

BDS Instrumentation

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Thanks to: Mike Woods, Manfred Wendt (FNAL)

Outline

- **Reminder of RDR**
- **Updated instrumentation list**
- **Development of WBS**

Reminder of RDR

- Instrumentation was ‘technical system’ with pan-machine view
- Purview: meas. of *beam-related* parameters:
 - eg. beam position, charge, size ...
 - NOT
 - RF control, temperature, pressure, flow, currents ...
- Boundary with Controls defined (NB feedbacks)
- **Luminosity, energy, polarimetry explicitly excluded**
- **Did not consider monitors for beam-related backgrounds**

RDR instrumentation master table

INSTRUMENT requirements (e.g. resolution)	AREA					
	e ⁻ source	e ⁺ source	DR	RTML	ML	BDS
Button/stripline BPM resolution (μm)	69 10-30	400 10-30	2 × 747 <0.5			120 <100
C-Band Cavity BPM (warm) resolution (μm)		109 <0.1-0.5		2 × 649 <0.1-0.5		262 <0.1-0.5
S-Band Cavity BPM (warm) resolution (μm)						14 < 0.1-0.5
L-Band Cavity BPM (warm) resolution (μm)				2 × 27 <1-5		42 <1-5
L-Band Cavity BPM (cold) resolution (μm)				2 × 28 ~0.5-2	2 × 280 ~0.5-2	
Laser-wire IP resolution (μm)	8 <0.5-5	20 <0.5-5	2 × 1 <0.5-5	2 × 12 <0.5-5	2 × 3 <0.5-5	8 <0.5-5
Wirescanner	12	8				
Optical Monitors	6	17	2 × 2	2 × 8		11
DMC resolution $\Delta E \sim 0.1\%$ / $s_x \sim 100 \mu\text{m}$	3	4		2 × 2		2 (cold)
Beam Current Monitors	7	11	2 × 1	2 × 2	2 × 3	10
Beam Phase Monitor	4	2		2 × 3		2
BLM (PMT/IC)	60/2	400/20	2 × 40/4	2 × 75/2	2 × 325/10	100/10
Feedback System	5	10	2 × 2	2 × 1	2 × 10	12

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RDR BDS Instrumentation List

• Button / stripline BPMs	120	< 100 um
• Warm C-band cavity BPMs	262	0.1 - 0.5 um
• Warm S-band cavity BPMs	14	0.1 - 0.5 um
• Warm L-band cavity BPMs	42	1 – 5 um
• Laserwire IPs	8	0.5 - 5um
• Optical monitors (bunch size)	11	
• Deflecting-mode (cold) cavities	2	100 um
• Beam current monitors	10	
• Beam phase monitors	2	
• Beam loss monitors (PMT/IC)	100/10	
• Feedback systems	12	

RDR BDS Instrumentation List

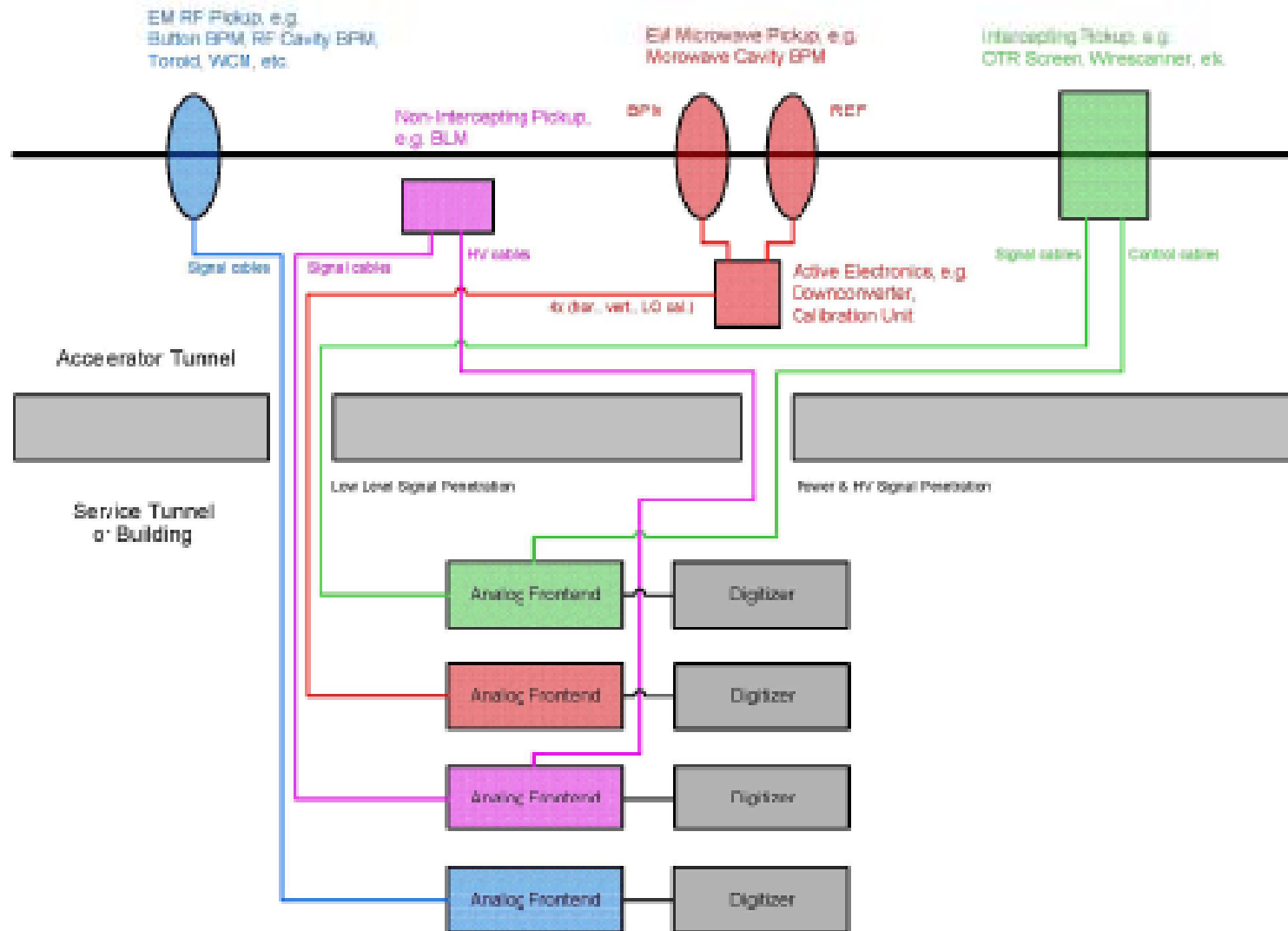
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NO SPARES!

What was costed

- **Pickup station (typically part of vacuum system)**
- **'Detectors': PMTs, scintillators, lasers, calib. systems**
- **RF system + infrastructure for DMCs**
- **Mechanical setup, incl. motors, switches ...**
- **Signal + control cables, connectors, patch panels**
- **Dedicated readout electronics (analogue + digital)**
- **Control, timing, calibration electronics**
- **Local software + firmware**
- **Intra-train feedbacks: dedicated DAQ**

Boundary with Controls



BDS Feedbacks

- Train-to-train trajectory 5 Hz
- IP collision: intra-train (3 MHz) + 5 Hz
- *IP luminosity: intra-train*

NB upstream feedbacks:

- End-of-linac trajectory: intra-train
- RTML feed-forward: intra-train
- Linac cascaded trajectory 5 Hz

Draft BDS Instrumentation WBS

1. **BPMs**
2. **Emittance: transverse**
3. **Emittance: longitudinal**
4. **Beam current monitors**
5. **Beam phase monitors**
6. **Beam loss monitors**
7. **Beam feedback systems**
8. **Beam energy measurements**
9. **Beam polarisation measurement**
10. **Background monitors**
11. **Collision diagnostics**

Draft BDS Instrumentation WBS

1. **BPMs**

1.1 Buttons

1.2 Striplines

1.3 Warm C-band cavities

1.4 Warm S-band cavities

1.5 Warm L-band cavities

2. **Emittance diagnostics: transverse**

2.1 Laserwires

2.2 Optical monitors (ODR, OTR, X-ray SR)

3. **Emittance diagnostics: longitudinal**

3.1 Deflecting-mode (cold) cavities

3.2 Other: electro-optic, diodes, Smith-Purcell ...

Draft BDS Instrumentation WBS

4. Beam current monitors

5. Beam phase monitors

6. Beam loss monitors:

6.1 PMT

6.2 Ion chambers

7. Feedback systems:

7.1 IP position, angle, luminosity (intra-train + 5Hz)

7.2 Upstream trajectory (5Hz)

7.3 BDS entrance intra-train

7.4 Integration and interface to global system

Draft BDS Instrumentation WBS

8. Beam energy measurements:

8.1 Upstream spectrometer

8.2 Extraction-line system

8.3 Energy spread

8.4 E-z correlations

9. Polarimetry:

9.1 Upstream

9.2 Extraction-line

Draft BDS Instrumentation WBS

10. Background monitors:

10.1 BSR pairs/photons

10.2 SR photons

10.3 muons

10.4 neutrons

10.5 beam halo

10.6 EMI?

Draft BDS Instrumentation WBS

11. Collision diagnostics:

11.1 Luminosity

11.2 Beam offsets

11.3 Beam divergence angles

11.4 Beamcal

11.5 Gamcal

11.6 Beam waists

11.7 Dispersion

11.8 Bunch tilts

'Standard diagnostics': alignment, B-field monitors, vibrations ...

Comments

**Some devices are high-volume, with 'low' unit cost:
toroids, BPMs ...**

**Some devices are (unique) complex systems:
laserwires, energy spectrometers, polarimeters,
LOLA bunch-length monitor, feedback systems ...**

Vast majority of effort will go into complex systems!

PRELIMINARY guess of status

- **Button / stripline BPMs** off-shelf / engineering
- **Warm C-band cavity BPMs** engineering / R&D
- **Warm S-band cavity BPMs** engineering / R&D
- **Warm L-band cavity BPMs** engineering / R&D
- **Laserwire IPs** R&D / engineering
- **Optical monitors (bunch size)** R&D / engineering
- **Deflecting-mode (cold) cavities** engineering
- **Beam current monitors** off-shelf
- **Beam phase monitors** R&D / engineering
- **Beam loss monitors (PMT/IC)** engineering
- **Feedback systems** R&D / engineering

Comment

- **In some cases (cavity BPMs, toroids ...) required performance may have been achieved for SINGLE-bunch mode**
- **Further R&D may be required to demonstrate TIME-RESOLVED performance bunch-by-bunch**

Commissioning strategy

- **If commissioning of BDS and/or IR is anticipated BEFORE the detector(s) are rolled on beamline**

it may be prudent to plan for appropriate instrumentation at the Machine Detector Interface

- **NOT included so far**

MDI 'Diagnostics'

- **Electromagnetic interference antennae?**
- **Radiation damage monitors?**
- **Crab cavity phase**
- **Magnet vibrations**
- **Alignment**
- **Vacuum**
- **Temperatures**
- **Magnetic fields**
- **Power supply currents**

Expressions of interest (Oct. 07)

Button, stripline, cavity BPMs	FNAL
Laserwire	UK
Bunch length (also beam phase)	UK, FNAL
OTR/ODR monitors	UK, FNAL
Toroids	FNAL
Feedback systems	UK, FNAL
E-spectrometer	UK, UCB, JINR, DESY, SLAC, Notre Dame, Oregon
Polarimeter	Iowa, INFN, SLAC, Tufts
Gamcal	BNL, Yale, DESY
<i>BDS/IR alignment</i>	<i>UK</i>
<i>Shintake Monitor (ATF2)</i>	<i>Tokyo</i>

Work package outline

scope

goals

schedule

milestones

deliverables

resources (personnel, materials, infrastructure)

co-ordinator

Generalised scope of each task

Review of performance requirements

Document listing specifications

resolution, timing, dynamic range, linearity ...

Review of state of the art / technologies

Specification of baseline / alternate technology

Conceptual engineering specification

Drawing / manufacturer's part number ...

Specification of R&D programme with deliverables

Revised cost estimate

Status/questions

- **Work packages ‘on hold’ since Black December**
 - **R&D ongoing:**
 - Laserwire, FONT FB, BPMs, bunch length meas., energy meas., polarimetry ...**
- much excellent progress!**
- **Decide on goals for TDP1, TDP2?**
 - **Presumably costing will be redone for TDP2?**
 - **Institute (monthly) instrumentation meetings?**