CombLayer: Towards a simple MCNP beamline builder

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- Neutron instrument are dense, complex systems made of many high scattering materials.

- We have traditionally modeled them as simple objects.
- This is NOT a choice! – Driven by the effort required to model.

MCNP is a nightmare

All of the following cause modelling difficult:

- Every volume needs to be described with individual quadratic surfaces.
- Volume needs to be completely described
- Surfaces like torus can only be on an axis
- The code is less readable than assembly code

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MCNP is a nightmare

All of the following *help* to the modeler are incomplete in the geometric algebra space and normally result in runtime penalty.

- Complementary cells
- Universes require full computation of objects within
- Transform cards / Lattice cards
- Macrobodies
- Boolean invariances

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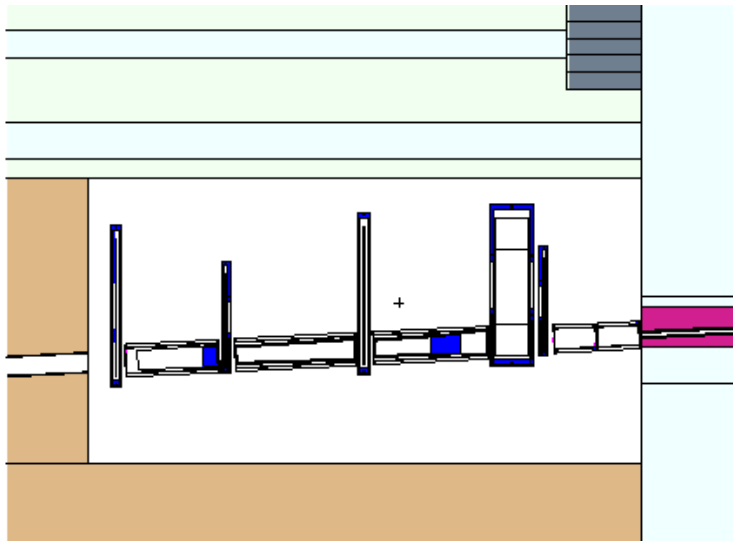
Requirement for CombLayer

Geometry:



- Build a model out of complex components [like McStas]
- Build complex components without needing to consider anything bigger.
- Have a toolbox of gadgets to help build our complex components

Requirement for CombLayer

Model:

- Output should be *good to run*
- A system of naming that allows construction without referring to numbers
- Tally/Variance reduction system that can use the CombLayer model

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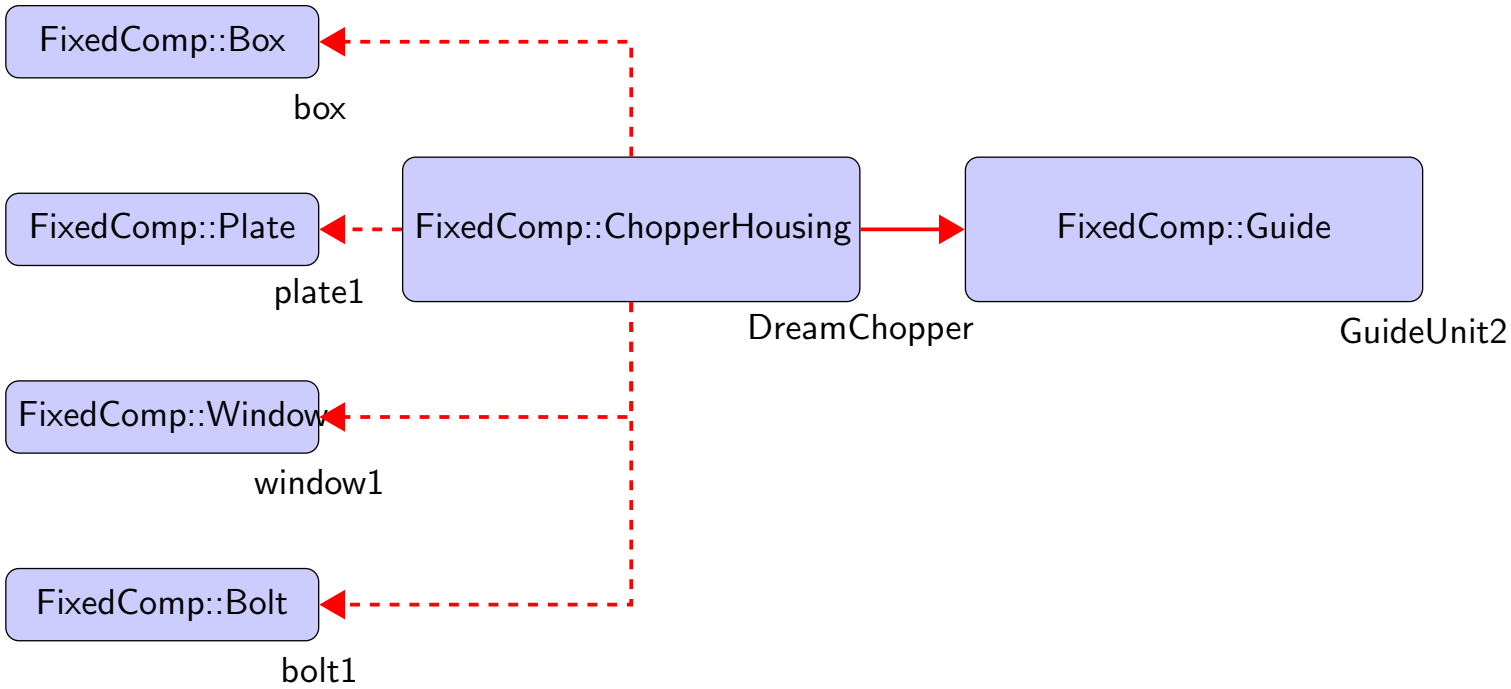
Geometry: Origins/Axis/Common surfaces

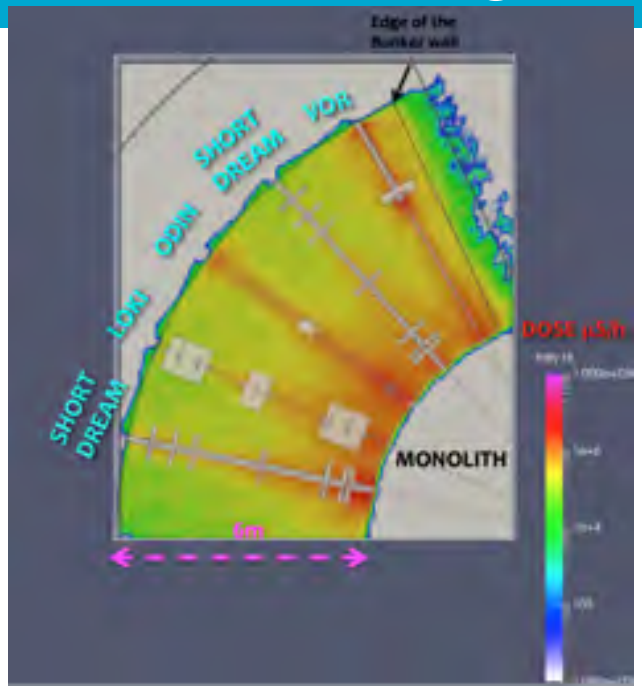


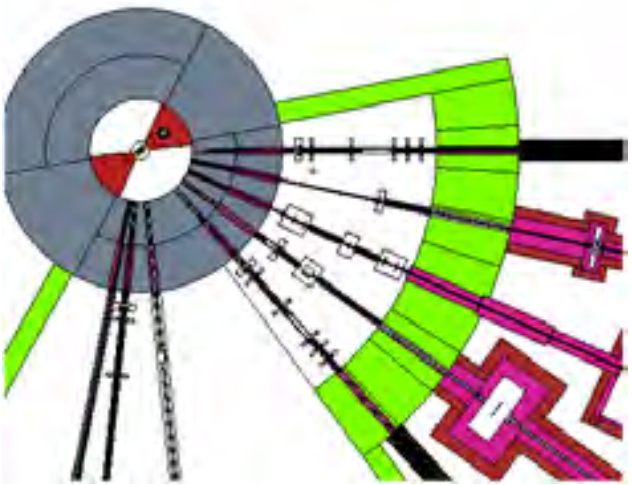
LOCAL origin and axis space

LOCAL surface map

EXPORTS origin and axis space and link points + axes

Multile Direction linkage





- Linkage **followed** by Rotation/Offset
- Start point - End Point linkage system

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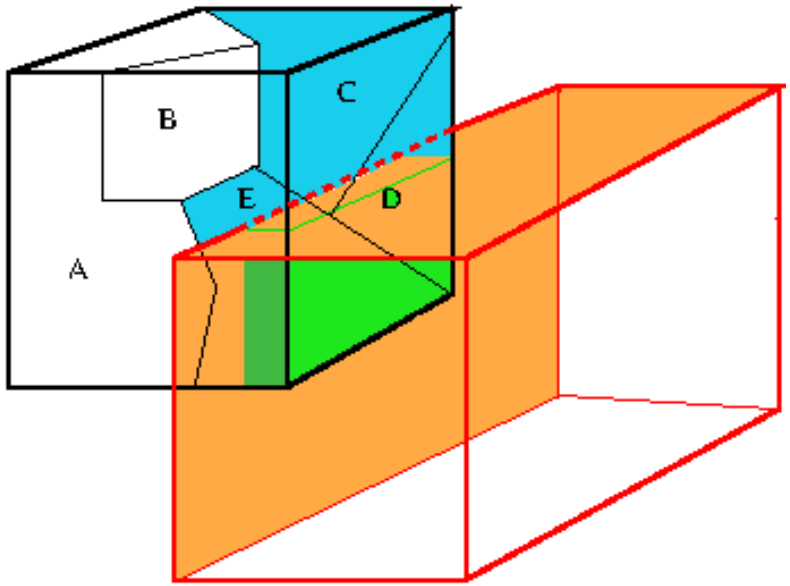
Evolution of object/object intersection



- Consider an Region of objects that needs to overlap and exclude a portion of another region of objects.
- The overlap region is defined in green.
- CombLayer adds union of orange surfaces to blue cells

Improves runtime by $\sim (\mathrm{NSurf}_{orange} \,/\, \mathrm{NIter})^2$

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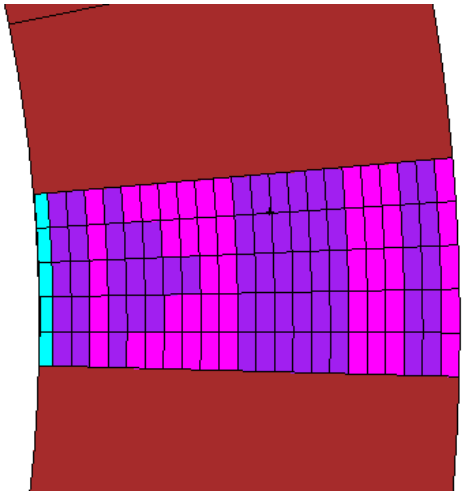
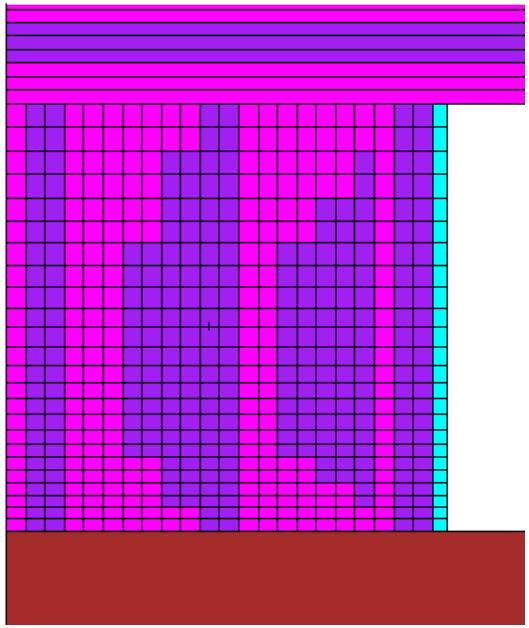
Bunker Wall Layout





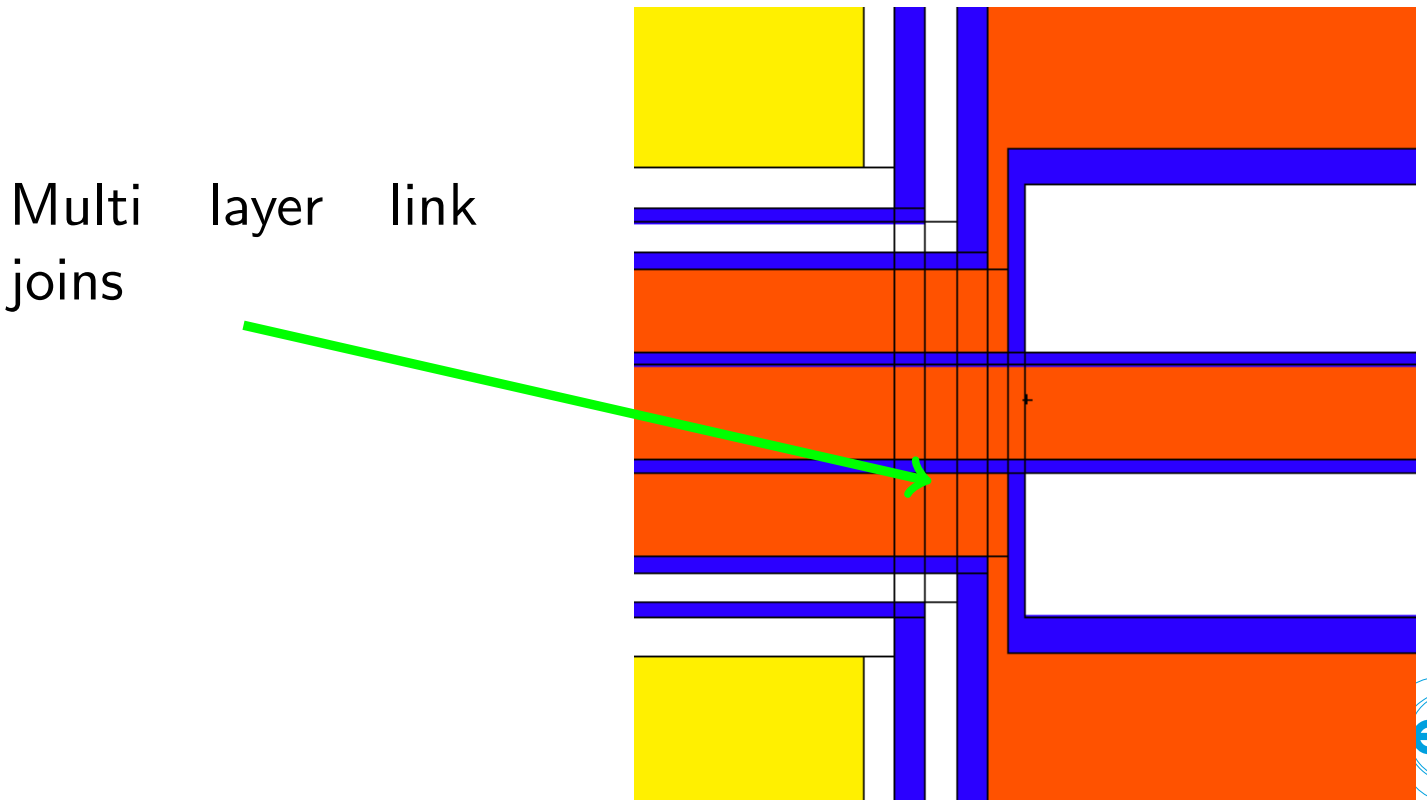
- Have the ability to make any cell discrete (3D)
- The material for each cell/cells are then read from an XML file
- Division allows cell-bases variance reduction

BunkerWall code

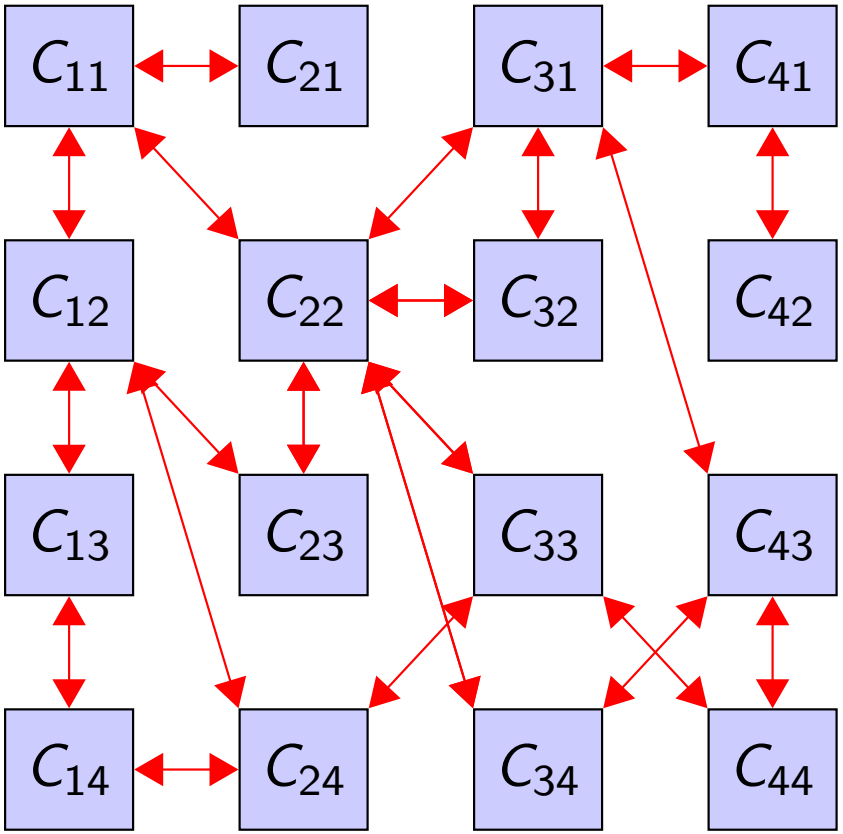
```
void Bunker::createMainWall(Simulation& System)
{
  ELog::RegMethod RegA("Bunker","createMainWall");
  size_t AS=activeSegment;  // binary system
  for(size_t i=0;AS && i<nSectors;i++)
    {
      const std::string CName="Sector"+StrFunc::makeString(i);
      if (AS & 1)
        {
          const int CN=getCell("frontWall",i);
          ModelSupport::LayerDivide3D LD3(keyName+"MainWall"+
                                          StrFunc::makeString(i));

          LD3.setSurfPair(0,SMap.realSurf(bnkIndex+1001+static_cast<int>(i)),
                          SMap.realSurf(bnkIndex+1002+static_cast<int>(i)));

          LD3.setSurfPair(1,SMap.realSurf(bnkIndex+5),
          SMap.realSurf(bnkIndex+6));
          LD3.setSurfPair(2,SMap.realSurf(bnkIndex+7),
          SMap.realSurf(bnkIndex+17));
          LD3.setFractions(0,segDivide);
          LD3.setFractions(1,vertFrac);
          LD3.setFractions(2,wallFrac);

          LD3.setMaterialXML(keyName+"Def.xml","WallMat",keyName+".xml",
                             ModelSupport::EvalMatString(wallMat));
          LD3.divideCell(System,CN);
          removeCell("frontWall",i);
          addSurfs(CName,LD3.getSurfs());
          addCells(CName,LD3.getCells());
        }
      AS>>=1;
    }
```

Specialized Link Units: Pipework

- CombLayer allows pipework using object that have links and free points
- Any convex profile is acceptable
- Multi-layer joins done for all object inherited from LayerComp



Variance reduction: Semi-Adjoint processing



- Create the object connections
- Calculate the attenuation and $1/r^w$ from cell centre to cell centre for each
- Evolve the Markov Chain cell interaction probability
- Use result as w_{ij} component.

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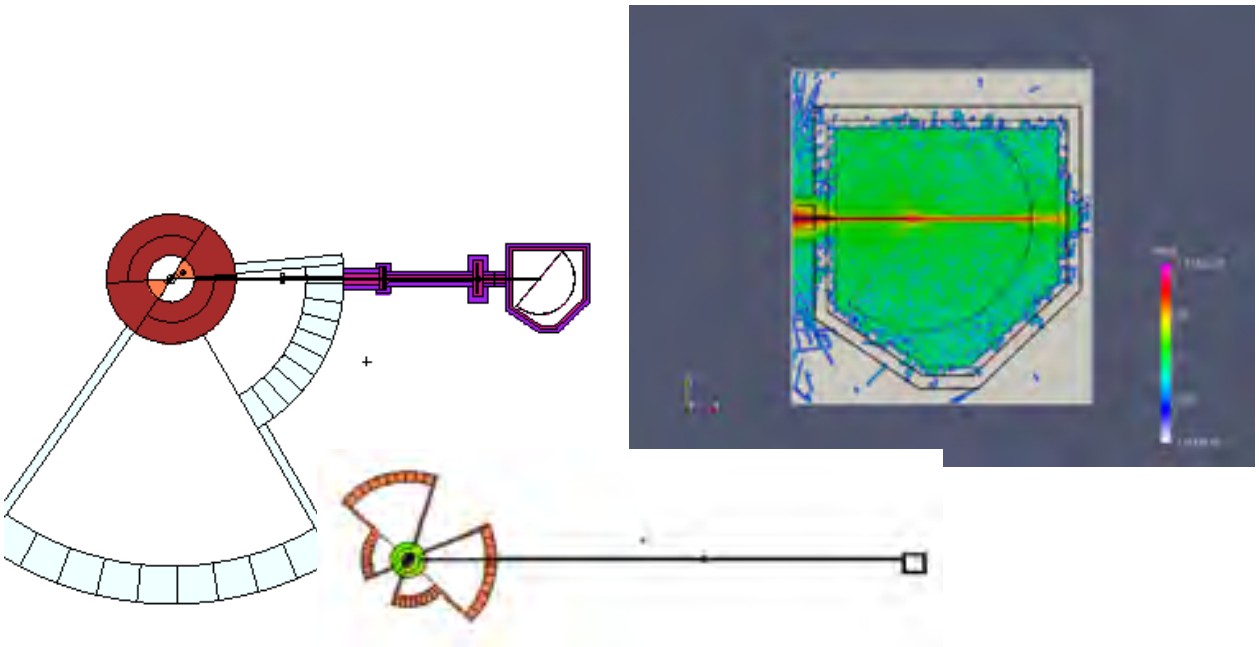
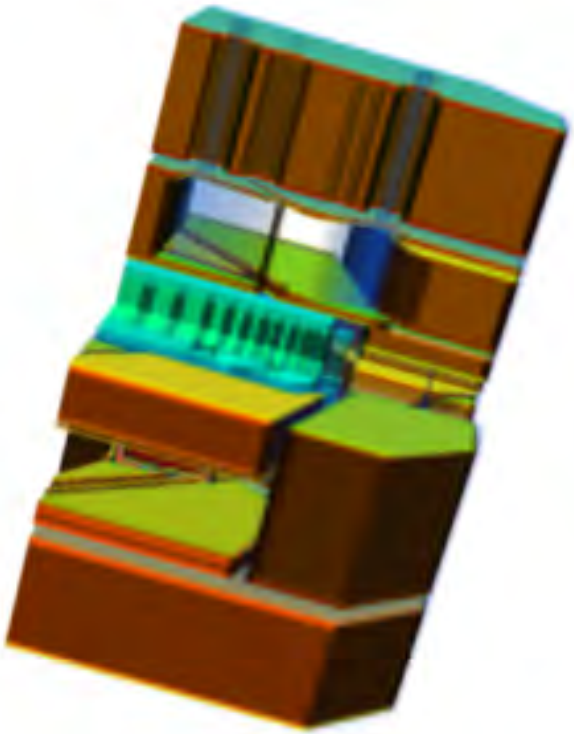
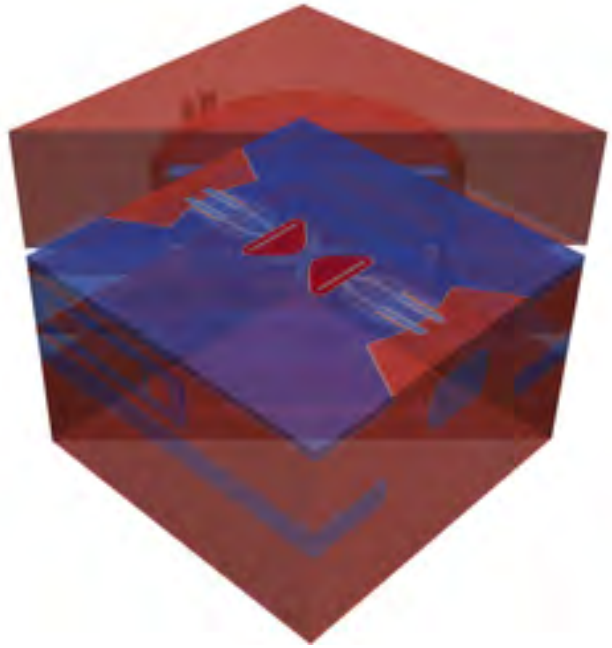
Variance reduction: Long beamlins



- Long beamline need to exploit angular biasing
- Auto-determined ext card on a cell/cell level
- Benefits from LD3 splitting

Conclusions





- We have tools to process complex geometries
- In a position to offer fast target to sample calculations
- Code/Build your model at a level away from MCNP

Download *https://gitbug.com/SAnsell/CombLayer*

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