Activation Analysis for Gold Coating/Hohlraum

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Key Parameters

FW EOL Fluence	21 MWy/m^2
FW Radius	4 m
FW Lifetime	6 FPY
FW Thickness (w/o armor)	1 cm
Fusion Yield	161 MJ
Rep Rate	6 Hz
# of Shots per year	189 million/y
Availability	85%

Computational Tools and Model

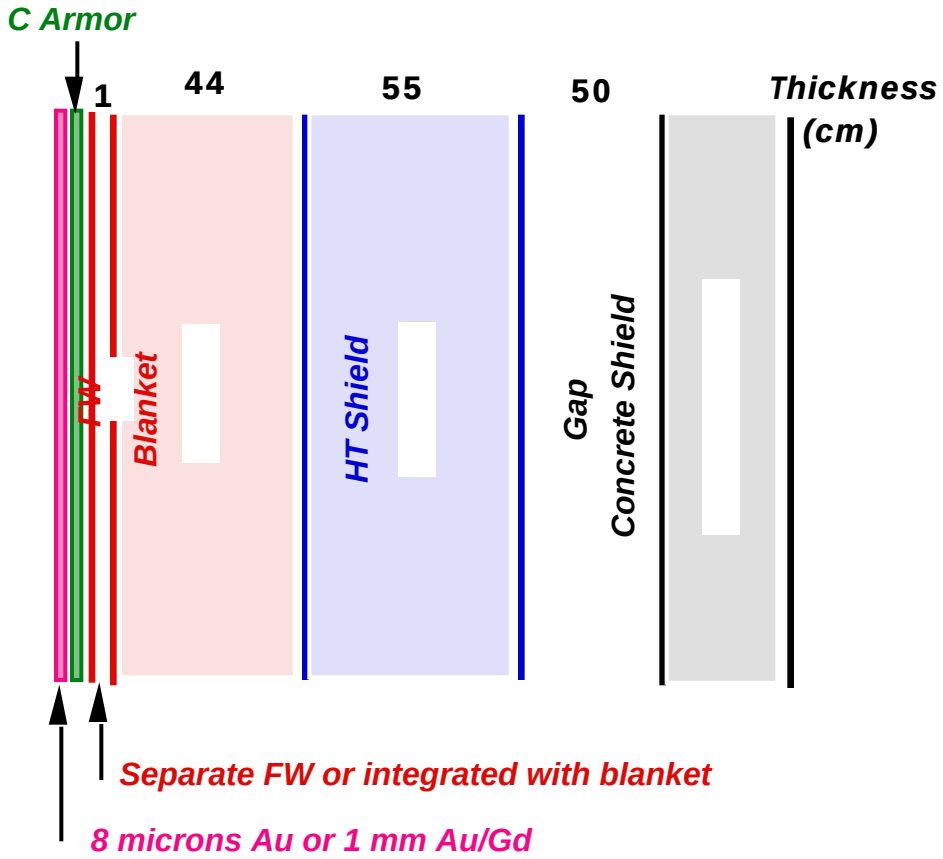
- Spherical model
- Neutron and gamma transport analysis:
  - DANTSYS discrete ordinate code
  - 175 neutron and 42 gamma group structure
  - P_3-S_8 approximation
- Activation analysis:
  - ALARA code
  - Exact modeling of pulse sequence
  - 175 neutron group structure
- Nuclear Data:
  - FENDL-2 IAEA cross section library

Target Coating/Hohlraum

	Laser	HIB
Materials	Au	Au/Gd (50/50 atom%)
Outer Radius	1.95 mm	6 mm
Equivalent Thickness	300 Å	60 µm
Mass	5 kg/y	70 tons/y
Δ on FW armor @ EOL	8 µm	15 cm*
Δ Sticking on FW	8 µm	1 mm

* Front layer of Au/Gd will be melted by x-rays, per Peterson and Haynes

Gold Plated FW



Activation of Gold Plated FW

Laser

- During burn, Au gets activated by source neutrons
- After burn, Au condenses on FW armor and gets reactivated during subsequent shots for 6 FPY or less
- Au could penetrate 10 μm into armor, per Haynes
- Au plated FW/armor will be disposed at end of service lifetime (6 FPY)
- Main activation concern is WDR of gold plated FW/armor
- Feasibility of recovering 8 μm Au (30 kg/6 FPY) needs to be assessed

HIB

- During burn, Au/Gd gets activated by source neutrons
- After burn, Au/Gd condenses on FW armor and gets reactivated during subsequent shots
- In 15 days, 1 mm Au/Gd ($0.2\ m^3$, 2.7 tons) accumulates on FW if $T<1050\ ^oC$
- X-rays melt additional Au/Gd layers
- Molten Au/Gd runs down (@ ~10 cm/s !), spending short time in chamber (minutes to days)
- Molten Au/Gd will be collected at bottom of chamber for recycling after certain cooling period
- Main activation concerns are WDR of Au/Gd plated FW/armor and recycling of radioactive Au/Gd

Waste Disposal Rating (Laser)

	Au	Au/FW	Au/FW/B
Class C Waste (@ SD):			
Fetter	1.00 (Hg-194)	0.08 (Al-26)	0.02 (Al-26, C-14)
NRC	0	0.06 (C-14)	0.03 (C-14)
Class A Waste (@ 100 y):			
NRC	0.08 (T)	0.6 (C-14, T)	0.3 (C-14)

Gold plated FW qualifies as Class A & C LLW

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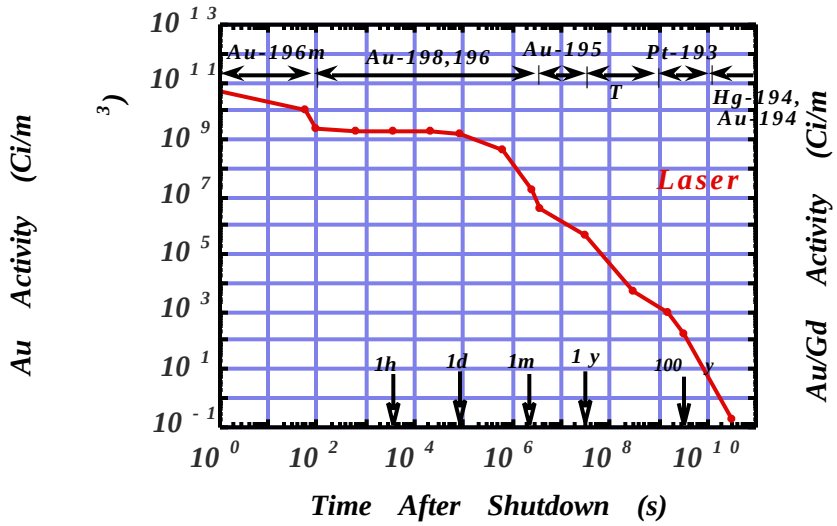
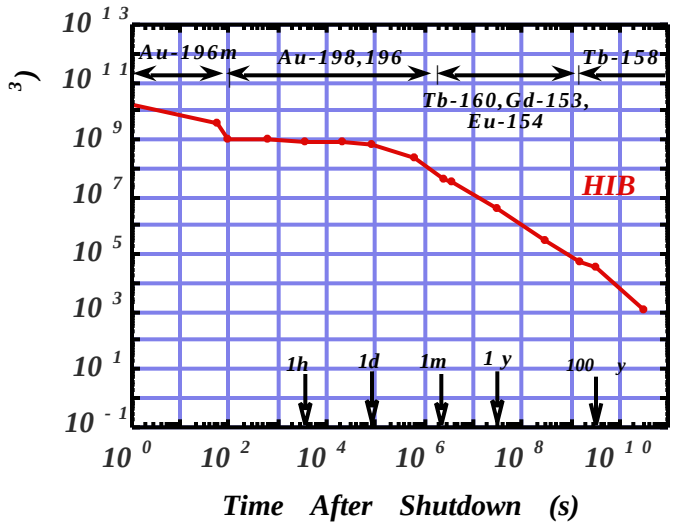
Waste Disposal Rating (HIB)

	Au-Gd	Au-Gd/FW	Au-Gd/FW/B
Class C Waste (@ SD):			
Fetter	12,000 (Tb-158)	1,080 (Tb-158)	110 (Tb-158)
NRC	0	0.06 (C-14)	0.03 (C-14)
Class A Waste (@ 100 y):			
NRC	0.04 (T)	0.6 (C-14, T)	0.3 (C-14)

Gadolinium causes waste disposal problem

Gold Activity Drops Rapidly After Few Days





- Irradiation of Au (& Au/Gd) with **target flux** for tens of pico-seconds dominates early activity following shutdown (SD)
- Few minutes after SD, almost all activities are due to reactivation of Au (& Au/Gd) @ FW with **FW flux**

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Conclusions

- No waste disposal problem identified for gold-coated NRL target
- Is it feasible to recover 8 μm of Au from FW armor to enhance economics? If yes, recycling dose will be evaluated.
- Gadolinium of HIB Hohlraum will condense on FW armor generating high level waste (1.3 m^3, 18 tons of Au/Gd @ 40 FPY). This violates ARIES top-level requirements that call for only low-level waste.
- **Recommendations**:
  - Replace Gd with other material(s), or
  - Separate Tb and dispose it as HLW. If feasible, check WDR of remaining radio-nuclides and dose for remote handling recycling