Variable AGK
Implementation of Protections

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Thanks to all of my TE/ABT colleagues for their inputs

OUTLINE

- Failure modes with variable AGK
- Parameters to be checked
- Protections implemented during EYETS2016-17
- SPS to LHC inhibit

Failure modes with variable AGK

- Beam on TDI
  - AGK signal problem, FIB interlocked (Or any MKI fast interlock)
  - MKI kick length shorter than batch length
- First batch kicked by last injection
  - MKI kick longer than AGK
- Beam in Abort Gap
  - AGK signal shorter than MKI length and injected beam length

Parameters to be checked

- Many parameters need to be coherent and checked:
  - AGK length / Period (FIB interlock)
  - MKI kick length
  - SPS extraction batch length

Protections implemented during EYETS

- New Fast Inhibit Board (FIB) firmware for surveillance of AGK signal
  - New FESA3 class to acquire measured period and length of AGK
  - Interlock of FIB in case AGK period/length not in limits => (No MKI pulse !)
  - ReArm needed in case of AGK signal problem.

- SIS will check the coherency of all MKI and AGK parameters:
  - AGK length / Period (FIB interlock)
  - MKI kick length (Actual flat-top length)
  - injection filling pattern (Injection length, not number of batches)

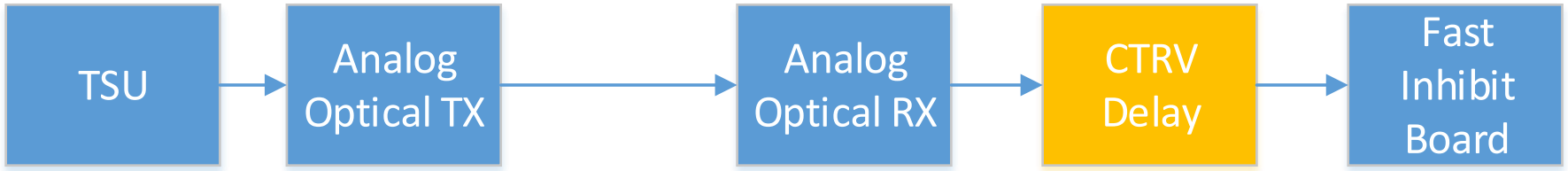
SIS will prevent injection request in case any incoherency is detected

No check added in SPS (BQM already checks that beam in SPS corresponds to requested filling pattern)

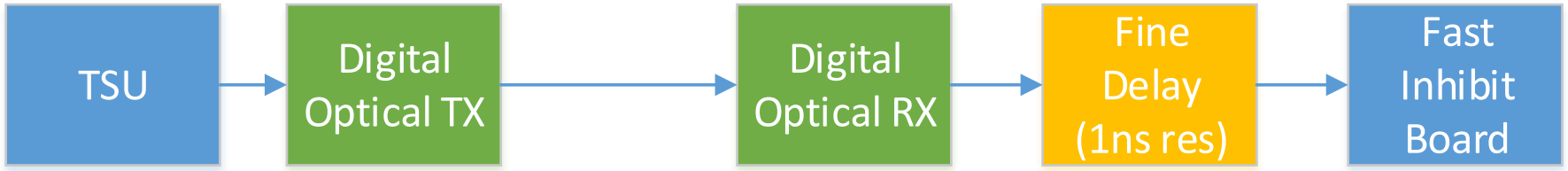
New optical link and delay

Previous analog optical transmission with fixed length (AGK length fixed bu TSU)

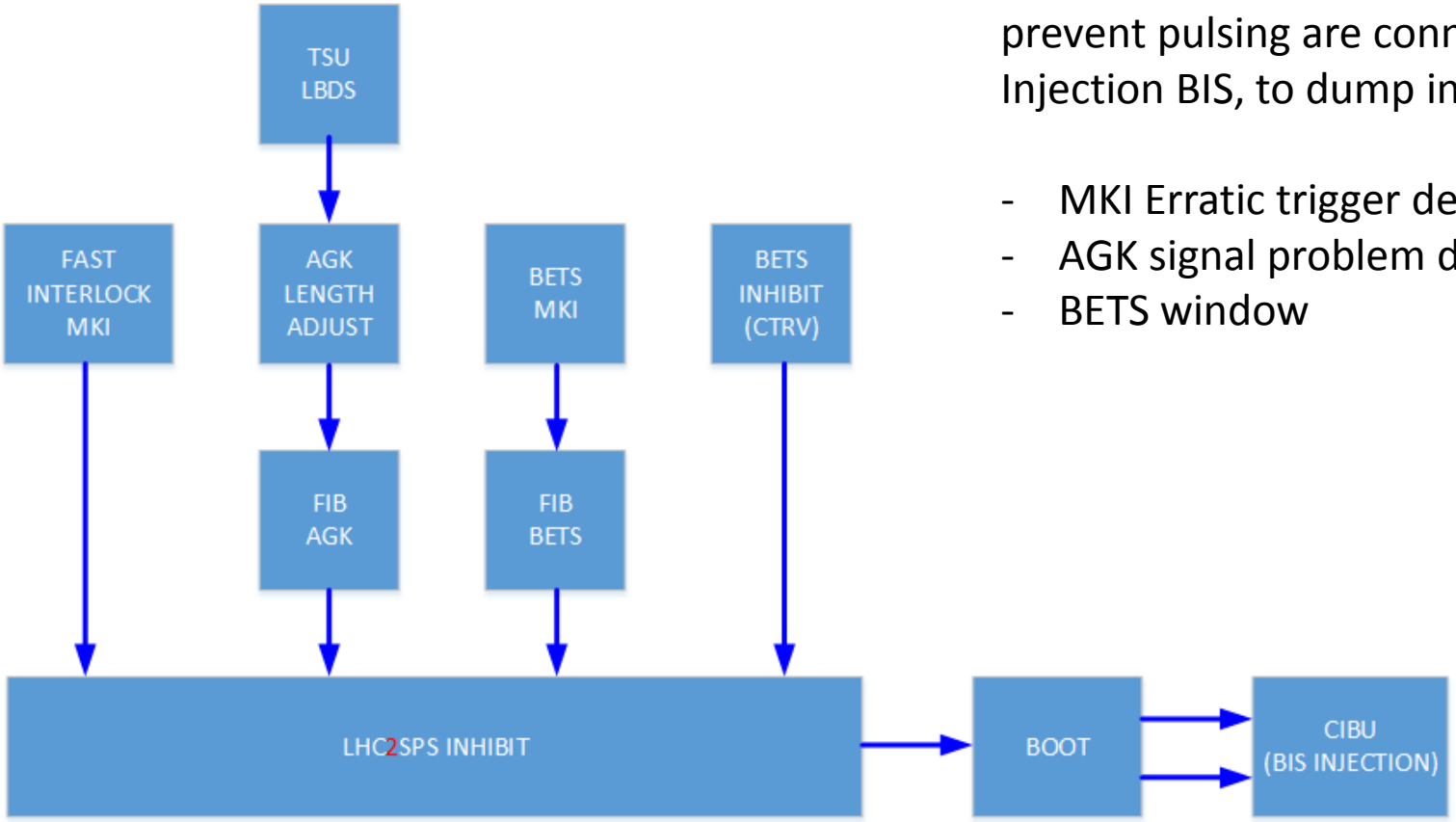
During Summer 2016, addition of CTRV delay to regenerate the AGK



During EYETS, upgrade of optical transmission(Only a pulse is transmitted)



SPS to LHC Inhibit



MKI fast interlocks that could prevent pulsing are connected to Injection BIS, to dump in SPS.

- MKI Erratic trigger detection
- AGK signal problem detection
- BETS window

Summary of changes during EYETS

- New transmission from LBDS to MKI, using RF optical transmission hardware:
  - Only one pulse is sent on AGK rising edge (Bunch 1 injection)
- New regeneration of AGK signal using FMC-Fine-Delay card=reduced jitter (1ns).
  - Since last summer we use a CTRV card = 25ns jitter on AGK edges
- Implementation of a surveillance of AGK signal in FIB card
  - AGK period and AGK length are continuously checked.
  - Injection prepulse blocked in case of instabilities detected.
- Implementation of SIS surveillance of all MKI and AGK parameters
  - To guarantee a coherence between AGK length, MKI length and injection filling pattern.
- Connection to the Injection BIS to avoid missing MKI pulses

Test needed before unsafe beam

- Test of monitoring of AGK signal in FIB card (1/2 shift, during Cold Checkout ?):
  - Change AGK length and check that FIB detects it
  - Change BRF period (resynch ?) and check that FIB detects it
  - Check that BE/OP can reset the FIB interlock in ARM LBDS sequence
  - Limits on AGK length and period set to 100ns (sound reasonable for a start), TBC.

- Revalidation of AGK edges, after new hardware deployed (1/2 shift with pilot):
  - New transmission system has unknown insertion delay.
  - New FMC-Fine-Delay has 1us insertion delay, compensated on TSU card

- Test of SIS check of all AGK, MKI and injection filling patter parameters:
  - Configure AGK and MKI length to be inconsistent, check that SIS blocks injection request.
  - Try an injection request larger than AGK or MKI length, check that SIS blocks injection request.

NOTE: Real MKI flat-top length wrt requested kick length TBD
  - constant to be subtracted.

Summary

Some failure modes exists with variable AGK

- No critical (accepted failures)

Many parameters need to be checked to prevent these failure modes

- Hardware protection implemented (FIB)
- Software Interlock to guarantee coherency of all MKI parameters

Full test and validation needed at LHC startup

Spares slides / Removed…