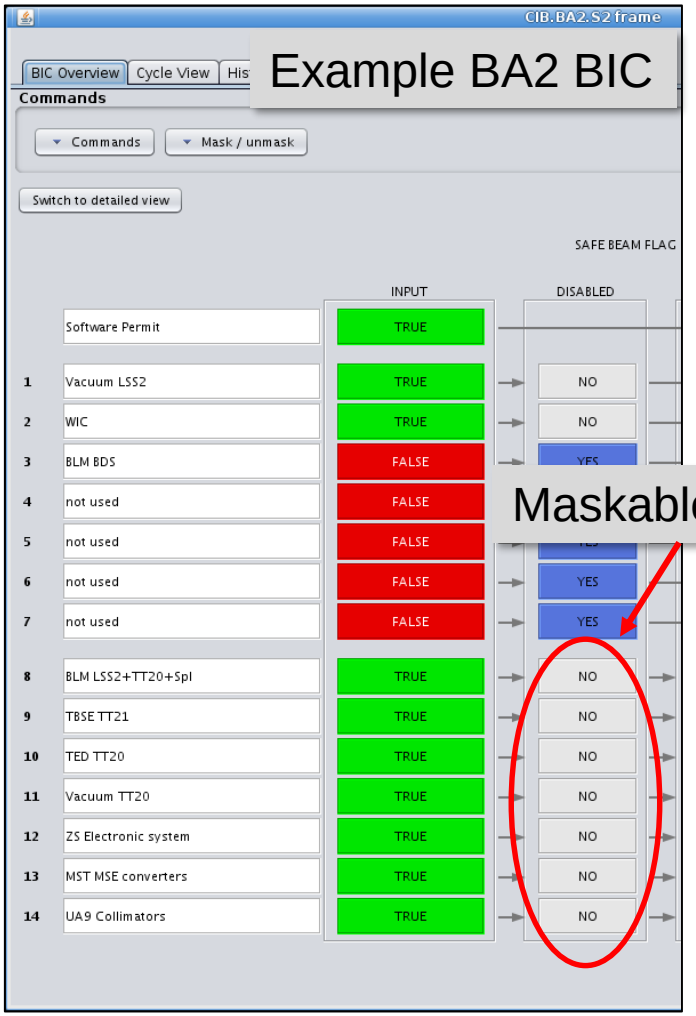


Question from organizers: use SBF for ring BICs in future?

- Philosophy in SPS for maskable vs unmaskable different from LHC.
  - Not all entries needed for all beams (high or low intensity) and facilities!

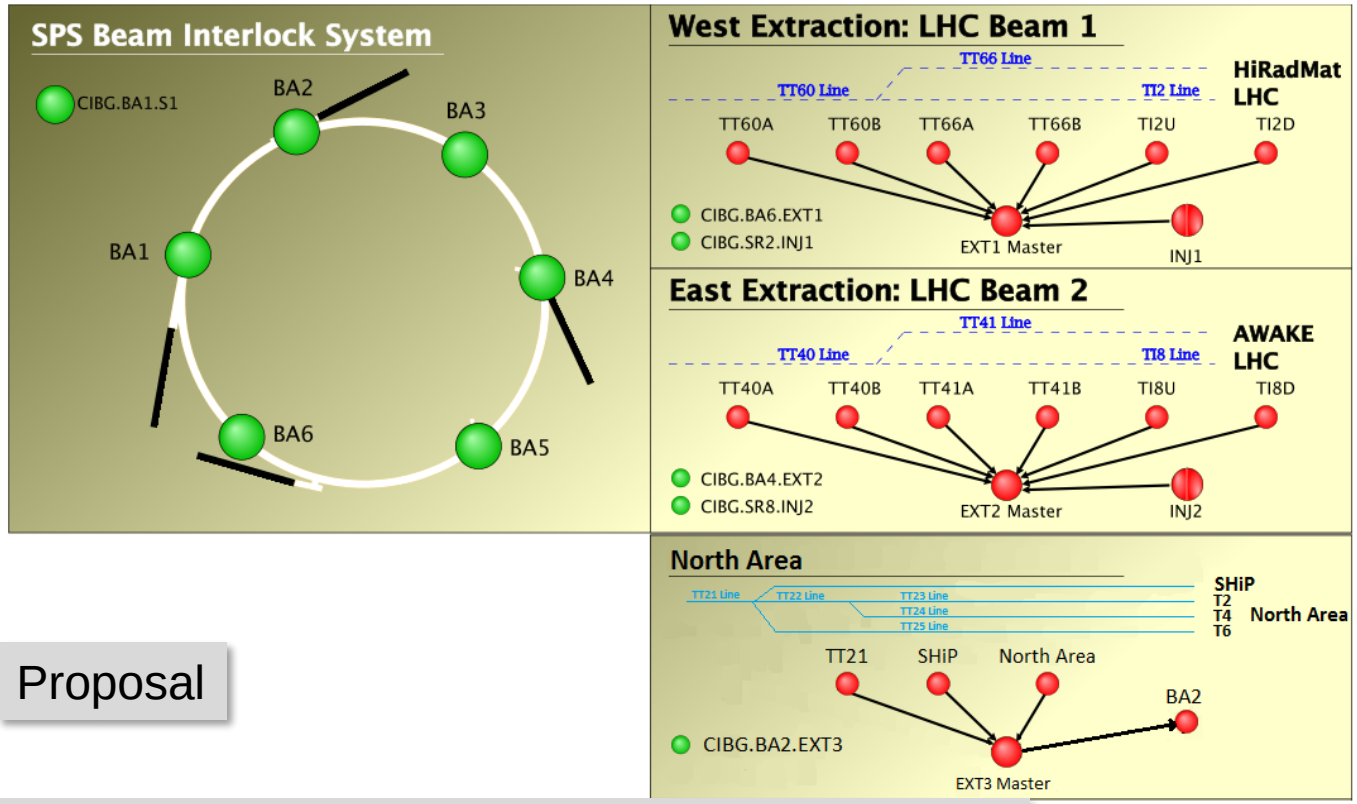
- Masking allows for degraded operation (e.g. ZS broken)
  - Can still run LHC beams
- Allows for distinction between normal and MD operation
  - MD moveable installations: crab cavities, UA9
- If separating out interlocking per beam types, then could be possible to unmask automatically with SBF
  - A la proposal for slow extraction

- For the time being : cannot use SPS SBF to remove masks systematically



Slow extraction interlocking improvement

- → Can use SBF for unmasking channels



Proposal

Simplified MASTER BIC equation:
(! SHiP destination AND ! NA destination) OR [TT21 AND ((SHiP destination AND SHiP interlocks) OR (NA destination AND NA interlocks))]

Future requirements for SMP

- Also require cross-check of SMP information
  - Currently not done
- Additional source for probe beam flag?
  - BCT4 wrong information published in the past with indiv beam extracted into empty LHC.

- Slow extraction interlocking: require "destination flags”
  - Would the SMP be the right place to generate this? Or should this come from the timing system directly

Future requirements for SMP

- Wire scans not possible with 288 LIU bunches at 450 GeV/c
  - Would damage the wire
- Settings of BSRT filters/gains depend on intensity/density
  - Currently BSRT is disabled on most cycles

- → Would require distribution of **intensity and energy information** from SMP via timing: BEAM INFORMATION DISTRIBUTION
  - Required for beam instrumentation to self protect
    - → Beam instrumentation more operational
    - Settings management would become less complicated
  - Total intensity and energy available in SMP, but not distributed.
  - Propose additional property (source FBCT): maximum bunch intensity in circulating train

A propos: future requirements for SMP

Beam information distribution: hot topic

- Other things that were discussed:
  - Distribute circulating bunch pattern
    - Fixed target vs LHC beams?
    - Believe can do without this.
  - Distribute intensity before beam is injected (e.g. from what is circulating in PS,…)
    - Should rather pre-program expected values and have a BQMlike system in the PS/PSB to not inject into the SPS to protect against too high intensities wrt to programmed values
  - What about optics/emittance
    - Brightness counts....
    - BCMS vs LHC25ns
    - Would setting extreme values for LHC beams and FT beams be sufficient for clients?
      - E.g. LHC beams: always use thresholds for BCMS even if working with LHC25NS
      - To be further discussed

Question from organizers: SMP useful concept also for other injectors?

- Beam information distribution is useful for every circulating machine

- PS use cases:
  - Certain cavities do not pulse without beam to protect the power amplifier from noisy RF signals.
    - Currently done with dedicated hardware
  - Trigger internal dump for EAST slow extraction in case intense TOF bunch was not extracted
  - Auto-calibration of various systems
  - Would require information every 10 ms.

- Other SPS use case:
  - Triggering dynamic economy. Dedicated FESA class to generate timing. Subscribes to BCT
  - Beam presence flag for beam dumping system

Summary and Conclusion

- Safe machine parameters are "only" used for the interlocking of the fast extractions in LSS4 and LSS6 in the SPS
- Due to nature of inputs and operational modes: the SPS setup beam flag is not used for the ring BICs
- The generated SMP information is not distributed over timing except the SPS SBF
- More flags are in the pipeline for TED interlocking
  - Destination flags for slow extraction interlocking?
- The biggest additional requirement for the future is “beam information distribution”
  - How safe this has to be, needs to be defined.
  - Requirement collection and functional specification has only started.