Geant4-based Simulation of a beam radiation monitor for SUPERB

FRONTIER DETECTORS FOR FRONTIER PHYSICS
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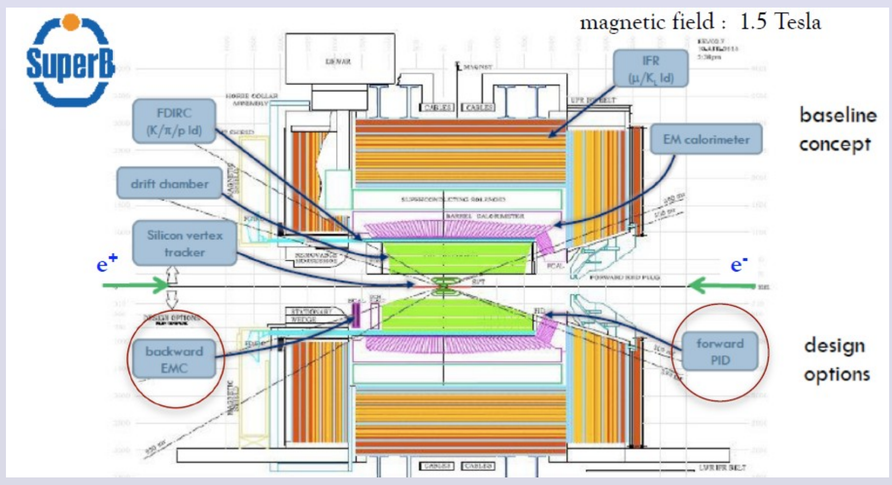
1. The SuperB project

- **Goal: perform precision measurements in flavour sector sensitive to New Physics**
  - interference effects in known processes, SM rare or forbidden decays
- Complementary/alternate path with respect to direct searches at LHC
- Requires very-high-statistics data samples
- Severe requirements on the accelerator design
- **The accelerator:**
  - asymmetric e+e- machine
  - CM energies:
    - mainly Y(4S) mass
    - also runs at Psi(3770), and scan between Y(1S) and Y(6S)
    - Design luminosity: 10^{36} cm^{-2} s^{-1} @ Y(4S)
- **Project status:**
  - approved by Italian government in Dec 2010
  - Site chosen in May 2011: Roma Tor Vergata University Campus
  - Goal is an integrated Luminosity of 75 ab^{-1} at Y(4S) in 5 years

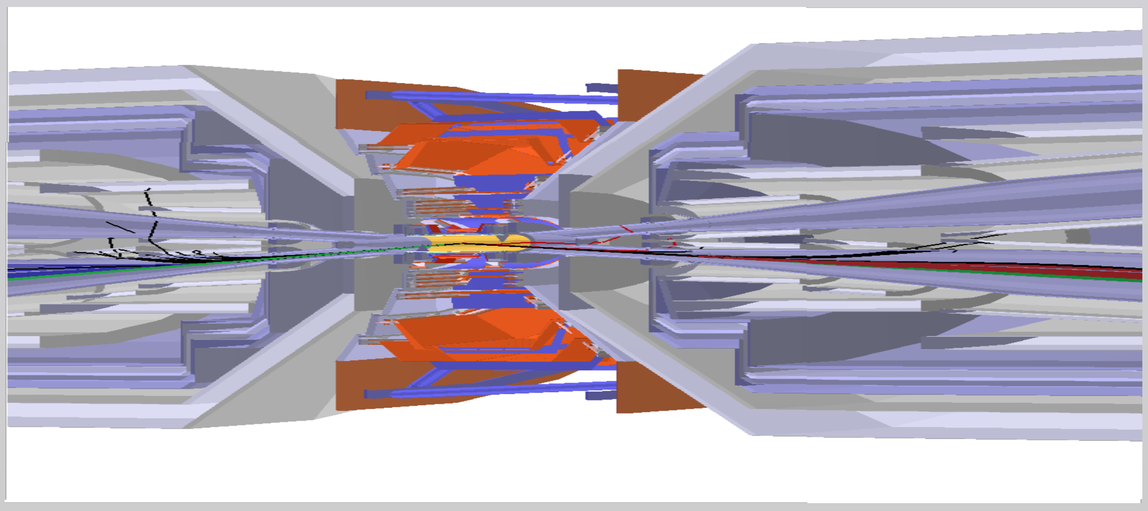
2. The SuperB detector and radiation monitoring



- Large beam intensities create a very demanding environment for detectors, in terms of machine-related backgrounds
  - Need to mitigate the impact on physics measurements by carefully designing the interaction region and introducing optimal shieldings
  - Constant monitoring of radiation dose close to the interaction point also crucial for safe operation of the beam and detector
- The radiation monitor for the SuperB experiment will be placed very close to the beam line
  - Expected dose and hit rate are of paramount importance for the choice of the detection technology
  - Need of a detailed simulation of the interaction region and the main machine-related background processes

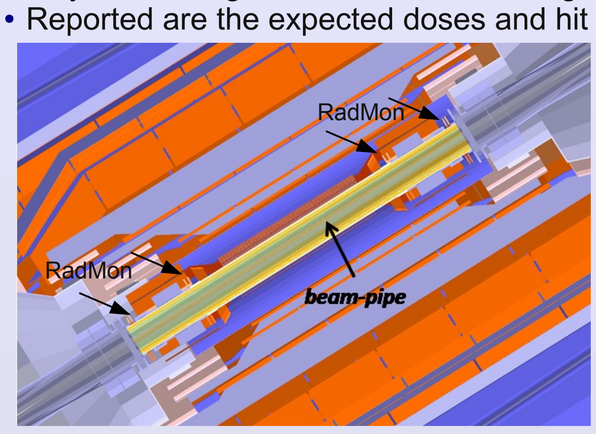
3. Software tools

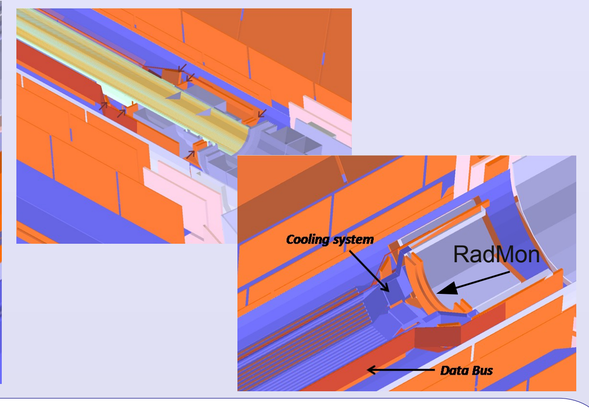
- Bruno: the SuperB full simulation software
  - Based on the Geant4 toolkit
    - Accurate description of physics processes
    - Precise model of the interaction region and all subdetectors
  - Allows to input events from external generators, and easily define scoring volumes for dose/rate evaluation
- Picture shows a display of a bunch crossing, with simulation of the radiative-Bhabha background
  - Beam pipe, shielding and Si tracker (SVT) are clearly visible, as well as off-momentum beam particles



4. Radiation Monitors: proposed locations

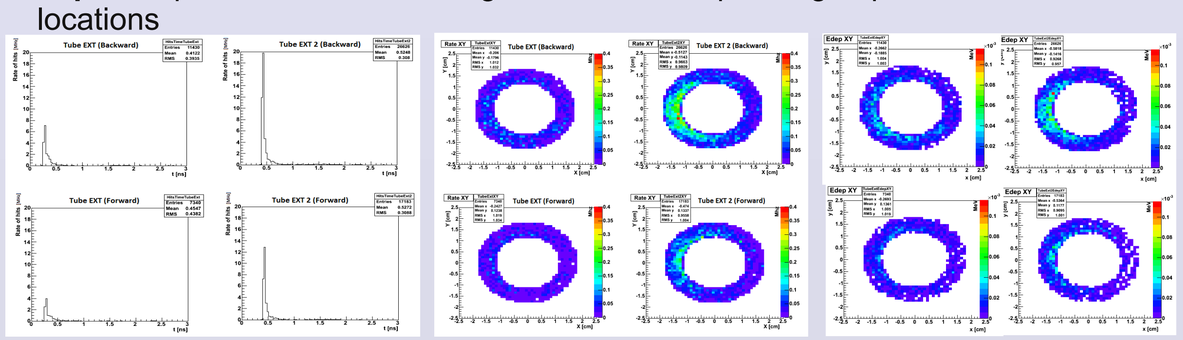
- The available area for the RadMon near the inner layer of SVT is very small
  - Beam pipe and supports
  - Services (cooling/readout) for the Si tracker
- Still, it was possible to identify regions with enough unallocated space to host a relatively small (<1cm) detector element
- Simulation was performed using the official full simulation software, and only the Radiative Bhabha background has been considered up to now
  - By far the largest cross section amongst the other backgrounds
- Reported are the expected doses and hit rates at some of those locations





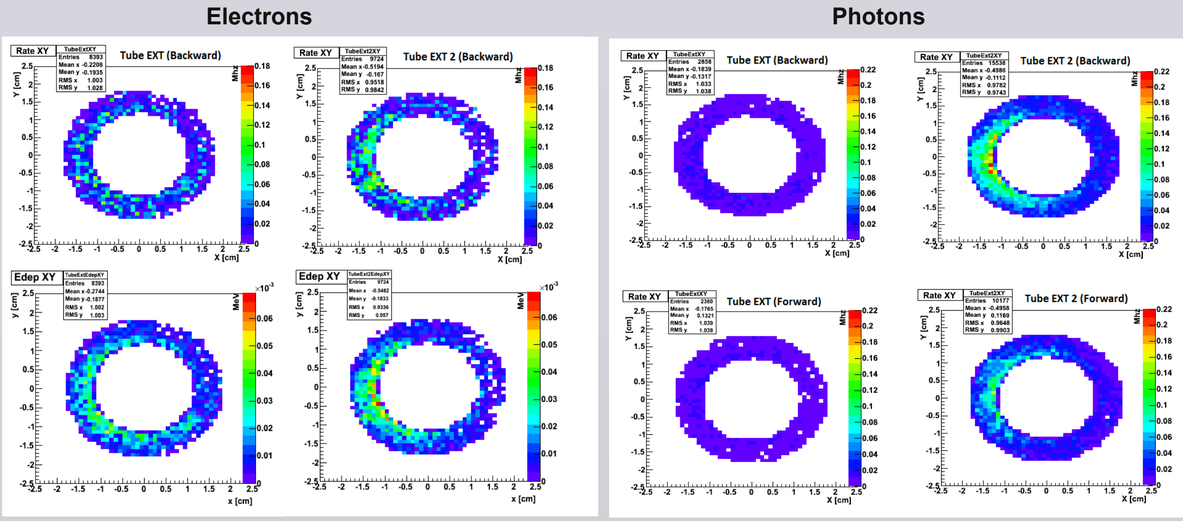
5. Radiative Bhabha background

- Results from the analysis on 130000 simulated bunch crossings, with Radiative Bhabha background are shown
- First of all, we report global **hit arrival times, rates and average energy deposits** per event in the scoring volumes corresponding to possible RadMon locations



- Shift in arrival times for downstream locations compatible with expected TOF delay
- Rate and energy deposit plots have 1mmx1mm bins
  - Rates up to 0.25 MHz/mm^2 are to be expected
  - Assuming a detector element of about 25mm^2, this corresponds to an expected rate of 6.25 MHz per detector
  - Note that the average deposited energy is, however, mostly below 1keV per event along all the scoring volumes
    - Scoring volumes placed farther from the interaction point tend to be more populated

- The same quantities have been studied for **different particle types**
- The following plots show, in the same scales and binnings as the above ones:
  - Left: the expected rates and energy deposits for electrons in the backward detectors. Due to the beam configuration, hits from electrons in the forward region are mostly absent
  - Right: expected hit rate for photons. The pattern already seen in all other plots, i.e. the tendency of the downstream detectors to be more populated, is even more evident



6. Conclusions

- Preliminary results shown here confirm that the operating environment for the SuperB Radiation Monitor will be extremely challenging
  - At about 12.5cm from the interaction point, close to the beam pipe, hit rates from Radiative Bhabha up to 0.25MHz/mm^2
    - Somewhat mitigated by rather low energy deposits per event (<1keV/mm^2)
- This information is being presently used to optimize technology for the implementation of the Radiation Monitor prototype
- Plan to include other sources of background in the near future