MAGNETIC INTERVENTION CHAMBER DESIGN CONFIGURATION OPTIONS

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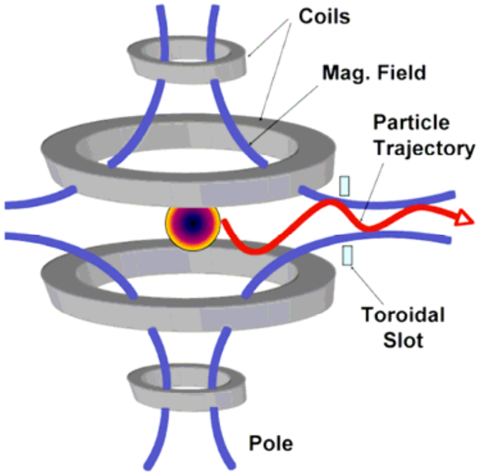
Outline

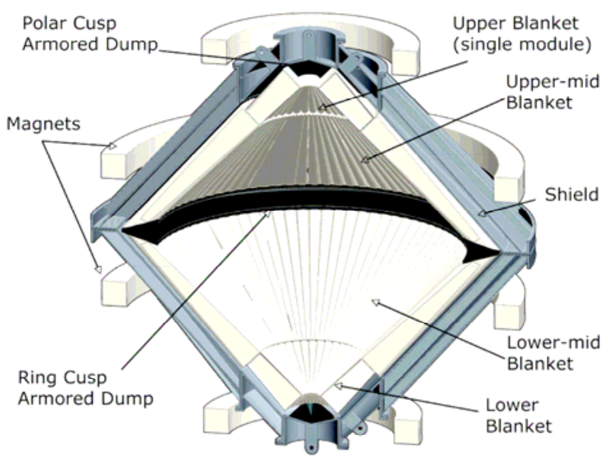
- **Original Magnetic Intervention Scheme**
- **“Octacusp”**
- **Inverted Martini Glass**
- **Inverted Burgundy Glass**
- **Inverted Tulip**

Original MI Scheme

- **Cusp-shaped magnetic fields are placed between the exploding target and the chamber walls.**
- **8-10% of the ions travel directly to the equatorial ring dump and the two polar dumps.**
- **Remaining ions attempting to cross the magnetic fields are slowed by the induced electric fields.**
- **Simple geometry is composed of two cones, two polar dumps, and the equatorial ring dump.**



Schematic of cusp field configuration[1]

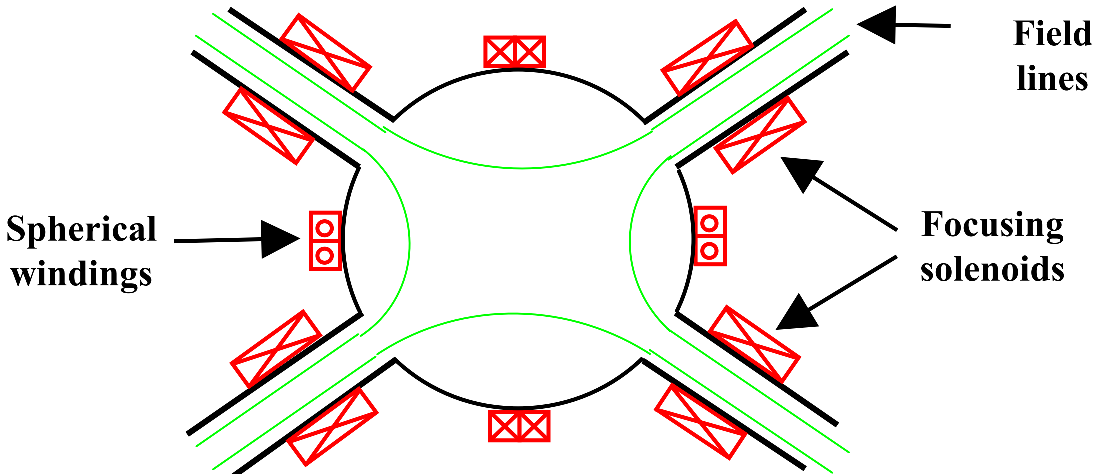


Example chamber configuration[1]

[1] A.R.Raffray, et. Al., "*Conceptual Study of Integrated Chamber Core for Laser Fusion with Magnetic Intervention.*" Proceedings of the 22nd IEEE/NPSS Symposium on Fusion Engineering, 2007.

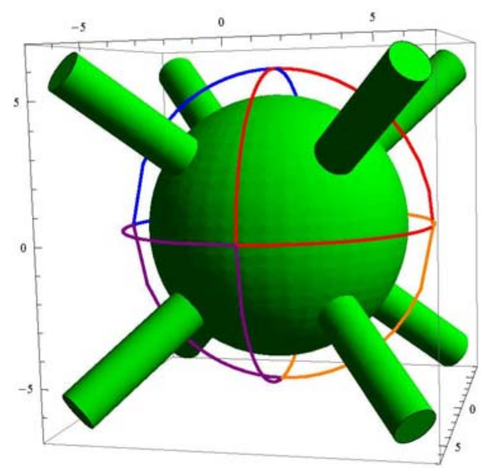
"Octacusp" Scheme[1]

- **An Octahedron was chosen for this "point cusp" chamber design since it is the only regular polyhedra which has an even number of faces at each vertex. This allows all the cusps to be point cusps.**
- **The aim of the "Octacusp" is to convert the isotropic expansion of the IFE target into eight identical beams.**



2-D Section Through Four Ports[1]

Model for Sample Ion Orbit Calculation[2]



[1] A.E.Robson, "*Improvements to Magnetic Intervention*." 17th High Average Power Laser Program Workshop, October 30-31, 2007.
[2] D. Rose, "*Computational Modeling of Magnetic Intervention*." 17th High Average Power Laser Program Workshop, October 30-31, 2007.

Inverted Martini Glass

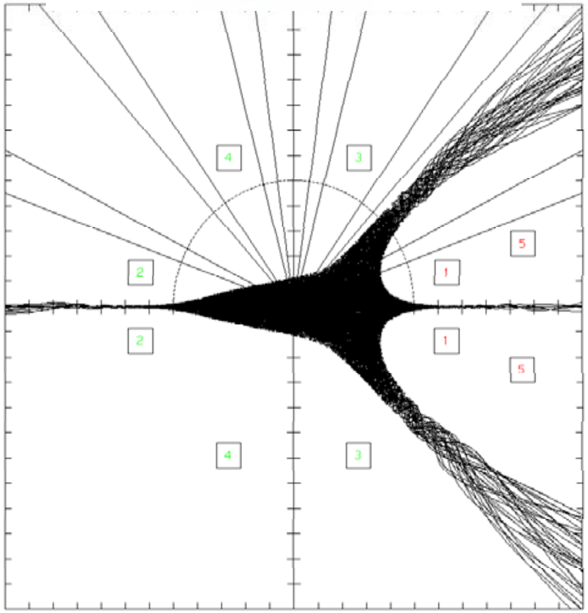
- **This design attempts to alleviate the contamination and energy density issues of the equatorial ring dump for the Original MI Scheme.**

- **97% of the ion energy exits the chamber through the annular dump.[1]**

- **Gravity aids in the design of a liquid Lead dump.[1]**

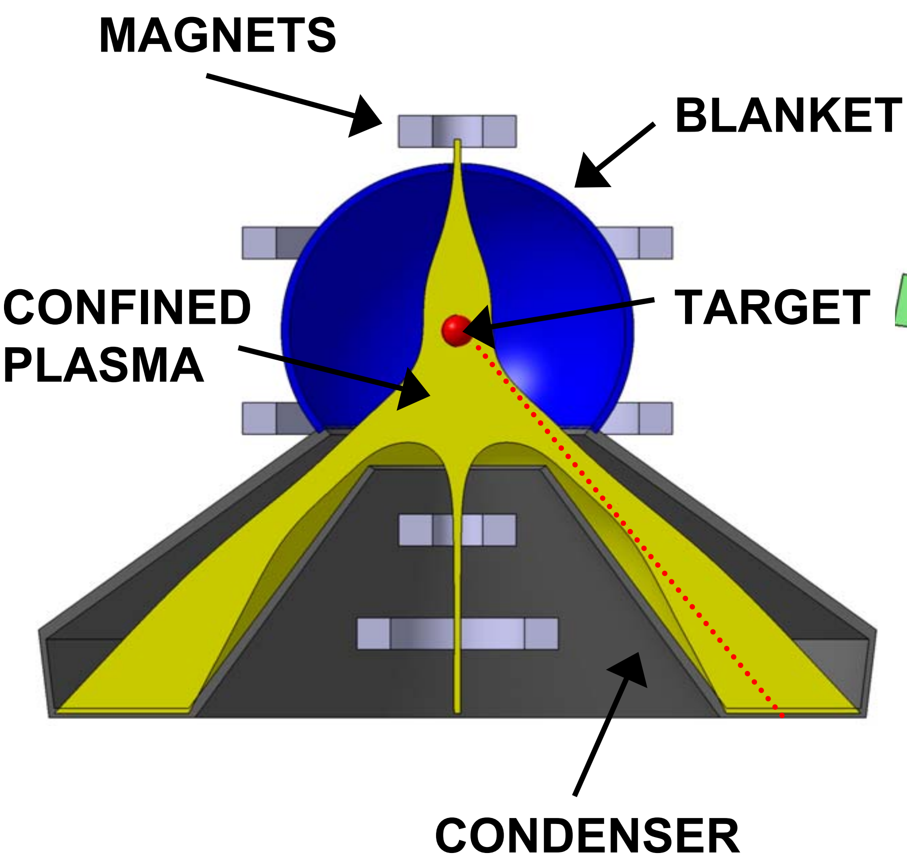
- **Despite pulling the ions downward, line-of-sight contamination is still an issue.**

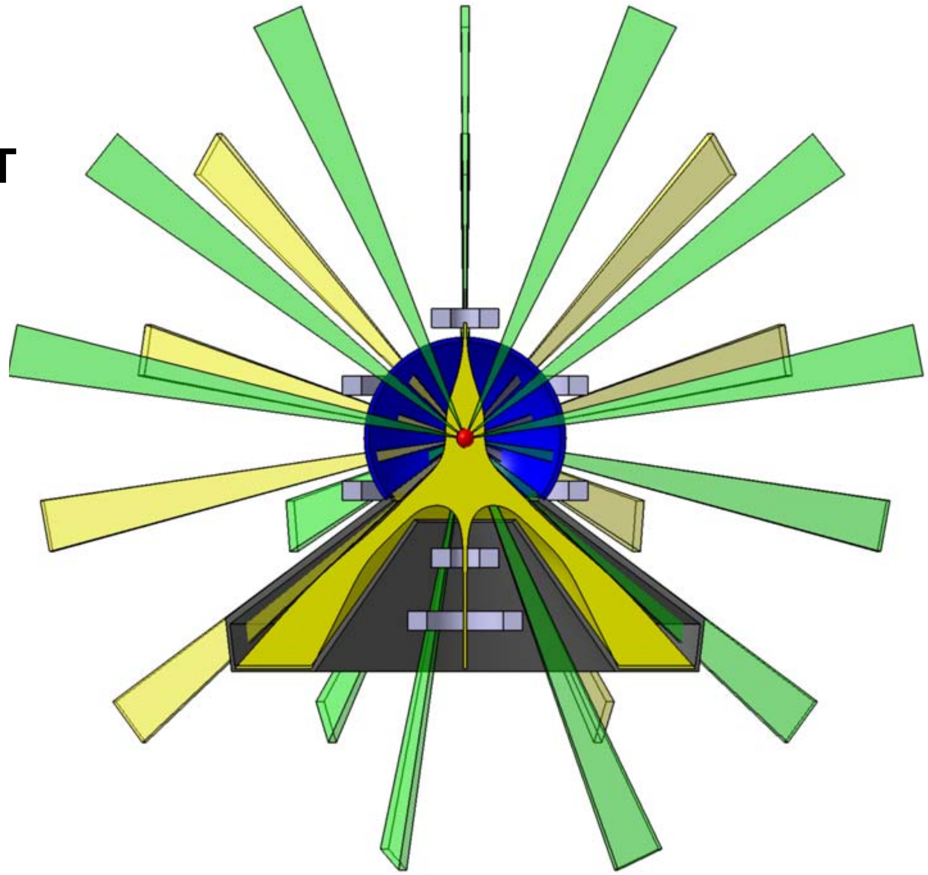
- **A solid model of the chamber has been created. There are potential issues with laser beam interference.**



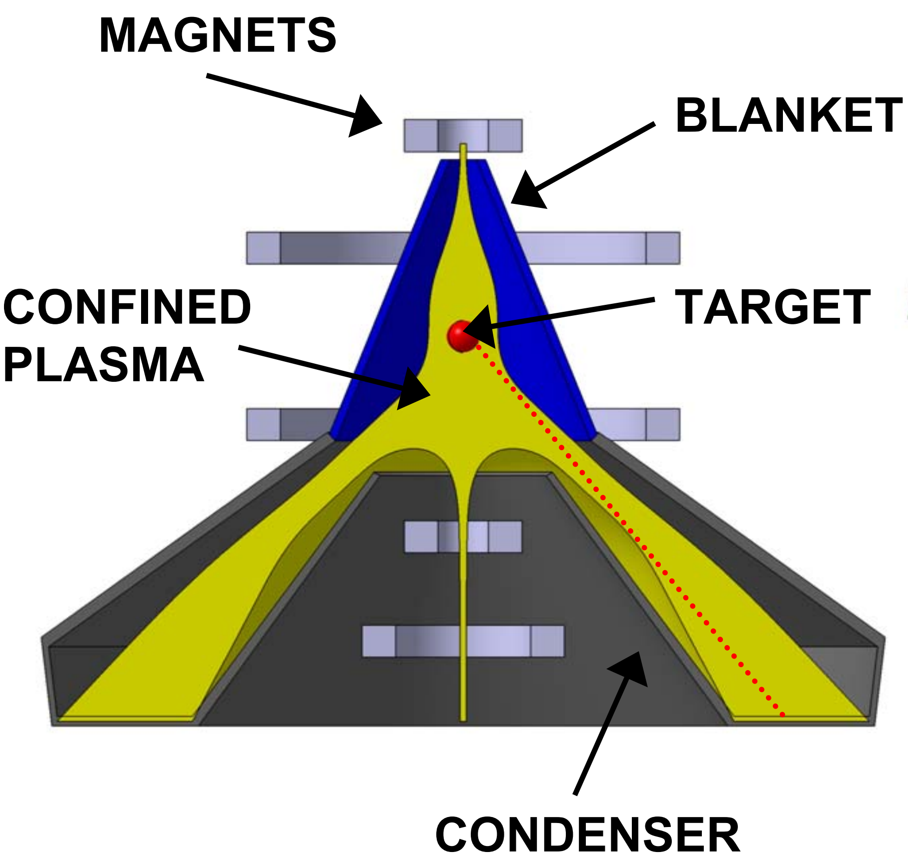
[1] A.R.Raffray, "*Magnetic Intervention Dump Concepts*." 18th High Average Power Laser Program Workshop, April 8-9, 2008.

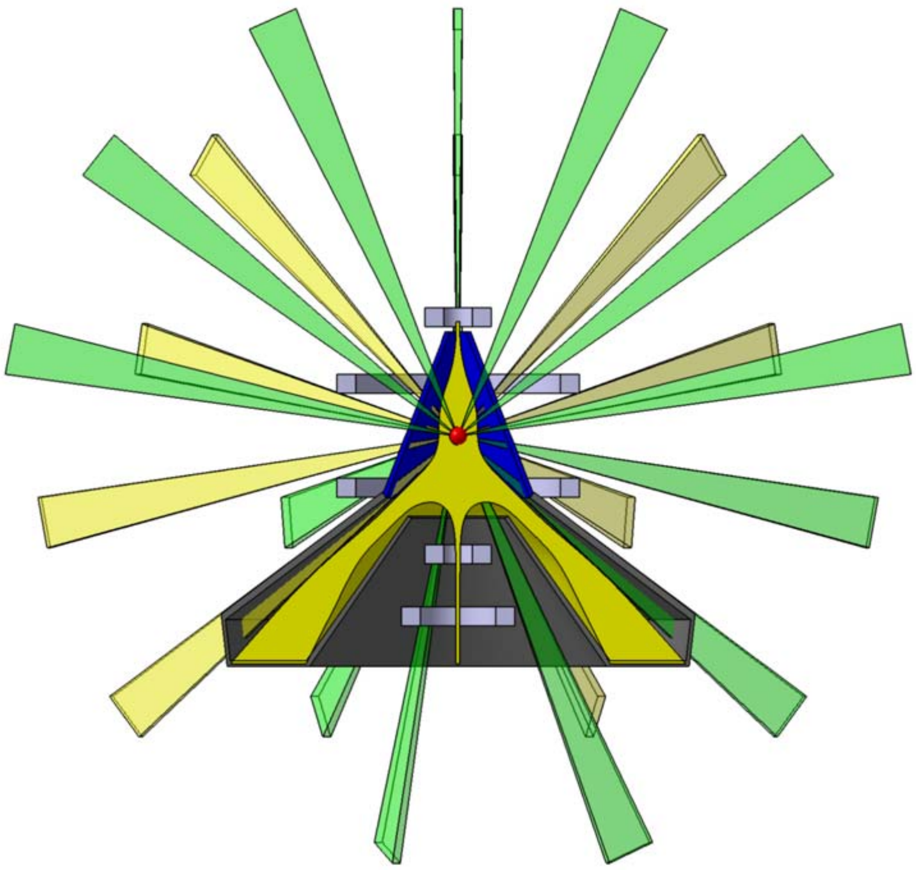
Martini Configuration #1





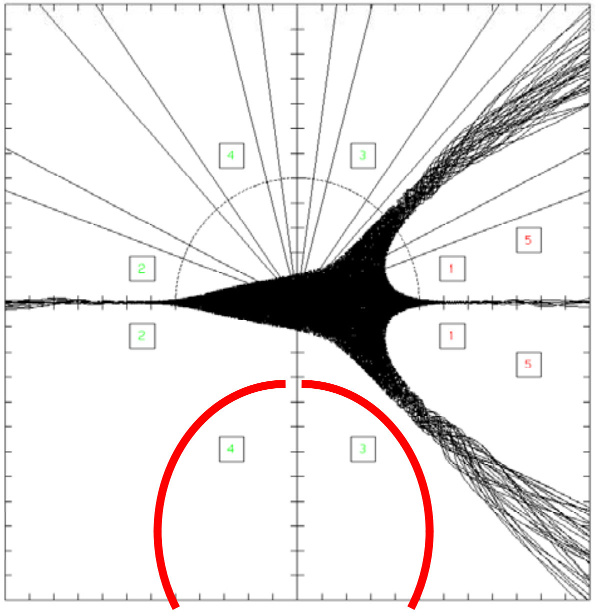
Martini Configuration #2





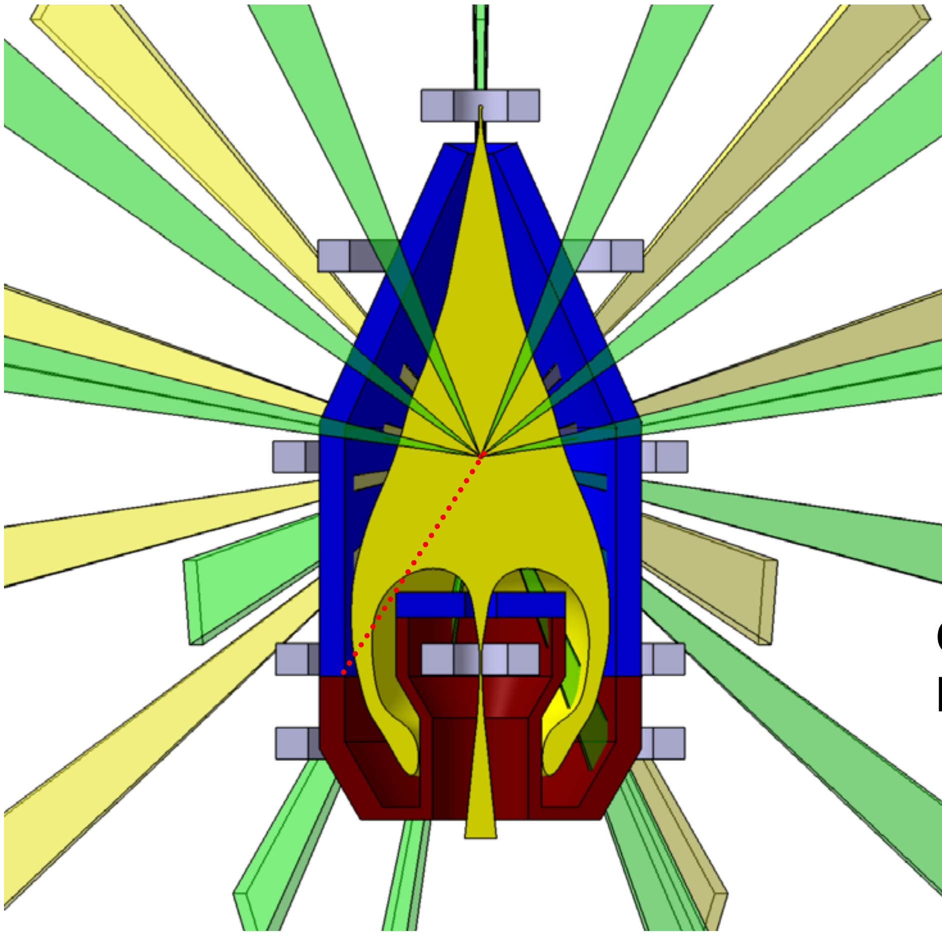
Inverted Burgundy Glass

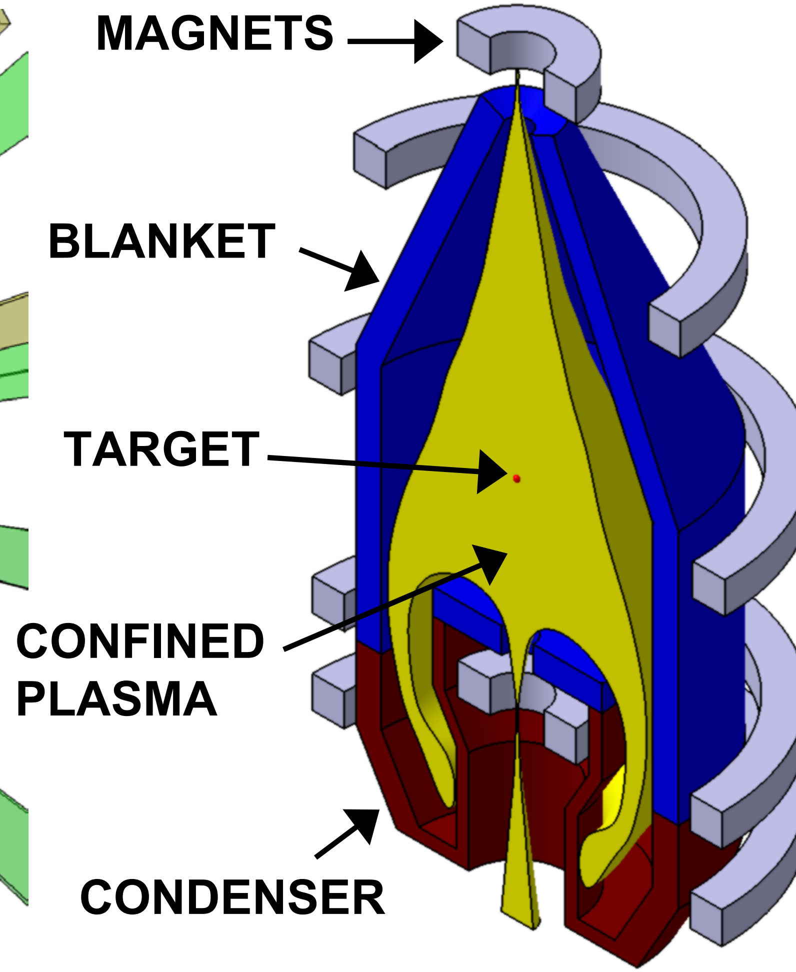
- **This "Inverted Burgundy Glass" concept will be better for prevention of line-of-sight contamination.**
- **The ions are curved underneath by the magnets, thus eliminating the line-of-sight unlike the Martini Glass. (The only solid angle losses exist at the poles)**
- **This also allows for a more compact design by having a smaller dump footprint than the Martini Glass.**
- **Again, there may be interference issues with the laser beams crossing the dump.**
- **A solid model for this geometry was also created.**



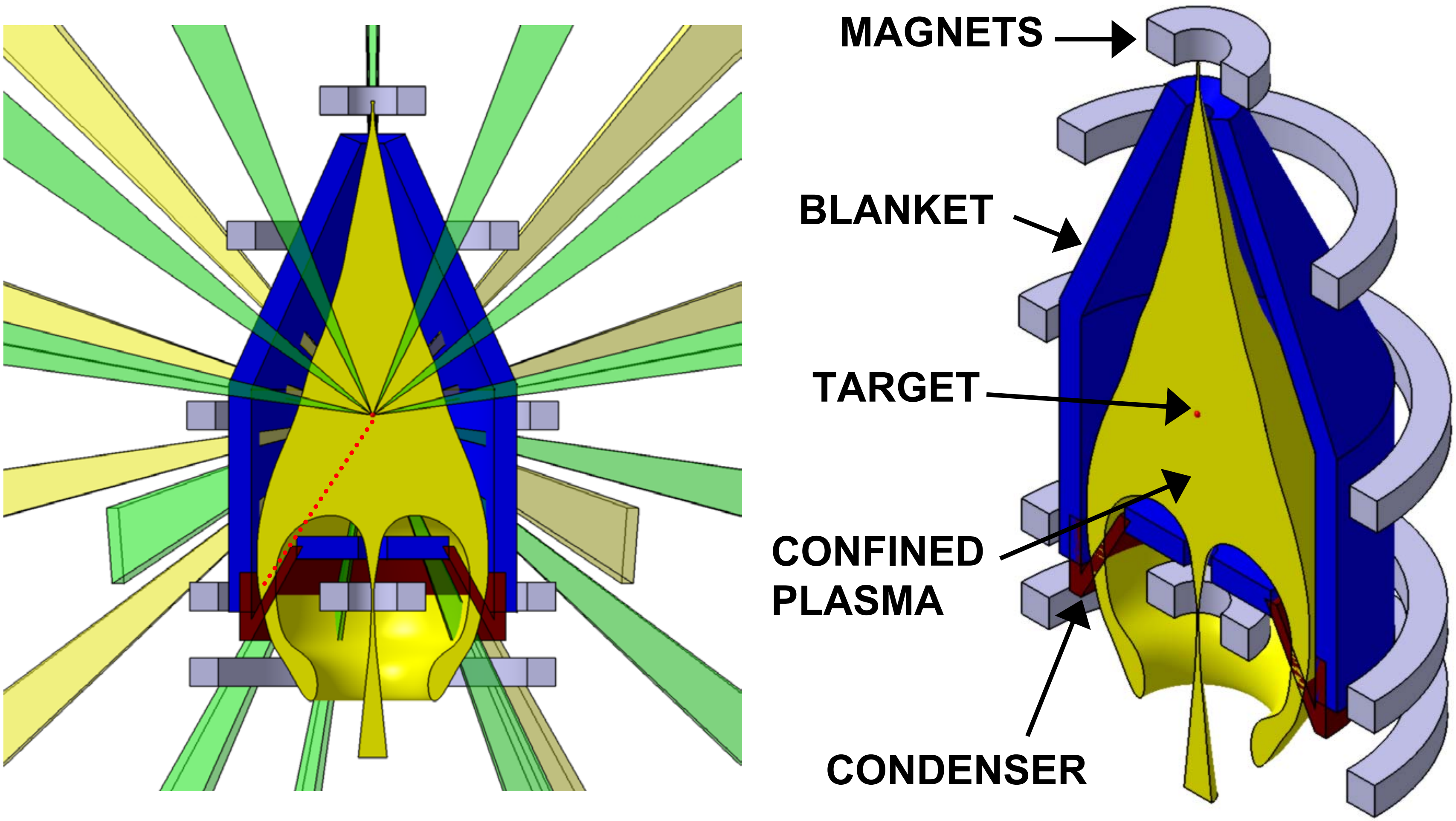
IMAGES FROM: A.R.Raffray, "*Magnetic Intervention Dump Concepts*." 18th High Average Power Laser Program Workshop, April 8-9, 2008.

Burgundy Design – Condenser #1



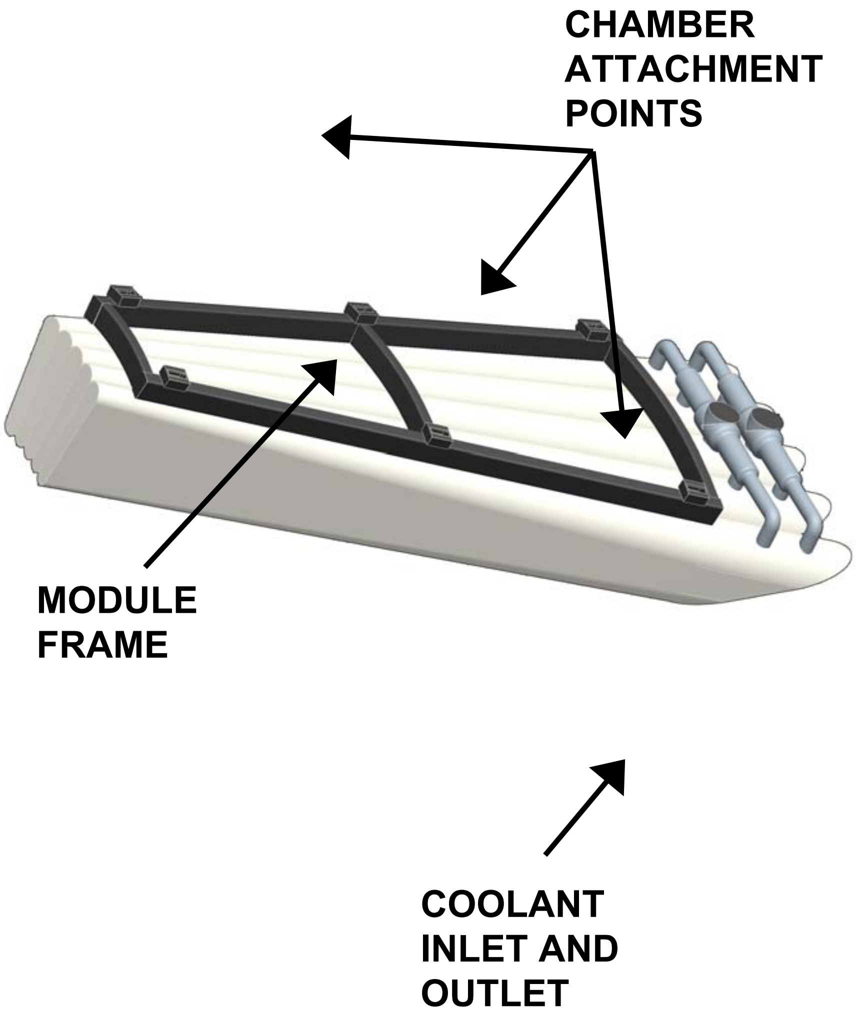


Burgundy Design – Condenser #2



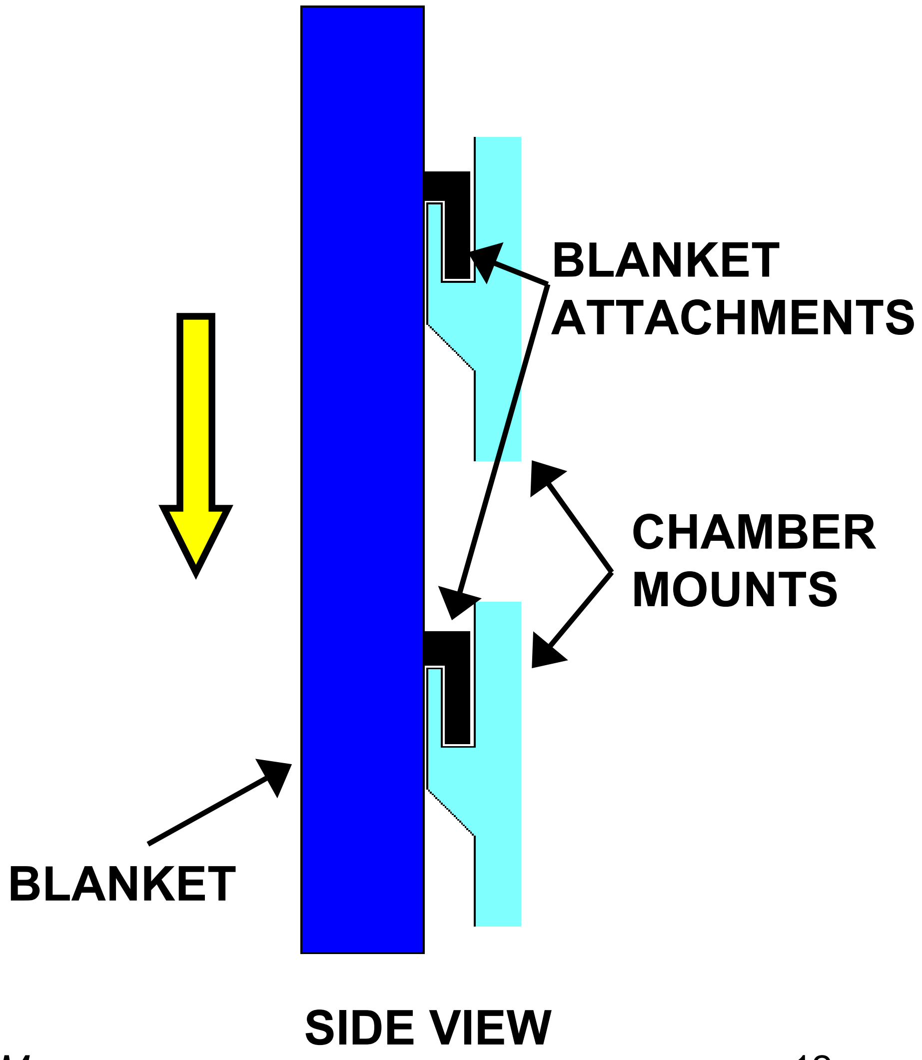
Manufacturing #1 : Cone Blanket

- **The design by Greg Sviatoslavsky will work with the cone portion of the design.**
- **For the cone portion only geometrical modifications will need to be made.**



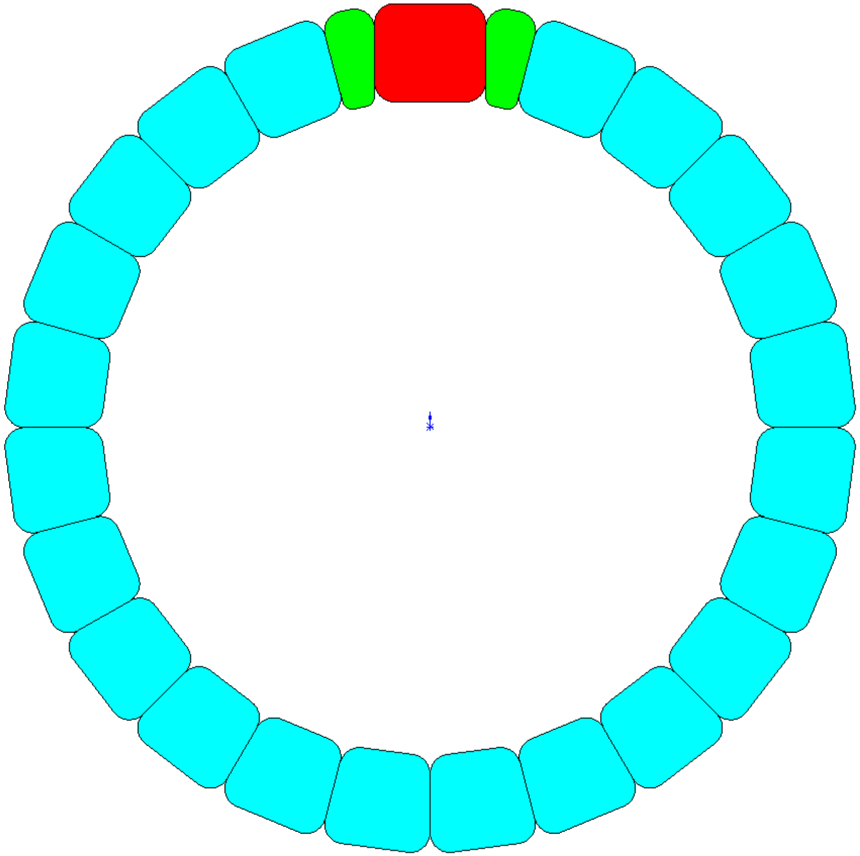
Manufacturing #2: Cylinder Blanket

- **The design by Greg Sviatoslavsky will also work with the cylinder portion of the design.**
- **Geometry will be simpler than the cone since the sections are perfectly vertical.**
- **One possibility is shown. Blanket sections are dropped onto Chamber Mounts that hold the sections in place.**



Manufacturing #3: Blanket Keystone

- **To install from the inside there must be a keystone section that is installed last (shown in red).**
- **Green sections are keystone mates.**
- **Blue sections are standard 15° sections. (Angle is arbitrary at this point of the design)**



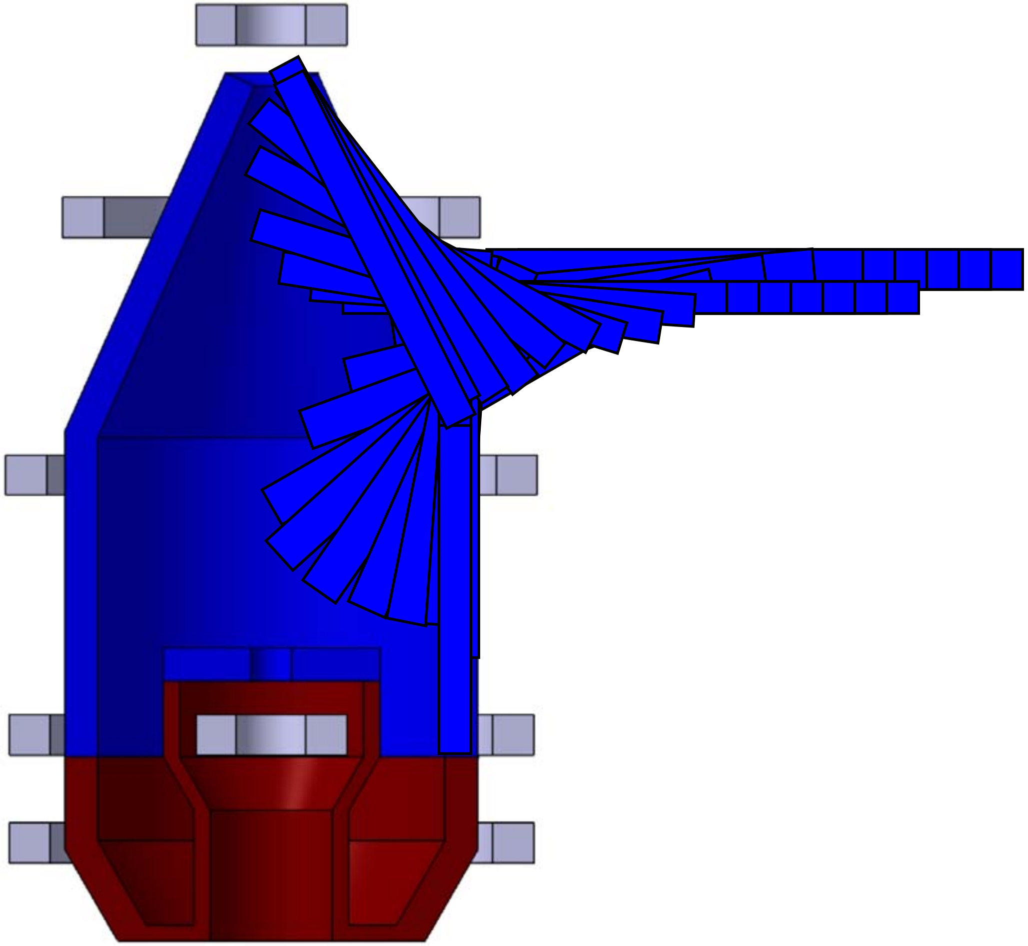
TOP VIEW

Burgundy Blanket Assembly

Step 1: Install Bottom Disc

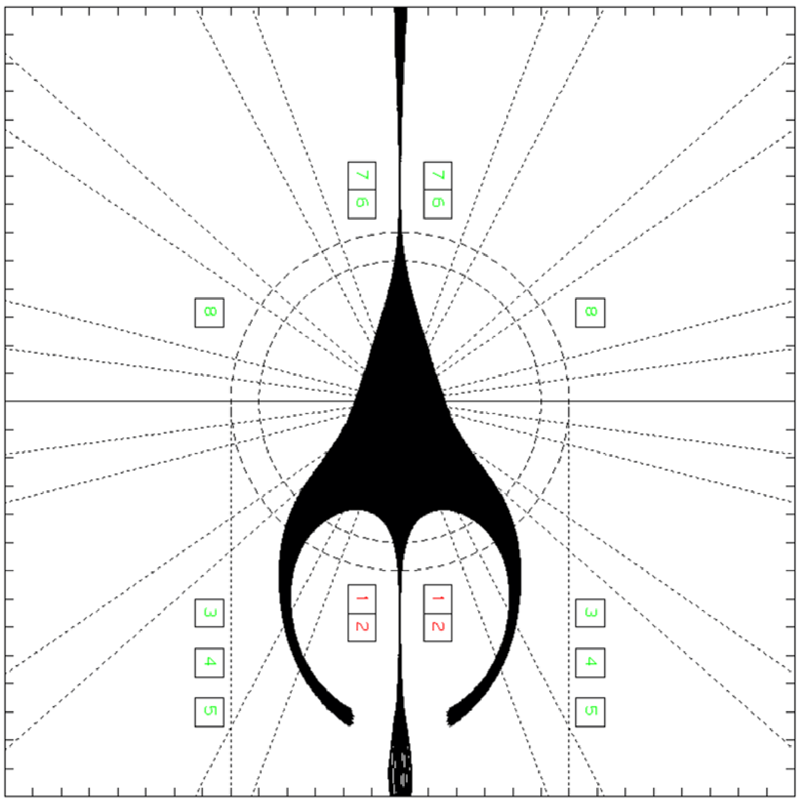
Step 2: Install Cylindrical Blanket

Step 3: Install Cone Blanket

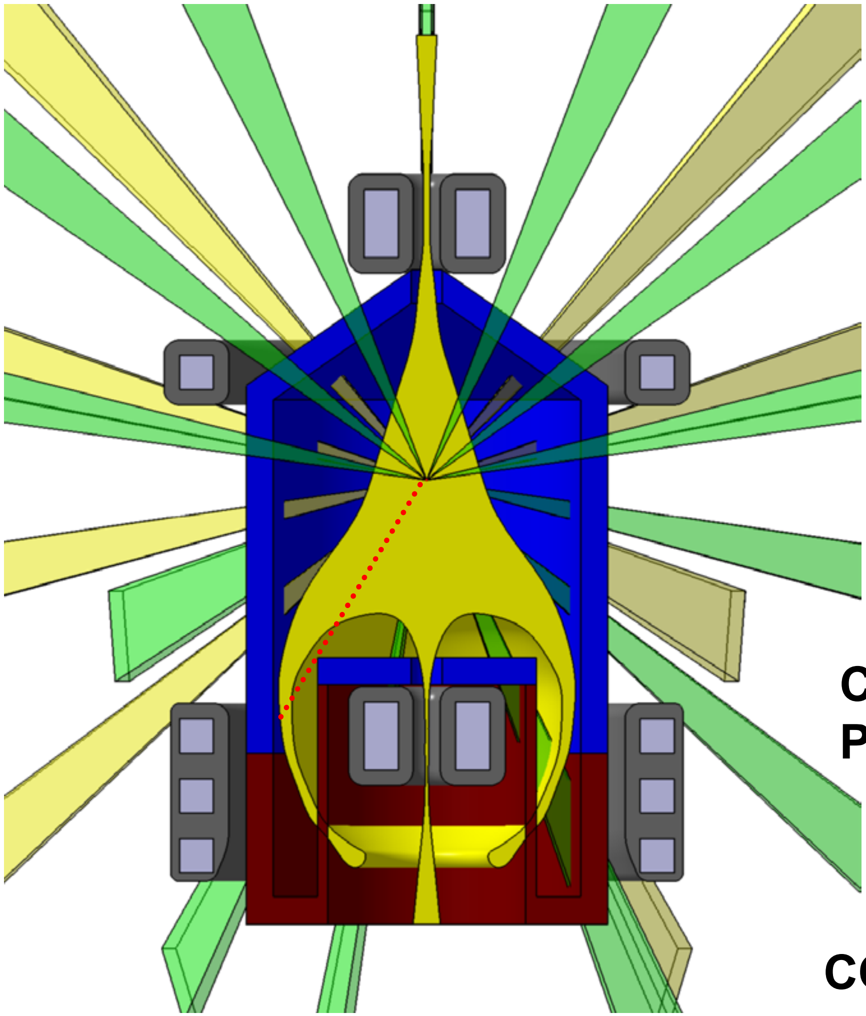


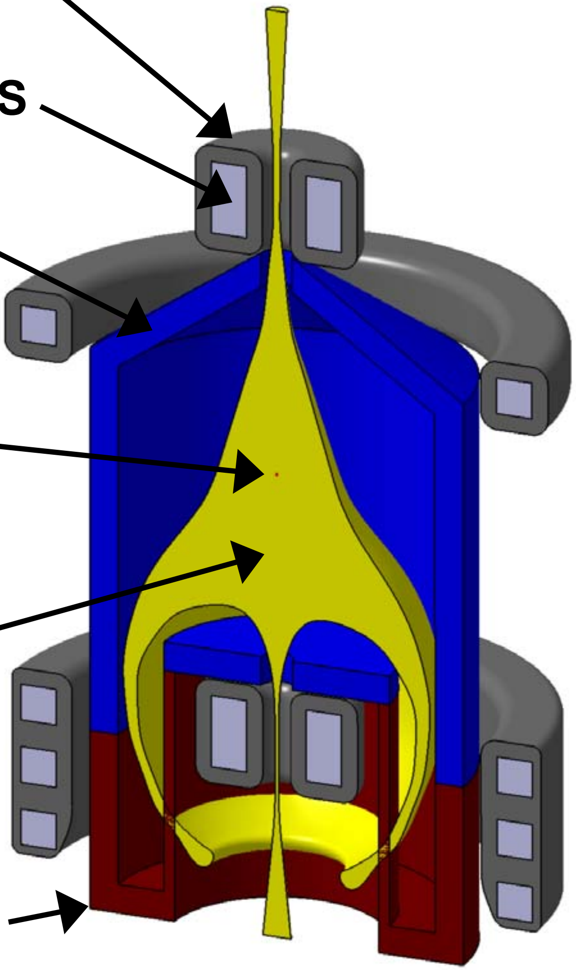
Inverted Tulip – Current Design

- **New design curves field lines more sharply out of line-of-sight.**
- **Magnet geometry has changed from Martini and Burgundy designs.**
- **Design allows for nearly complete elimination of chamber contamination.**
- **Design also allows for simpler blanket design and installation compared to Martini or Burgundy.**

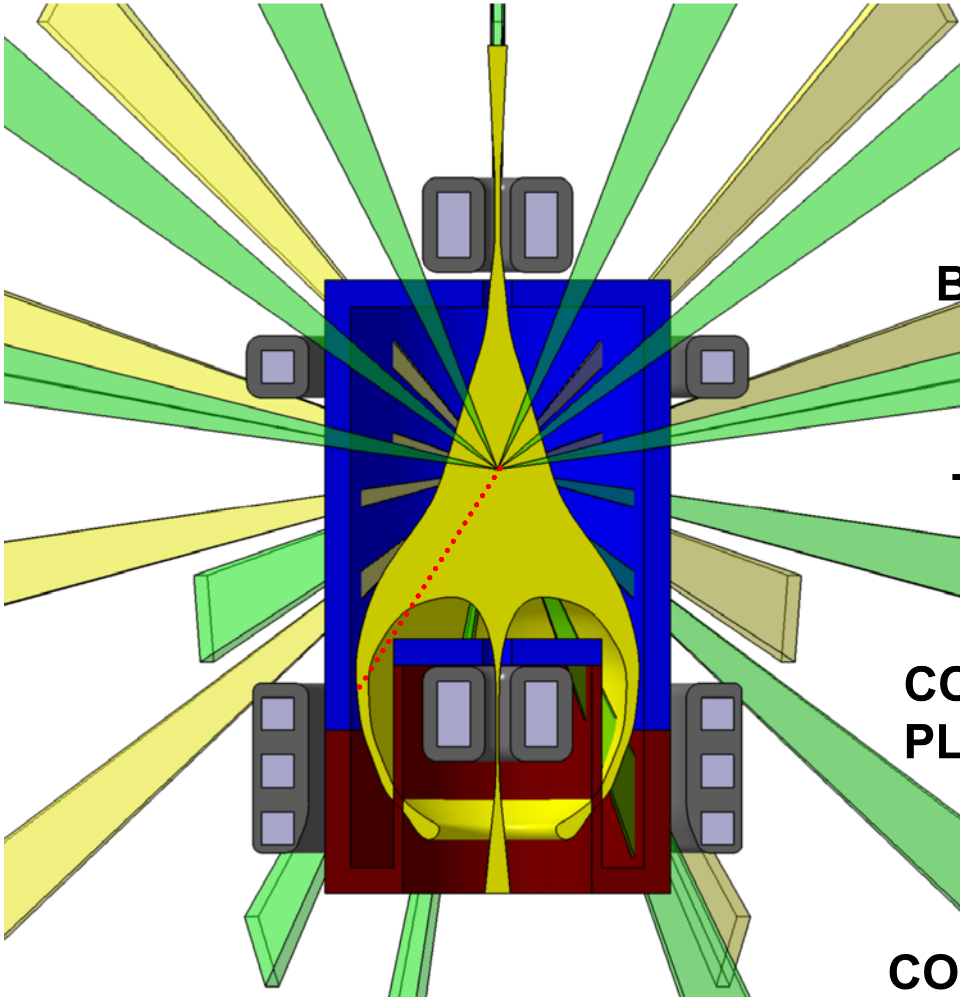


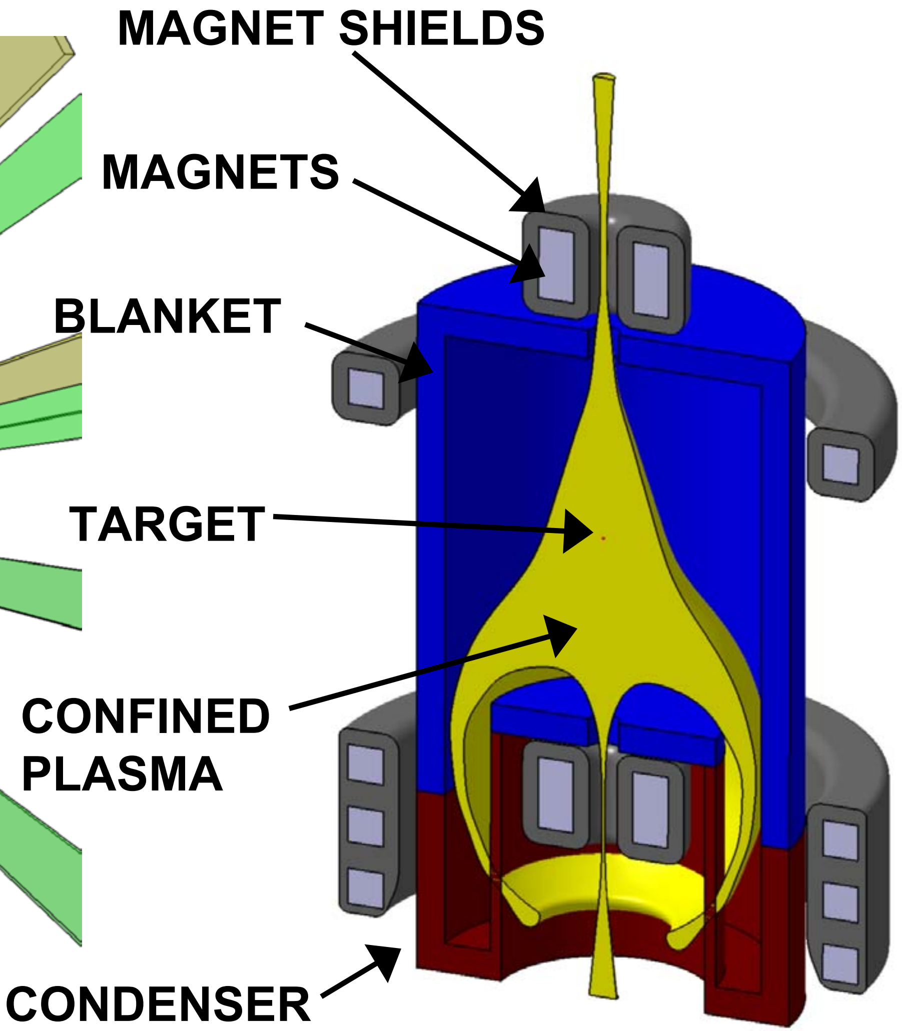
Tulip Configuration #1



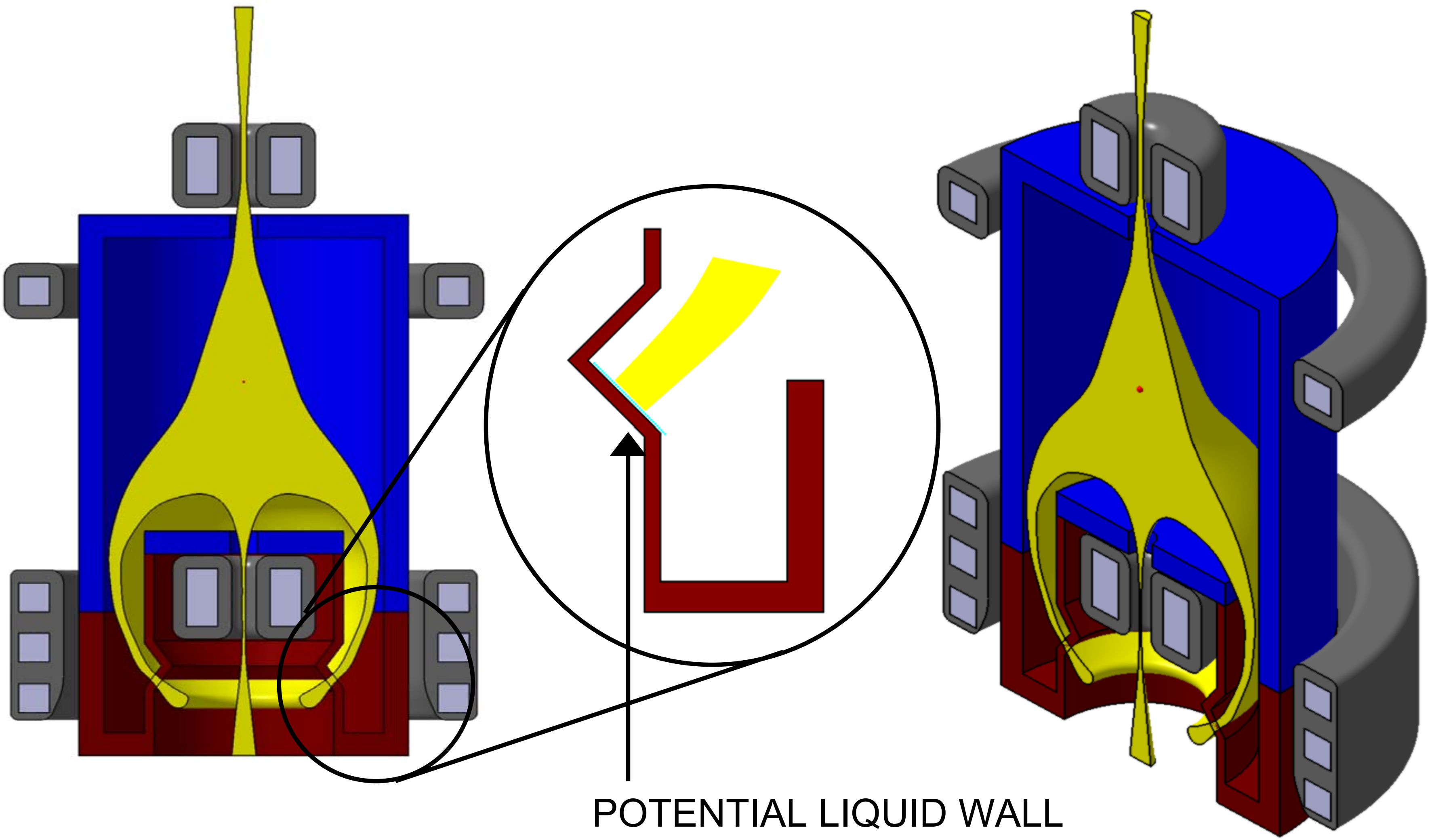


Tulip Configuration #2 - Preferred





Tulip Alternate Condenser



Conclusions…

- **Design is still evolving.**
- **Keys to the design include:**
  - **Compactness.**
  - **Eliminating line-of-sight losses to prevent chamber contamination.**
  - **Simplicity.**
  - **Feasibility.**
- **Once a magnet system has been chosen, then reactor and blanket design can continue in more detail.**

Questions ??

Why Magnetic Intervention?

- **Charged particles from an Inertial Fusion Energy (IFE) implosion represent the biggest threat to the survival of the first wall.**
- **These particles cause undesirable heating in the armor layer of the first wall. Magnetic intervention can prevent/limit the heating by diverting the ions to "dumps" and thus eliminating the need for 40 separate ion deflectors.**[1]
- **Ions give up greater than 50% of their energy in the resistive wall.**[2]
- **Partial confinement in the cusp field means that the heat pulse duration at the dumps is extended by a factor of ~10.**[2]
- **Therefore a more compact reactor could be designed with emphasis on materials for the dumps.**[2]

[1] A.E.Robson, "*Improvements to Magnetic Intervention*." 17th High Average Power Laser Program Workshop, October 30-31, 2007.
[2] A.E.Robson, "*Principles of Magnetic Intervention*." Magnetic Intervention Chamber Core Meeting, January 30-31, 2007.

Original MI Scheme Problems[1]

- The chamber is large and is awkward in shape.
- Since the lower half cannot be used as support for the upper half, there are structural issues that increase costing through structural requirements.
- Polar dumps receive too much radiation due to excessive power density.
- Armored surfaces will not suffice for the polar dumps.
- If a better technology can be developed, then an M.I. system can be designed that is composed of only point cusps.

[1] A.E.Robson, "*Improvements to Magnetic Intervention*." 17th High Average Power Laser Program Workshop, October 30-31, 2007.

“Octacusp” Problems

- **The 3-D geometry is more complicated than the Original MI Scheme.**[1]
- **Field line control may involve additional coils, whose placement may be constrained by the lasers.**[1]
- **Ion fluxes require fluid protection in the dump regions.**[2]
- **Gravity works against the liquid wall concept in the upper dumps.**[2]
- **Chamber contamination is an issue when designing the liquid wall dumps.**[2]

[1] A.E.Robson, “*Improvements to Magnetic Intervention*.” 17th High Average Power Laser Program Workshop, October 30-31, 2007.
[2] A.R.Raffray, “*Magnetic Intervention Dump Concepts*.” 18th High Average Power Laser Program Workshop, April 8-9, 2008.