# SC Magnet Shielding

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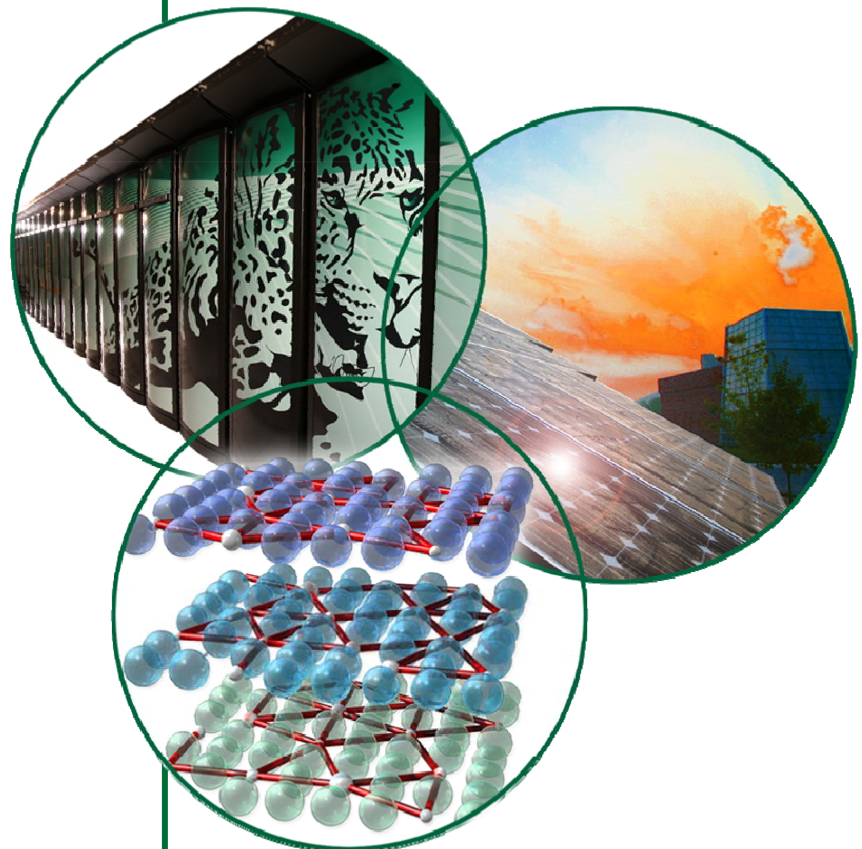
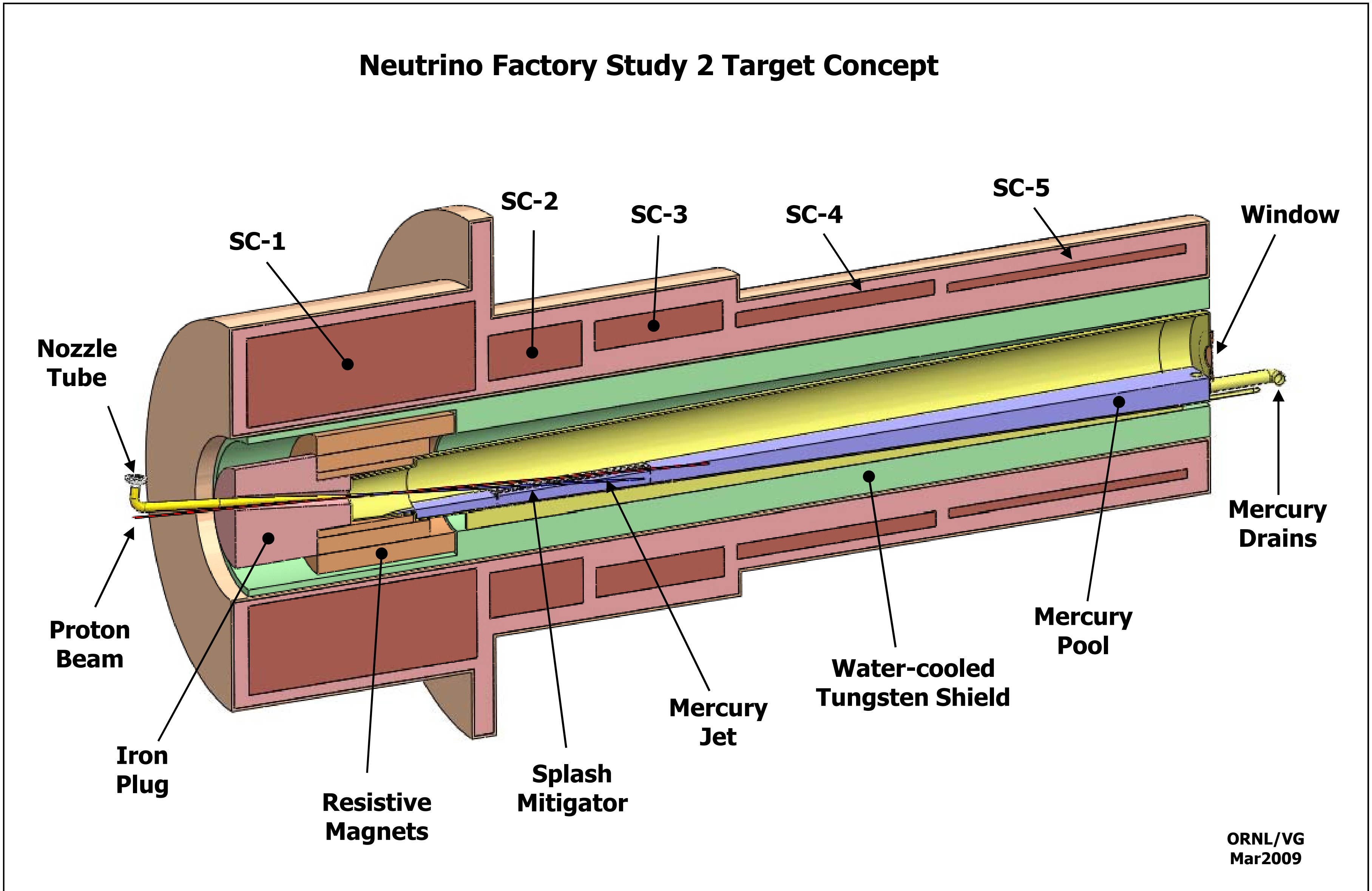


# General Target Concept



# Study 2 Energy Deposition (Table 3.5)

- SC shielding absorbs ~60% of beam power (589kW for 1MW beam)
- Value confirmed by more recent studies

Table 3.5: Energy deposition by cell in the target system. (x) stands for $\times 10^x$.

| Cell Number | Description | Energy Deposition (Mev/gm-$p$) | (W/cm$^3$) | (kW) |
|---|---|---|---|---|
| 8 | Surrounding shield | 3.11(-4) | 0.16 | 589 |
| 12 | Primary mercury target | 2.62 | 1.48(3) | 53.1 |
| 2 | Coaxial shield around target | 1.55(-3) | 0.82 | 40.4 |
| 3 | Iron plug behind target | 1.21(-3) | 0.39 | 0.99 |
| 81 | First coaxial magnet | 2.61(-4) | 0.08 | 3.54 |
| 82 | Second coaxial magnet | 1.04(-4) | 0.03 | 4.43 |
| 83 | Third coaxial magnet | 2.38(-5) | 0.01 | 1.70 |
| 91 | Mercury beam stop | 6.04(-4) | 0.34 | 1.07 |
| 92 | Mercury beam stop | 8.64(-4) | 0.49 | 2.55 |
| 93 | Mercury beam stop | 1.13(-3) | 0.64 | 4.01 |
| 94 | Mercury beam stop | 4.80(-4) | 0.27 | 1.20 |
| 95 | Mercury beam stop | 4.42(-4) | 0.25 | 1.57 |
| 96 | Mercury beam stop | 4.89(-4) | 0.28 | 1.74 |
| 97 | Mercury beam stop | 5.34(-4) | 0.30 | 1.89 |
| 98 | Mercury beam stop | 6.87(-4) | 0.39 | 2.44 |
| 99 | Mercury beam stop | 6.61(-4) | 0.37 | 2.35 |
| 100 | Mercury beam stop | 4.86(-4) | 0.27 | 1.73 |
| 101 | Mercury beam stop | 3.65(-4) | 0.21 | 0.93 |

# Shielding Geometry

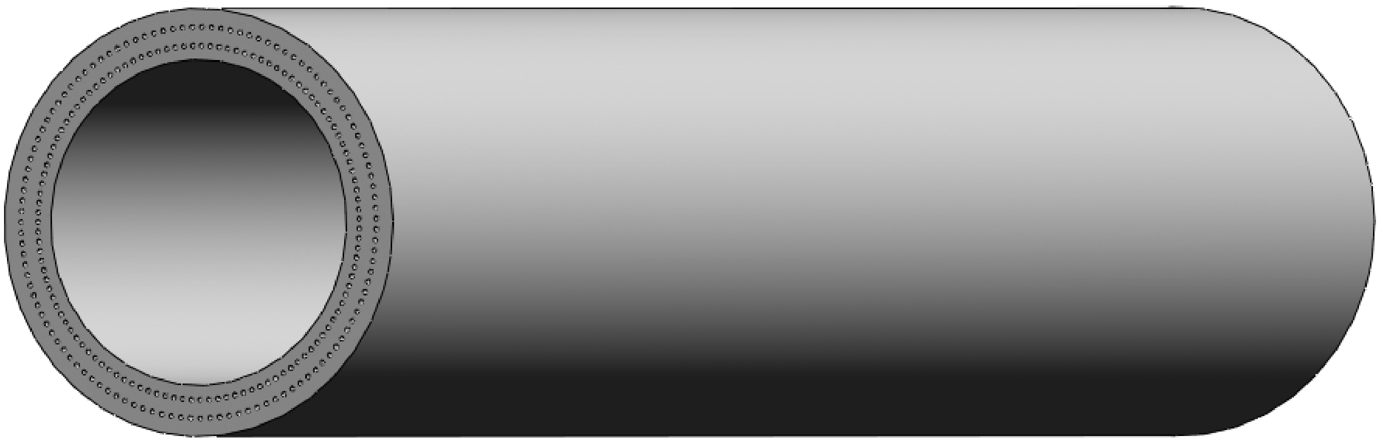
- Baseline concept is water-cooled Tungsten spheres
  - Unknown heat transfer coefficient
  - Unknown packing factor
- Geometry
  - ID = 70cm, OD=114cm, thickness=22cm
  - Length =5m
  - Less thickness available at up-beam end due to resistive magnets
- Can this geometry remove 600kW heat energy?
  - 2.3MW for 4MW beam???

# First Approximation Heat Transfer

- Assume solid tungsten cylinder with internal water tubes, single pass water flow
- $Q=\dot{m}*c_p*(To-Ti)$
  - Q=600kW
  - $c_p$=4186J/kg*K


Using water as the coolant and assuming 600kW of heat generated, the required flow rate is 1.4 $m^3$/s.

# Flow Distribution



- The large flow rate can be distributed into 1 cm tubes.
- 152 tubes are required to achieve the necessary flow rate.
  - q = 570 liters/min (150gpm) per tube
  - v = 120 m/sec, not feasible
- 11cm of Tungsten allows enough room for the cooling tubes, while 82% of the cross-sectional area is Tungsten.
  - Reduces effective shielding density

# Issues/Next Steps

- Further analysis needed for this case
- More sophisticated analysis needed for spheres

- Look at mercury as a shield/coolant
- Recalculate for 4-MW beam