Title: MCNP6 Unstructured Mesh (UM) for Criticality Accident Alarm System (CAAS) Analysis

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Monte Carlo Methods, Codes, and Applications (XCP-3)

CAAS UM-CSG Example

Criticality Accident Alarm Systems

- criticality and shielding calculation methods.

UM for facility details

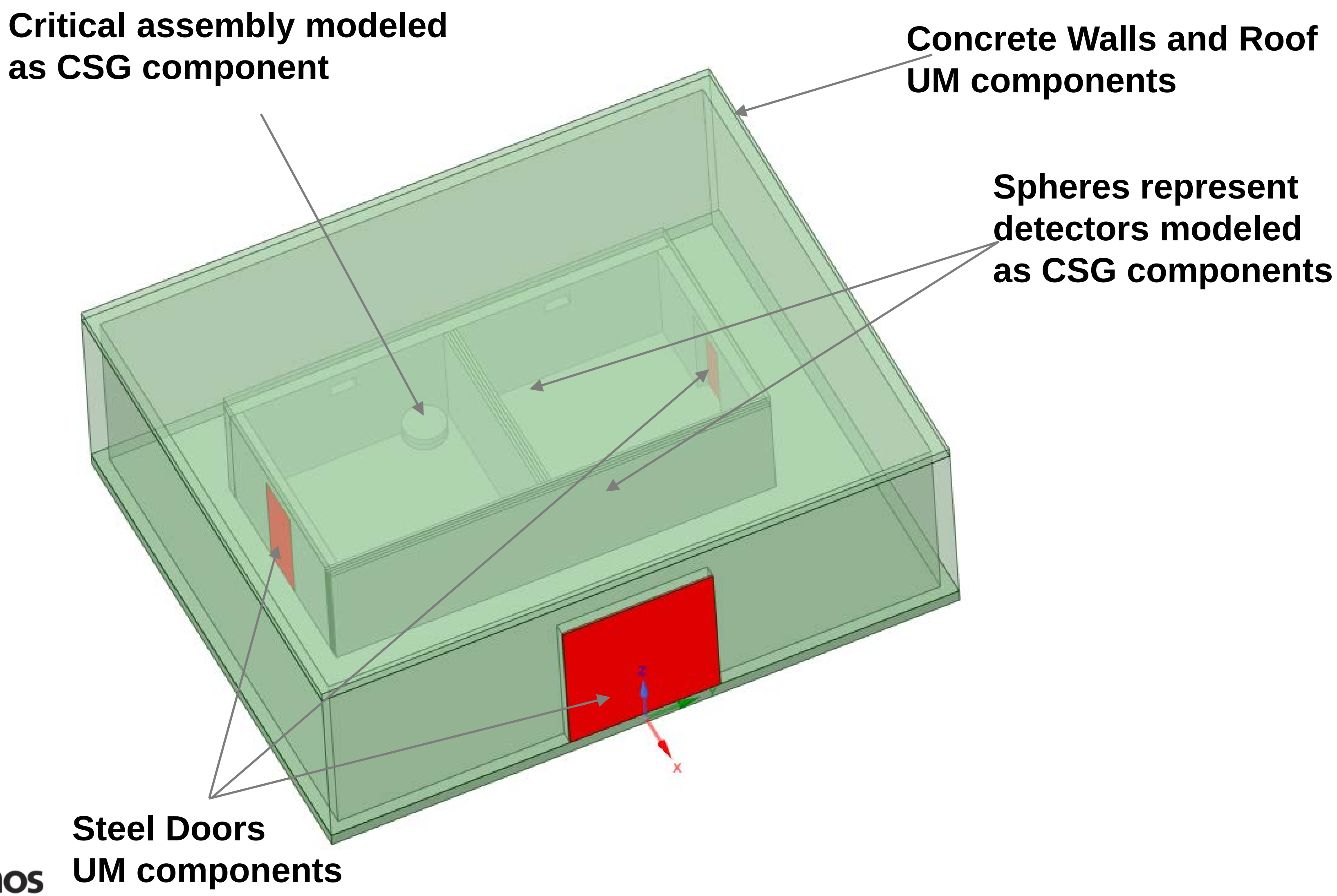
- import of existing facility drawings.

CSG used for criticality and detector cells

- place criticality/detector cells in multiple locations
- conserve mass/volume geometry for criticality cells

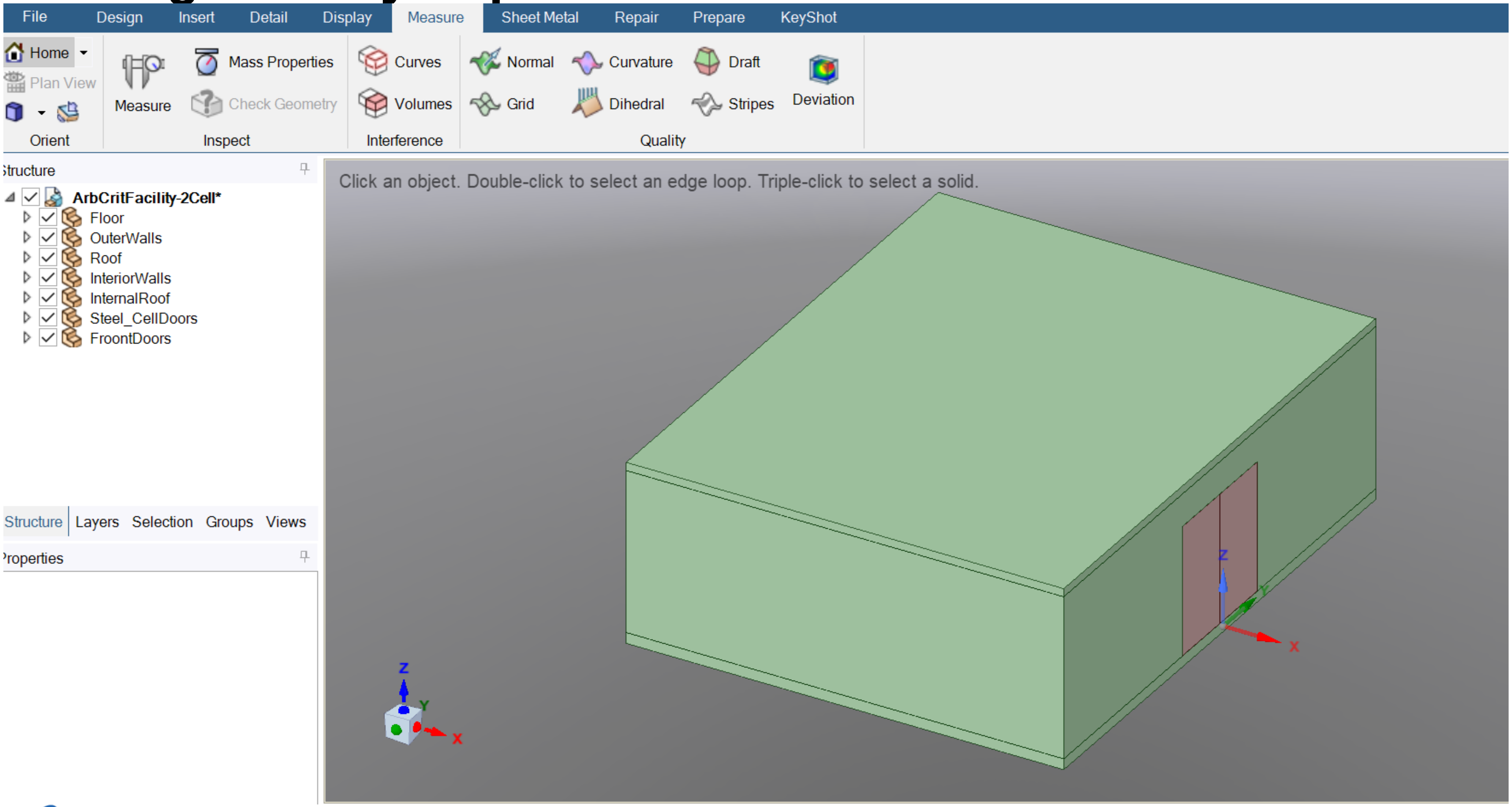
- Import solid geometry, generate mesh, create calculation in Attila4MC and create MCNP6.2 UM file
- Insert CSG cells for criticality tank and detectors into MCNP6.2 UM file
- MCNP6.2 KCODE calculation, ensure convergence & generate source
- Tallies for detector energy deposition, MCNP6.2 fixed source calculation
- MCNP6.2 and Attila variance reduction techniques for reliable tally results
  - Weight windows – stochastic and deterministic, DXTRAN

CAAS UM-CSG Example



CAAS UM-CSG Example

Solid geometry import into Attila4MC



CAAS UM-CSG Example

Cell Cards Showing only UM Geometry

```
c ---------------------------- Cell Cards --------------------------------- 80
1   2   -2.3      0                      u=1
2   2   -2.3      0                      u=1
3   2   -2.3      0                      u=1
4   2   -2.3      0                      u=1
5   2   -2.3      0                      u=1
6   1   0.08636     0                      u=1
7   1   0.08636     0                      u=1
8   0               0                    u=1 $ background
9   0               100 -101 102 -103 104 -105   fill=1 $ fill cell
10  0               (-100:101:-102:103:-104:105)
c -------------------------- End Cell Cards ------------------------------ 80
```

Cell Cards Showing only UM-CSG Geometry

```
c ---------------------------- Cell Cards --------------------------------- 80
1   2   -2.3      0              imp:n=1         u=1
2   2   -2.3      0              imp:n=1         u=1
3   2   -2.3      0              imp:n=1         u=1
4   2   -2.3      0              imp:n=1         u=1
5   2   -2.3      0              imp:n=1         u=1
6   1   0.08636     0            imp:n=1         u=1
7   1   0.08636     0            imp:n=1         u=1
8   0                 0          imp:n=1         u=1 $ background
9   0               -100 201 202 203  fill=1 imp:n=1 $ fill cell
c
c Criticality Cells CSG
21  0               -201 #30 #31 #32 #40  imp:n=1
22  0               -202 #41              imp:n=1
23  0               -203 #42              imp:n=1
c
c Pu Nitrate solution in cell 1
30   94 9.9270e-2      -301 -303     imp:n=1
31   0                 -301  303     imp:n=1
32   1    0.08636      -302  301     imp:n=1
c
c Detector Spheres
40   96  -0.92  -401  imp:n=1
41   96  -0.92  -402  imp:n=1
42   96  -0.92  -403  imp:n=1
c
c outside world
99 0               100 imp:n=0
c -------------------------- End Cell Cards ------------------------------ 80
```

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CAAS UM-CSG Example

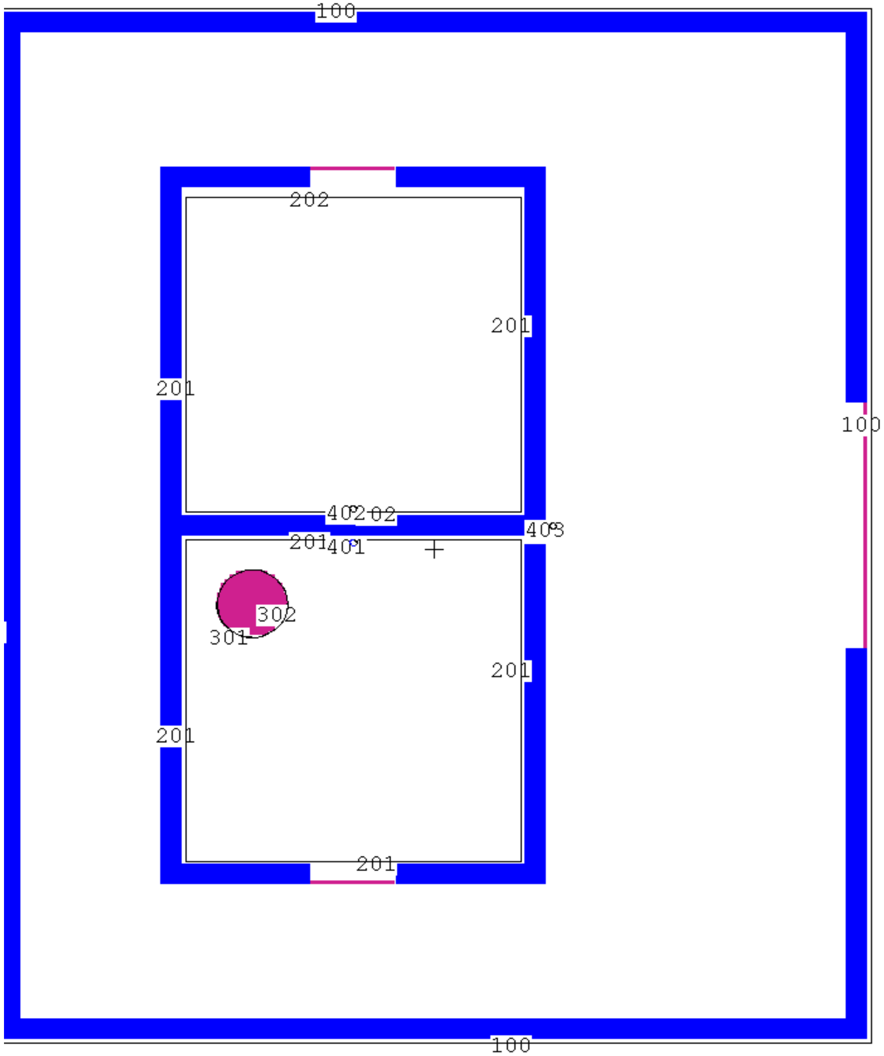
Cell Cards Showing only UM-CSG Geometry

```
c --------------------------- Surface Cards ------------------------------- 80
c
100 px -2304.02
101 px -8.0175
102 py -761.92
103 py 772.08
104 pz -35.48
105 pz 485.06
c ------------------------- End Surface Cards -------------------------- 80
```

Cell Cards Showing only UM-CSG Geometry

```
c --------------------------- Surface Cards ------------------------------- 80
c
c 100 px -1252.46
c 101 px -8.0175
c 102 py -761.92
c 103 py 772.08
c 104 pz -35.48
c 105 pz 485.06
100 RPP -1252.46 -8.0175 -761.92 772.08 -35.48 485.06
c
c Crititicality Storage Cells with 5cm buffer to UM walls
201 RPP -983.38 -505.7  -492.83 -15.15  5.0 269.32
202 RPP -983.38 -505.7    25.15 492.83  5.0 269.32
203 SPH -460.2175 5.085 100 7
c
c Plutonium-Nitrate Container in inside corner of cell 1
301   RCC   -888.38 -110.15 100.0    0. 0. 131.7     50
302   RCC   -888.38 -110.15 99.0    0. 0. 132.7     50.5
303   pz    117.0
c
c Detector Sphere in inside corner of cell 2
401   sph -744.5375 -20.1549 100.0   5
402   sph -744.5375 30.3251  100.0   5
403   sph -460.2175 5.085      100.0   5
c ------------------------- End Surface Cards -------------------------- 80
```

CAAS UM-CSG Example: MCNP6 Geometry, fmesh plots



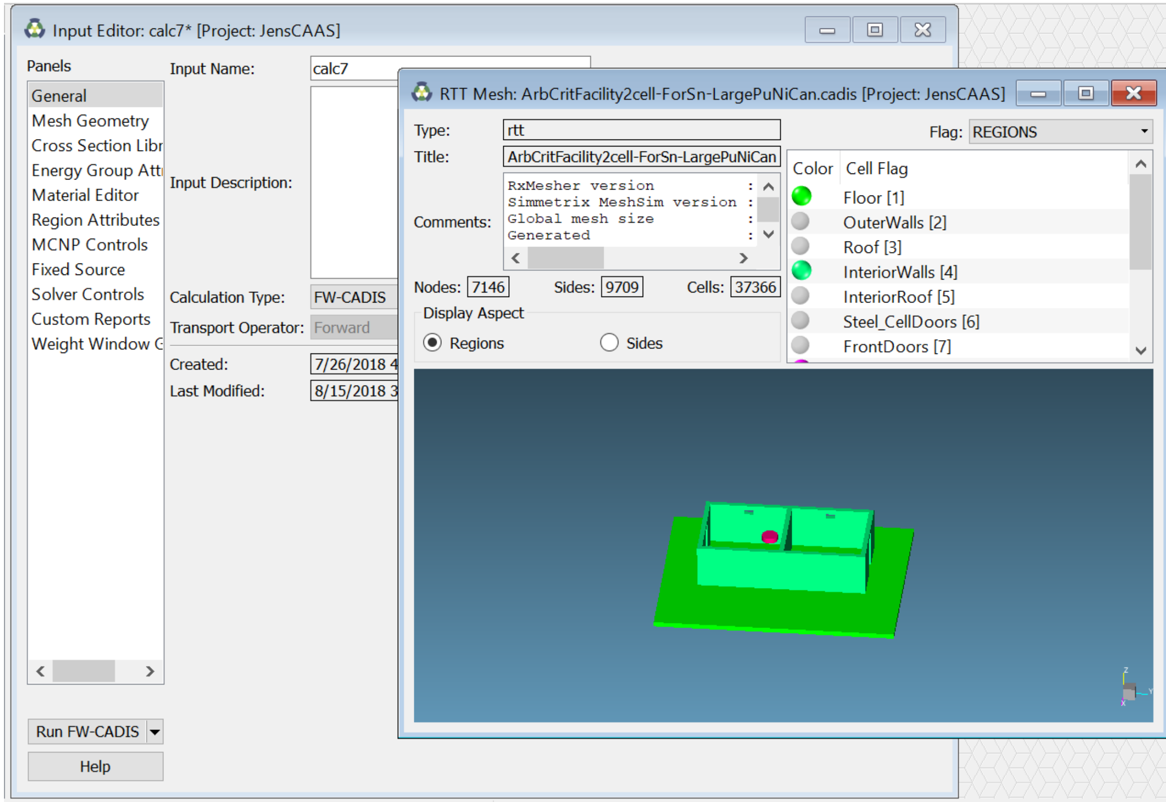
CAAS UM-CSG Example

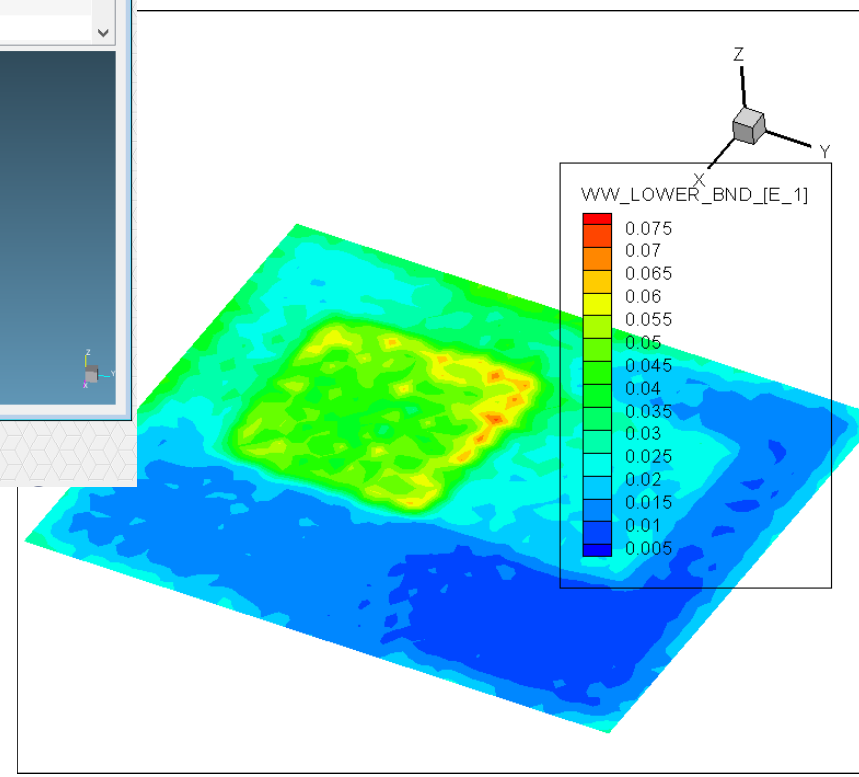
MCNP6.2 Neutron Energy Deposition Results

Run	Detector 1 Mean Estimate (Gy)	Relative Error Estimate	Detector 2 Mean Estimate (Gy)	Relative Error Estimate	Detector 3 Mean Estimate (Gy)	Relative Error Estimate
1: UM-CSG using FW-CADIS	2.2870E-02	0.0397	6.3406E-04	0.0367	1.0857E-04	0.0512
2: UM-CSG using DXT, ESPLT	2.3486E-02	0.0374	6.3958E-04	0.0345	9.7151E-05	0.0710
3: CSG using DXT, ESPLT	2.2815E-02	0.0131	6.2337E-04	0.0128	1.0838E-04	0.0305
Difference 1-2	-2.69%		-0.87%		10.52%	
Difference 1-3	0.24%		1.69%		0.18%	

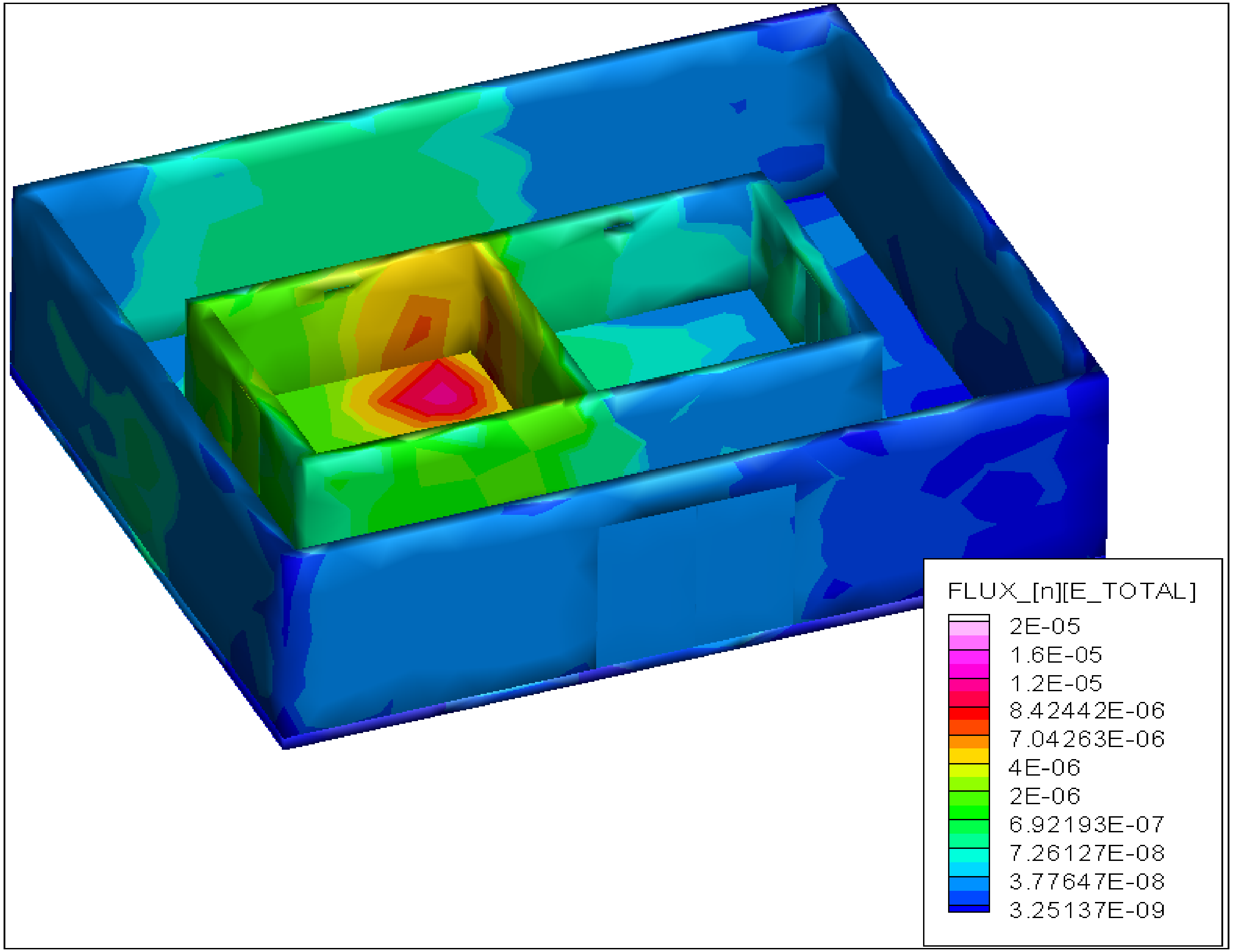
CAAS UM-CSG Example

Attila FW-CADIS

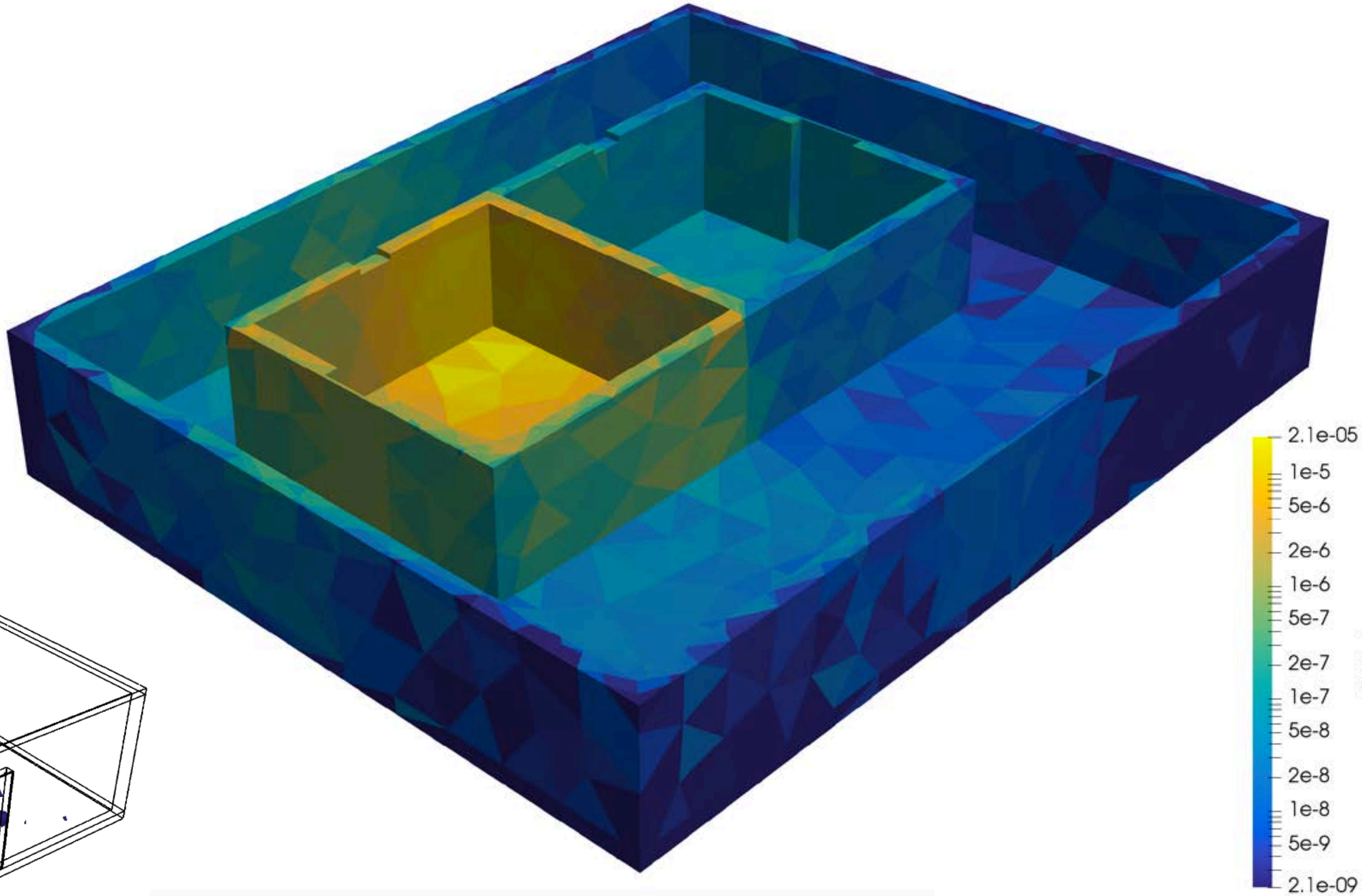


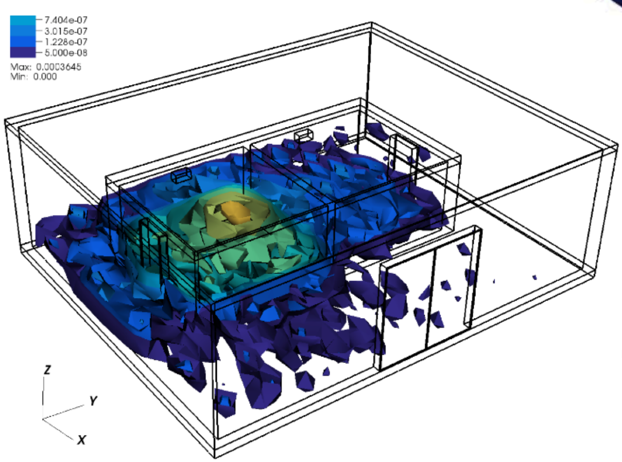


CAAS UM-CSG Example: MCNP6.2 eeout → Tecplot



CAAS UM-CSG Example- MCNP6 Meshtal → Paraview





CAAS UM-CSG Example

Acknowledgements:

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