Target Support Facility for a Hg Target Neutrino Production Facility

"Target Support Facility for Feasibility Study II of a Neutrino Source Based on a Mercury Jet Target"

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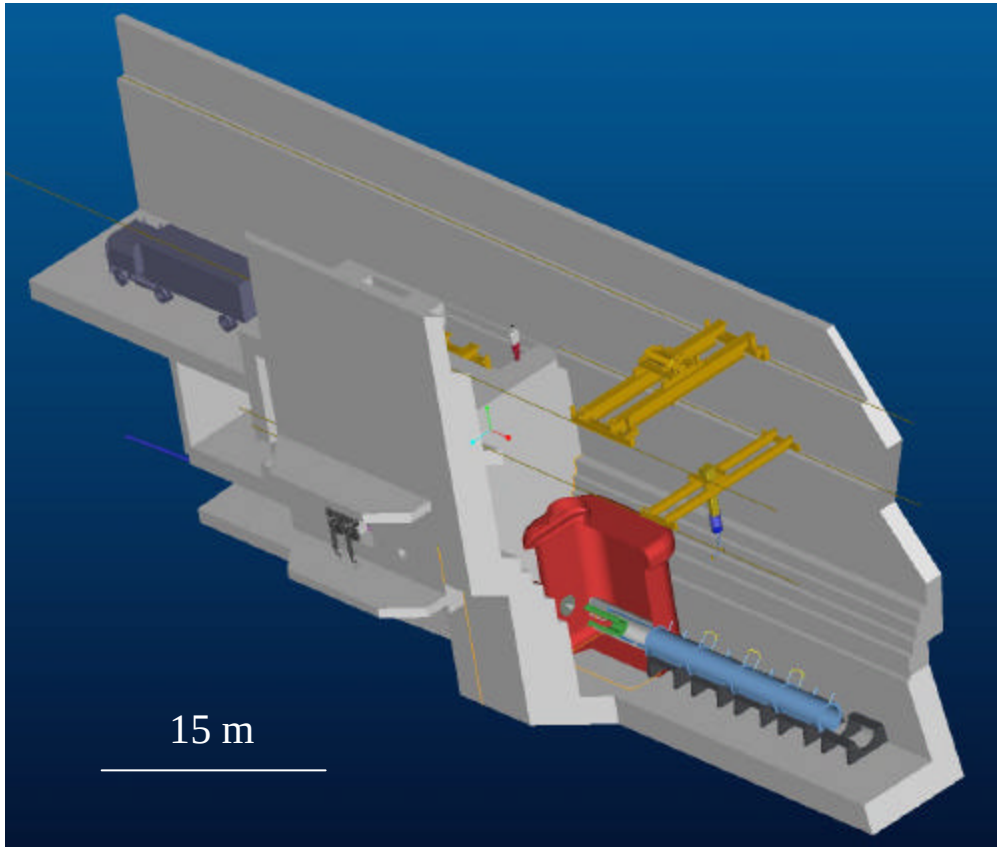
Operated by UT-Battelle

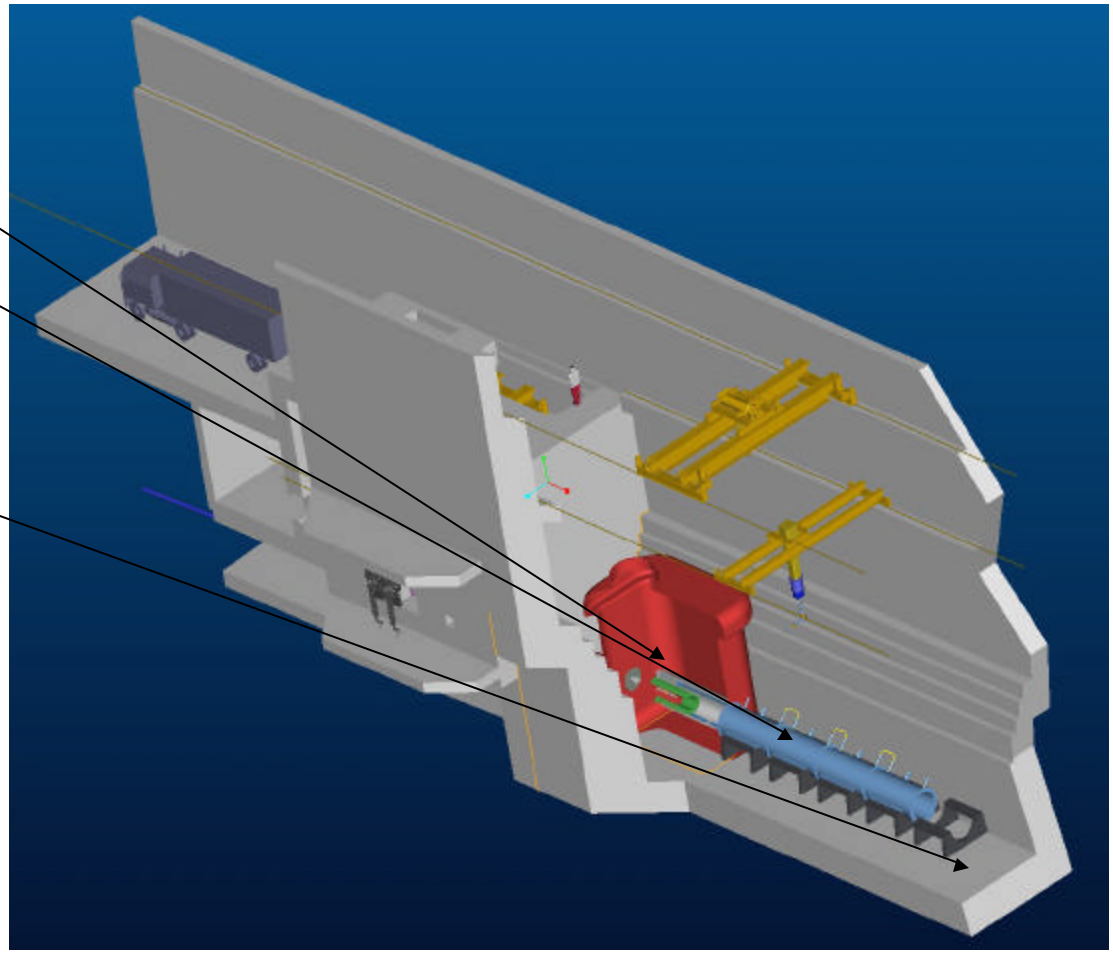
Outline

- Overall facility Feasib. Study I
- Design requirements & assumptions
- Decay channel
- Shielding
- Radiation handling
  (aka remote maintenance)



Features of the Target Support Facility for Study I

- Graphite target, He vessel
- Hybrid solenoid system – *high field & low field*
- Decay channel
- Nuclear shielding
- Radiation handling



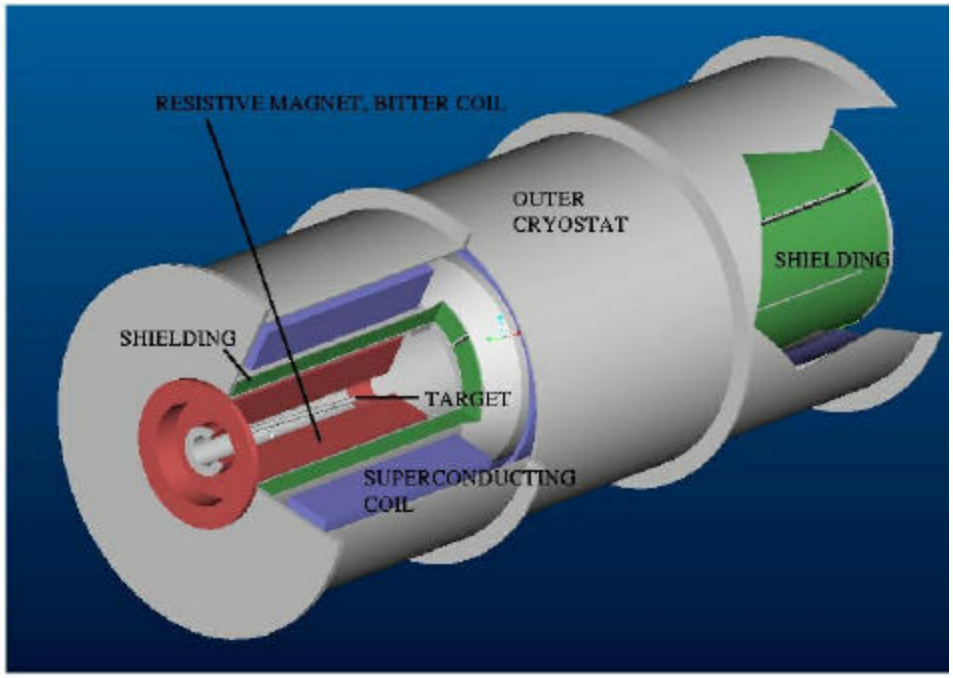
Design Requirements/Assumptions

- 16 GeV (24 Gev), 4 MW (1 MW) beam on target
- Operating availability 2 x 10^7 sec/yr *(~8 mos, therefore, life-limited components are modular)*
- Dose for personnel access in crane hall <0.25 mr/h

Component	Expected Lifetime	Replacement Time
Target	3 mos	6 days
Target + Bitter Coil	6 mos	7 days
Target +Bitter Coil + PBW	1 yr	8 days
PB Instrumentation	1 yr	5-7 days
Beam Dump	5 yrs	1.5 mos
High Field S/C Coils	>20 yrs	9-12 mos
Low Field S/C Coils	>20 yrs	9-12 mos

The Target Region is in a He Containment Vessel that Minimizes Air Activation

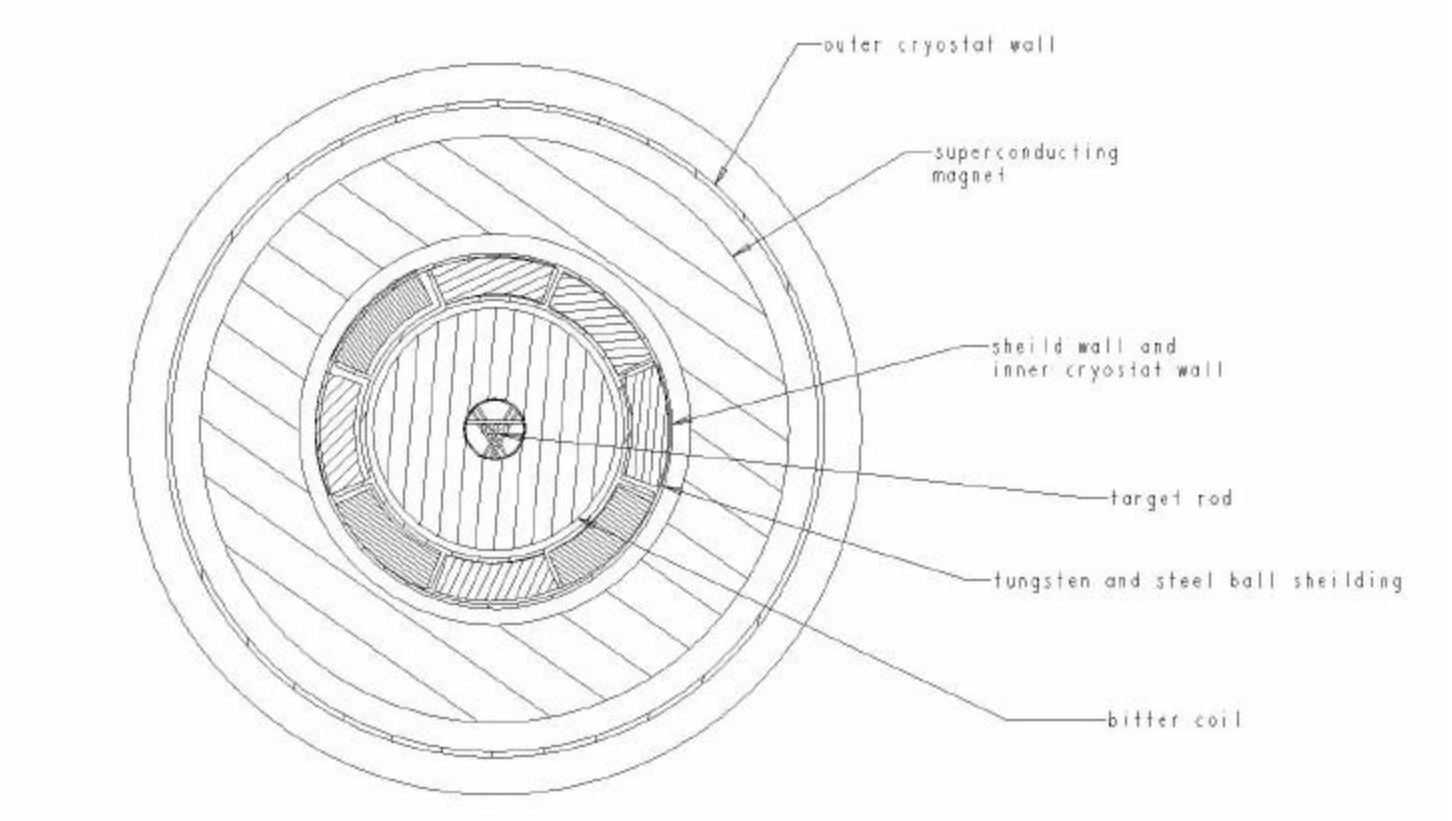
- Target: 1.5 cm diam x 80 cm length *(per Mokhov)*
- High field solenoid: 8T Bitter, 12T Nb_3Sn
- Low field: 1.25T NbTi
  - coils are arranged in 4 m common cryostats to self-react magnetic forces
- Magnet shield: WC, H_2O, steel
- Bulk shield: 4.5 m steel & 2 m steel in decay channel



MODULAR ARRANGEMENT OF COMPONENTS IN THE TARGET REGION

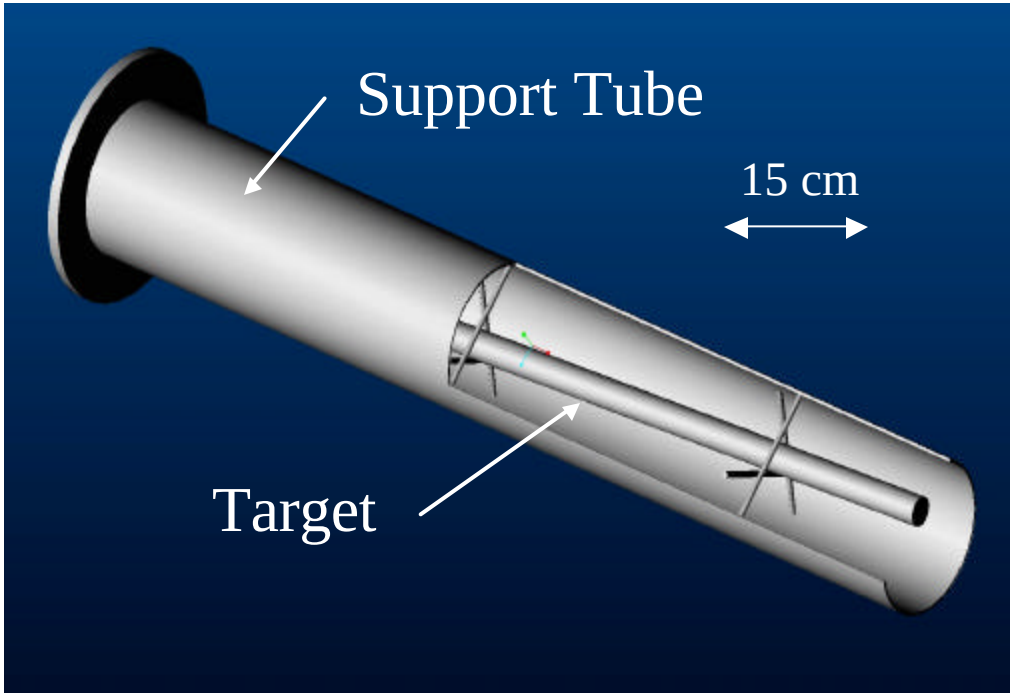
Target Region (cont.)

- A section through the target shows the arrangement of modules within modules



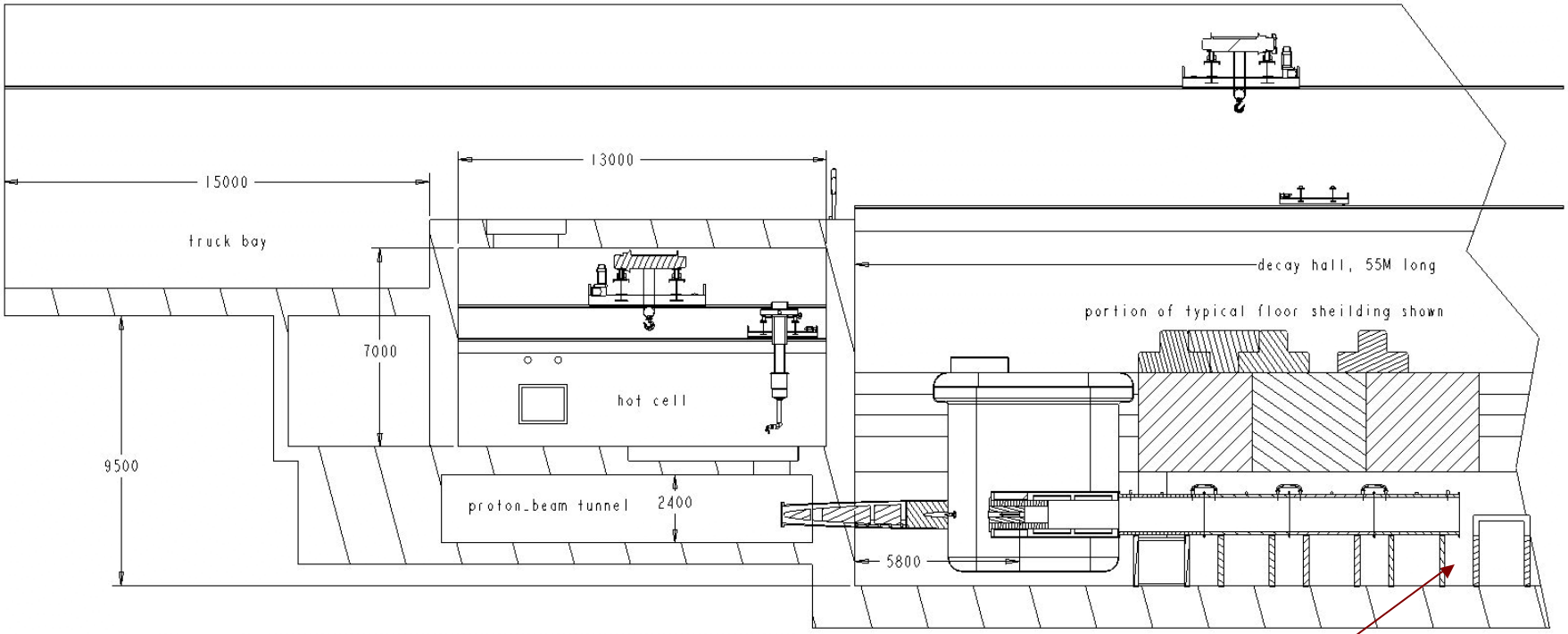
The Graphite Target/Support Tube is Designed for Simple, Modular Replacement

- It is coaxial with the proton beam, but 50 milli-radians to the magnetic axis of the decay channel (*Mokhov*)
- Supported on graphite spokes
- Radiates to a water-cooled stainless steel support tube (15 cm diam.)



Decay Channel

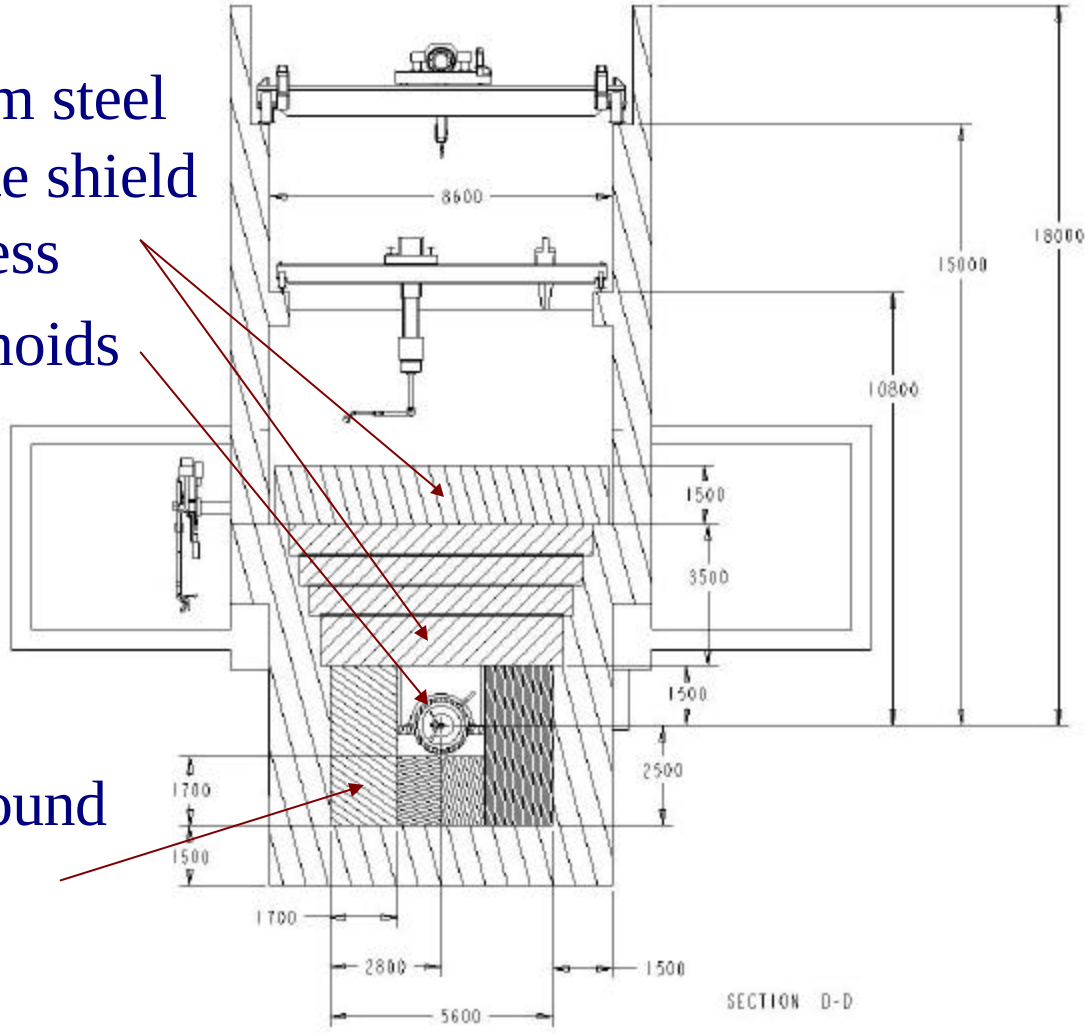
- 50 m long, located under crane hall; contains twelve 4 m LF cryostats
- LF coils have 30 cm SS/water shield; beam dump at 5.5<Z<6.5 m
- 60 cm diam Ti window separates He from vacuum



Decay Channel

Decay Channel (cont.)

- Covered by ~4.5 m steel and 0.5 m concrete shield for personnel access
- Contains LF solenoids
- 1.7 m steel for ground water protection



Shielding

- Neutron/gamma/proton flux profiles in the target area and decay channel (0<Z<16m) were generated to estimate dose rate and evaluate shield dimensions
- Criteria: 0.25 mr/h in the crane hall with beam on; beam power = 4 MW
- MCNPX cylindrical model

Dose Levels In Target Area	Dose>1GeV	Dose<1GeV	Total Dose
	7.4515E+11 (mrem/h)	9.7505E+11 (mrem/h)	1.7202E+12 (mrem/h)
Tunnel Segment			
0.2 to 0.70	1.0005E+11	1.7095E+11	2.7099E+11
0.7 to 1.70	9.6226E+10	1.3606E+11	2.3228E+11
1.7 to 2.70	8.3777E+10	1.9958E+11	2.8335E+11
2.7 to 3.70	6.2515E+10	2.4726E+11	3.0977E+11
3.7 to 4.70	4.4562E+10	2.2039E+11	2.6495E+11
4.7 to 5.70	3.3549E+10	3.1250E+11	3.4605E+11
5.7 to 6.70	2.8647E+10	3.6626E+11	3.9491E+11
6.7 to 7.70	2.3574E+10	1.3264E+11	1.5621E+11
7.7 to 8.70	1.9190E+10	7.6736E+10	9.5926E+10
8.7 to 9.70	1.5758E+10	5.3156E+10	6.8914E+10
9.7 to 10.70	1.3255E+10	3.8942E+10	5.2196E+10
10.7 to 11.70	1.1229E+10	2.9572E+10	4.0801E+10
11.7 to 12.70	9.7006E+09	2.2883E+10	3.2584E+10
12.7 to 13.70	8.4020E+09	1.8354E+10	2.6756E+10
13.7 to 16.00	1.1923E+10	2.2099E+10	3.4022E+10

Shielding (cont.)

Criteria	Distance Downstream From Target (m)					
	3 to 5	5 to 7	7 to 9	9 to 11	11 to 13	13 to 15
	Steel Thickness (ft) / Concrete Thickness (ft)					
Minimum Total Thickness	14.8/1.0	14.8/1.4	14.2/0.9	13.9/1.0	13.1/1.6	14.1/1.0
Minimum Steel Thickness	14.2/2.0	14.8/1.4	12.8/3.4	11.8/4.4	11.5/4.7	12.1/4.1

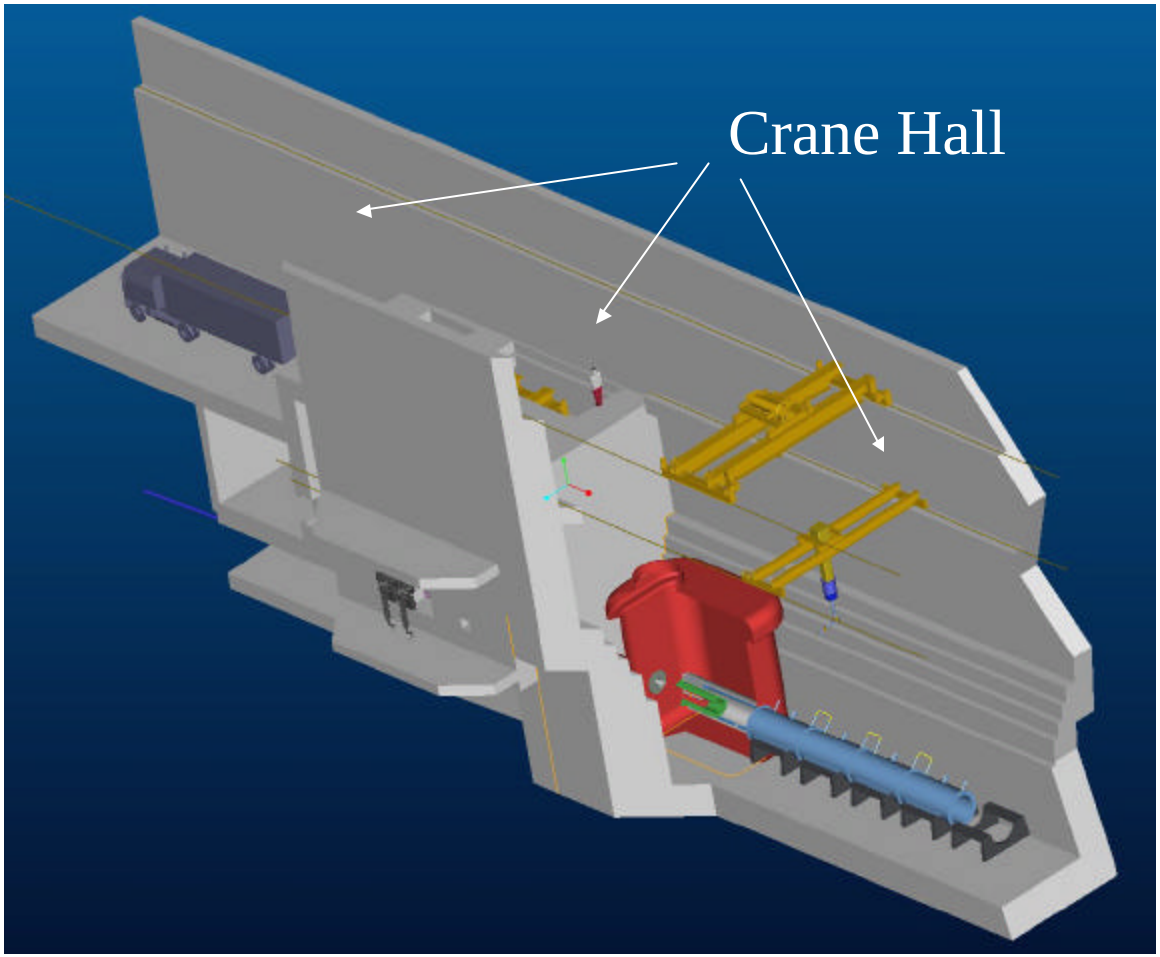
Shield (cont.)

- A high neutron/gamma flux will be present along the length of the decay channel (and beyond !)

	Total Neutron Flux		Total Gamma Flux	
Segment	**all protons**	**terminated p.**	**all protons**	**terminated p.**
(cm to cm)	(n/cm**2/s)	(n/cm**2/s)	(g/cm**2/s)	(g/cm**2/s)
target	9.6911e+12	9.6495e+12	2.9729e+13	2.9731e+13
20 to 70	1.8919e+12	1.8818e+12	4.7647e+12	4.7907e+12
70 to 170	1.5281e+12	1.5206e+12	3.1056e+12	3.1449e+12
170 to 270	2.0809e+12	2.0988e+12	3.3005e+12	3.3192e+12
270 to 370	2.5212e+12	2.4968e+12	3.7693e+12	3.7820e+12
370 to 470	2.2949e+12	2.0483e+12	3.4240e+12	3.3310e+12
470 to 570	3.1645e+12	1.1266e+12	3.7925e+12	2.4159e+12
570 to 670	3.6004e+12	5.4587e+11	4.5052e+12	1.5945e+12
670 to 770	1.4011e+12	4.7507e+11	2.3729e+12	1.2952e+12
770 to 870	7.9235e+11	4.7067e+11	1.5967e+12	1.1328e+12
870 to 970	5.3975e+11	3.8577e+11	1.1962e+12	9.2990e+11
970 to 1070	3.9134e+11	2.9575e+11	9.3197e+11	7.5742e+11
1070 to 1170	2.9506e+11	2.3312e+11	7.4797e+11	6.3161e+11
1170 to 1270	2.2796e+11	1.8900e+11	6.1290e+11	5.3764e+11
1270 to 1370	1.8210e+11	1.5578e+11	5.1870e+11	4.4537e+11
1370 to 1600	1.2125e+11	1.0064e+11	3.8147e+11	3.3290e+11

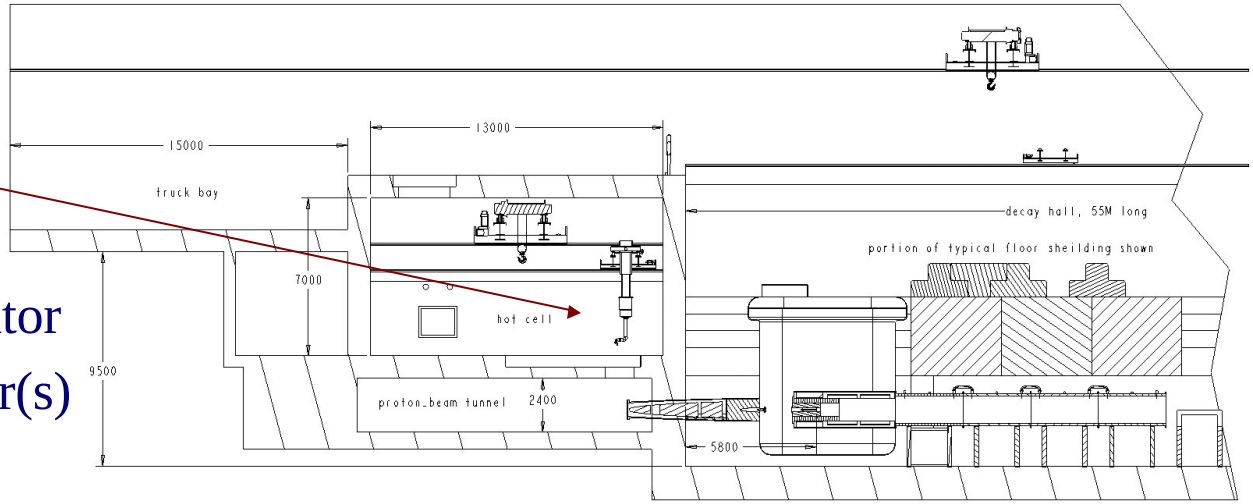
Crane Hall and Remote Handling

- Crane Hall
  - 12 m above floor level
  - 80 m length
  - 40 ton crane
  - bridge mounted manipulator
  - removable shield slabs (not shown)



Crane Hall and Remote Handling (cont.)

- Hot Cell
  - 20 ton crane
  - bridge manipulator
  - wall manipulator(s)
  - CCTV, …



Component	Weight (lbs)	Size (m)
HF Cryostat	72,500	1.5 dia x 4.2
HF S/C Coil	18,000	1.5 dia x 1.2
Tungsten Shield Module	44,000	1.0 dia x 4.0
LF Cryostat/Steel Shield	44,000	1.3 dia x 4.0
Steel Shield Slabs	72,000	0.4 x 1.0 x 3.0
Vert. Steel Shield Blocks	28,000	0.6 x 1.2 x 2.0

Table of Component Sizes and Weights

Summary and Conclusions

- The Target Support Facility for Study II will be an integrated system design of the target region and decay channel that also incorporates remote maintenance issues and a hot cell facility
- Design of the mercury target system must address containment, recovery (Hg recycling), and remote handling; these will be integrated into the Target Support Facility
- The solenoid magnet lifetime requirements and remote handling/replacement will be incorporated into the Target Support Facility design
- Near term and long term R&D issues will be identified
- A cost estimate will be developed
- The facility arrangement will incorporate work previously done for Study I and the Spallation Neutron Source