

Occupancies in T1 at  $\mathcal{L} = 2 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

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## Background

- Past work suggests three problems for SciFi operation in future upgrade ([U. Uwer](#)):
  - 1. Occupancy per channel
  - 2. Radiation damage to fibres
  - 3. Radiation damage to SiPMs
- This talk will directly address point 1, which also has implications for 2.
- Point 3. not discussed here

## Where is the problem with occupancy

	No IT	No ½ IT	No ¼ IT	No 1/8 IT	No 6/100 IT	Full FT
Seed ghostrate	1.3 %	3.0 %	6.2 %	9.7 %	12.8 %	19.4 %
Seed eff (fromB)	64.6 %	70.7 %	75.2 %	78.3 %	80.6 %	83.2 %
Forward ghostrate	30.4 %	30.6 %	31.1 %	32.2 %	33.6 %	38.6 %
Forward eff (fromB)	71.5 %	77.9 %	82.2 %	85.5 %	87.6 %	90.5 %

- With current SciFi, removing an IT-sized region lowers the ghost rate by an order of magnitude ([Jacco De Vries](#))
  - Occupancy is only a problem in the innermost regions
  - If we remove a large enough region, ghost rate will be under control for 10X luminosity

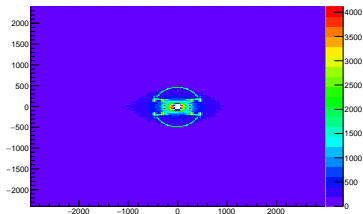
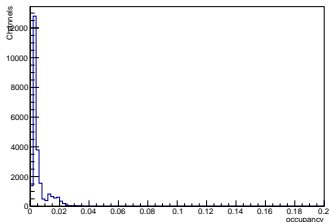
## Simulated sample

- MinBias sample simulated with current upgrade geometry, but  $\mathcal{L} = 2 \times 10^{34} \text{cm}^{-2} \text{s}^{-1}$  (Jacco De Vries)
  - Thanks to Mark Williams
- At present, tracking won't run on this sample (memory issues)
- For now, no detailed studies of efficiency / ghost rate
  - Use occupancy as a proxy
  - Make like-for-like comparison with current SciFi

## Method

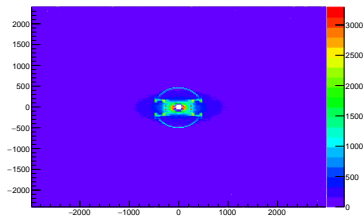
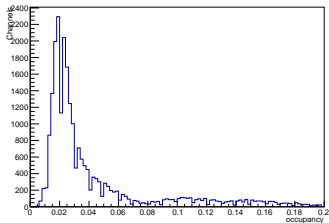
- Take MCParticles matching 'StableCharged'
- Transport to T1 Z location, save XY positions
  - Thanks to Laurent Dufour
- Count particle hits per 250  $\mu\text{m}$  channel, divide by nEvents and call this occupancy
- Several caveats:
  - No clustering
  - No noise
  - No spillover
  - Secondaries simulated according to current upgrade geometry  
→ no secondaries from new IT

# SciFi at $\mathcal{L} = 2 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$



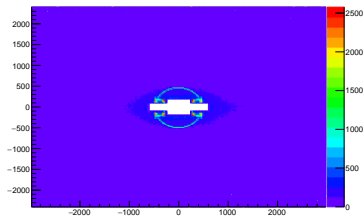
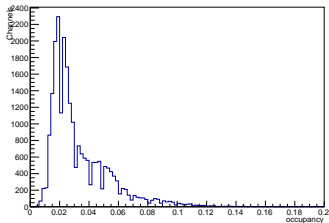
- To get a baseline, determine occupancies for current upgrade geometry
- MinBias,  $\nu = 7.6$
- Tracking performance acceptable at  $2 \times 10^{33}$  with this occupancy  $\rightarrow$  look for a SciFi+IT geometry which gives similar occupancy at  $\mathcal{L} = 2 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

SciFi at  $\mathcal{L} = 2 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$



- Now raise luminosity by a factor 10
- Occupancies bad

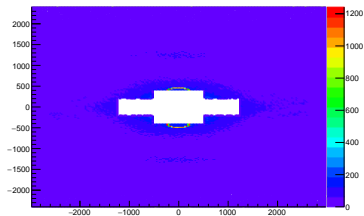
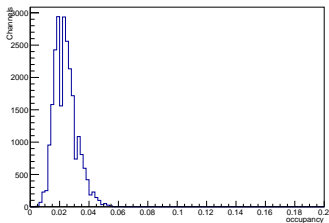
## SciFi + IT



- SciFi + new detector with current IT dimensions
- Occupancy higher than current SciFi

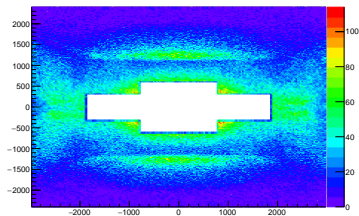
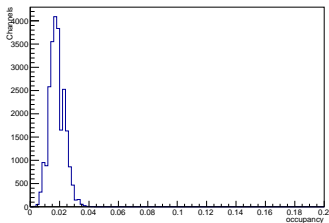


# SciFi + ITx2



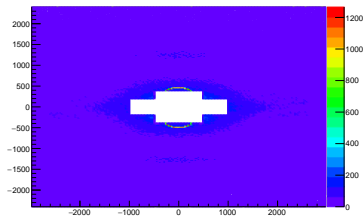
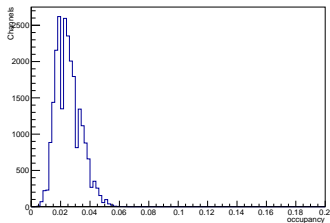
- SciFi + new detector with 2x current IT dimensions
- Occupancy closer to current SciFi

# SciFi + ITx3



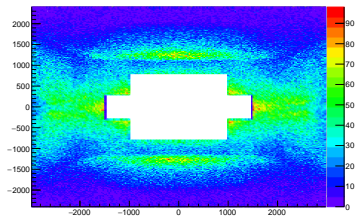
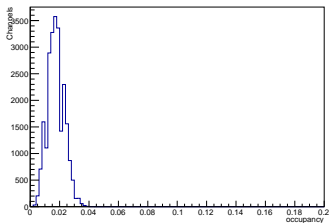
- SciFi + new detector with 3x current IT dimensions
- Occupancy closer to current SciFi

# SciFi + four module width IT



- Easier to have IT boundaries to exactly match SciFi module boundaries
  - IT extends exactly two modules either side of beampipe

# SciFi + six module width IT



- Easier to have IT boundaries to exactly match SciFi module boundaries
  - IT extends exactly three modules either side of beampipe

## Conclusion

- SciFi occupancy would be too high for future upgrade
- By adding a new inner tracker, this can be reduced considerably
- Current IT size looks too small, probably needs to be a factor 2-3 larger for  $\mathcal{L} = 2 \times 10^{34} \text{cm}^{-2} \text{s}^{-1}$ 
  - Need detailed track reconstruction studies to see how high an occupancy we can get away with
  - Current estimates do not include Secondaries generated by IT!
- IT width of six SciFi modules looks a reasonable starting point