LHC Beam Interlock System

&

PM event

Based on a R.Schmidt's drawing
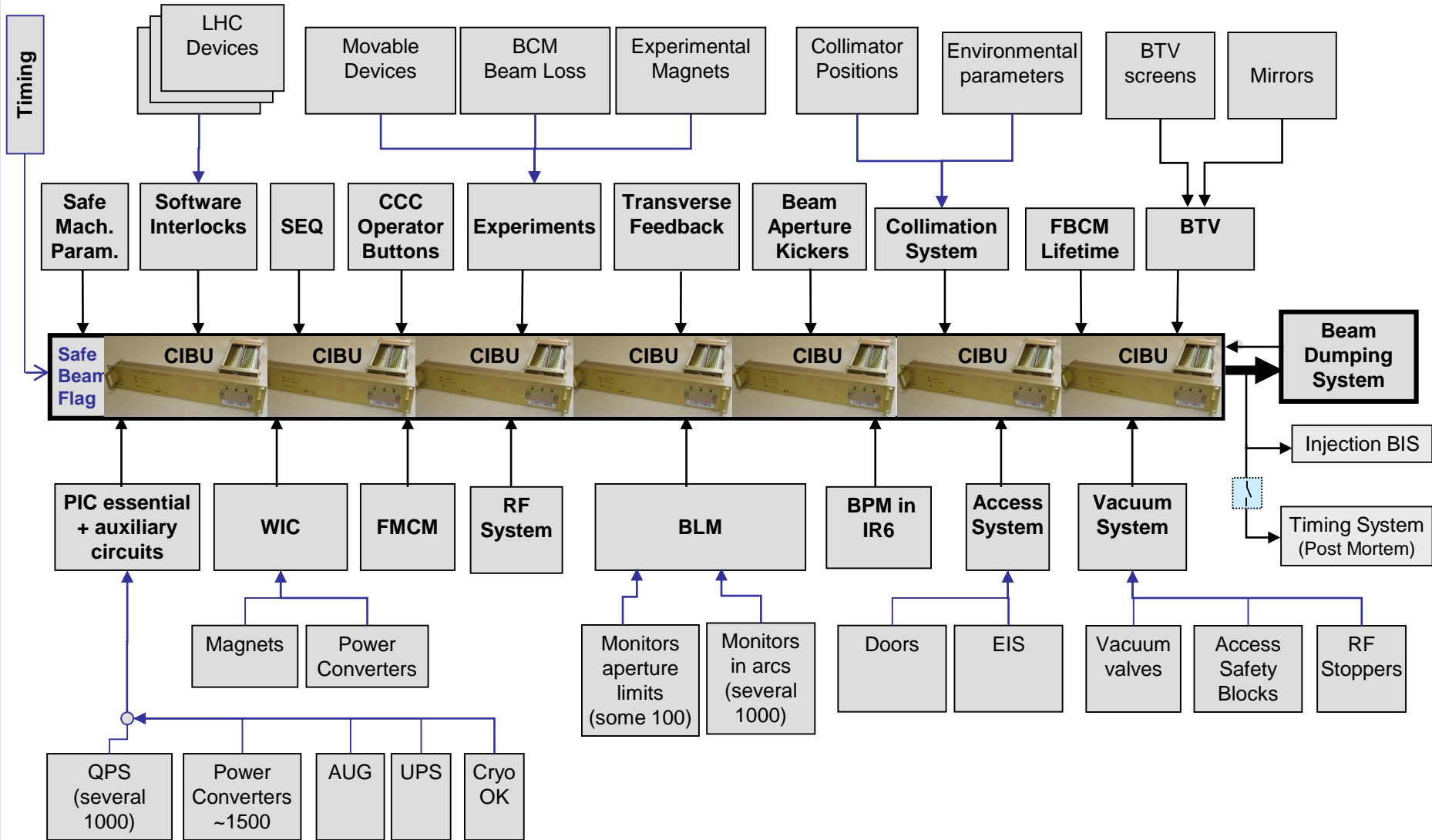
→ LHC BIS produces a BEAM_PERMIT for each beam:

<p align="center">BEAM_PERMIT_1 and BEAM_PERMIT 2.</p>

- Distributed via redundant BEAM_PERMIT_LOOPS to:

  - LHC Beam Dump System (LBDS)

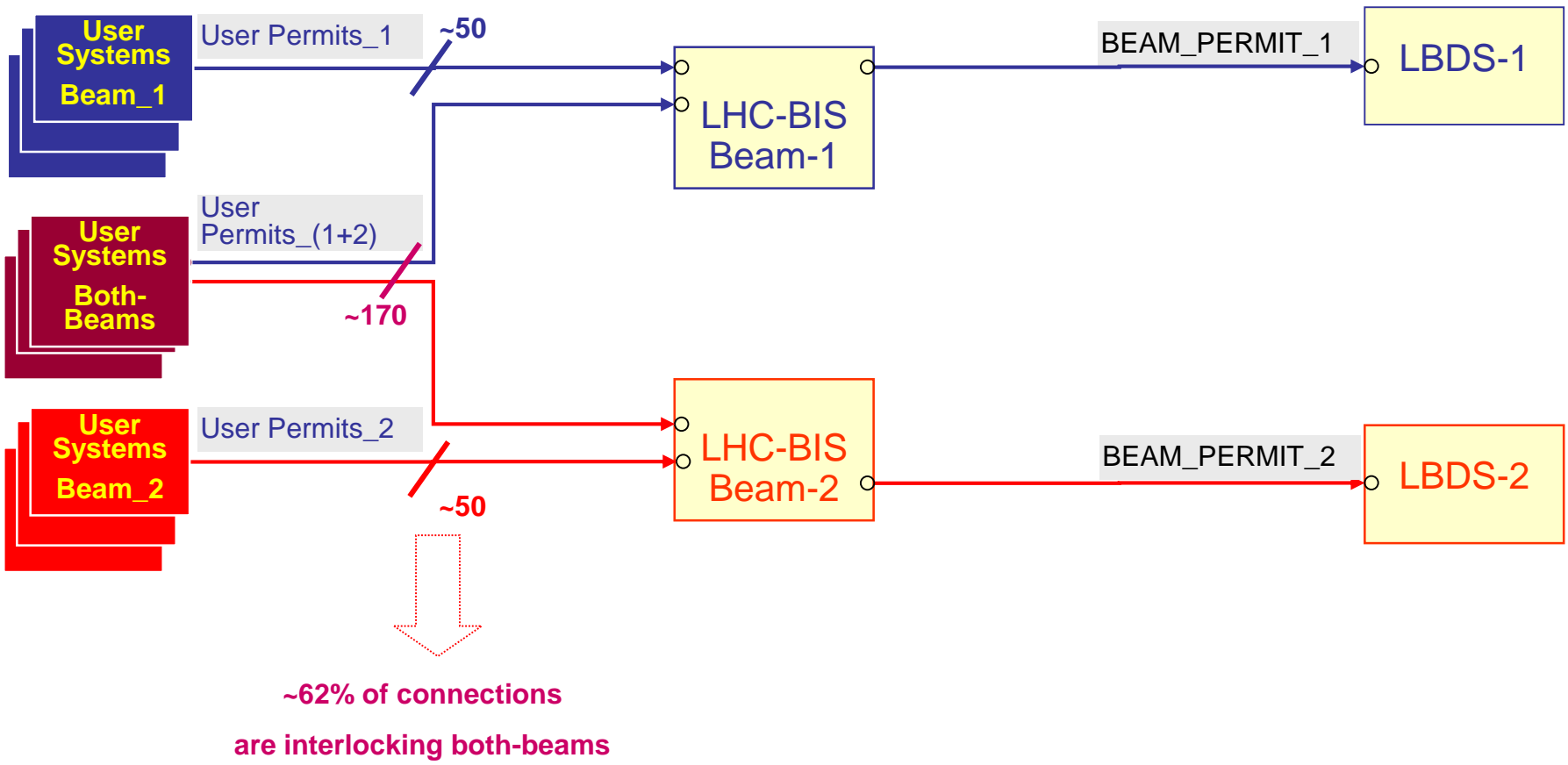 - Injection Interlock

  - Timing System

→ BEAM_PERMITS derived from USER_PERMIT signals:

- given by the different LHC *User Systems.*

- Half ones could be masked (if Safe_Beam_Flag= TRUE)

→ Two different families of *User Systems*:

- interlocking the two beams independently

  » User provides USER_PERMIT signals for Beam-1 and Beam-2

- interlocking the two beams simultaneously

  » User provides USER_PERMIT signals for Both-Beam

Shown in the next slide

User Systems Beam_1

User Permits_1

~50

LHC-BIS Beam-1

BEAM_PERMIT_1

LBDS-1

User Systems Both-Beams

User Permits_(1+2)

~170

User Systems Beam_2

User Permits_2

~50

LHC-BIS Beam-2

BEAM_PERMIT_2

LBDS-2

~62% of connections

are interlocking both-beams

→ If BIS activated during "Normal" beam operation:

⇒ we call it an **Emergency Beam Dump**

– Planned to dump both beams whatever the User System source.

- If *User System* requests BD for one beam, not foreseen to keep the other one circulating.

→ For some others machine modes *(examples given in a following slide)*

there is a clear need to be able to dump only one beam.

⇒ named **Programmed Beam Dump**

→ The BIS has been designed for managing separately the two beams:

⇒ must have a link between the two BEAM_PERMIT_LOOPS.

⇒ But depending of the machine mode: unlinking should be possible.

Note: *As Hardware implementation not yet finalized, it won't be presented here*

The Linking /Unlinking will be managed by the LHC Sequencer
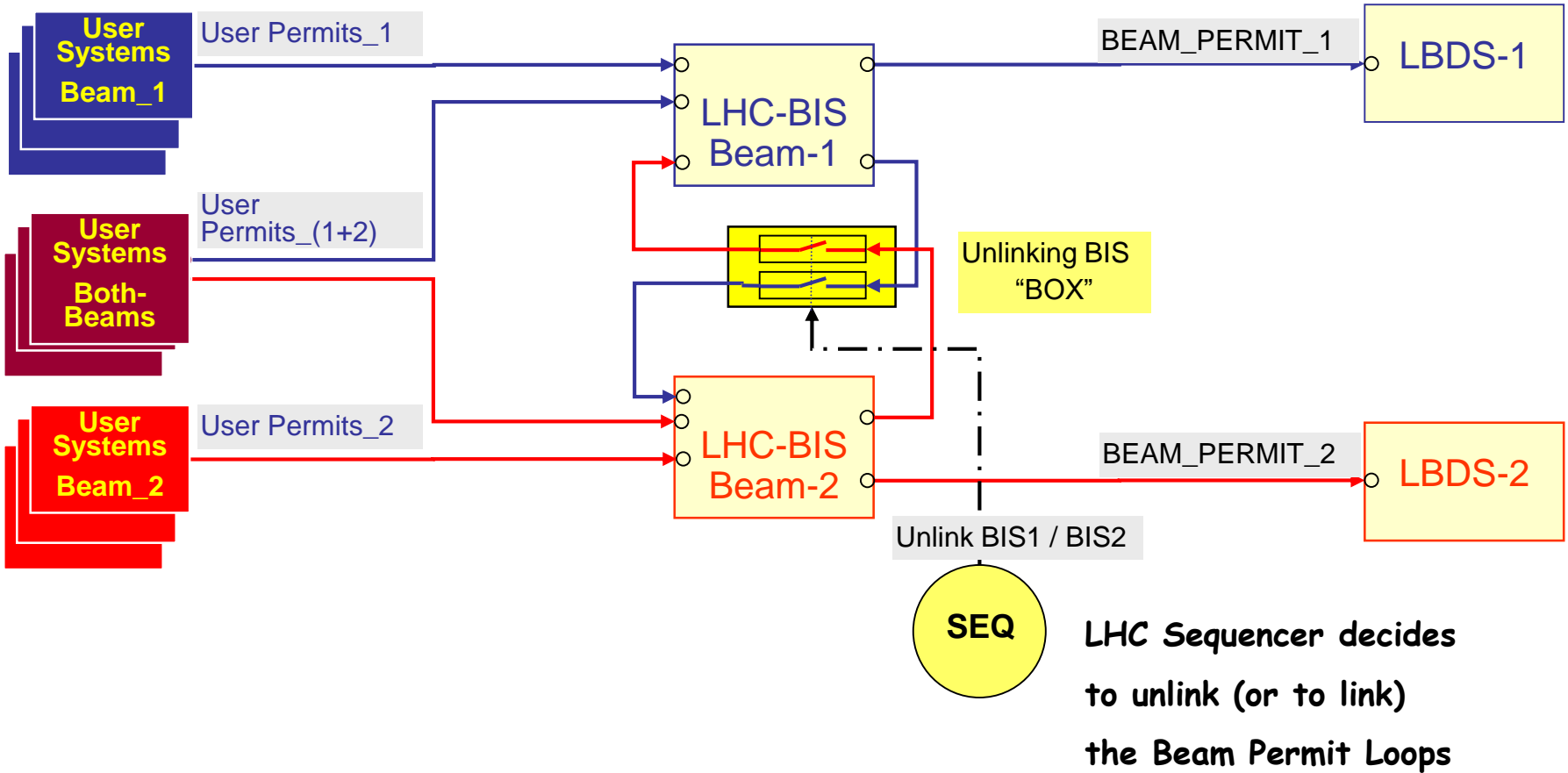
→ For some machine modes, we will have a **Programmed Beam Dump.**

– Need to dump only one beam. As for example:

- **Inject & Dump:** 0 – 1000 turns

- **Circulate & Dump:** 0.1 – 1000 s

- **Injection – intermediate**.

- **MD mode**

Described in…

– The two beams will be dumped at the "End of Physics"

Engineering Specification

Date: 2005-04-04

POST-MORTEM AND BEAM DUMP DATA ACQUSITION TRIGGERING

Abstract

Programmed beam dumps via timing events are required for the LHC in different machine modes, including at the end of fill, during the injection sequence, and for machine development studies. Timing events will also be required for emergency beam dumps, where the Post Mortem data acquisition has to be triggered.

In addition, timing events are needed to trigger data acquisition for the beam dump XPOC, and also in Inject and Dump mode to provide redundancy. This document defines the requirements and proposed solution for the different types of timing events associated with emergency and programmed LHC beam dumps, with particular attention to: the suppression of the Post Mortem request for some programmed dumps; the Inject and Dump mode; and the linking/unlinking of the beam permit loops.

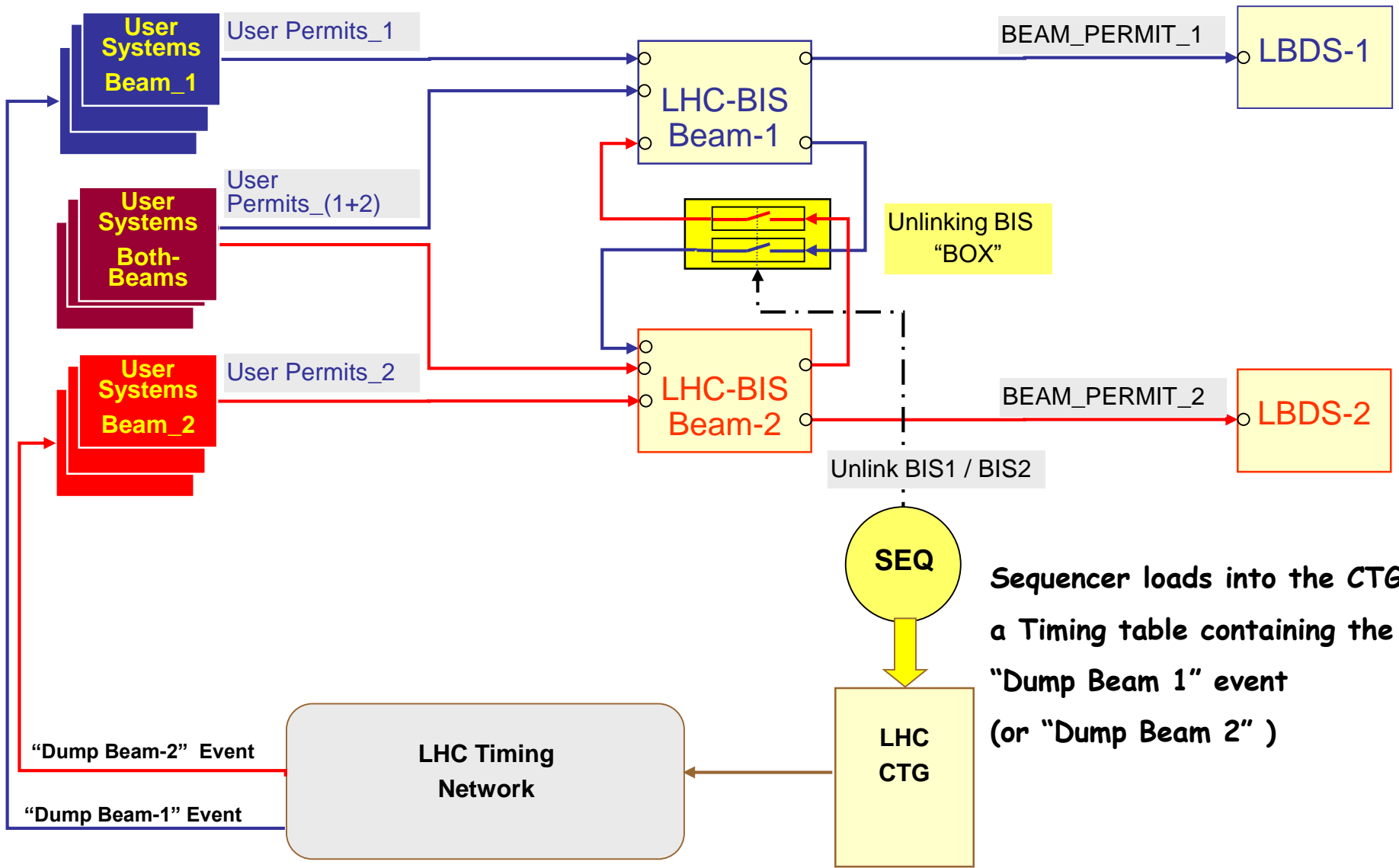| *Prepared by :*	*Checked by :*	*Approval Group Leader:*
B. GODDARD AB/BT M.LAMONT AB/OP J. LEWIS AB/CO B. PUCCIO AB/CO S. DEGHAYE AB/CO	R. ALEMANY AB/OP E. CARLIER AB/BT V. MERTENS AB/BT B. TODD AB/CO J. UYTHOVEN AB/BT J.J. GRAS AB/BI A. BUTTERWORTH AB/RF L. JENSEN AB/BI J.WENNINGER AB/OP	R. SCHMIDT AB/CO

Approval Group Members:

→ The LHC Sequencer uses the Timing system to trigger the BD of one intermediate beam via the BIS:

⇒ Timing receiver card connected to User Interface (CIBU)

⇒ Dedicated events for dumping either Beam-1 or Beam-2:

- at the end of fill

- during the injection sequence

- for machine development studies

User Systems Beam_1

User Permits_1

User Systems Both-Beams

User Permits_(1+2)

User Systems Beam_2

User Permits_2

LHC-BIS Beam-1

LHC-BIS Beam-2

Unlinking BIS "BOX"

BEAM_PERMIT_1

LBDS-1

BEAM_PERMIT_2

LBDS-2

Unlink BIS1 / BIS2

SEQ

LHC CTG

Sequencer loads into the CTG a Timing table containing the "Dump Beam 1" event (or "Dump Beam 2")

LHC Timing Network

"Dump Beam-2" Event

"Dump Beam-1" Event

→ As written in this Specification, ----------------------→

during "Normal" operation,

it is not foreseen to dump and post-mortem one beam only.

→ Therefore there will be <u>only one **"PM Request"** event</u> (common to both rings).

→ BEAM_PERMITS are connected to the LHC Timing Generator (CTG)

as "External conditions" inputs.

→ "PM Request" event will be broadcasted when the CTG

will detect a change (from TRUE to FALSE) of its dedicated inputs

(the ones connected to the BEAM_PERMITS)

→ However, for some Use Cases*

   there is a need to be able to dump one beam without provoking a PM.

   ⇒ **'PM Suppression Box'** for masking a BEAM_PERMIT Change

→ Nonetheless, some Key systems** should be informed that one Beam has been dumped.

   => The Timing system should be anyway informed of a BEAM_PERMIT Change.

   In order to allow the generation of a "Beam Dumped" event.

   ⇒ 'PM Suppression Box´ should perform a kind of "half-done" masking.

   ⇒ This feature will be managed

      by the LHC sequencer via dedicated events

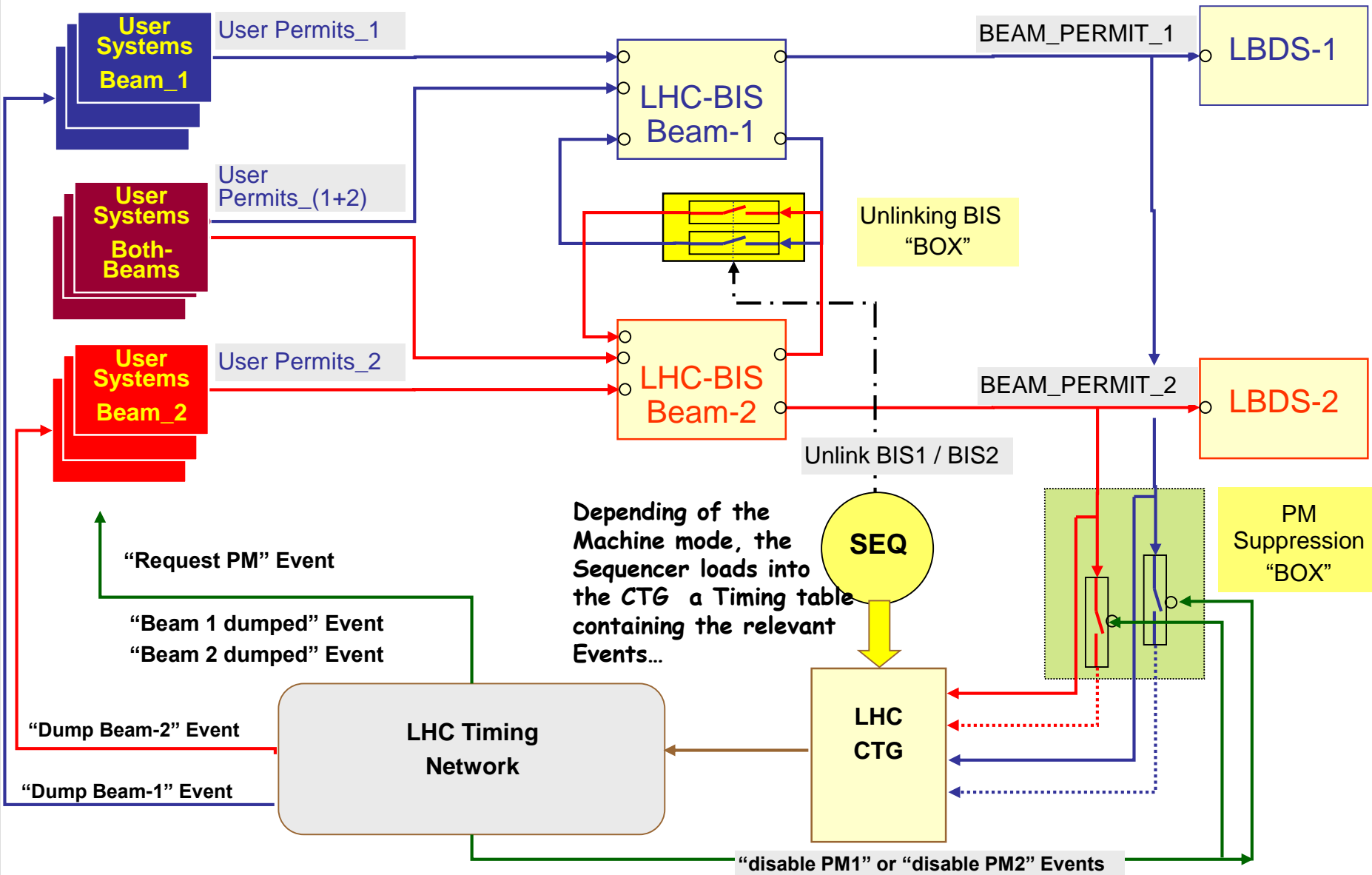   ⇒ Masking should be taken into account during only a short period
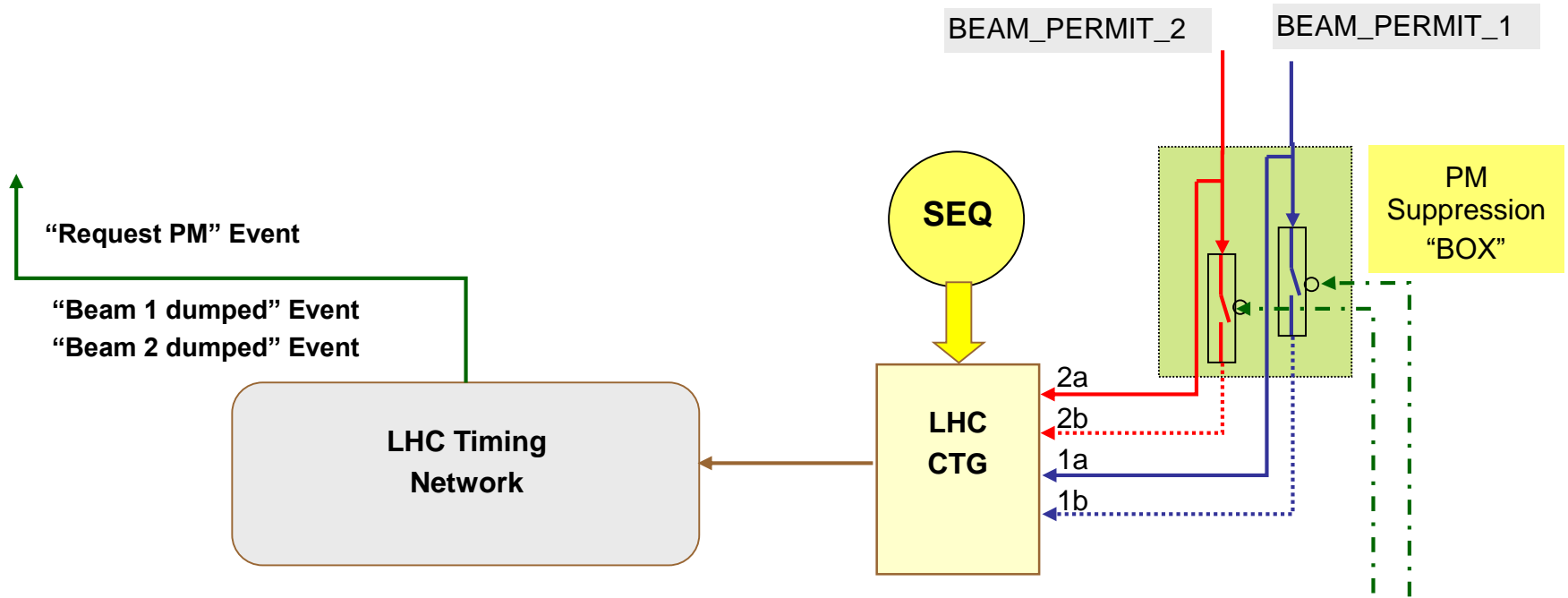
   (2mSec is proposed)

Shown in the next slide

* Inject & Dump, Circulate & Dump, Injection – intermediate, & MD.

** at least the LBDS and the BIS…

BIS & PM Status for MPWG Meeting 30th March 07 / B.P.

User Systems Beam_1

User Permits_1

User Systems Both-Beams

User Permits_(1+2)

User Systems Beam_2

User Permits_2

LHC-BIS Beam-1

BEAM_PERMIT_1

LBDS-1

Unlinking BIS "BOX"

LHC-BIS Beam-2

BEAM_PERMIT_2

LBDS-2

Unlink BIS1 / BIS2

Depending of the Machine mode, the Sequencer loads into the CTG a Timing table containing the relevant Events...

SEQ

PM Suppression "BOX"

"Request PM" Event

"Beam 1 dumped" Event
"Beam 2 dumped" Event

"Dump Beam-2" Event

"Dump Beam-1" Event

LHC Timing Network

LHC CTG

"disable PM1" or "disable PM2" Events

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"Beam 2 dumped" Event is generated when a change is detected on Input 2a (BEAM_PERMIT_2)

"Beam 1 dumped" Event is generated when a change is detected on Input 1a (BEAM_PERMIT_1)

"PM Request" Event is generated when a change is detected on Input 2b or on Input 2b

	Programmed Beam Dump (for 1)	Programmed Beam Dump (for 2)	Emergency Beam Dump
SEQ => **BIS**	the unlinking mode is set		BIS is in linking mode (by default)
	=> Only beam-1 will be dumped	=> Only beam-2 will be dumped	=> Both beams will be dumped

➜ Two Beam Dump types: Programmed BD or Emergency BD

➜ In case of Emergency BD: both beams will be always dumped

➜ Single "PM Request" Event will be broadcasted

➜ Programmed BD (always) managed the LHC Sequencer

    – SEQ will provoke the Beam Dump in using Timing event

    – SEQ will avoid the PM process (via the 'PM suppression box ')

➜ In all cases (Programmed BD or Emergency BD):

"Beam-1 Dumped" and/or "Beam-2 Dumped" events will be broadcasted

→ In case of Beam Dump, the *User Systems* have 2 actions to take:

- Freeze the PM buffers when the "PM Request" is received.

- (possibly) Freeze the BD data when the "Beam-1 Dumped" and/or "Beam-2 Dumped" event(s) is/are received.

Are they achievable?

That's all !