Status of the BI Work Package in the LIU-PSB frame

Jocelyn TAN, BE-BI

Thanks to the contributions of the WU holders:

Outline

- Foreword
- Relevant Observables
- H⁻ injection System & Half Sector Test
- Conclusion
LIU-PSB-BI Work Package

- **Total budget:** 3635 kCHF
- **5 budget codes**

<table>
<thead>
<tr>
<th>Machine sector</th>
<th>Total: 20 Work Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI line</td>
<td>2</td>
</tr>
<tr>
<td>H⁻ Injection &amp; Half Sector Test</td>
<td>6 + 3</td>
</tr>
<tr>
<td>Ring</td>
<td>5</td>
</tr>
<tr>
<td>Extraction lines</td>
<td>4</td>
</tr>
</tbody>
</table>

- **4 cost drivers represent 79.8 % of the WP budget**
  - Wire Scanners: 970 kCHF
  - Booster TMS: 750 kCHF
  - Upgrade for L4: 648 kCHF
  - BLMs: 532 kCHF
LIU-PSB Milestones

- Half Sector Test
  - Part 1 Q3 2015
  - Part 2 Q1 2016

- EYETS = Extended-Year-End Technical Stop
  - 16 weeks, from Dec. 2016 to March 2017
  - All WPs related to Linac4 connection: end 2016, should Linac2 fail all of a sudden.

- LS2
  - 1.5 year, from Q2 2018 to Q4 2019
  - All WPs related to PSB energy upgrade
  - Linac4 connection to PSB *if not done during EYETS*

Presently there is no management decision to relax on the end-2016 deadline for the Linac4 connection to the PSB. Therefore this has to stay the baseline for our planning.
Outline

- Foreword
- Relevant Observables
  - Beam intensity
  - Beam profile
  - Beam loss
  - Beam position
- H⁻ injection System & Half Sector Test
- Conclusion
Relevant Observables

- **Beam Intensity**
  - Injection efficiency (Slow)
  - Acceleration efficiency (DC)

- **Beam Profile**
  - Transfer-lines: septum position plates
  - Injection matching
  - Transverse emittance

- **Beam Loss**
  - Ring and transfer lines: Monitoring

- **Beam Position**
  - Orbit and trajectory
  - Transverse instabilities between PSB and PS
BEAM INTENSITY
Measurement of injection efficiency with Linac4

Summary
• *Needed for Linac4 connection* → EYETS
• Four monitors **BR.TMD in 8L1**, installed in ‘72, un-used since early 80s’
• Analog turn by turn acquisition, up to 100 turns
• *Watchdog*: comparison with Bl.BCT20 after 100 turns

Status after LS1
• One BCT available (without shielding) in the laboratory

Plans for 2015-2016
• Study of the electronics, test of a prototype in the machine
• Manufacturing of a ceramic vacuum chamber. **There is no spare!**
• Manufacturing of the Front and Back End Electronics
• Specification of the SW for the acquisition chain based on the TRIC card

Plans for EYETS 2016-2017
• New cables pulling
• Reshuffle the monitors in the BI radioactive workshop: **ALARA to be checked**
• Installation: monitors & Electronics
• Full system commissioning

Courtesy: P. Odier
Summary

- **Needed for Linac4 connection → EYETS**
- Four monitors BR.BCTDC in section 9 (DCCT)

**Status after LS1**

- **Acquisition chain upgraded**
  - 12 bit ADC replaced by 16 bit ADC (VD80)
  - Simplification of the HW (intervalometers for the hot spots replaced by markers acquired with the ADC)
  - Common Expert GUI for the DCCTs in the injectors 😊
- **Front End Electronics assembled**: Not installed due to higher priorities
- **Front End housing**: manufacturing launched (BI-ML)

**Plans for 2015**

- **Test of the new B Train Receiver** (White Rabbit, SVEC VME card) in // with the current β Normalizer based on the old B Train
- **Share the firmware and the mezzanine**: contact H. Damerau (RF)
- **Installation of the new Front End Electronics** (TS 2015-2016)

**Plans for EYETS 2016-2017**

- **Installation of the new B train** (White Rabbit) Receiver
- **Adaptation for Linac4 intensities**: Front and Back End for Linac 4

**Courtesy**: P. Odier
New WU created in 2014, baseline End 2016. Still OK? Should be aligned with the work done by ABT

New INJECTION SEPTUM for 160 MeV beams

Based on existing system

Specifications under discussion w/ Bettina

- Ensure the **distributed beams** are centered in their respective apertures.
  - @ input plates: stripped electrons charge deposition
  - @ output plates: secondary emission, expected to be very weak!
- Linear, $10^4$ dynamic range, large bandwith (min 50ns beam pulse), Direct signals on OASIS
- No interlock, no aperture restriction

Planning for 2015 (in agreement with TE-ABT Team)

- April-June: Design
- Mid-Sept: Procurement of parts: Ti plates 1mm thick
- October: Installation in BI.SMV

New BI.SMV

Courtesy: F. Roncarolo, D. Gerard
Specifications:

- **Needed for Linac4 connection → EYETS**
  - injection of half a PSB turn (i.e. 0.5 μs, 2x10^{11} protons) to well separate turn-by-turn profiles. Only Ring 3 H+V planes
  - acquisition of – **say up to 20** – consecutive profiles
  - **External condition interlock**: to shorten the Linac4 pulse (max 1-turn-injection)
  - NOT PPM In/Out
  - Permanent implementation for commissioning, MDs and operation
  - **Compact SEM grids**, grid size: 26mm, 64 graphite wires (⌀= 33 μm)
  - Thick frame for stopping scattered protons

Status

- Mechanics designs: not started
- Electronics: conceptual design started
- Proposed SEM's integration: **section 4L1**
- To do: Space Reservation Request for 4L1+ ECR
**BEAM PROFILE**

**Wire Scanner**

- **Baseline:** LS2
- **Aim:** adaptation of the scanner design for the PS and SPS to the limited space in the PSB

**Status**
- Mechanical design proposals are under discussion:
- Development of control end acquisition electronics advancing
- Proposed BWS’ integration: section 11L1 + 16L1?
- To do: Space Reservation Request for 11L1 and 16L1+ ECR

**2015**
- Two prototypes (SPS + Lab) are used for optimisation and development of control electronics
- If PSB study shows that integration is possible, then we can finalize the design (mechanics)
- **Budget update**

**2016**
- Production prototype scanner for installation YETS16-17

**2017**
- Commissioning of prototype

**Aim:** Completion during LS2
- but we are on the critical path

*Courtesy: B. Dehning*

*Bl is in favor having 2 sections: could be 16L1*
MOTIVATION:
The need of longer magnetic length for Septa induced by increased beam energy

<table>
<thead>
<tr>
<th>Monitor</th>
<th>BT.BTV10</th>
<th>BT.BTV30</th>
<th>BI. BTV30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>Tanks installed</td>
<td>Design in good progress</td>
<td></td>
</tr>
<tr>
<td>Plan for 2015</td>
<td>Production of optical mechanical part and of support</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Production of transition pipes</td>
<td>Tank production</td>
<td>SRR + ECR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Modification of adjacent pipes</td>
</tr>
<tr>
<td>Baseline</td>
<td><strong>LS2</strong>: Monitors installation</td>
<td></td>
<td>EYETS: Modification of existing tank</td>
</tr>
</tbody>
</table>
BEAM LOSS
PBS and Transfer lines BLM system

Baseline: End 2016

Ionization Chambers (ICs): from LHC, for free

Status

- ICs in L2 sections
  - WU completed during LS1: Cable pulling

- Flat ICs in L3 sections
  - 2014-15: monitors’ procurement
  - YETS16-17: cable pulling ECR
  - 2017: commissioning/operation

- ICs for injection and extraction lines
  - 2014-15: Electronics procurement
  - YETS16-17: cable pulling
  - 2017: commissioning/operation

All systems should be ready for the 2017 start-up if cabling is granted
**Specifications**
- **Needed for Linac4 connection → EYETS**
- Bunch-by-bunch, turn-by-turn trajectories over the whole cycle
- Various derived averages (Orbits, M[RV]P)
- Position resolution 200μm
- No more multiplexing over the four rings
- New front-end electronics with settable gain

**Status**
- One full ring can be acquired, multiplexed, Design target resolution of 0.2mm
- Software: FESA interface, with hooks for YASP and the Sampler + Expert GUI
- We’re still using the old front-end electronics, without VGAs
- Interference on analogue signals is a real nuisance

**2015-16: Qualify the acquisition system**

**Start-up 2017: Project COMPLETION**

**Budget:** new re-baseling for 515 kCHF

New baseline: FEASIBLE for 2017 if we can get cables in BOR
**BEAM POSITION**

Wide Band BPM in the BTP line

- **Baseline:** End 2016

- **Specifications**
  - Spot transverse instabilities during beam transfer between PSB ans PS
  - Based on existing PS design (section 94)

- **Status**
  - Not started

- **Plans for 2015**
  - Design + production
  - DIC
  - Space reservation Request in BTP + ECR

- **Plans for 2016**
  - Installation and commissioning
  - Acquisition : OASIS

Courtesy J. Belleman
BEAM POSITION
Inductive BPMs in the extraction lines

- **Baseline: LS1**
- **Upgrade**
  - 8 monitors + 2 spares
  - New front and back end electronics for compatibility with Linac4 beams
  - New lab test bench
- **BTP and BTM lines: LIU budget**
- **Status**
  - **WU completed during LS1**
  - Some interference noise with beam being investigated
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Beam Diagnostics for the new H⁻ charge-exchange injection system in section 1L1

- H⁻/H⁺ current monitor
- Stripping efficiency
- INTERLOCK for dump protection
- Stripping foil current monitor
- BTV
  - Optimization of the injection process
  - Inspection of the stripping foil

Baseline: end 2016
All four rings

80 mm magnets, 316 mm magnetic length, 66 mrad, 340 mT, 126 mTm

- ICs for beam loss monitoring
- Diamond detectors: for observation of fast losses and foil degradation

Courtesy: W. Weterings
Beam Diagnostics for the new H\(^-\) charge-exchange injection system: HST in Linac4 tunnel

H0/H\(^-\) current monitor
Baseline: Q1 2016
Stripping efficiency
INTERLOCK for dump protection

BTV
Baseline: 1 BTV Q3 2015, the other one Q1 2016
Optimization of the injection process
Inspection of the stripping foil

Stripping foil current monitor
Baseline: Q3 2015

ICs for beam loss monitoring
Diamond detectors: for observation of fast losses and foil degradation

Courtesy: W. Weterings
New \( \text{H}^- \) charge-exchange injection system

Beam Loss and Interlock Systems

**Ionization chambers**: \( \times 6 \)
- Monitoring foil degradation
- Machine protection (\( \text{H}^0/\text{H}^- \) dump)
- Interlock

**Diamond**: \( \times 8 \)
- Monitor fast losses & foil degradation
- Optimize stripping efficiency

Both detectors share the same support system

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<table>
<thead>
<tr>
<th>Monitoring</th>
<th>Observation</th>
<th>Half Sector Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Status</strong></td>
<td></td>
<td><strong>BLM support design and integration done</strong></td>
</tr>
<tr>
<td><strong>2015</strong></td>
<td>Acquisition chain</td>
<td>Acquisition chain</td>
</tr>
<tr>
<td></td>
<td>Diamond detector</td>
<td>Installation + cabling</td>
</tr>
<tr>
<td><strong>2016</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>YETS 16-17</strong></td>
<td>Cabling</td>
<td>Cabling</td>
</tr>
</tbody>
</table>

*Courtesy: W. Weterings*
New H⁻ charge-exchange injection system

**H0/H⁻ Current Monitor**

Monitor to be installed in front of each H0/H- dump.
- low-Z material, low activation: Titanium plates
- medium-level conductivity (best compromise between read-out of the deposited charge and the presence of a pulsed magnetic field)

Fabrication can be launched
- BI wants to approve the production drawings
- B.Riffaud (MME) (via BI-ML ?)
  - 1 system will be ready for HST part 2

- 1 VME per ring, with following outputs
  - Interlock
  - 4xOasis (fast Amplifier)
  - 4xIntegrator (from 50ns to 1us)
  - 1xStripping foil current (next slide)

- 1 MHz ADC
  - Interlock
  - Sampling of integrator @ 1us → time signal
  - DAC for interlock reference

- Will be ready for HST
  - Part1: only stripping foil current
  - Part2: first H0-H- current system

Courtesy: F. Roncarolo
New H⁻ charge-exchange injection system
H0/H⁻ Stripping Foil Current

Signal cable feed through included in mechanical design

BI is responsible from signal feedthrough

Electronics design on going
- Included in H0-H- VME, same readout
- BIAS +-10V via DAC likely envisaged (if compatible with magnetic fields)

Will be ready for HST part 1
New H⁻ charge-exchange injection system

Beam Profile and Foil Inspection

<table>
<thead>
<tr>
<th>BTV Stripping Foil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>L4T</td>
</tr>
<tr>
<td>HST</td>
</tr>
<tr>
<td>BOOSTER</td>
</tr>
<tr>
<td>Spare</td>
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<table>
<thead>
<tr>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
</tr>
<tr>
<td>Integration</td>
</tr>
<tr>
<td>Production</td>
</tr>
<tr>
<td>Assembly/Test</td>
</tr>
<tr>
<td>Interlock</td>
</tr>
<tr>
<td>Interface and test to be done</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BTV in front of proton dump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>HST</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of available spare BTV AD/BASE type (pneumatic)</td>
</tr>
</tbody>
</table>

Special Rad Hard ThermoFisher cameras (CID8726DX7) and dedicated cabling have been received for the L4T and the HST installation.
Conclusion

- Two WUs completed during LS1
- HST: on time Part 1 Q3 2015 & Part 2 Q1 2016
- BLMs & BTMS: A large cabling effort for YETS 16-17
- H⁻ injection: on time for Linac4 connection
- BWS: on the critical path
- Other BI Work Units: No showstopper
- Can LIU provide a wishlist of monitors which might be installed before LS2?
THANK YOU FOR YOUR ATTENTION!
## Cost Breakdown

<table>
<thead>
<tr>
<th>LIU-PSB</th>
<th>Budget Code</th>
<th>Section</th>
<th>Description</th>
<th>Type</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>TOTAL LIU (kCHF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSB BLM System w/ IC in L2 sections</td>
<td>64020</td>
<td>BL</td>
<td>LIU-PSB BLM Upgrades</td>
<td>Ring - L2 section</td>
<td>127</td>
<td></td>
<td></td>
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<td></td>
<td>127</td>
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<tr>
<td>PSB BLM System w/ IC in L3 sections</td>
<td>64020</td>
<td>BL</td>
<td>LIU-PSB BLM Upgrades</td>
<td>Ring - L3 section</td>
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<td>30</td>
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<td>164</td>
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<tr>
<td>BLMs for Extraction line w/ IC</td>
<td>64021</td>
<td>PI</td>
<td>LIU-PSB PU &amp; BCT Upgrades</td>
<td>Extraction</td>
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<tr>
<td>BLMs for H- injection</td>
<td>64021</td>
<td>PI</td>
<td>LIU-PSB PU &amp; BCT Upgrades</td>
<td>BL line and H- injection</td>
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<tr>
<td>Fast BLMs at Injection dump</td>
<td>64022</td>
<td>PM</td>
<td>LIU-PSB Profile Measurement Upgrades</td>
<td>H- injection</td>
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<td>45</td>
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<td>New Orbit System</td>
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<td>PM</td>
<td>LIU-PSB Profile Measurement Upgrades</td>
<td>Based on fast SEM readout</td>
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<tr>
<td>Watchdog (BR8.TMD)</td>
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<td>DCCT Upgrade</td>
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**TOTAL LIU (kCHF)**: 19 203 485 159 681 1179 357 552 3635