Specifications

- PIC, WIC, FMCM : approval closed & updated. In the process of being released
- Injection : approval closed & updated. Final checks in progress.
- BLMs : approval closed.
- LBDS : a new version is circulating…

Kicker Test Modes

MKI Test Mode (Inj. Kicker)

- To pulse the MKI in remote, it is necessary to have a LHC beam produced by the SPS injectors and sent down the SPS injection line.

  >> coupled to the so-called Dynamic Destinations in the timing system.

- If any elements in the injector chain gives an interlock (access, HW failures…), pulsing in remote becomes impossible.

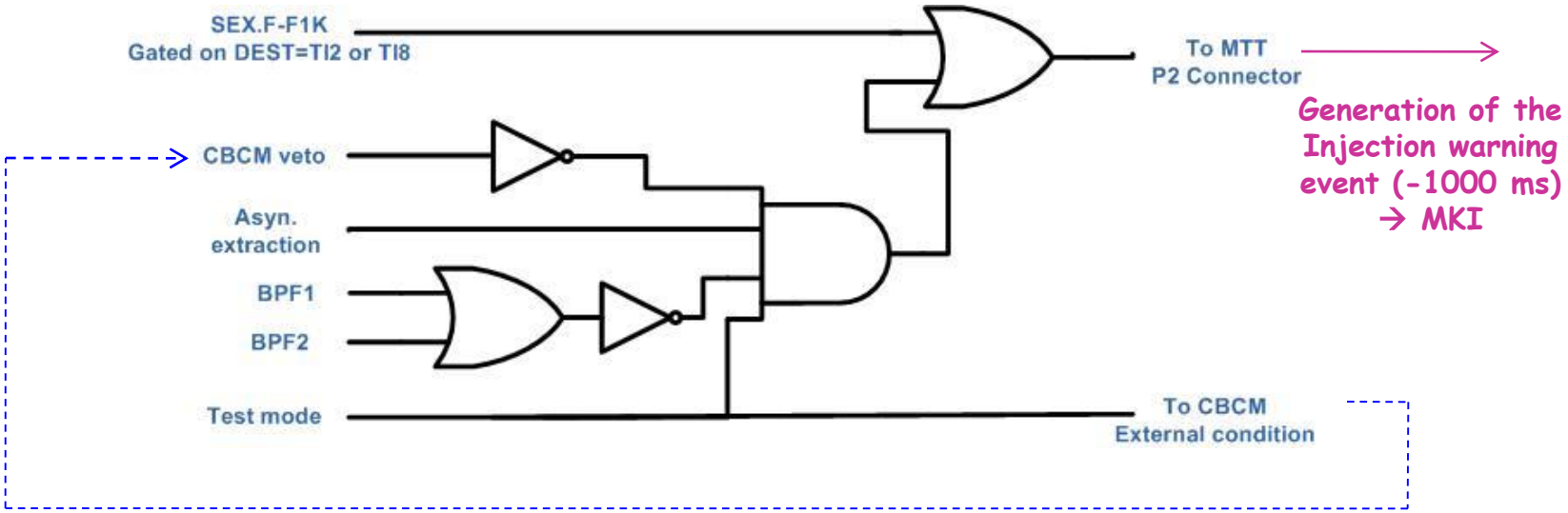
  >> very safe, but not tricky for tests.

Aim is to find a solution for pulsing the MKI in remote more easily without constraints from the injectors. Note however that:

- The LHC beam permit must be TRUE.
- The corresponding injection permit must be TRUE.
- The energy from the BETS must be 450 GeV.

>> this is clearly not the case today !!!

Proposal for a logic for testing LHC injection – 'ALL in timing' (J. Lewis)



Test mode:

A logic level controlled by a 'button' on the CCC external conditions panel.

CBCM Veto:

Set by the CBCM when it detects the "Test Mode"
The TI8/TI2 and corresponding Dump dynamic destinations cannot be sent.

Async Extraction:

This is a pulse generated by an LTIM under control of an application program.

BPF1 & BPF2

Beam presence in either ring blocks the test mode.

Issues…

- Key instead of button : under investigation. Will probably require CABLING in the CCC !!
- To get both beam permit and injection permit requires clearing all non-maskable interlocks:
  - **Vacuum.**
  - **Powering.**
  - **Access.**
  - **Experiments.**
  - **…and a couple more.**

>> in general far from trivial, even during a stop a running period.

>> excluded during a normal shutdown?! Unless we disable all inputs…
(Arghh !!)

MKE Test Mode (SPS Extr. Kicker)

Same as for MKI

- To pulse the MKE in remote, it is necessary to have a LHC beam produced by the injectors and sent down the SPS injection line.

  >> *coupled to the so-called Dynamic Destinations in the timing system.*

- If any elements in the injector chain gives an interlock (access, HW failures…), pulsing in remote becomes impossible.

  >> very safe, but not tricky for tests.

Aim is to find a solution for pulsing the MKE in remote more easily and in parallel with other SPS production beams. Note that:

- The SPS extraction permit must be TRUE.
- The SPS main bends must be pulsing to 450 GeV.

>> only for tests during the running period (includes checkout).

>> much easier to establish than the conditions for the MKI !

Possible test mode logic – 'all timing'

- A new 'test mode' button is needed in the external conditions panel (same as for MKI, but on SPS side).
- When the button is pressed:

No beam in SPS

  - **A beam tagged 'TO_LHC' in the timing sequence will have its dynamic destination set to 'TEST'.**
  - **The linac tail clipper is activated to kill the beam.**
  - **The PS beam destination is set to TT2_DUMP.**
  - **+ some SIS protection activated at the level of TI2, TI8 & TEDs.**

>> no change to the MKE trigger logic.

>> only requires some LTIMs to be defined for the new destination.

Chamonix follow up

3.) What can go wrong ?

a rough statistics of 20 years HERA

B. Holzer's table from Chamonix

Injection:
- too early (during magnet cycle)
- too late (during accleration)
- into a filled bucket (timing problem)
- with kicker/septum off
- with magnet at transferline off
- after wrongly applied injection correction ... why ???
- with closed collimators
- with closed vacuum valve
- with wrong magnet polarity (after maintenance day)

Acceleration:
- failure of persistent current compensation
- errors in ramp correction tables
- tune jump during polarity switch of a quadrupole
- collimators too close to the beam
- head tail problems (chromaticity correction)
- magnet failures

Luminosity:
- aperture limitations due to RF fingers
- beam quality issues: beam beam spoils the emittance (up to beam losses at the aperture limit)
- orbit correction loop: coil at limit or off
- dedicated beam orbit steering
- coasting beam (rf problems)
- failure at dump kicker
- failure of dump timing system
- collimator control defect (radiation problem)
- error in BLM / BPM signal processing (server)
- vacuum valve closes during luminosity run

Nota bene: each of these errors lead to a beam loss alarm or quench

3.) What can go wrong ?

a rough statistics of 20 years HERA

Injection: **too early (during magnet cycle)**

NO - MKI energy tracking (! only 4 RBs + Q4/MSD IR6 !), SIS

YES – limit to < 10^11 charges into empty machine !

too late (during accleration)

NO - MKI energy tracking

into a filled bucket (timing problem)

YES – protection by TDI, SIS (check requested bucket)

with kicker/septum off

NO – Septum has 3 levels of interlocks (FMCM, PC fast, PC current)

NO - MKI state interlock, settings in MCS

YES - enable/disable → TDI

with magnet at transferline off

NO – Up to 3 levels of interlocks (FMCM, PC fast, PC current [all])

after wrongly applied injection correction ... why ???

I interpret this as a trim/controls error

YES/NO – PC current interlocs (TL), injection protection !!!!

with closed collimators

YES/NO? – limit to < 10^11 charges into empty machine !

with closed vacuum valve

NO - interlocked

with wrong magnet polarity (after maintenance day)

YES – limit to < 10^11 charges into empty machine !

3.) What can go wrong ?

a rough statistics of 20 years HERA

Acceleration:

failure of persistent current compensation
YES – BLMs, BPMs

errors in ramp correction tables
YES – BLMs, BPMs

tune jump during polarity switch of a quadrupole
YES – BLMs, BPMs

collimators too close to the beam
YES – Steffano, BLMs

head tail problems (chromaticity correction)
YES – BLMs

magnet failures
YES – QPS, PIC, WIC, FMCM, BLMs, BPMs

Nota bene: each of these errors lead to a beam loss alarm or quench

3.) What can go wrong ?

a rough statistics of 20 years HERA

B. Holzer's table from Chamonix

Luminosity:

aperture limitations due to RF fingers

YES – Steffano, Aperture checks !

beam quality issues: beam beam spoils the emittance (up to beam losses at the aperture limit)

YES – Collimator define aperture

orbit correction loop: coil at limit or off

YES – PIC (> 60 A), orbit FB (limit detection), 60 A trip → BLMs, BPMs

dedicated beam orbit steering

YES – BLMs, SIS interlock on orbit/cods

coasting beam (rf problems)

YES – TCDQ, abort gap cleaning

failure at dump kicker

Ouphs !! LBDS SIL4, 14 out of 15...

failure of dump timing system (asynchronous dump?)

YES – TCDQ

collimator control defect (radiation problem)

YES – Pos. Interlocks, autoretract?

error in BLM / BPM signal processing (server) difficult to make parallels...

No direct dependence???

vacuum valve closes during luminosity run

NO – interlocked

HERA BCT Interlock

From Matthias Werner (DESY):

- The HERA BCT interlock was based on a Fast BCT.
- The interlock was set to trigger for a loss of 1.5 mA for a maximum beam current of 100 mA). LHC beam current is 500 mA (but must also consider pattern & machine length).

  A bit high for us, but as last resort trigger better than nothing !!
- The system was tracking the intensity and triggered on fast changes (reaction time ~ 2 HERA turns – 40 μs).

Following the discussions in Chamonix, R. Jones and Co. will prepare a draft specification for a FBCT interlock to be discussed with MPP.

Other follow up

- "What if the dump does not work?"
  Should start working on a (simple) procedure. Who?

- Failure catalog.
  Started on the TLs (JW). Trying to find a good 'format'.
  Have to agree on how & who for the LHC (start with single failures?).

- Scheduling tests.
  Work ongoing.