

Realization of the interlocking between SPS, LHC and CNGS and open issues

B.Puccio & B.Todd (AB-CO-IN)

LHC ring, LHC- Inj, SPS ring , Transfer-Lines

1. A CERN-wide generic Beam Interlock System

2. Fast

~70 μ s over 28km

3. Safe

4. High Test Coverage

Requesting Beam Dump = SIL 3

5. Maintainable

6. Monitorable

On startup – ‘As Good As New’

7. Cost Effective

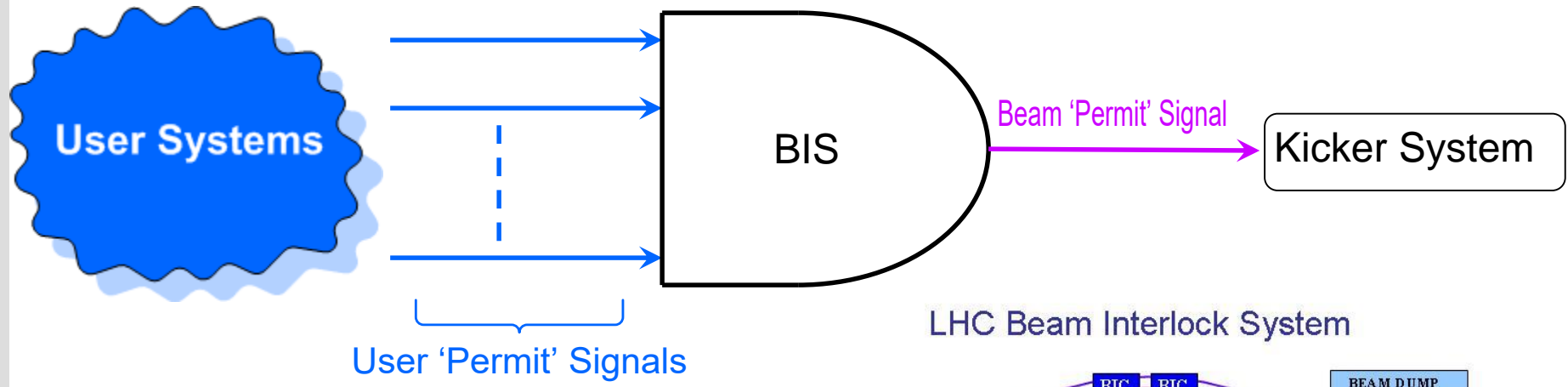
8. Deterministic

Low repair time

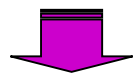
Self-Diagnosing
Provides first Post Mortem info

Protects \$\$\$ but need not be \$\$\$

Know what it's going to do & when



- **16 Beam Interlock Controllers (BIC)**
- **4 fibre-optic channels: 1 clockwise & 1 anticlockwise for each Beam**
- **10MHz Permit Loops generated at IP6**
 - Signal can be cut by any BIC
 - Signal can be monitored by any BIC

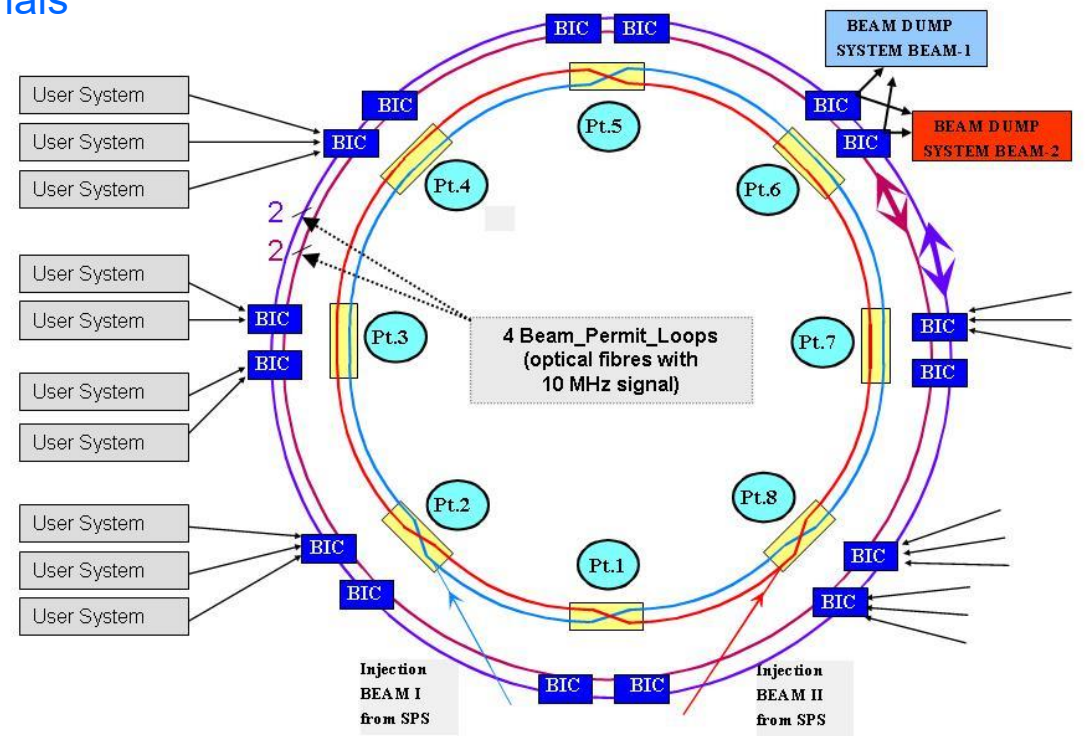


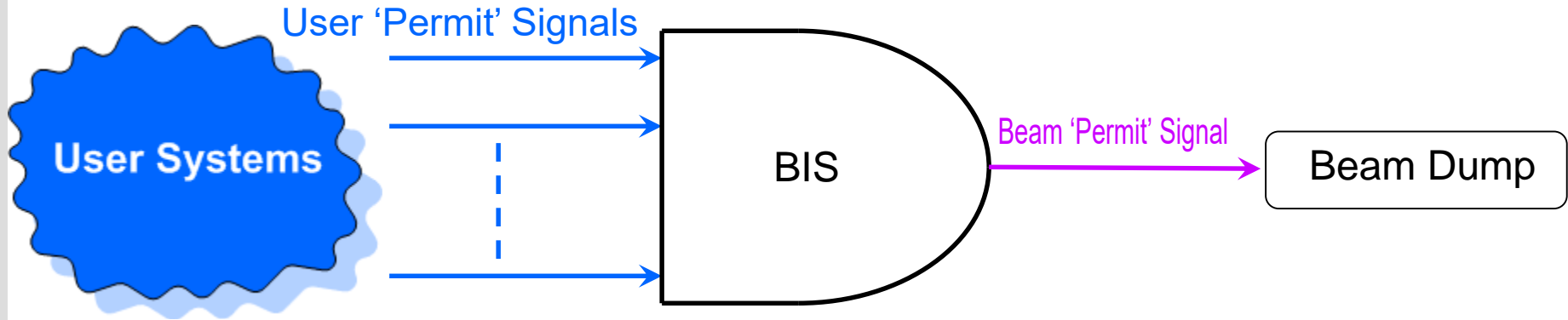
Missing 10MHz triggers BEAM DUMP!

- **Beam-1 / Beam-2 are independent!**
 Some *User Systems* give simultaneous permit.
 Others give independent permit.

■ **~120 User Systems distributed over 28kms**

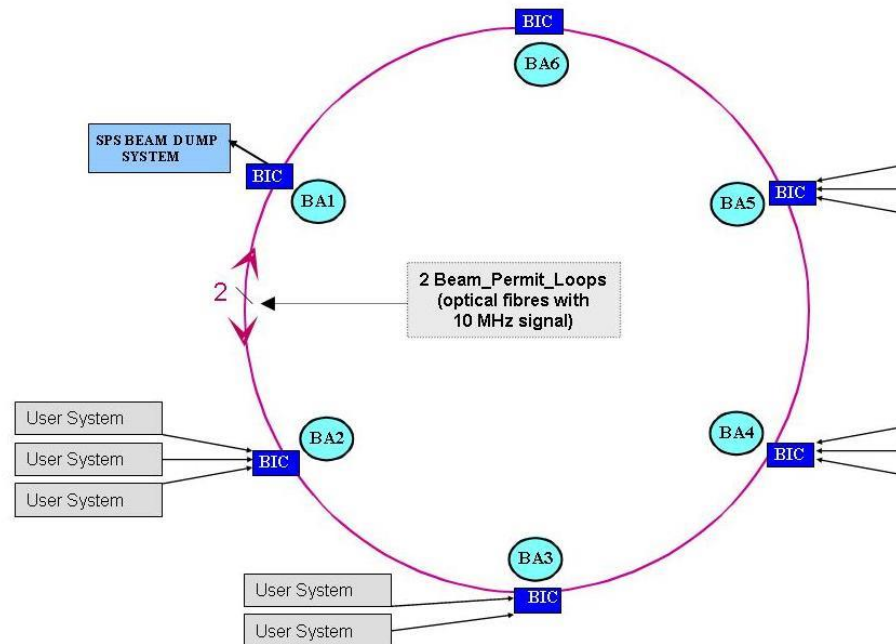
LHC Beam Interlock System

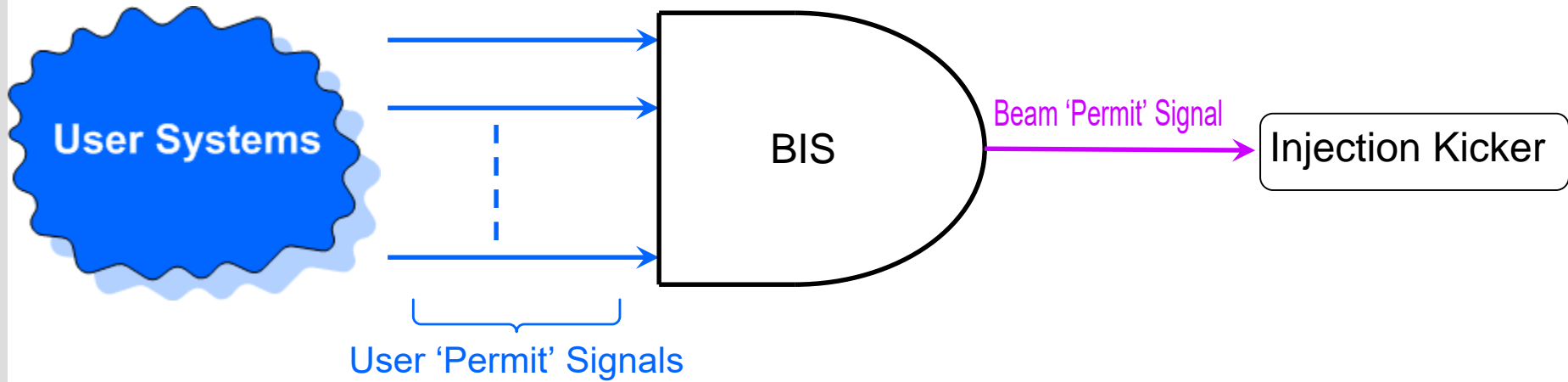




- similar as LHC with only one beam
- 6 Beam Interlock Controllers (BIC)
- 2 fibre-optic channels:
(1 cw & 1 anticw)
- ~30 User Systems

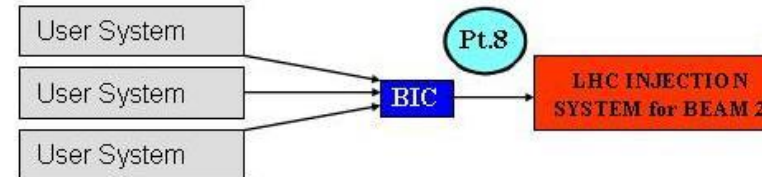
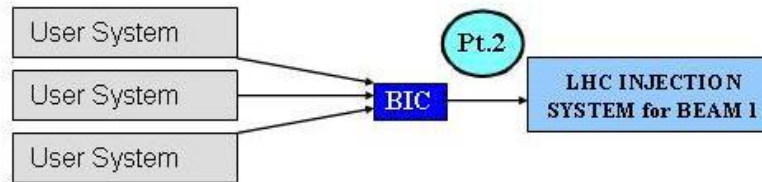
SPS Beam Interlock System

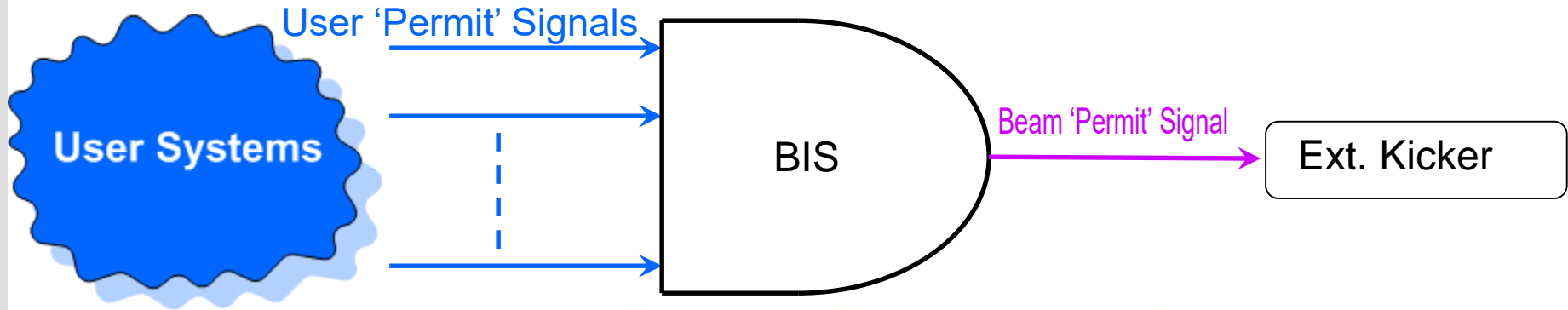




Injection Beam Interlock System

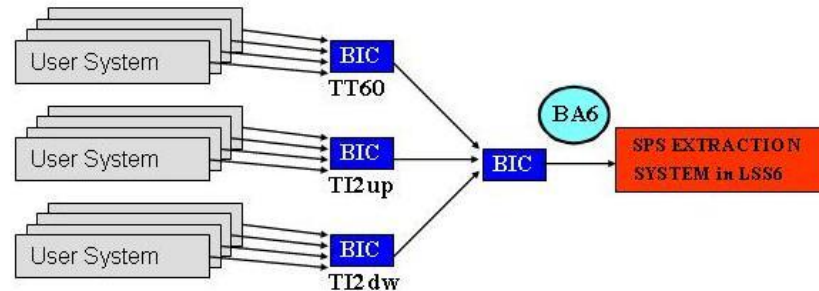
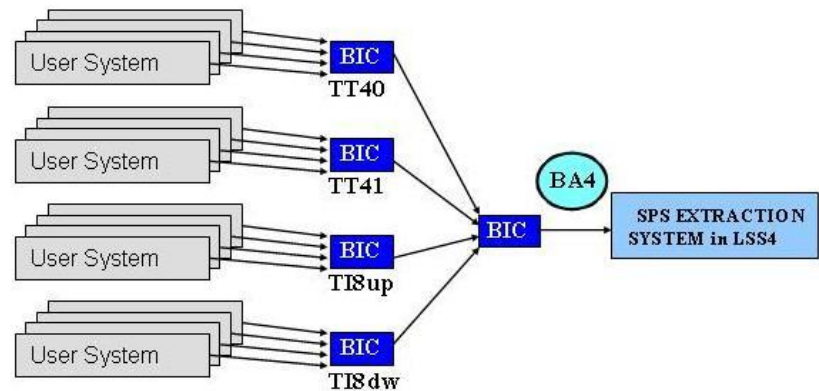
- 1 BIC per Injection region
- fiber-optic or copper outputs are available
- ~20 User Systems

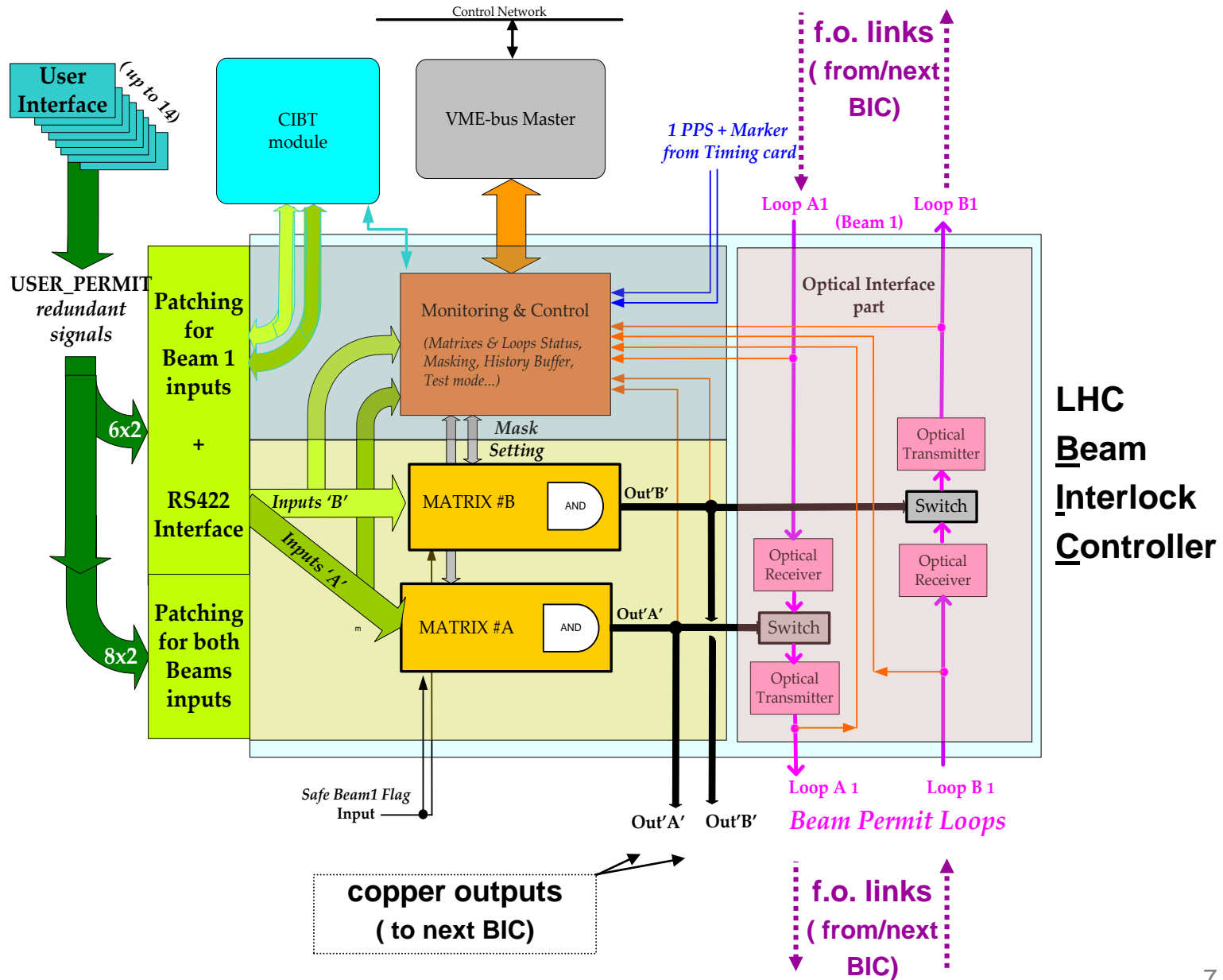


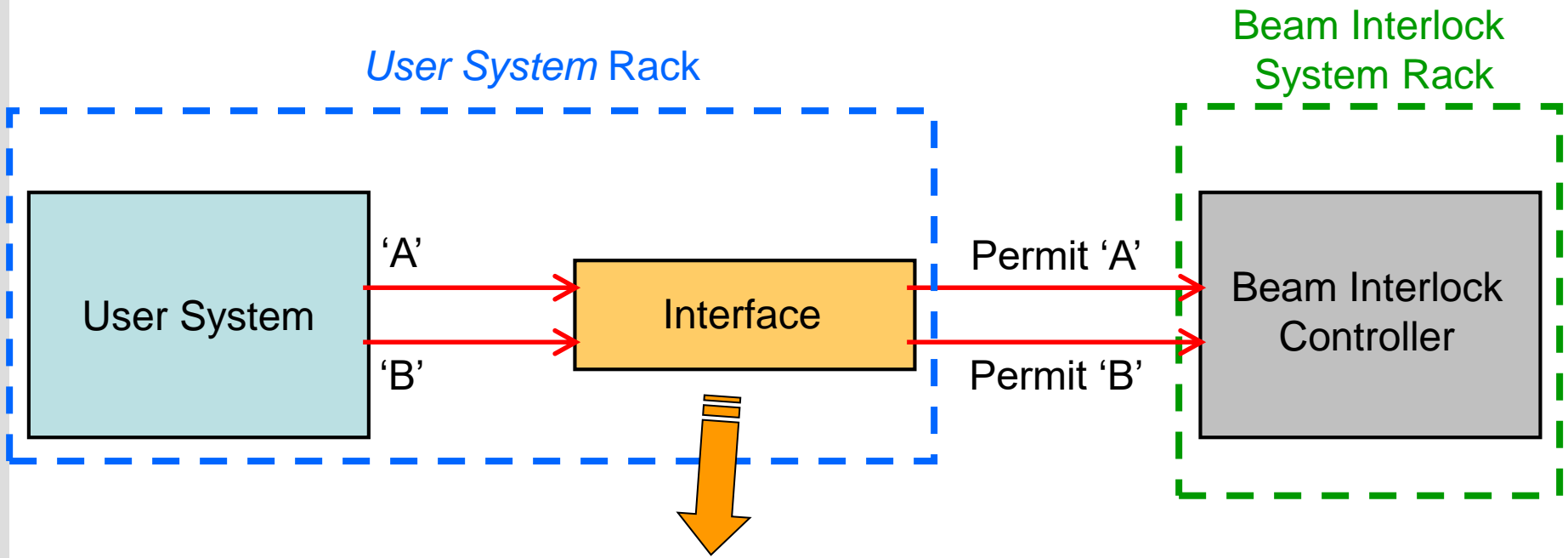


Extraction Beam Interlock System

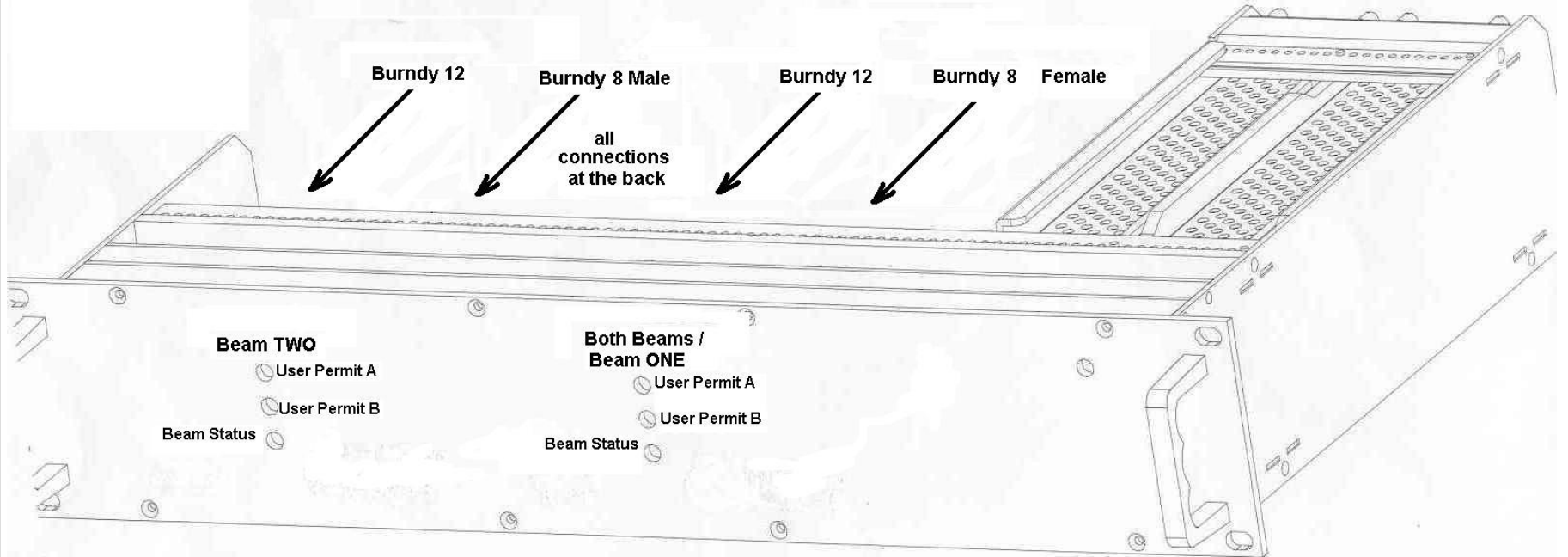
- **several “slaves” BICs**
(each one is managing a part of transfer line)
- **One “Master” BIC per extraction kicker**
- **fiber-optic or copper outputs are available**
- **~60 User Systems in total**

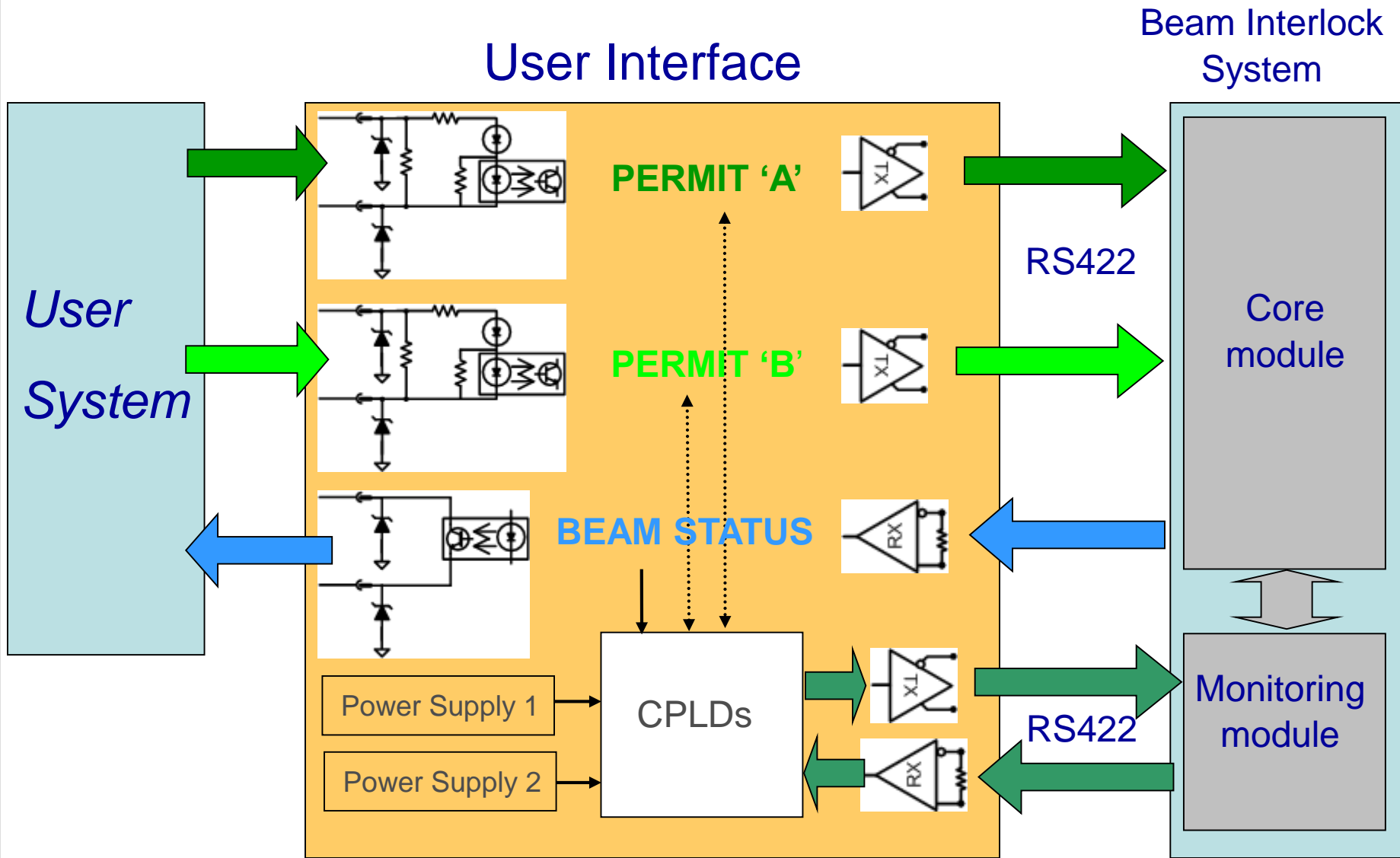




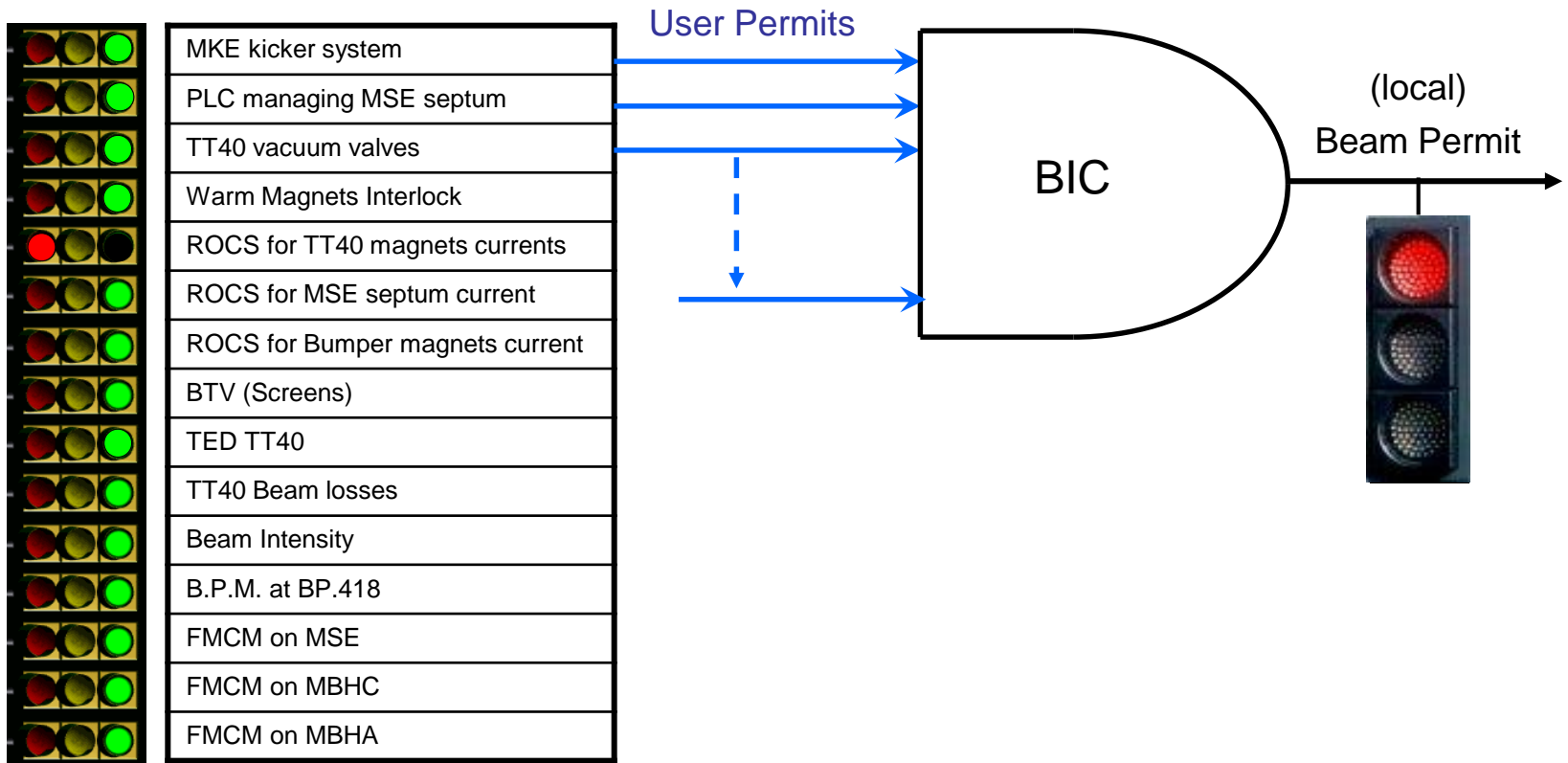


- allows direct connection with many different types of hardware platform
- takes the two USER_PERMIT signals
- transmit them to the nearest BIC in a safe and reliable manner
- using differential signals (RS422 standard) on copper cable: **1.2km distance max.**
- 19" rack mounted board (height of 2U)
- fully redundant Power Supplies
- Hw within the panel can be tested and monitored at distance.





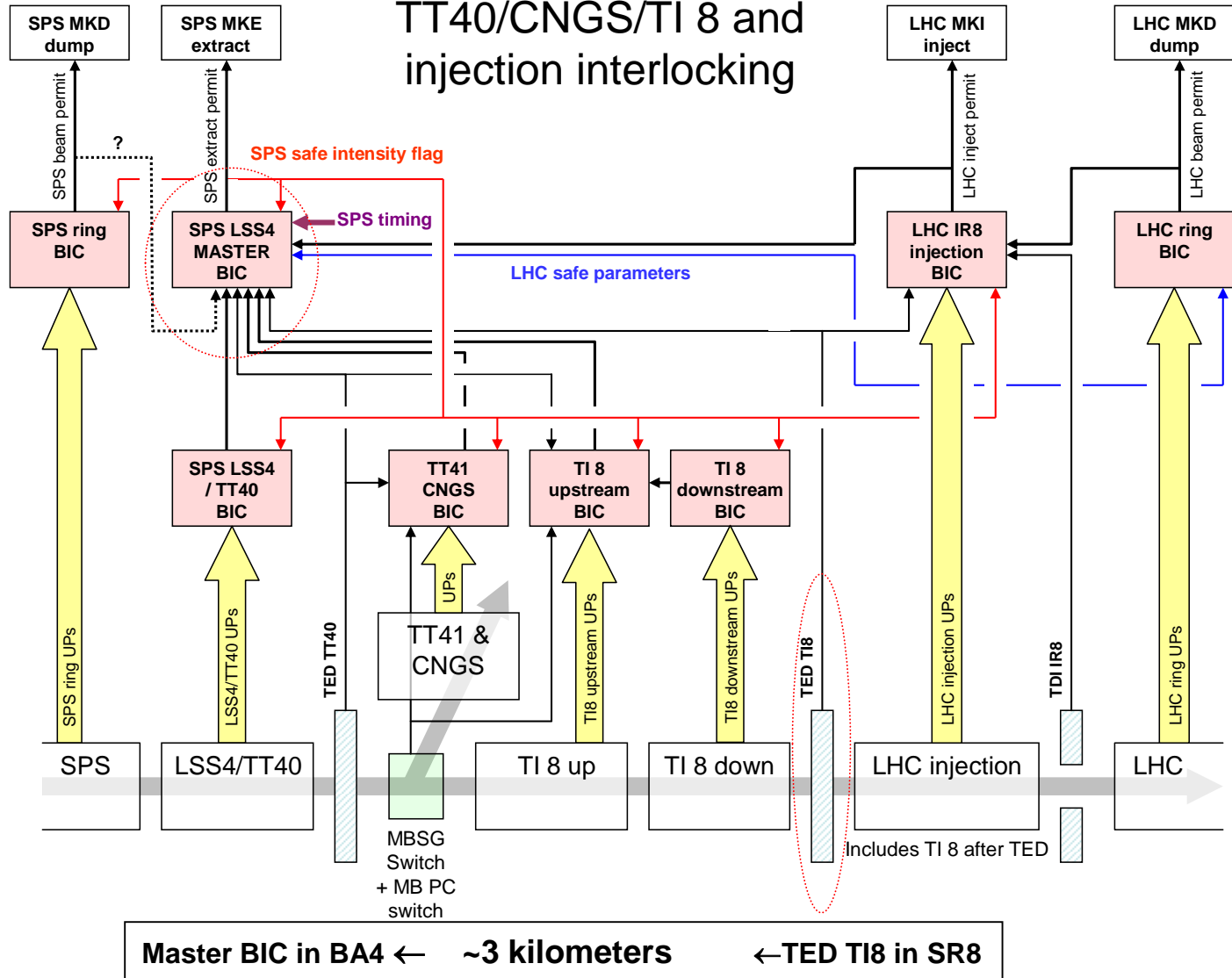
an example with BIC managing TT40:



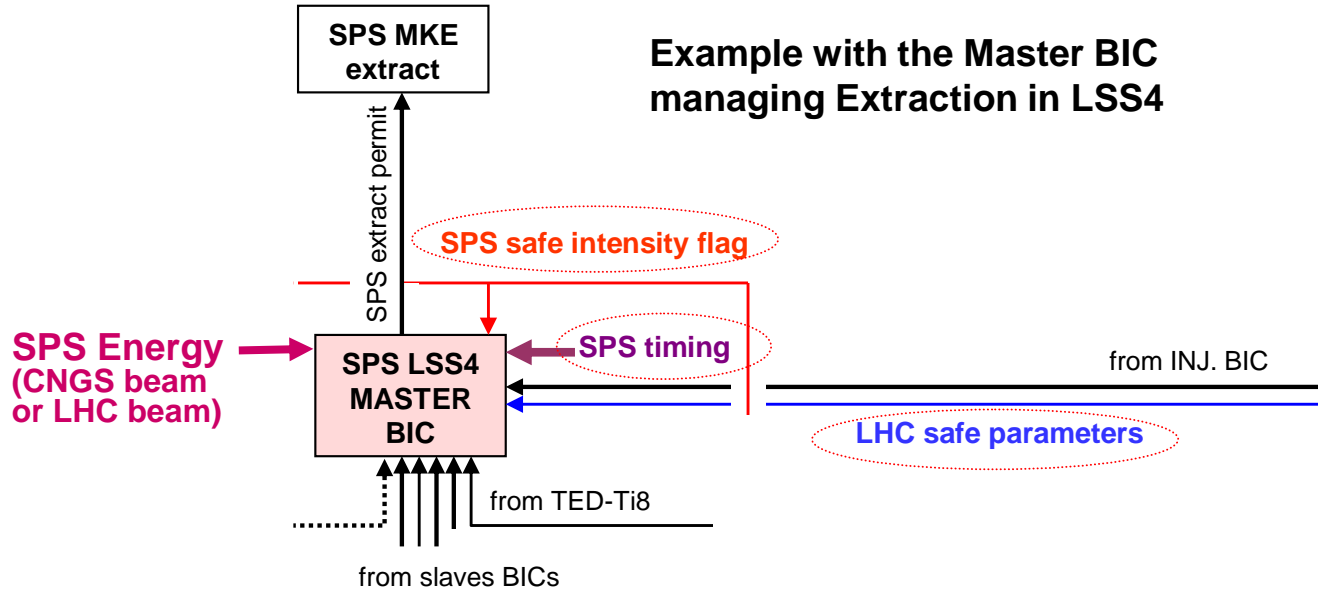
The open issues...

How to transmit User Permits when distance > 1.2km?

Example with the
TT40/CNGS/TI 8 and
injection interlocking



How to “translate” SLP data and Timing frame as User Permits?



How to link the SPS Energy value to the Master-BIC (i.e. as User Permit) ?

Master BIC is diverging from all other BICs

How to perform its commissioning and perform efficient cold check out?

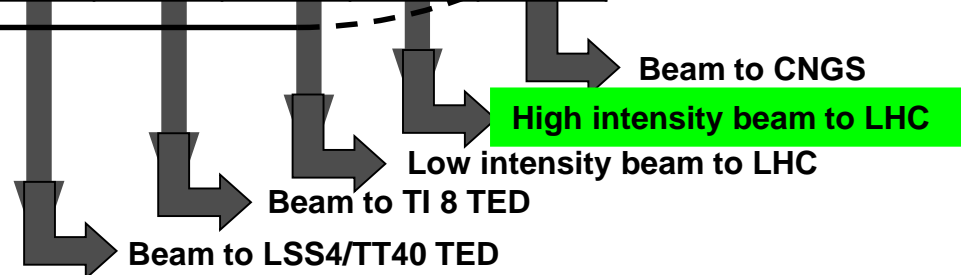
	TT40 User Permits	1	1	1	1	1
	TT41 User Permits	x	0	0	0	1
	TI 8 up and downstream User Permits	x	1	1	1	0
	LHC IR8 injection User Permits	x	x	1	1	x
	TED upstream 'IN beam'	1	0	0	0	0
	TED upstream 'OUT of beam'	0	1	1	1	1
	TED downstream 'IN beam'	x	1	0	0	x
	TED downstream 'OUT of beam'	x	0	1	1	x
	TDI / TCLI in 'PROTECT' position	x	x	x	1	x
	LHC Beam Permit	x	x	x	1	x
	LHC Beam Presence Flag	x	x	x	1	x
	LHC Safe Beam Flag	x	x	x	0	x
	SPS Safe Beam Flag	x	x	1	x	x
	LHC beam type (timing signal)	x	1	1	1	0
	CNGS beam type (timing signal)	x	0	0	0	1

Truth table for Master-BIC in LSS4

Extraction Beam Permit



Distributed information:
 - Safe LHC Parameters
 - Timing frames



- BIC designed for LHC could be “easily” used for interlocking LHC Injection & SPS Extraction
- Generic solution with unique Hw + common SW

(BIC + User Interfaces)

(Monitoring purpose only)

- Redundancy throughout: *User Systems* ⇔ BIS ⇔ Kicker system
- Designed to be Safe, Fast, Monitorable, Deterministic,...
- Simplicity for crucial process ⇔ Effort on monitoring and maintainability
- Cost effective:
 - BIC cards ≅ 6k CHF (VME Crate not included)
 - User Interface ≅ 1k CHF each (connection cable not included)

→ Any problem for interlocking LHC injection

→ Some issues for interlocking the SPS-LHC-CNGS Transfer Lines:

- Technical ones (User System@3km? SLP data=User Permit? SPS Energy=User Permit?)
- Operational one with Master BIC’s commissioning

*That's all
Thank you !*