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SVT Rate Study with Background

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https://indico.bnl.gov/event/30532/contributions/118673/

Contents

- Simulation files and workflow
- **Results**
- Summary and plan

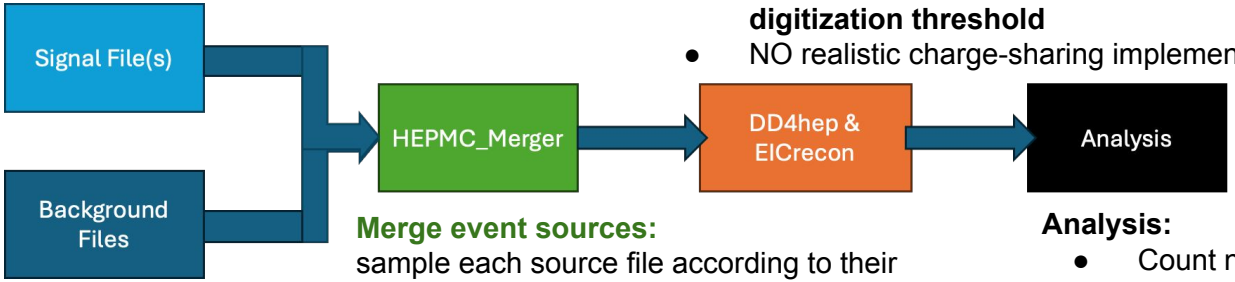
DIS Signal+Background Event Samples

Raw source files:
1 event = one collision

merged

1 event = one 2us time slice that contains (in this presentation):
- One Q^2>1 GeV^2 NC DIS events
- Beam background at calculated freq.

Sensor response:
- Each sensitive pixel is 20x20x40um (L,W,T). with **0.54 keV digitization threshold**
- NO realistic charge-sharing implemented



Merge event sources:
sample each source file according to their frequency within a fixed-length (2us) time window (details)

Analysis:
- Count number of digitized hits on SVT per area per unit time
- Assume 3 pixels/hit

Event	signal	synrad	ebrems	etouschek	ecoloumb	p.b.gas
Event 1	🔴	⚪⚪⚪⚪	🔵			
Event 2	🔴	⚪⚪⚪⚪			🟡	🟣
Event 3	🔴	⚪⚪⚪		🟢		
Event 4	🔴	⚪⚪⚪	🔵			🟣
Event 5	🔴	⚪⚪⚪⚪	🔵			

DIS Signal+Background Event Samples

Table from Background wiki
See Sakib's talk for available files

This table shows the rates for electron+proton beam configurations:

Electron beam-gas rates consider larger region of -5 to +15 meters along the IP, hadron beam-gas rates consider region of -5.5 to +5 meters.

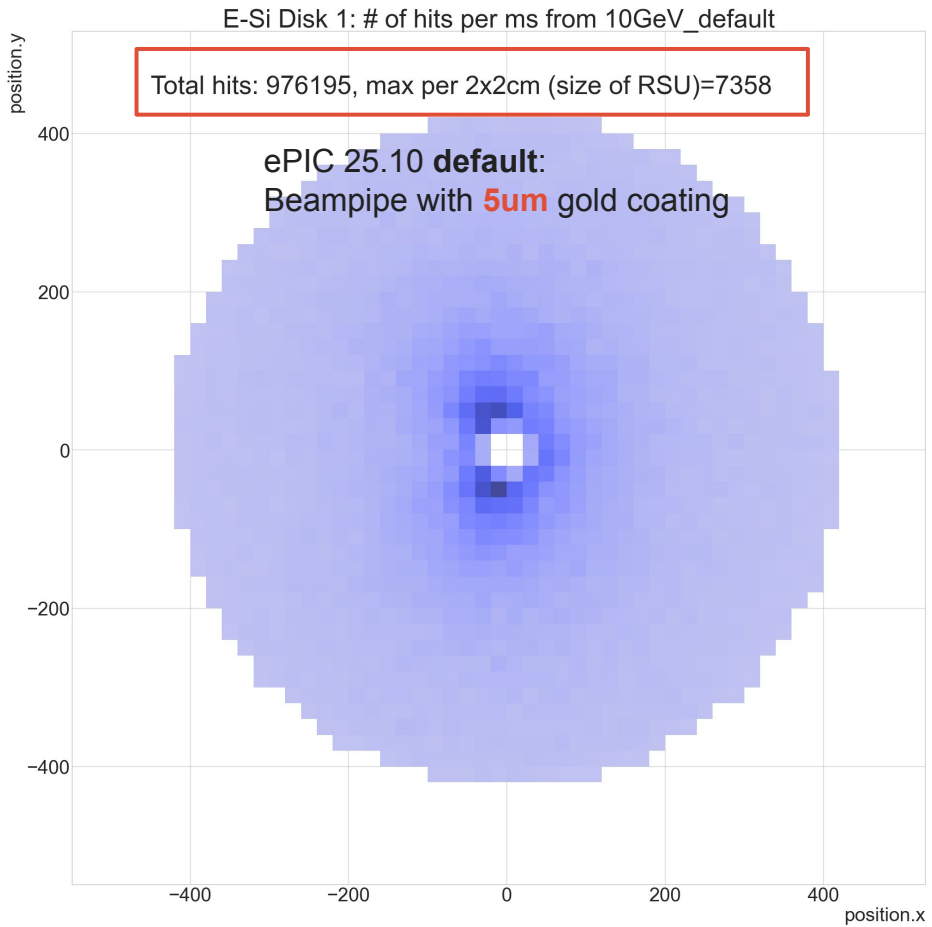
rates in kHz	5x41 GeV	5x100 GeV	10x100 GeV	10x275 GeV	18x275 GeV	Vacuum
Total ep	12.5 kHz	129 kHz	184 kHz	500 kHz	83 kHz	
hadron beam gas	12.2kHz	22.0kHz	31.9kHz	32.6kHz	22.5kHz	10000Ahr
	131.1kHz	236.4kHz	342.8kHz	350.3kHz	241.8kHz	100Ahr
electron beam gas (Bremsstrahlung scatterings)	2181.97 kHz	2826.38 kHz	3177.25 kHz	3177.25 kHz	316.94 kHz	10000Ahr
electron beam gas (Coulomb losses - w/ collimators)		116.57 kHz		29.56 kHz	0.86 kHz	10000Ahr
electron intrabeam (Touschek losses - w/ collimators)		1112.3 kHz		233.5 kHz	0.55 kHz	
DIS eA	kHz	kHz	kHz	/	/	
hadron beam (Au) gas	7.36kHz	10.3kHz	10.3kHz	/	/	10000Ahr
	79.1kHz	110.7kHz	110.7kHz	/	/	100Ahr
electron SR		36608 MHz		36608 MHz	3324 MHz	

- SR events are provided at the outer surface of beampipe. See note

This talk will focus on 10x275 (highest rate). Sample size = 1000 events.

Count the SVT Hits

- ➔ plot digitized hits (edep > 0.54 keV) on each SVT surface
  - ◆ Rphi v.s. Z on barrels
  - ◆ x v.s. y on disks
- ➔ accumulate number of hits per
  - ◆ 2x2cm square (roughly size of one RSU = 12 tiles),
  - ◆ or 9.8x3.5mm (tile)
- ➔ Show **accumulated/averaged** counts per **ms** (500 x 2us slices → kHz)



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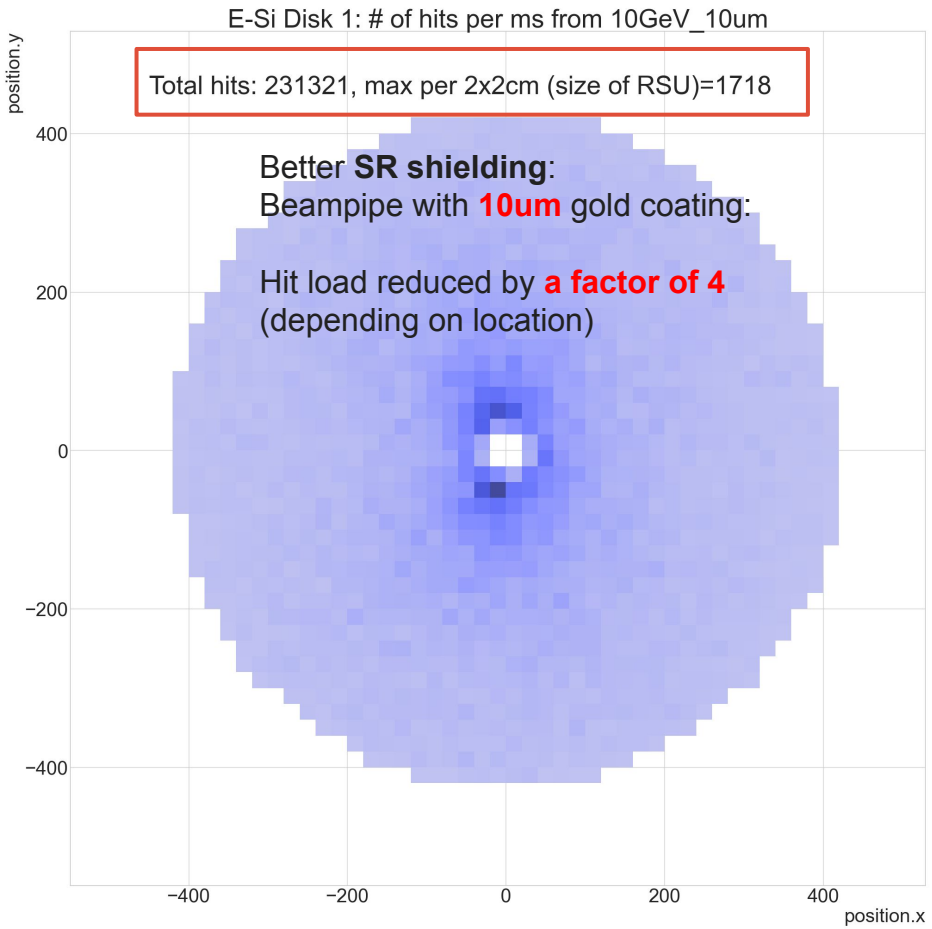

Hits to Data Rate

Ref: Jo Schambach, and Joao de Melo at SVT Oxford working meeting

10x275 beam, 10um gold coating, **accumulated/averaged** 1ms of hits:

Layer name	Total hits	MAX hit on a single RSU (20x20mm)	Tile (9.8x3.5mm)
E-Si Disk 4	30,796	46	12
E-Si Disk 3	144,894	394	71
E-Si Disk 2	222,634	1326	212
E-Si Disk 1	231,321	1718.5	230
E-Si Disk 0	129,168	1611.5	258
H-Si Disk 0	111,486	1405.5	201
H-Si Disk 1	155,315	1301	250
H-Si Disk 2	36,345	144.5	35
H-Si Disk 3	6,602	137	28
H-Si Disk 4	5,001	86	18
L0	360,929	4330	594
L1	251,520	2188.5	250
L2	154,420	538	73
L3	493,530	711.5	110
L4	314,902	217.5	39

Work within SVT-DSC has focused on the bandwidth out of MOSAIX and EIC-LAS. Assume:

- 3 pixels per hit
- 32 bits per pixel on average

Then, OB and disk max. rates are:

- 258 hits/tile/ms * 3 pixels/hit * 32 bits/pixel = **25 Mbps/tile**
- 1720 hits/RSU/ms * 96 bits/hit = **165 Mbps/RSU**

Multiply by 5 (6) for EIC-LAS with 5 (6) RSUs (12 tiles/RSU)

For the IB (L0, L1, L2), the max. rates are:

- 594 hits/tile/ms ⇒ **57 Mbps/tile**
- 4330 hits/RSU/ms ⇒ **415 Mbps/RSU**

Sensor noise, estimated at 5 Mbps/RSU, is not included in these estimates.

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Total rates out of SVT (no sensor noise)**:**

- IB (L0,L1,L2): 74 Gbps
- OB (L3, L4): 78 Gbps
- Disks (E): 73 Gbps
- Disks (H): 30 Gbps
- Total: **254 Gbps**

Rates receive a large contribution from SR

For reference, total rate is **76 Gbps** at **18x275 GeV,** for 5um gold coating (10um not yet in hand).

Summary

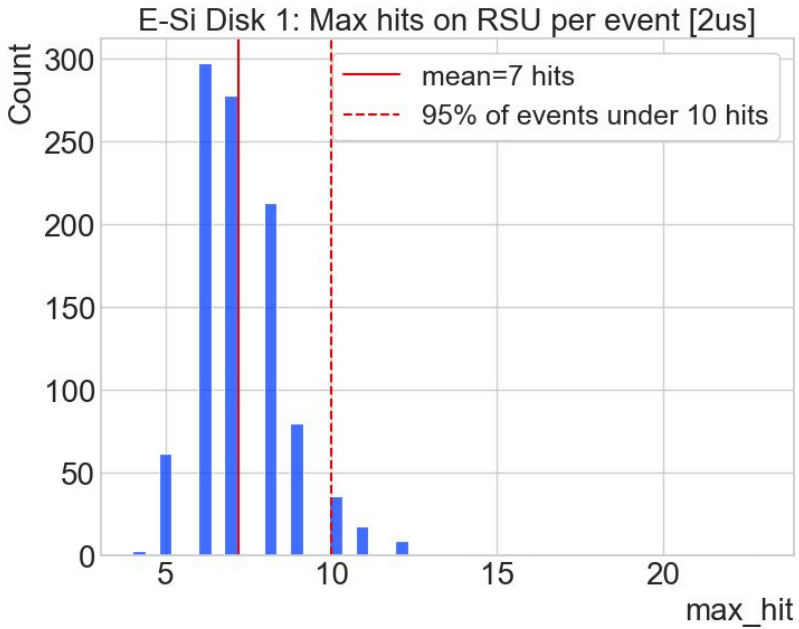
- Rate study with 18 and 10 GeV electron beam are available. The 10GeV configuration are studied with
  - the standard beampipe, and beampipe with a thicker gold coating,
  - a sample of 1000 DIS-background mixed events with the current detector configuration.
- Hit rates (average, event-by-event) are converted to data rates,
- Current estimates are **254 (76) Gbps** in the **10 (18) x 275 GeV** beam configuration, i.e. large, based on simulations with 10 (5) um Au coating of the beampipe.
- Ongoing work within SVT-DSC, tracking, and reconstruction groups:
  - Complete evaluations for the set of configurations (10 x 275 GeV is worst case),
  - Study tracking performance (demonstrated for 18 x 275 GeV),
  - Improve sensor response,
  - Model frame-by-frame fluctuations, i.e. studies beyond averages.
- Also aware of ongoing efforts within the machine group to (further) reduce S.R. background

Backup

Frame to Frame Fluctuation

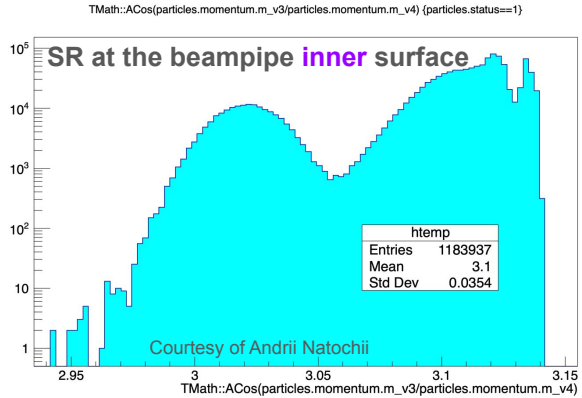
Distribution of the max number of hits at any RSU/event [2us frame] on a given layer:

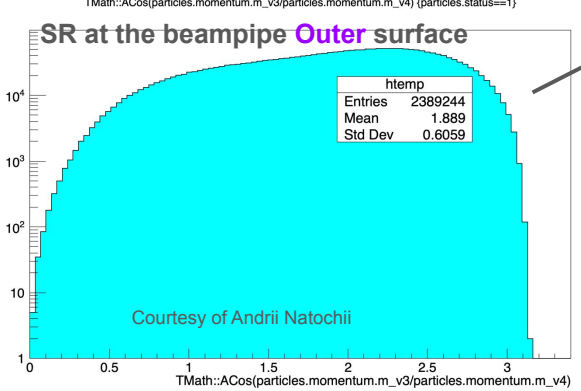
- For each event, a different RSU can take the max hits.
- **ED1:** 10 hits/ RSU/2us → 480 Mbps/RSU which is much larger than the previous max of 165Mbps/RSU from the accumulated counts on a specific RSU



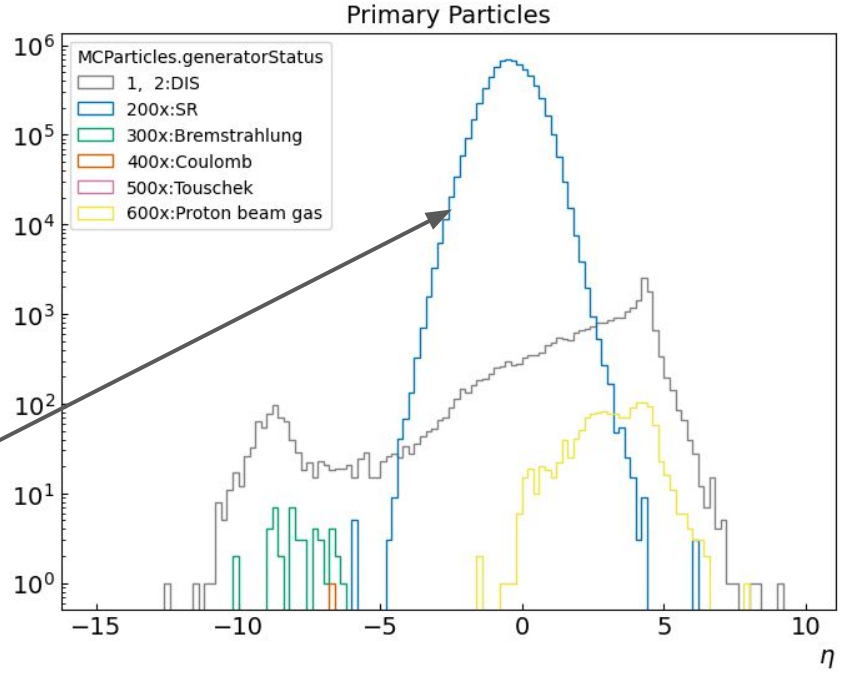
Signal+Background Event Samples

Theta distribution





eta distribution, 18x275, 1000 time slices



Notes on 10 GeV SR:

https://wiki.bnl.gov/EPIC/index.php?title=Synchrotron_Radiation