CREATION OF WORKFLOW TO USE EXISTING ISS CAD MODELS FOR RADIATION SHIELDING ANALYSIS

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HUMAN RESEARCH PROGRAM WORKSHOP

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Problem: Integration of CAD/Transport

Radiation transport programs have their own distinct methods of defining geometries

- Tend to accommodate simple shapes only
- Pre-existing CAD (i.e., ProE) drawings not easily incorporated into software
- Translating geometries into format readable by Fluka, etc time-consuming and error-prone

Possible to use existing hooks in radiation transport programs

- Model: FLUGG (interface to Fluka for Geant4 geometry)
- Transport program receives particle location from external geometry file
- Transport code performs calculations (i.e., energy deposition)
- Moves particle to next location

Scope

Work previously performed by University of Wisconsin – Madison

- Direct Accelerated Geometry (DAG) workflow
- Integrated into MCNP transport code

Current progress

- FluDAG
- DAG application to Fluka transport code (CERN)

Future work

- DAGSolid (Geant4 interface) – mostly complete, testing in work
- HZETRN (LaRC) – in work
- DAGU – allow comparison of multiple transport programs using single identical geometry

Current Process

Prepare geometry

- Clean CAD (ProE) file to remove gaps and interferences (SpaceClaim)
- Export to .SAT (ACIS) format

Pre-process ACIS file

- Assign material names/properties (PyNE) to all volumes (Cubit)
- Assign tally information to geometry
- Add 'graveyard' – area where particles go to die
- Export revised geometry, with metadata, to .SAT format

Current Process

Facet Geometry

- Using CGM/HDF/MOAB
- Outputs geometry file and material ‘snippet’

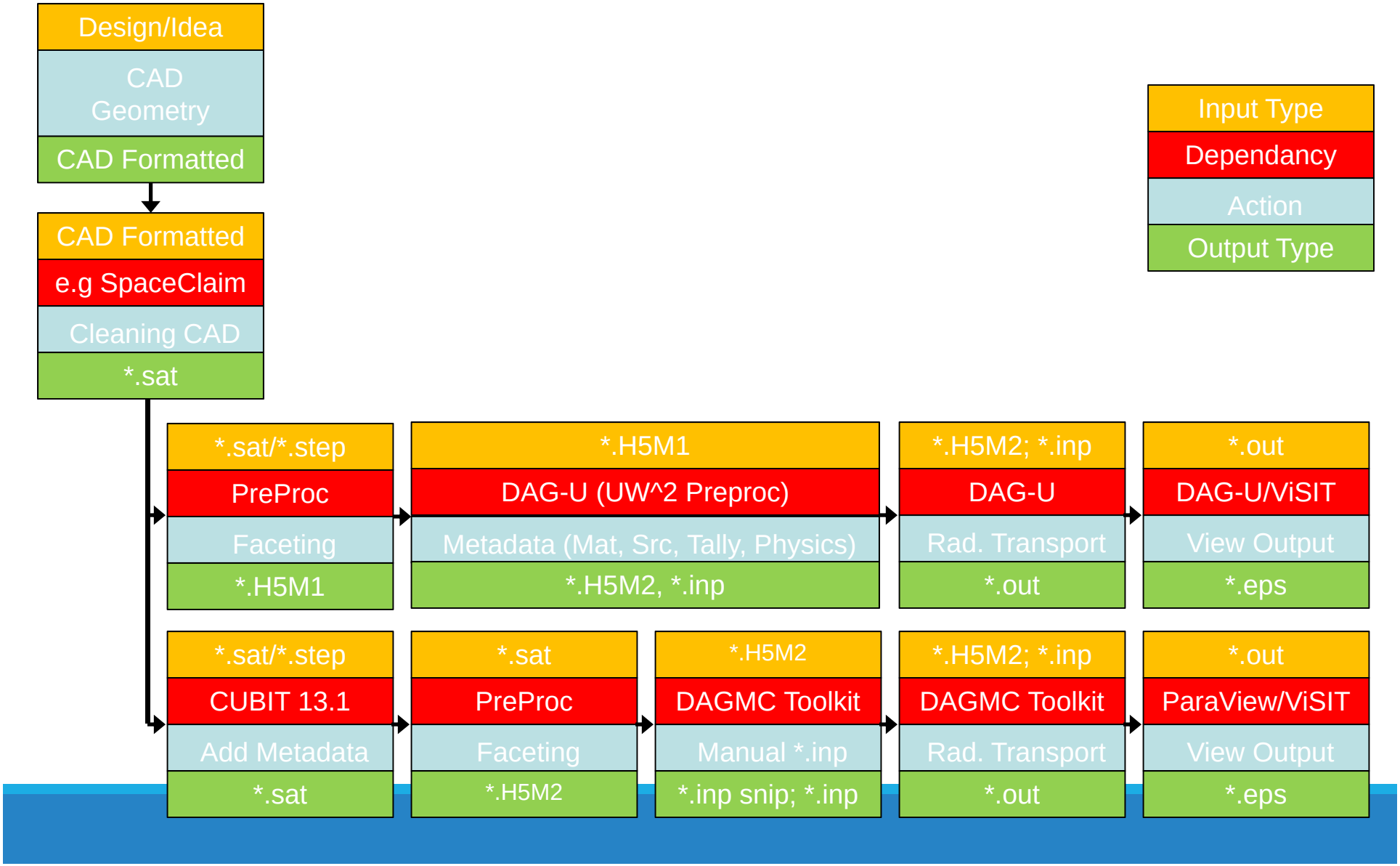
Integrate into Fluka

- Build Fluka input file using material ‘snippet’.
- Link input file to geometry file (‘FLUGG’ tag)
- Run Fluka using FluDAG plugin

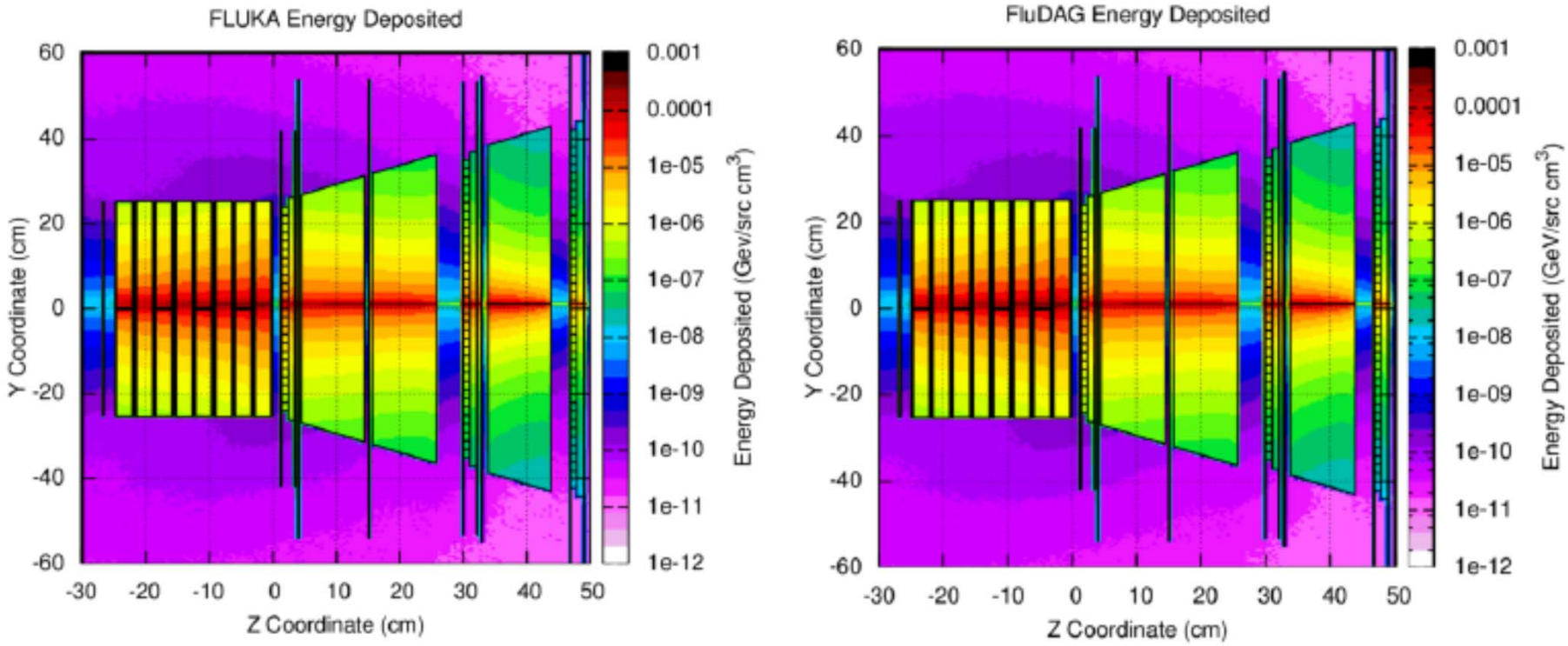
View Data

- Output to Flair (FLUKA viewer)
- Output data files to VisIt/Paraview (Python plugin)

Walking Through the Workflow



Fluka/FluDAG Comparison



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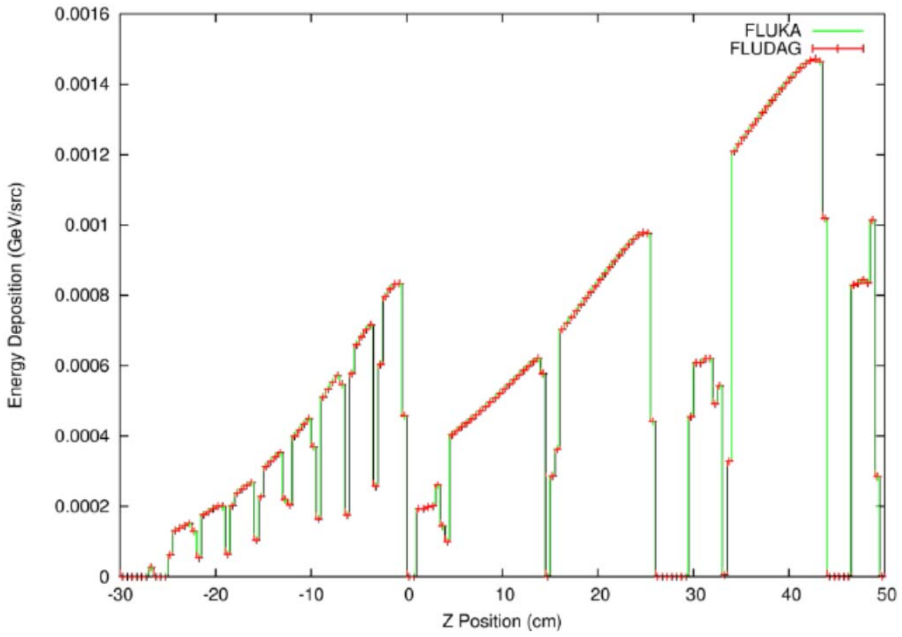
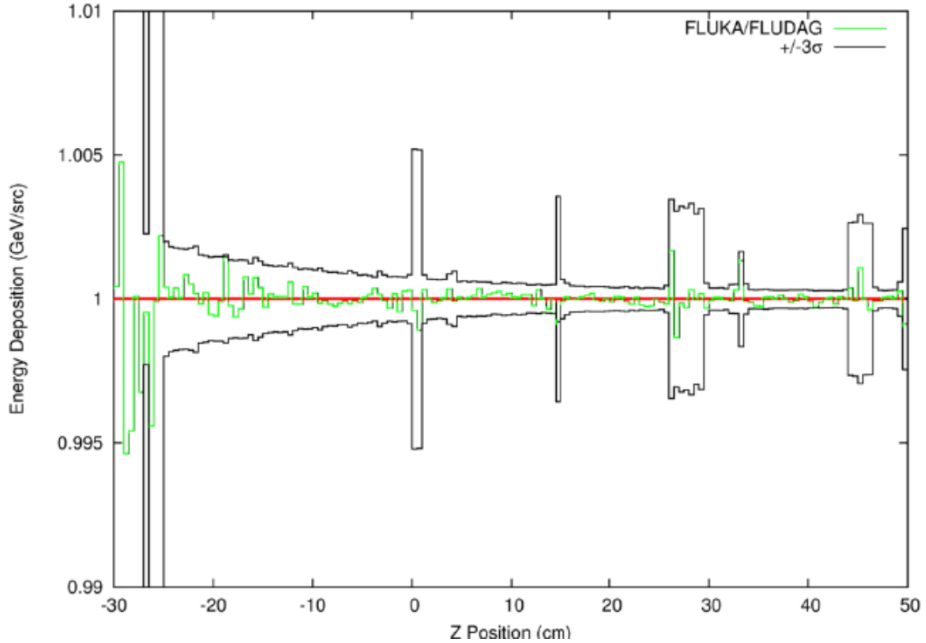
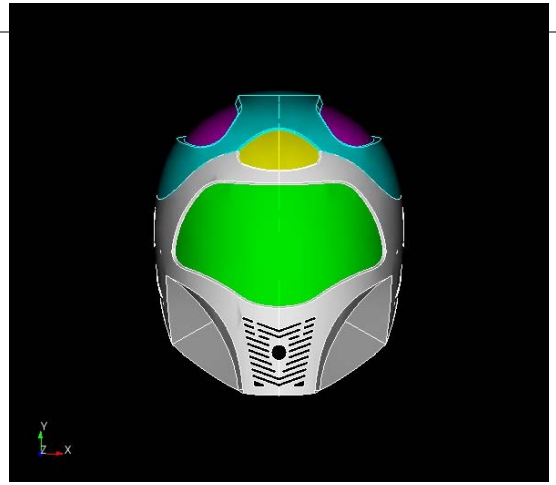
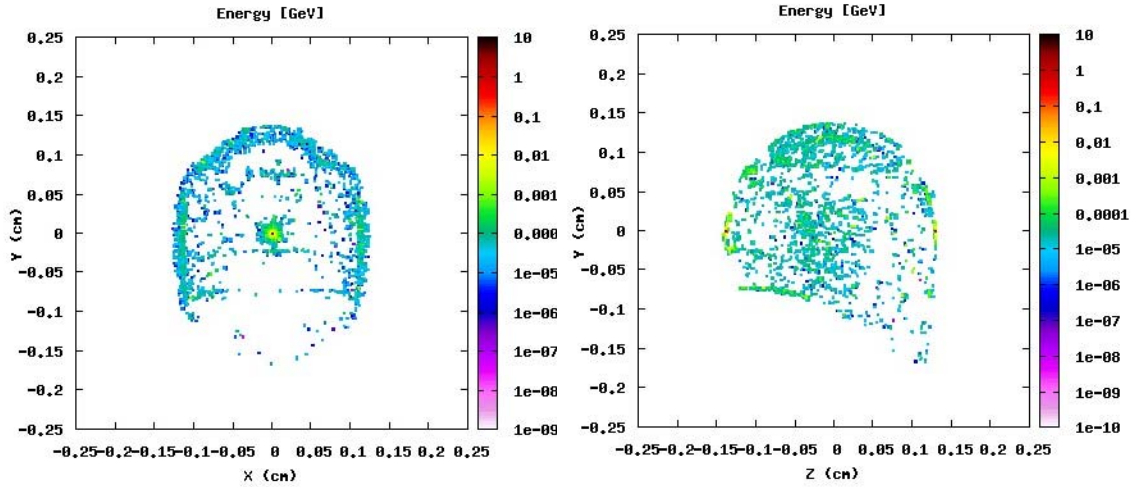




DAG Workflow – Robonaut

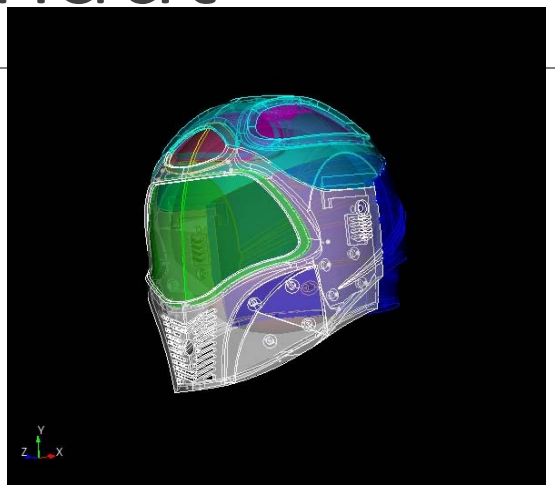
- Fluka run
  - Al frame, C lights/faceshield
  - 1.0 GeV protons
    - (0,0,-10)
  - 100k particles
    - 5 runs
  - Bins = 0.02mm

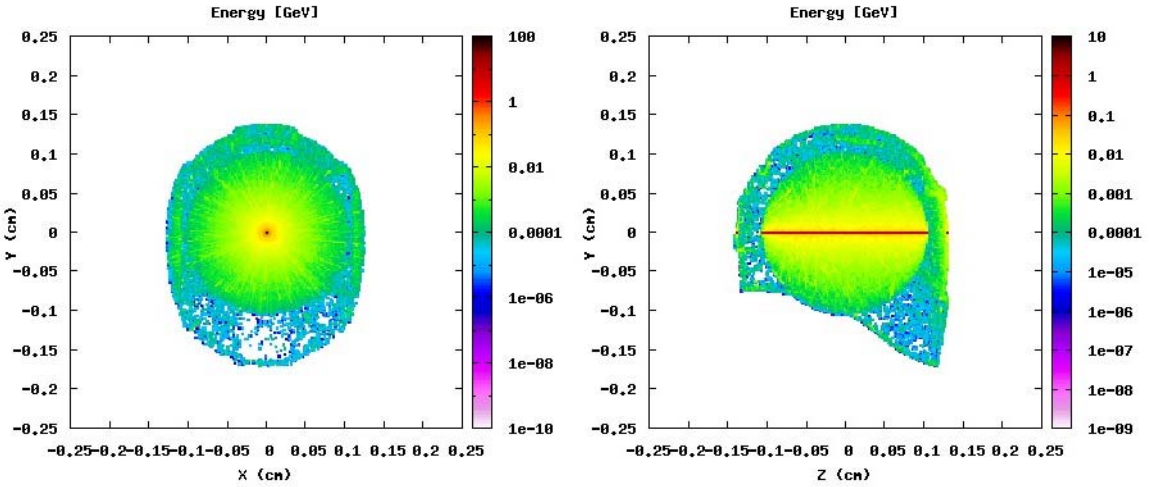




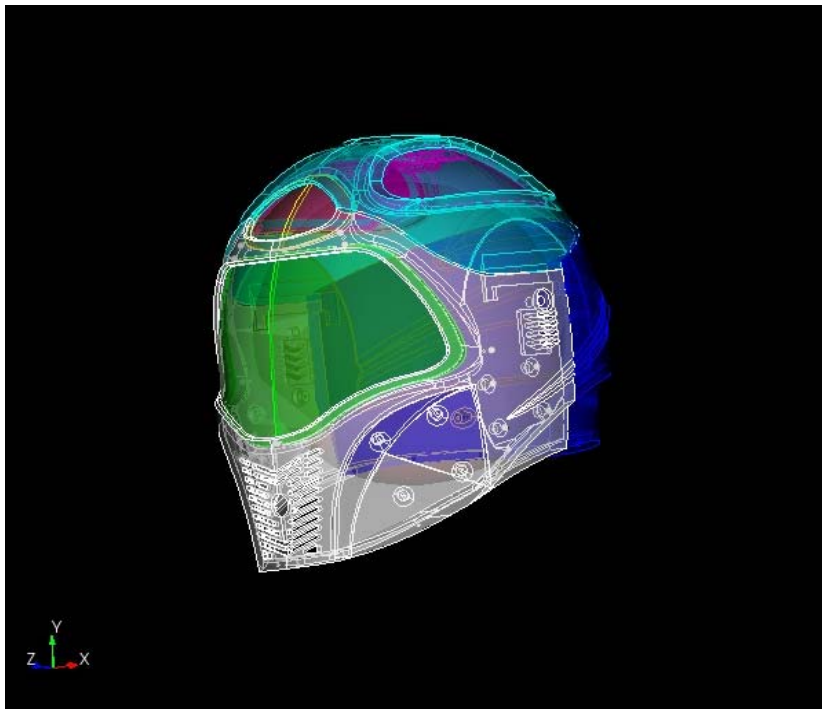
DAG Workflow - Robonaut

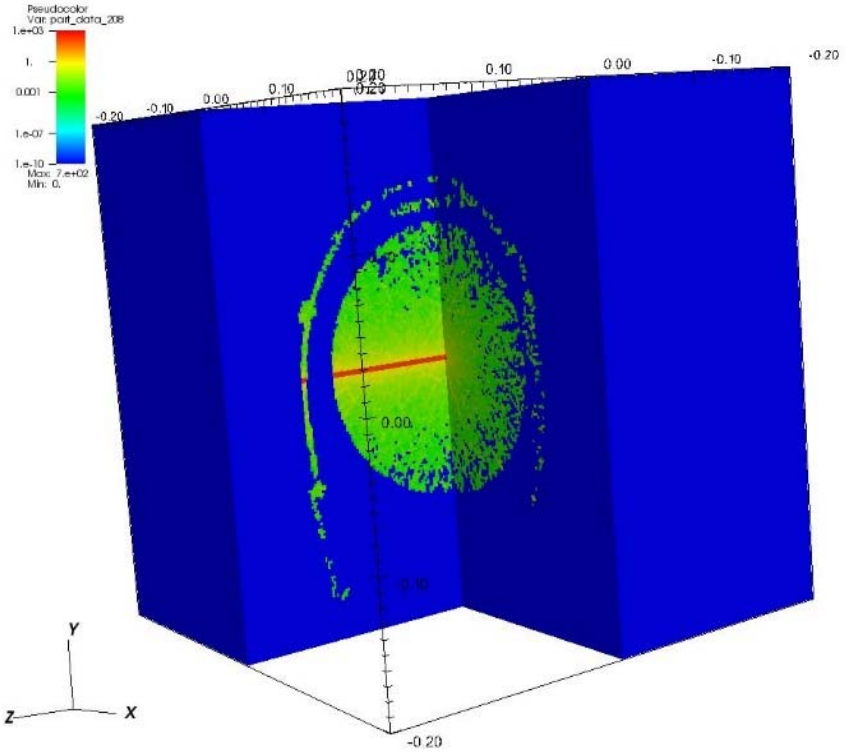
- Identical simulation conditions
- Added H2O sphere inside helmet
- Next steps
  - Robonaut torso/arms/head (in work)
  - Vehicle (MPCV)





3-D View of FLUKA Results





Conclusions

FluDAG and Fluka produce nearly identical results for a simple geometry

FluDAG workflow allows detailed radiation analysis for a more complex geometry

FluDAG workflow can be applied to current ISS and MPCV (ProE) CAD files

Forward Work

Incorporate additional radiation transport codes (Geant, HZETRN) into workflow

Incorporate standard Galactic Cosmic Radiation (GCR) and Solar Particle Event (SPE) inputs, in addition to user-defined spectrum

Incorporate additional output/tally options

Compare identical geometry files using FluDAG (Fluka), DAGSolid (Geant), and HZETRN

Compare results of shielding of new vehicles (i.e., MPCV) with previous SRAG process