MDI and BP improvements

S. Tanaka (KEK)
Belle II VXG open workshop
## MDI subjects

<table>
<thead>
<tr>
<th>IR mechanical integration:</th>
<th>Machine commissioning group:</th>
</tr>
</thead>
<tbody>
<tr>
<td>– VXD, BP, shields, QCS(final focus magnets)</td>
<td>Belle II Run Coordinators:</td>
</tr>
<tr>
<td></td>
<td>– Belle II Commissioning Group (BCG)</td>
</tr>
<tr>
<td></td>
<td>Beam Injection</td>
</tr>
<tr>
<td></td>
<td>– Injection timing (by injector group)</td>
</tr>
<tr>
<td></td>
<td>– Trigger group (Injection veto control)</td>
</tr>
<tr>
<td></td>
<td>Collimators:</td>
</tr>
<tr>
<td></td>
<td>– Controlling BG</td>
</tr>
<tr>
<td></td>
<td>Beam loss monitors:</td>
</tr>
<tr>
<td></td>
<td>– For beam abort, monitoring collimator effectiveness</td>
</tr>
<tr>
<td></td>
<td>Belle II beam abort (diamond): Interlock</td>
</tr>
<tr>
<td></td>
<td>– To protect Belle II sensors</td>
</tr>
<tr>
<td></td>
<td>Belle II beam background measurements and simulations:</td>
</tr>
<tr>
<td></td>
<td>– Consistency check of simulation with BG data</td>
</tr>
<tr>
<td></td>
<td>– Additional collimator planning</td>
</tr>
<tr>
<td></td>
<td>And more….</td>
</tr>
<tr>
<td></td>
<td>– Luminosity : LumiBelle2/ZDLM, ECL</td>
</tr>
<tr>
<td></td>
<td>– Vertex position</td>
</tr>
<tr>
<td></td>
<td>– (Slow control to handshake each other)</td>
</tr>
</tbody>
</table>
Continuous injection from May: 6Hz

By short beam life time (less than 10min. on final LER design), continuous injection is essential to keep beam current.

On Belle II L1 trigger, trigger information is vetoed about a few ms after Injection (Global Decision Logic), because of BG spikes by noisy bunch.

Injection bunch information: LINAC group
Trigger group managing L1 trigger veto tuning and PXD is individually applying gated mode operation to avoid BG hits from injection.
Full menu of injection tuning

- Initializing magnet (reset of magnet excitation curve)
- Beam injection with detuned optics (~10mA)
  - Getting Beam orbit information in main ring
  - Tune control
  - Injection tuning with single shot (energy, phase matching, kicker angle + position. Septum angle + position, kicker jump)
- Switching to beta_y* = 3mm optics
- Optics correction (to stabilize beam condition of main ring)

Injection BG is resulting of machine tuning error. In future this injection BG might be reduced by fine beam parameter control.

After full menu of injection tuning in spring run

Beam current

BG dose @ IP

Beam loss

Beam loss

~4 hours
Beam Collimator

Mechanics preparation: machine group
Operation: Belle II commissioning group

Beam collimators tuning is the key operation to control BG quality both in injection and storage

Closing to small aperture: lower BG, smaller beam life but it should avoid secondly shower by beam core hit

Input Parameters on tuning
Injection efficiency
Beam life time
Beam loss at each collimators
BG in Belle II

- Each collimator has two jaws.
- Positioning accuracy: ±25 μm
- Mechanical stroke (i.e. max stroke)
  - horizontal: 2 mm ~ 30 mm
  - vertical: 0.2 mm ~ 20 mm

Limiting max. current

New mechanical design and faster operation is on discussion
VXD Sensor protection from BG

- Diamond sensors
  - Monitoring VXD BG environment
  - Issuing injection inhibit on worse BG condition
  - Issuing beam abort to protect sensor from huge BG
  - Sensor HV shutdown on huge BG

Collimator head break down by unexpected beam orbit change
Beam crossing angle: 87 mrad
IP straight section: ~25cm
VXD with final focus magnets

VXD weight ~80 kg
(by CDC structure limitation)
Beam Pipe at IP

- Beam pipe design
  - Inner beam pipe design is taken by SuperKEKB group
    - Beam orbit from optics design,
    - controlling SR fan,
    - Heating power estimation by mirror current and HOM
  - Outer pipe shape design is by BelleII VXD
    - BG protection (material choice and thickness)
    - Space allocation (PXD/SVD/cables/shield material)

Tapered ridge shape to absorb SR
10umt Au inside of Pipe to stop SR photon
PXD+IP pipe mechanics

~1.5mm clearance btw. BP (12.5mm) and PXD 1st layer (14mm)

Beryllium

IP pipe: double tube (paraffin cooling)

There is possibility to modify inner pipe design around crotch part. (but IP pipe is very difficult)

On future PXD upgrade, keeping the same mechanical support or not is important decision
VXD design

- 2011: IP pipe design has basically finalized
- 2014 summer: PXD + SVD + VXD mechanics design
  - About 4 years took from scratch design
    - Integration procedure
    - BG shields
    - Service space management

If VXD mechanics have to be modified, 4~5 years will be necessary to finalize the design.
Service space limitation

If we keep current sensor allocation, 50cm Kapton flex from PXD ladder is necessary because of limited space btw. SVD cone and heavy metal.

Improving of bellows design is ongoing (RF finger design, material choice)
VXD service space management

Space critical area on VXD services

Zero suppression or optical data transmission (but rad. hard issue)?
CDC update idea for future huge BG condition

- If huge rate of BG hits causes CDC HV trips or reduction of gas gain, we may have to consider to replace inner layers with silicon trackers.

- Big issue is to manage large number of cables at narrow space btw. CDC and QCS
Summary

• SuperKEKB and Belle II have taken good relationship on
  – Injection BG control
  – Collimator control
  – Beam Abort
  – BG simulation
  – Mechanical integration

• IP Beam pipe
  – All of material for another new one is in hand
  – Outer shape is limited by sensor and service space
  – Inner pipe shape may have some room to modify

• Bellow pipe
  – New pipe design (RF finger)
  – Material choice

• CDC issue on future operation
  – Small cell area may have to be replaced with silicon tracker in future
    • (challenge) Limited cable space
VXD integration

- Major parts of the VXD are individually assembled before integration:
  - Beam pipe + Shield structure
    - IP beam pipe, Bellows pipe,
  - PXD
  - SVD
  - Installation parts
    - Control VXD position to fit machine orbit