# Geant4 Geometry
Speed-ups

Geometry optimisation

- '*Smart voxels*' technique to optimise search for intersections
  - Adopted and 'tuned' since the early years of the Geant4 project (1995)
  - Do not require large memory or computing resources
  - At tracking time, searching is done in a hierarchy of virtual divisions
  - No need to tune geometry according to different topology
    - Possibility to manual tune voxels resolution for specific setups - `SetSmartless(n)`
  - Can handle at the best also 'flat' geometries
- 3D voxelisation can be applied also to parameterised volumes
  - Improves efficiency in complex geometry setups where more than one parameterisation in different axes is applied - `kUndefined` in `G4PVParameterised` constructor
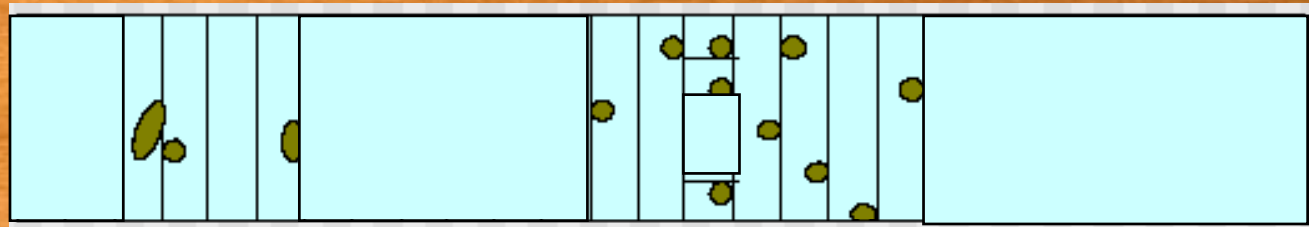
Use of verbosity

- Print the statistics of voxelisation
  - Using `/run/verbose 2`
  - Allows to identify volumes which are more consuming

Prefer structured geometry setups to flat geometries

- Avoid defining volumes with too many daughters
  - Will help in the generation of a proper optimisation, avoiding to manually tune it afterwards
  - Will allow navigation to happen more efficiently

Selection of Solids

- If CPU performance is a constraint
  - Avoid choice of solids which may require high CPU cost
    - Complex compositions of G4Polycone , G4Polyhedra
    - Solids with complex surfaces: twisted solids, G4Torus
  - Adopt simple basic shapes if at all possible
  - Avoid an excessive use of Boolean solids
    - Automatic geometry translations
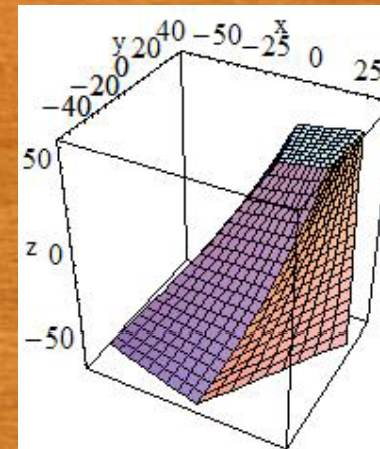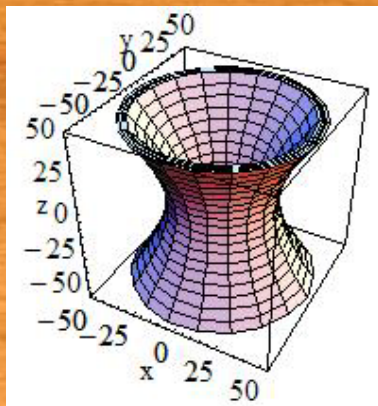
Dynamic geometries

- Geant4 can handle geometries which *varies* in time
  - Multiple geometry setups in memory with immediate switching between runs
  - Modification of just a portion of the 'active' geometry setup
  - <u>Adopts optimisation technique to consider 'partial' regeneration of voxels</u>

Use of Detector Regions
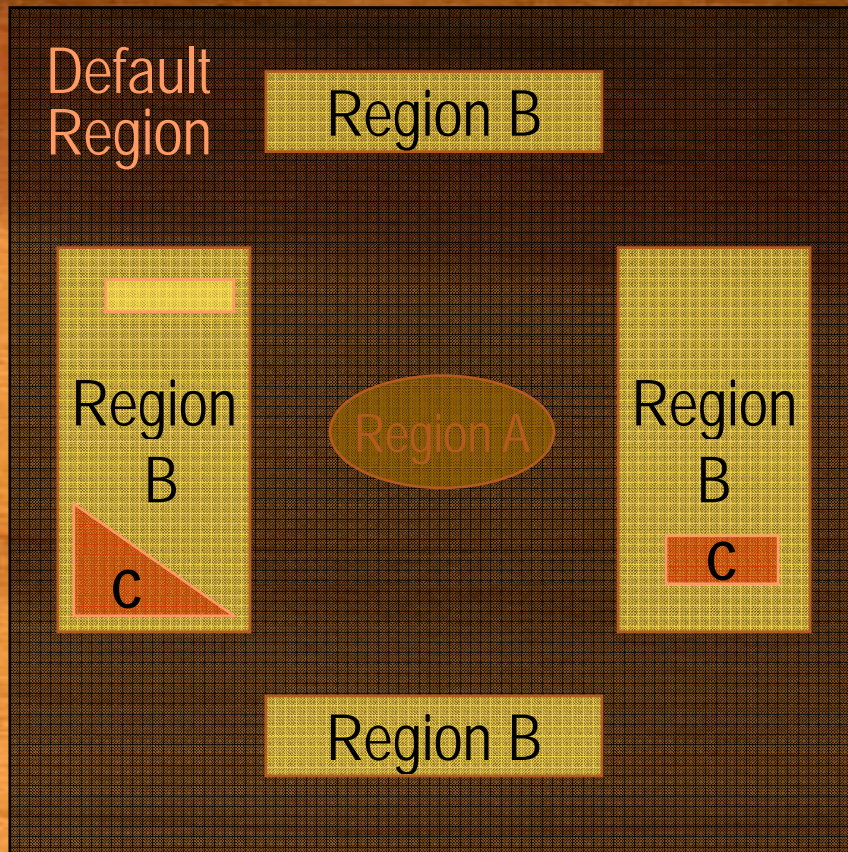
- A *region* represents a set of geometry volumes, typically of a sub-system
  - Has a cut in range associated. A different range cut for each particle is allowed in a region

Tuning of geometrical tolerance

- An absolute small value (`10E-9 mm`) of accuracy may be redundant and inefficient for use on simulation of detectors of big size or macroscopic dimensions

Available since Geant4 9.0   8

Avoid overlaps of volumes

- "Overlaps" in the geometry can be detected at volume positioning stage
  - Boolean flag to be activated in the physical-volume constructor
    - Valid for placements and parameterised volumes
  - With explicit call to *CheckOverlaps()* through the pointer of the physical-volume

- A correctly defined geometry helps in preventing problems of looping particles or particles stuck on boundaries