Impact of background on SVT performances

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Outline

- Background frames
- Initial tests in FastSim
- Plans for studies for TDR

Bkg Frames for QED Pair events

- Alejandro provided two different sets of bkg frames generated with FastSim:
  - Layer0 radius=1.4 cm (for comparison with FullSim)
    - Track rate 1.66 MHz/cm^2
  - Layer0 radius=1.6 cm
    - Track rate 1.11 MHz/cm^2

Bkg frames in FastSim

- Generate single track neutrino events with bkg frames for basic tests:
  - removed p cut for simulated particles;
  - 0.5 μs sensitive window to mix in pair backgrounds;
  - use PacDisplay module for analysis. Added new features for evaluation of multiple track interceptions in svt layers.
- Preliminary measurement of track rates and cluster rates. Several aspects still under investigation.

First comparison FastSim vs FullSim

	NEvt	N Track	N cluster	<#intercepts>	Radius (cm)	HM Length (cm)	Track FastSim MHz/cm^2	Track FullSim MHz/cm^2	Cluster FastSim MHz/cm^2	Cluster FullSim MHz/cm^2
L0	1000	993	993	1	1.4	4.55	2.82E+00	3.20	2.82E+00	8.22
L1	1000	169	191	2.936	3.32	10.73	8.58E-02	1.20E-01	9.70E-02	2.70E-01
L2	1000	166	185	5.031	4.02	13	5.74E-02	7.18E-02	6.40E-02	1.52E-01
L3	1000	128	186	6.772	5.92	19.14	2.04E-02	3.12E-02	2.97E-02	5.78E-02
L4	1000	79	109	8.176	12.22	22.28	5.25E-03	9.79E-03	7.24E-03	1.31E-02
L5	1000	92	122	8.856	14.22	30.91	3.79E-03	5.88E-03	5.02E-03	7.65E-03

Track rate on L0 is not compatible with evaluation on bkg frames directly
1.7 MHz/cm^2 (Bkg Frames) 2.8 MHz/cm^2 (FastSim).
Under investigation the method of analysis and the FastSim setup.

Nominal configuration

	NEvt	N Track	N cluster	<#intercepts>	Radius (cm)	HM Length (cm)	Track FastSim MHz/cm^2	Cluster FastSim MHz/cm^2
L0	1000	813	953	1.277	1.6	5.172	1.78E+00	2.08E+00
L1	1000	163	171	1.089	3.32	10.73	8.28E-02	8.68E-02
L2	1000	128	148	1.304	4.02	13	4.43E-02	5.12E-02
L3	1000	102	140	1.76	5.92	19.14	1.63E-02	2.23E-02
L4	1000	66	80	1.982	12.22	22.28	4.38E-03	5.31E-03
L5	1000	57	79	2.317	14.22	30.91	2.35E-03	3.25E-03

Plans for TDR studies

- Hit efficiency can be determined for each layer as a function of the bkg rates and modeled in FastSim;
- Worsening of track parameters and vertex resolution can be studied in FastSim using "hit merging" and "patRec confusion".
- Pattern Recognition is not present in FastSim but semiquantitative estimates can be provided (e.g. number of bkg hits within track uncertainty projected on silicon sensors).
- Study track parameters and vertex resolutions in presence of bkg. Finally estimate the impact on physics quantities (i.e. sin2beta per event error). Machinery for the studies is in place.
- FastSim setup requires extensive validation before proceeding with the actual bkg studies.

Some considerations

- Cluster rate is relevant for tracking and vertexing studies. Good news: factor 4-5 (2-3) reduction wrt hit rate for inner (outer) layers.
- Pairs bkg clusters are wide: 4-5 strips in inner layers (at higher occupancy) due to curling low p_t tracks. Signal clusters depend on incident angle of the track wrt sensor. Assign clusters to tracks when cluster extension is compatible with track angle. Interesting topic to be studied.
- Track time tagging in principle can improve time resolution given by the clock period. Is it useful for SuperB?
- Ideas on how further reduce/reject bkg hits are very welcome and should be stimulated.

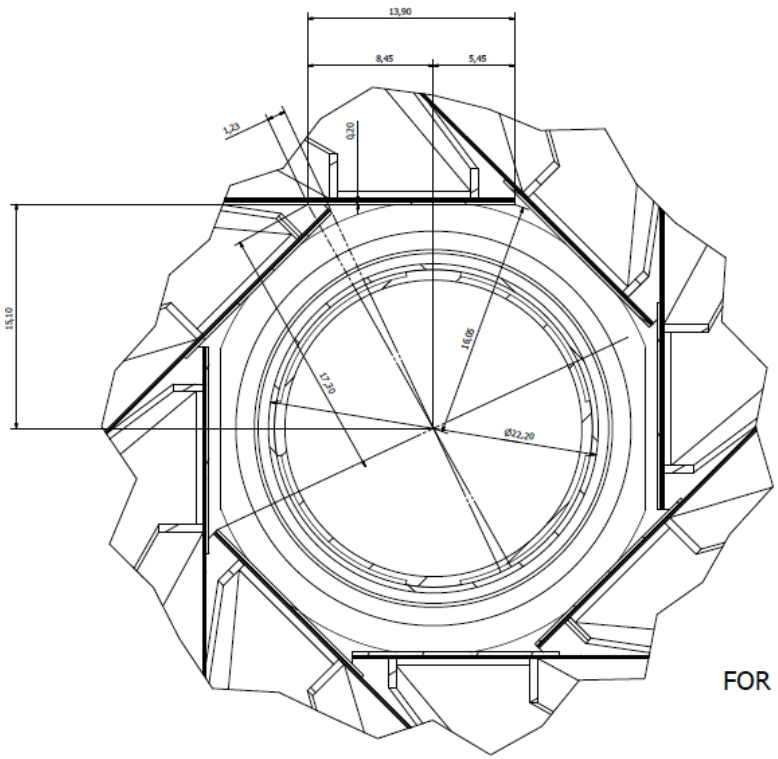
Some requests

- We should request bkg frames using Bruno with SVT with cylindrical geometry for Tousheck and radiative Bhabha events? Also for Pairs at this point.
- QED Pairs bkg seems to be under control and after Vienna. SuperB and Belle II simulations are understood and in agreement with (Belle) data. Reduction of factor 5 safety for this bkg source could be considered.

Backup

Geometries for striplet detectors

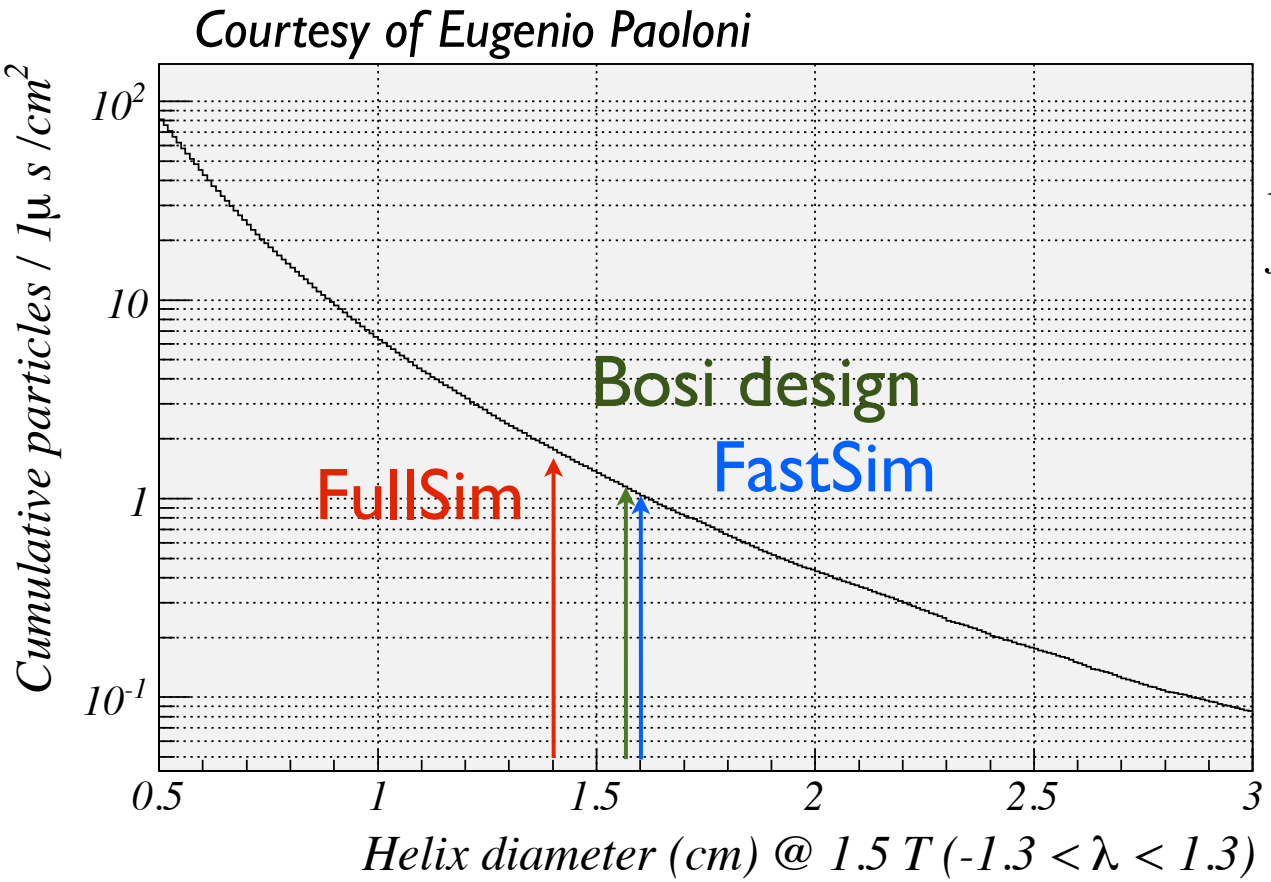
Courtesy of Filippo Bosi



	Average radius
Bosi design	15.64 mm
FastSim	16.00 mm
FullSim	14.02 mm

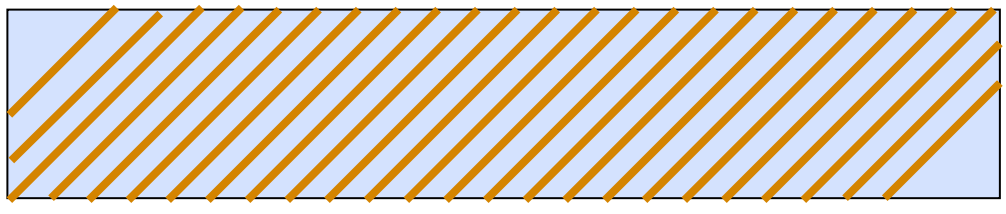
L0 parameters in simulations need to be updated according to new Bosi design.

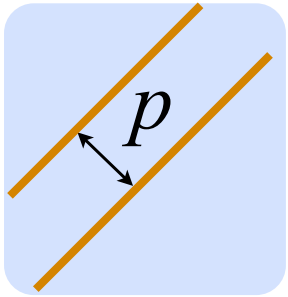
QED Pairs Bkg rates vs L0 radius



Bkg rates evaluated with FullSim for striplets are overestimated so far. Should be evaluated with new Bosi geometry.

Estimate for L0 striplets occupancy





$$Occ = B \cdot T \cdot p\sqrt{2} \cdot W = 0.8\%$$ at radius 15.64 mm

4.0% with x5 safety factor

B = *hit rate/Area = 17 MHz/cm^2*
T = *50 ns (L0 sensitive window)*
p = *50 μm (pitch)*
W = *13.9 mm (detector width)*

Changes also in striplets efficiency 99.0% (95.4% x5 safety factor)
Now in FastSim we have 90%

dead time due to analog 2.5 x shaping time

Comparison with occupancy for Layer1 of the BaBar SVT

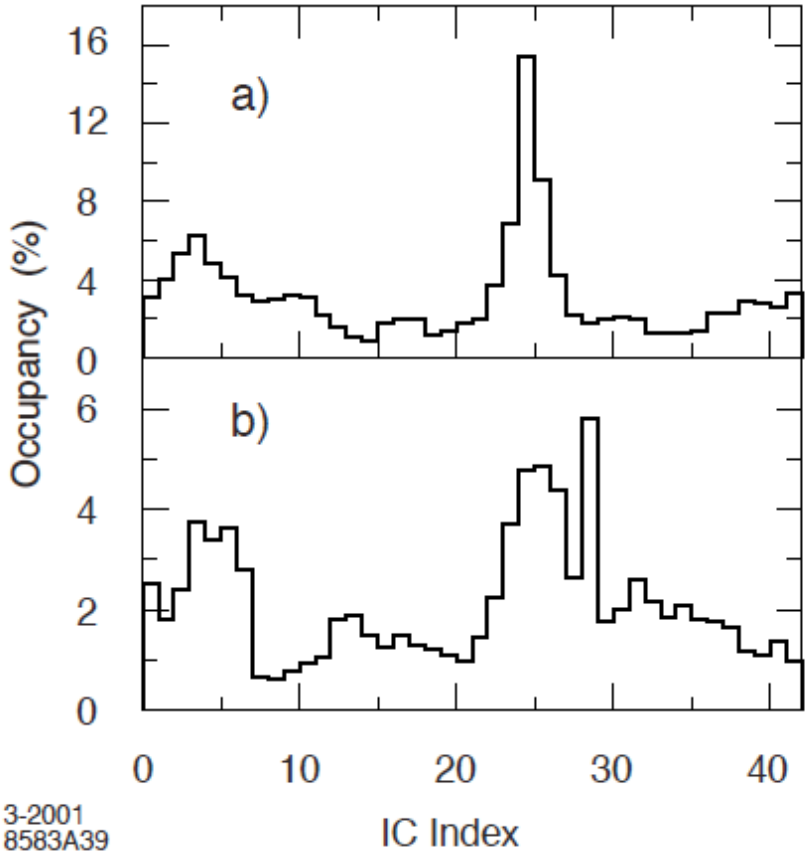


Figure 23. Typical occupancy in percent as a function of IC index in layer 1, ϕ side for a) forward half-modules and b) backward half-modules. The IC index increases with azimuthal angle and the higher occupancy in the horizontal plane is visible near chip indices 3 and 25.

Under normal running conditions, the average occupancy of the SVT in a time window of 1 μs is about 3% for the inner layers, with a significant azimuthal variation due to beam-induced backgrounds, and less than 1% for the outer layers, where noise hits dominate. Figure 23 shows

The offline time window cut in BaBar was 200ns. Hence, the offline average occupancy for L1 was 0.6%, to be compared with 0.8% (4.0% with x5 safety factor) occupancy for L0 striplets detector of SuperB.