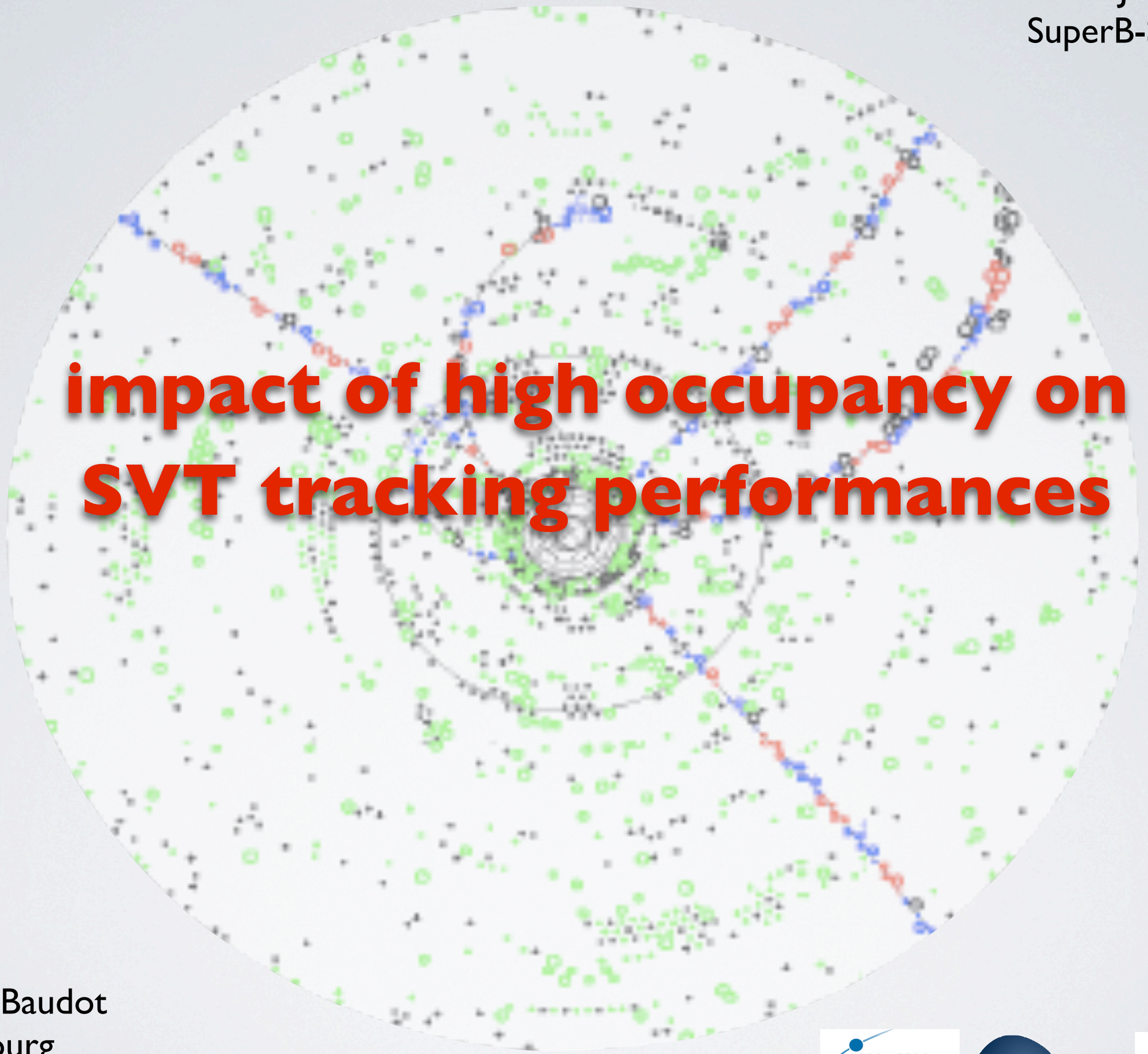
July 13th, 2012
SuperB-SVT meeting



impact of high occupancy on SVT tracking performances

Isabelle Ripp-Baudot
IPHC Strasbourg
CNRS/IN2P3 and Université de Strasbourg

inputs for the TDR (Nicola/Isabelle)

- Preliminary considerations:
  - No detailed studies of tracking performances because no full pattern recognition algorithm in the SuperB Fastsim.
  - The ALICE experiment identified as a good benchmark for the SuperB SVT.
  - Tracking performances will be impacted by cluster off-line occupancy.

    - BaBar SVT monitoring data ➛ compare BaBar observed off-line cluster occupancy with SuperB predictions.
    - BaBar SVT Long Term Task Force study (BaBar AD #707)
      ➛ predict for each layer in SuperB: hit-to-track matching efficiencies,
      hit detection efficiencies,
      hit global efficiencies.
    - SuperB predicted hit detection efficiencies are compared with an ALICE study (simulations) of tracking efficiencies as a function of layer hit detection efficiencies.

➛ Conclusion:

- better tracking performances expected in SuperB with nominal background than BaBar,
- achievable with x5 safety factor on background included.

BaBar SVT monitoring data (I)

- BaBar SVT monitoring data taken in January 2008 (inst. lumi. = 1.2×10^{34} cm^{-2} s^{-1})

➛ measured maximal occupancy (based on Fast Monitoring plot limit values for occupancies).

- cluster occupancy = ratio of strips with signal / strip multiplicity in a cluster.

- on-line vs. off-line occupancy: to reconstruct tracks a narrow off-line cut is applied on the hit time-stamp.

➛ see next slide with Nicola's calculations.

Details available on:
https://sbdocserver.pd.infn.it:5210/share/page/site/svt-pat-rec/documentlibrary

BaBar SVT monitoring data (2)

BaBar

	Average Strip Occ (%)	Cluster Size	Average Cluster Occupancy (%)	Average Offline Cluster Occ(%)
L1 phi	11.88	2.35	5.05	2.02
L1 z	12.25	3.13	3.91	1.57
L2 phi	9.14	2.27	4.02	1.61
L2 z	9.58	3.17	3.02	1.21
L3 phi	6.29	2.09	3.01	1.20
L3 z	4.60	3.33	1.38	0.55
L4 phi	2.17	1.70	1.27	0.51
L4 z	1.61	1.82	0.88	0.35
L5 phi	2.09	1.64	1.28	0.51
L5 z	2.02	1.87	1.08	0.43
Average	6.16	2.34	2.49	1.00

SuperB

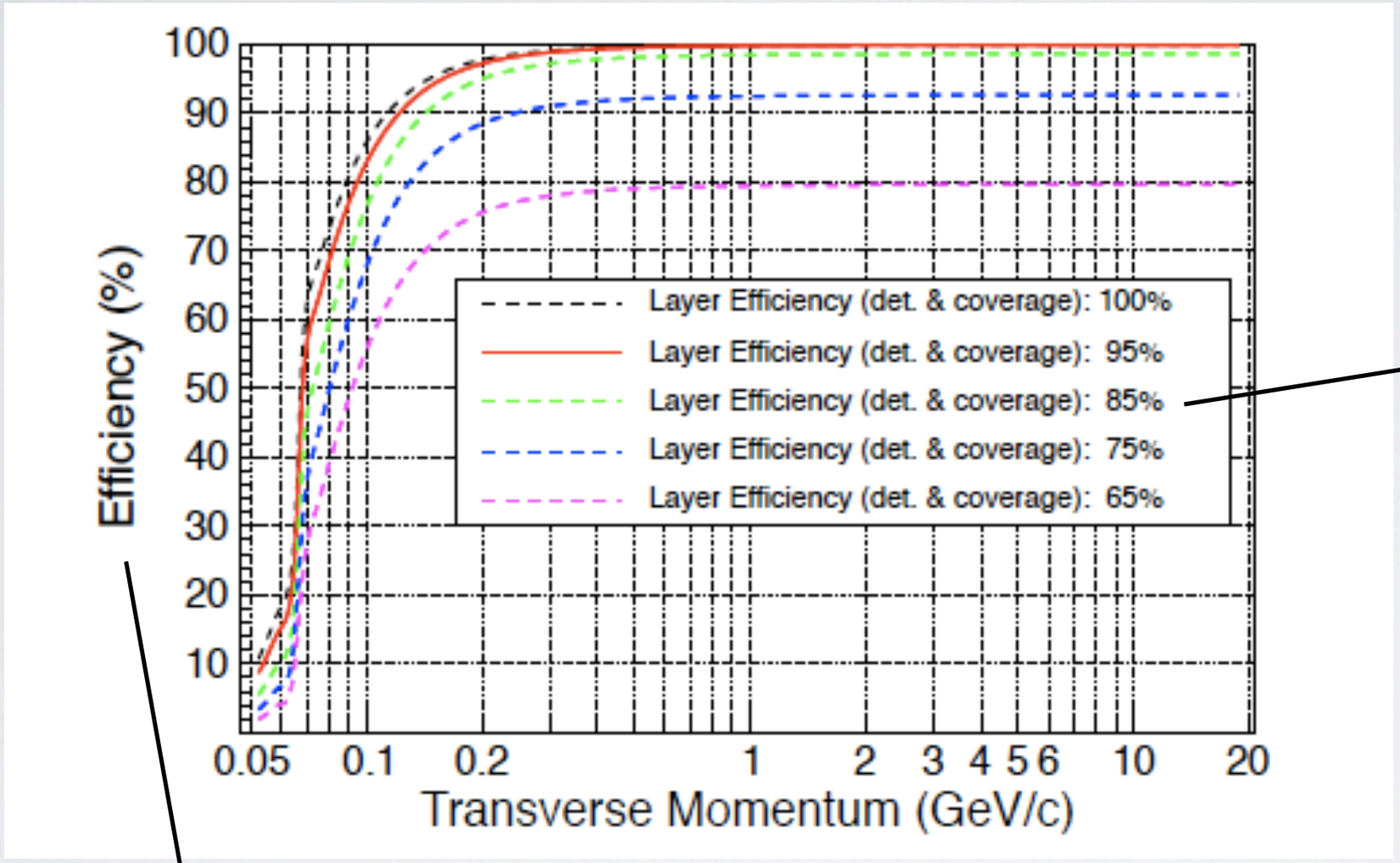
	Offline occ. (%) nominal peaking time	x5 Bkg	5x Bkg +/- 3 sigma TW	Offline occ (%) short peaking time	x5 Bkg	x5 Bkg +/- 3 sigma TW
L0 u	0.39	1.94	1.16	0.39	1.94	1.16
L0 v	0.38	1.92	1.15	0.38	1.92	1.15
L1 phi	0.34	1.69	1.02	0.30	1.49	0.90
L1 z	0.26	1.30	0.78	0.23	1.15	0.69
L2 phi	0.33	1.63	0.98	0.29	1.43	0.86
L2 z	0.22	1.10	0.66	0.19	0.97	0.58
L3 phi	0.61	3.06	1.83	0.39	1.96	1.18
L3 z	0.25	1.25	0.75	0.16	0.80	0.48
L4 phi	0.37	1.84	1.10	0.28	1.42	0.85
L4 z	0.26	1.31	0.79	0.20	1.02	0.61
L5 phi	0.54	2.68	1.61	0.21	1.07	0.64
L5 z	0.32	1.62	0.97	0.13	0.65	0.39
Average Occ (%)	0.36	1.78	1.07	0.26	1.32	0.79

BaBar AD #707 (2004)

Layer	on-line strip occupancy (x5 included)	off-line cluster occupancy (x5 included)	hit detection efficiency (simulation) (x5 included)	hit-to-track matching efficiency (estimation from off-line cluster occ.)	total hit efficiency
0 φ	0.28	0.023	0.96	0.96	0.92
0 z	0.28		0.96		0.92
1 φ	0.25	0.022	0.88	0.96	0.84
1 z	0.20		0.89		0.85
2 φ	0.20	0.019	0.89	0.97	0.86
2 z	0.20		0.89		0.86
3 φ	0.20	0.050	0.77	0.88	0.68
3 z	0.17		0.86		0.76
4 φ	0.12	0.025	0.89	0.96	0.85
4 z	0.07		0.93		0.89
5 φ	0.08	0.034	0.86	0.93	0.80
5 z	0.04		0.91		0.85

ALICE upgraded ITS

Fig. 3.3 from Progress Report on the Conceptual Design Report for the Upgrade of the ALICE ITS, June 18, 2012



all 7 layers have 85 % detection ε each.

in SuperB: ~ 90 % averaged over all layers and sides.

global tracking efficiency = detector efficiency x matching efficiency

$$\varepsilon = \frac{\text{tracks reconstructed with at least 4 clusters and no fake clusters}}{\text{all trackable particles (= crossing at least 4 layers)}}$$

ALICE Inner Tracking System

- Documention:
  - ALICE ITS: http://aliceinfo.cern.ch/ITS
  - ALICE ITS Upgrade: http://aliceinfo.cern.ch/ITSUpgrade/

  and also: Progress Report on the Conceptual Design Report for the Upgrade of the ALICE ITS, June 18, 2012 (aliceinfo.cern.ch/ITSUpgrade/node/15).

- ALICE ITS: outer radius = 43 cm with B = 0.5 T
  w.r.t. SuperB SVT : 14 cm with B = 1.5 T

current ITS:

analogue read-out for dE/dx

Layer	Det.	Radius (cm)	Length (cm)	Surface (m2)	Ch.	Spatial precision (mm)		Cell (μm2)	Max occupancy central PbPb (%)	Power dissipation (W)		Material budget (% X/X0)
						rφ	z			barrel	end-cap	
1	SPD	3.9	28.2	0.21	9.8M	12	100	50x425	2.1	1.35k	30	1.14
2		7.6	28.2						0.6			1.14
3	SDD	15.0	44.4	1.31	133K	35	25	202x294	2.5	1.06k	1.75k	1.13
4		23.9	59.4						1.0			1.26
5	SSD	38.0	86.2	5.0	2.6M	20	830	95x40000	4.0	850	1.15k	0.83
6		43.0	97.8						3.3			0.86

ITS standalone tracking for very low momentum particles (80-100 MeV).

ALICE ITS Upgrade

- Upgraded ITS: to improve pointing resolution by at least x3.

because current ITS not sufficient for:
- low momenta < 2 GeV,
- charm baryons ($c\tau$ from Λ_c ~ 60 μm < $\sigma(IP_{R\varphi})$),
- read-out rates.

Also: detector occupancy increases (pile-up)
➢ track reconstruction ε drops due to cluster/track association ambiguity at inner layers (particularly at low momentum).

- Particle flux: ~100 particles / cm^2 per recorded event (pile-up, ~ no background) in the first layer of the upgraded ITS (2.2 cm)

to be compared to SuperB: 100 MHz / cm^2 (x5 safety factor included) at Layer-0 (1.5 cm).

Layer / Type	r [cm]	$\pm z$ [cm]	Intrinsic resolution [μm] $r\phi$	z	Material budget X/X_0 [%]
Beam pipe	2.0	-	-		0.22
1 / new pixel	2.2	11.2	4	4	0.30
2 / new pixel	2.8	12.1	4	4	0.30
3 / new pixel	3.6	13.4	4	4	0.30
4 / new pixel / strip	20.0	39.0	4	4	0.30
5 / new pixel / strip	22.0	41.8	4	4	0.30
6 / new pixel / strip	41.0	71.2	4	4	0.30
7 / new pixel / strip	43.0	74.3	4	4	0.30

PbPb event @ 2.76 A TeV