The TOPAS Tool for Particle Simulation Capabilities and Outlook

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Advancing Medical Care through Discovery in the Physical Sciences
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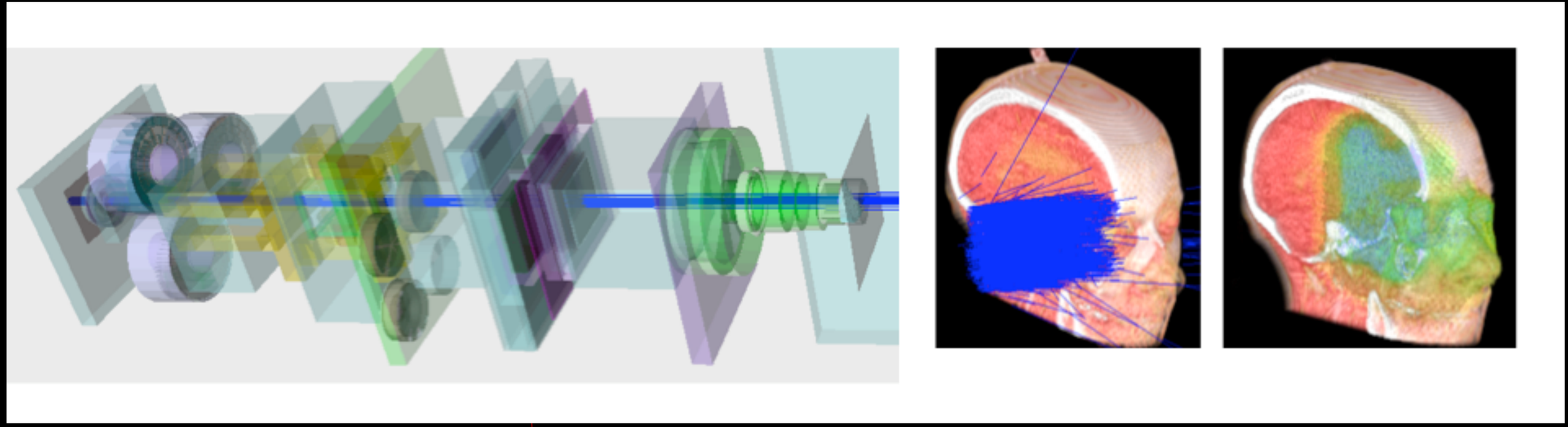
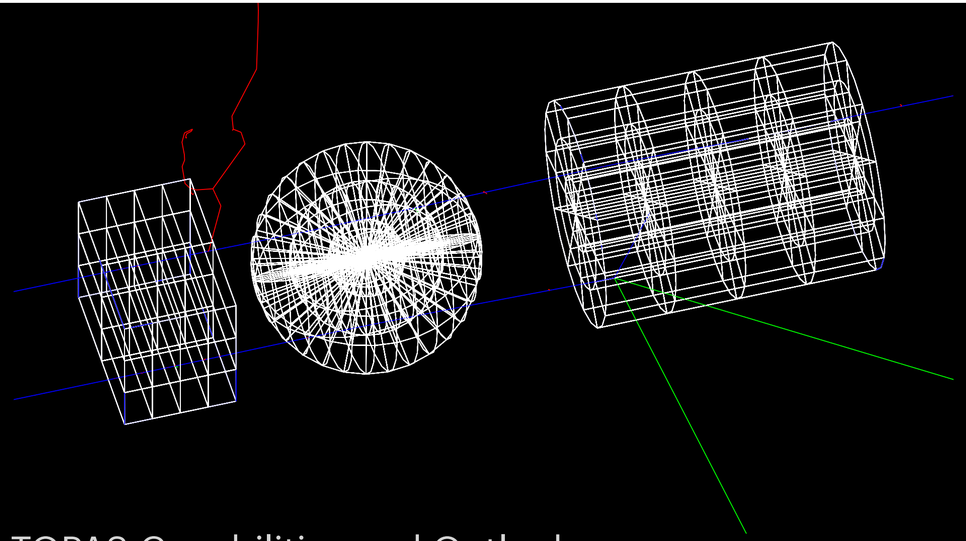
Tool for Particle Simulation



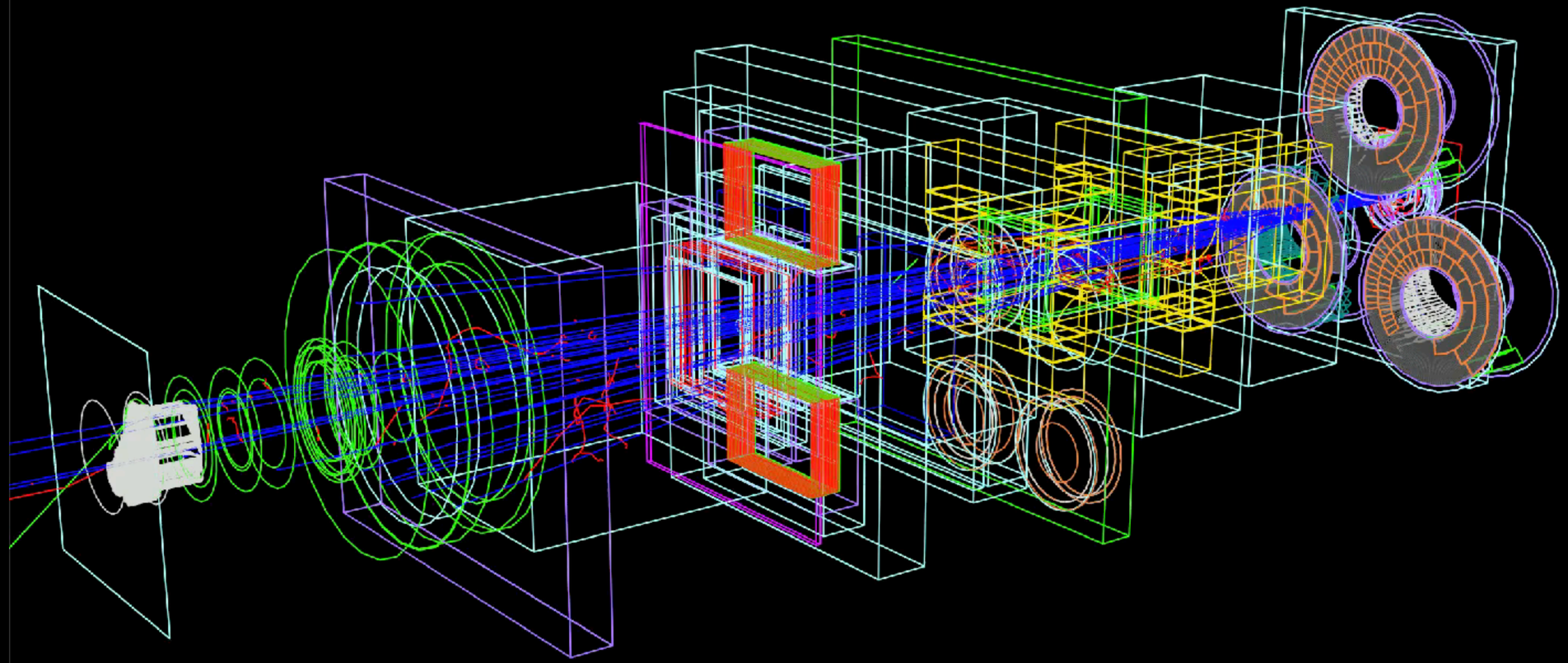
Score Dose, Fluence, etc. to various formats: csv, binary phase space nTuple DICOM



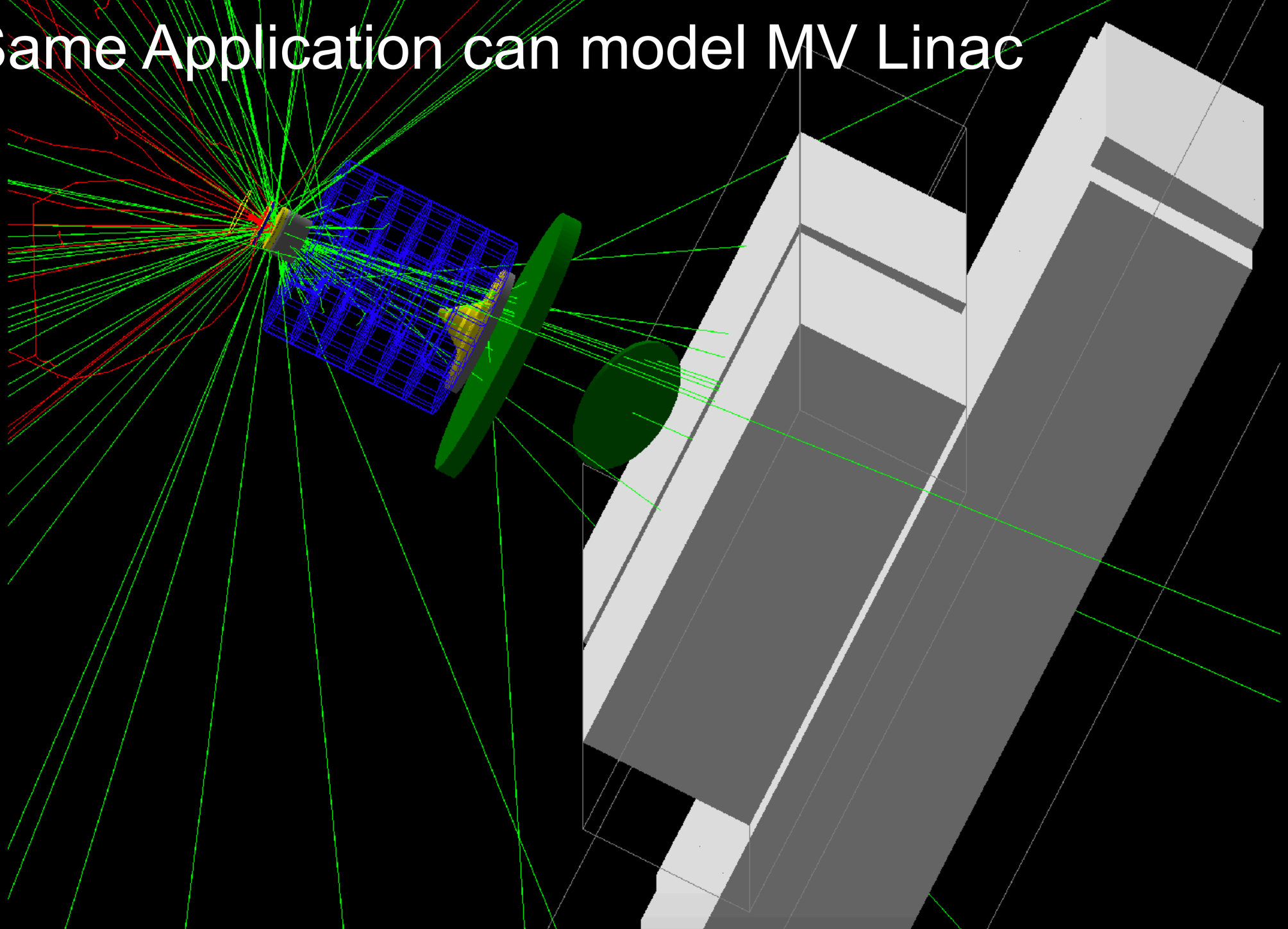
4-Dimensional

2368 Users at 616 Institutions in 67 Countries

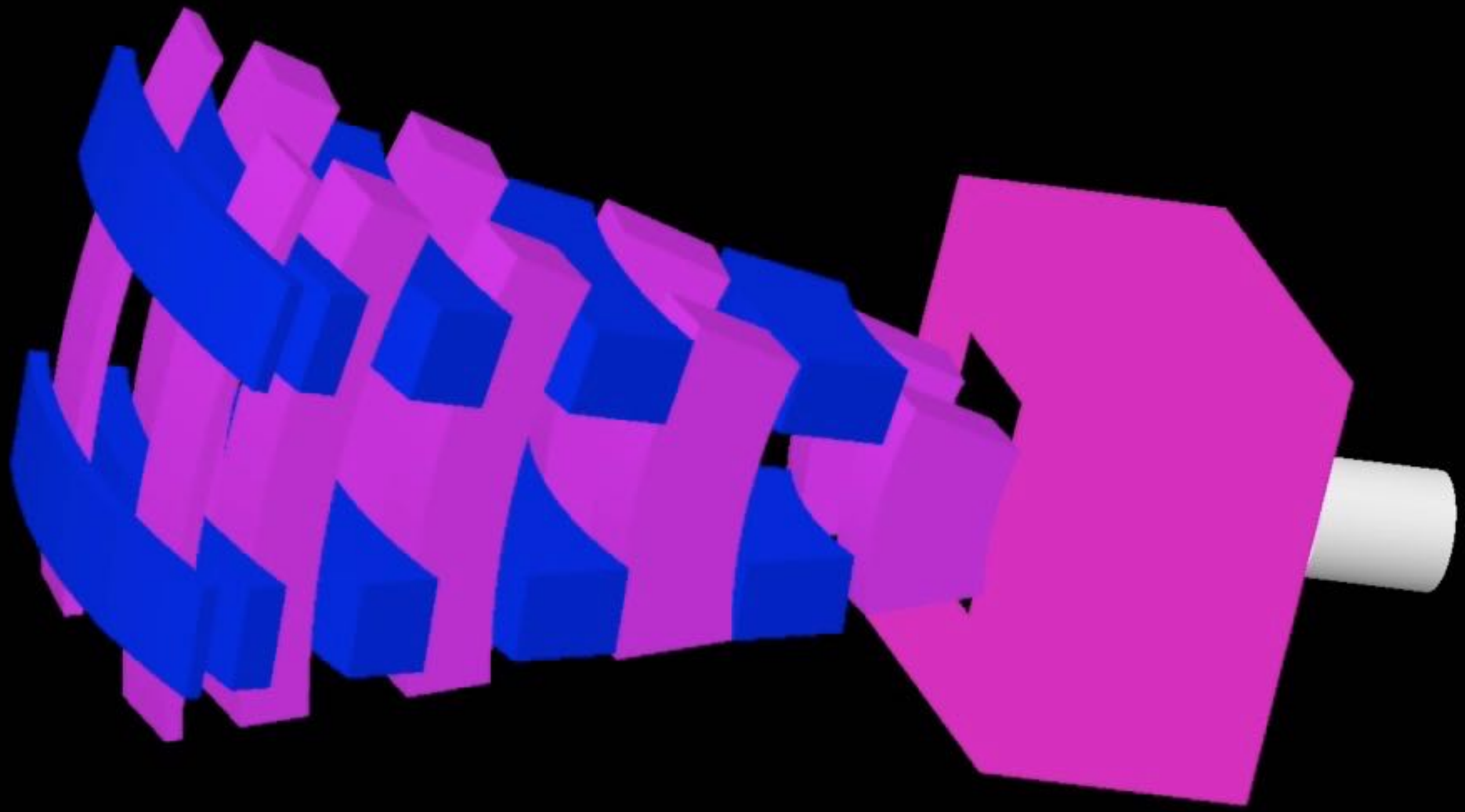
Users can build complex and precise models, such as this Proton Therapy system



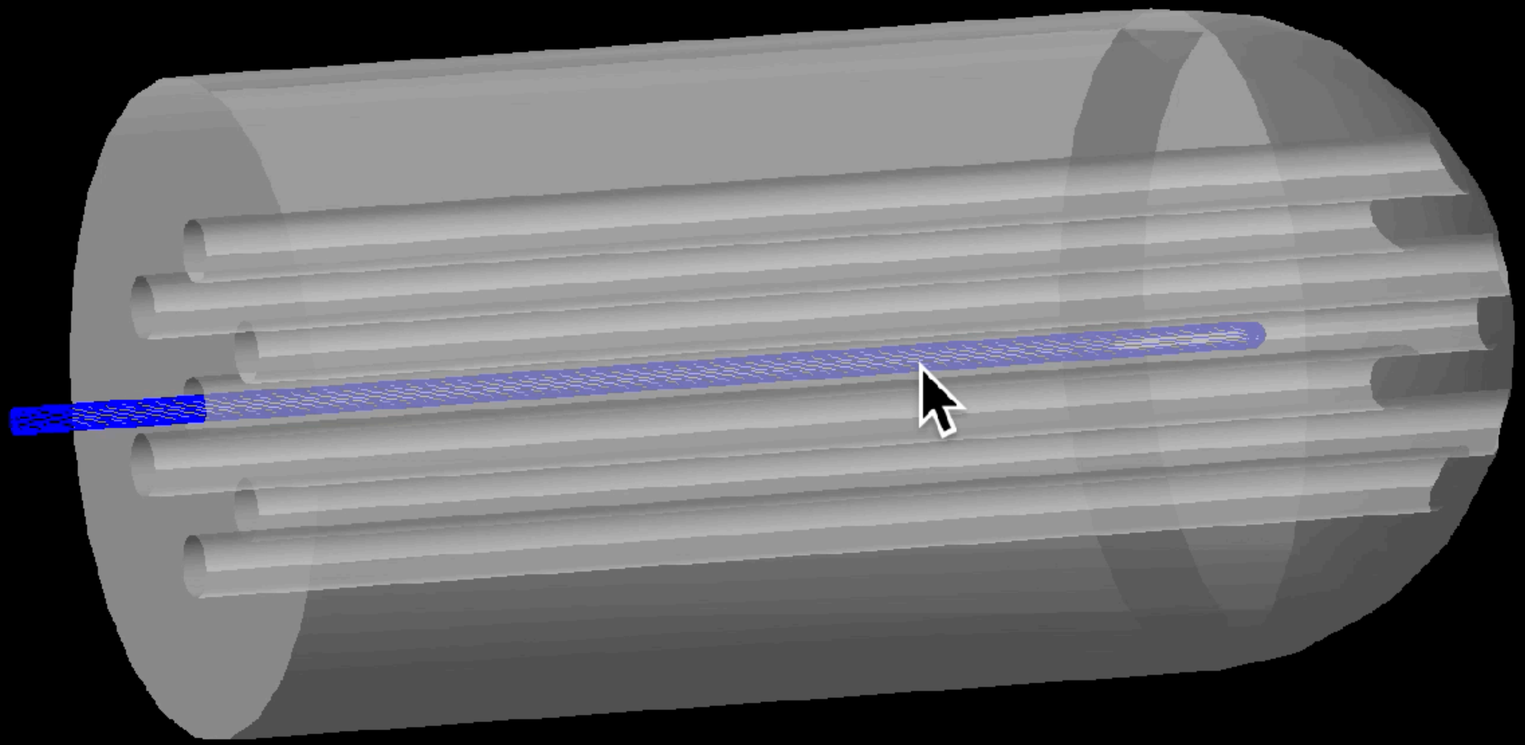
Same Application can model MV Linac



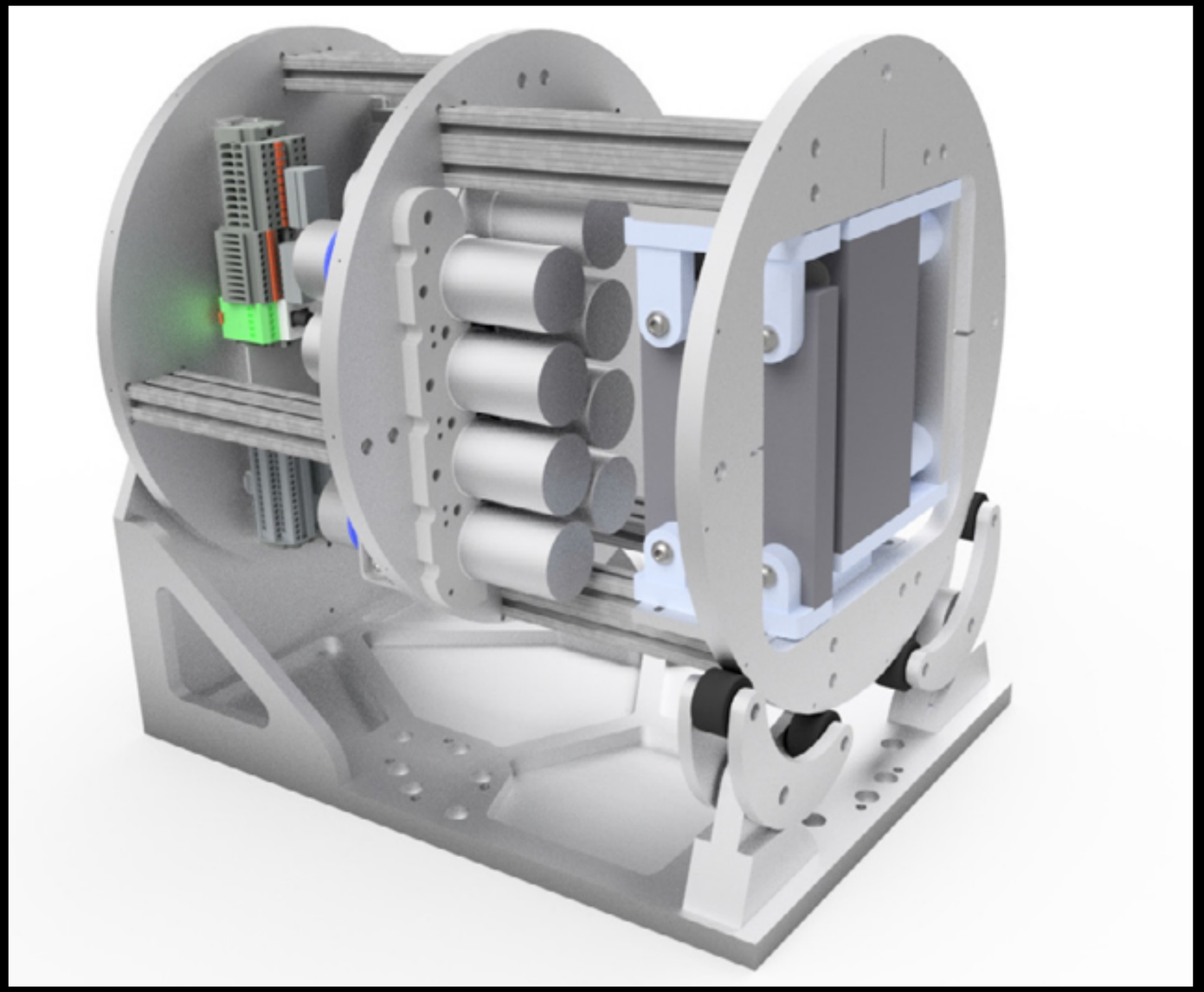
Cobalt Therapy System



HDR Brachytherapy



Prompt Gamma Range Verification



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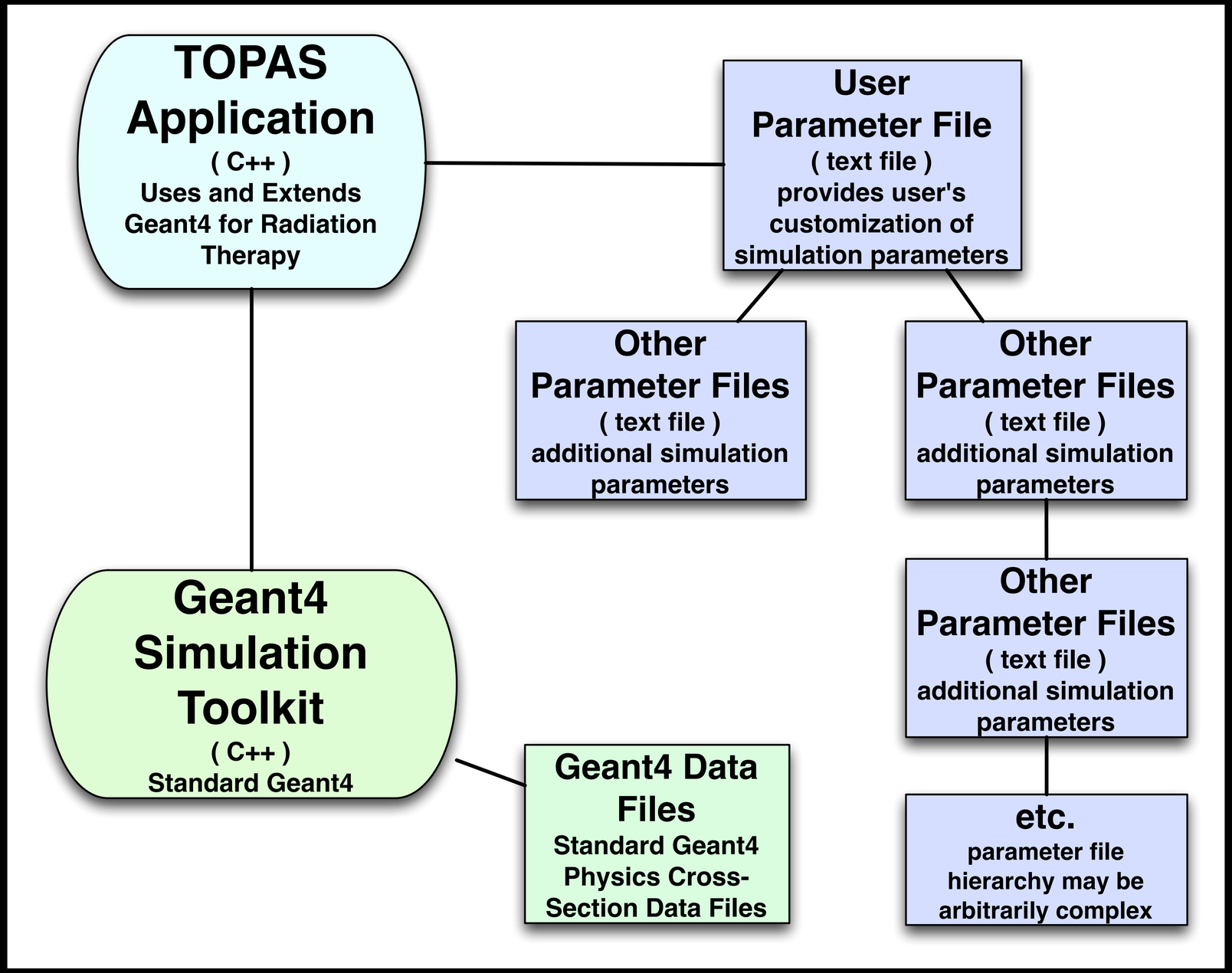
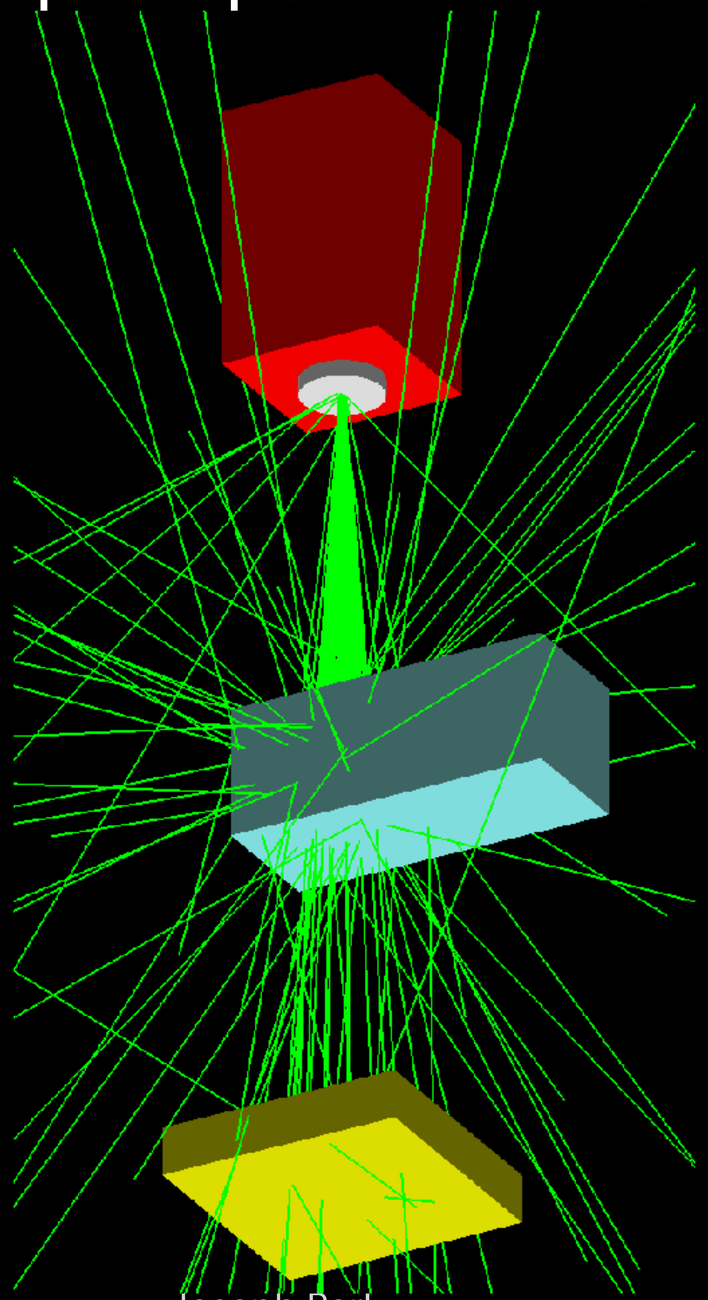
Geant4 Inside

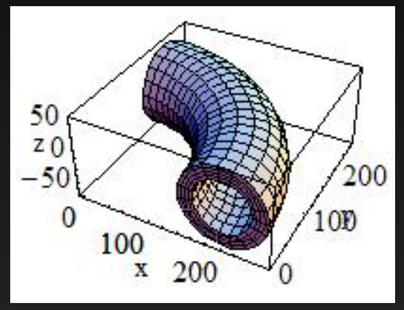


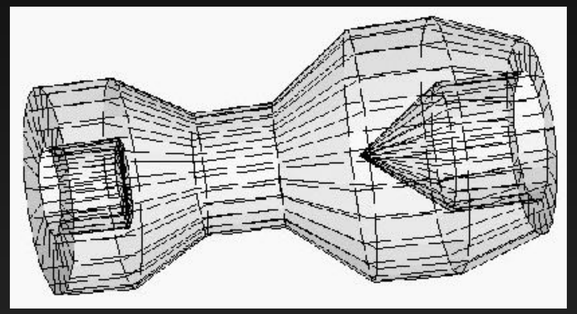
TOPAS Parameter Control System: Up to speed in 2 Hours

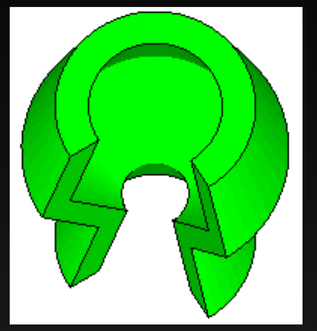
```
s:Ge/XRaySystem/Type      = "Group"
s:Ge/XRaySystem/Parent    = "World"
d:Ge/XRaySystem/RotZ.     = 90. deg
d:Ge/XRaySystem/TransX = 0. cm

s:Ge/XRayExitWindow/Type      = "TsCylinder"
s:Ge/XRayExitWindow/Parent    = "XRaySystem"
s:Ge/XRayExitWindow/Material = "G4_Ti"
d:Ge/XRayExitWindow/RMax     = 5. mm
d:Ge/XRayExitWindow/HLZ       = 0.05 mm

s:So/LinacBeam/Type = "Beam"
s:So/LinacBeam/Component = "XrayExitWindow"
s:So/LinacBeam/BeamParticle = "gamma"
d:So/LinacBeam/BeamEnergy = 6. MeV
u:So/LinacBeam/BeamEnergySpread = 0.2
s:So/LinacBeam/BeamPositionDistribution = "Gaussian"
s:So/Demo/BeamPositionCutoffShape = "Ellipse"
```

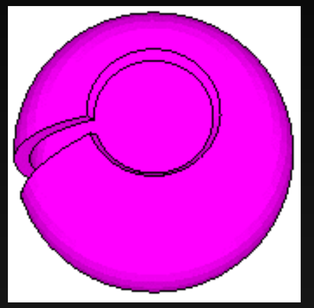


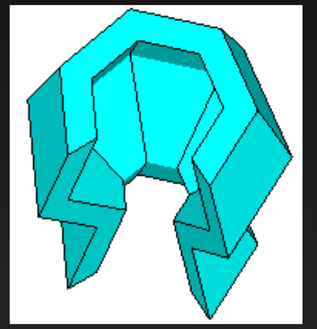
Wide Selection of Geometry Components

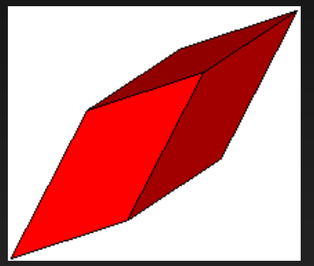


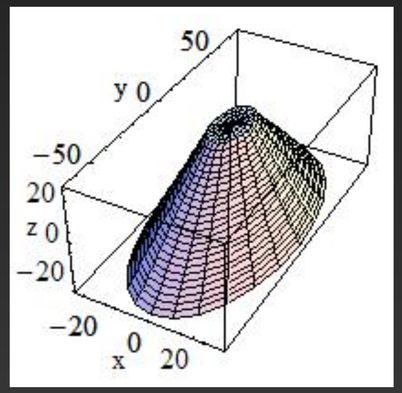


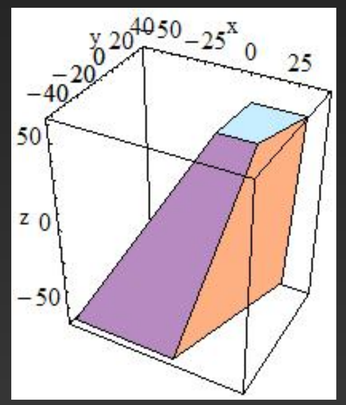


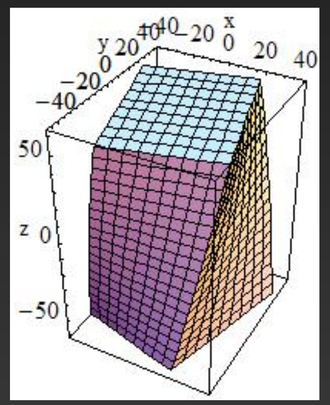


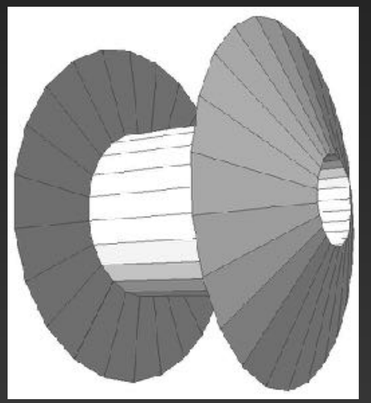




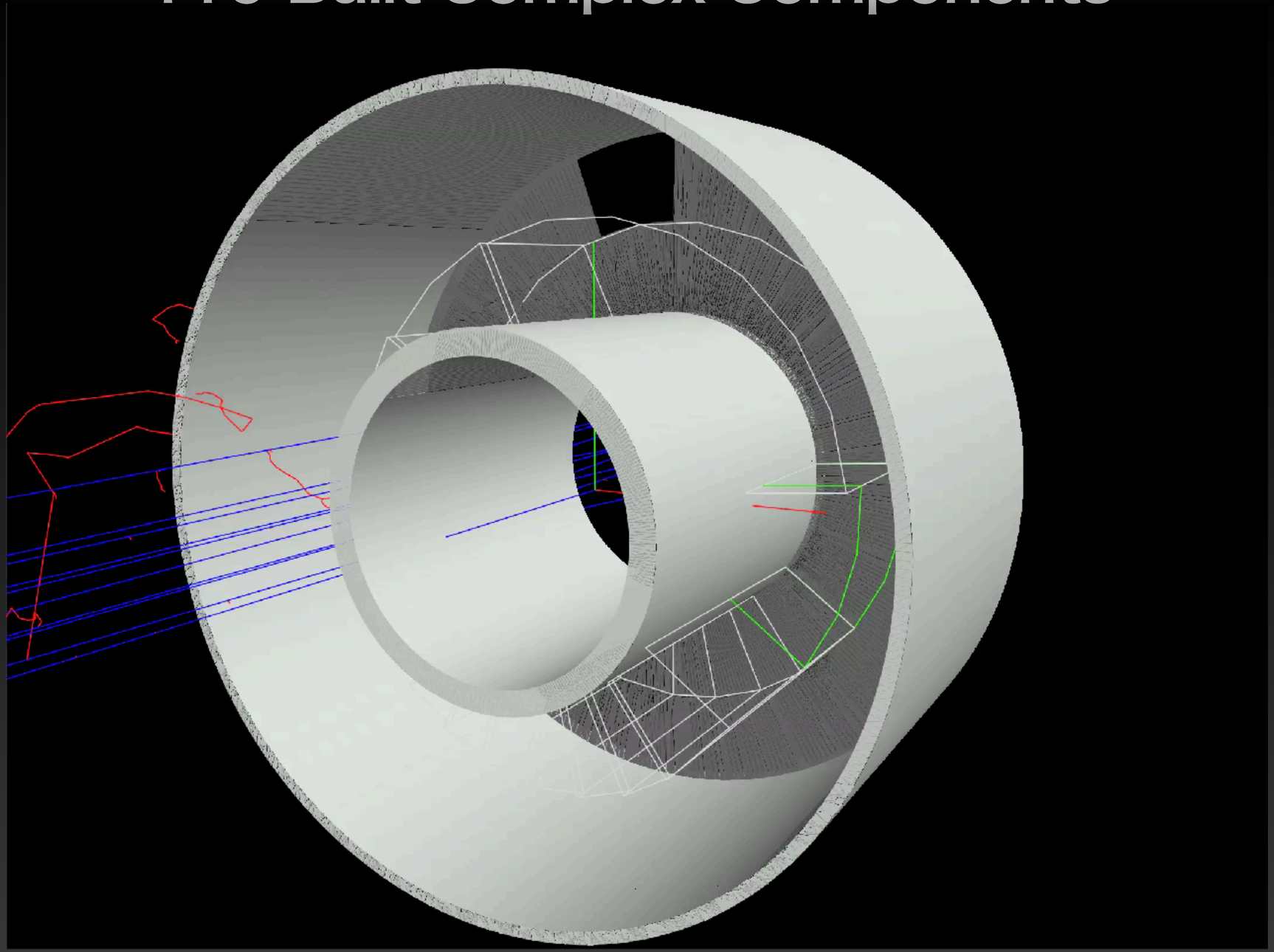




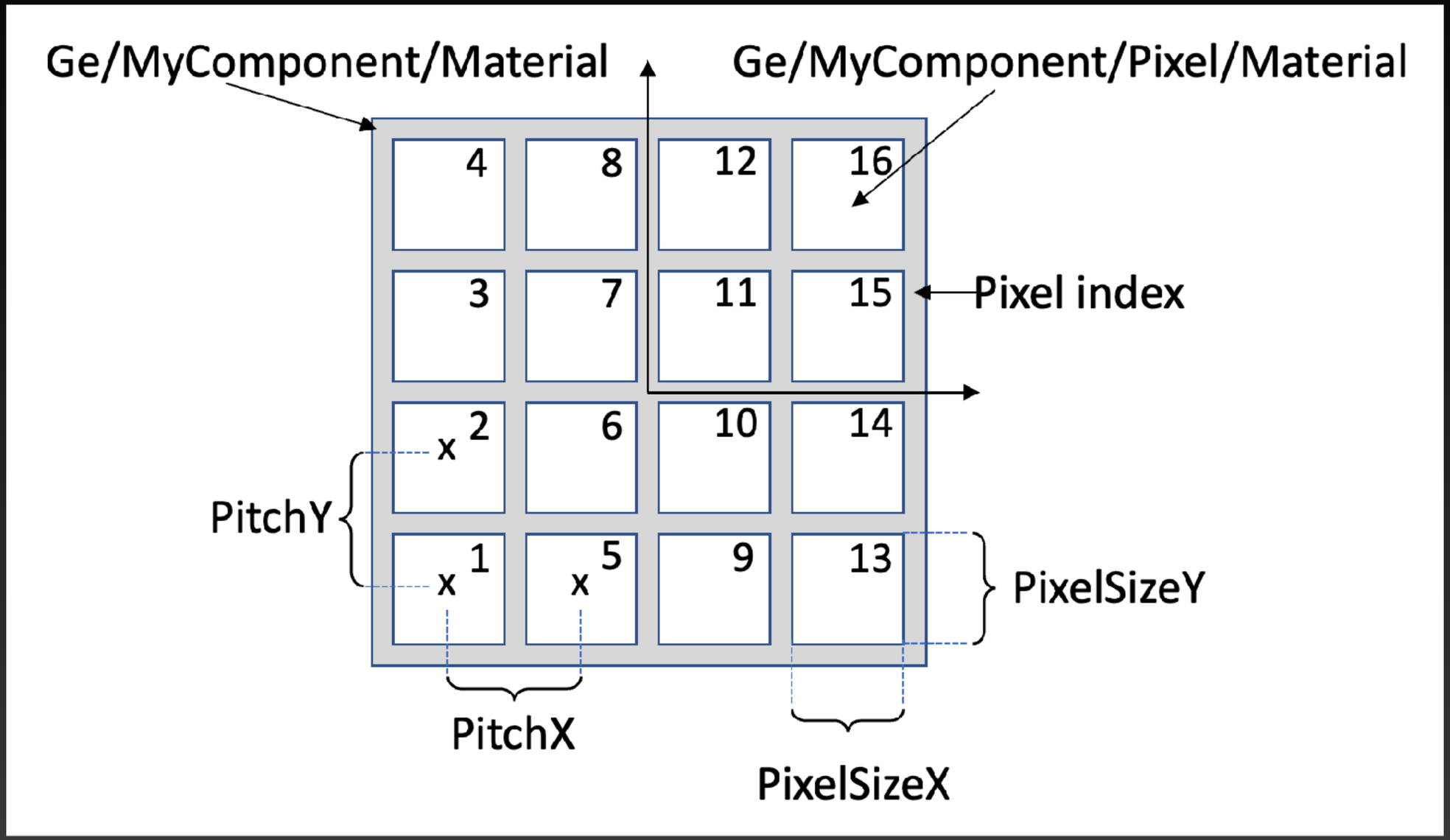




Pre-Built Complex Components



Specialized Geometry Components for Imaging



Optical Physics

EXAMPLE PARAMETER FILES

- Basic
- Brachytherapy
- Graphics
- MVLinac
- Nozzle
- ⊟ Optical
  - OpticalMaterialSample.txt
  - OpticalPhotonCount.txt
  - PixelatedDetector.txt
  - PlasticScintillator.txt
  - Rotating_Surfaces.txt
  - Surfaces.txt
  - WavelengthShifter.txt
- Outcome
- Patient
- PhaseSpace
- Scoring
- SpecialComponents
- TimeFeature
- UCSFETF
- VarianceReduction

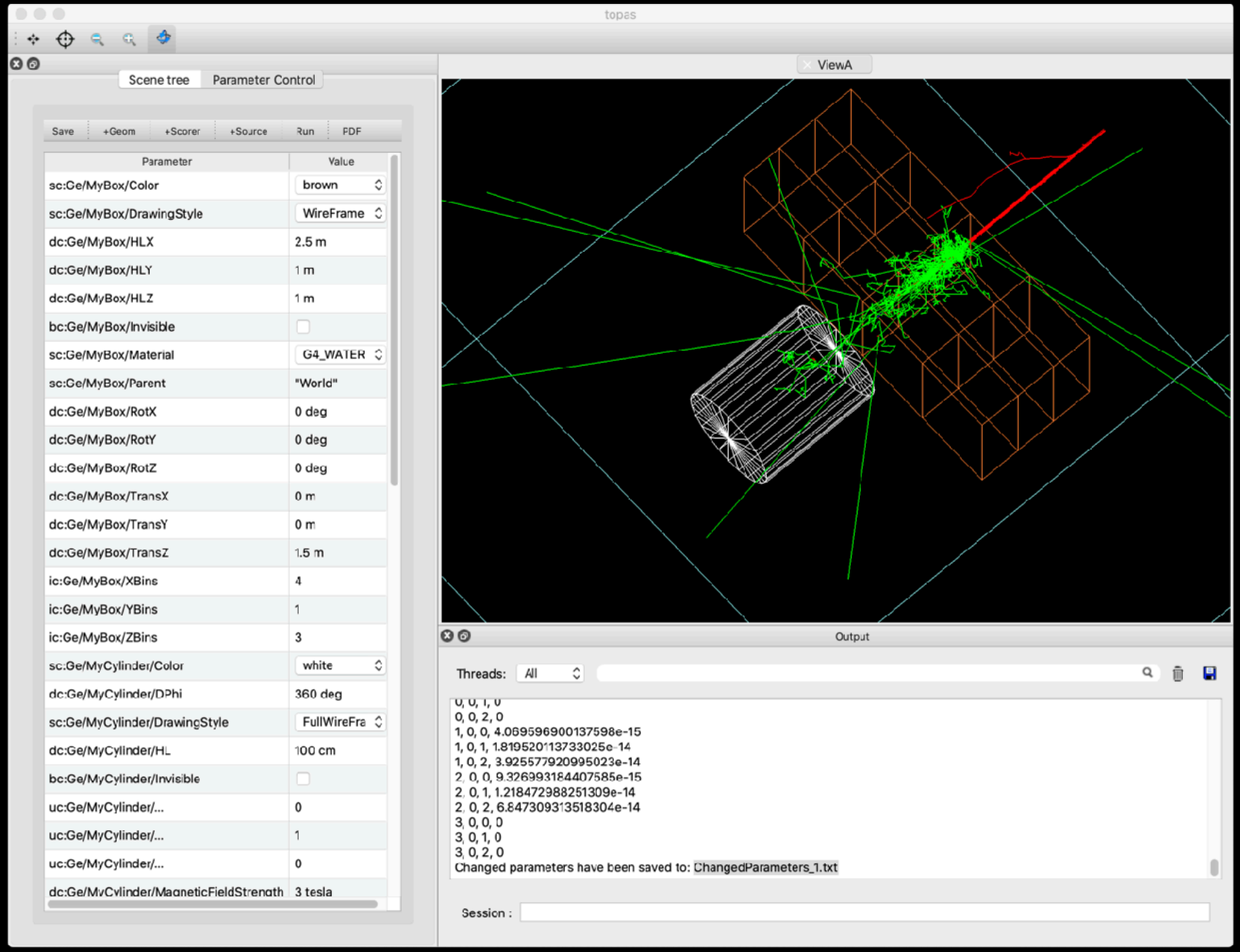
Docs » Optical » WavelengthShifter.txt

Edit on GitHub

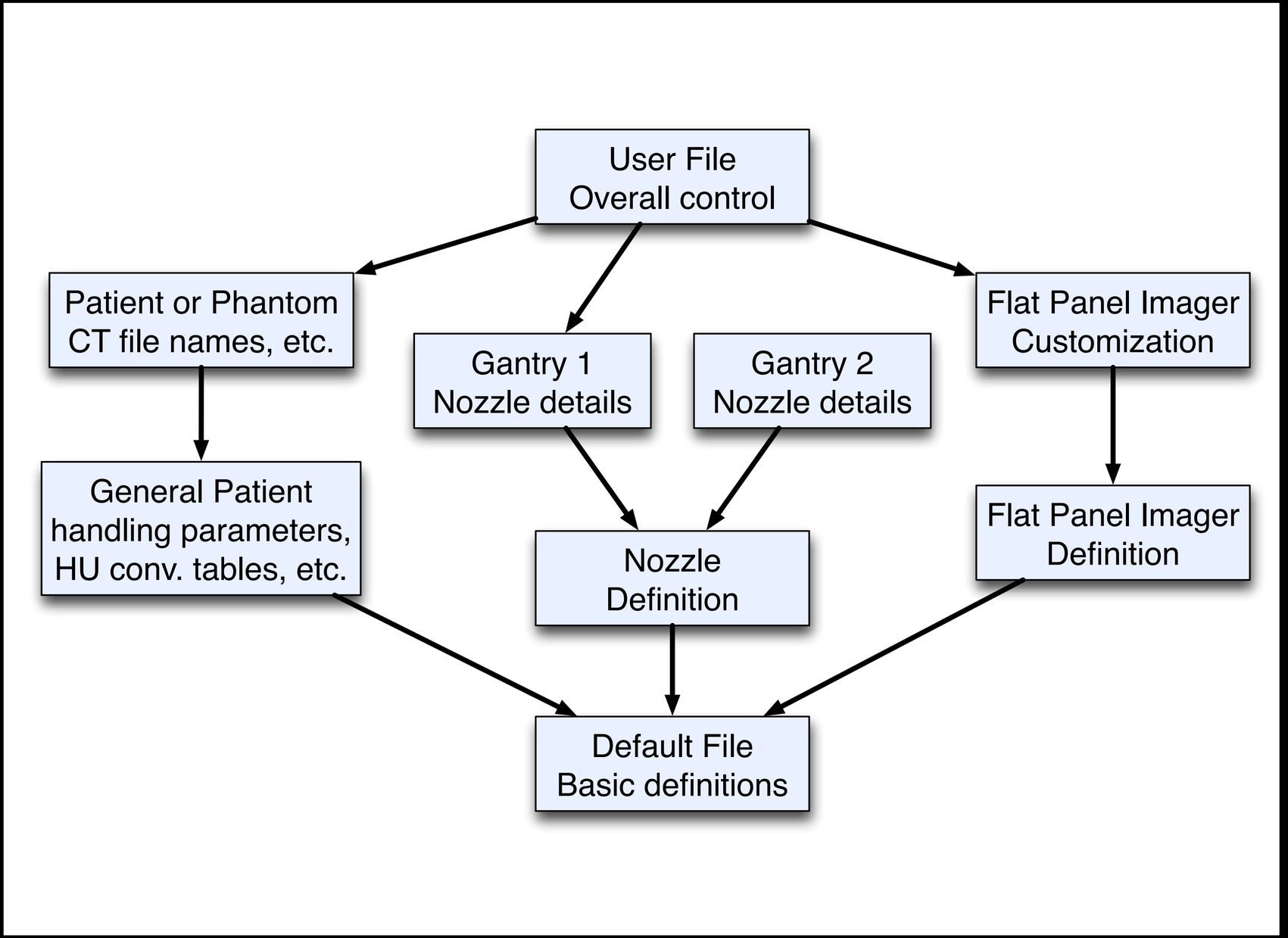
WavelengthShifter.txt

```
# Demonstrates optical behavior in a wavelength shifter

includeFile = OpticalMaterialSample.txt

i:Ts/SequenceVerbosity = 0

# SEQUENCE
b:Ts/PauseBeforeQuit = "False"
b:Ts/ShowCPUTime = "True"
i:Ts/ShowHistoryCountAtInterval= 10000

# SCORER
s:Sc/PhSp1/Quantity                      = "PhaseSpace"
s:Sc/PhSp1/Surface                       = "WLS/OuterCurvedSurface"
s:Sc/PhSp1/OutputType                    = "ASCII"
s:Sc/PhSp1/OutputFile                    = "In"
s:Sc/PhSp1/IfOutputFileAlreadyExists     = "Overwrite"
b:Sc/PhSp1/IncludeTimeOfFlight           = "true"
b:Sc/PhSp1/UsePDGEncoding                = "True"
sv:Sc/PhSp1/OnlyIncludeParticlesFromVolume = 1 "Plastic"
s:Sc/PhSp1/OnlyIncludeParticlesGoing     = "in"

s:Sc/PhSp2/Quantity                  = "PhaseSpace"
s:Sc/PhSp2/Surface                   = "WLS/Core/ZPlusSurface"
s:Sc/PhSp2/OutputType                = "ASCII"
s:Sc/PhSp2/OutputFile                = "Out"
s:Sc/PhSp2/IfOutputFileAlreadyExists = "Overwrite"
b:Sc/PhSp2/IncludeTimeOfFlight       = "true"
b:Sc/PhSp2/UsePDGEncoding            = "True"
```

GUI for Rapid Prototyping



Collaboration through Sharing of Parameter Control Files



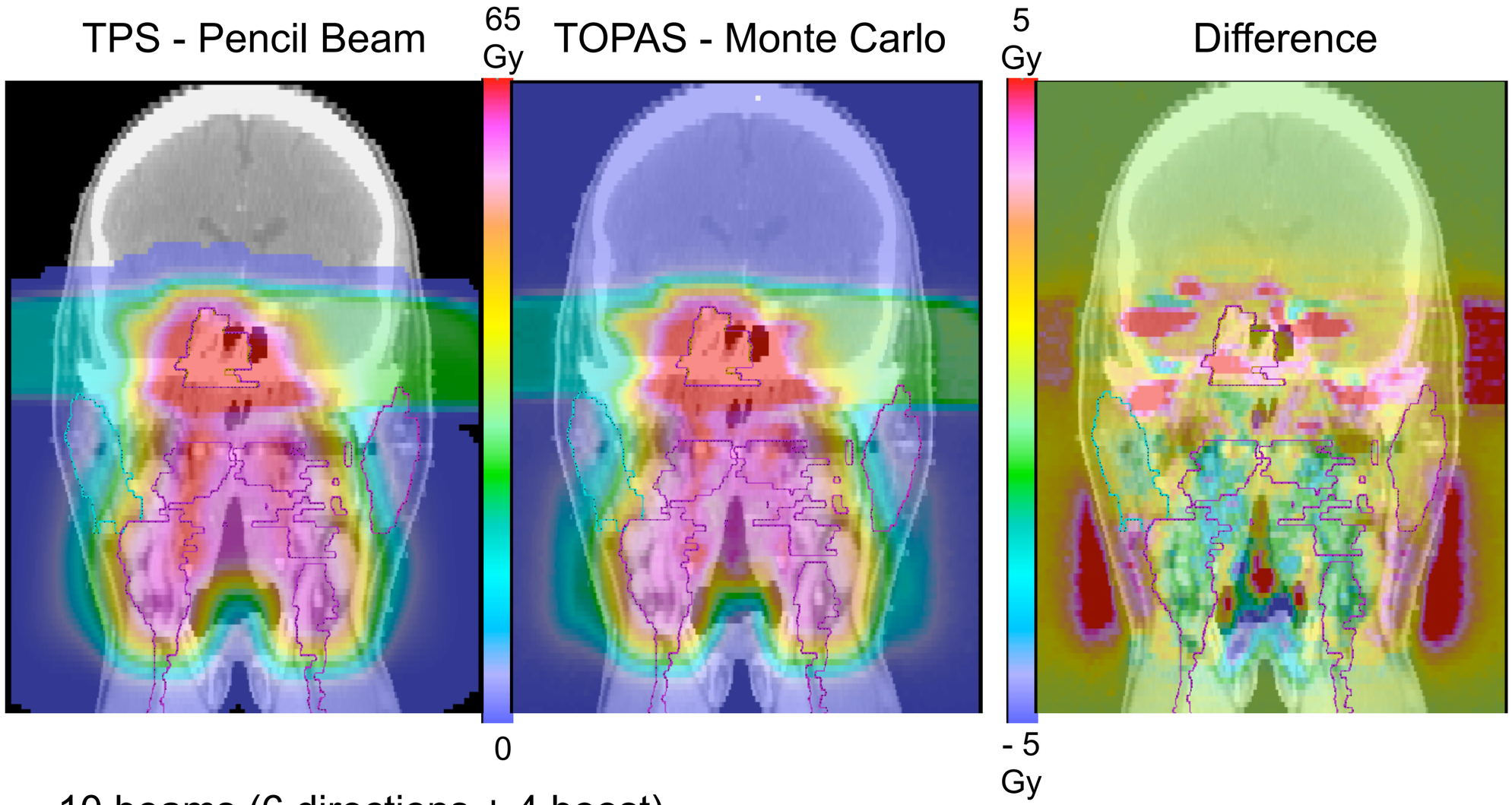
Designed for Portability and Integration

- Limited dependencies (only Geant4, gdcm and Qt)
- Runs on any common desktop, cluster or cloud
- Easily driven from scripts

Image Handling

- DICOM Input and Output through gdcm
- 4D
- RTStruct
- RTPlan
- XCat
- ImageCube
- Flexible system of Imaging to Material Converters
- Multi-modality
- DECT, etc

TPS Integration



10 beams (6 directions + 4 boost)

Rapid Growth of our User Community

Four Years Ago

Proton, X-Ray, Electron, Ion

679 Users

271 Institutions

37 Countries

257 citations in Google Scholar

Rapid Growth of our User Community

Today

Proton, X-Ray, Electron, Ion, Brachy, Imaging, Nuclear Med

2368 Users

616 Institutions

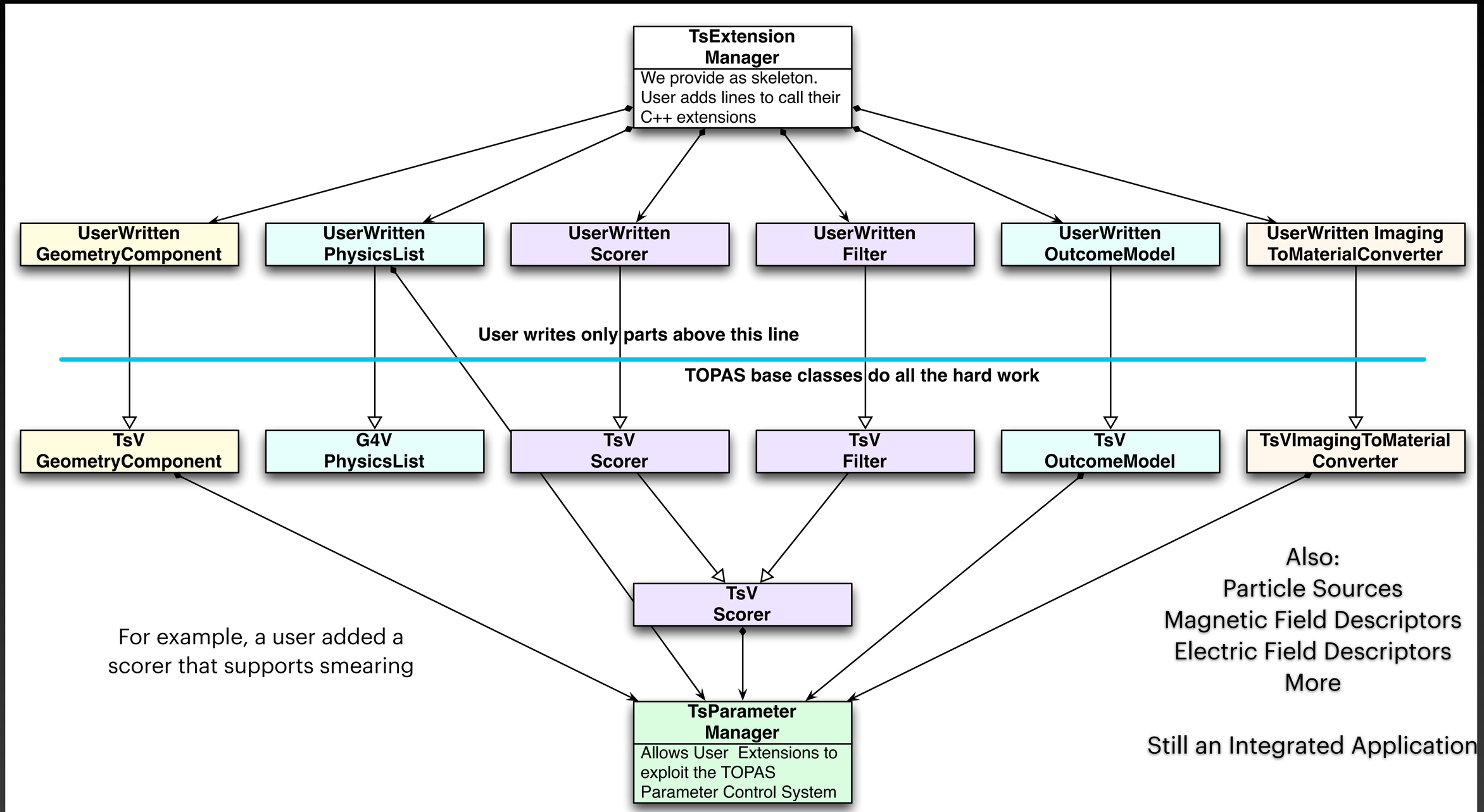
67 Countries

794 citations in Google Scholar

Three Modes of User Engagement

- Standard Users
  Prebuilt executables, all user work is through parameter control files
- Extensions Developers
  Able to extend TOPAS by writing small amounts of C++
- Open Source Community
  Open Source Initiative MIT License

TOPAS Extensions System



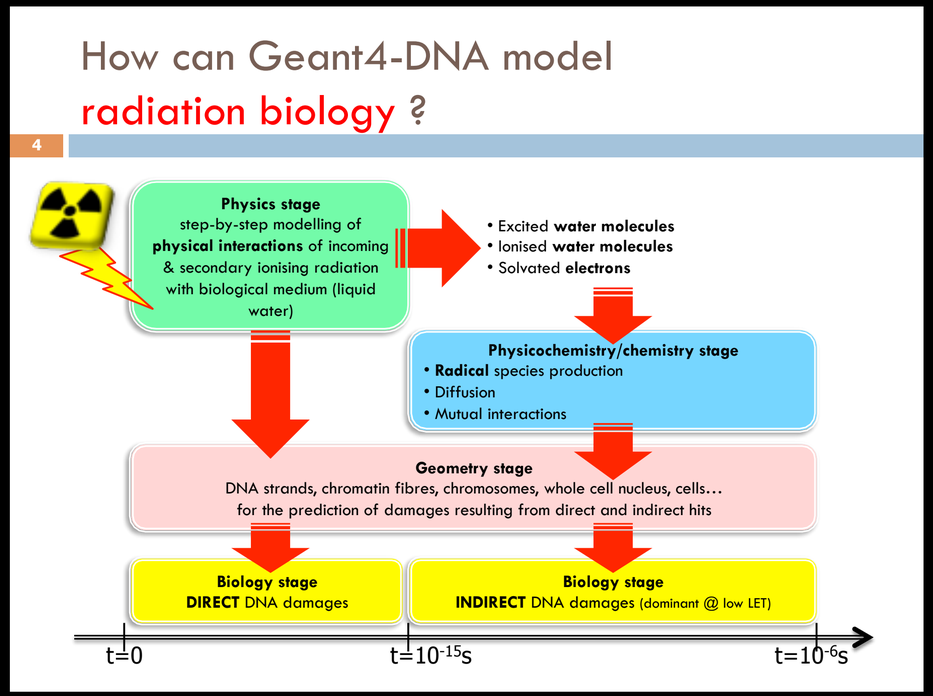
For example, a user added a scorer that supports smearing

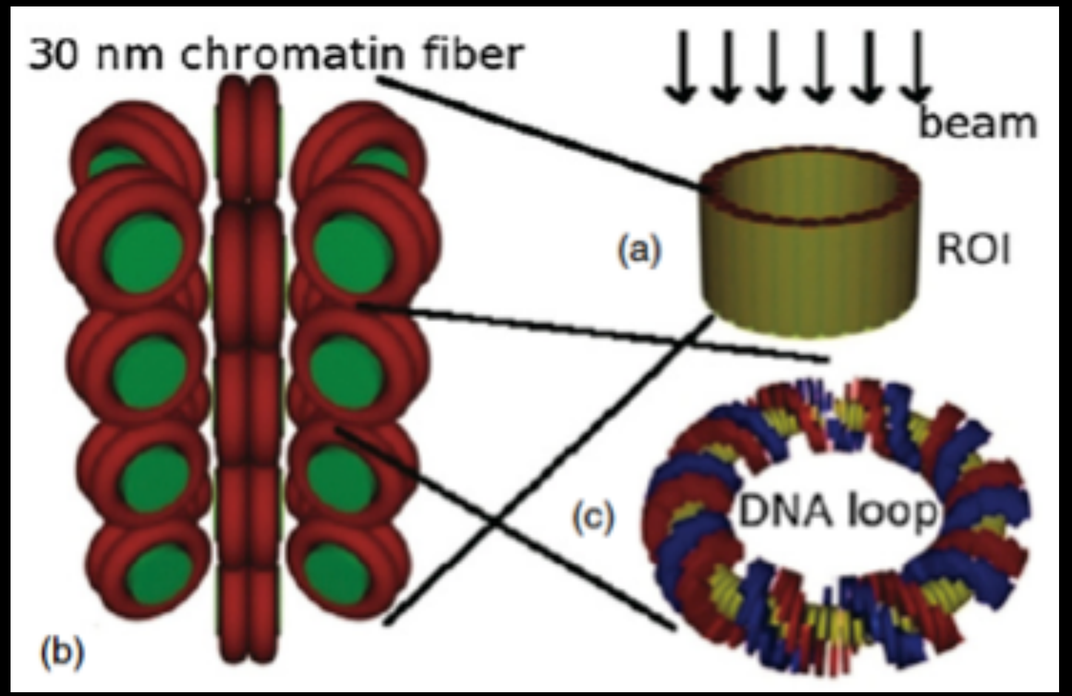
Also:
Particle Sources
Magnetic Field Descriptors
Electric Field Descriptors
More

Still an Integrated Application

Extensions Example: Radiation Biology

TOPAS nBio





Major Imaging Extension soon to be released

Paper under review at PMB

TOPAS-imaging: Extensions to the TOPAS simulation toolkit for medical imaging systems

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Outlook: Imaging and Nuclear Medicine

- Work with others to develop more specialized Geometry Components and Scoring features for Imaging, and specialized Particle Source models for nuclear medicine
  so that what can currently do by writing their own extensions
  becomes features that are already pre-built in the TOPAS kernel.

Outlook General

- Support users at all levels - Standard, Extensions, Open Source
- TOPAS collaboration focuses on specific areas where our expertise is most required
  - Variance Reduction and other speedups
  - Memory management
- Big plans for how to remove barriers for cluster and cloud use

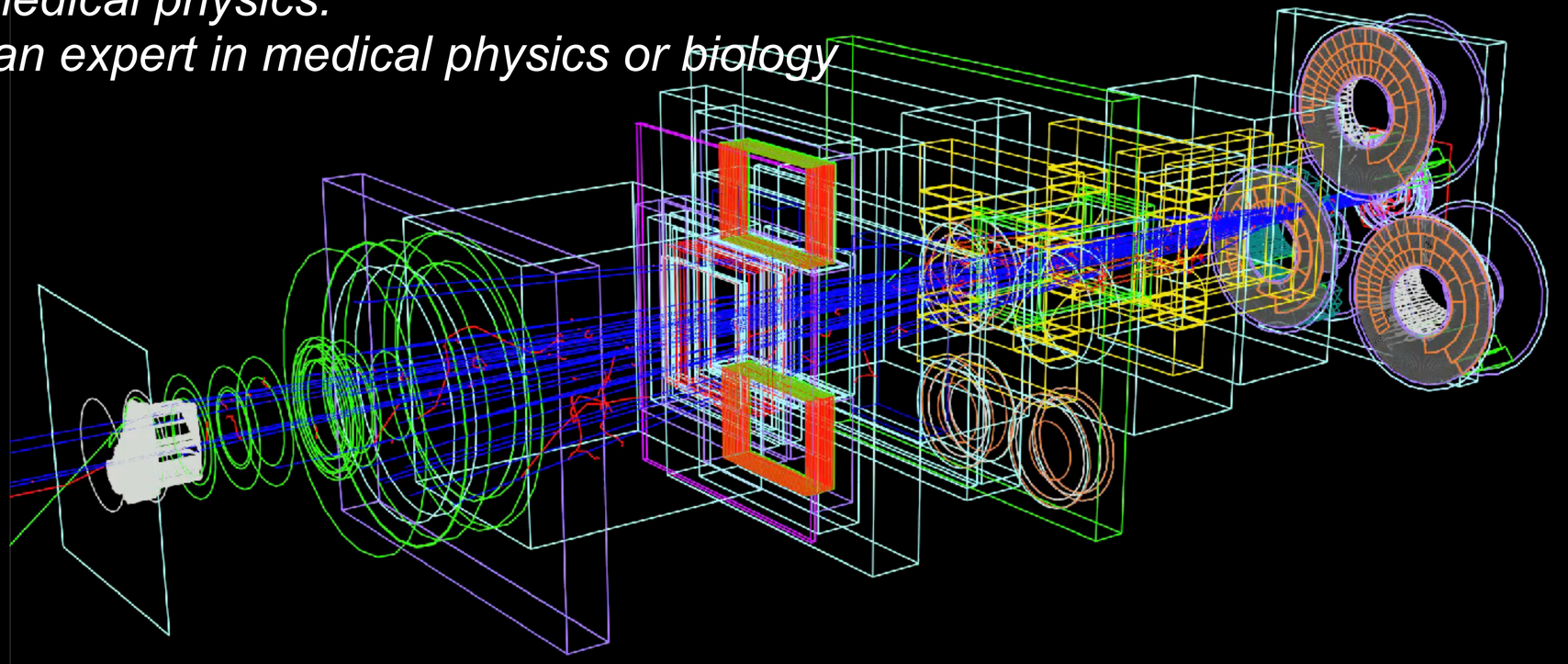
Outlook

- Our current funding runs only through this May
- New U24 is currently under review. Study section meets end of this month
- Fingers Crossed
- (and one way or another, we will find a way)

Tool for Particle Simulation

http://topasmc.org

To use Monte Carlo transport for radiation therapy research in the past, one had to be both an expert in Monte Carlo and an expert in medical physics.
With TOPAS, it is sufficient to be an expert in medical physics or biology



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Jhonatan Hernandez
Naoki Kondo
Hoyeon Lee
Ramon Ortiz
Wook-Geun Shin

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