MPWG meeting 3-10-2003

Beam Interlock System

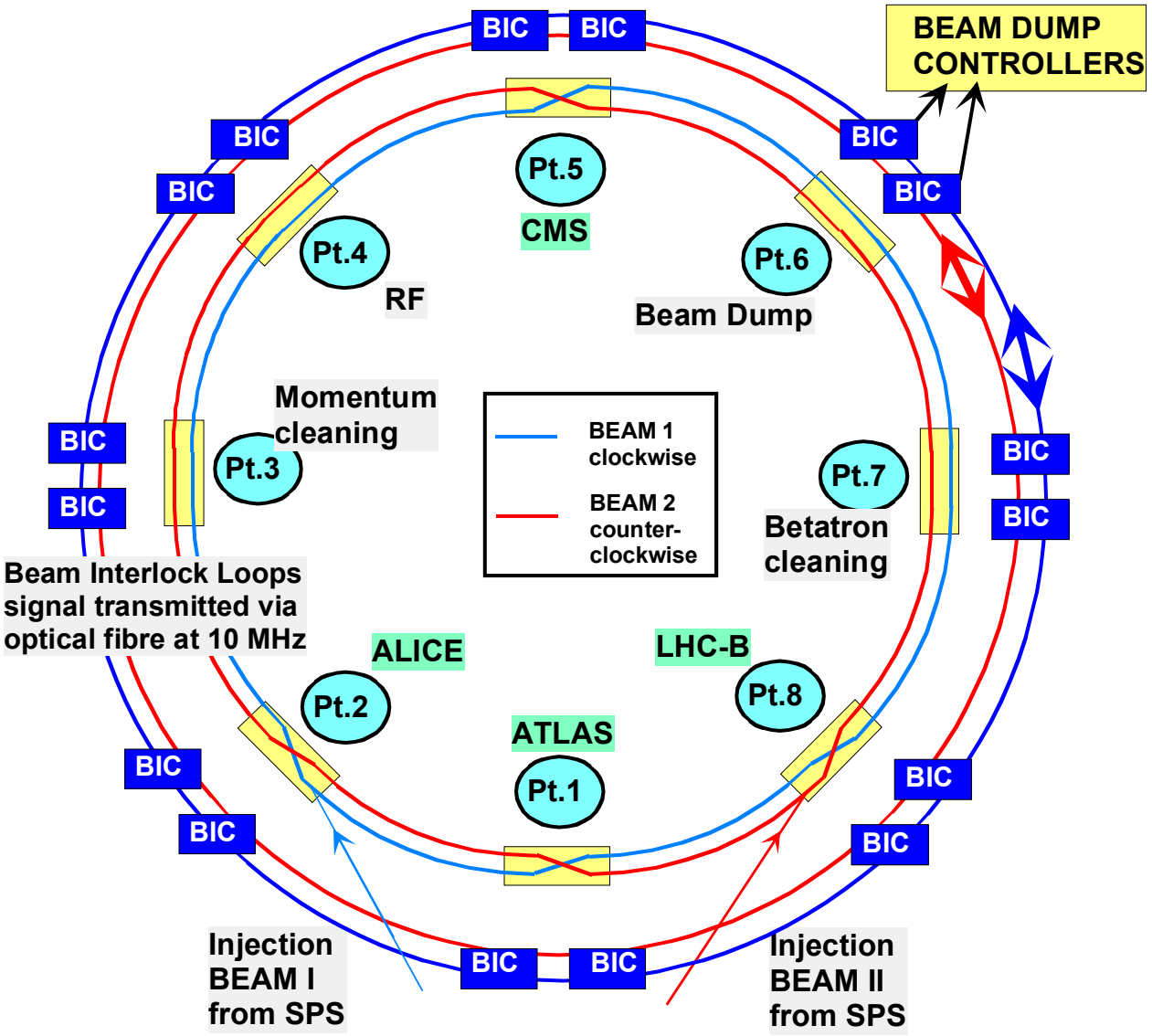
- experience with the Beam Interlock Controller in SPS tests (B. Puccio)
- safety beam and masking of input signals (R. Schmidt)
- general strategy and interfaces to users (R. Schmidt)

Fast detection of magnet failures (M. Zerlauth)

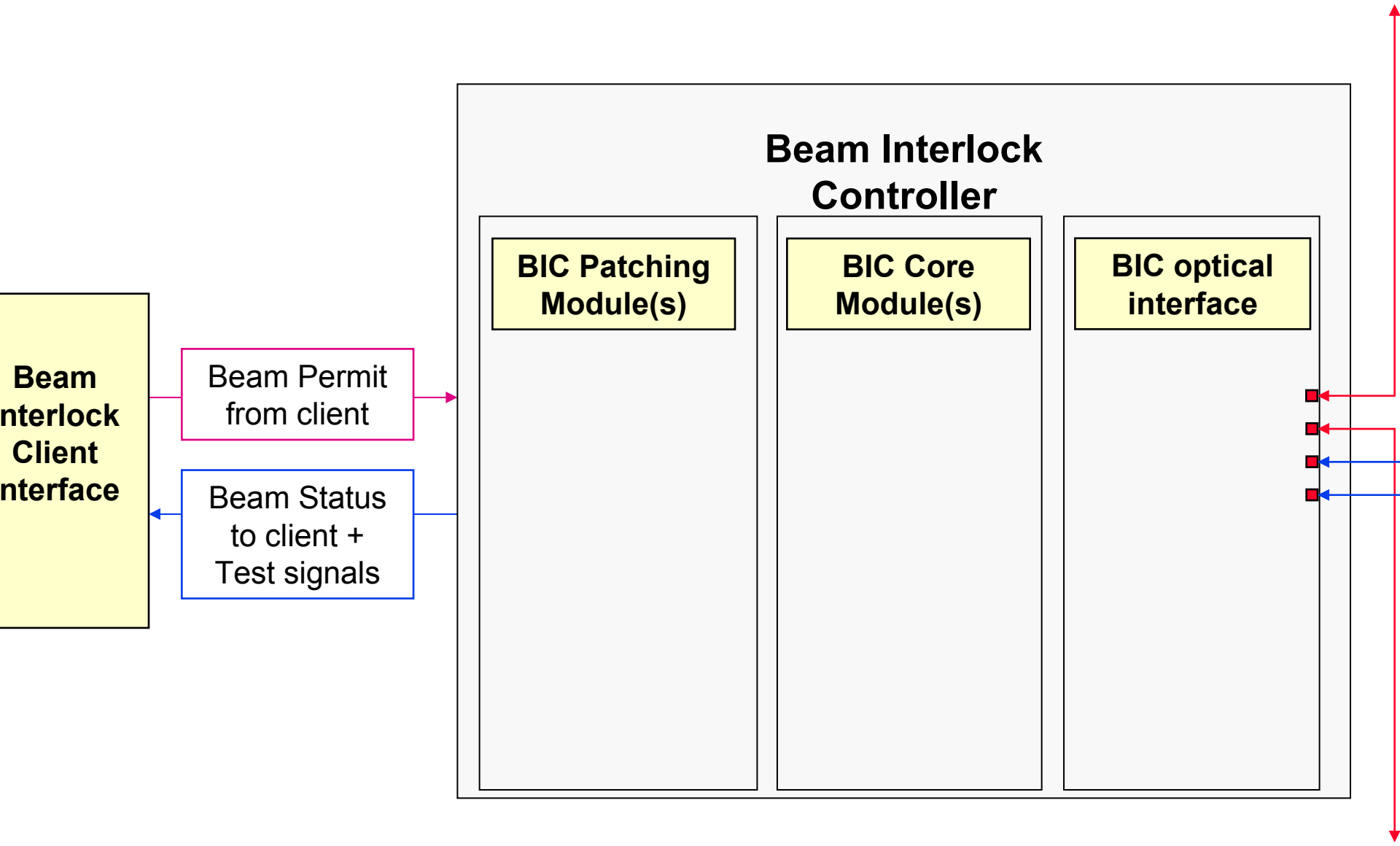
AOB

- News from calculations on heating of collimators in transfer line
- Collimator and material test in SPS extraction line next year
- BCT for beam abort gap monitoring
- Next MPWG: discuss about a review on beam interlocks and associated ystems?

Beam Interlock Control System



Beam Interlock Controller and client interface



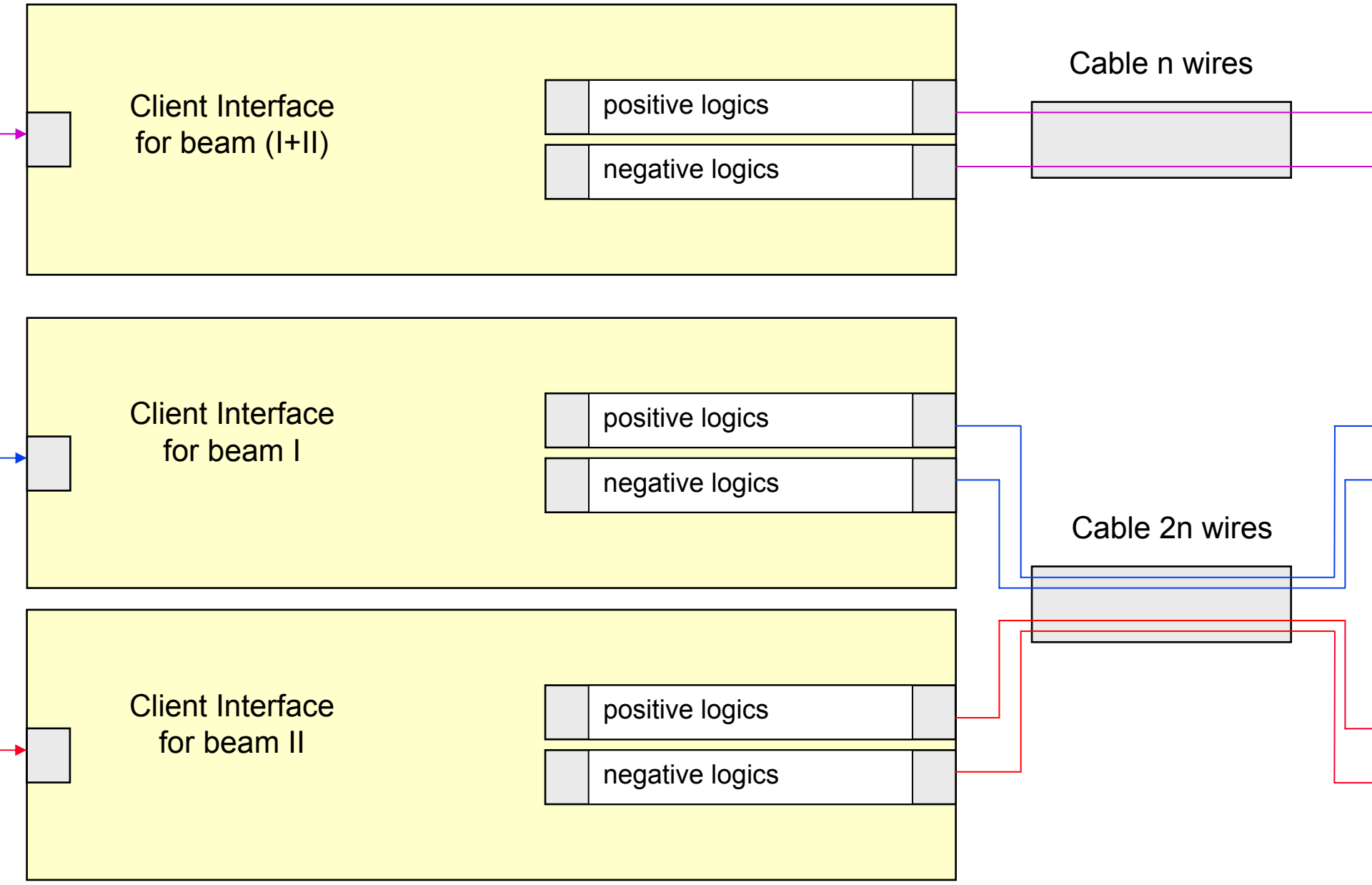
Some general requirements for Beam Interlock System

Collect beam permit signals from clients, and provide one general beam permit signal for each beam

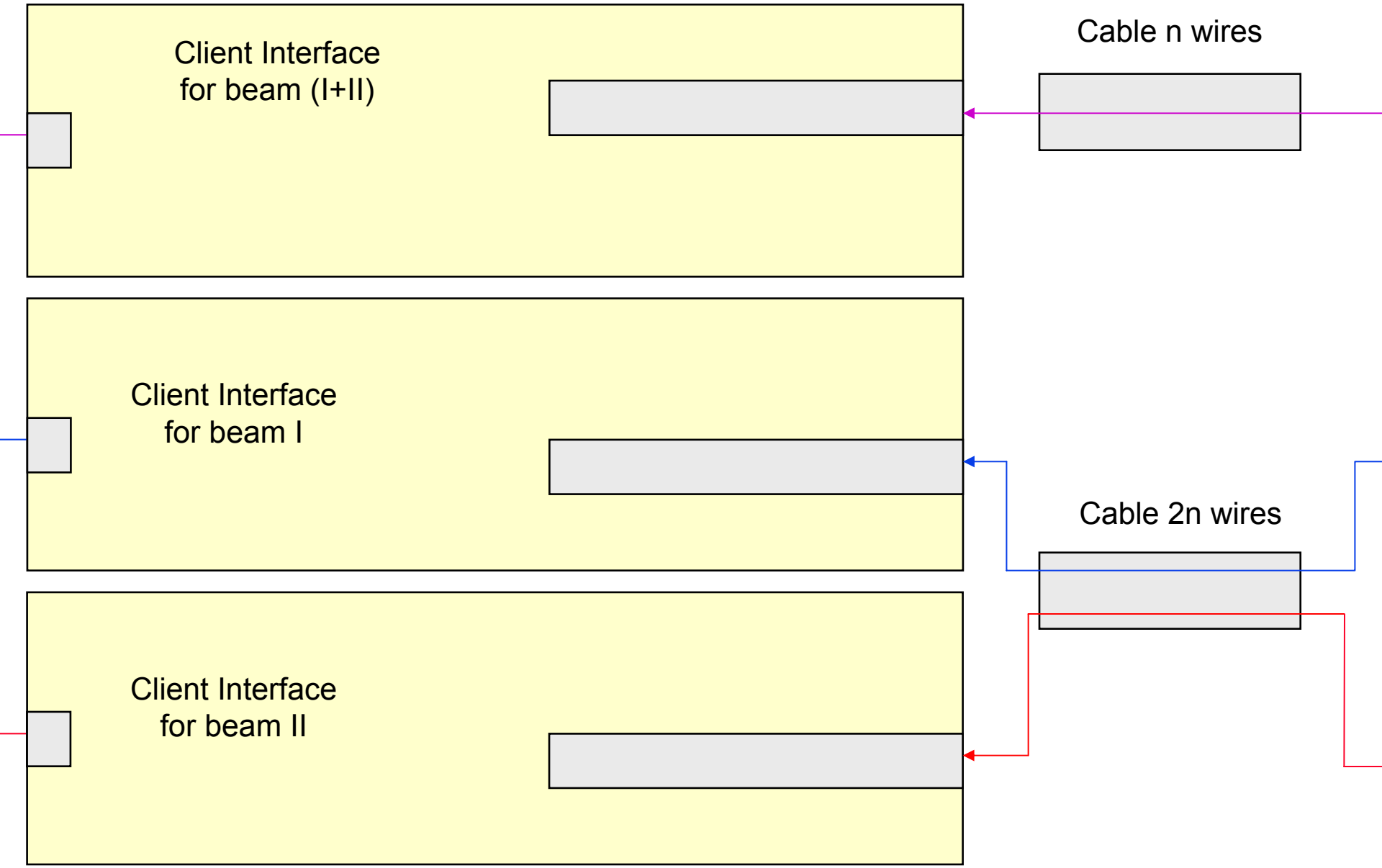
Distribute beam permit signals to clients

- Very high reliability (SIL3)
  - Redundancy (two optical fibres for one beam, in total four in the LHC, optional with two fibres using bi-directional tranceivers)
- Modular: easy to use for SPS and LHC
- Monitoring with time stamping
- Some inputs act on one beam (beam 1 or 2) , some inputs act on both beams - beam (1+2)
- Some inputs must be maskable
  - inputs maskable might depend on beam intensity (new requirement)
  - inputs maskable might not depend on beam intensity
  - how many inputs should be maskable?
- Allow for tests when users are not ready
  - test mode should never result in accidental beam permit

Client interface boxes – signals from clients – one cable per client?



Client interface boxes – signals to clients – how to get from two signals to one ?



General questions for MPWG members

- Who are the clients? For beam I and beam II, or for beam (I+II)? Did we forget anything? Are there possibly future signals?
  - Do we need signals from the injection kicker as input? (maybe not….)
- What signals should be maskable?
- What clients need information on beam permit? At what SIL? One beam – both beams – any beam?

- Safety beam flag or beam intensity? Where to make the flag? Is redundancy required for such flag? We need such flag for each beams.
- Strategy using safety beam flag:
  - for all maskable channels the same ?
  - for each maskable channel to be selected ?

- Interface to injection and extraction (to be discussed with AB-BT - Etienne)
- Operational procedure with beam dump permit? Interfaces to beam dump system to be defined in detail.
  - beam dump not ready – no beam permit
  - beam dump ready – no beam permit – leads to beam abort….

Questions related to beam client interface

- How many types of client interface modules ? Is one type sufficient ?
- Signals to clients: we suggest one signal? Do all such boxes provide beam status information?
- Have one module for each beam? And one module for beam (I+II)?
- Cables: one cable for each beam? one common cable?

BIC hardware and signal from clients

- Some clients give one signal permit / inhibit operation with both beams (max. 7
  - PIC supraconducting magnets, critical and non-critical
  - PIC normalconducting magnets
  - Access
  - Beam Loss Monitors, possibly with two thresholds in BLMs (?)
  - Energy Meter (?)
  - Fast magnet failures
- Some clients give one signal for each beam (max 4)
  - Beam dump system
  - RF system
  - Beam position monitoring and beam lifetime monitoring (to be confirmed)
  - Vacuum system (attention – only partly true – what about common vacuum system in insertions?)
  - Collimators
- Signals can be maskable or nonmaskable
- Within Beam Interlock Control System: Positive / Negative for each type

	BICL1	BICR6
PIC main	1	1
BLM highTh	1	1
NC magnets	1	1
Access	1	1
Fast magnet interlock	1	1
Energy meter	0	1
Experiments	1	0
PIC aux	1	1
BLM lowTh	1	1
	8	8
Beam dump	0	1
Vacuum	1	1
Injection	0	0
RF	0	0
Beam monitors	0	1
Collimators	1	1
	2	4
Beam dump	0	1
Vacuum	1	1
Injection	0	0
RF	0	0
Beam monitors	0	1
Collimators	1	1
	2	4

Examples

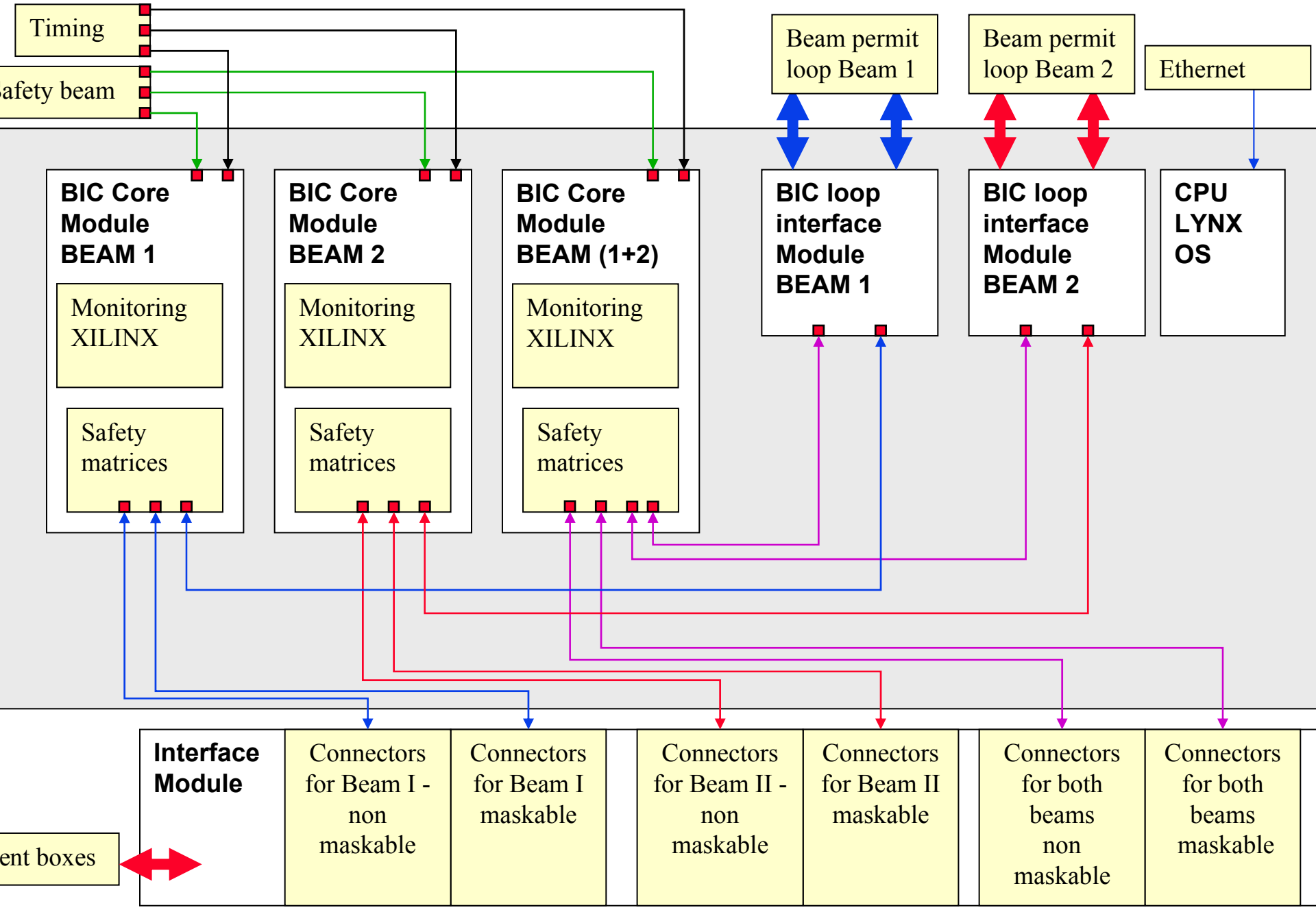
BIC	IR1L	IR6L
Client signals that act on both beams	7	7
Client signals that act on both beams and are maskable	3	5
Client signals that act on both beams and are not maskable	4	2
Client signals that act only on beam I	2	4
Client signals that act only on beam I and are maskable	1	2
Client signals that act only on beam I and are not maskable	1	2
Client signals that act only on beam II	2	4
Client signals that act only on beam II and are maskable	1	2
Client signals that act only on beam II and are not maskable	1	2

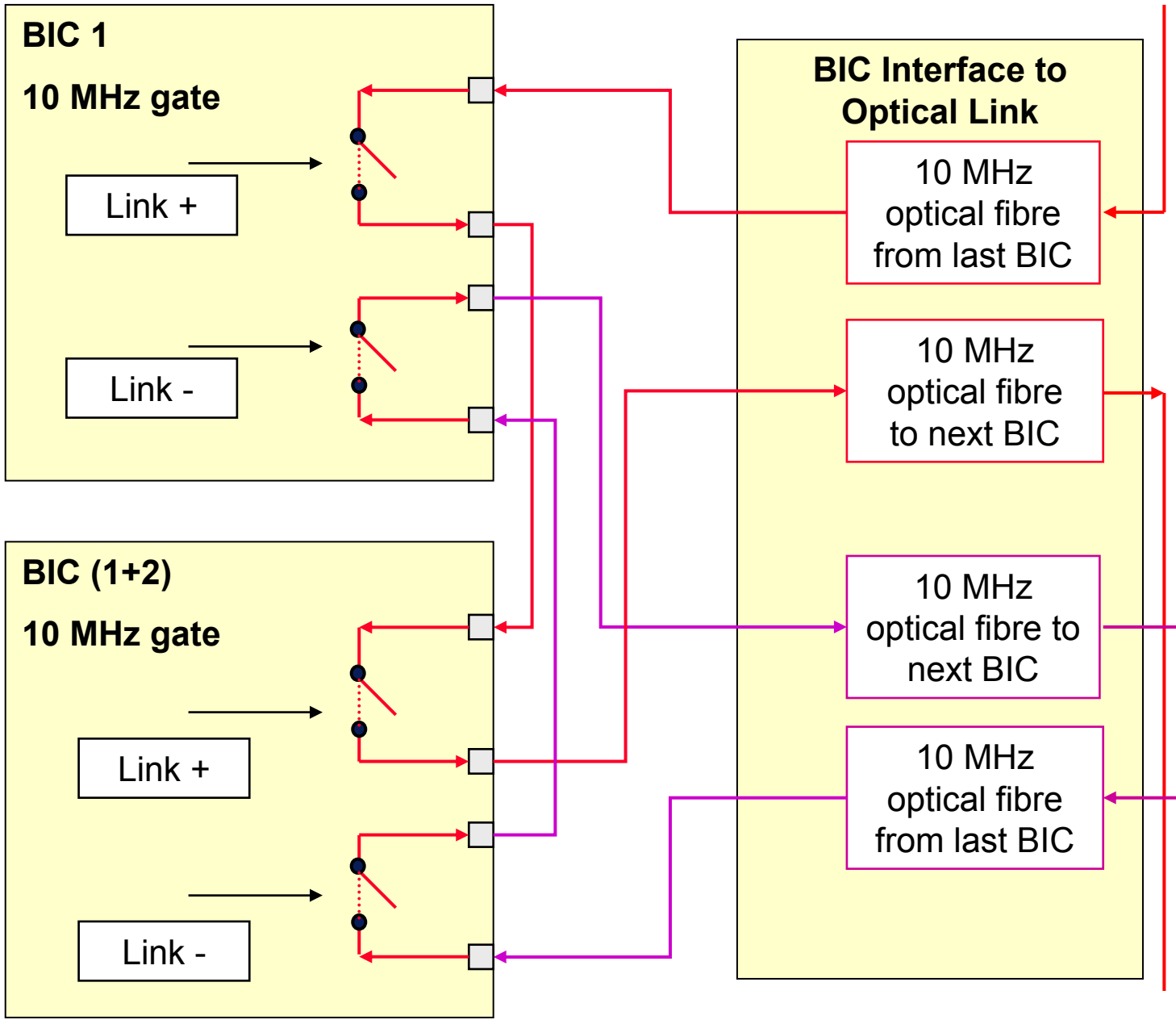
	BICL1	BICR1	BICL2	BICR2	BICR3	BICL3	BICR4	BICL4	BICR5	BICL5	BICR6	BICL6	BICR7	BICL7	BICR8	B
PIC main	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
BLM highTh	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NC magnets	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	
Access	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Energy meter	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	
Experiments	1	1	1	1	0	0	0	0	1	1	0	0	0	0	1	
PIC aux	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
BLM lowTh	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	7	7	7	7	6	6	5	5	7	7	7	7	6	6	7	
Beam dump	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	
Vacuum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Injection	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
RF	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	
Beam monitors	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	
Collimators	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	
	2	2	2	3	2	2	3	2	2	2	4	4	2	2	2	
Beam dump	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	
Vacuum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Injection	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
RF	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	
Beam monitors	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	
Collimators	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	
	2	2	2	3	2	2	3	2	2	2	4	4	2	2	2	
Sum total	11	11	11	13	10	10	11	9	11	11	15	15	10	10	11	
Beam I+II + Beam II	9	9	9	10	8	8	8	7	9	9	11	11	8	8	9	
Beam I+II + Beam I	9	9	9	10	8	8	8	7	9	9	11	11	8	8	9	
Beam I+II + Beam II unmaskable	5	5	5	5	5	5	4	4	5	5	7	7	5	5	5	
Beam I+II + Beam II maskable	4	4	4	5	3	3	4	3	4	4	4	4	3	3	4	

BCT for machine protection

- Specification being written by C.Fischer within BISpec
- Possible uses of BCTs for machine protection to provide safe information on beam intensity:
  - minimum intensity of circulating beam is required to inject high intensity beam from the SPS
  - 'safety beam flag' for masking / unmasking client signals to beam interlock controller
  - if dI/dt or (dI/dt · E) drops below a specified value => dump beam
- Consequences:
  - BCT becomes instrument of SIL class (my guess: SIL2)
  - Distribution of beam intensity or/and beam intensity flag around LHC, and to SPS
- Assumptions + Questions:
  - I guess, BDI is responsible for the BCTs
  - Who is responsible for making the safety beam flag?
  - Who is responsible for the distribution of the flag?
  - This is more of less identical to the distribution of the info from the beam energy meter – one should use same technology

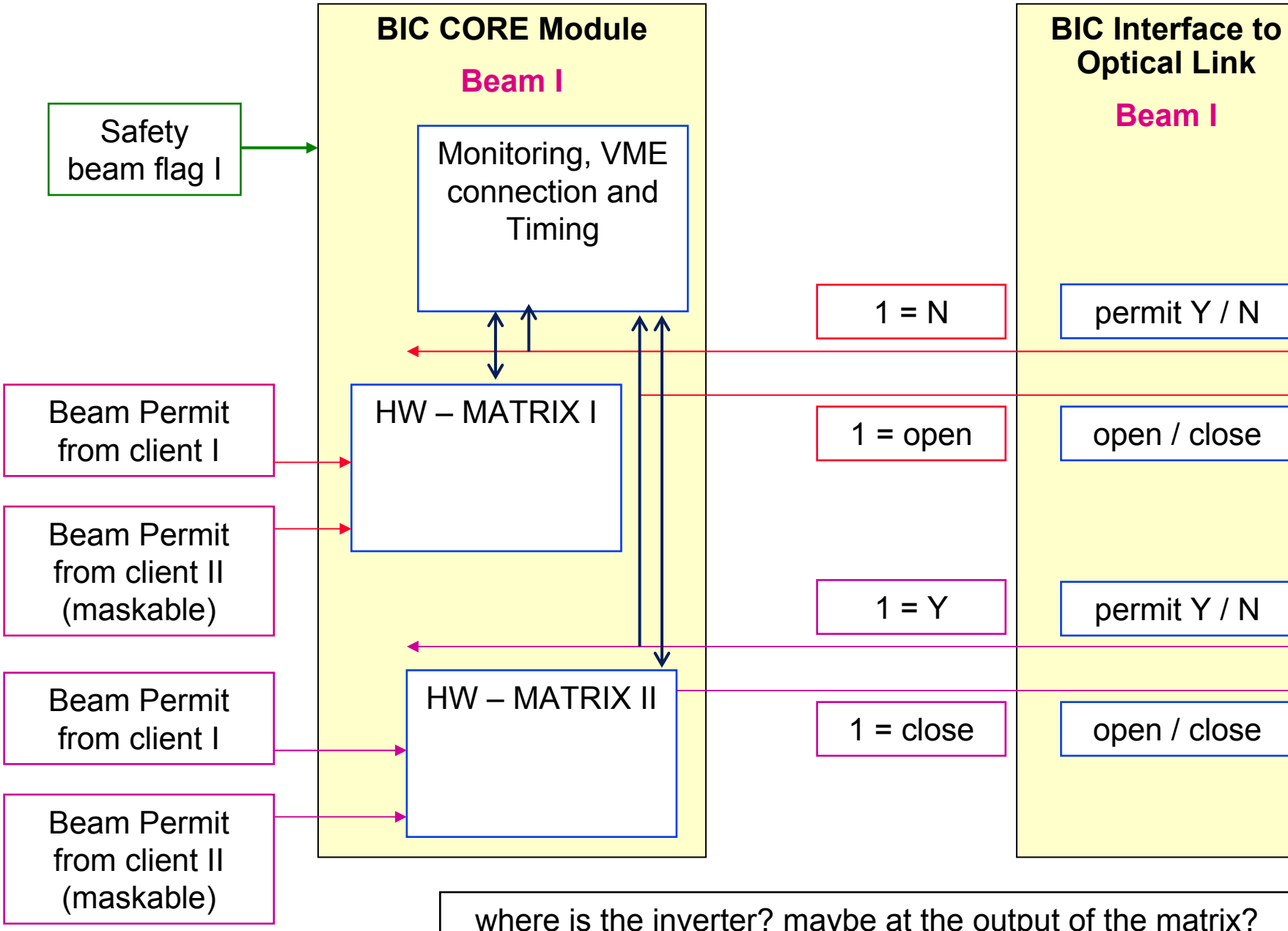
VME crate - layout for the LHC – three core solution





Two gate modules in series

BIC core for beam I (same for beam II)



where is the inverter? maybe at the output of the matrix?

Masks and safety beam flags

- Some signals cannot be masked

- Some signal can be masked. There are three options to be selected by the operator:
  1. no mask (default option)
  2. mask only for « safety beam » - that means for low beam intensity (for high beam intensity signal is NOT masked)
  3. mask independent of beam intensity (can be risky)

Inputs for one core module

- 8 signals from clients, positive
- 8 signals from clients, negative
- 1 signal from beam safety flag, to be split for positive and negative branch
- 2 signals from beam permit loop
- 4 masks
- 4 conditions for masking

- Drive signals across line? YES
- Does the patching module need active components? YES
- Send permit signals to all clients?

Interface to clients: Tests

- It should be possible to test the entire systems without relying on the users
  - all user input signal need to be set to 0 or 1
  - is it necessary to address both redundant signals? **YES**
  - is it necessary to do this for each beam in an independent way? **YES**
  - how to do it?
  - how to avoid that the system is in test mode during beam operation?
- Test if redundant signals are both ok (synchronisation issue, since one signal will always come first)
- For each beam, one BICI, or for both beams one BICI ?
  - some users act always on both beams (PIC, BLM, access, …)
  - some users act only on one beam (Vacuum, RF, SPS, beam dump, …)

Questions for beam core module

- Two BIC core modules, one for each beam – in one VME crate, or in two VME crates?
- Alternative: have one core modules for each beam, or mixed core modules?
- Number of inputs: total number, maskable, conditional masks …. to be defined
- Strategy using safety beam flag:
  - for all maskable channels the same
  - for each maskable channel to be selected
- At what level to monitor the signals towards the users (in core module, in BICI?)