Background Inclusion - desired changes for the Far-Backwards region

Simon Gardner - 05/09/2023

Bremsstrahlung is not being included as a background

Essential to be able to fully develop and understand reconstruction behaviours.
18.7 Bremstrahlung interactions per bunch crossing @ 18x275 GeV with e- energy >0.1 GeV.
Additional 18700 electron-photon pairs per event for 10us integration window.
Lots of extra particles to slow down the simulation
There are alternative implementations but are they worth it?

- Sum from sample of after simulation – clumsy or complicated with podio
- Only include Brem sample from bunches around signal – Might create analysis artifacts

Background sample generation stops at the end of the central detector

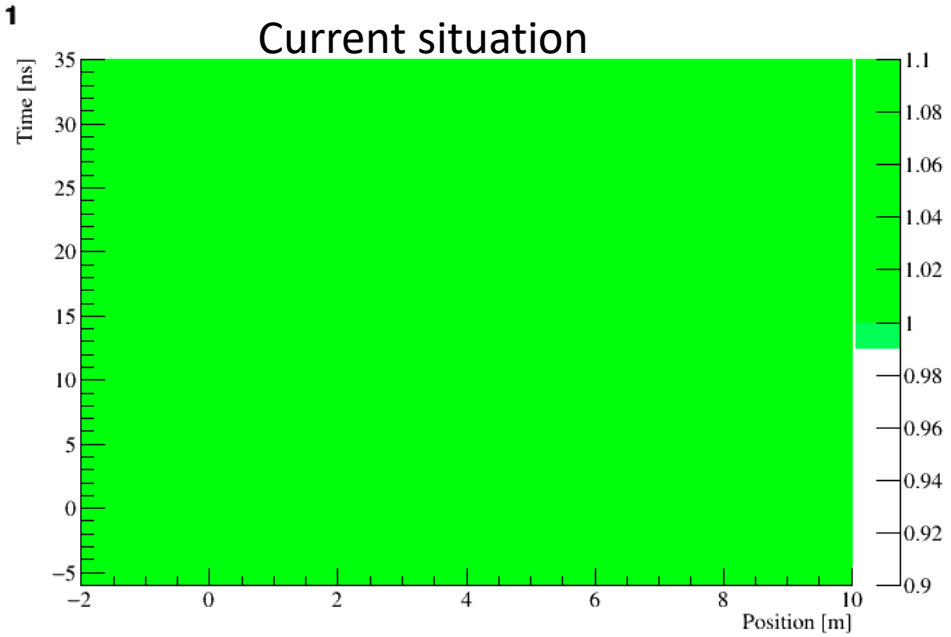
Extended Electron Beam Gas and Synchrotron radiation samples essential to understand rates.

Background sample generation is spread uniformly throughout time

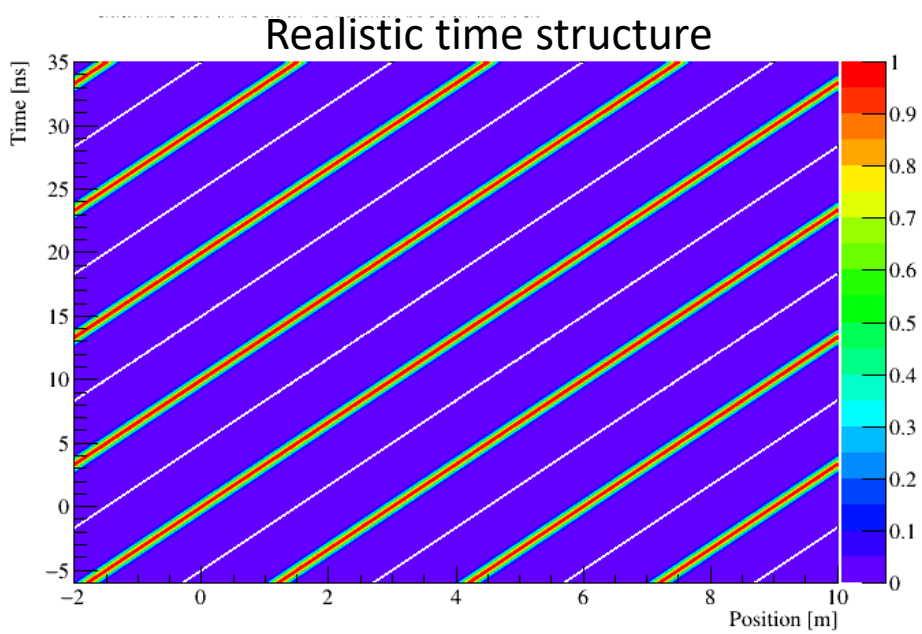
Fine for long integration time detectors but not for fast timing detectors.
Currently any time dependant analysis would result in huge over/under estimate of background.
Beam gas and synchrotron interactions need their time to be correlated with a bunch passing generated location.

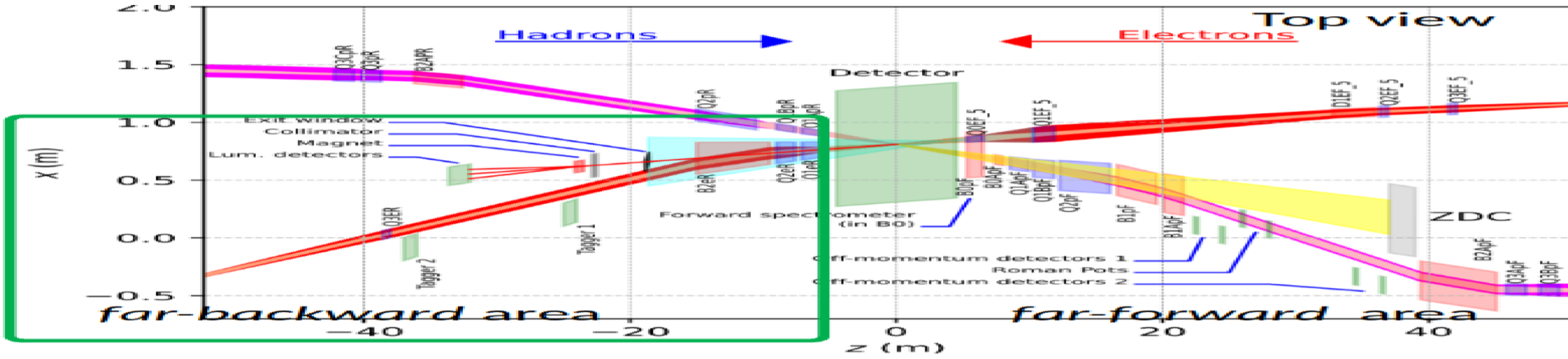
Background event sampling

Current situation



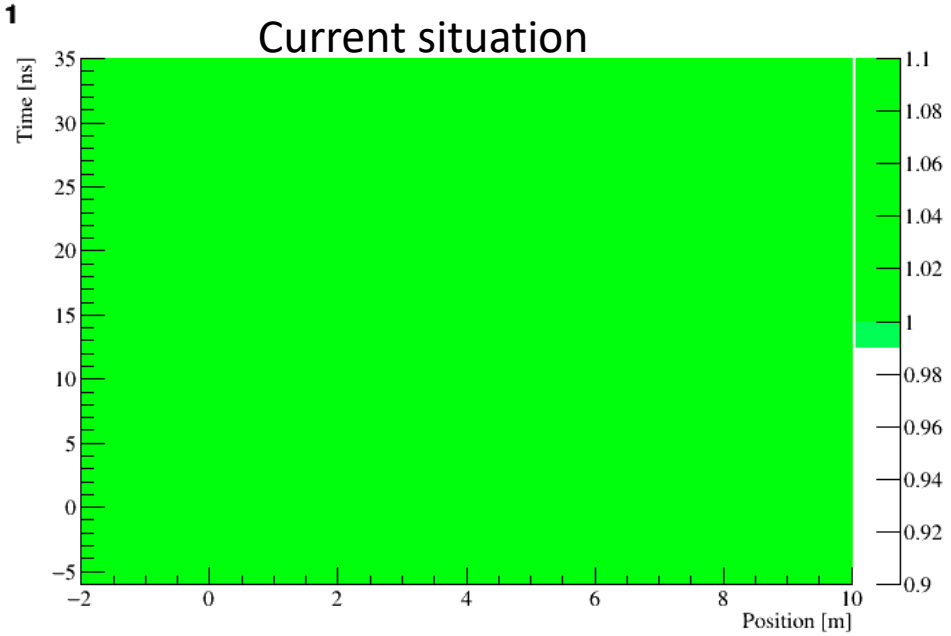
Realistic time structure



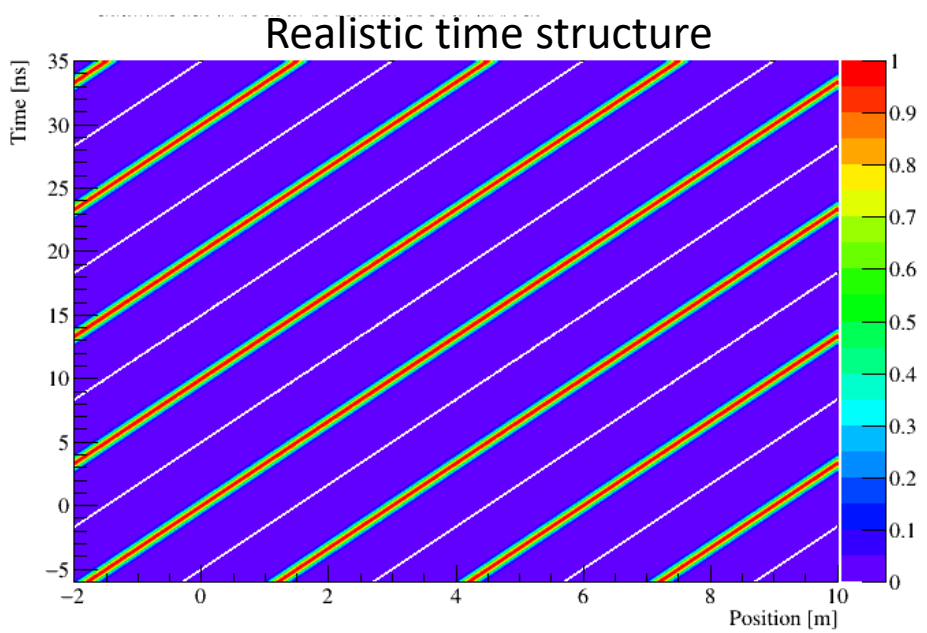


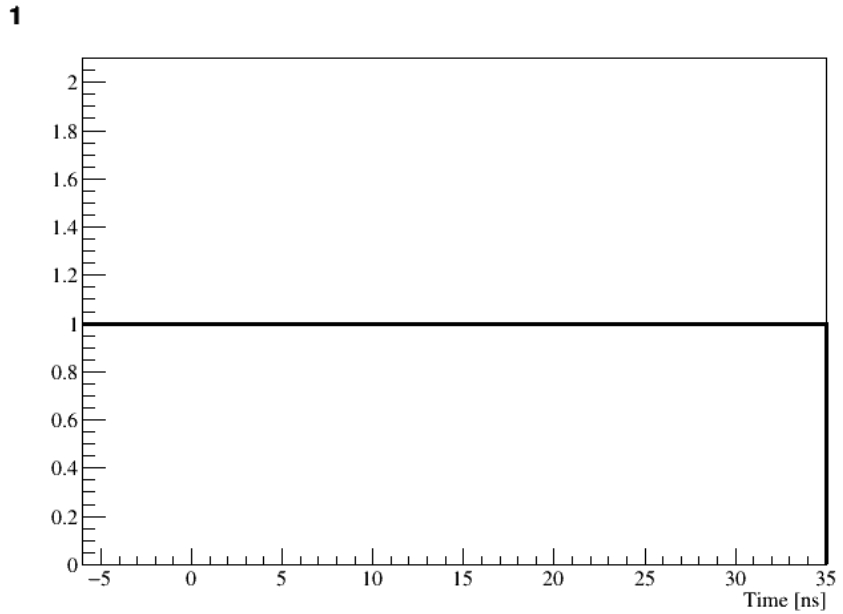
Background event sampling

Current situation

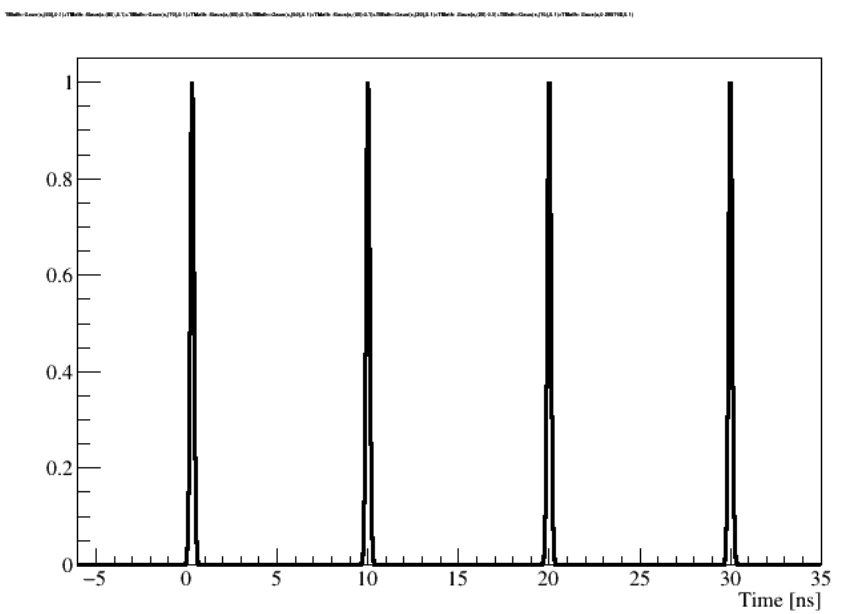


Realistic time structure



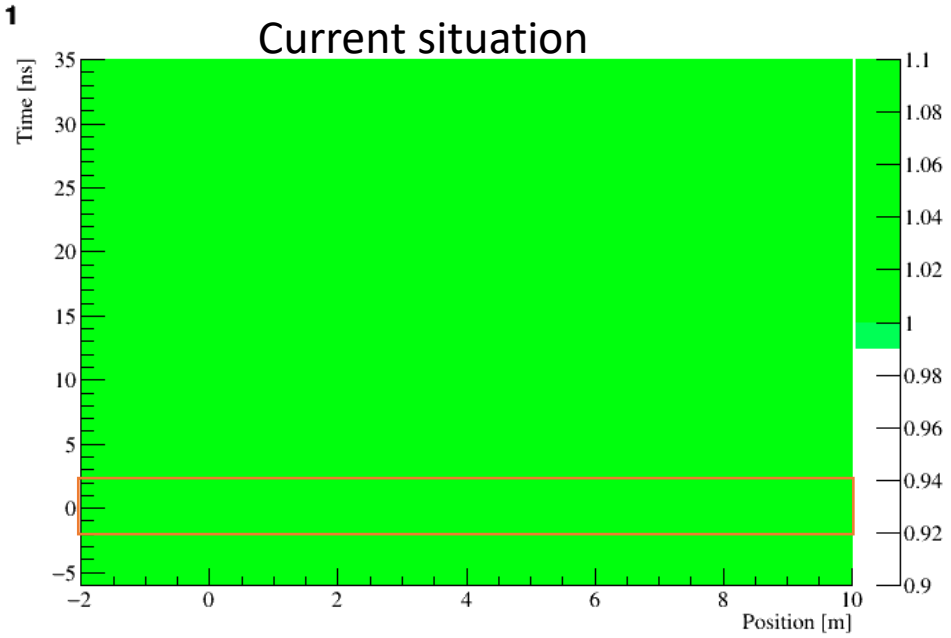


What the detector sees

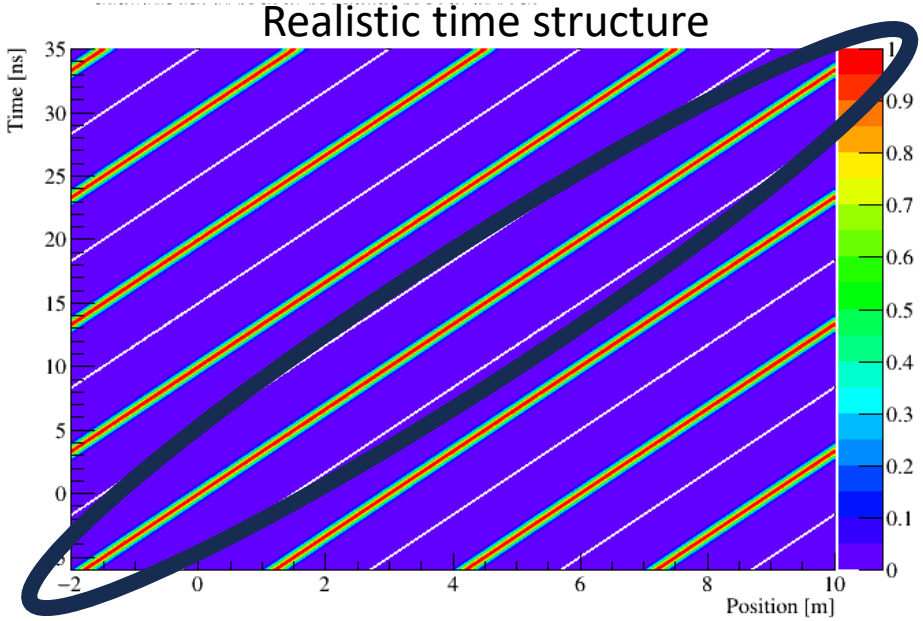


Background event sampling

Current situation



Realistic time structure



- Currently uniformly distributed throughout time for DAQ and central tracking studies.
- Any timing studies could exclude O(100x) too much background.

<u>For fast timing detector studies</u>

- Should not be any backgrounds* coming from somewhere and sometime a beam bunch isn't.
- Having a small timing window doesn't help, background still distributed across time when it reaches detector
- Instead need position (z) correlated background
- Backgrounds will only then arrive at the detector at about the same time

*Maybe some backgrounds

Background event sampling

Proposed solution

- Create a simple z-time map for the centre of the beam bunch
- Create a bunch-time profile (Can be updated later if beam structure gets more complex)

Background sampling would then be

- Select a background event position.
- Calculate mean time based on position.
- Randomly vary based on bunch profile.
- Select which bunch (N) this goes into based on Poisson from beam current, add N*10ns (or 40ns)

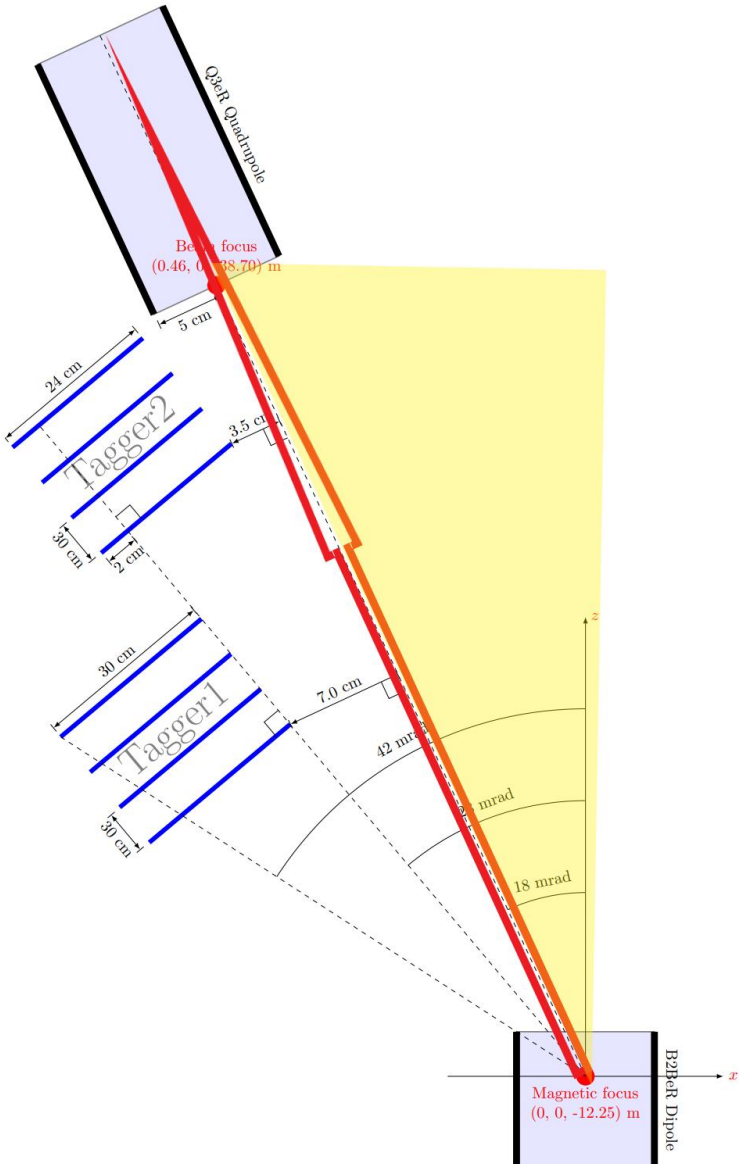
Notes

- Some thought needs to go into a running weight total when moving through bunches. (If a rate greater than a few per bunch you could get stuck in the first bunch)
- Will still fall short of extra dimensional correlations, particularly any crabbing, x/y information.
- The way Synrad creates events on a surface might mean some other considerations are needed if timing information isn't kept.

Synchrotron in the Simulation

- Distribution of SR from interaction electrons is different from beam.
- Several orders of magnitude smaller than beam SR
- For LowQ2, the beam SR needs to be scattered before it hits the detectors, SR from interaction electrons can be direct.
- Correlated with event electron so can't use a background sample file
- Exit window might absorb most of it making it a negligible background
- **SR produced between central detector tracking layers might be worse**
- Should compare simulations with and without to quantify the background and decide if it's necessary to include in the long run

SR cone from beam - SYNRAD



SR cone from scattered events – Geant4