Background study in Svt and Dch using FullSim

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Goal for this background study: Svt

- Plots of significant background quantities:
  - **Hits frequency** (Mhz/cm^2), occupancy
  - **Equivalent fluency of 1MeV neutron** (cm^{-2}), bulk doping and inversion
  - **Radiation Dose** (Mrad), damage to electronics
- ... vs geometrical parameters:
  - SVT Layer0 inner radius
  - Beampipe inner radius
- Note: only electrons and positrons (primary and secondary), but not photons, are taken for computing bkg quantities

Goal for this background study: Dch

- **Occupancy** of Drift Chamber
- Parameters:
  - Chamber inner radius
  - Cells size
  - Stereo or axial superlayers
  - Different shape of endplates
  - Cell shape

FullSim version and geometry

- **Bruno v00-01-04, r247**
  - Only Svt code has been committed
- **Geometry**:
  - Beampipe (BP) thickness: 1mm
  - SVT Layer 0 is a tube, not a pin-wheel
  - SVT L0 length 10 cm, thickness 300um, inner radius 1.3-1.6 cm
  - BaBar SVT
  - Gold foil outside BP: 10um
  - BP and L0 centered at z = 0
  - Cylindrical drift chamber
    - Rmin 230mm, Rmax 830mm
    - Length 2775mm, centered at z = +367mm
    - Carbon fiber structure filled by material with density averaged from gas and wires

Background events

- **Beam-strahlung (radiative Bhabha's)**
  - 1k evts
  - Processing time: 30 evts/hour
  - Generator embedded into Bruno
- **Pairs production**
  - 40k events
  - External standalone generator, good idea to embed it into Bruno asap
  - Processing time: 10k evts/hour
  - Main known bkg for SVT
- Not a big statistics for Svt outer layers and Dch
- More events can be generated or any other bkg events, if readable by Bruno, can be used to produce easily the same plots

Clean-up, fixes and additions

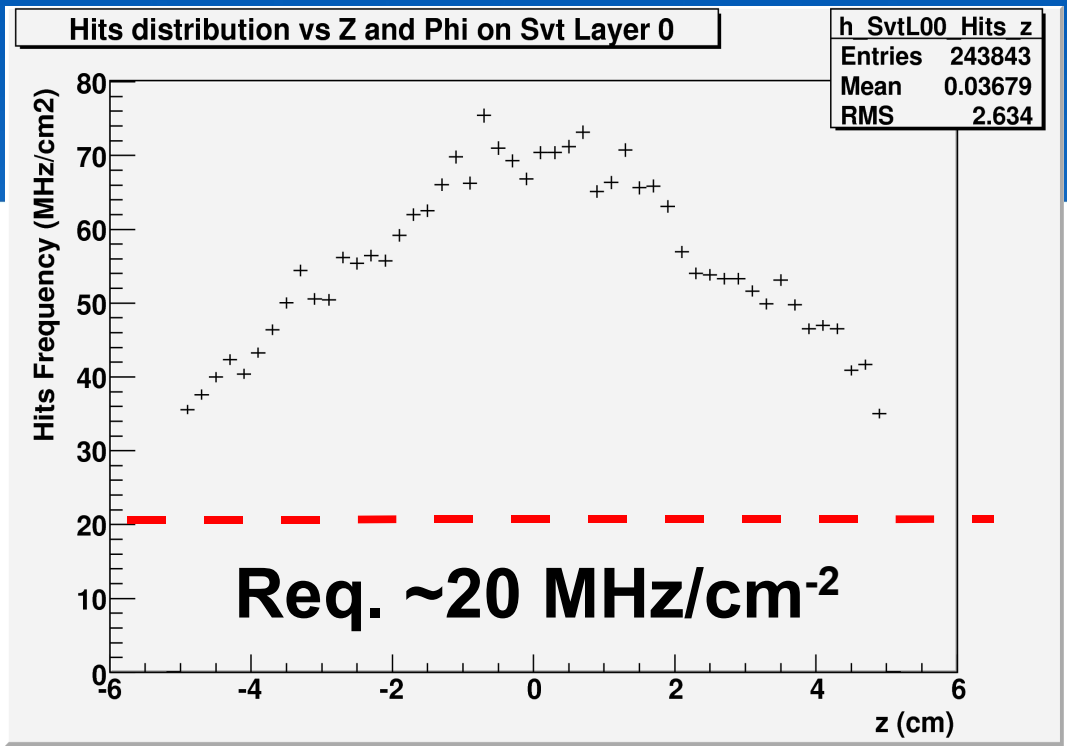
- Main geom parameters to be changed written in a single file, **SuperB_constants.xml,** included in different GDML modules
- Geometrical par's can be written into the Root file as TParameter
- G4 geometry tolerance set to main volume size to avoid crashing jobs
- Geometry checked for overlapping over all the volume levels:
  - Output file @CNAF: /home/BABAR/cenci/simu_sb/Bruno/out/geomtestfull/geomtestfull_090930.log
  - Problems in SVT, many from EMC (visualization problem with HepRep), still need to go through it
- G4Step reduced to 1cm for e+ and e-: just to have hits points along the track, don't affect physics. Maybe worth to try 0.5 cm

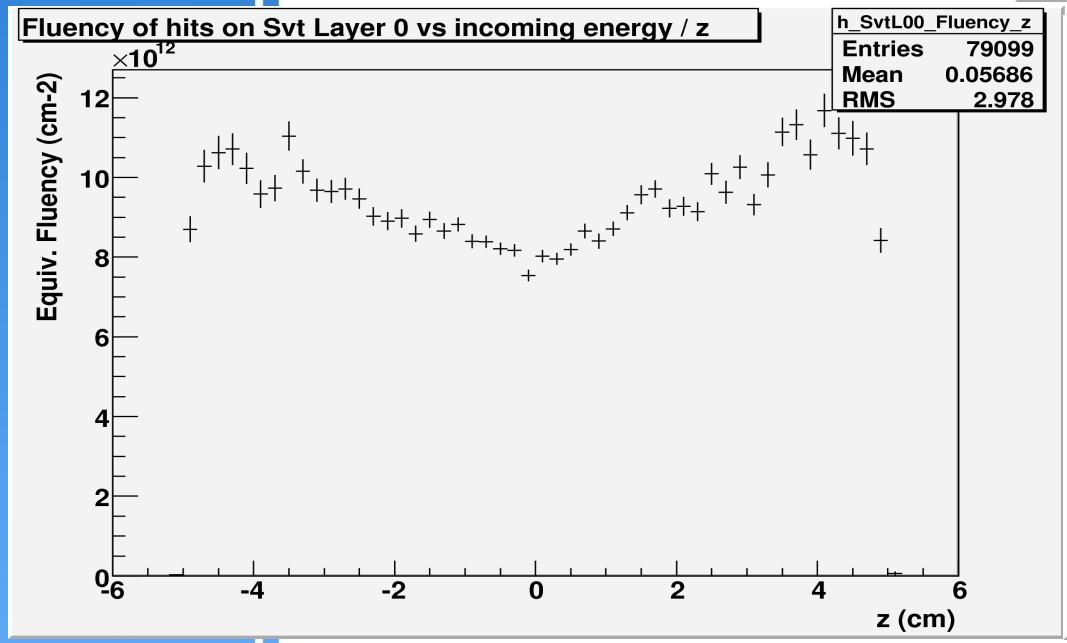
Bruno Hits

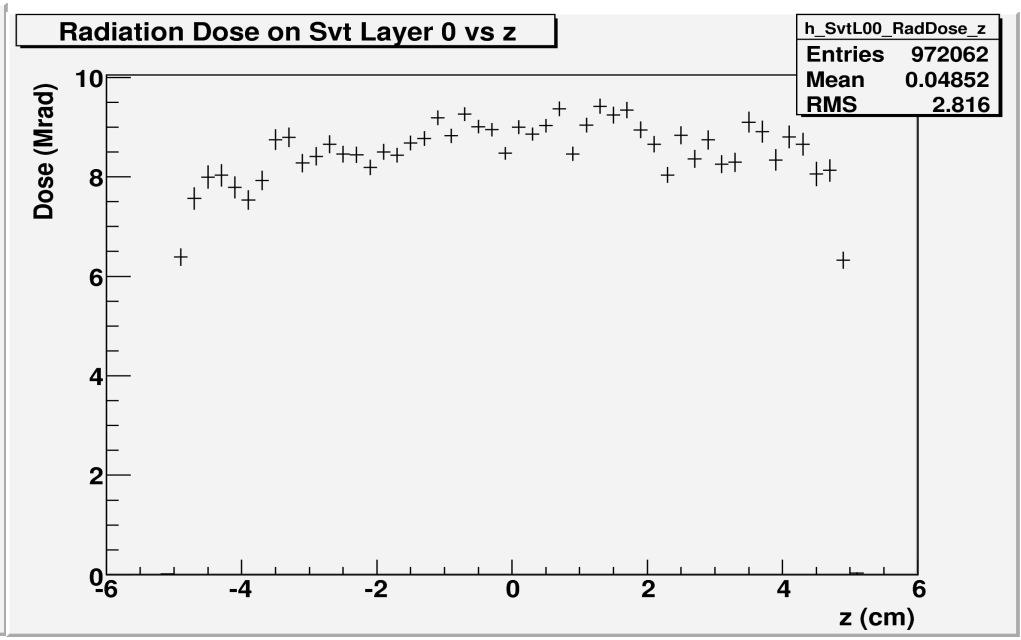
- Hits stored corresponds to G4Step
- Many similar classes for different subsysts, starting to write a common class and derive specific ones when needed (not yet in repo)
- **Bruno Root hits**
  - Starting point coordinates, time, step length, incident and released energy, particle and track ID
- **SVT hits**
  - BrnRootHits plus Svt layer
  - Merging hits in the same pixel/strip 50x50um
  - Additional methods of MyRootSvtHit for checking hits distance (pixel size can be changed without running Bruno again)
  - First results compatible with Eugenio's plots filled during Bruno running

SVT Results

- Basic configuration
  - BP @ 10mm
  - L0 @ 13 mm
- Z on x axis

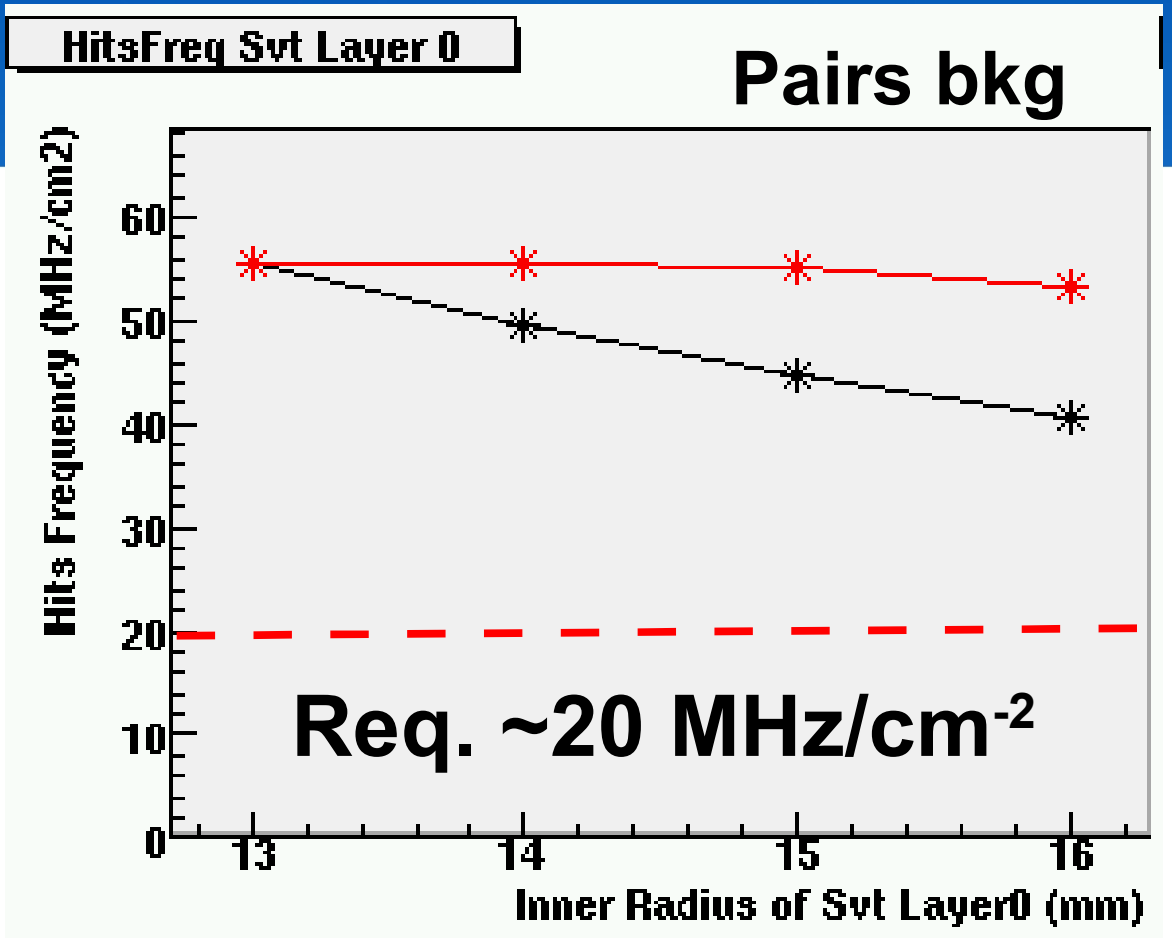






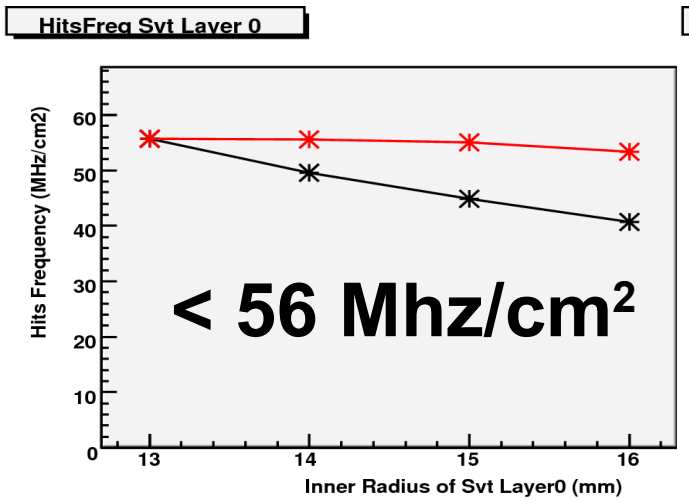
- All the considerations from here made with a **safety factor of 5**

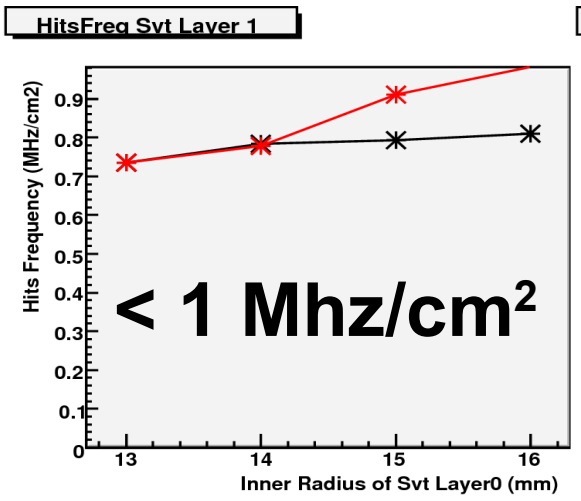
SVT Results

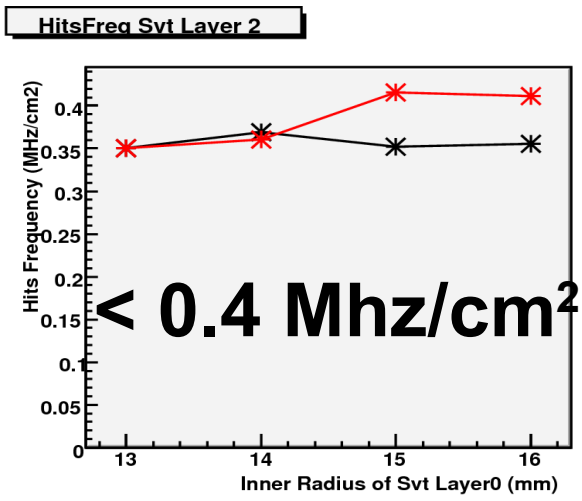


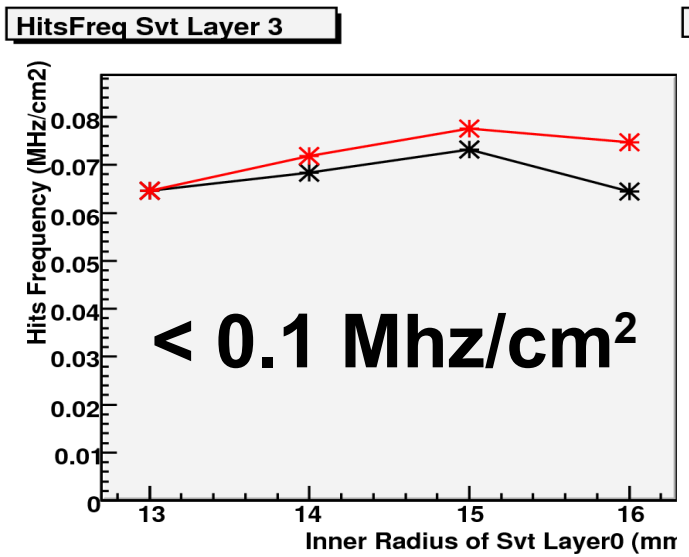
- Average over the whole layer
- X axis: inner Layer0 radius **13 – 16 mm**
- Configurations:
  - **Black:** BP close to L0, BP inner radius is equal to the inner L0 one minus 3 mm (BP thickness + clearance + pin-wheel average)
  - **Red:** BP inner radius fixed at 10mm
- **Black** is clearly the best option

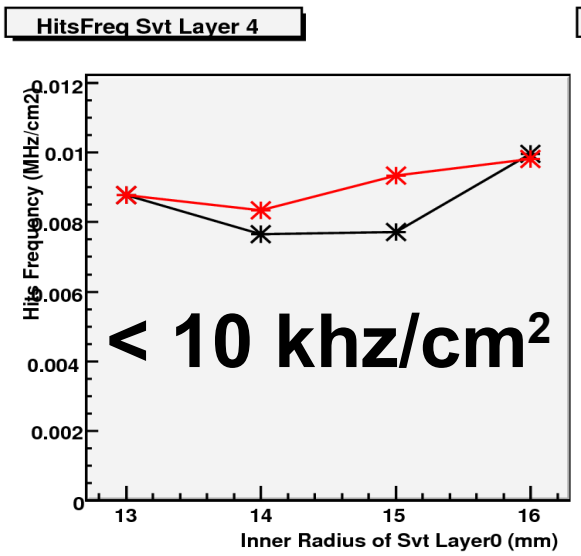
Hits Frequency, pairs bkg

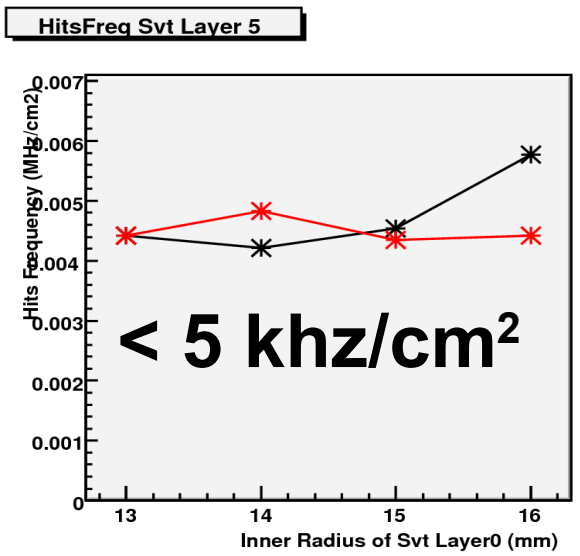






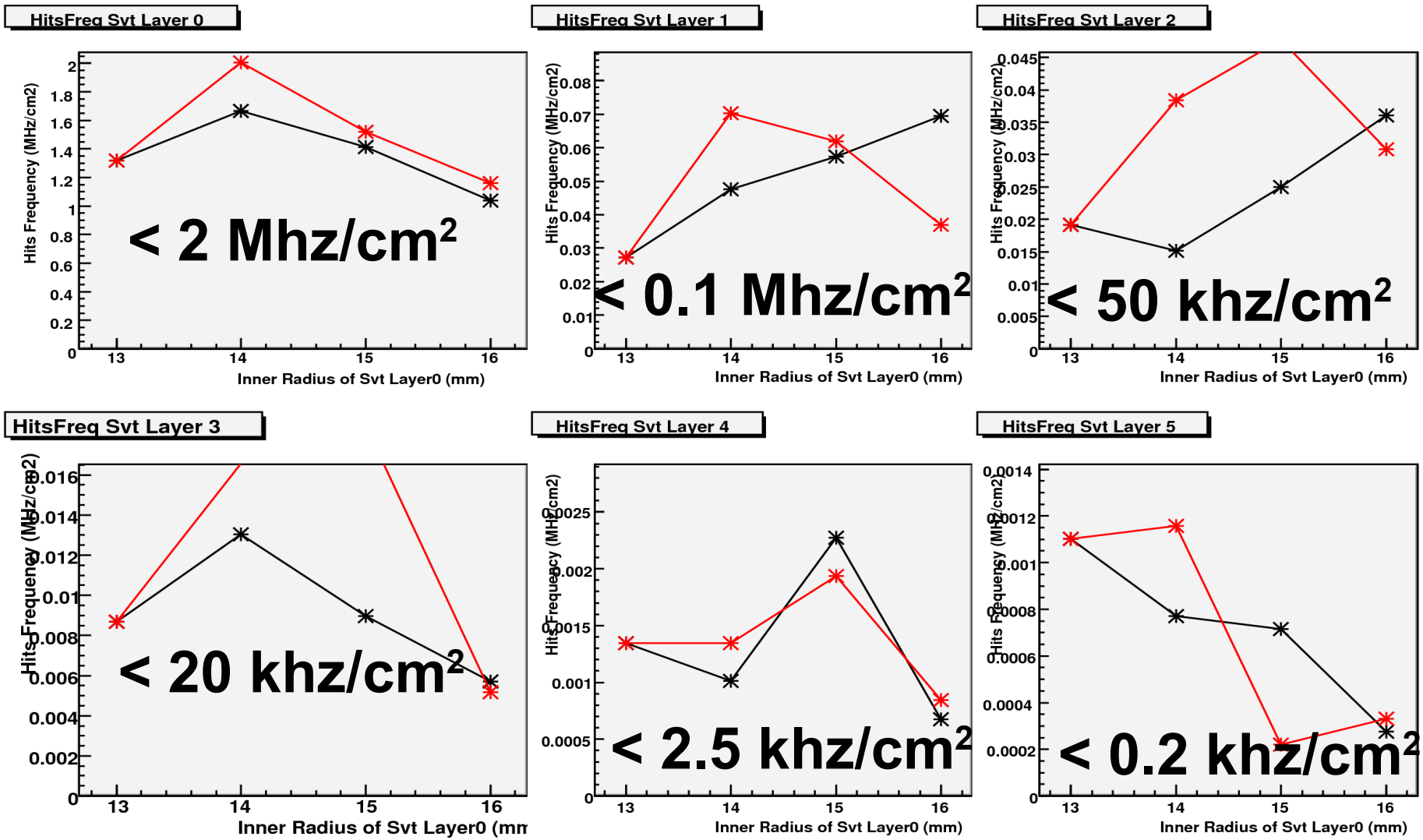






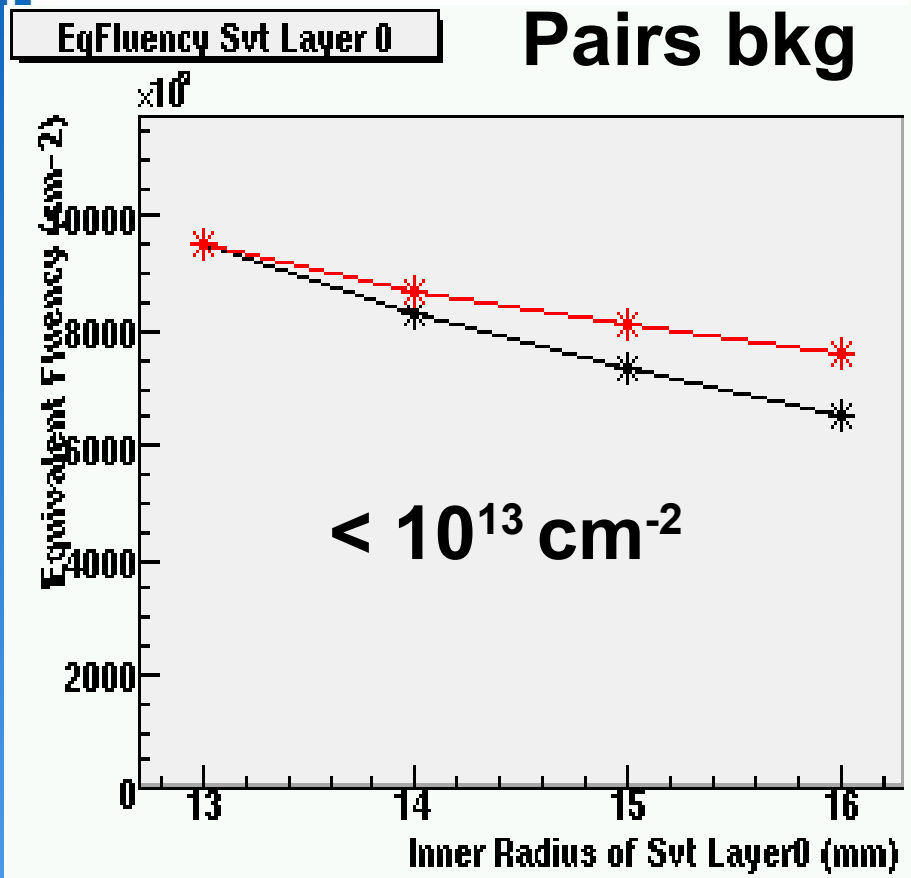
- Fluctuations due to lack of statistics, error bars needed

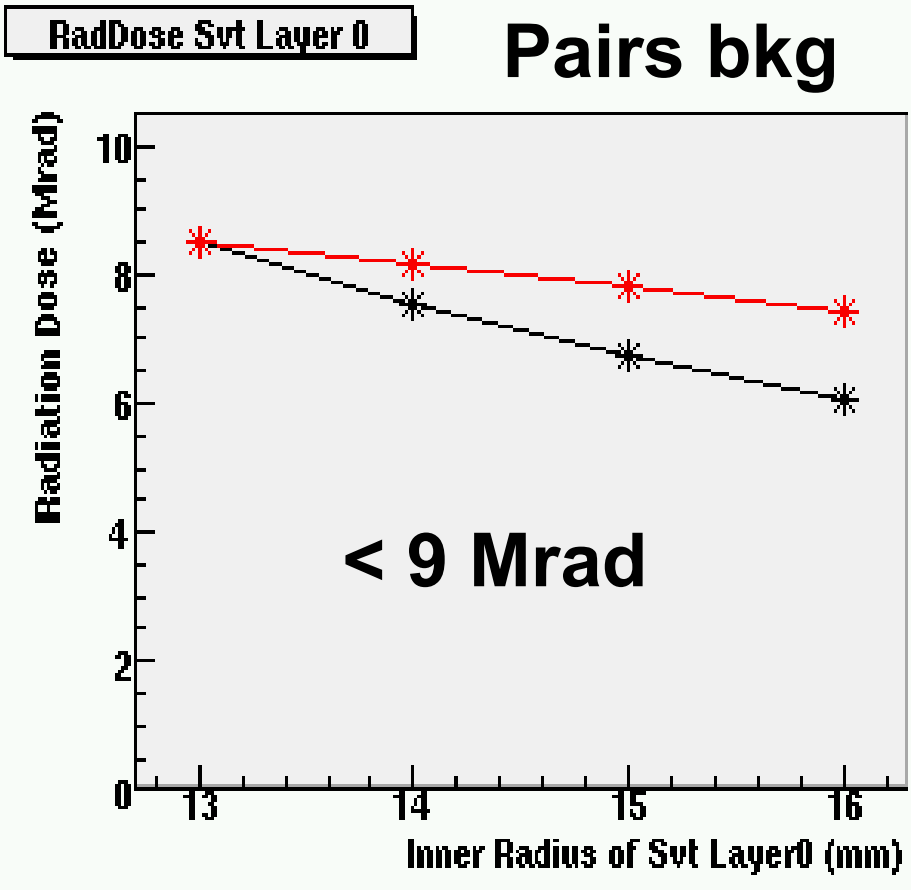
Hits Frequency, bbbrem bkg



- Fluctuations due to lack of statistics, error bars needed

Results for EqFluency and Rad Dose (10^7 sec)





- Same behaviour with different configurations
- Both of those are slightly critical including safety factor
- For outer layers, Fluency < 10^{11} cm^{-2} and Dose < 60 krad, but we need to consider also other bkg sources

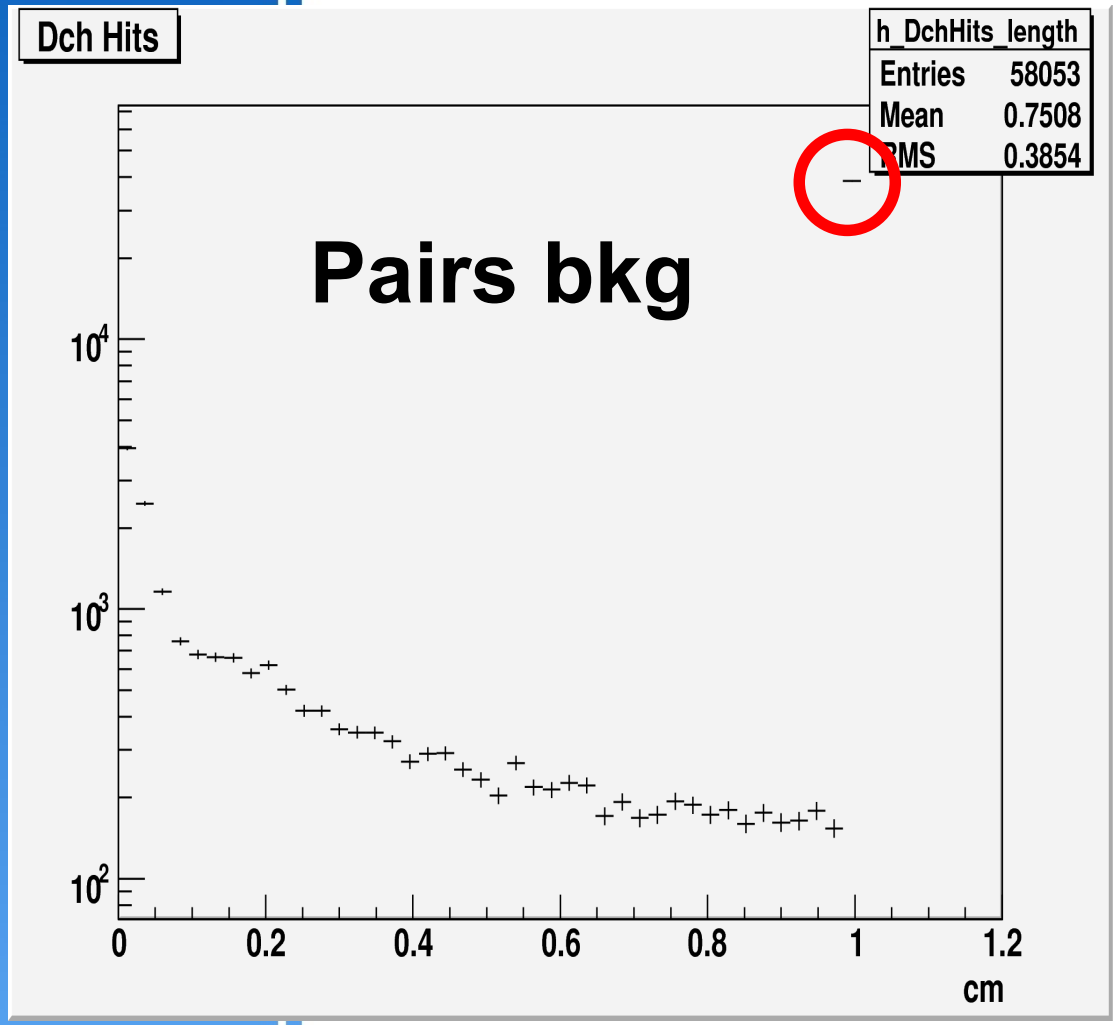
Getting the DCH occupancy... (1)

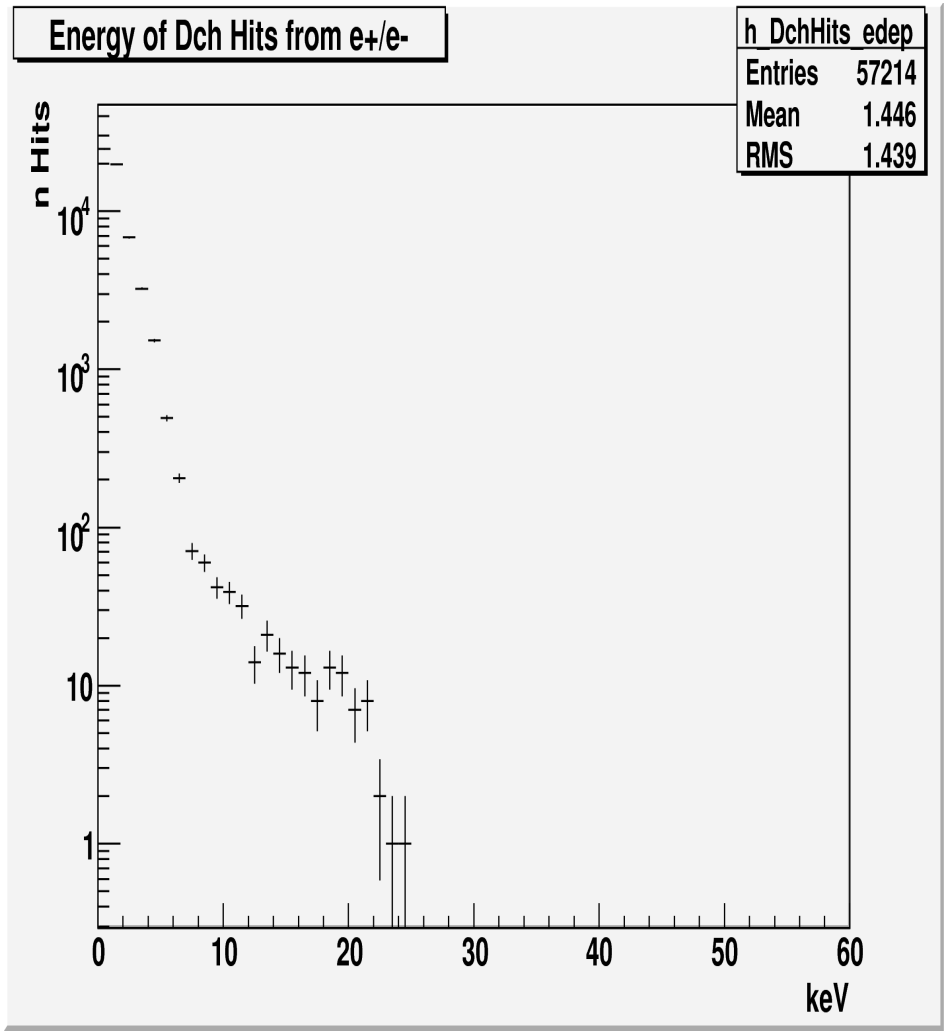
- **DCH Hits** on Root file are std Bruno hits
- A **DchRootStructure** object is build by a Root macro using superlayer objects, made by layer objects. Layers are defined only by cell size r and phi
- DchRootStructure contains the number of cells per layer and a matrix with the energy released for each cell
- Processing the root file, we match each hit with a cell and add the energy in the matrix
- One event of bkg sample is not equivalent to the Daq Dch slot (1us, is it ok?), so we collect hits from more events: 750 for pairs, 266 for bbbrem bkg (to be checked)

Getting the DCH occupancy... (2)

- **Basic Dch configuration**:
  - Inner radius: 23 cm, Outer radius: 83.5cm
  - 1.4 (r) x 1.4 (phi) cm, cell size
  - Superlayer made by 4 layers
  - 10 superlayers (spaced 0.5 cm), **9540 cells**
  - Cells are not staggered
  - Only axial layers
- Caveats:
  - Hits correspond to energy release in 1cm or less, it can be shared by two cells
  - Low statistics
  - Particles with very low energy, trajectories are small spirals through z (1 or 2 cells)

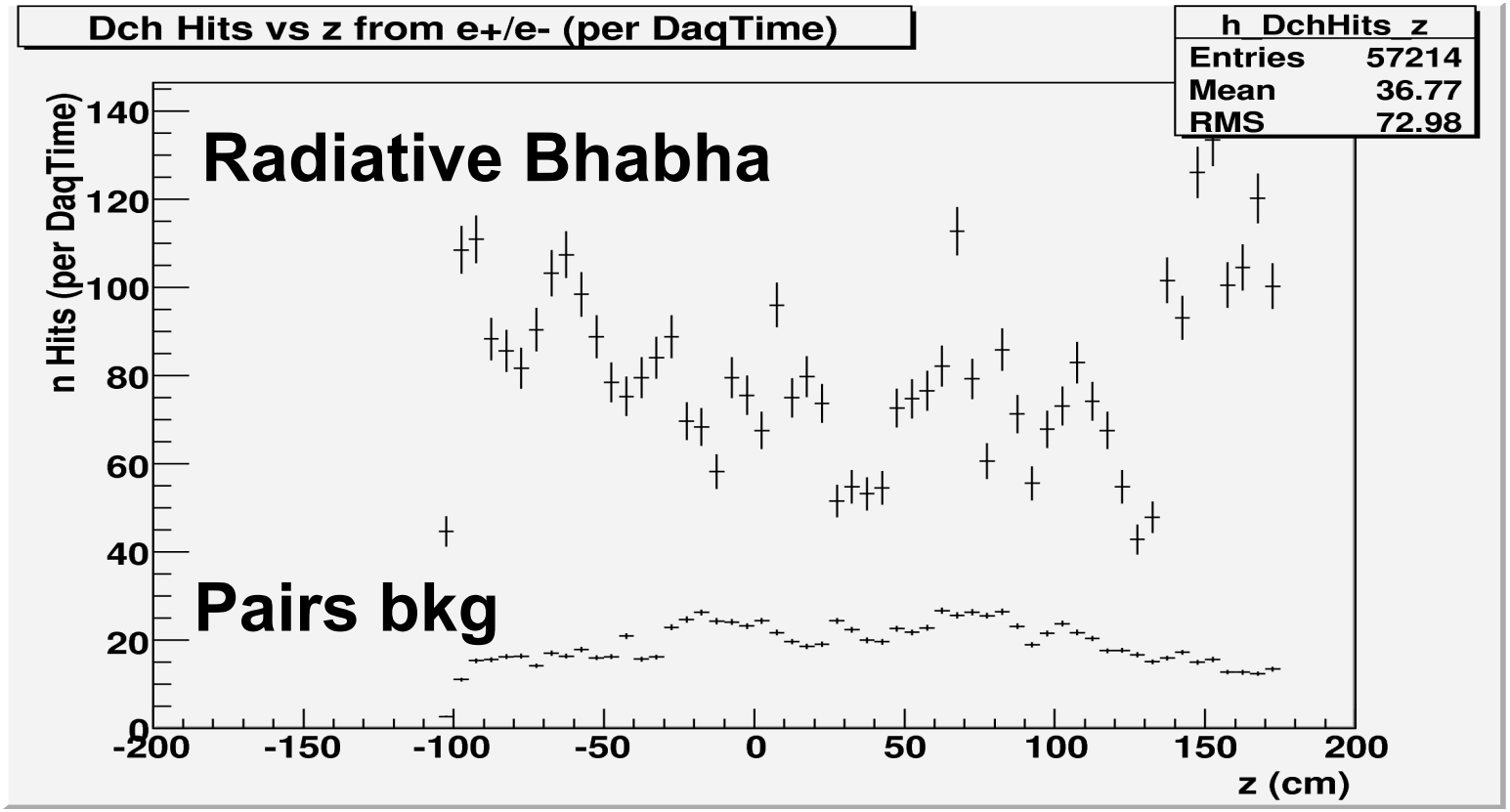
Hits sanity checks: length and energy





- Huge peak in step length at 1cm, as from Bruno setting
- Mean released energy compatible with MIP in Dch gas

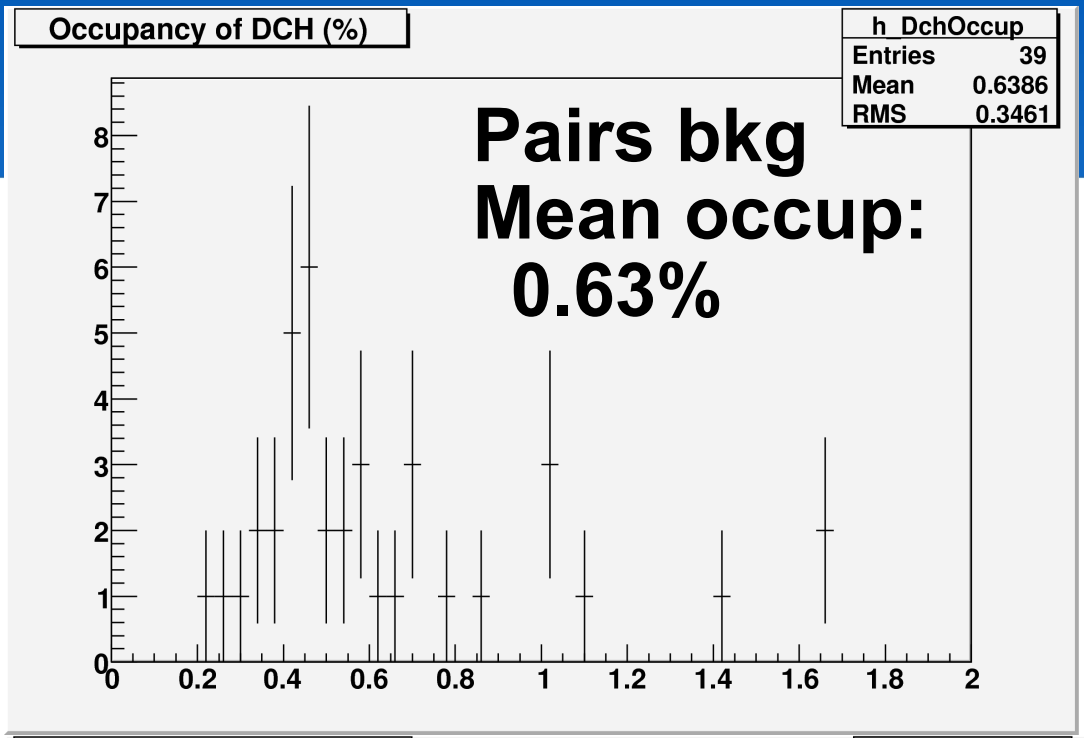
DCH Hits vs z

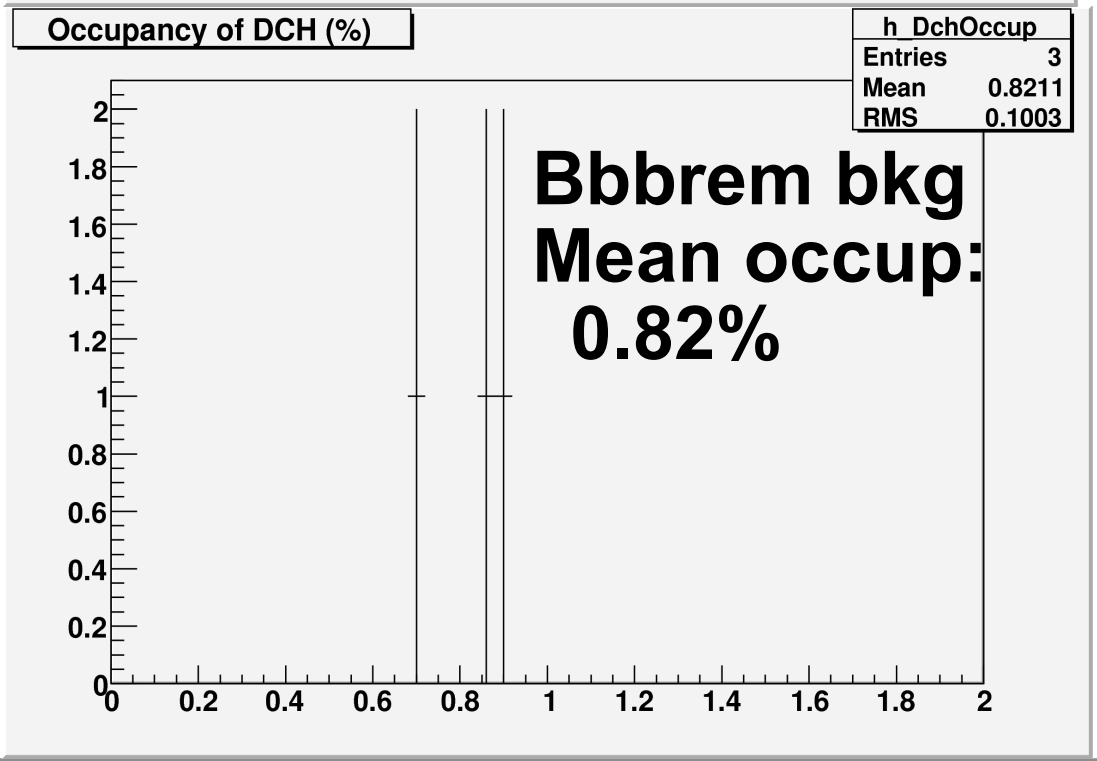


- Not weighted by released energy
- Bump on fwd direction for Radiative Bhabha, pretty flat for Pairs bkg
- Bhabha rad bkg most probably not from IP, but from upstream off-shell e+/e- that create a shower

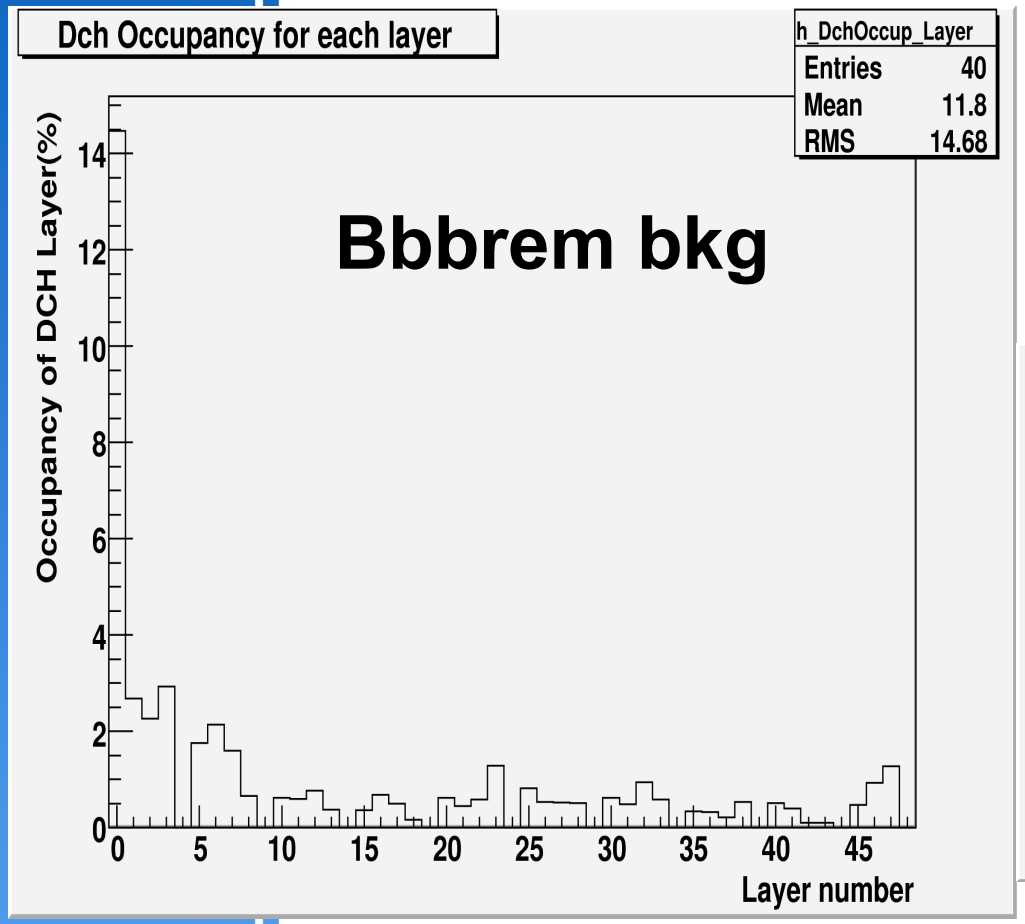
DCH Results

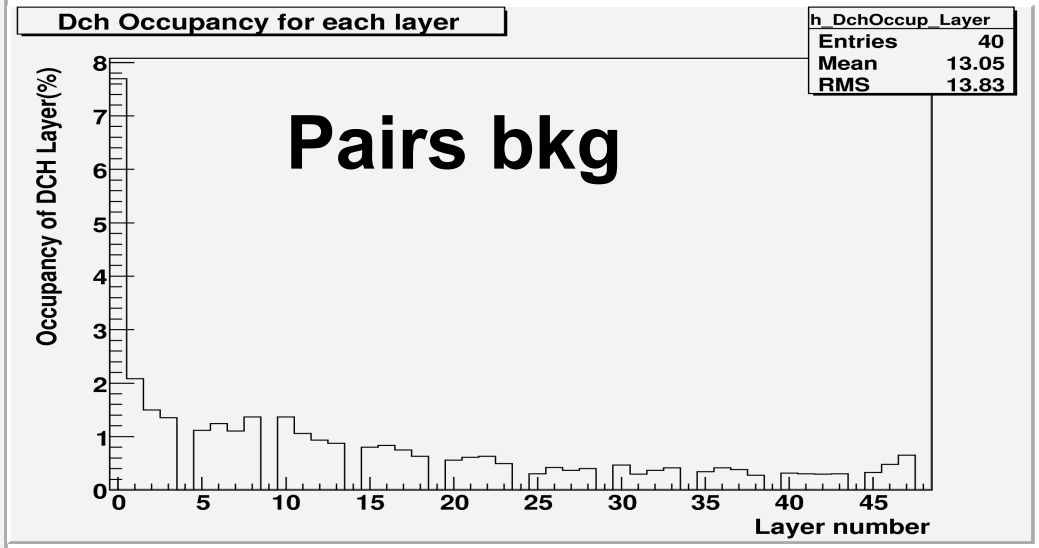
- Counting number of cells with energy greater than 0, then by total number of cells...
- Collecting hits over 1us of Dch Daq time slot
- **Occupancy 1.5%** (found bug in the code respect to the values shown at Dch Meeting)





DCH Occupancy per layer





- Occupancy by layer, same y scale
- 22% total on layer 0, it can be shielded by guard wire
- Reasonable occupancy on other layers, correlated with radius

Conclusions

- Tools for producing background plots as needed by subsystems
- Easy to get them from Bruno using different bkg types and geometrical configurations
- Some settings, like pixel size, can be modified even after running FullSim
- Results:
  -
- Many requests from people: priority list, but they are encouraged to look into the code and get their own plots

Conclusions

- Tools for producing std bkg plots of occupancy, more can be added, easy to get them using different bkg types and geometrical configurations
- Some settings (pixel size, Dch structure) are available also after running FullSim
- Results:
  - Pairs production remain the first bkg source for SVT, while Radiative Bhabha are ~10 times less than this
  - Bkg variables are correlated
  - Beampipe should stay close to L0
  - Dch bkg mostly from interaction on chamber wall
  - Occupancy values seem reasonable apart from the first layer (22% total)
- Many requests from people: priority list, but they are encouraged to try to get their own plots from the code

General Todo List (not in priority order)

- Check geometry at all levels
- Interaction region
  - Modify according last design by Mike
  - Test different shielding configuration
- SVT
  - Add realistic silicon on L0, same as FastSim
  - Test different rad length for BP (0.4-0.6%) and clearance BP-L0 (0.5-1mm)
- DCH
  - Stereo layers, cell shape, staggering (?)
  - Test other geometrical configuration (smaller inner radius, wedding cake end-plate, different shielding)
- Understand hit sources (useful tools from Andrea)
- Make a FullSim Production
- Add error bars on bkg quantities
- Other bkg sources, try to embed them into Bruno
- Clean-up the code and std naming for classes
- Advise for priority. Any help or manpower available?
- Personal comment: GDML, see next slide

GDML: do we really need it?

- Those are personal comments about GDML
- Pro's
  - GDML allows to pass different geometries at runtime
  - Good for easy structure
- Con's
  - Not all G4 features for G4 volumes are available, even a simple loop is a problem
  - Not easy to debug
  - No development in 2009
- FastSim is using EDML, similar but different from GDML, we can have in the future the same values written in two different places, this should be avoided IMHO
- Are there any more advanced solutions? What CMS and Atlas are using? Configuration database?
- Changing from GDML is a huge amount of work, but later it is going to be tougher too