SL/BI
Timing requirements for LHC

➢ Timing Classification

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➢ LEP Beam instrumentation Timing overview

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Classification

A) Millisecond based machine timing :   (Slow Timing)
    Actual features provide by TG8.
    With detailed machine status (pilot pulse, injection nb, energy level, etc...)
    With Time of day : sec. > x μs (GPS) ?
    For archiving of data.

B) Beam Synchronous distributed commands :
    Injection Warnings, Instrument triggers, Real time settings
    Post Mortem Synchronisation to freeze acquisitions
    With Cable length delay compensation

C) Revolution Frequency (11KHz) :
    With Cable length delay compensation
    With Local Turn Nb identification & selection

D) Bunch Frequency   (40 MHz) :
    With Internal delays compensation
    With Batch Nb identification or selection
    With Bunch Nb identification or selection

E) Radio Frequency (400 MHz) :
    With RFcounter reset

Item	Time Resolution
A) Millisecond based machine timing	1 ms
With Time of day (GPS)	50 μs
B) Beam Synchronous distributed commands	10 μs
C) Revolution Frequency (11KHz)	5 ns
D) Bunch Frequency (40 MHz)	5 ns
E) Radio Frequency (400 MHz)	100ps

Summary List of SL / BI Instruments   (See LHC- Project Note 144)

	Designation	Code	Detectors Location	Total Number	Acquisition Crates Location	Number of Crates	Timing Requirements
Transfer Lines TI2 & TI8	**Beam Loss Monitor** **Beam Position Monitor** Screen	**BLMI** **BPMI** BTVI	**distributed outside line** **distributed along line** distributed along line	**20 per line** **62 in TI2 48 in TI8** 10 per line	**Spread** **Along lines**	**16 in TI2** **12 in TI8** 2	**A , B, C, D** **A , B, C, D** A , B
Injection Points	Screen	BTVI	upst. or downst. MSI/MKI/TDI 1 downst. IP between Q5&Q6	4 / injection point 1 / injection point	US 25 / US 85	2	A , B
Two Dump Lines	Scintillator Screen Collimator	BSCD BTVD TCD	1 downst. Dump block TDE up. or downst. MSD/MKB/TDE 1 upstr. Q4 in the ring	1 per dump line 4 per dump line 1 per ring	US 65	2 2 1	A , B A , B A , B
Two Rings	**Beam Loss Monitor** **Beam Position Monitor & 4 strip lines**	**BLM** **BLMC** **BPM** **BPMS**	**around each quadrupole** **around collim. Blocks in IR3&7** **At the end of each quadrupole**	**~ 2000 per ring** **~ 25 per ring** **486 per ring** **16 for 2 rings**	**Spread** **Around tunnel**	**247**	**A, B, C, D**
	Pick-up for Specific use	BPXX	Around IP4	~ 10 per ring	US 45	10	A , B , C , D , E
	New Profile Monitor Synchro. Rad. Telescope	BISH/V BSRT	at Q3 in IR4 downst. D2 in IR1 (or IR5)	1 H &1 V per ring 1 per ring	US 45 US 15	1 1	A , B , C A, B, C, D
	Wire scanner	WSH/V	in IR1(or IR5) & at Q3 in IR4	2 H & 2V per ring	US 15 , US 45	2	A, B, C
	Screen for Single Turn+ Screen for B Matching	BTV BTVM	in IR1 , 2 , 3 , 4 , 5 , 6 , 7 & 8 at Q3 in IR4	8 per ring 1 H &1 V per ring	In 8 US or UJ US 45	8 1	A , B A , B
	Luminosity Detector	LUM	In IR 1 , 2 , 5 , 8	4 per ring	In 4 US	8	A , B , C , D

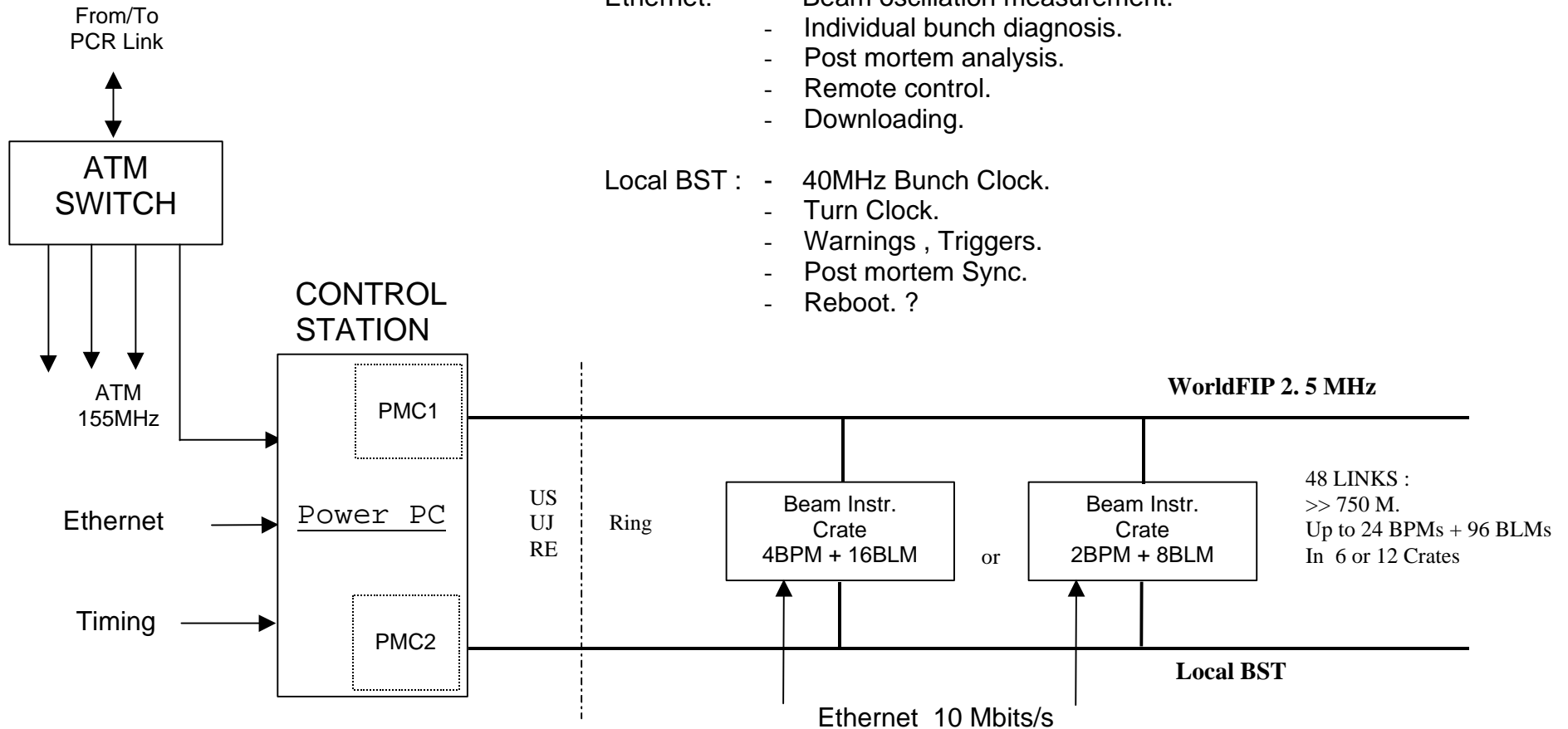➢ **Major requirements : BLM & BPM**

➢ **Specific requirements : Around IP4**

BPM / PLM Control in LHC Tunnel (First proposition)

WorldFIP: -   10Hz Real-time orbit correction acquisition.

Ethernet: -   Beam oscillation measurement.
             -    Individual bunch diagnosis.
             -    Post mortem analysis.
             -    Remote control.
             -    Downloading.

Local BST : -   40MHz Bunch Clock.
             -    Turn Clock.
             -    Warnings , Triggers.
             -    Post mortem Sync.
             -    Reboot. ?

From/To
PCR Link

ATM
SWITCH

ATM
155MHz

Ethernet

Timing

CONTROL
STATION

Power PC

PMC1

PMC2

US
UJ
RE

Ring

WorldFIP 2. 5 MHz

Beam Instr.
Crate
4BPM + 16BLM

or

Beam Instr.
Crate
2BPM + 8BLM

48 LINKS :
>> 750 M.
Up to 24 BPMs + 96 BLMs
In 6 or 12 Crates

Local BST

Ethernet 10 Mbits/s

! Objective : Combine data flow in one medium and without using optical fibre in tunnel !

Reuse of LEP BST (Beam Synchronous Timing) ?

Short Description of BST System :

Goal: Synchronise instruments together and/or with events.

Sequence of broadcast message at revolution frequency from a master to all instruments.

Transmission clock rate : ~ 2.9 MHz = Revolution frequency * 256 carry out by a PLL.

Transmission media : Single mode 1310 nm F.O. network from PCR to US / UJ and RE.

BST MESSAGE BIT ALLOCATION

Header	S.R.	T.C.R.	Hardware	Software	Stop
12 bits	1 Byte		2 Bytes	5 .. 13 Bytes	1 bit
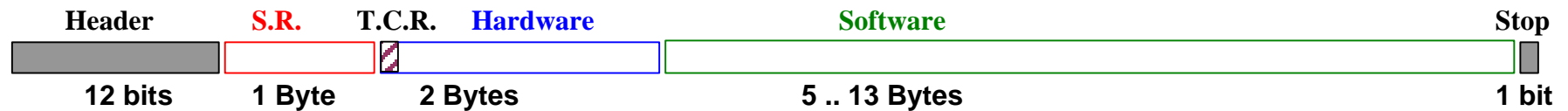
BST MESSAGE ASSEMBLER (BSTMaster)

- **Continuous transmission of one message per cycle (88.924 μs)**
- **Master scans a list of instruments controlled by tasks.**
- **A task is a sequence of predefined messages controlled by events.**
- **An event could be an external trigger, GMT event, Service Request, internal event, etc…**
- **Transmitted message = "OR" of empty message and current message of all instruments +**
- **Set Turn Clock Reset bit every 2^{15} turns.**

BST MESSAGE RECEIVER (BSTI + BSTR)

- **Return message with service request if any.**
- **Put message in a temporary memory and wait x ~ 43 ns step delay.**
- **Send Local Turn Clock & Hardware message on an output connector.**
- **Count turn. (Reset counter if TCR)**
- **If subscripted (Masked), Send Software message in local FIFO and send an IRQ to the CPU.**

BST update to cover SL/BI requirements for LHC :

➤ Redesign a PLL .
    40 MHz Free Run Frequency.
    40 MHz Bunch clock recovery.

➤ Extend distribution around LHC tunnel & transfer lines.
    50 Ohms cables or optical fibre transmission ?
    Simplex or duplex in tunnel ?

➤ Redefine message partitioning.
    Increase the number of bytes up to 16.
    Include new fields for machine status, SSC number, etc....

➤ Update BSTI
    Include BSTR functionalities & new features.
    Conserve VME format or new design in mezzanine card ?