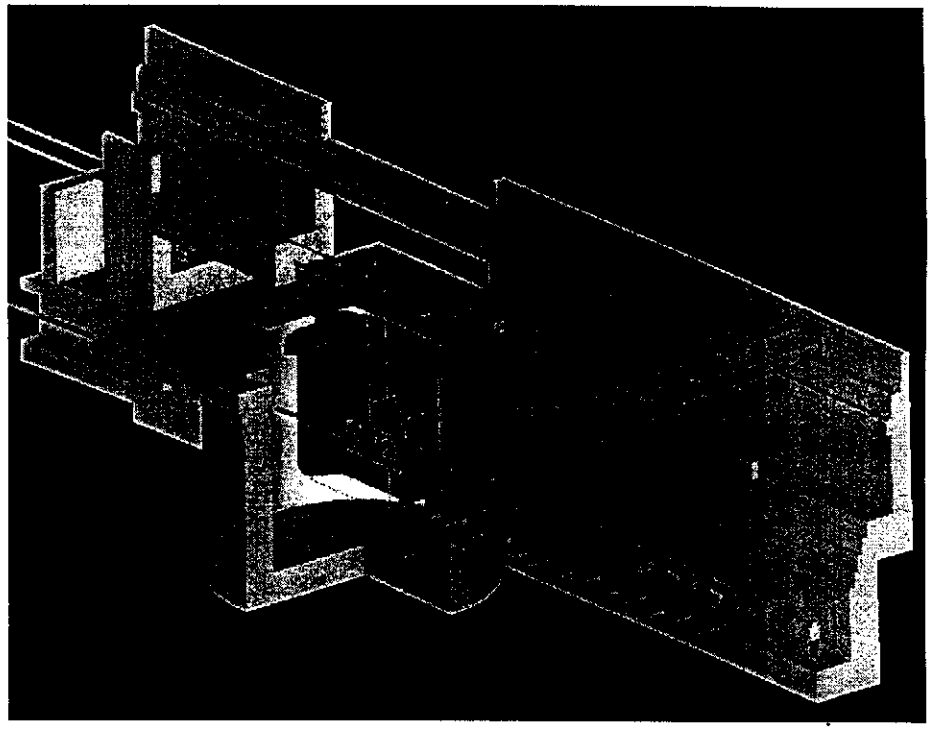
# Design Status of the Target Support Facility for the Muon Collider/Nu-Factory

Phil Spampinato & Joel Chesser
Oak Ridge National Laboratory
(865) 576-5267
<spampinatop@ornl.gov>

February 15-16, 2000
Fermi National Accelerator Laboratory

# Target Support Facility - Outline

- Design Requirements and Assumptions
- Overview of the Target Facility General Arrangement
- Remote Handling Considerations
- Design Interface Issues
- Facility Cost Drivers
- R&D
- Next Steps



# Facility Design Requirements

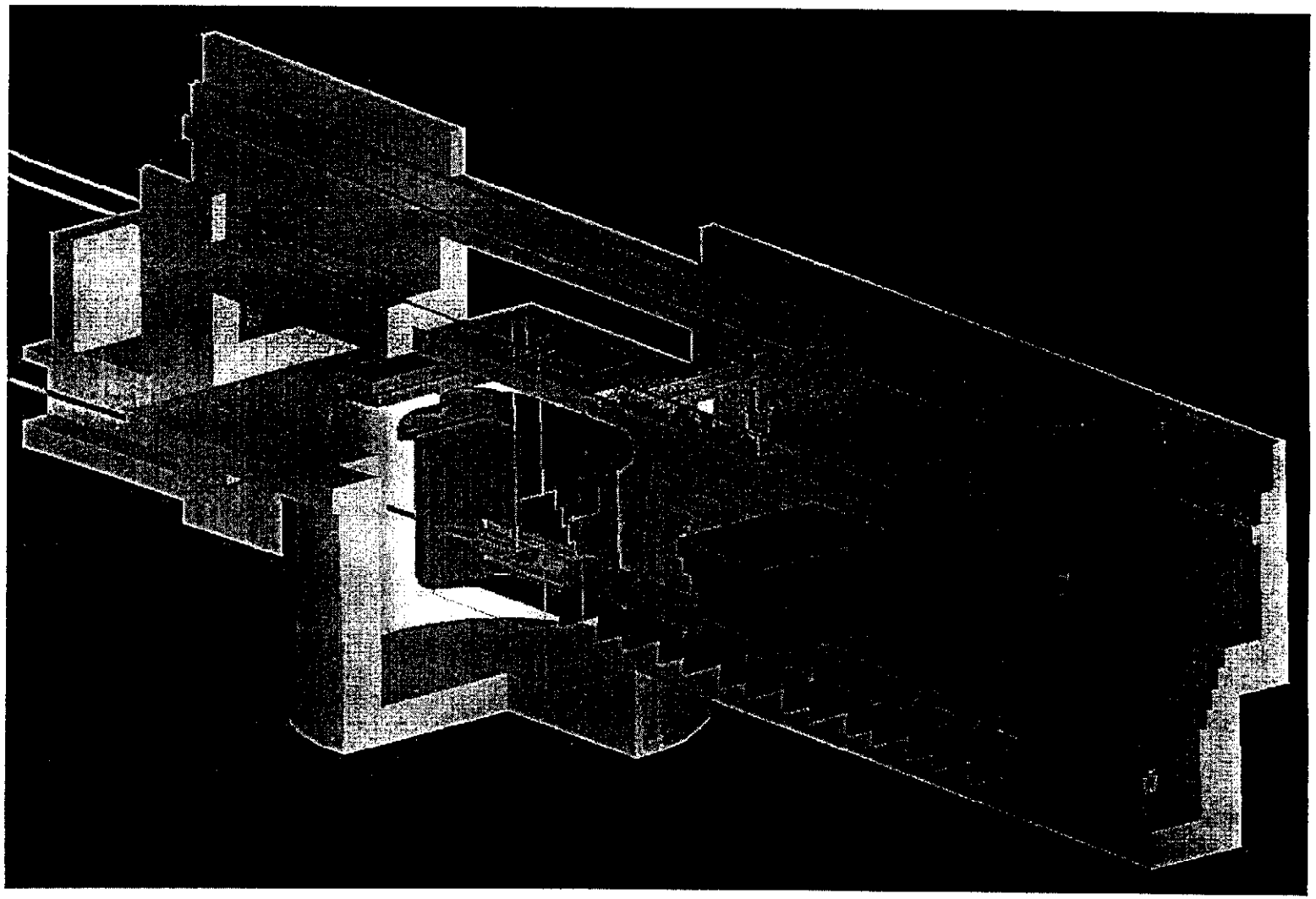
- Handle highly activated components that have varying lifetimes
- Operating availability of $2 \times 10^7$ s/y (230 days/y)
- Scheduled/unscheduled maintenance operations limited to $1.2 \times 10^7$ s/y (135 days/y)
- Minimize facility cost drivers
- Avoid air activation in target region
- Shielding designed for 0.25 mr/h; unlimited personnel access in crane hall
- *Extrapolate from similar SNS work*

# Design Assumptions

- Target life - 3 mos
- Bitter coil life - 3000 h
- Proton beam quad module & window - 1 y

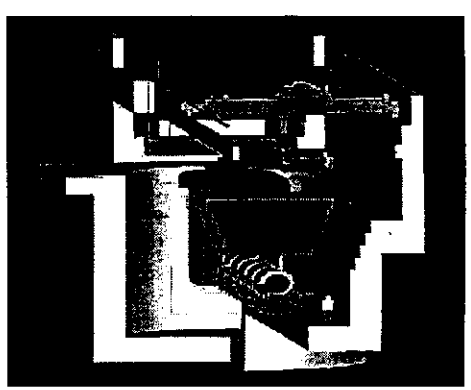
| Component | Design Life |
|---|---|
| Carbon Target | 3 mos |
| HF R/C Solenoid | 6 mos |
| Proton Beam Window | 1 y |
| PB Quad/Instrumentation | 1 y |
| Beam Absorber Shield | 5 y |
| HF S/C Solenoid | 20 y |
| Low Field Solenoids | 20 y |

# The Facility is a Linear Arrangement of the Crane Hall and Hot Cell Over the Beam Tunnel



# Preliminary Shield Analysis

| Criteria (0.25 mr/h) | Distance Downstream from Target (m) | | | | | |
|---|---|---|---|---|---|---|
| | 3 to 5 | 5 to 7 | 7 to 9 | 9 to 11 | 11 to 13 | 13 to 15 |
| | Steel Thk. (ft) / Concrete Thk. (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 |



# Weight and Size of Key Components Drive the Facility Design

- High field solenoids
  - Bitter coil - 6,500 lbs
  - tungsten shield - 15,000 lbs
  - $Nb^3Sn$ coil - 18,000 lbs
- LF solenoid (r=60cm) and tungsten shield (r=30cm)
  - 11,000 lbs/meter
- Target cryostat module
  - 72,500 lbs
  - 4.2 m long
- Other cryostat modules
  - 44,000 lbs
  - 4.0 m long
- Main crane is 40 T (coils 1-8 cryostat module)
  - Steel shield blocks
    - 24x48x80" (14 T)
    - 15x40x120" (36 T)
- Hot cell crane is 20 T

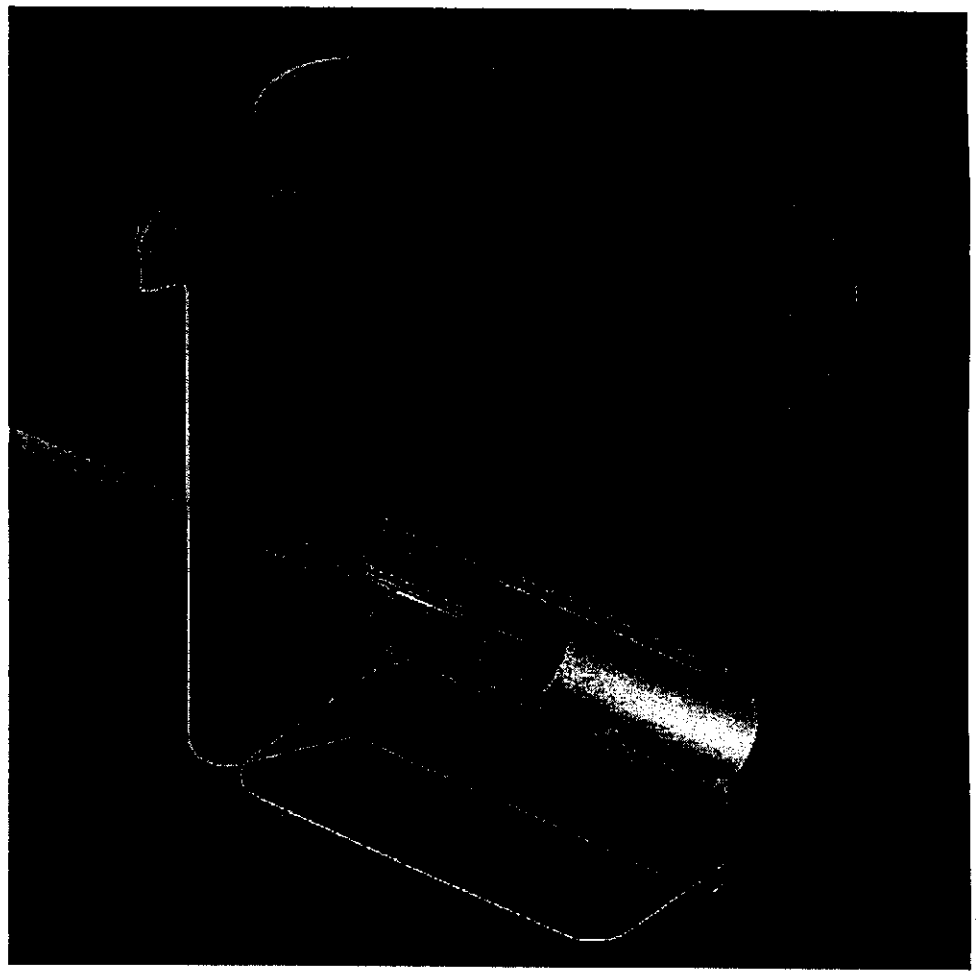
# Facility Configuration

## Design Features

- He containment vessel eliminates air activation

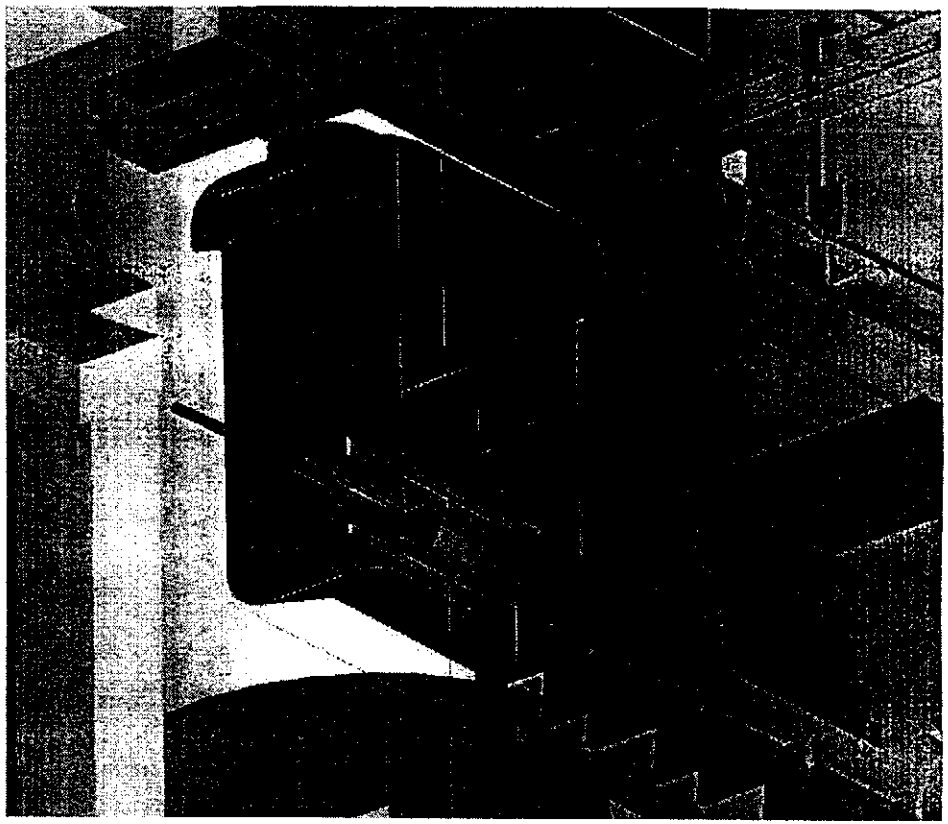
  <u>contains</u>

  - proton beam window w/ special connector
  - target & HF coil assy
  - first 3 LF solenoids
  - steel shield (water ??)
- Be window (He/vac.) downstream of absorber



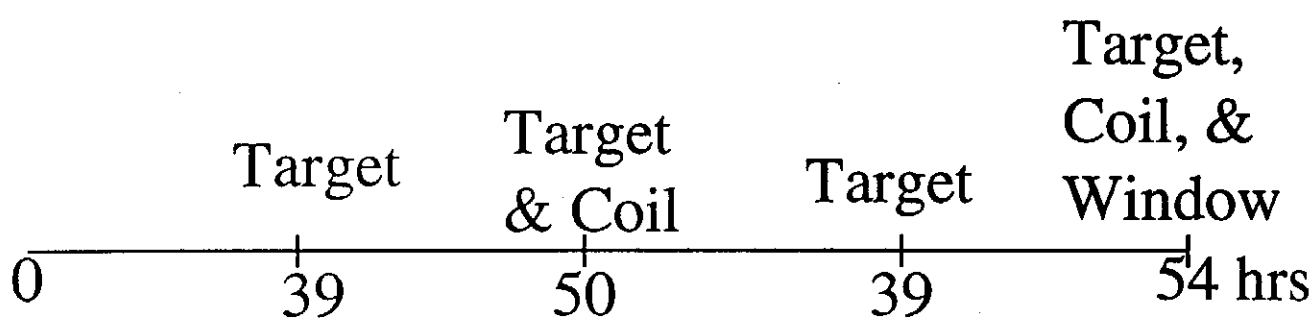
# Facility Configuration (cont.)

- LF solenoid cryostats (each w/ 4 coils) provide the vacuum boundary in the decay channel
- Removable shield slabs for crane & manipulator access to target region and all cryostats
- Target region cryostat - 72,500 lbs
- LF cryostats - 44,000 lbs
- Vertical steel shield - 28,000 lbs
- Horiz. steel shield - 72,000 lbs



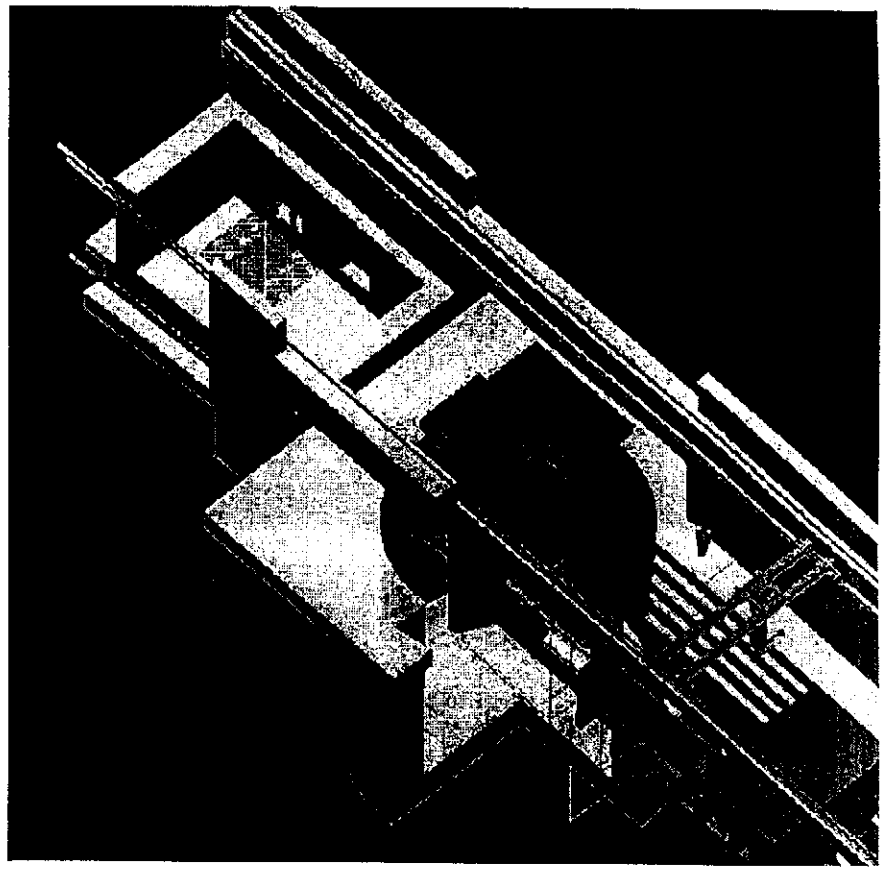
# Scheduled Replacement of Key Components

- A Mix of Hands On and Remote Operations
- Based on the assumed component lifetimes
- 182 estimated annual hours = 182/.75/8 = 30 days/y
- ~8 days/qtr for scheduled replacements
- 26 days/qtr for unsched. events & other sched. tasks



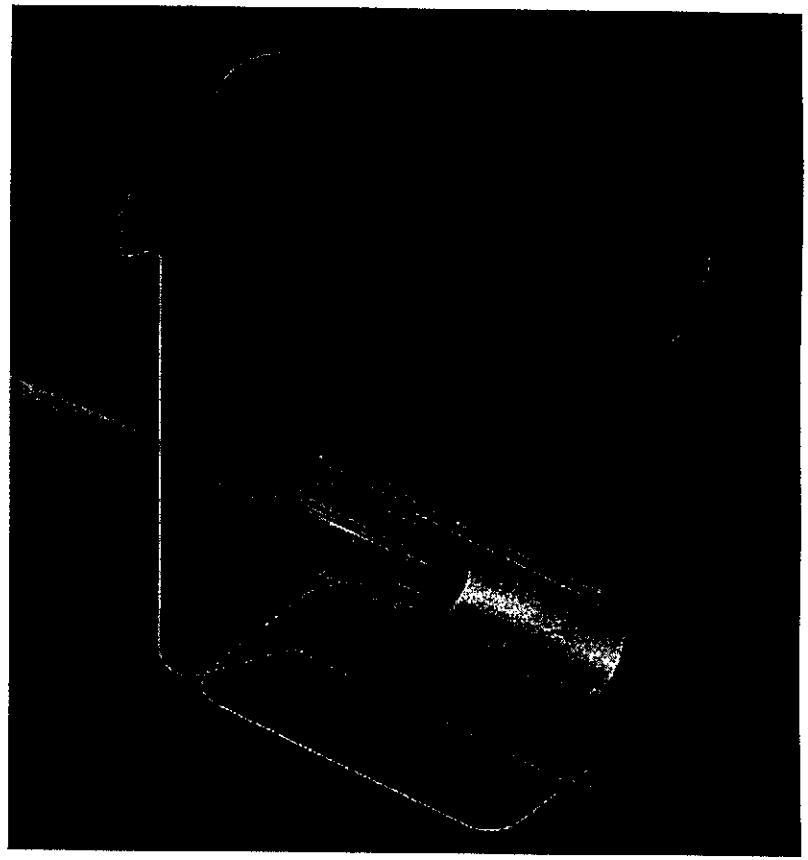
# The Hot Cell is Located Over the PB Tunnel

- Roof-plug access for target; floor-plug access for PB quad
- 20 ton crane (hf s/c+r/c+shield)
- Cryostat module (4.2m x 1.6m dia.)
- One dismantled hf coil module (3 pcs)
- Three used targets + 1 Bitter coil in shield casks
- Cryostat (absorber) module (4.0m x 1.4m dia.)
- 1 target/coil work station



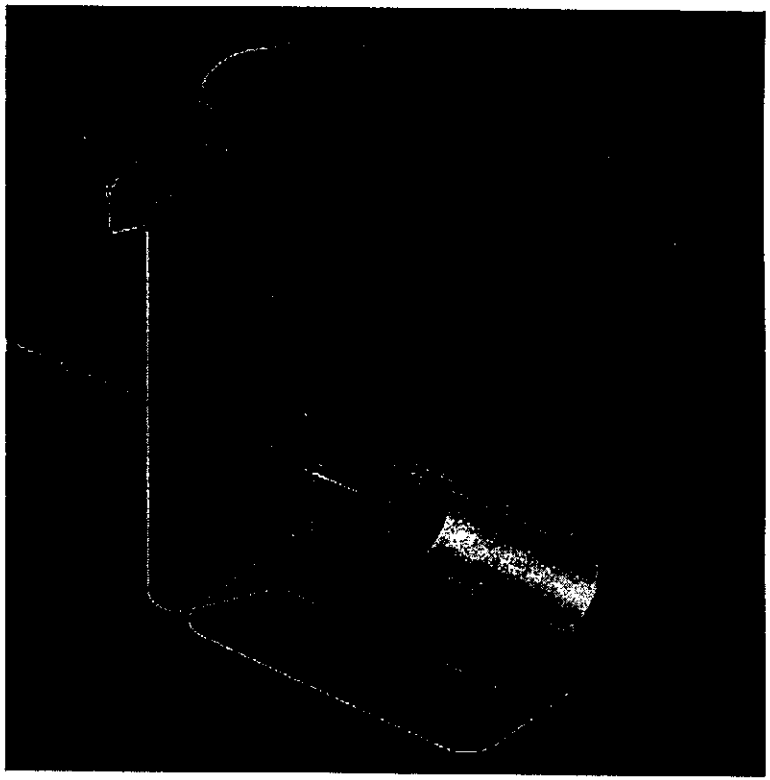
# Facility Design Issues & Cost Drivers

- Design Issues
  - target lifetime
  - steel shield in vessel; passive cooling??
  - cooling the W shield & absorber
  - PB quad./instrument module located in shield
  - Activation products in cooling water
- Cost Drivers
  - Shield Optimization
    - decay tunnel shield
    - W vs steel $: factor of 16



# R&D - Preliminary Thoughts

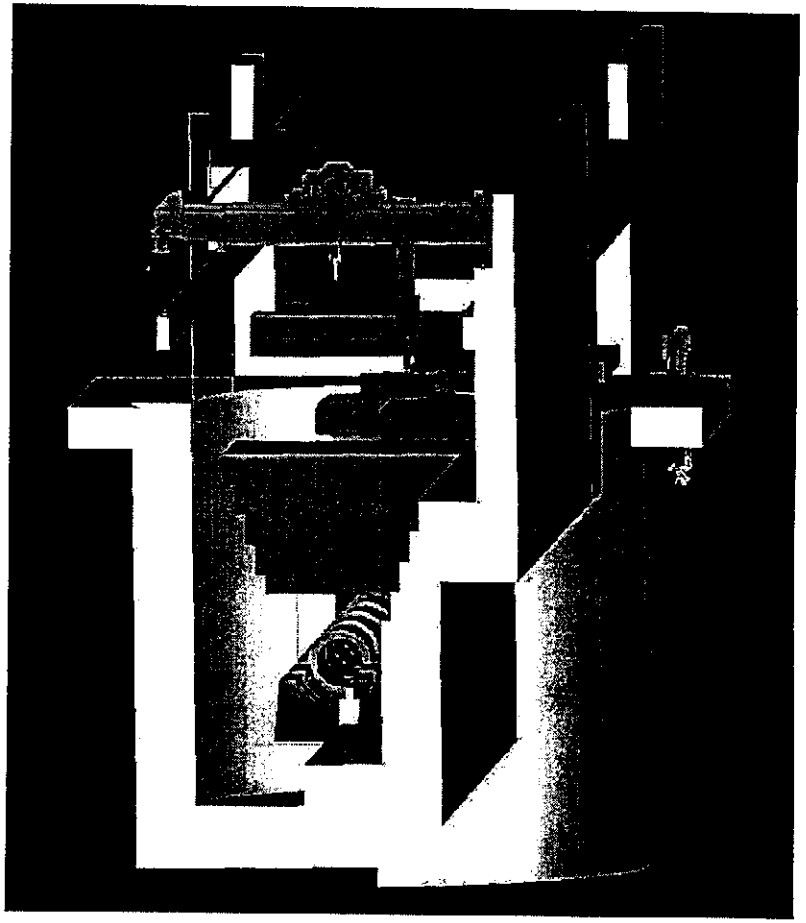
- C target life: thermal shock tests; rad resistance tests; evaporation
- Target support structure thermal tests
- Neutronic modeling/shield optimization
- Tungsten shield packing factor/coolant flow tests
- Target mock up remote handling tests
- PBW mock up remote handling tests



# Conclusions/Next Steps

## Conclusions

- Design of the target/radiation handling facility is underway
- Much of the facility design appears to be <u>independent</u> of the type of target
- Prelim. shield analysis done - more work is needed
- No insurmountable design issues have been uncovered



## Next Steps

- Optimize shield
- Resolve design issues
- Further develop costs
- Write report