

# Geometry

## Recent & ongoing developments



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*for the Geant4 Geometry Working Group*

# Outline



- ❧ Developments/fixes in the last year
  - ❧ Introduced in release 9.6 and patches
- ❧ Planned for release 10.0 and ongoing ...
  - ❧ Currently under development and scheduled for inclusion in the December release

# Fixes/updates to solids - 1



- ❧ Refined protection for potential cases of infinite loop in *DistanceToIn(p,v)* of *G4SubtractionSolid* 9.5.p02
  - ❧ Return computed distance instead of zero and provide more descriptive information when issuing warning
  - ❧ Problem report [#1304](#)
  
- ❧ Fixed calculation of  $\sin(\alpha)$  from cosine and tangent in *G4Para::SurfaceNormal()* 9.5.p02
  
- ❧ Revised values of delta in *G4Torus*, to account for precision loss in calculating radius *pt* 9.5.p02
  - ❧ Reordered a few computation for better FP accuracy
  
- ❧ Fixed cases of hang-ups in *G4ExtrudedSolid* on 32-bits platforms
  - ❧ Due to *G4TessellatedSolid* and *G4SurfVoxelizer*, caused by accessing bitmask arrays with negative indexes 9.6.p01

# Fixes/updates to solids - 2



- ❧ Fix in *G4ExtrudedSolid::IsSameLine()* to use the perpendicular distance to a line when deciding, and not the y-intercept difference. 9.6.p02
  - ❧ Issue responsible for a problem observed in ATLAS in a Boolean subtraction composition
  
- ❧ Fix in *G4Polycone::GetPointOnCone()* for cases of shape with decreasing Z. Fixes cases of false report for overlaps detection
  - ❧ Added check with exception in constructor for polycone with  $rInner > rOuter$  for the same Z; corrected conversion from generic construct
  - ❧ Problem report [#1462](#) 9.6.p02 & 9.6.ref07
  
- ❧ Fix in calculation of normal in *G4Tet::DistanceToOut(p, v, ..)* and *SurfaceNormal(p)* 9.6.p02
  
- ❧ Fixed problem in *G4TessellatedSolid* with navigation in solids with concave surfaces 9.6.p02
  - ❧ Problem report [#1456](#)

# More fixes/updates



- ❧ Removed deprecated BREPs module, NURBS code from solids and scorer base classes  
❧ Part of general cleanup for the major release 10.0.beta
- ❧ Provide method *GetGlobalExitNormal()* in *G4Navigator* to be used in place of *GetLocalExitNormal()* by optical processes 9.5.p02
  - ❧ Compute normals also for replicas
  - ❧ Problem report [#1300](#)
- ❧ Introduced new class *G4ChargeState* 10.0.beta
  - ❧ to hold charge, spin, magnetic moment
- ❧ Added new messenger class *G4GlobalMagFieldMessenger* 9.6.ref09
  - ❧ Defining UI commands for creating/deleting the global uniform magnetic field and activating/inactivating it according to the set field value
- ❧ Added *G4Ellipsoid* among solids enabled for parameterisation 9.6.ref08

# New UI commands for overlaps checks

☞ Archived UI checks through grid/cylinder lines. Replaced with calls to built-in overlaps checking based on random points located on surface

☞ `/geometry/test/run` 

10.0.beta

*to start overlaps checking recursively through the volumes tree*

☞ `/geometry/test/tolerance [double] [unit]`

*to define tolerance by which overlaps should not be reported. Default is '0'*

☞ `/geometry/test/verbosity [bool]`

*to set verbosity mode. Default is 'true'*

☞ `/geometry/test/resolution [int]`

*to establish the number of points on surface to be generated and checked for each volume. Default is '10000'*

☞ `/geometry/test/recursion_start [int]`

*to set the starting depth level in the volumes tree from where checking overlaps. Default is level '0'*

☞ `/geometry/test/recursion_depth [int]`

*to set the total depth in the volume tree for checking overlaps. Default is '-1', which means checking the whole tree*

☞ `/geometry/test/maximum_errors [int]`

9.6.ref08

*to fix the threshold of maximum errors to report for wach volume. Default is '1'*

# More developments included in release 9.6



- ❧ New implementation of G4TessellatedSolid
  - ❧ Derived from the Unified Solids library development
  - ❧ Providing 3D spatial optimisation for fast localisation of facets for intersection
  - ❧ Huge speedups (factor thousands), depending on shape complexity
  
- ❧ Implementation of precise ComputeSafety() in navigation for EM use
  - ❧ *Refined implementation of alternative Computesafety() for use by physics processes (mainly EM) for measuring the exact safety value, not limited by voxels boundaries*
  - **Review of current status & open issues in parallel session 4b**

# Yet expected for release 10.0 ...

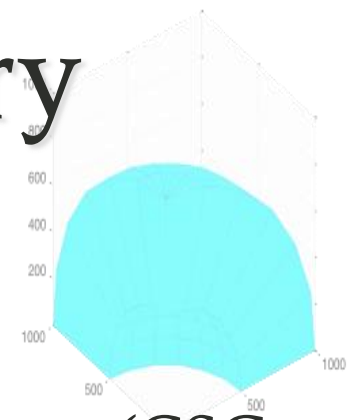
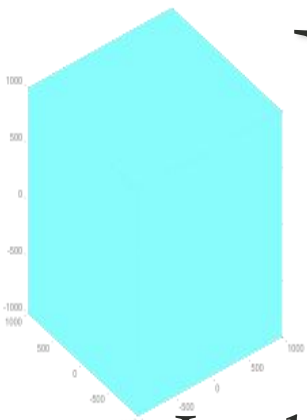


- ❧ Identification of first/last step in a volume for curved tracks
  - ❧ *Feature currently possible only for linear track*
  - ❧ *Requires to be extended also for curved tracks in magnetic field*
- ❧ Finalise adaptation of relevant classes for multi-threading
  - ❧ *Introduction of “work-spaces” for better handling of allocated memory by threads*
    - **Review in parallel session 4b; talk by J.Apostolakis**
- ❧ Integration of Unified Solids library shapes
  - ❧ As optional component, with wrappers for the implemented shapes
  - ❧ Splitting of polycone and polyhedra for simple/generic constructs (only-increasing/also-decreasing Z)
  - ❧ Extension of GDML schema

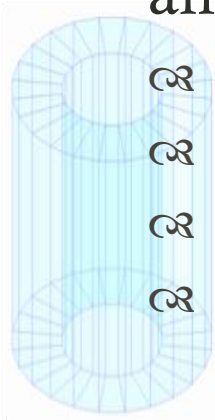


# Unified Solids library

## on-going development



☞ Implementation of a common library for shapes (CSG and specific) with Root geometry



☞ Work started in the context of the [AIDA EU Project](#)

☞ Types and common interface defined

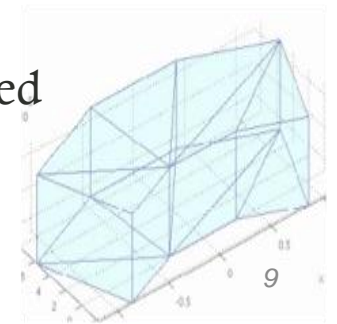
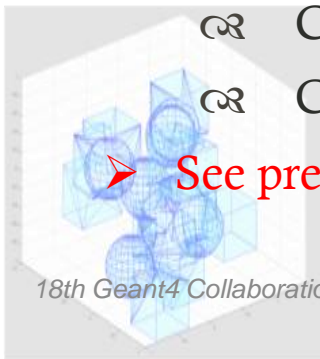
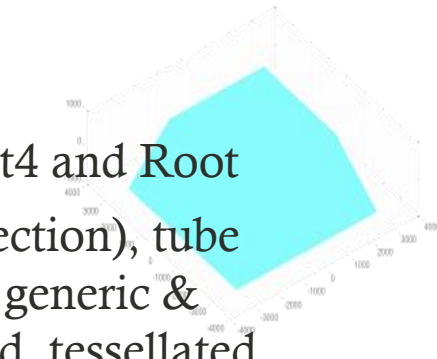
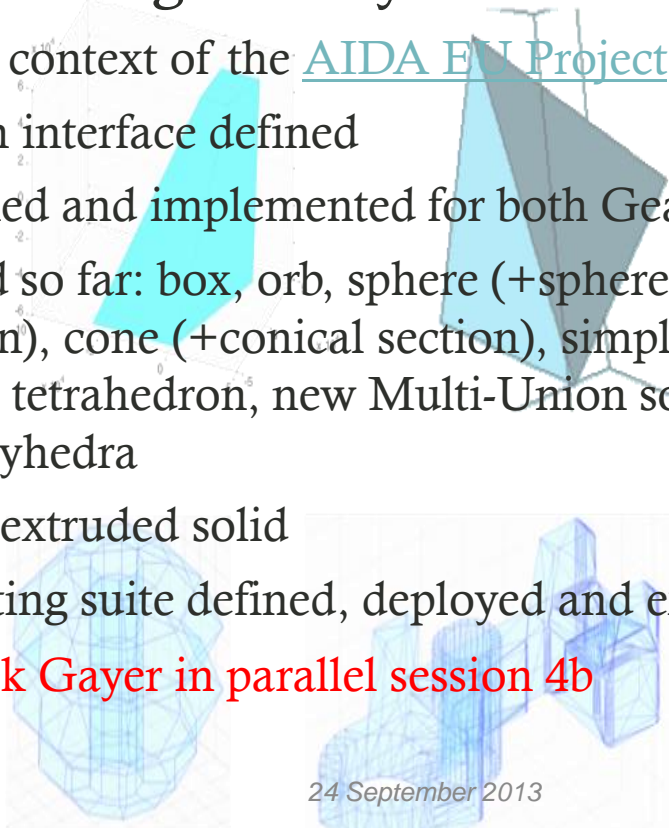
☞ Bridge classes defined and implemented for both Geant4 and Root

☞ Solids implemented so far: box, orb, sphere (+sphere section), tube (+cylindrical section), cone (+conical section), simple, generic & arbitrary trapezoid, tetrahedron, new Multi-Union solid, tessellated solid, polycone, polyhedra

☞ Currently tackling: extruded solid

☞ Comprehensive testing suite defined, deployed and extended

➤ See presentation by Marek Gayer in parallel session 4b



# Thanks!



**Status of development of the Unified Solids library** *Marek GAYER*

*Seville, Spain* 17:00 - 17:45

**Optimizing geometry routines for (SIMD)vector particle tracking: A status report** *Sandro Christian WENZEL*

**Developments for multi-threading: work-spaces** *John APOSTOLAKIS*

*Seville, Spain* 18:05 - 18:25

**Use of precise safety by EM processes & open issues**

*Seville, Spain*

**Discussion**

*Seville, Spain* 18:45 - 19:00