# Update on the TS1 Upgrade project

Stuart Ansell and Goran Skoro

Rutherford Appleton Labs, Oxfordshire, U.K.

September 9, 2014

# TS2 : Target / Reflector / Moderator Assembly

- The TRAM assembly is complex, dense , interconnected and highly non-symmetric.
- It is unrecognisable from the simple models used in the 1990's


Science & Technology Facilities Council
ISIS

# Requirements on TRAM design and modeling

- Protons to neutrons is relative efficient (15 per proton)
- Neutron moderation is **highly** inefficient ($10^{-6}$)
- Highly constrained engineering – no hands on maintainance –
- Engineering (e.g. pipework/clearances etc) are 12% of the volume
- **EVERYTHING hurts** – adding 1mm clearance gap adds 1.7% loss

Model ABSOLUTLEY everything as realistically as possible

Science & Technology Facilities Council
ISIS

# Simulation fundamental requirements

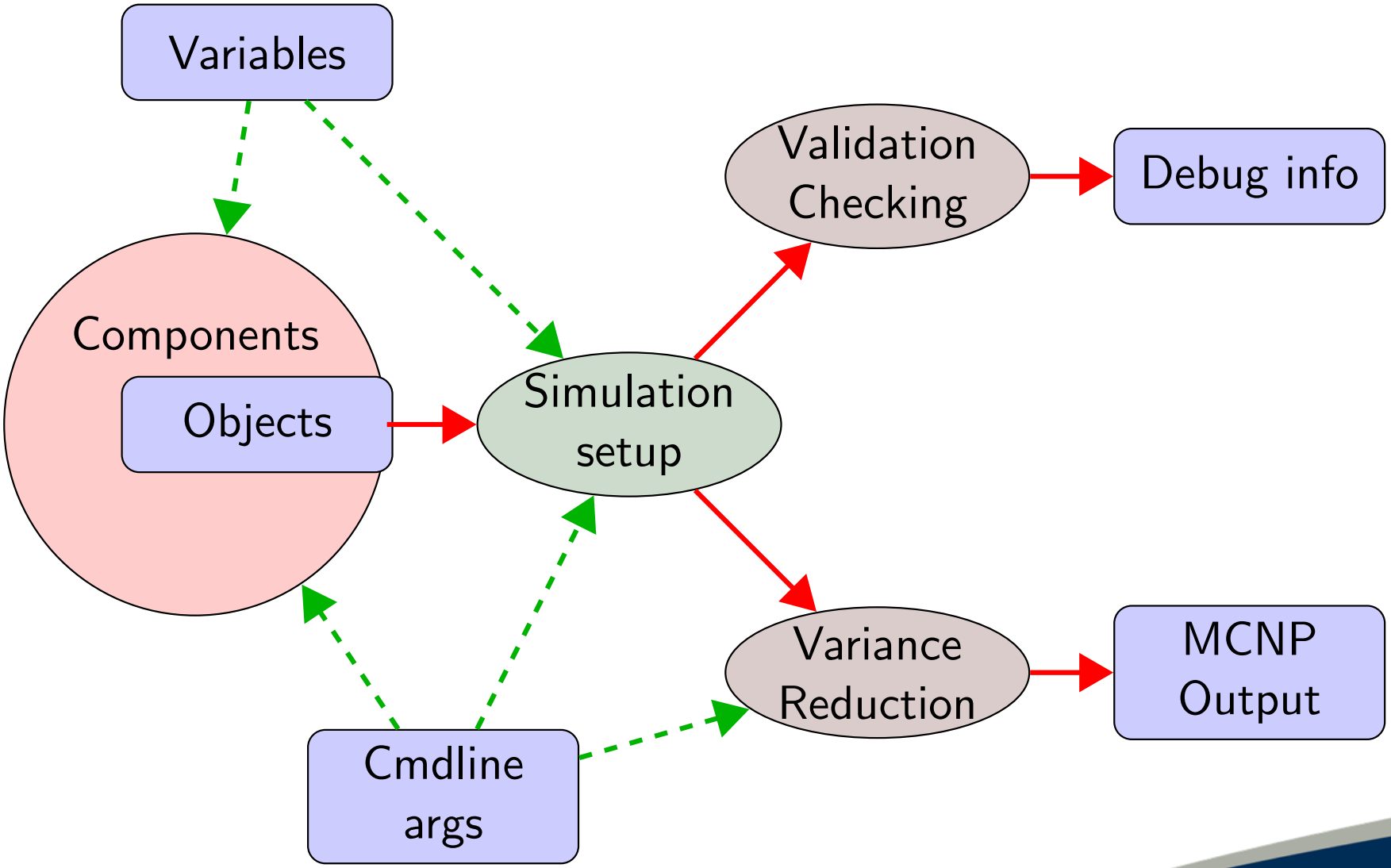
- **Source :** Protons on target
- **Tally :** at the sample position
- **Fast :** 60min on ONE CPU processor for 5% error
- **Engineering :** Add as much engineering reality as possible

# MCNP(X) is an unforgiving code

All of the following normally result in runtime penalty

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

# CombLayer Process



# Object Composition

- Objects in MCNP are only boolean state systems that operate on a point or a track
- Each surface is a *discrete literal*
- Logic of a cell can be expressed as a normal boolean expression

$$1\ {-2}\ 3\ {-4}\ 5\ {-6}\ (-11 : 12) \rightarrow \text{ab'cd'ef'(g'+h)}$$

# Object Composition

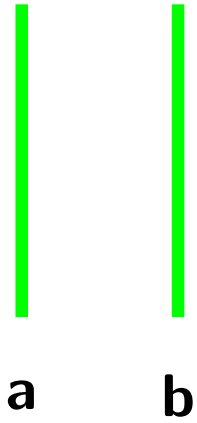
- Objects in MCNP are only boolean state systems that operate on a point or a track
- Each surface is a *discrete literal*
- Logic of a cell can be expressed as a normal boolean expression

$$1\ \text{-}2\ 3\ \text{-}4\ 5\ \text{-}6\ (\text{-}11 : 12) \rightarrow \text{ab'cd'ef'(g'+h)}$$

- Primary importance is to remove literals [not typical]
- Secondary importance is to sequence the logic into maximum surface area first

Science & Technology Facilities Council
ISIS

# Object Composition

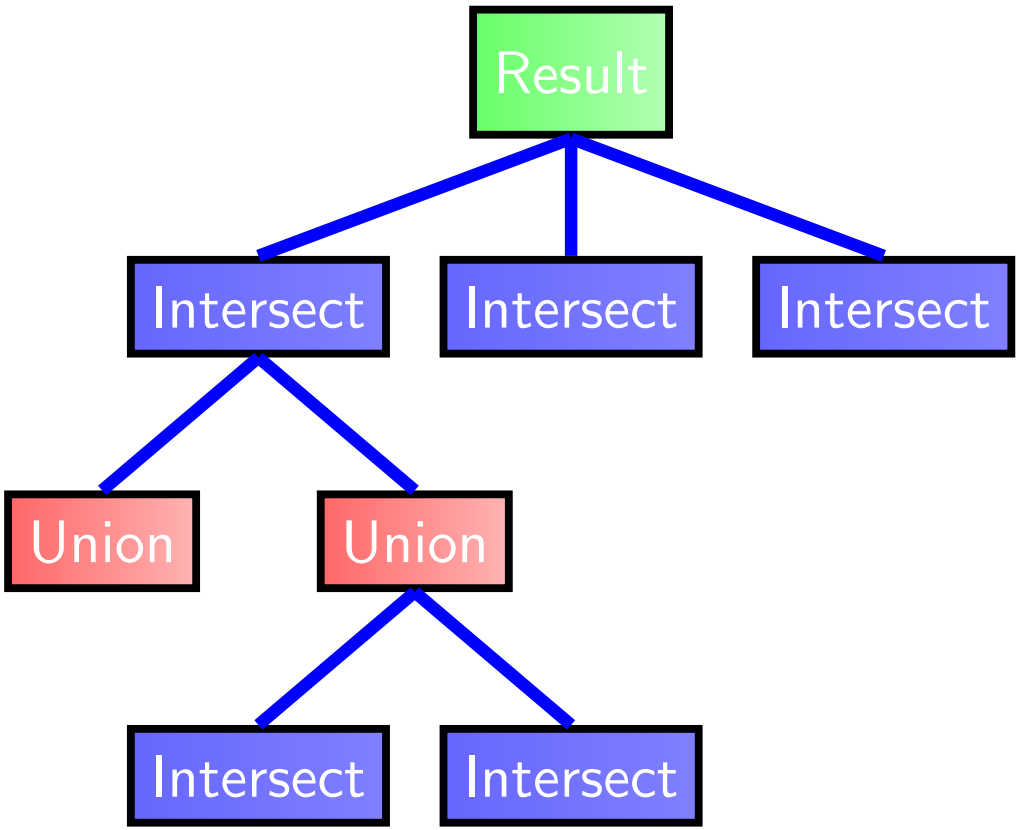



- Use can be made of $b \implies a$ and $a' \implies b'$
- b $\implies$ a := b'+a and a' $\implies$ b' := b+a'
- Add these rules as intersections to the main rule

CombLayer Provides:

- CNF / DNF resequencing [Quine Method]
- Weak boolean algebra division
- Doesn't provide two factor minimization [yet!]
- Selection of minimal literal format

# Object Composition




**Level 0 :** Surface List

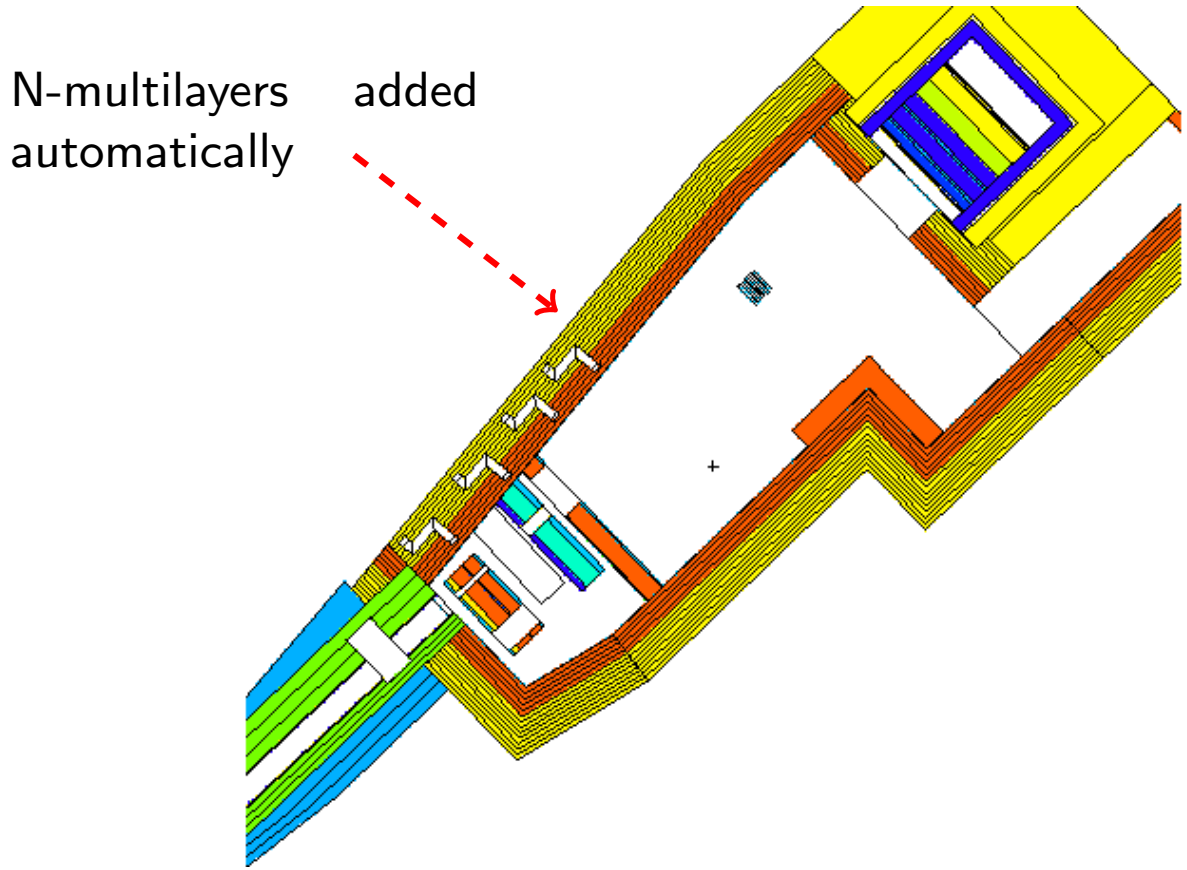
**Level 1 :** Surface List

**Level 2 :** Surface List

- Maximize level 0 components
- Observe that interaction points can be calculated as level-0 sub units

Science & Technology Facilities Council
ISIS

# Object Compartmentalization

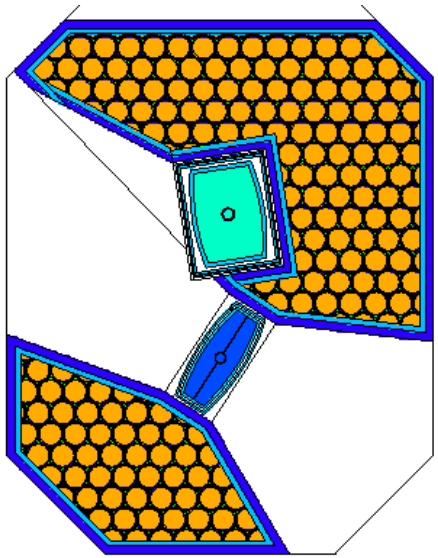


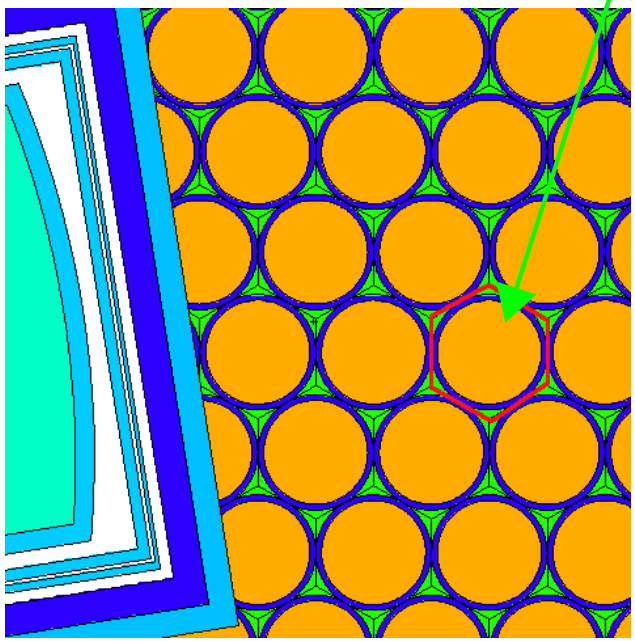

- Layer compartments to improve sampling/variance reduction
- Compartments used to reduced individual cell complexity

Science & Technology Facilities Council
ISIS

# Object Compartmentalization

Each cylinder is in its own local cell



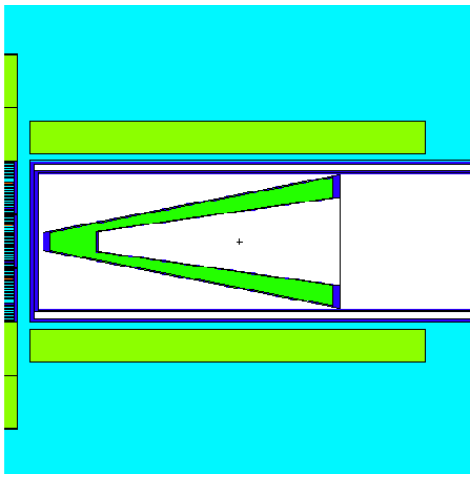


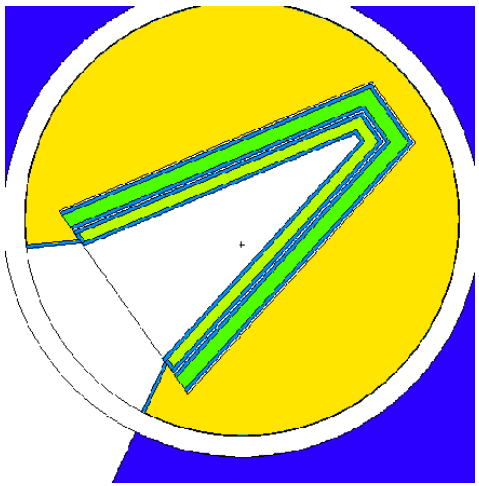
- Layer compartments to improve sampling/variance reduction
- Compartments used to reduced individual cell complexity

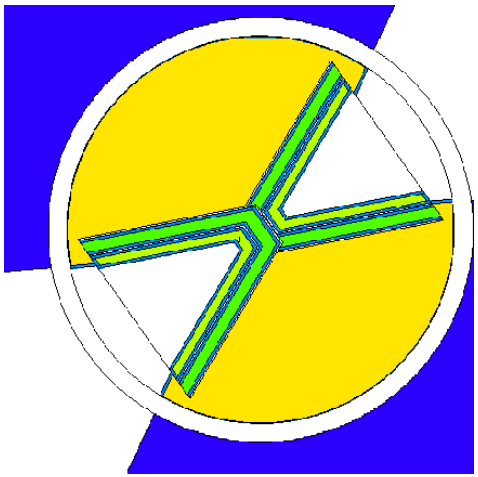
# CombLayer Component Construction

Models are made of components:

- Local parameters e.g. number of layers
- Containers that allow insertion
- Link points that allow joining



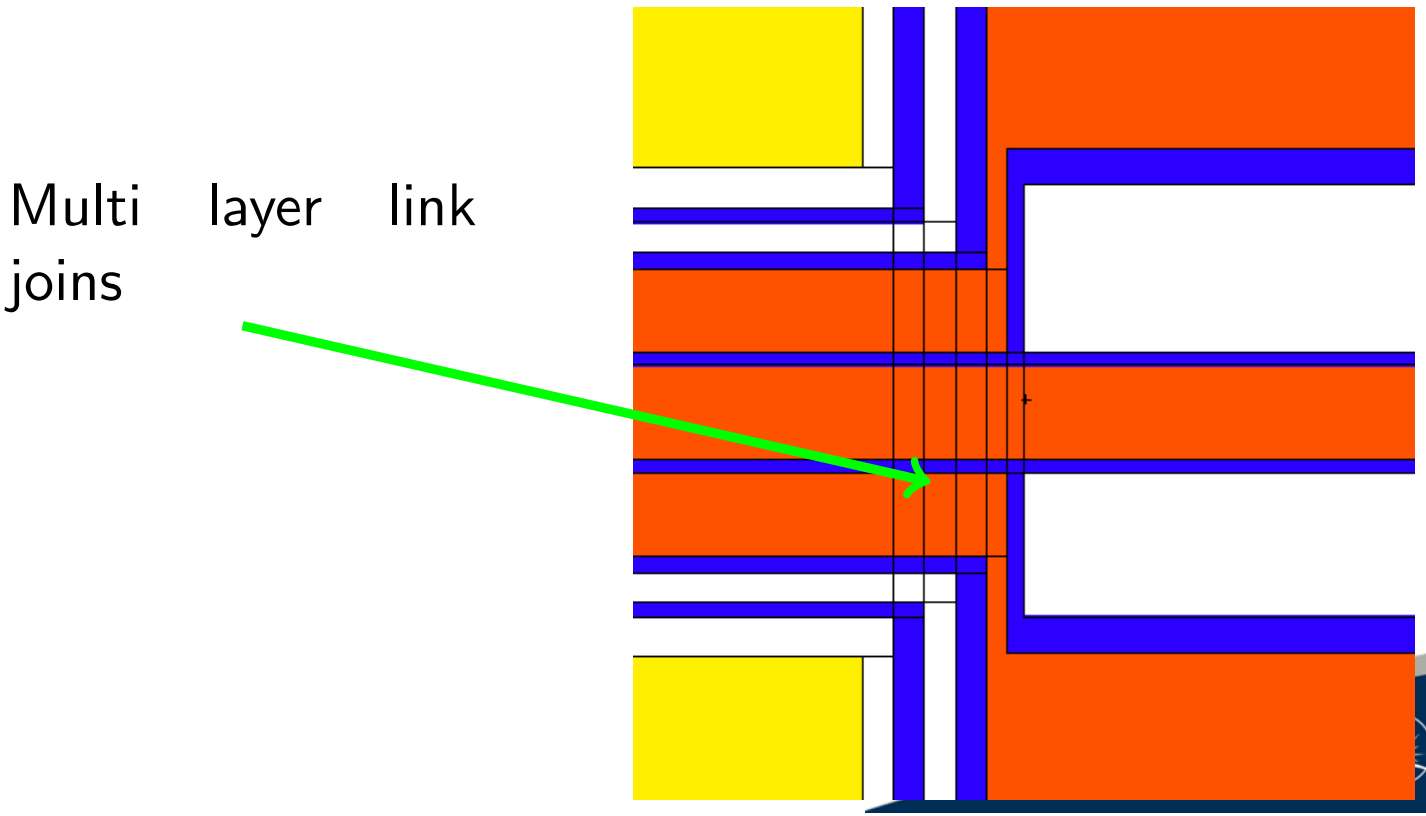




Same object

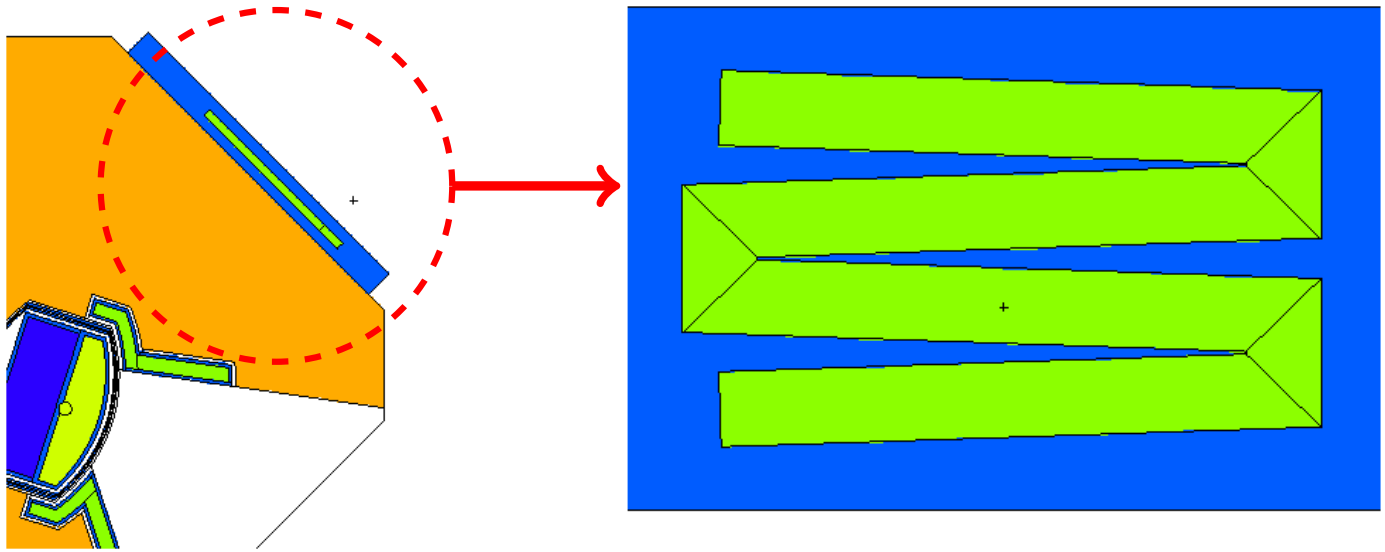
# Specialized Link Units: Pipework

- 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

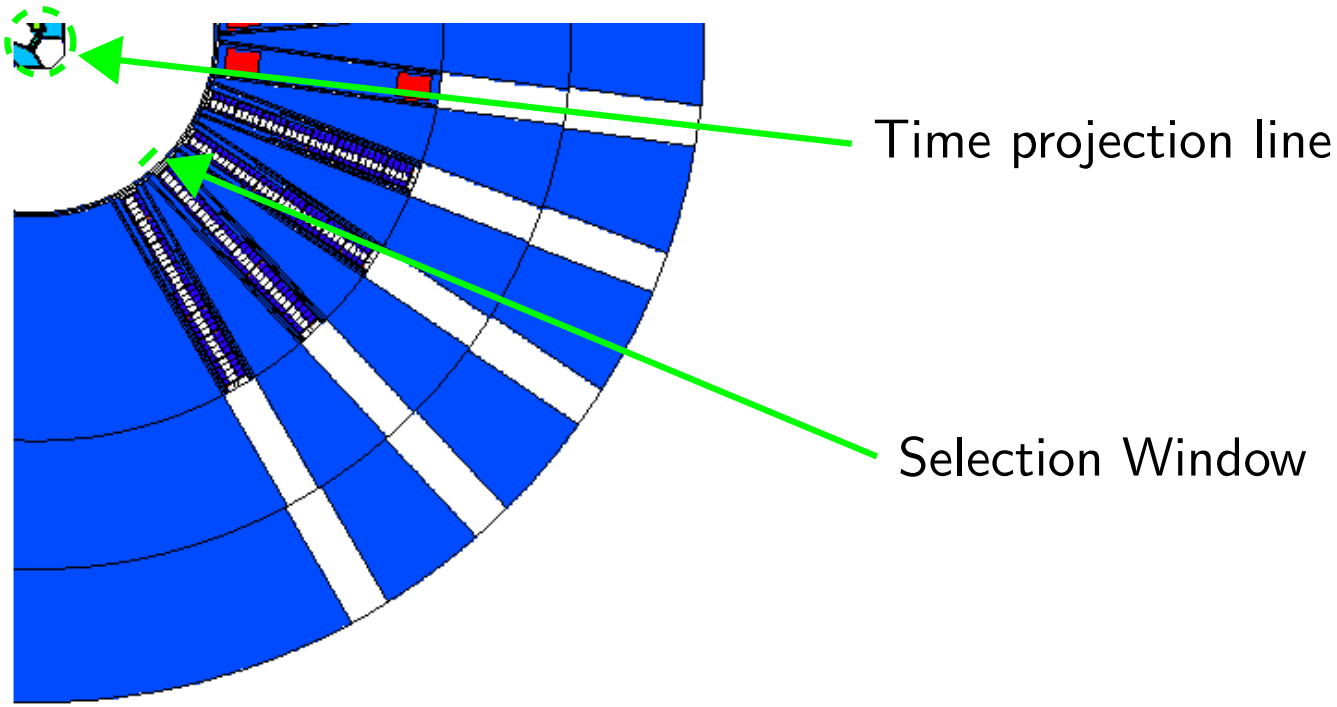


# Specialized Link Units: Pipework

- Pipework auto-joined on any free-point/link Point pattern



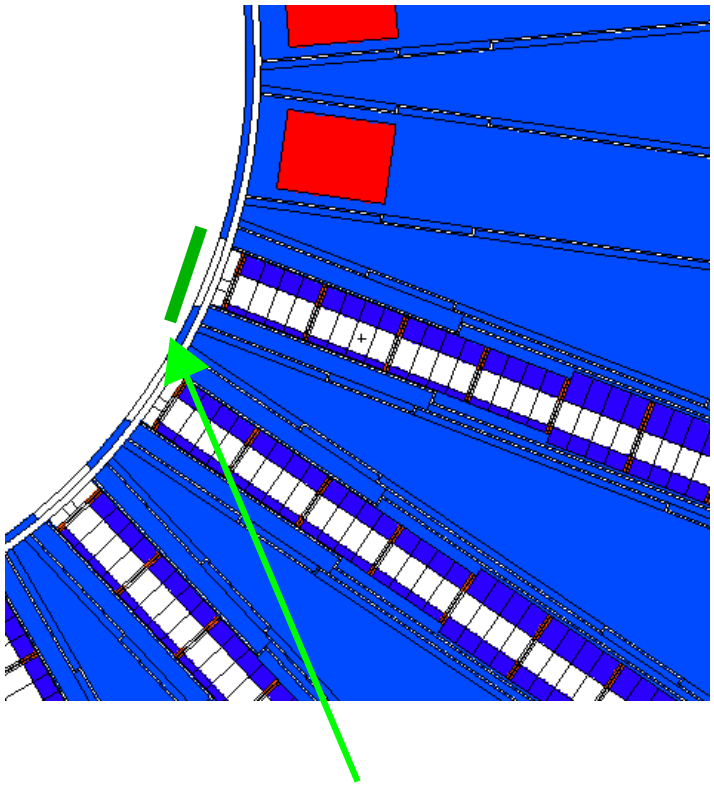
# Point Detector System




- Point Tally

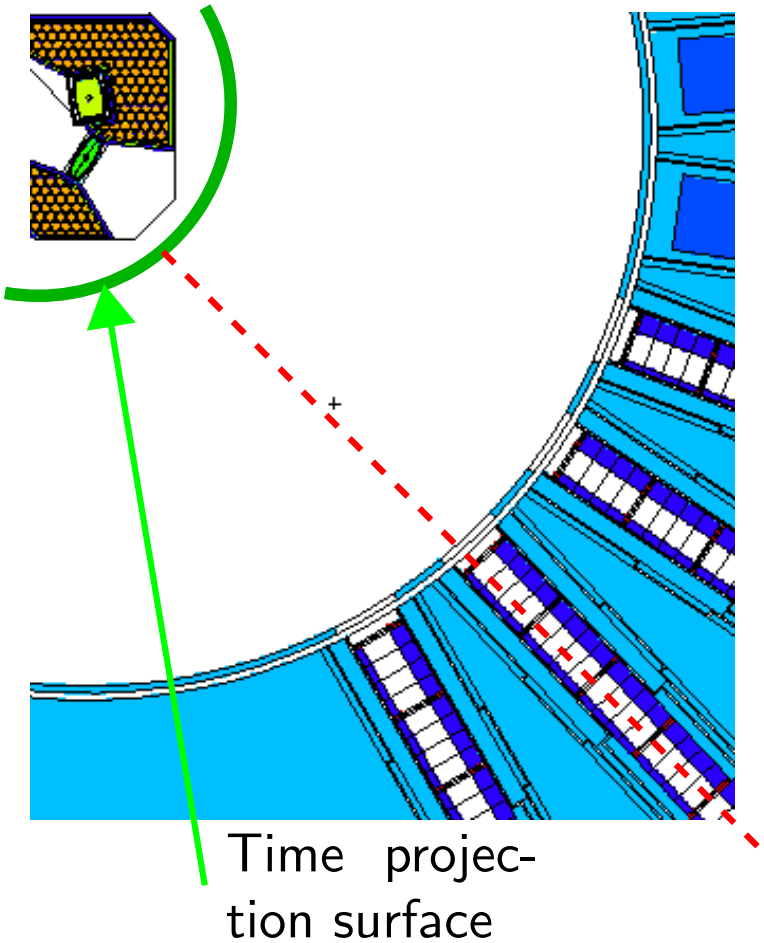
- Point tally has three parts: (i) Tally Point (ii) Selection window (iii) Time projection surface

# Point Detector System: Selection Window



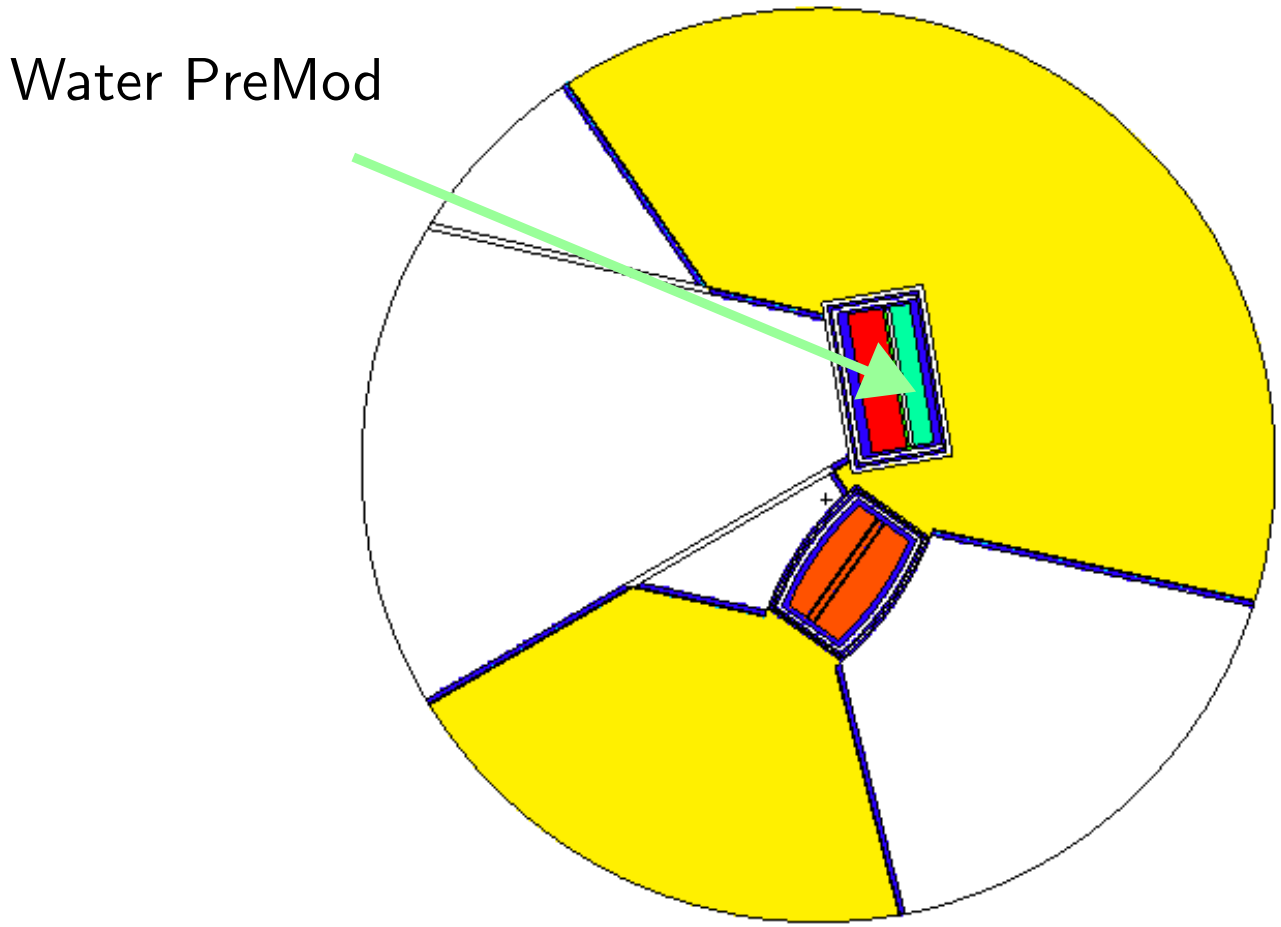

- Selection window is convex-planar surface on N points
- Only track that pass through are tallied
- Boundary proximity used to speed calculation

# Point Detector System: Time Selection



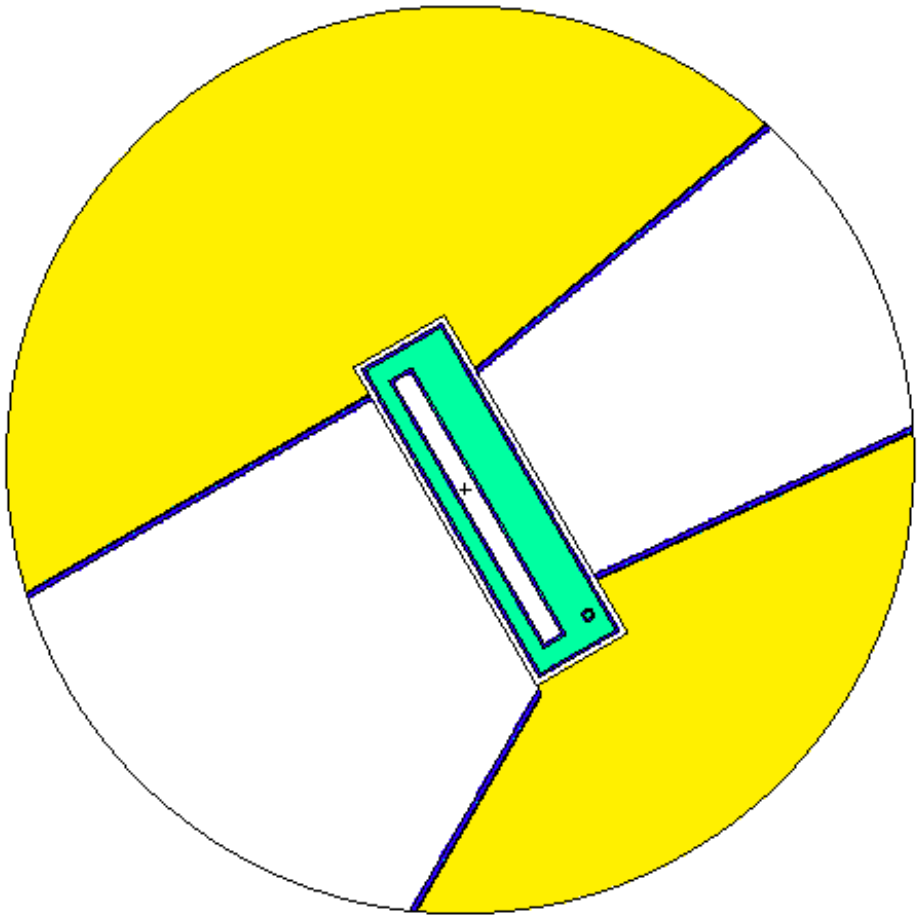

- Tally is back projected onto the time surface
- The time surface was constant for all TS1 models
- Efficient way of dealing with the time information in a binded tally

# Cold Moderators



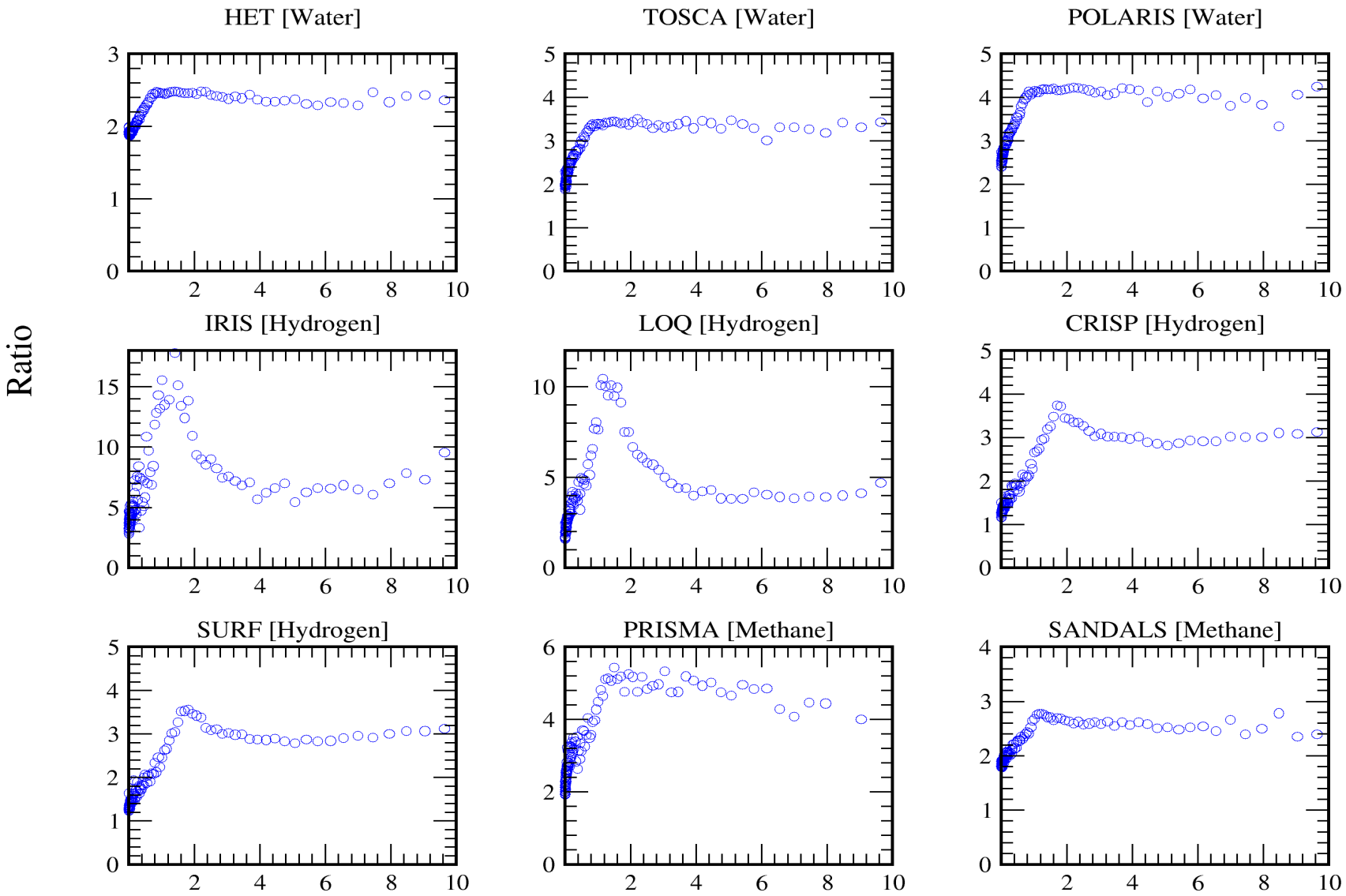

- Two moderator $H_2$ and $CH_4$
- Pre-Mod - view-through system for $H_2$

# Water Moderator

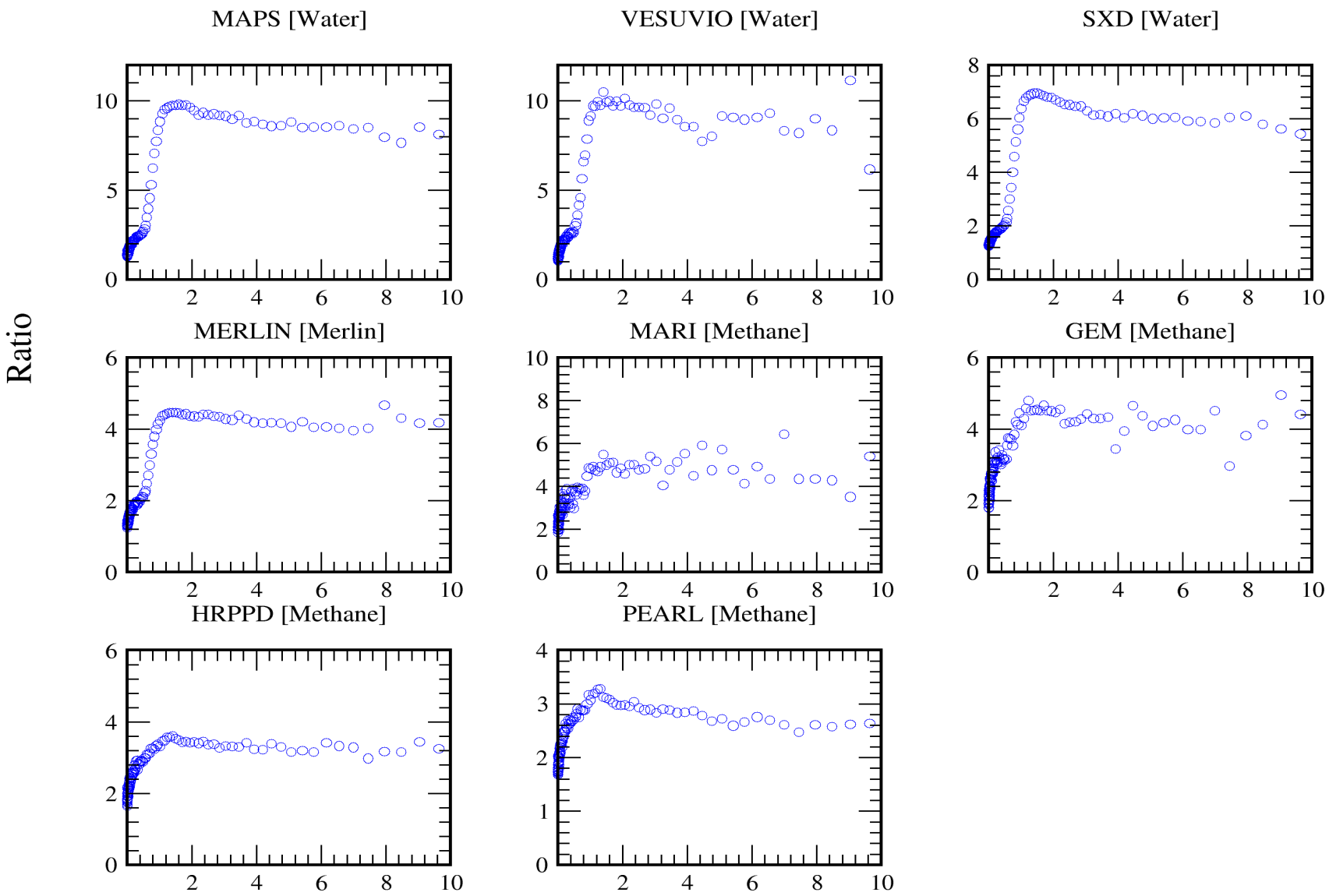


- Combined single moderator
- Hole centre to allow fast population

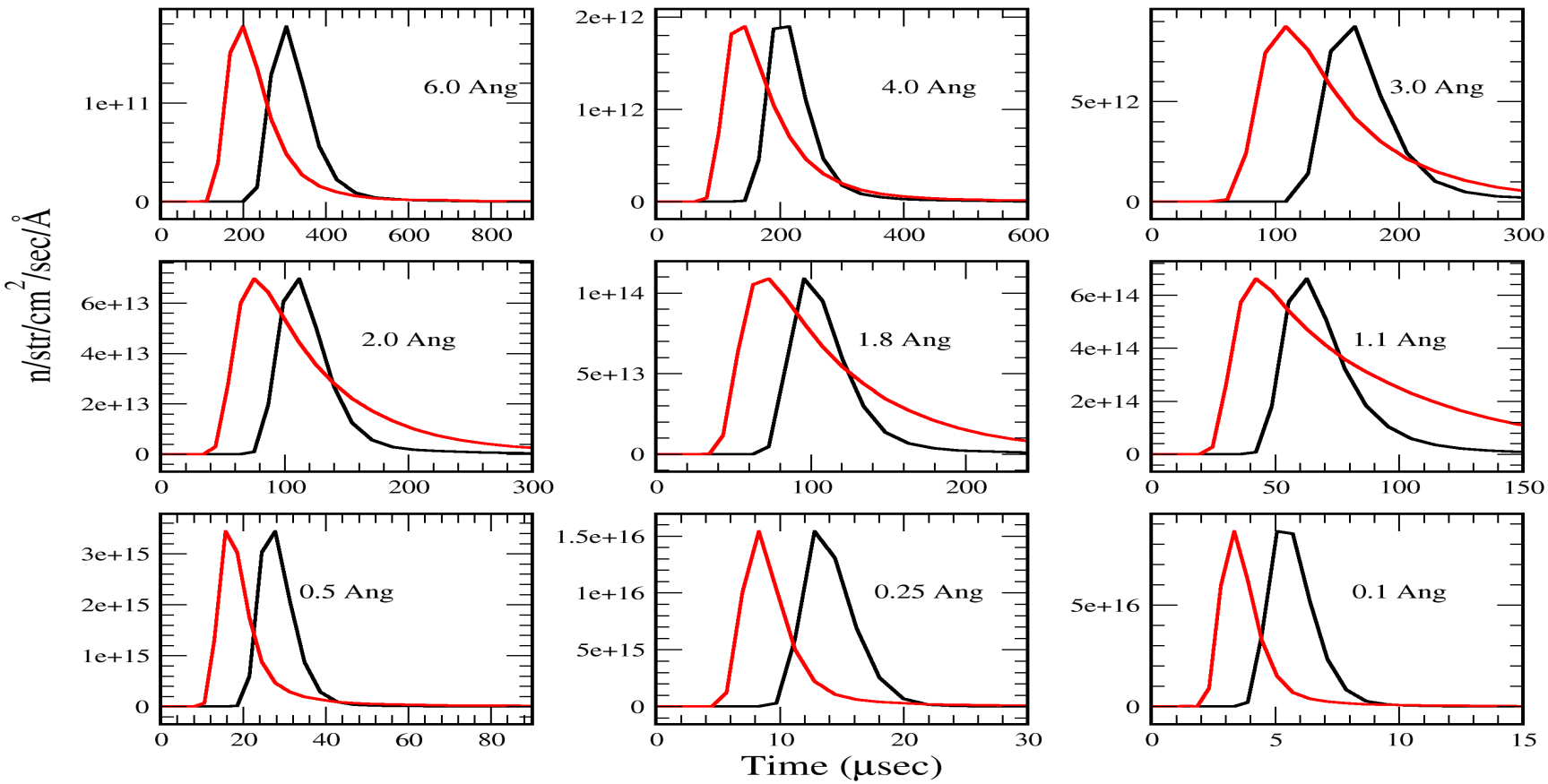
# North Beamline Ratio



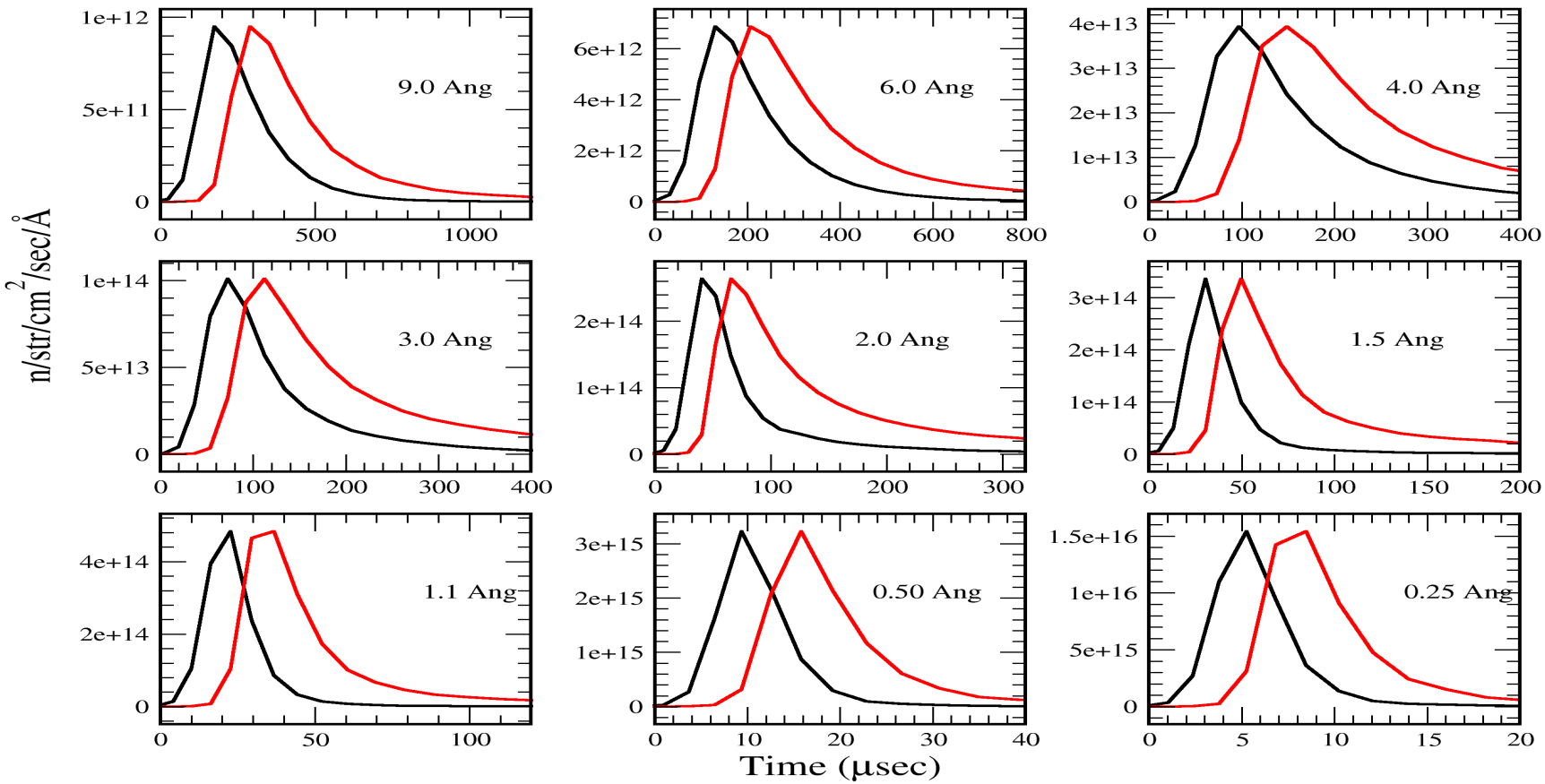
# South Beamline Ratio



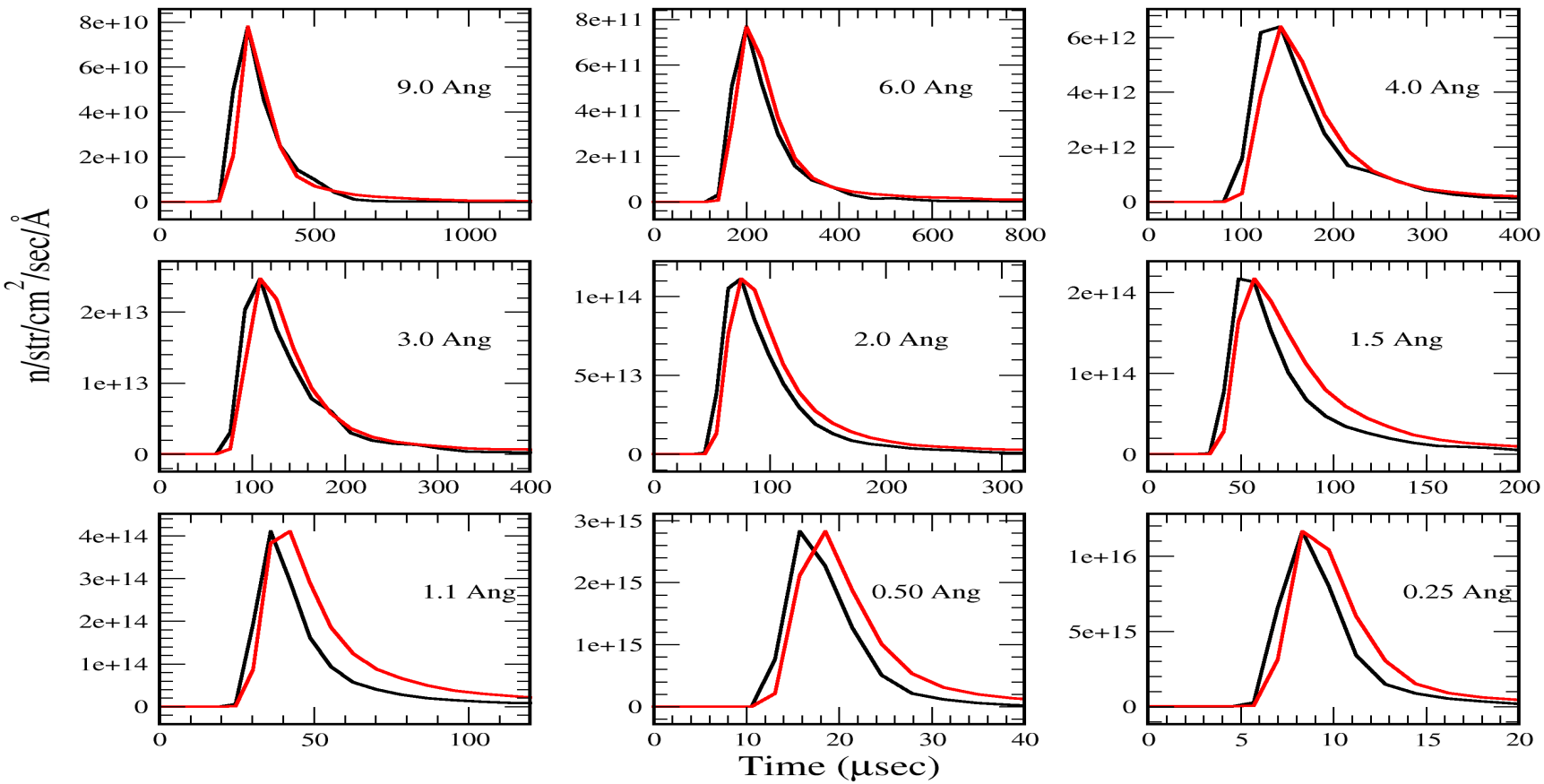
# Water Pulse Width [Water]



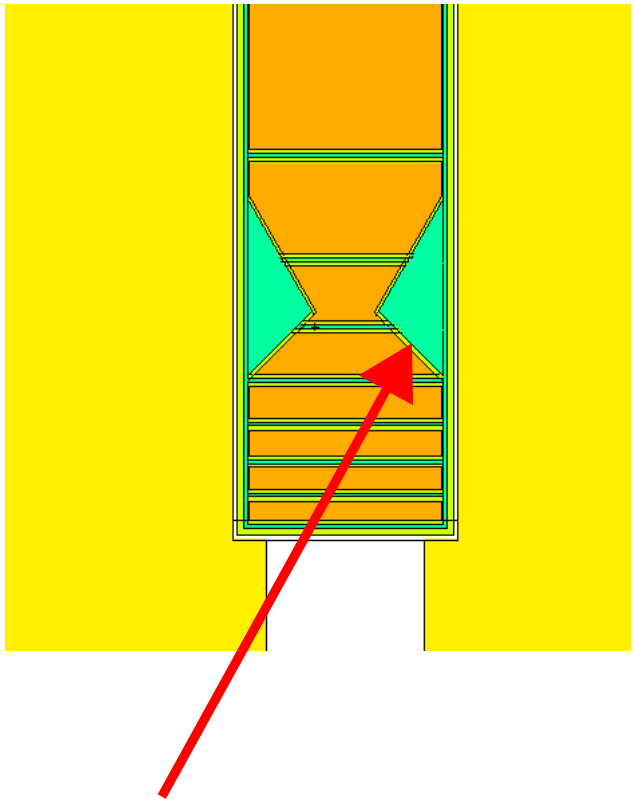
# Water Pulse Width [Hydrogen]



# Water Pulse Width [Methane]



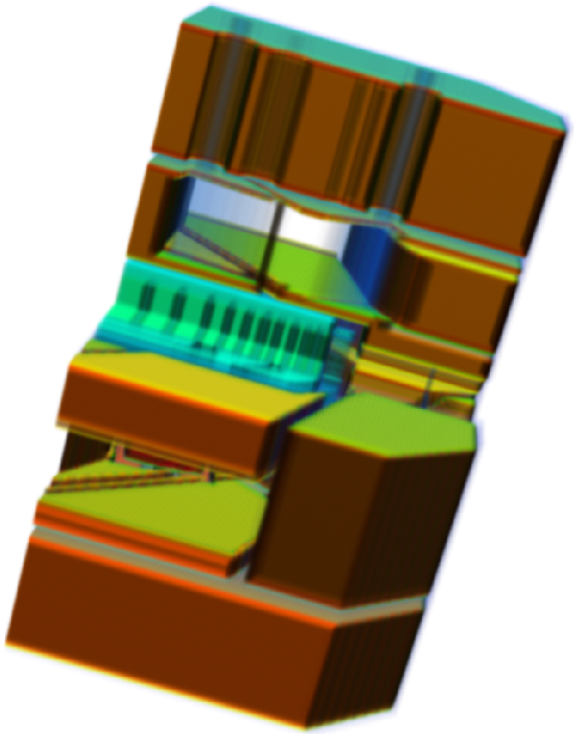
# Target : Future modification



Conic flux trap

- $H_2O$ / $D_2O$ Water Mix (35/65)
- Cooling channels kept the same

# Conclusions



**TS1 Project :**

- 6694 Cells
- 6411 Unique Surfaces
- 4313 Model dependent variables

- We have tools to analyse complex geometries
- In a position to offer fast target to sample calculations
- Don't forget the details

Science & Technology Facilities Council ISIS