Thoughts on Si-XRM, other improvements

(a) Severely damaged tungsten head ~720 μSv/h

(b) Scar along the beam of the melted copper coated titanium head

9-August-2022
We are now into Long Shutdown 1 (LS1)

1. Complete original IRSX-based readout of SLAC Si sensor

2. Look for ways to improve performance/functionality

3. Initial idea floated has been to look at possibility of measuring head-tail motion

4. What would this require?

5. Are there other diagnostics we could provide that might address serious SuperKEKB issues? (e.g. leverage LCLS development)
Phase 3 Operation Summary

Delivered peak luminosity (10^{34} /cm^2/s)

- KEKB record: 2.11 \times 10^{34} /cm^2/s
- 4.65 \times 10^{34} /cm^2/s

Delivered peak luminosity during physics runs

Daily max beam current (A)

- LER: 1.41 A
- HER: 1.26 A

Integrated luminosity (fb^{-1})

- 427 fb^{-1} recorded
- 491 fb^{-1} delivered

[Delivered \mathcal{L}(\text{plan})] = \sum [\text{Daily delivered } \mathcal{L}(\text{plan})]

[beam current] = \sqrt{i_{\text{LER}} \cdot i_{\text{HER}}}, \; i_{\text{LER}}, \; \text{or } i_{\text{HER}} \text{ when the HV permission is given.}
1. What is the component due to orbit excitation?
2. Head-tail?
Uncontrolled beam losses

- During stable machine operation unexplained beam instabilities and beam losses may occasionally occur in one of the rings causing **fast beam losses** at a specific location around the ring due to
  - Injection kicker errors
  - Beam-dust interaction
  - Vacuum element defects
- **Consequences**
  - Detector and/or collimators damage
  - Superconducting magnet quenches
  - Belle II background increase
- Usually only a few such catastrophic beam loss events happen per year
  - In 2022, we had many of these events in the LER trying to go beyond 0.7 mA/bunch
- **Cures**
  - Upgraded abort system → fast abort signal
  - Low-Z materials for collimator heads (MoGr, Ta+Gr)
  - Understand the source of the unstable beam (vacuum system inspection, beam dynamics study)
Physical process of the “Fireball” hypothesis, leading to fast beam loss

1. A microparticle with a high sublimation point is heated by the beam-induced field.  ➔ Fireball

2. The fireball touches some metal surface with a low sublimation point (e.g. copper).

Order of ~s or longer

3. Plasma is generated around the fireball.

4. The plasma grows up into a macroscopic vacuum arc, possibly leading to significant interactions with the beam particles.

Order of ~100 ns at the fastest
Discussion Items

• Existing Si-XRM completion, calibration @ KEK, installation and commissioning schedule?

• What to propose this year? (due ~Christmas)

• RFSoC development at SLAC?

• New sensors?

• New ideas?
Backup Slides