Specification

	Measurement	Specification
LINAC LTB BTS	Beam position	Resolution 100 μ m@2Hz
	Beam profile	Resolution 200 μ m@2Hz
	Bunch charge	Relative accuracy 2%
	Energy	Relative accuracy 0.1%
	Emmitance	Relative accuracy 10%
BS	Beam position	Resolution 100 μ m@1.67MHz
	Beam profile	Resolution 200 μ m@2Hz
	DC current	Resolution 50 μ A@10kHz
	Tune	Resolution 0.001
SR	Beam position	Resolution 10 μ m@694kHz Resolution 1 μ m@10kHz
	Beam profile	Resolution 10 μ m
	Beam length	Resolution 2ps
	DC current	Resolution 10 μ A@1Hz
	Tune	Resolution 0.0001

	LINAC	LTB	BS	BTS	SR
Stripline BPM	3	3	50	5	
Button BPM					152
PCT			1		2
WCM	5	2	1	3	
PM	5	3	4	4	2
ICT	1			1	
Faraday cup	1				
Tune monitor			1		1
Slit		2		1	
Scraper					2
Diag beamline					1
MBTF					1
Orbit feedback					1

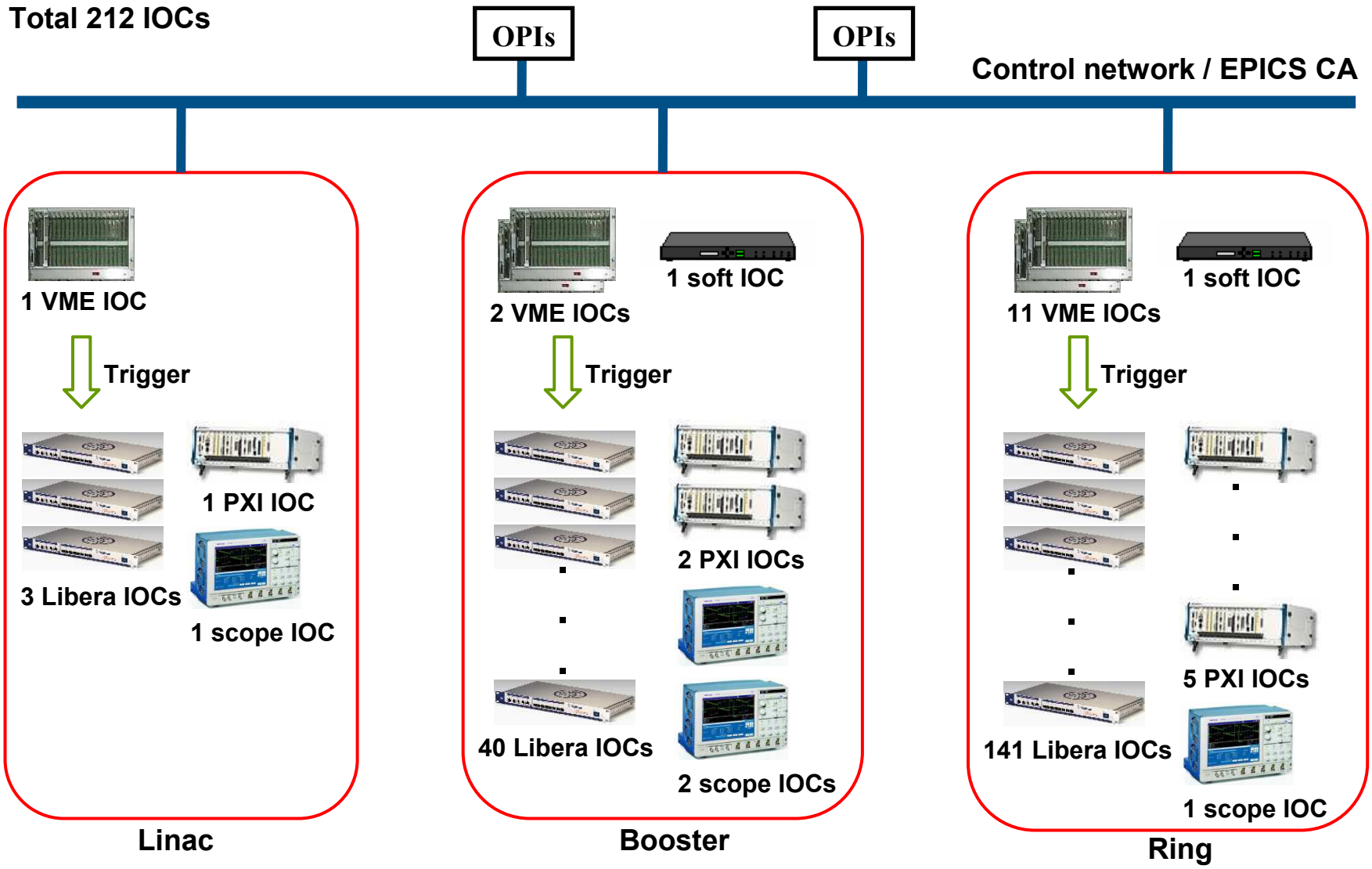
Solution

subsystem	Sensors	Electronics	DAQ/Control
Beam position	Button/stripline	Libera	Linux embedded IOC
Bunch charge	WCM/ICT/FC	Oscilloscope	Windows embedded IOC
Tune	Stripline kicker	Function generator	HTTP access
Trans profile	Phosphor screen	CCD	PXI IOC+ image grabber
Beam current	NPCT175	Bergoz	PXI IOC + DMM
Slit / Scrapper	Step motor	Motor driver	PXI IOC + Motion controller
Trans feedback	Stripline kicker	Spring-8 board	PXI IOC + DI/O
Filling pattern	Button	RF front-end	PXI IOC + waveform recorder
Beam size	SRM	Interferemeter (CCD)	PXI IOC + image grabber
Beam length	SRM	Streak camera	**IPC + image grabber**
Timing		EVR	VME (VxWorks) IOC

PXI IOC talks to EPICS through Shared Memory IOCcore, which wins due to

- **We had experiences before**
- **Easy to learn and use for new players**
- **Easy to move from lab test system to field system**
- **Easy to modify and debug in the field**

DAQ System Architecture



BPM system development & commissioning

	Primary issues	Solution
Design stage	All Liberas VS Hybird	All Liberas
Fabrication stage	Pickup quality control	Custom defined specification, join factory acceptance test
Installation stage	Tight installation space for pickup cable	Dedicated skilled person
Commissioning stage	Understand and familiar with Libera Fine tuning Libera	Beam experiments Talk with DLS & IT
Next	Put more functions to low level Heating due to high current	EPICS DB level development, more beam experiments

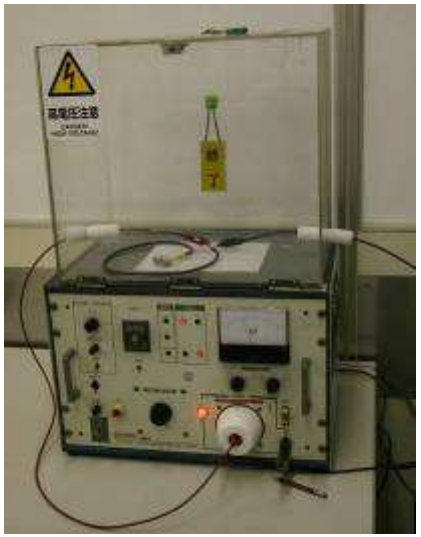
Ring pickup factory test

Mechanical inspection

DC isolation resistance

Network analyzer S11

Capacitance



AC voltage break down

BPM block gauge

Magnetic permeability

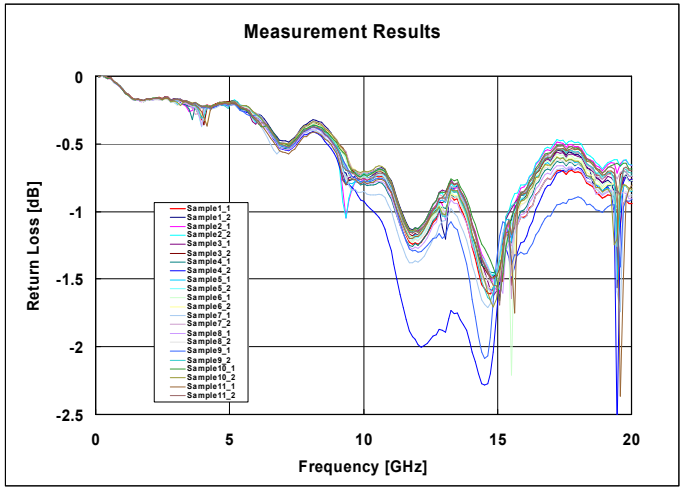
Leakage

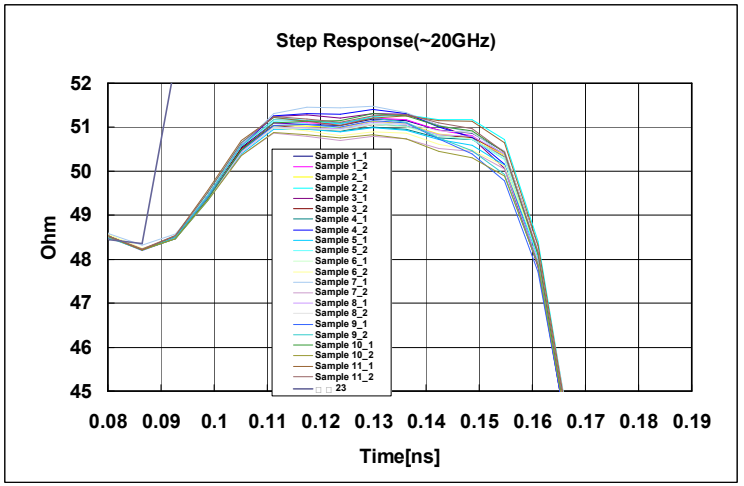
Ring pickup factory test

Measurement point	1	2	3	4	5	6	
Inspection device	Micro-meter	Micro-meter	Linear-gauge	Micro-meter	Micro-meter	Pin-gauge	
Specification / Serial#	16.6+0/-0.05	32.6+0/-0.05	3+0/-0.04	32.6+0/-0.05	16.6+0/-0.05	0.3+/-0.05	
						0.25	0.35
001	16.567	32.563	2.989/2.992	32.557	16.572	OK	OK
002	16.566	32.567	2.980/2.988	32.578	16.573	OK	NO
003	16.561	32.558	2.992/2.990	32.572	16.566	OK	OK
004	16.565	32.563	2.985/2.991	32.578	16.571	OK	OK
005	16.566	32.566	2.993/2.998	32.579	16.573	OK	OK
006	16.570	32.567	2.994/2.989	32.578	16.574	OK	OK
007	16.570	32.585	2.984/2.986	32.552	16.570	OK	OK
008	16.566	32.563	2.996/3.000	32.552	16.574	OK	OK
009	16.570	32.562	2.984/2.984	32.574	16.573	OK	OK
010	16.566	32.556	2.988/2.977	32.578	16.573	OK	OK
011	16.564	32.566	2.995/2.987	32.572	16.571	OK	OK

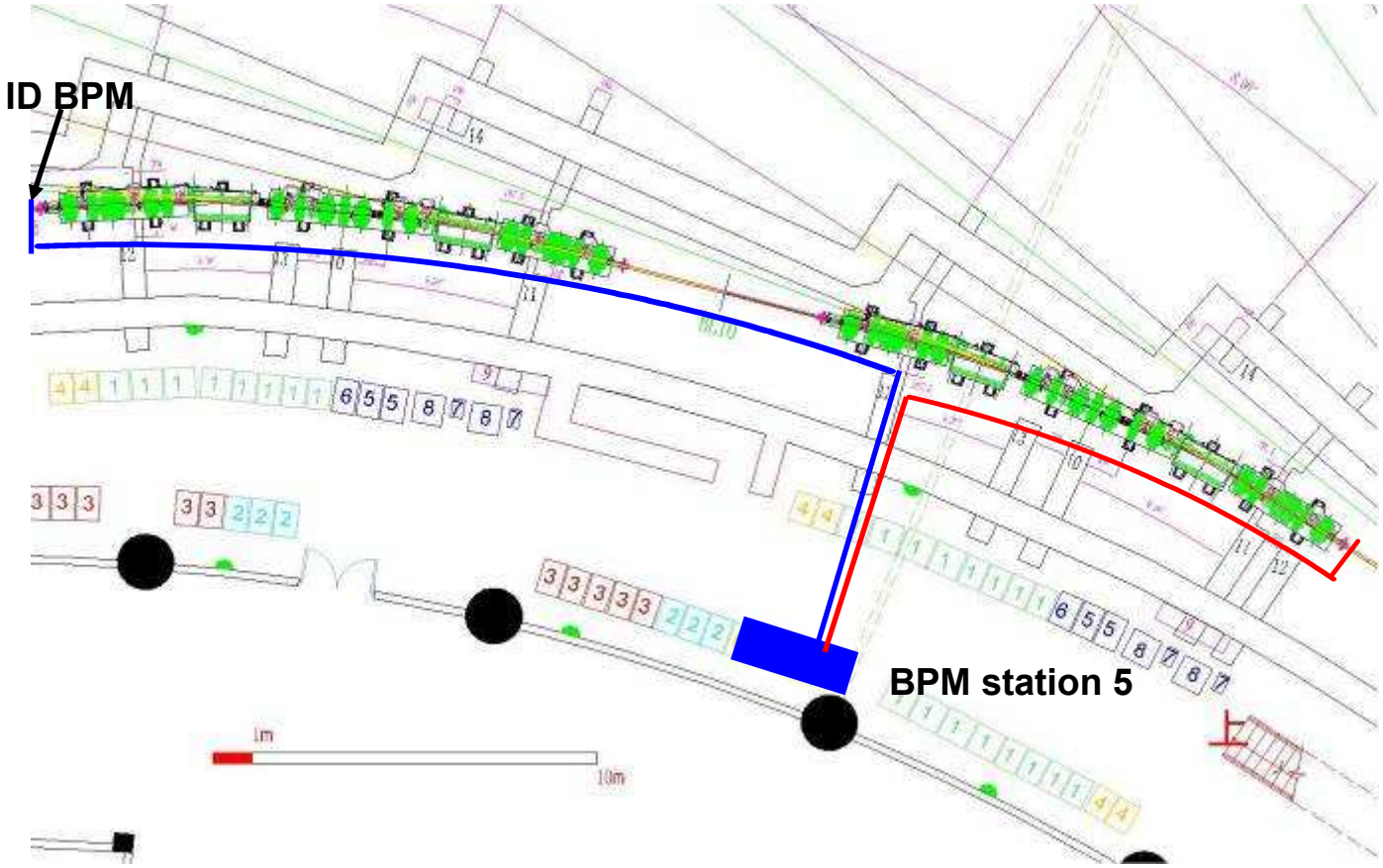
Kyocera inspector: T Kitamura Signature: J. Ushio

SSRF inspector: YONGBIAO LENG Signature: Leng Yin





BPM cabling

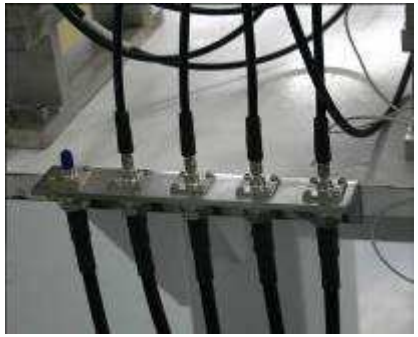


Major cable
TIMES LMR400
Loss < 10dB/100m

Jumper cable
TIMES LMR240
Total loss < 0.5dB

Blue line 30m, redundancy for installation 20m
The longest cable should be shorter than 30m + 20m = **50m**
Total insertion loss < 0.1 * 50 + 0.5 + 0.5 = **6dB**

BPM cabling



Fabrication & Installation

- **Electronics just can process signal but not ‘fix’ signal**
- **Electronics could achieve the best performance with ideal beam**
- **In the commissioning stage it’s hard to say beam is bad or BPM system is bad**
- **High quality fabrication and installation of pickups and cables could save a lot of time for trouble shooting**

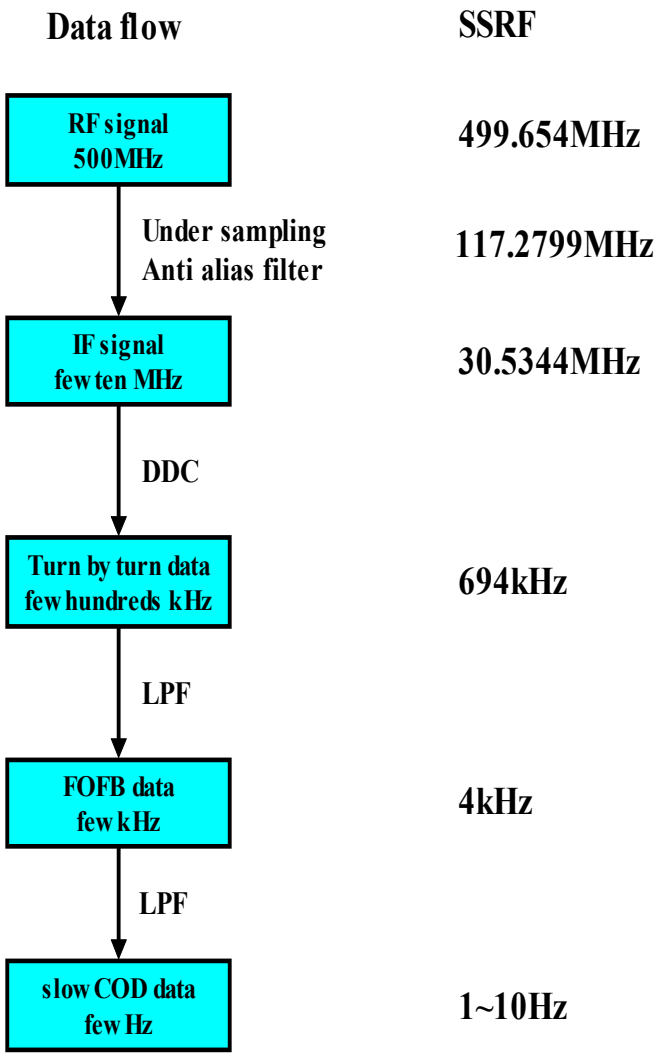
- **2 months for major cable installation, 1 week for jumper cable installation at SSRF**
- **Suffered for bad cable connection (20 BPMs) in stage II**
- **10BPM5 damaged permanently (SMA connector)**

  Connect 1 button to power splitter to evaluate Libera

Electronics

Libera EBPM processor

- **Sub micrometer resolution**
- **Multi branch data paths (few Hz & few kHz)**
- **Turn by turn mode**
- **First turn mode**
- **Potential capability for feedback system**
- **Embedded EPICS IOC (DLS package adopted)**
- **Libera community:**
  DLS, Soleil, Australia Light Source, etc.



BPM data & functions ready for accelerator physicists

Support by DLS package

- ADC raw data @ 117MHz, 2048 points
- First turn data synchronized by injection trigger
- First 2048 samples of TBT data synchronized by injection trigger
- Up to 0.5 samples of TBT data on demand
- 10Hz SA data, orbit measurement
- Embedded position interlock logic
- User defined current scaling factor (beam current measurement)

Instrumentation Technologies delivered

- 10kHz FA data @ SFP port

SSRF added some applications

- 24 hours buffer for SA data @ EPICS DB level
- Auto Gain Control logic (1Hz) @ EPICS DB level
- Beam lifetime measurement @ EPICS DB level
- Phase advance measurement @ EPICS DB level

Libera application

Libera application

	Linac	Booster	Ring
Commissioning	Beam arrival monitor Position measurement Charge measurement	Beam arrival monitor Position measurement Charge measurement	Beam arrival monitor Position measurement Tune measurement Phase space monitor
Operation & Machine study	Position measurement Charge measurement	Position measurement Charge measurement Tune measurement	Position measurement Tune measurement Current measurement Beam spectrum monitor Phase space monitor More…