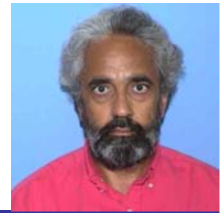
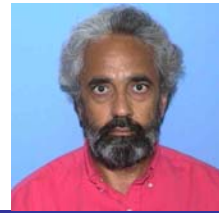
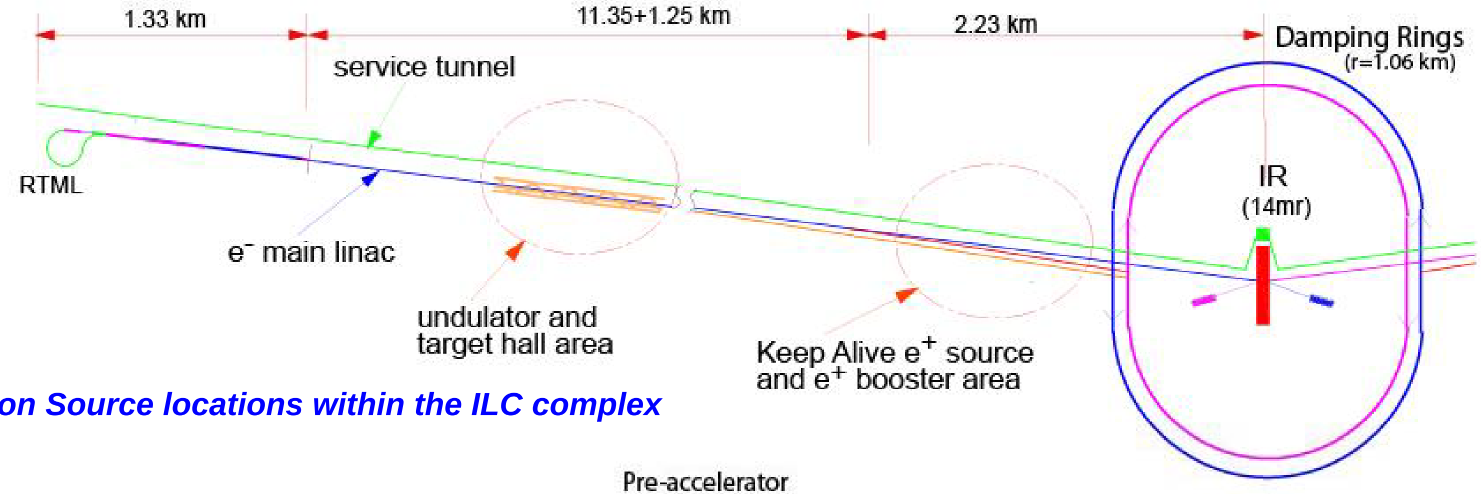
Remote Handling



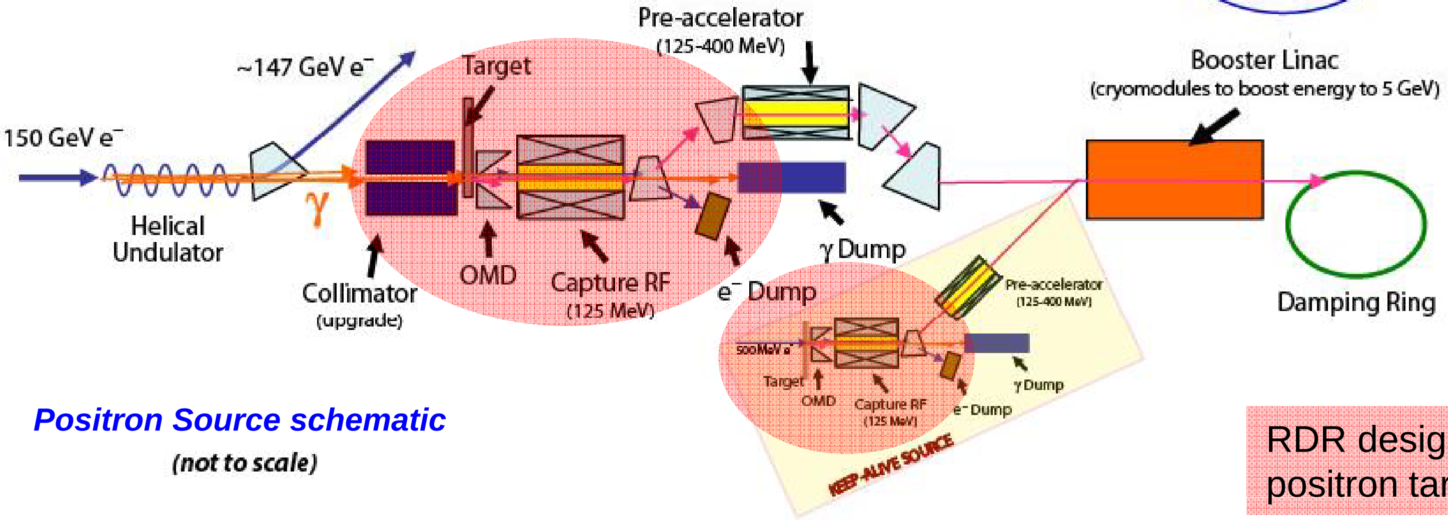
Vinod K. Bharadwaj
SLAC
October 9th, 2007

Positron Source Layout





Positron Source locations within the ILC complex

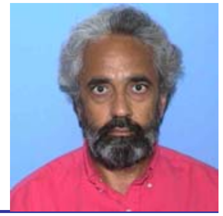


Positron Source schematic

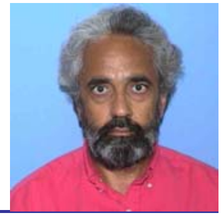
(not to scale)

RDR design has two
positron target halls

Target Hall / Remote Handling

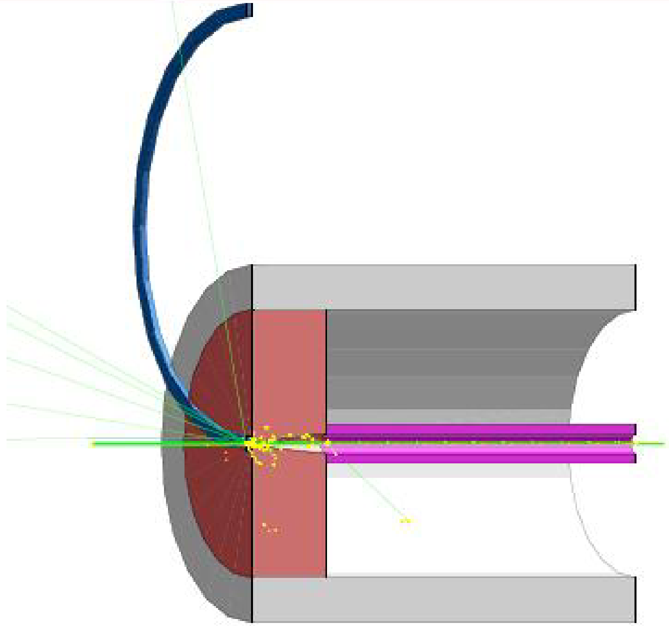


- Projected ILC running mode
  - 9 month run + 3 month shutdowns
- Target stations designed with 2 year lifetime
  - Replace target station every shutdown
  - If target fails then
    - EITHER a "hot" spare
    - OR fast replacement
- Radiation levels ~ 100 rem/hour immediately after beam shutoff
  - Remote handling needed
- Target hall deep underground
  - Vertical target extraction/replacement



Activation Calculations / DESY-Z

Positron Source Model



Helical Undulator

e^- drive beam energy, GeV	150
Undulator K-value	0.92
Undulator period, cm	1.15
Undulator-target distance, m	500

Target

Material	Ti6Al4V
Thickness	0.4 X_0

AMD

B_0 (z = 0)	6 T
B_0 (z = 20 cm)	0.5 T
∅ (z = 0)	1 ÷ 24 mm
∅ (z = 20 cm)	46 mm

SW Structure

Aperture	46 mm
Number of cells	11
Ave. gradient	14.5 MeV/m

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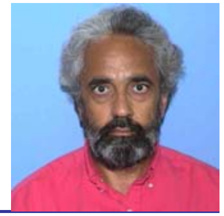
Source Activation

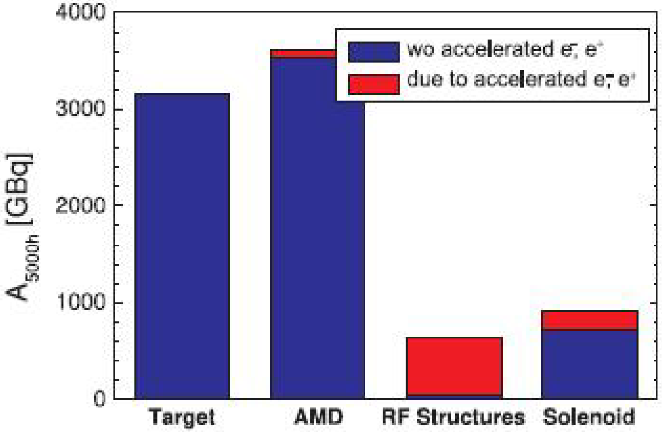


Source Activation

88 kW Photon Beam. K = 1. $\lambda = 1$ cm

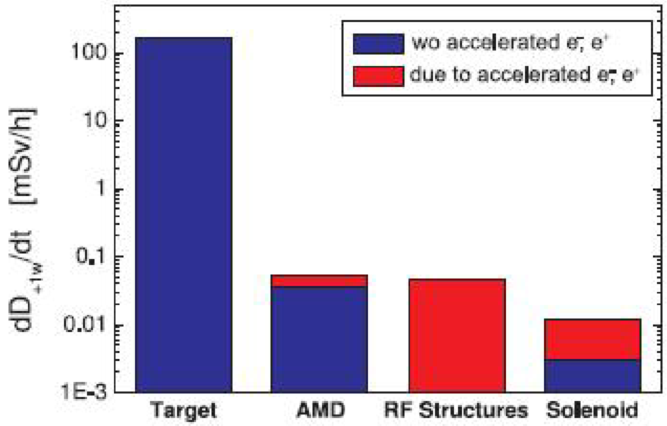
Activity of Source Parts

(after 5000 hours of source operation)



Equivalent Dose Rate

(after 5000 hours of source operation and 1 week of cooling time)



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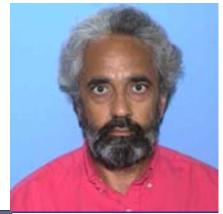
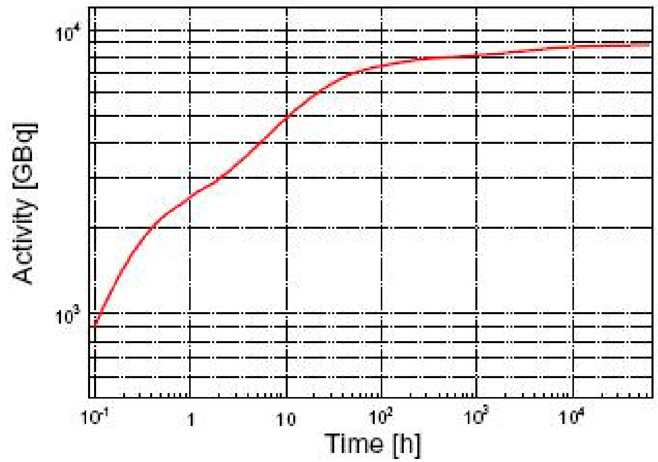
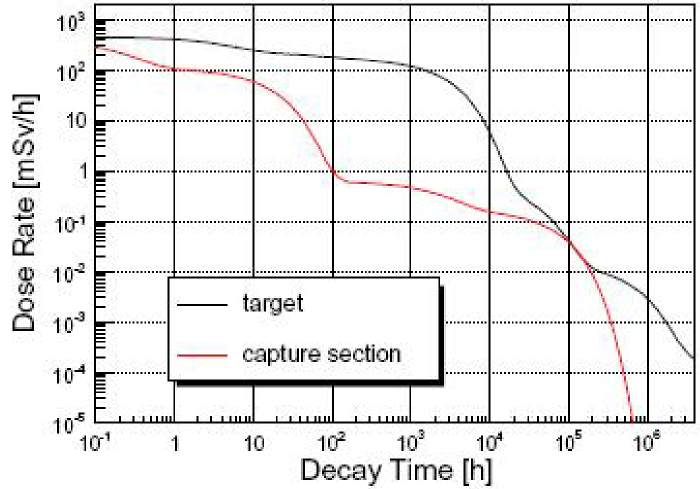
Time Evolution



Time Evolution of Activity and Equivalent Dose Rate at 1 m from the Source

88 kW Photon Beam. K = 1. $\lambda = 1$ cm





Nuclei	A	$T_{1/2}$, h	A_{5000h}, GBq	E_γ, keV (Intensity, %)
Sc	47	80.4	1416.4	159.4 (68.3)
Ti	45	3.1	961.2	719.6 (0.15)
Sc	46	2011.9	544.5	1120.5 (99.99)
Sc	44	3.9	198.3	1157.0 (99.9)

Nuclei	A	$T_{1/2}$, h	$\dot{D}_{+1w}$, mSv/h
Sc	46	2011.9	153.7
Sc	47	80.4	5.7
Sc	48	43.7	2.6
V	48	389.7	2.1

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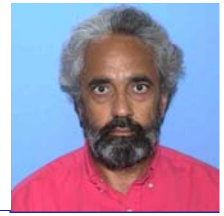
ANL – Activation Calculations



Simplified Target Model

- Assume all the secondary beam (e+ and e-) from the target traveling in Z-direction (50 MeV average) are lost into a Cu cube
- The target is a 10*10*10 [cm] cube, all decay particles through an observing sphere are registered.

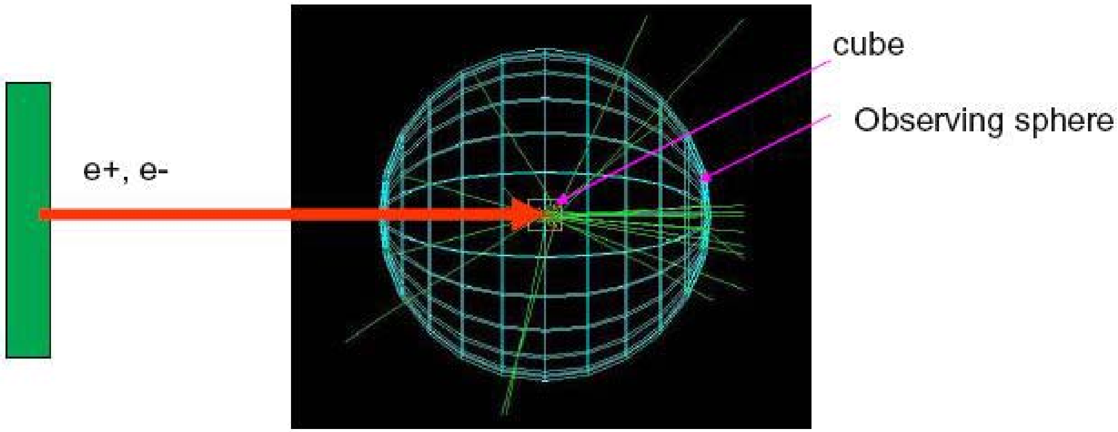


Fig.1 the layout of the simulation

Cu/Fe Activations

Comparison Copper and Iron

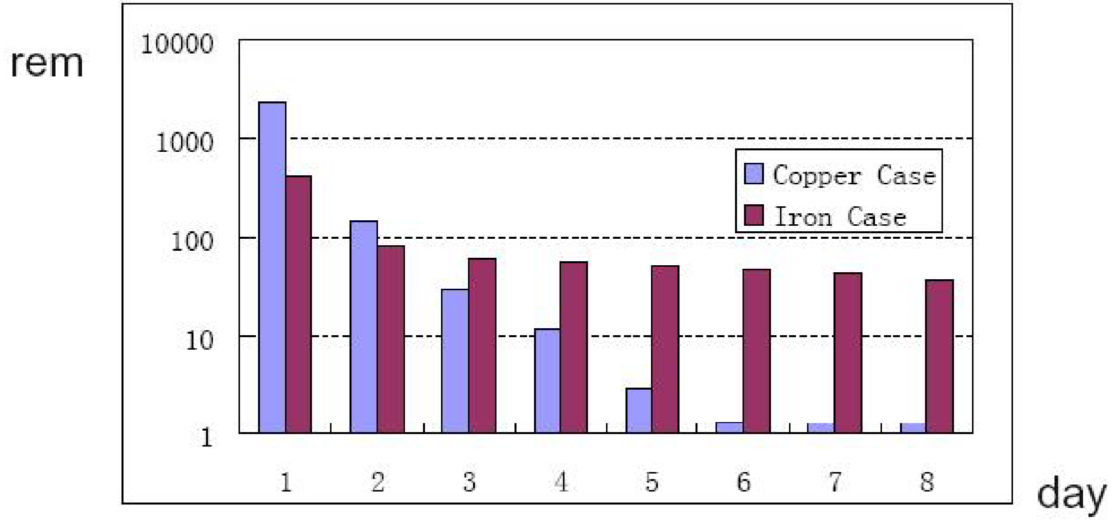
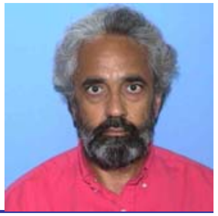
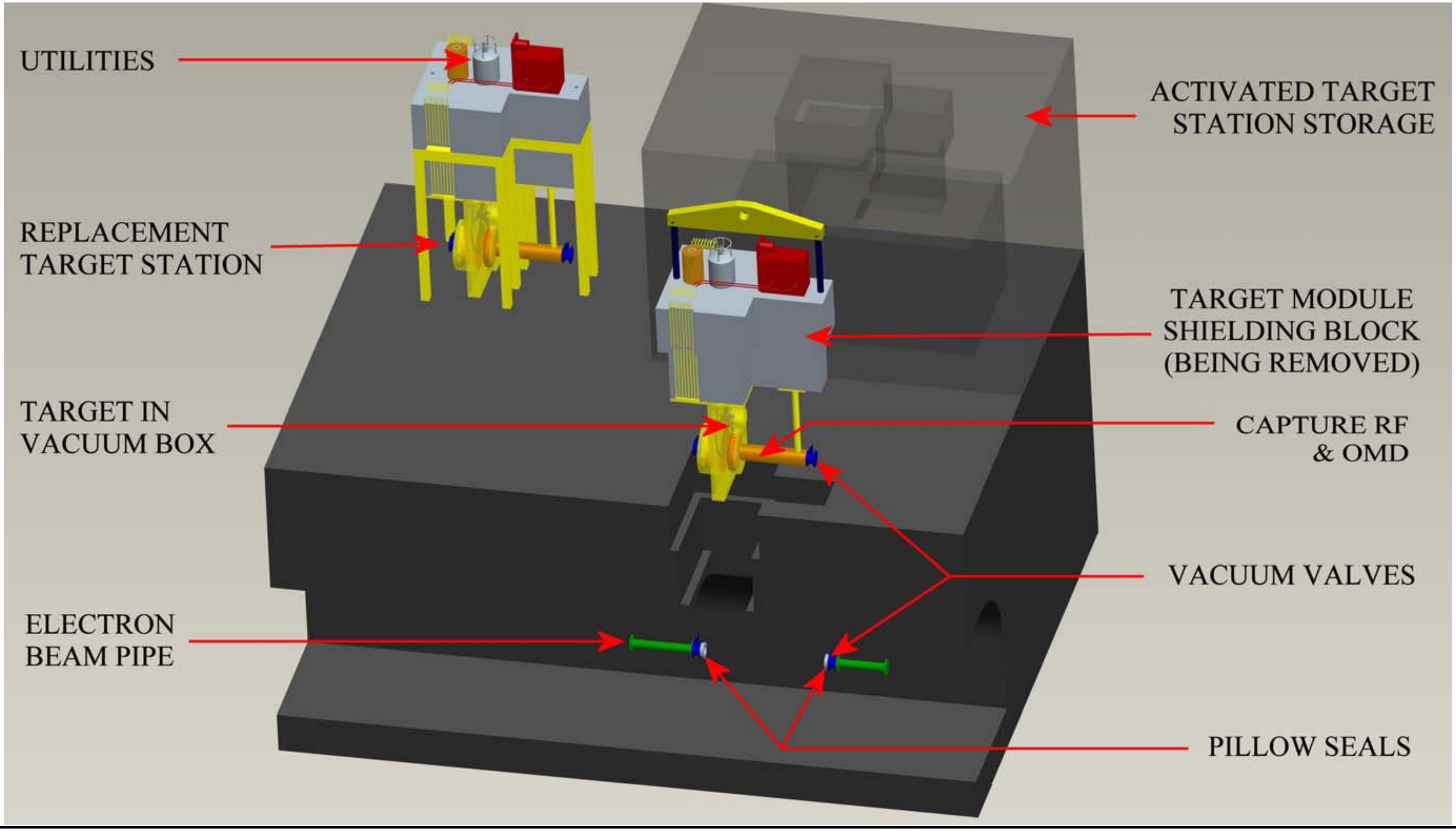


Fig.6 total dose (short life+ long life) drop trend in a week

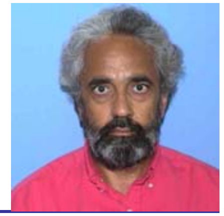
Target Remote Handling

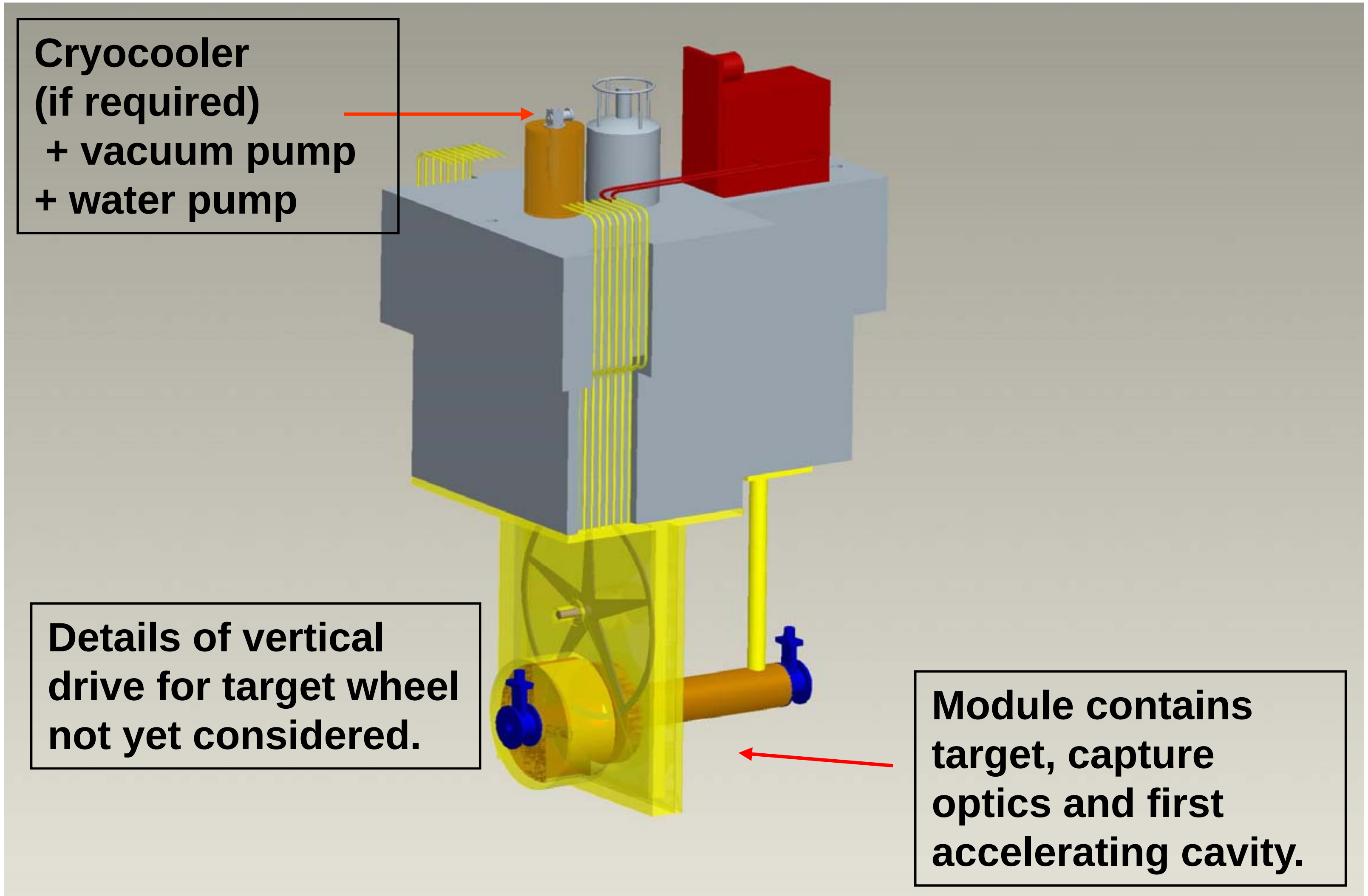


Estimated 53 hour replacement time



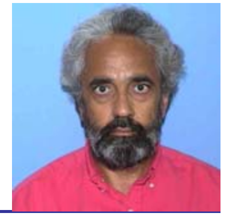
Remote-Handling Module and Plug





M. Woodward, RAL

TRIUMF – ISAC FACILITY

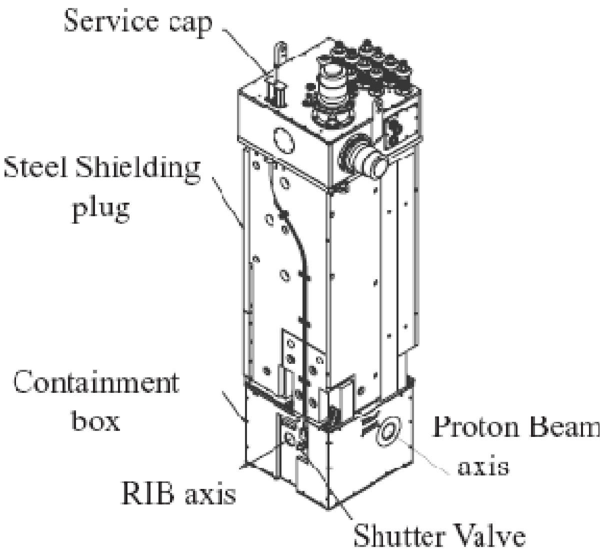


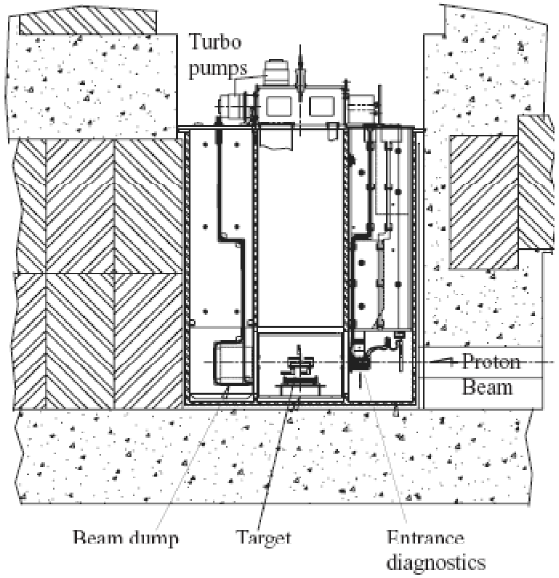
Paper presented at PAC'99, XVIII Particle Accelerator Conference
New York, March 29 -- April 2

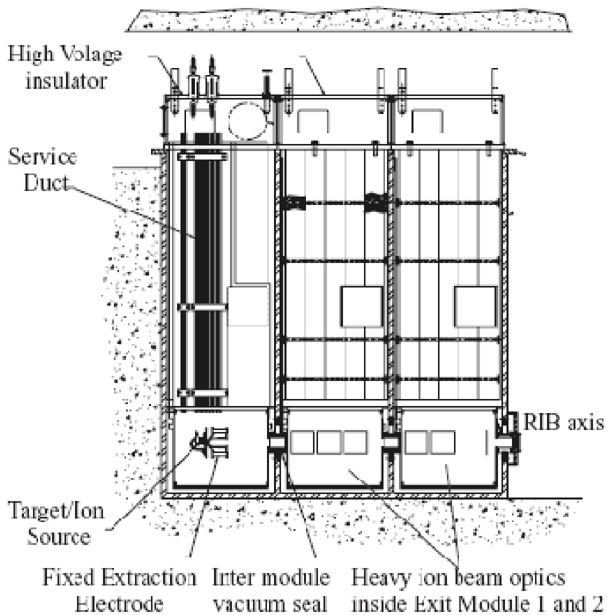
TRI-PP-99-11
April 1999

A 500 MeV-100μA PROTON TARGET FOR THE ISAC RADIOACTIVE ION BEAM FACILITY

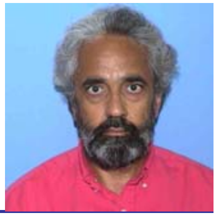
Pierre Bricault, Marik Dombsky, Paul Schmor, Guy Stanford, Ian Thorson and Jaroslav Welz
TRIUMF, 4004 Wesbrook Mall, Vancouver, BC, Canada

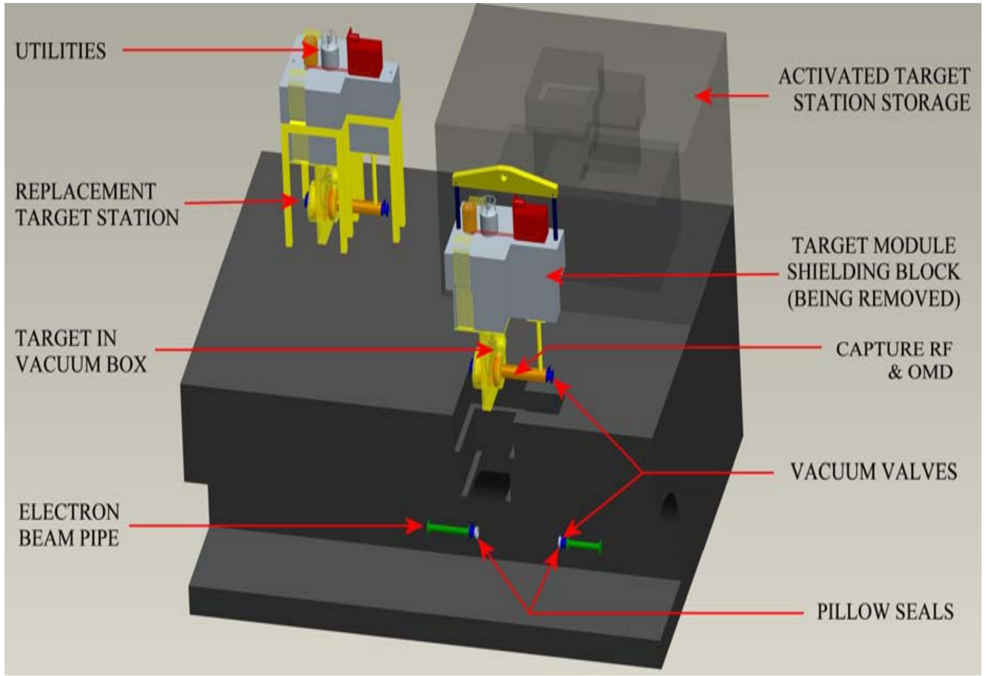


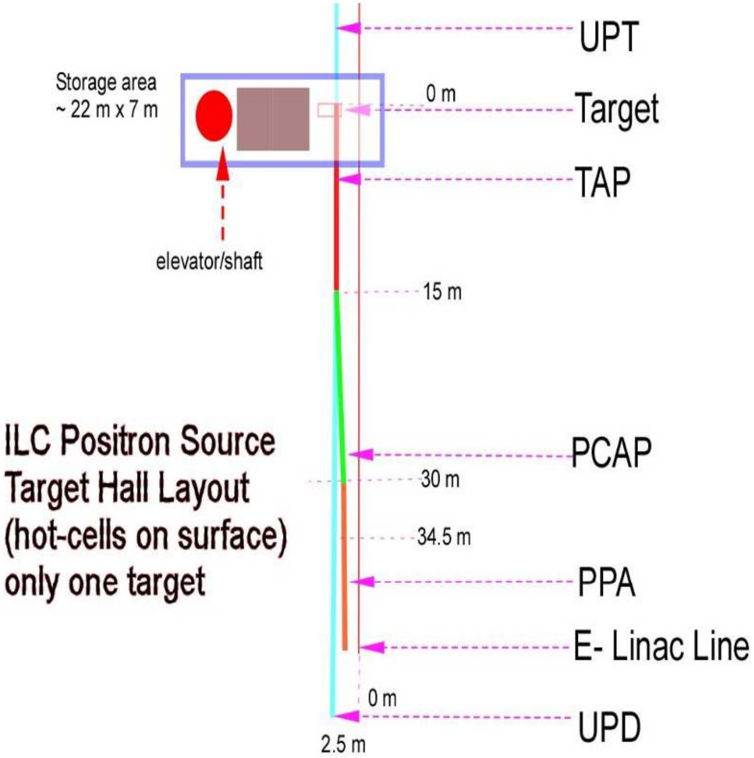




Target Hall/Remote Handling



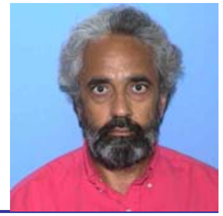


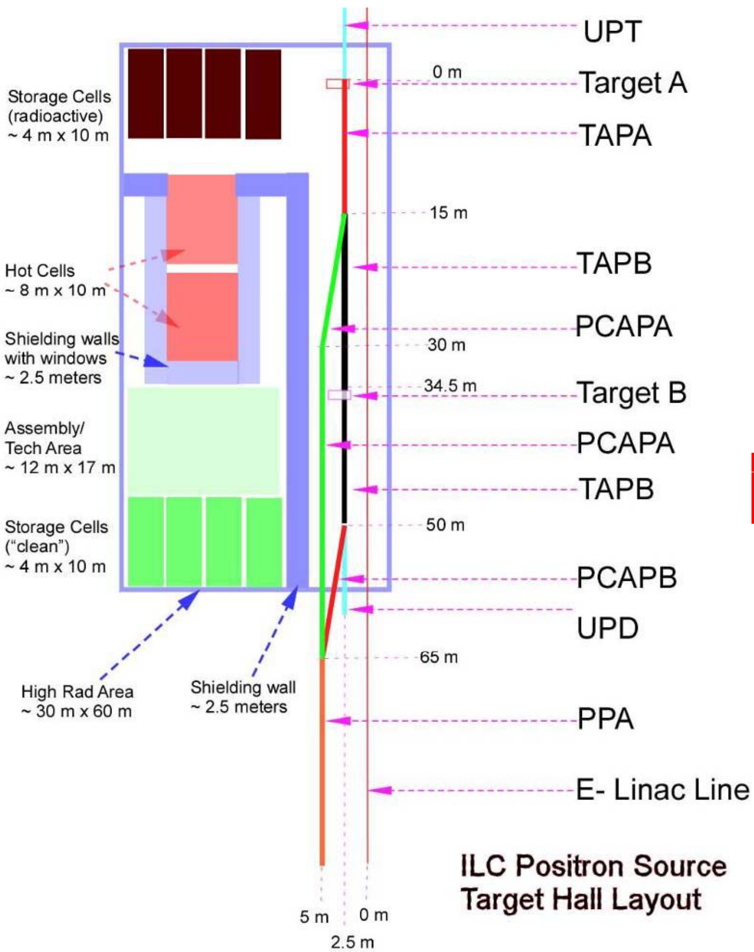


Target station deep underground
Excavation costs volume dependent

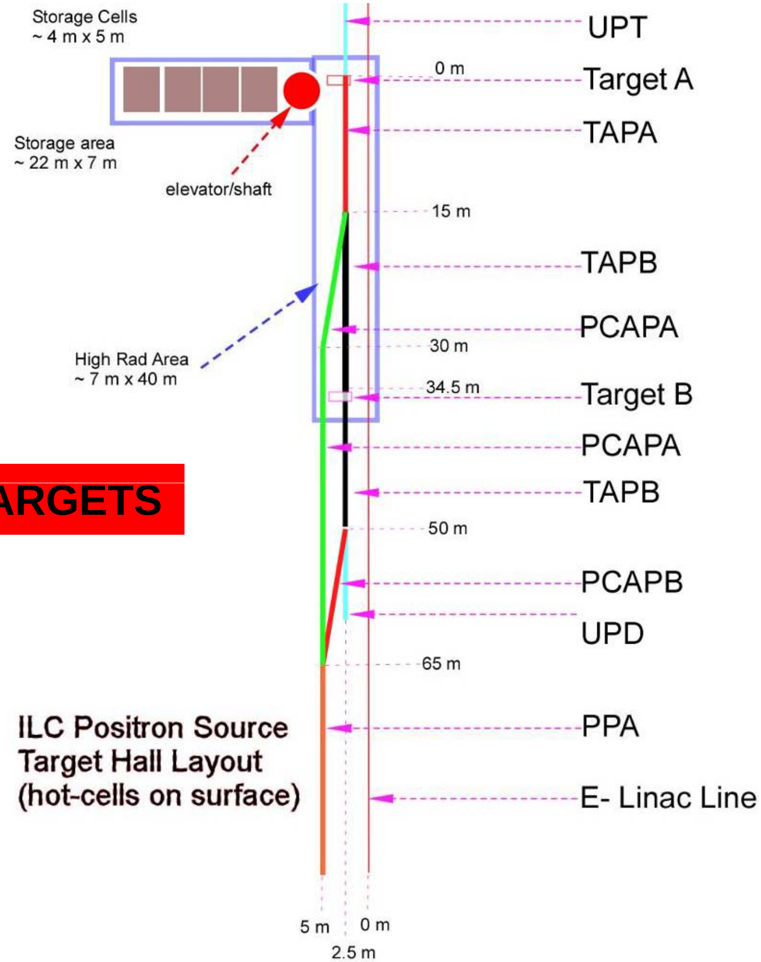
Mini-hall concept

Target Hall/Remote Handling



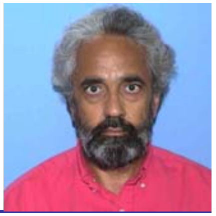


TWO TARGETS



Maybe we will need more area underground

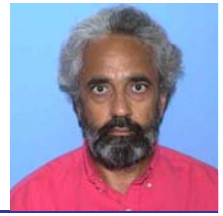
ORNL – RH Expertise

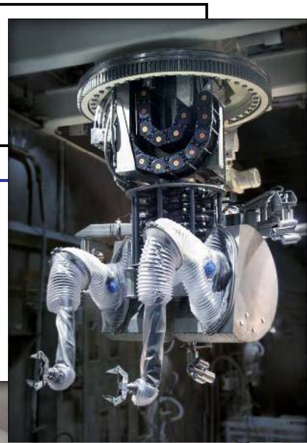


- Remote handling concept developed by RAL with input from SLAC. RAL stopped working on RH due to lack of money
- Approached ORNL to see if they could help
  - Yes, they have the expertise, probably as good as anywhere
  - Yes, they would like to help
  - Just have to arrange for funding, in the works but not final
- Nuclear Science and Technology Division (Tom Burgess – Fuels, Isotopes, and Nuclear Materials/Remote System Group)

- Help from JPARC?

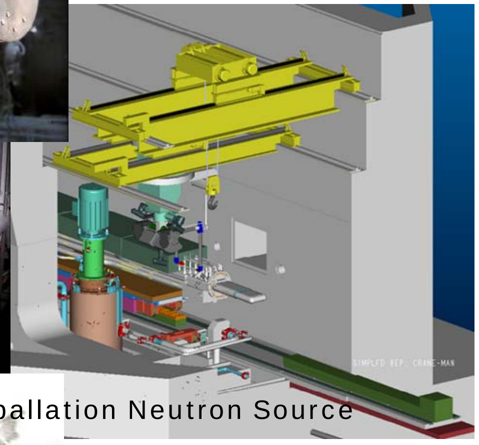
Remote Systems Group





Robotics and Remote Handling

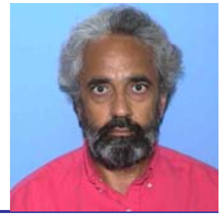
- Specializes in development and application of advanced robotics, remote processes and handling technology for hazardous environments in:
  - nuclear fission
  - fusion
  - accelerators
  - radiochemical processing
  - environmental restoration
  - space exploration
  - military defense



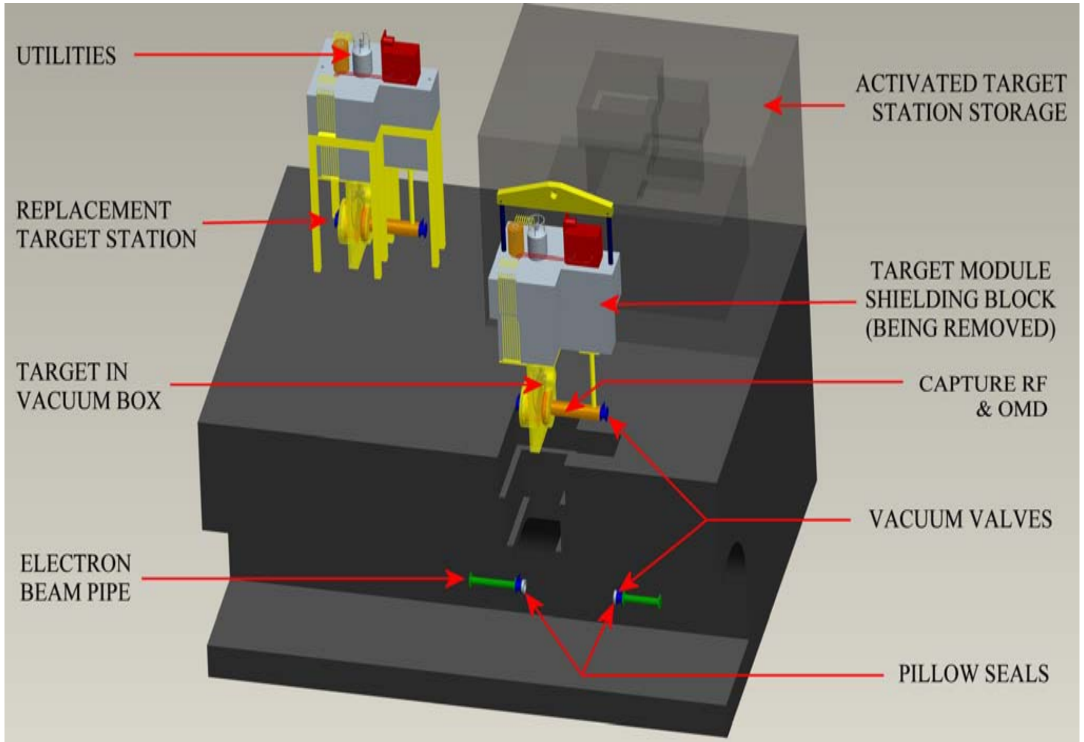
Spallation Neutron Source

Future Armor Rearm System

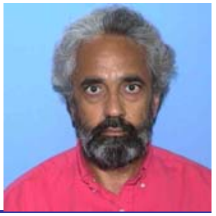
Target Remote Handling Design Comments (by Tom Burgess, ORNL)



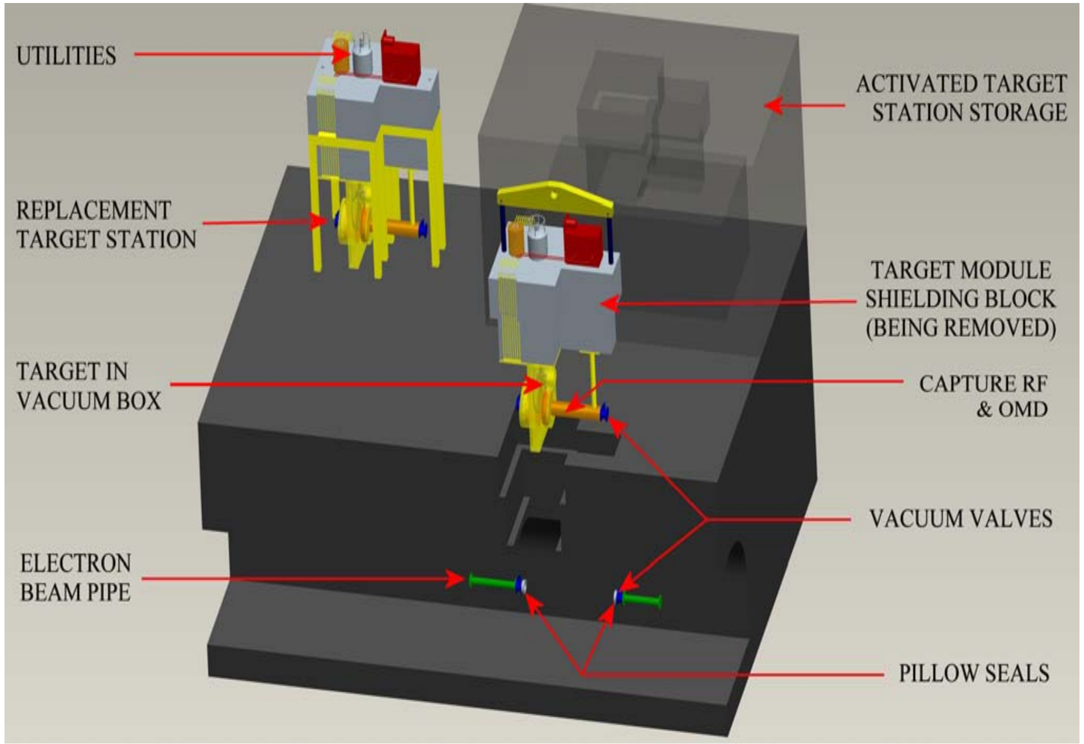
- Maximize hands-on access, minimize remote handling
  - Are utility and seal connections at top hands-on accessible?
  - What are shutdown rad levels?
- Shield rad-sensitive components to extent possible
- Assess lifetime of irradiated components (e.g., fluid seals, insulation, and other organics good to ~ 10^8 rad TID at best)
- Identify all remote maintenance / replacement / adjustment tasks and assess viability
- Modularize target module design based on component lifetimes, maintenance requirements and capabilities
- Any rad contamination expected?



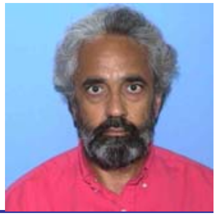
Target Remote Handling Design Comments
(cont'd)



- Develop conceptual target design including remote handling equipment and facility support features
- Transferring target module to a cask and moving it to a hot cell on the surface may be cost effective
- Remote handling R&D, mock-ups, required will be more evident once a concept is further developed
- R&D items ?
  - Ferro-fluidic shaft seal is a potential issue – shaft speed, mag fields, radiation
  - Rotating water seal life another possible issue



Target Remote Handling Design Comments
(cont'd)



- Pillow vacuum seal proven? Full atmosphere dp or secondary vacuum? remotely replaceable?
- What are radiation / activation levels downstream and upstream beam line and components?
- Beam line vacuum valves replaceable / necessary?