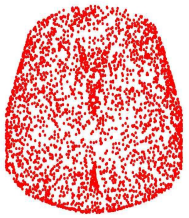
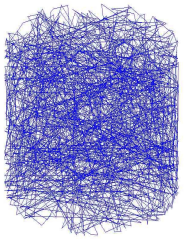
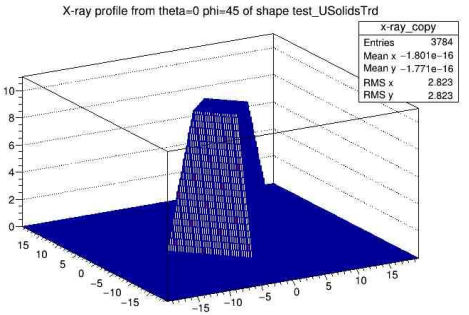


VecGeomPolycone
(GetPointOnSurface Test)



UTubs
(Rays in SurfaceNormal Test)



UTrd
(X-ray profile)

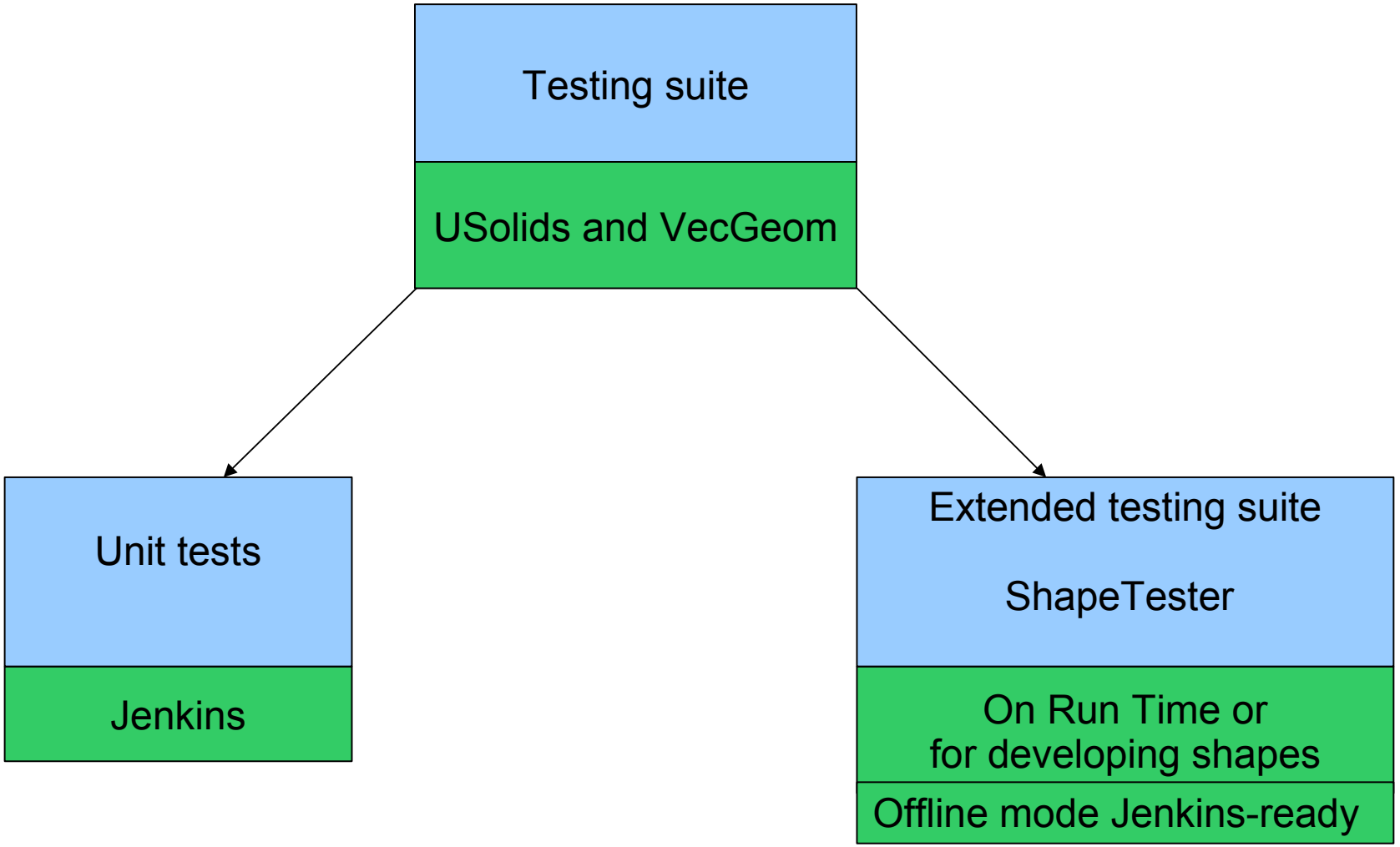
Extensions to testing suite and

effects on using coarse/precise safety calculation

Tatiana Nikitina, CERN PH/SFT
On behalf of the Geant4 Geometry WG
& VecGeom team

30 September 2015, 20th Geant4 Collaboration Meeting

USolids & VecGeom Testing Suite



Unit tests

- based on Geant4 unit tests + important bugs fixes
- the same test used for USolids/VecGeom
  - a few differences for conventions
- asserts for all methods
  - only Contains() has to be added
- tests are done for almost all shapes
  - missing: UGenericTrap, UExtrudedSolid & UTessellatedSolid
- some of the tests are included in Jenkins nightly
  - other tests are not included yet
  - still errors reported by the unit tests

Unit tests

Unit test for Shape	Jenkins	Comments
UBox/VecGeomBox	yes	
UTubs/VecGEomTube	yes	
UCons/VecGeomCone	no	Ready to be included
UTrd/VecGeomTrd	no	Ready to be included
UTrap/VecGeomTrap	no	Ready to be included
USphere/VecGeomSphere	no	Ready to be included
UOrb/VecGeomOrb	no	Ready to be included

Unit tests

Unit test for Shape	Jenkins	Comments
UTet	no	Ready to be included
UPolyhedra/VecGeomPolyhedra	no	**UPolyhedra** -error in SurfaceArea() and Capacity() **VecGeomPolyhedra-** error in Inside() for Phi Section
VecGeomTorus	no	New code, under testing
VecGeomParaboloid	no	Error in Inside() for points on Surface
VecGeomEllipsoid and VecGeomHype	no	Ready to be included

Extensive testing suite : ShapeTester

Geant4 tests

- SBT(solid batch test)
- SurfaceChecker
- OpticalEscape
- SurfaceVisTest
- testDistanceAccuracy.cc

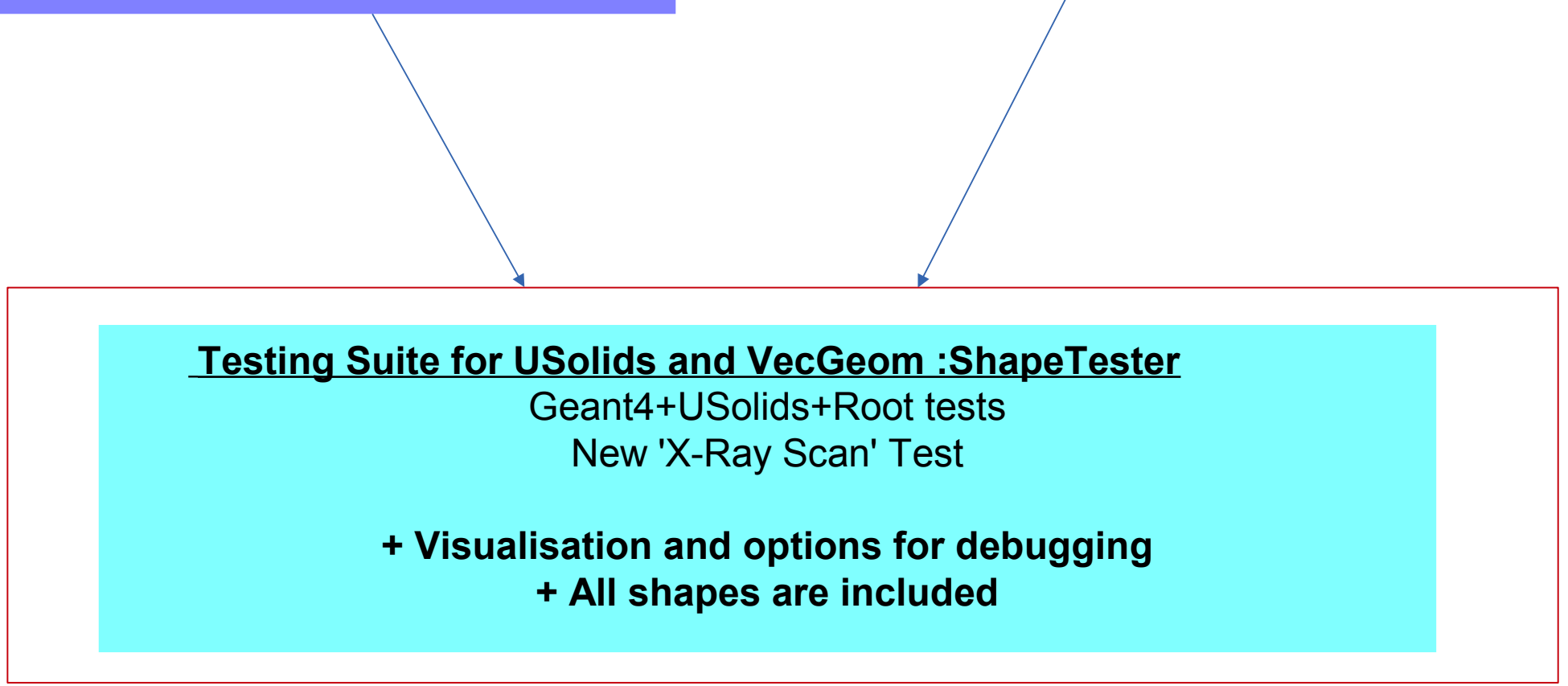
…

Extensive Testing Suite

Root tests

CheckShape:
-ShapesDistances()
-ShapesSafety()
-ShapeNormal()

Possibility to test shape on Run Time



Extensive testing suite : ShapeTester

New:

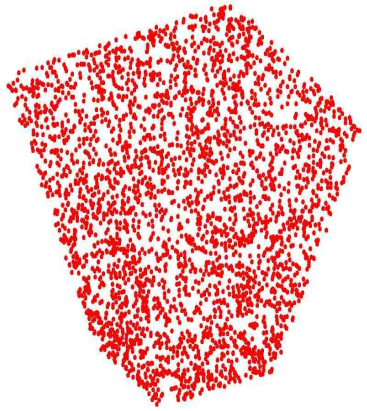
- Working with USolids and VecGeom shapes
- Can be run with any shape from GDML file (FullCMS)
- Can be included in automatic testing
- Possibility of visualisation
- Convexity test

Type of Tests:

- Consistency of response for different methods
    - for points Inside,Outside,Surface
- Accuracy tests for DistanceToIn(p,v) and DistanceToOut(p,v)
- Test for Safeties
- Test for GetPointOnSurface()
- X-Ray Test for Capacity() calculation and Navigation queries
- Test for Normals and convexity

ShapeTester: consistency Tests

Example : Test SurfacePoints()



GetPointOnSurface()
UTrd

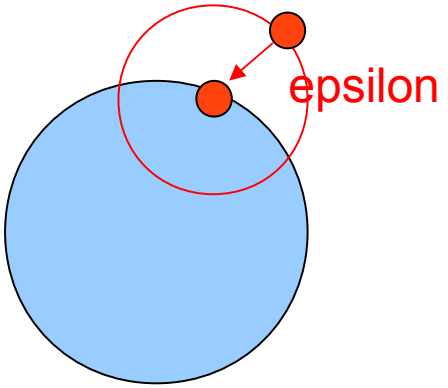
- Test consistency between Inside() and GetPointOnSurface()
  Inside(GetPointOnSurface())== kSurface

- Check consistency between of DistanceToIn() and DistanceToOut() (can not be both zero)

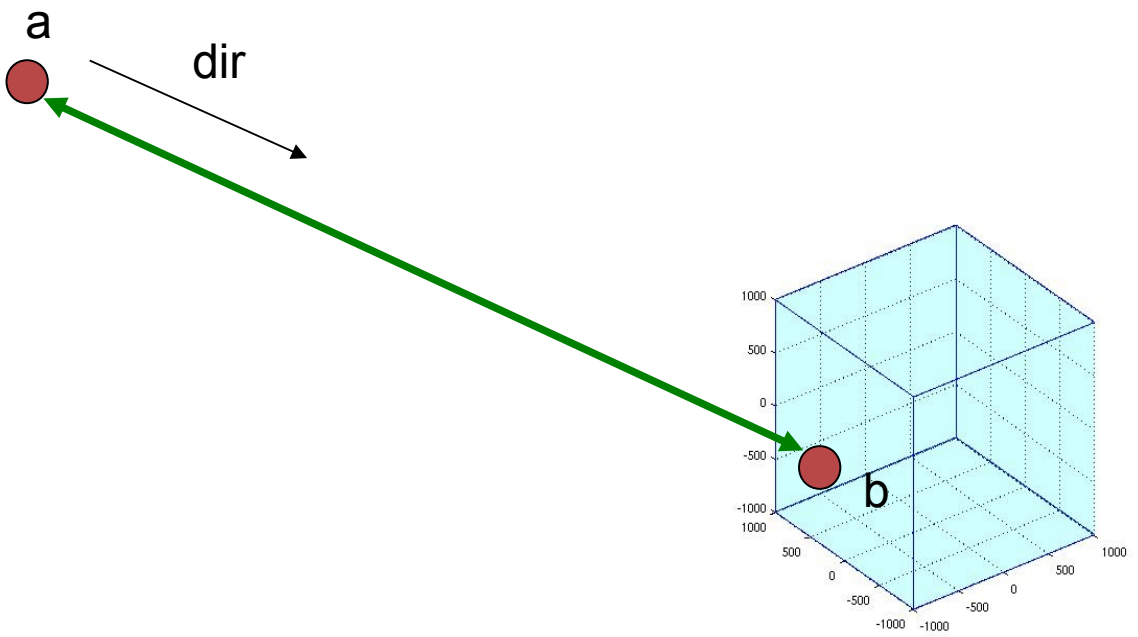
GetPointOnSurface()
VecGeomPolycone

- Check accuracy of DistanceToIn() and DistanceToOut()

- Visualisation of SurfacePoints



ShapeTester
DistanceToIn() accuracy

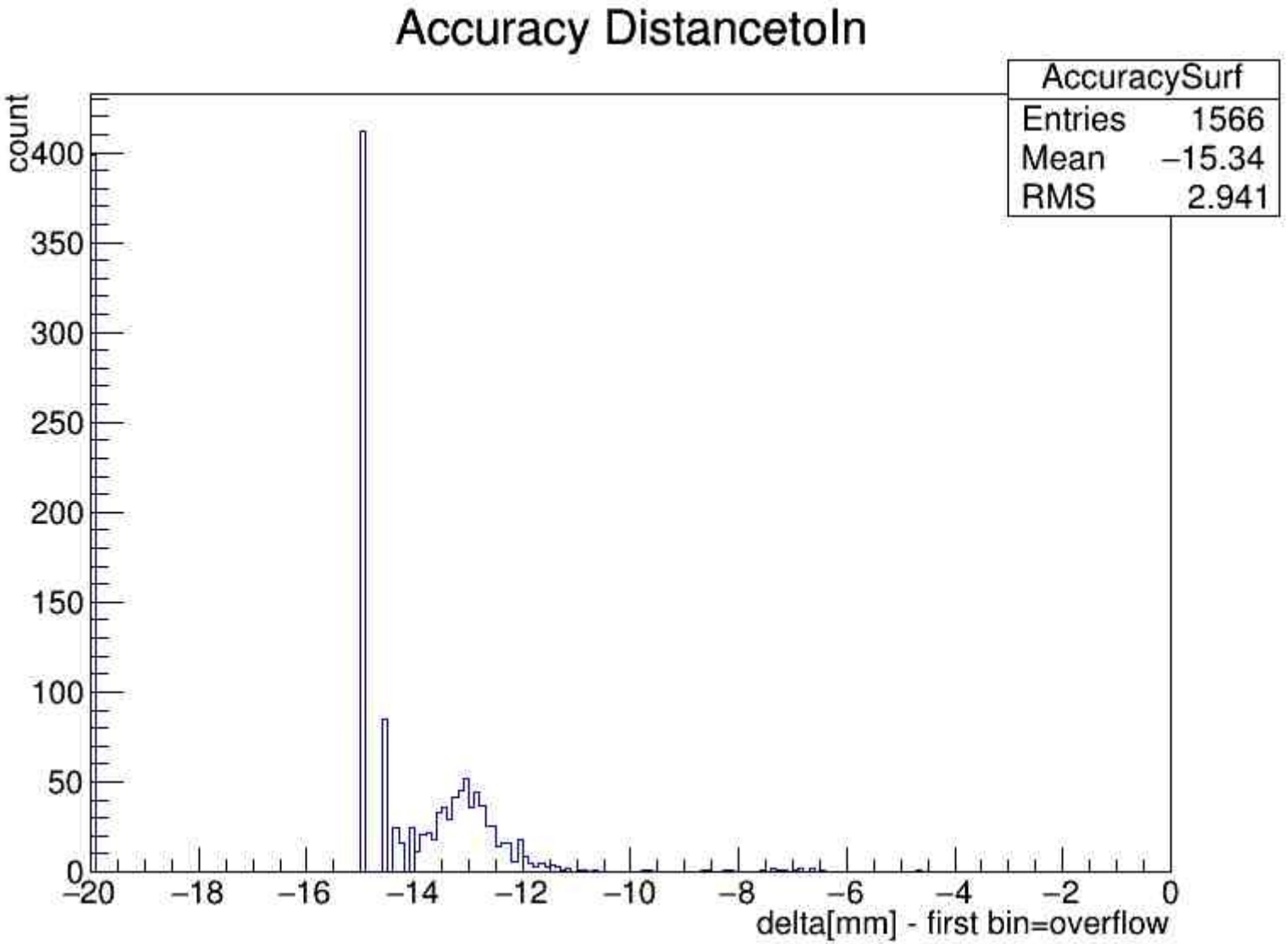


Point ‘b’ located on surface

Accuracy = |DistanceToIn(a,dir) − |a – b||

Shape Tester

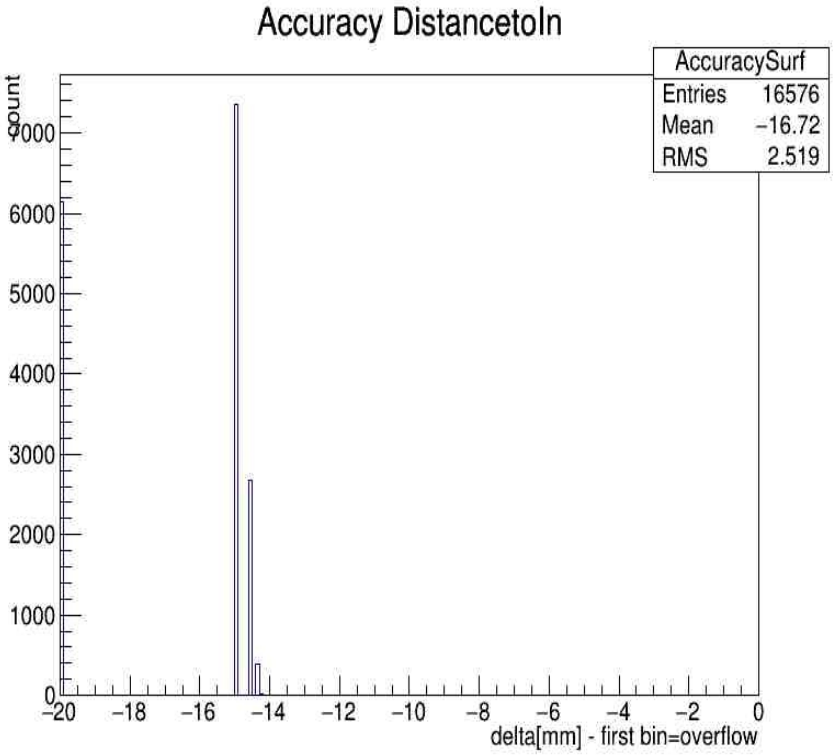
DistanceToIn() accuracy test: UPolycone



Order of magnitude

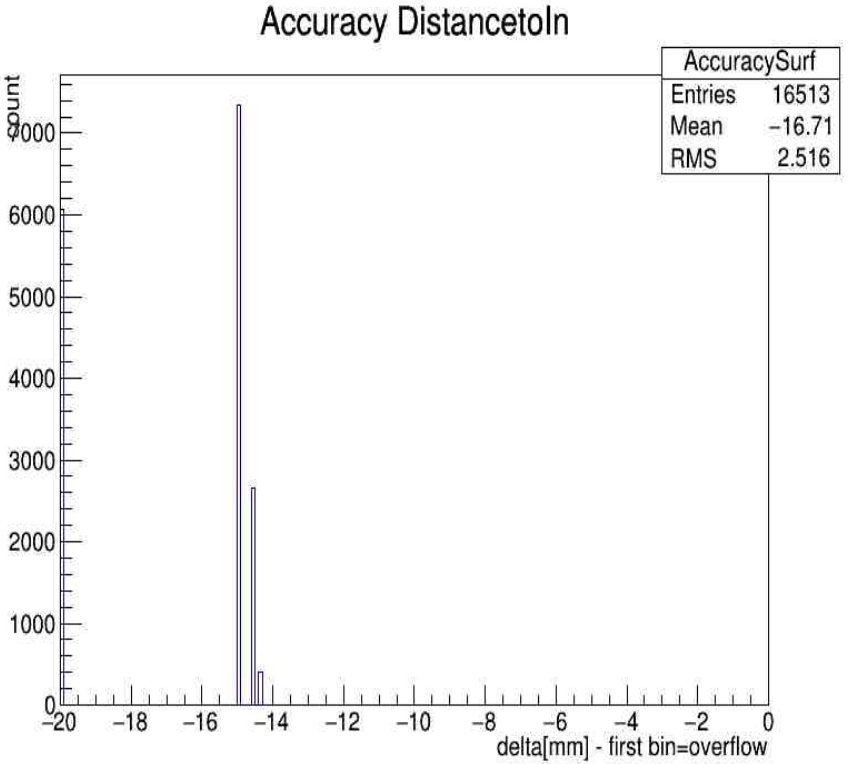
ShapeTester

DistanceToIn accuracy test: UBox and VecGeom Box



Order of magnitude

UBox

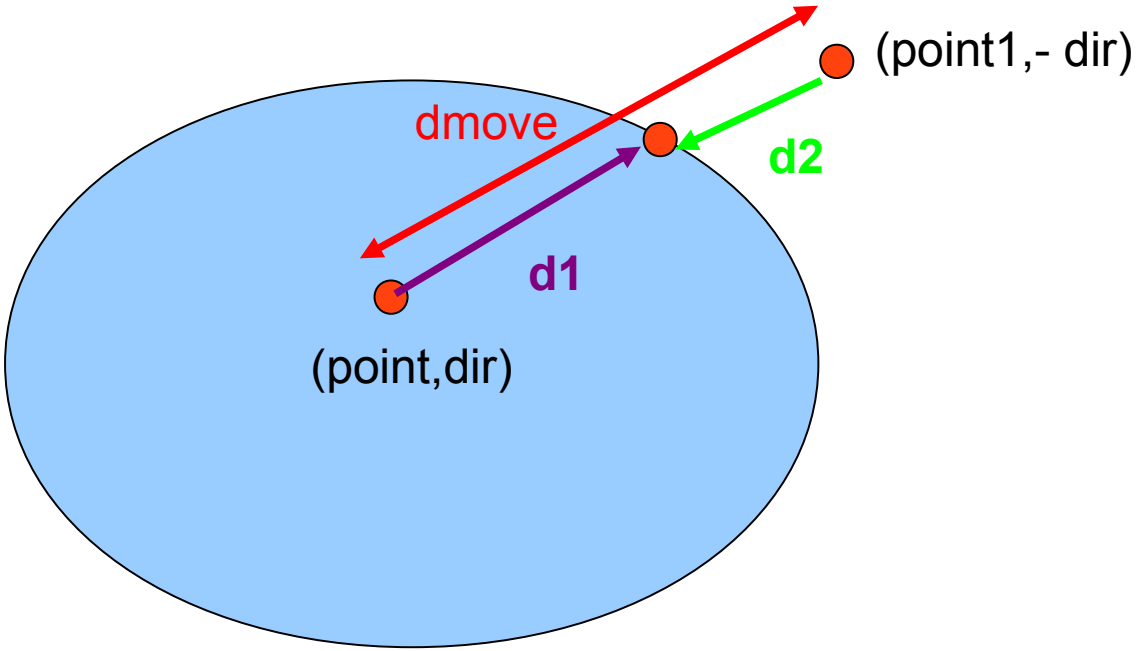


Order of magnitude

VecGeom Box(Scalar version)

ShapeTester

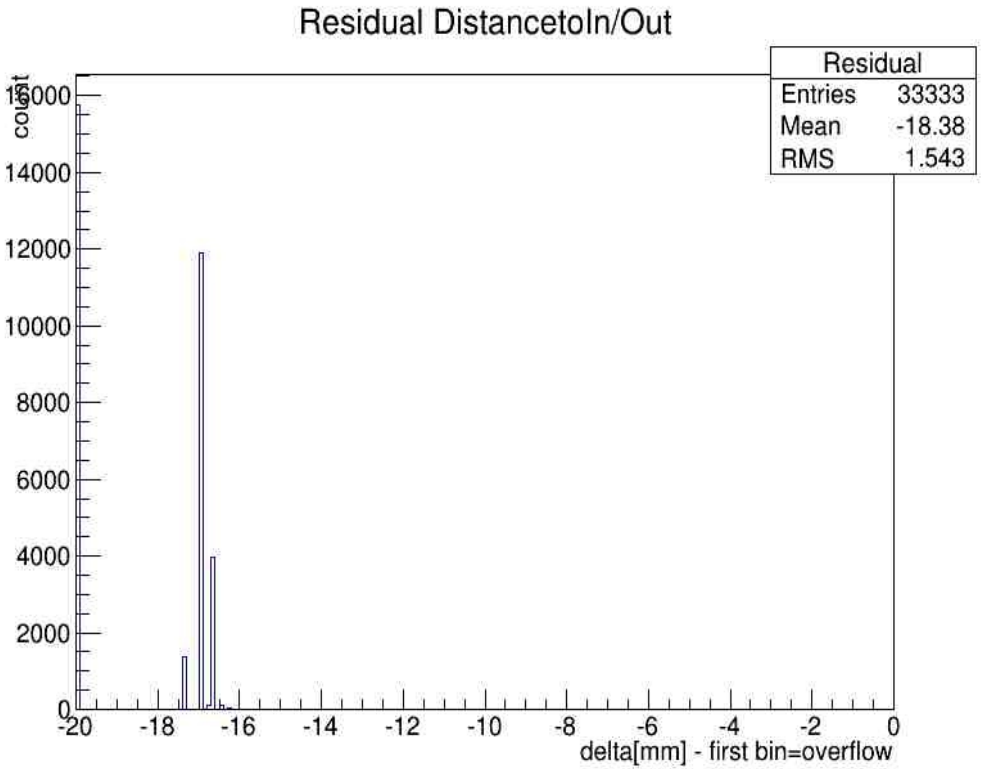
DistanceToIn()/DistanceToOut() accuracy



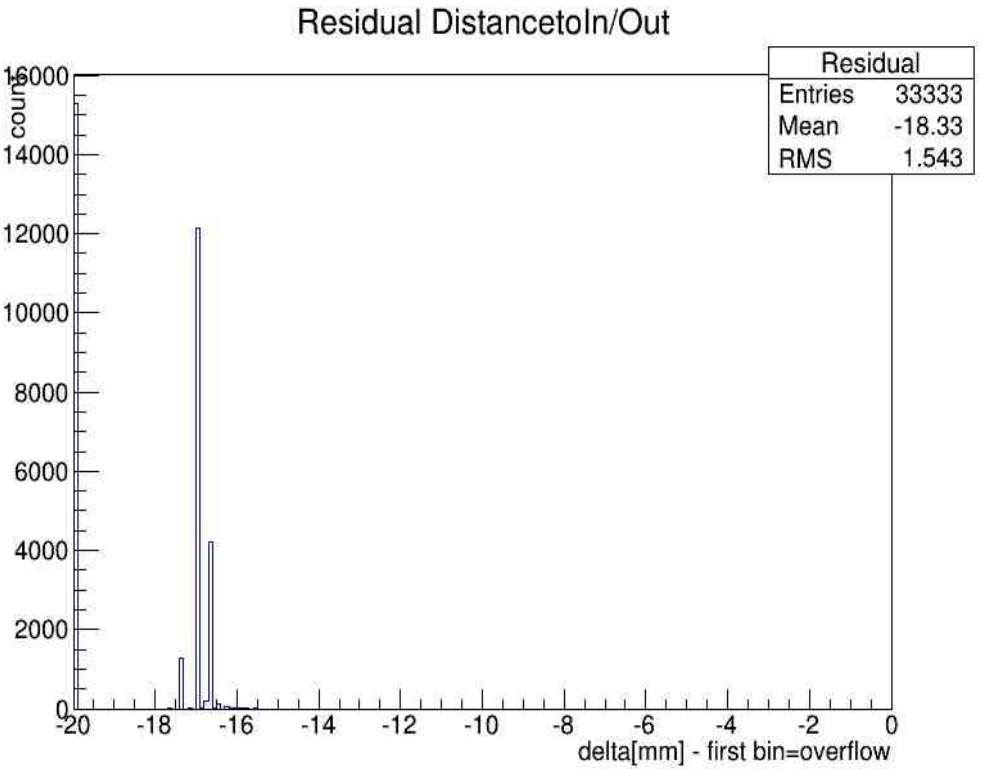
Difference = max (|dmove – d1 – d2|)

Extended testing suite

DistanceToIn/ToOut accuracy test: UBox and VecGeom Box



Order of magnitude



Order of magnitude

UBox

VecGeom Box(Scalar version)

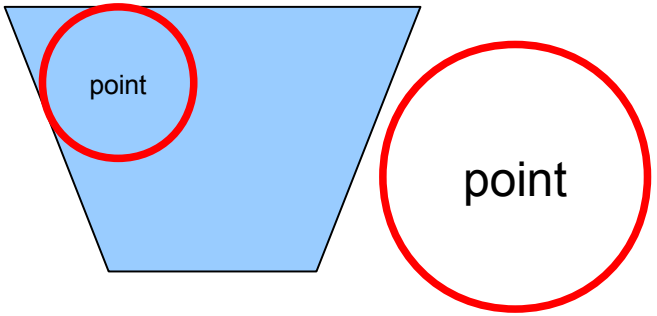
ShapeTester

Safety test

For each point situated Inside or Outside check If calculated Safety S is 'safe' :

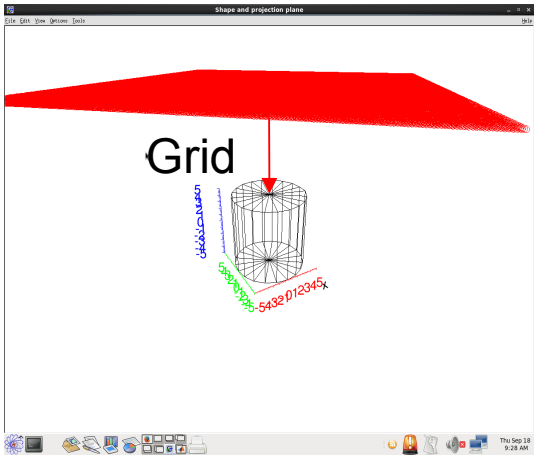
- Points situated at distance S from starting point have to be still Inside/Surface or Outside/Surface.

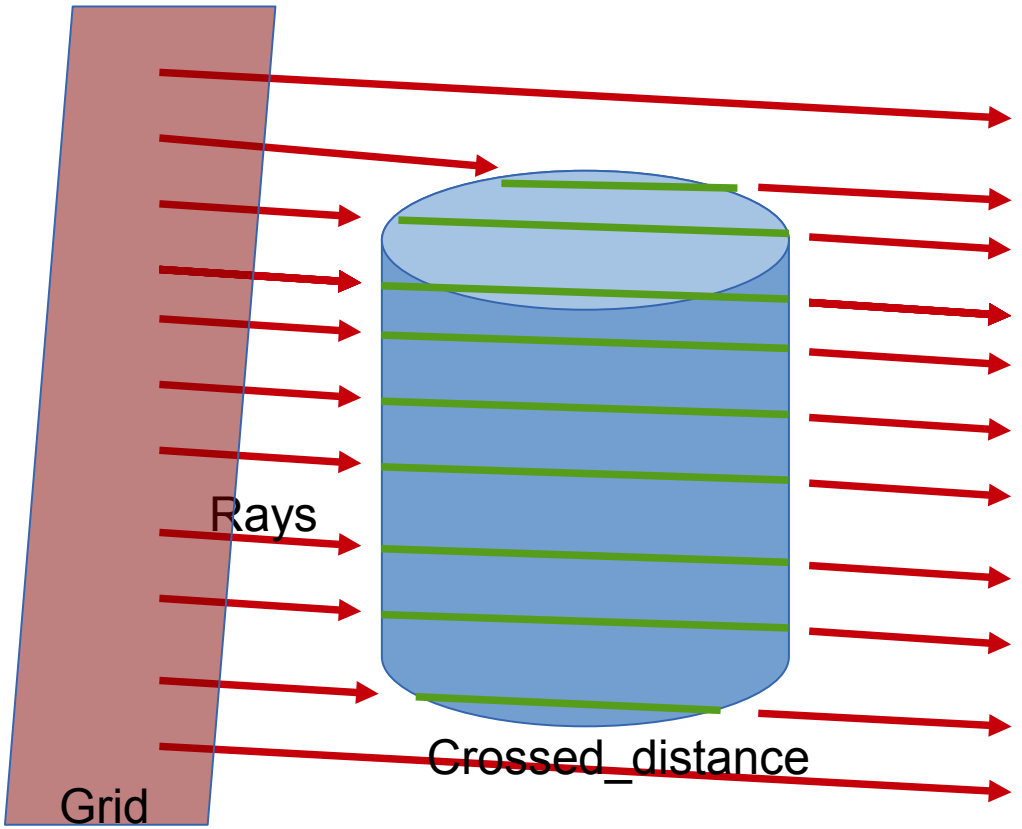
- At the same time, test checks if Safety S <= real Distance (point, direction)



ShapeTester

X-Ray Scan





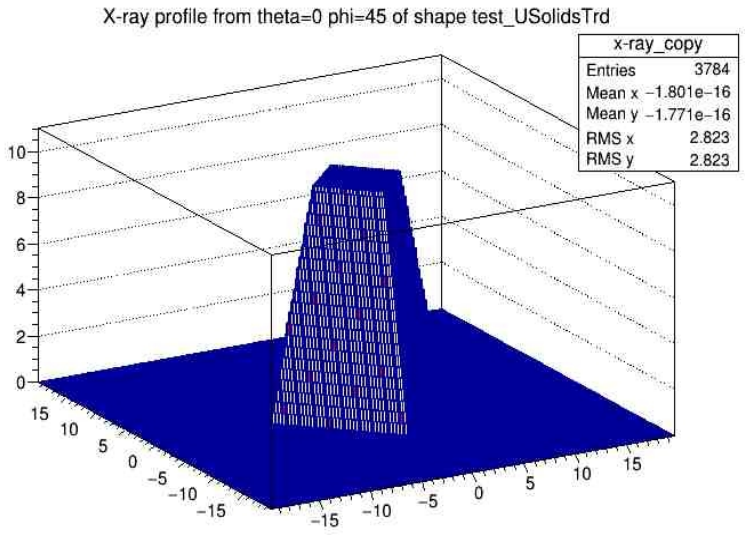
Estimated Volume = ∑(distance × cell-area)

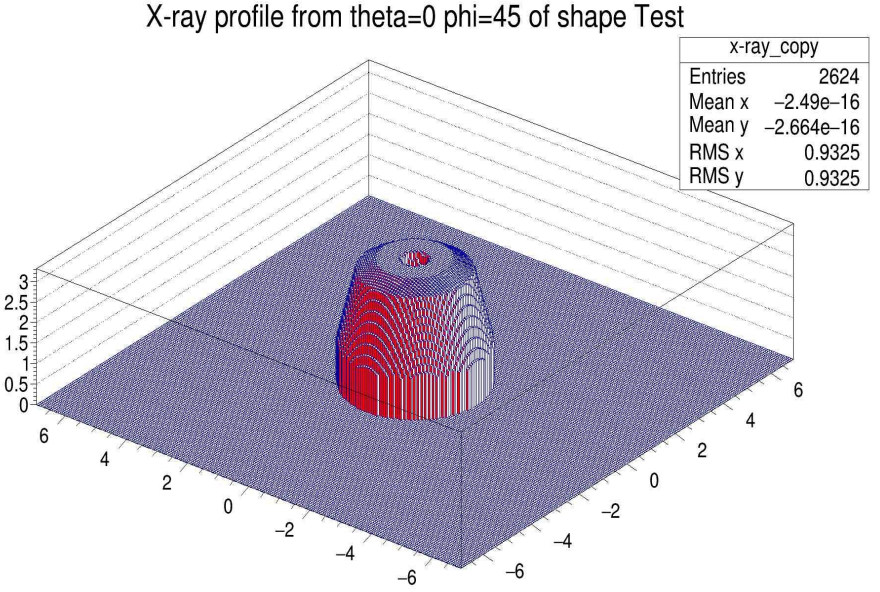
Error = Analytic Volume − Estimated Volume

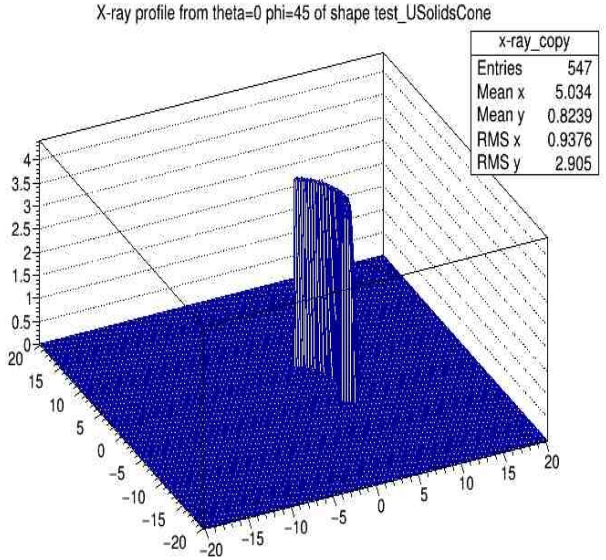
Scan can be done for different angles in Theta and Phi

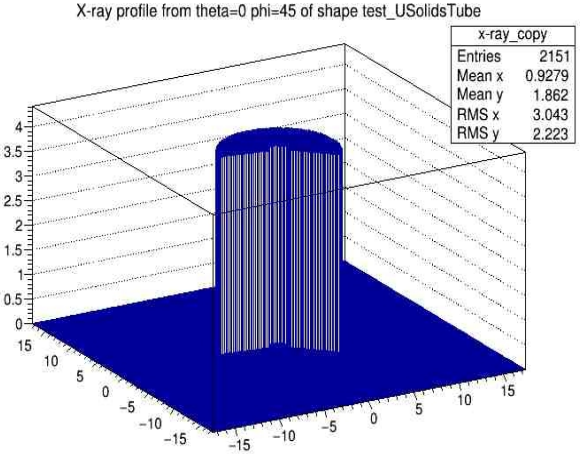
ShapeTester

X-Ray Scan, examples



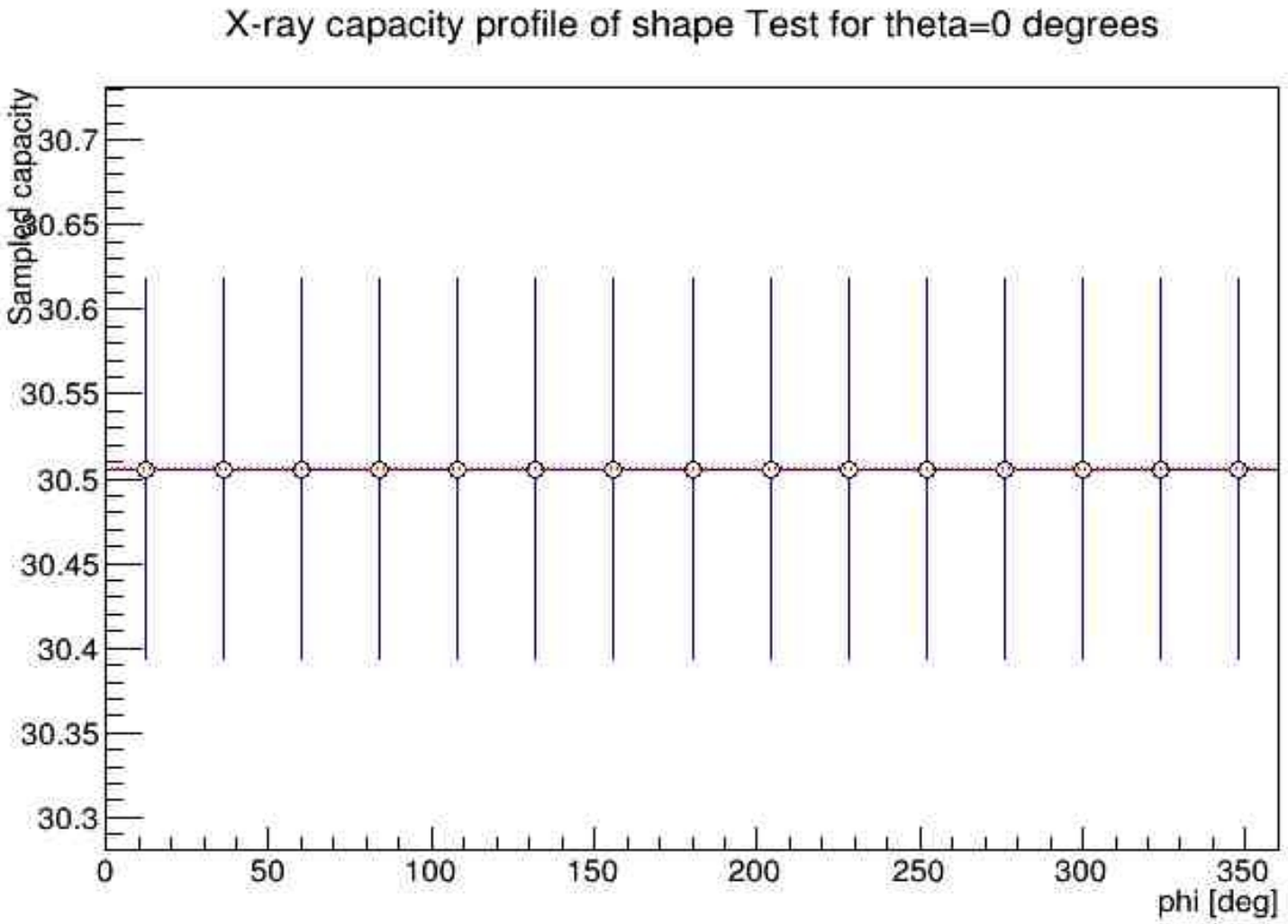


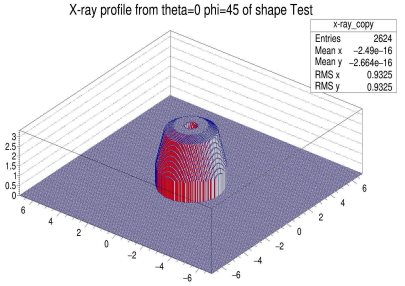




ShapeTester

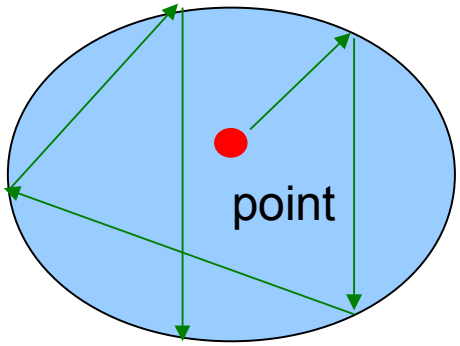
X-Ray Scan, Estimated Volume for VecGeom Polycone



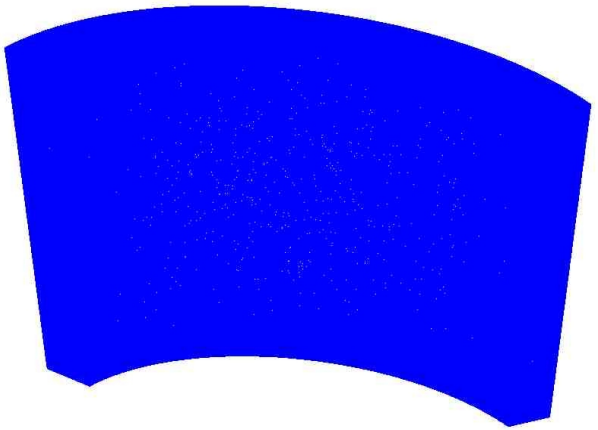


ShapeTester

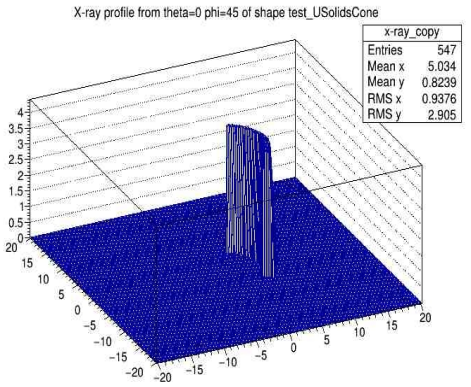
UCons vs VecGeom Cone

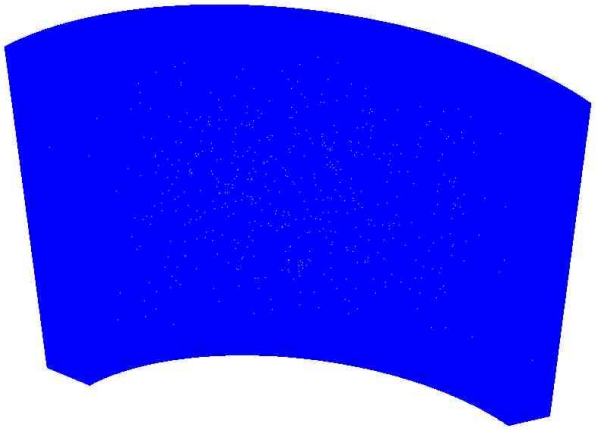


Optical Escape or Shape Normals Test



UCons





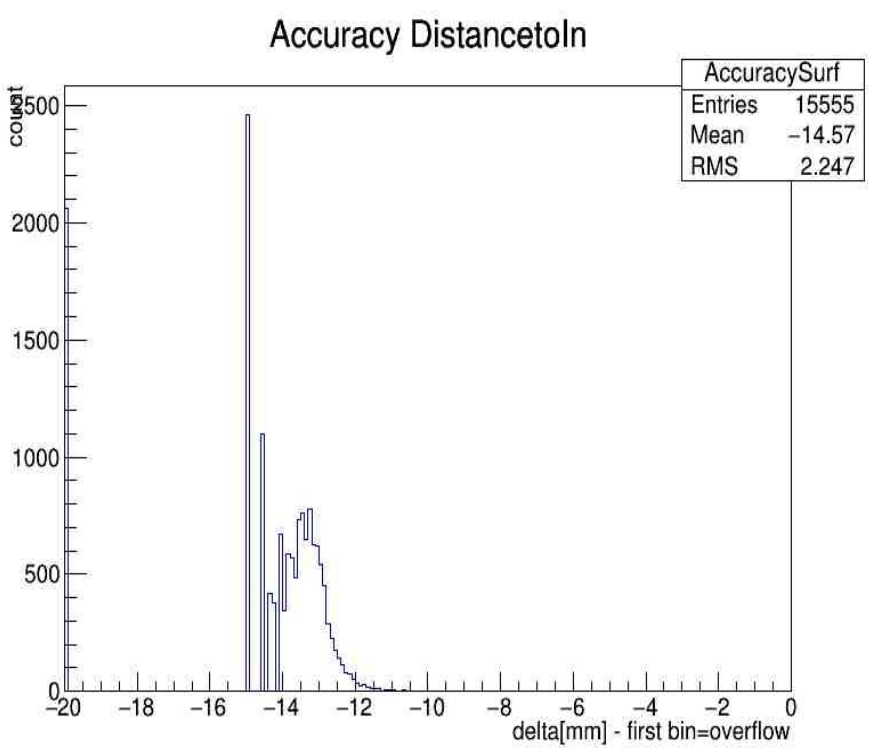
VecGeomCone

Cone with Phi section and Rmin != 0

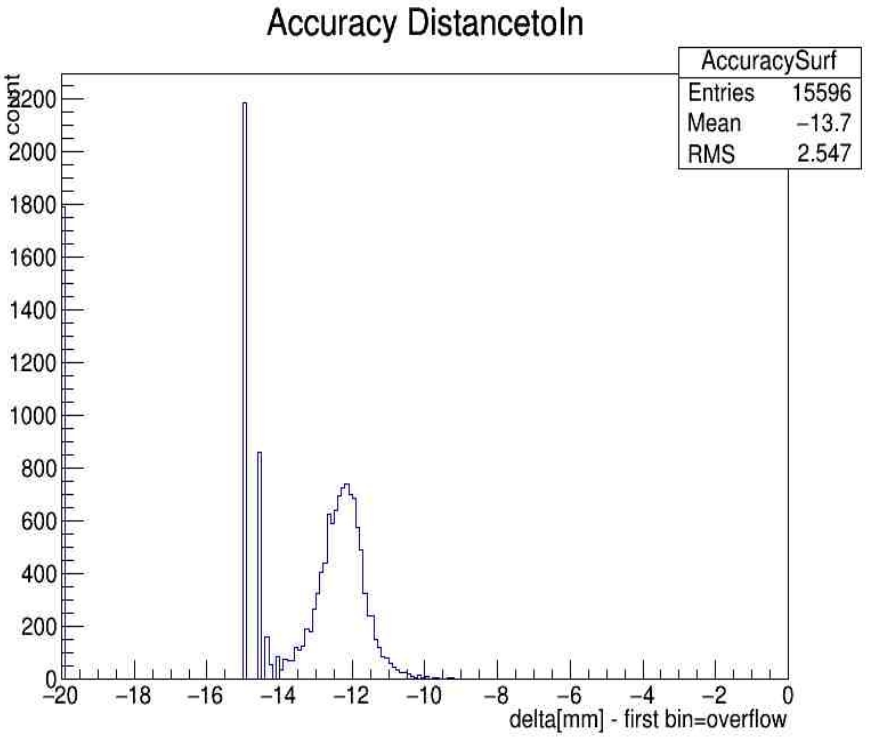
ShapeTester

UCons vs VecGeom Cone

DistanceToIn Accuracy Test



Order of magnitude



Order of magnitude

Cone with Phi section and Rmin != 0

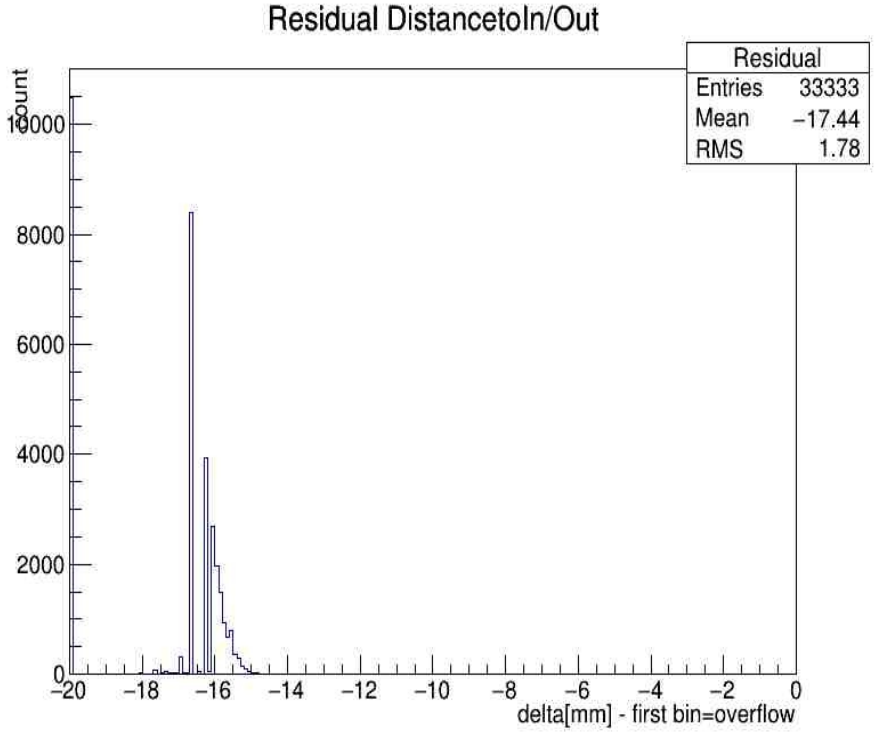
UCons

VecGeom Cone

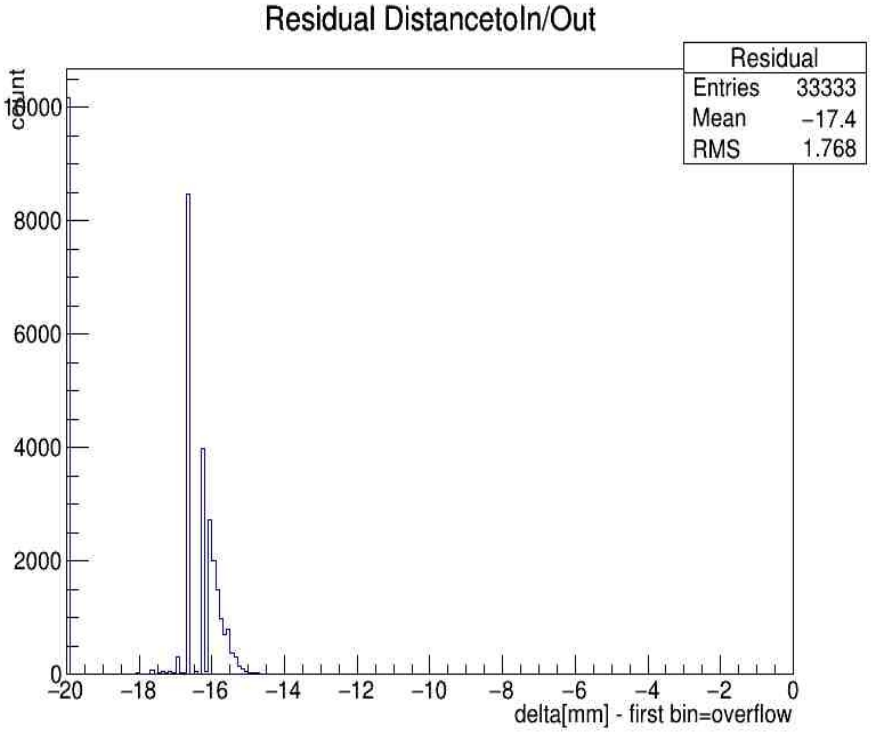
ShapeTester

UCons vs VecGeom Cone

DistanceToIn()/DistanceToOut() accuracy



Order of magnitude



Order of magnitude

Cone with Phi section and Rmin != 0

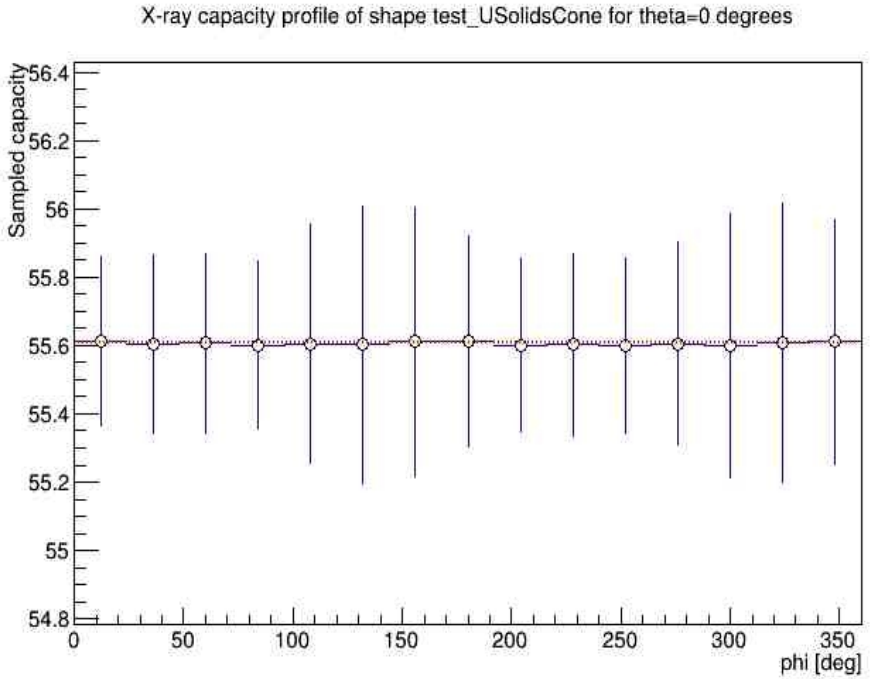
UCons

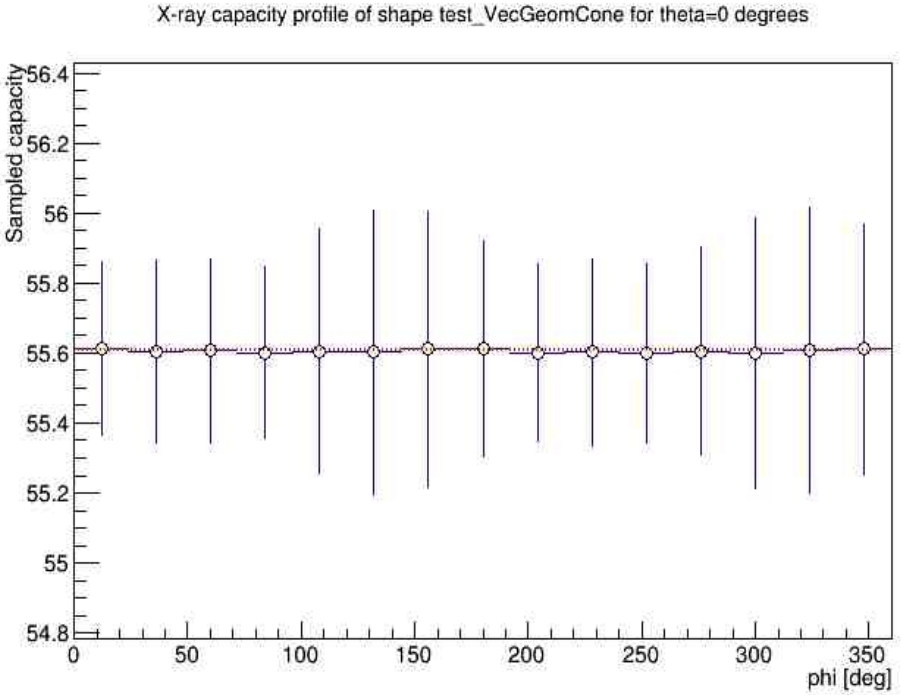
VecGeom Cone

ShapeTester

UCons vs VecGeom Cone

X-Ray Test, estimated Capacity()





Cone with Phi section and Rmin != 0

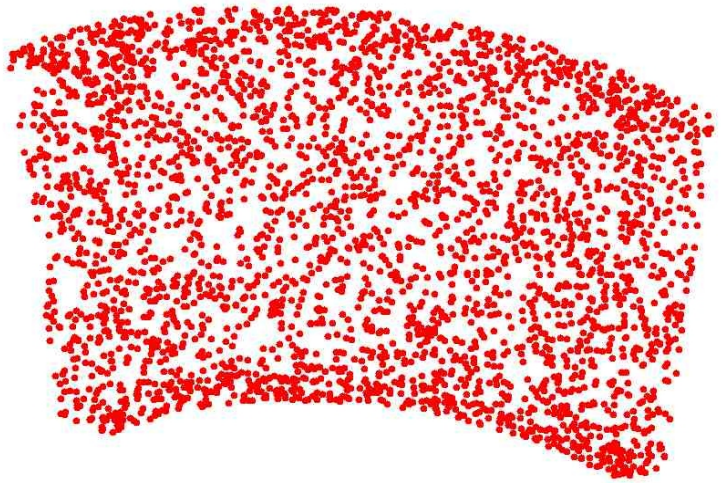
UCons

VecGeom Cone

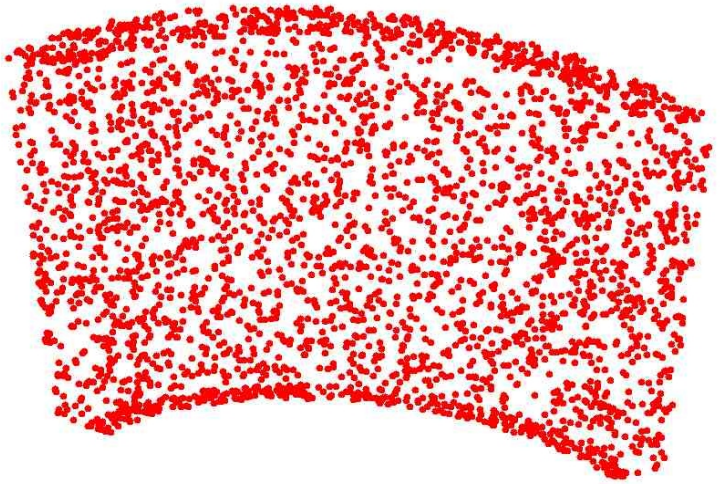
ShapeTester

UCons vs VecGeom Cone

GetPointOnSurface()



UCons



VecGeom Cone

Cone with Phi section and Rmin != 0

ShapeTester

Shapes set

Shapes given by user (user creates a test file)

Simple subset of basic shapes included in testing

Examples :

Test for Box – cube and rectangular prism

Test for Tube – full tube, hollow tube and hollow tube with phi section

Test for Trd – box like trd and trd with different Dx and Dy

Test for Polycone – full polycone with 4 sections, hollow polycone, polycone with phi section

Data base of shapes from FullCMS, ready to be used

Shapes from other experiments, to be added

ShapeTester

Status

- Adapted for USolids and VecGeom different conventions

- Automatic error report, can be made at RunTime

- Box , Cons, Orb, Sphere, Trd are passing ShapeTester without errors in simple test configuration
- Work in progress for shapes from DATA BASE

Work in progress:- Investigation of reported errors by other solids,
sometimes error is a false positive
- Separate subset of tests that can be run frequently

Missing tests:
- Better test for Safety
- Specific test for precise Safety
- Test for Contains() for VecGeom shapes
- GetPointsOnEdge()
- ComparisonSolid test

ShapeTester

Conclusions

Testing suite is ready and in use

Main work of this year was :
- bug fixing
- making shapes pass the tests
- and creation of utility for debugging

Still there are errors to be fixed and tests to be added

Safety studies

Performance

Status :

- Implementation of missing precise Safety for UTubs, UCons and UPolycone
- All USolids are passing existing test for Safety for precise and coarse versions

Timing of individual shapes :

Precise SafetyFromOutside(p,true) is 20-40% slower for CSG USolids

Precise SafetyFromOutside() is about 9 time slower for UPolycone

- Non precise version uses BoundingBox, which is very fast
- For UPolycone precise version is about 4 times faster than Geant4 precise version

See details in:

https://indico.cern.ch/event/309348/contribution/1/attachments/591243/813832/Meeting-USolids-07-04-2014.pdf

Measurement with FullCMS application:

No penalty or gain was measured in FullCMS application by using precise or coarse safety

Safety studies

What next ?

- Specific test for precise Safety
  - *Changes in interface are needed, if we want to call Precise and Coarse safety on each step*

- How safety can influence physics results?
  - *Add counts for steps and physics observables to the test*

Any suggestion is welcome !