Beam abort in KEKB
and
Background measurement by SVD

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Properties of the KEKB beam abort

- Beam abort is done by kicker pulse magnets in KEKB.
- The beam circulation period of KEKB is 10 μsec.
- About 100 μsec delay in KEKB side to avoid beam aborts due to electric noise (can be shorter).
- KEKB has its own strong beam abort detections to protect KEKB components.
  - Beam phase abort → If the beam bunches fail to synchronized with the phase of the acceleration RF system, the beam is aborted.
  - Loss monitor abort → Radiation monitor in the tunnel.
  - Super conductive Cavity abort → Discharge in SC cavities.
- Basically, unstable beam is aborted before it induces fatal beam back ground level in Belle.
- Because of beam-beam effect, LER/HER beam becomes unstable, causing BKG, when the other beam is lost.

Background condition

- SVD1 --- Very weak to radiation.
  - VA1 chip, 0.7μm technology: Strong constraint to KEKB operation.
- SVD2 --- Rad hard (VA1TA, 0.35 μm).
  - We allow high radiation level in KEKB vacuum scrubbing. 40 mrad/sec.
  - Normal operation is less than 1 mrad/sec.
  - The sensitivity of the radiation monitor dropped at least to half.
    - No reliable measurement after 3-4 years.
    - I propose to install at least a few DIAMONDS in addition to many PIN diodes.
- Everyday local run data (noise, gain…) was carefully watched. Although ~ 1 % bad channels newly appeared, the SVD2 performance did not change significantly through the experiment especially due to radiation.

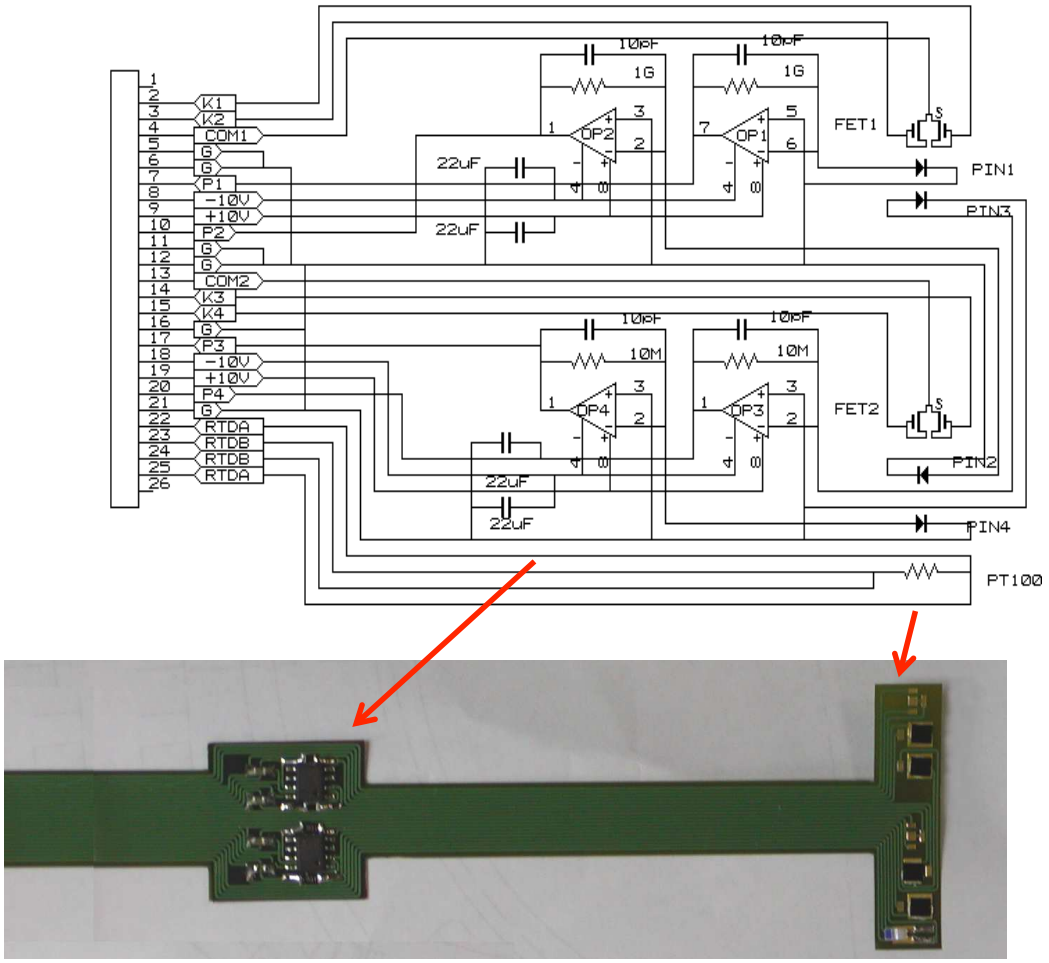
Belle radiation monitor for SVD

- Un-biased PIN diode (4mmx6mm) with high-gain charge amplifier.
  - If biased, increase of leak current (drift significantly) can not be compensated.
  - Sensitivity changes due to radiation damage.
- Two PIN diodes with different OP amplifier gain.

PIN system	Dynamic range (mrad/sec)	Main use
High gain/slow	0.1 – 1000	Radiation monitor
Low gain/fast	10 – 10^5	Beam abort

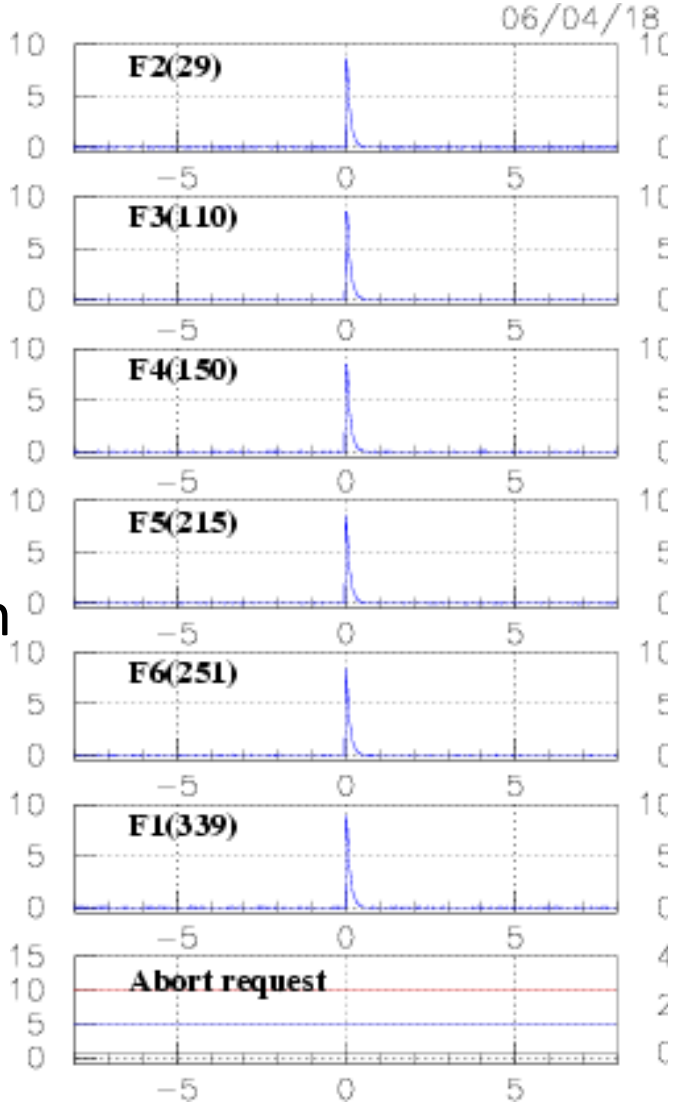
Radiation monitor for SVD2

- Un-biased PIN diode (4mmx6mm) with high-gain charge amplifier.
- Two PIN diodes with different OP amplifier gain.



Observation

- 100 rad/sec radiation level time occurs often.
- Most of them are very short time. If we issue beam aborts, KEKB operation is not possible.
  - We need larger dynamic range, or , much less gain.
- SVD send beam abort signal when high background condition is kept for ~300 μsec.



Beam abort due to slow measurement

- In order to keep attention of KEKB operators to the radiation background, I implemented a “slow beam abort”.
  - When 100 mrad/sec radiation level continues for 1 minutes, the beam abort is issued.
- This is effective to reduce BKG when the beam injection is very dirty. (We can ask KEKB operators to stop or reduce rate of the beam injection with a very bad condition.)

Summary

- KEKB has its own strong beam abort system and Belle is usually very safe.
- Belle used PIN diodes. In Belle2, I recommend several diamond sensors to calibrate PIN diodes.
- For a reliable beam abort decision, a system with low gain (1000 rad/sec or less) PIN diodes is enough.

Nov. 2011 B2GM

I changed my mind after hearing the experiences of CLEO radiation monitor in Nov2011 B2GM.

Summary@Feb2012

- I recommend PIN diodes + a few diamonds.
- I now do not recommend preamplifiers are integrated close to the PIN diodes and diamonds.
  - The performance of SVD2 radiation monitor was limited by the built-in OP amplifier circuit.
  - After installation, we can change the operation parameters: Speed, saturation level, gain…
  - There are good cables: thin, low-leakage, high bandwidth.
  - The signal processing can be done in the E-hut using various circuit design. Improvement can be done after installation.

If we prefer a similar hybrid to SVD2…

- RADFET (with high dynamic range).
- PIN diodes and a diamond on a Kapton flex.
- Pt100 temperature sensor
- No amplifier integrated.
- We should be careful about the high voltage for diamond (E~1V/μm). We need a good insulator layer covering the Kapton circuit.