

The Monitoring System of the Belle-II Vertex Detector



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Abstract

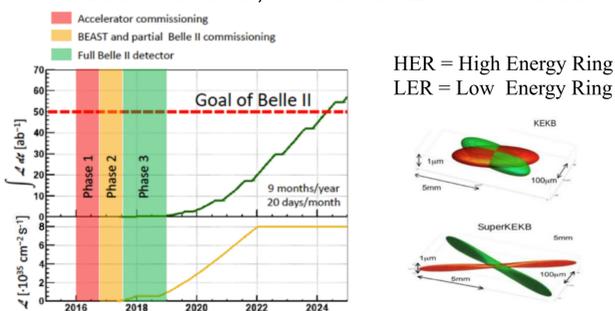
The Belle-II Vertex Detector (VXD) is a 6 layers silicon tracker device that will cope with an unprecedented luminosity of $8 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$ achievable by the new SuperKEKB e^+e^- collider, at the KEK laboratory (Tsukuba, Japan).

All environment parameters such as **temperature**, **humidity** and **radiation** levels, must be constantly monitored and under certain conditions action must be promptly taken, such as **interlocking** the power supply or deliver an **abort** signal to the SuperKEKB collider.

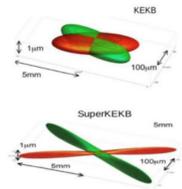
In this contribution we present the first results of the temperature and humidity system commissioned in a Beam Test at DESY in April 2016 and the preliminary results of the radiation monitoring achieved with a prototype system during the first SuperKEKB commissioning phase in February-June 2016.

SuperKEKB and Belle-II

Asymmetric e^+e^- collider @ Y(4s) B-factory
Design luminosity $8 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1} \rightarrow 40 \times \text{KEKB!}$
with \geq beam currents, \ll beams size at interaction



HER = High Energy Ring
LER = Low Energy Ring

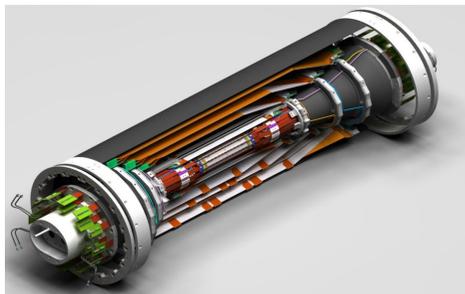


\Rightarrow severe beam-induced bkg & radiation doses
Mainly $e^+e^- \gamma$ from e^+e^- pair production in $\gamma\gamma$ scattering, **radiative Bhabha**, **Touscheck**, **off-momentum** particles from beam-gas, Synchrotron radiation (controlled by shielding).

Belle-II VXD and its environment

- PXD**: PiXel Detector, 2 layers of DEPFET pixels
- SVD**: Silicon-strip Vertex Detector, 4 layers of double-sided silicon strips (see talk&posters)

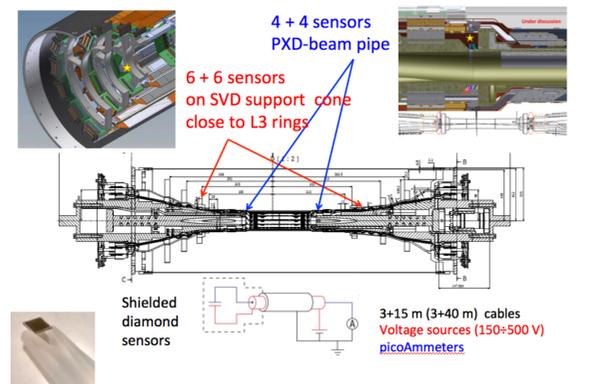
PXD
 $r = 1.4, 2.2 \text{ cm}$
SVD
 $r = 3.8, 8.0, 10.4, 13.5 \text{ cm}$



It must be protected by radiation spikes \rightarrow **abort**
Integrated radiation doses must be measured:
expected doses in Belle-II projected lifetime: PXD $\sim 20 \text{ Mrad}$ - SVD L3 $\sim 4.5 \text{ Mrad}$
Readout chips cooled by -30°C CO_2 pipes:
Humidity & temperature steadily monitored \rightarrow trigger hardwired **interlock** to VXD power supply

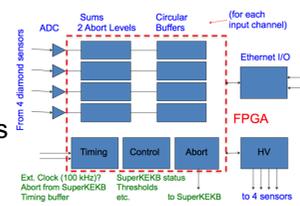
Radiation Monitoring: Diamond Sensors

Belle-II radiation monitoring system based on 20 radiation-hard **sCVD** single-crystal Chemical Vapour Deposition diamond sensors



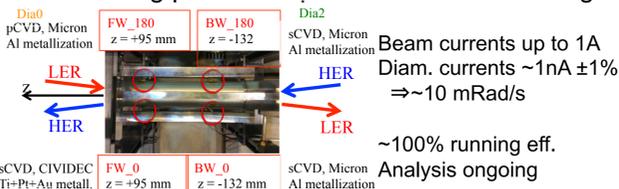
Small **sensors** $4.5 \times 4.5 \times 0.5 \text{ mm}^3$
Ti-Pt-Au metallization
Compact & shielded **Package**

Long ($\sim 30 \text{ m}$) coax **cables** direct connect HV & signal to
Remote readout
highly flexible
3 current ranges
Programmable thresholds
4 averaging levels
 $10 \mu\text{s} \rightarrow 1 \text{ s}$



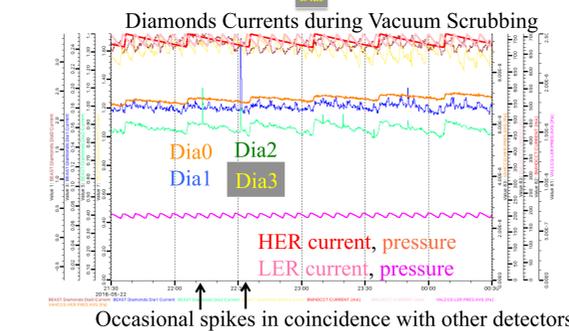
Radiation Monitoring: Phase1 Validation

Feb-Jun 2016: prototype system with 4 sensors tested during phase1 SuperKEKB commissioning

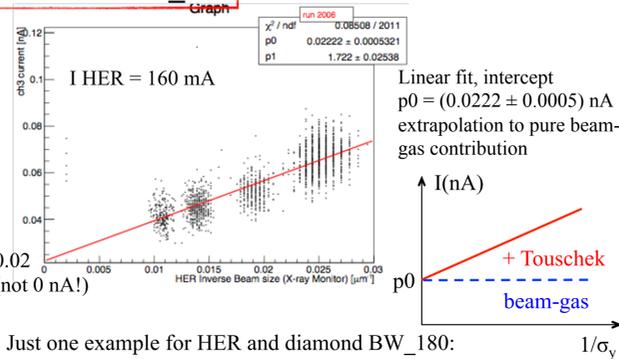


Beam currents up to 1A
Diam. currents $\sim 1 \text{ nA} \pm 1\%$
 $\Rightarrow \sim 10 \text{ mRad/s}$

$\sim 100\%$ running eff.
Analysis ongoing



Diamond BW_180 Graph



Just one example for HER and diamond BW_180:
beam vertical size = {90 μm , 75 μm , 51 μm , 46 μm , 42 μm }

T & H Monitoring: NTC, FOS, Dew Point Sniffers + PLC Interlock

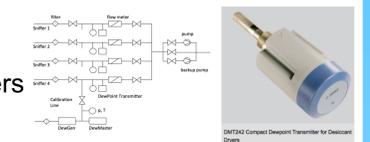
- 96 NTC sensors (in pairs) along key points in -30°C CO_2 pipes inlet/outlet circuits & ladder cooling blocks+spares



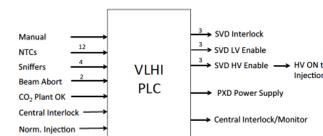
- 224 FOS sensors along 38 optical fibers embedded in the SVD layers
2 more fibers in SVD outer covers -2 half cylinders



- 4 sniffing pipes to
4 dew point transmitters



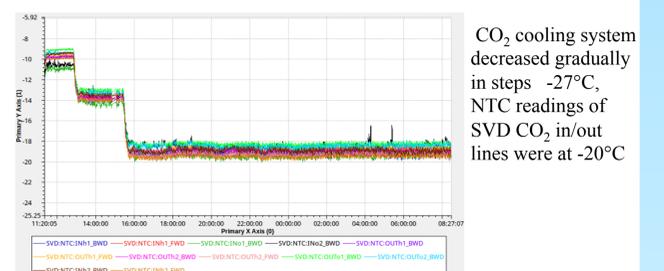
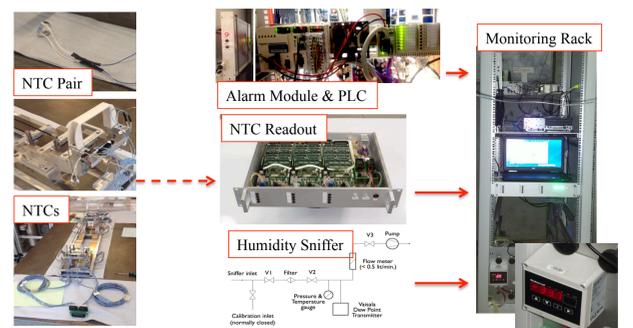
- PLC (Schneider Electric Modicon M340) + units collects input signals
delivers VXD Local
Hardwired Interlock



T & H Monitoring: DESY BT Validation

Apr 2016: during a combined PXD+SVD Beam Test at DESY a reduced monitoring system installed in the VXD cartridge (see SVD talk & posters) consisting in:

- 32 NTC sensors with final readout
- 1 prototype fiber with 5 FOS sensors
- Pump + sniffing pipe + 1 Dew Point transmitter
- Alarm Module+ Schneider PLC



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