

Improving Efficiency of Access to Keck Interferometer M7 Optics Bench



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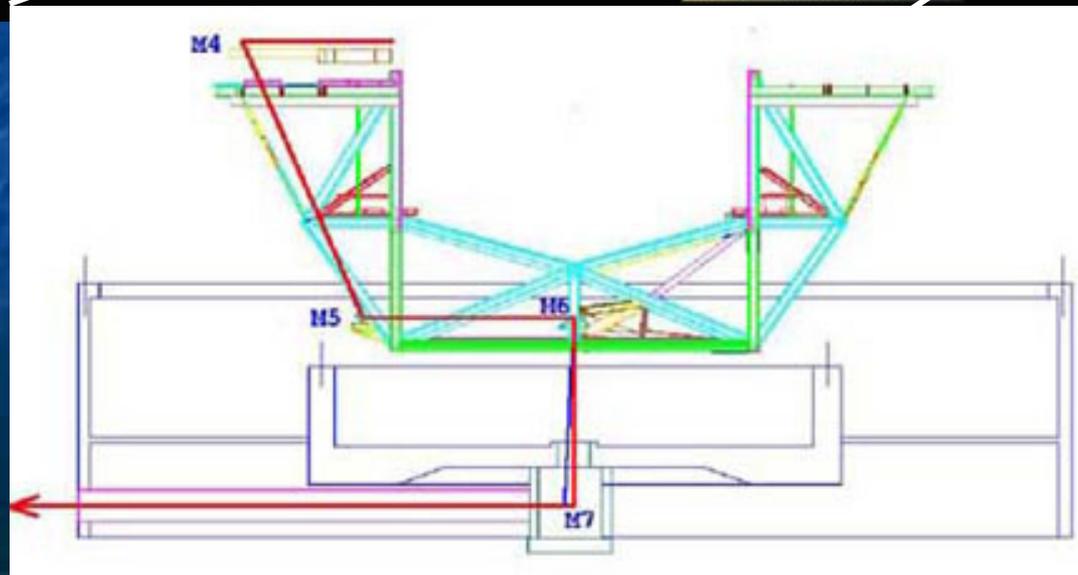
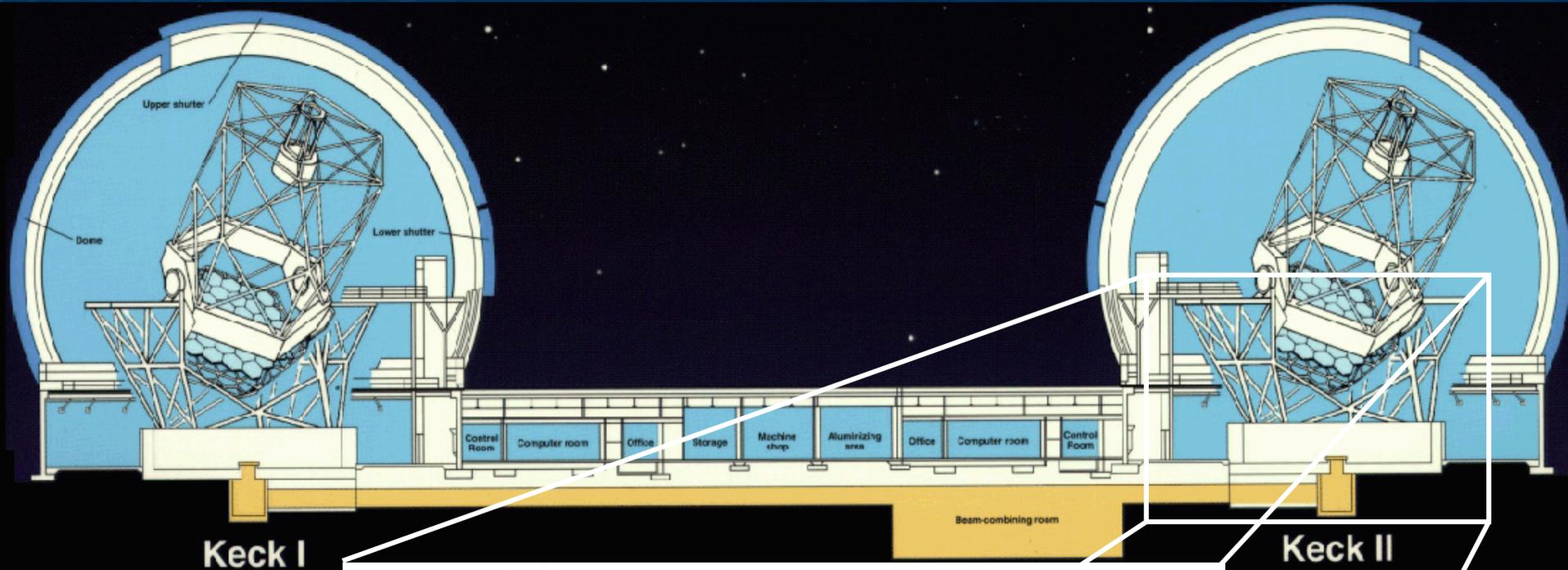


The Keck Interferometer: Timeline

- **September 1985** – W.M. Keck Observatory groundbreaking on Mauna Kea
- **January 1990** – First Towards Other Planetary Systems (TOPS) Workshop
- **July 1990** – NASA partners with the W.M. Keck Observatory
- **January 1992** – Second TOPS Workshop in Hawaii
- **April 1992** – Keck I first light
- **January 1996** – Keck II first light
- **March 2001** – Keck Interferometer first light
- **2003** – Exosolar-planet related findings with Keck Interferometer announced

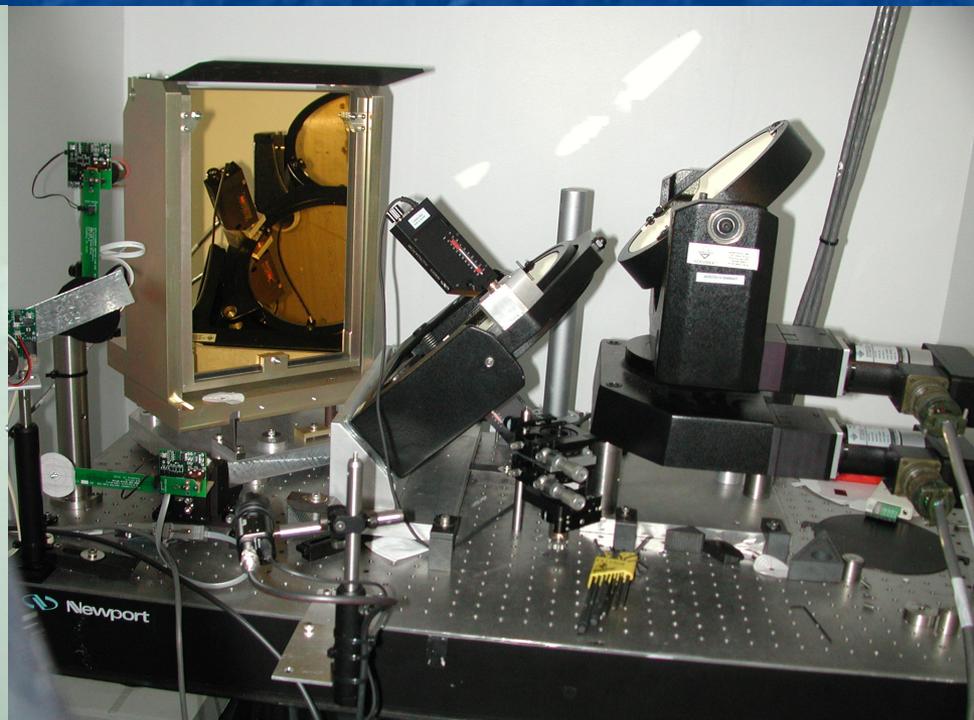


The Keck Interferometer: Coude Train



The Keck Interferometer: Coude Crypt

- 6' x 7' x 8' concrete room
- Optics bench with M7 mirror
- Coude tunnel: 42-inch diameter corrugated steel pipe
- Accessed on cart pulled by hand for 30+ feet



The Problem

Temperature variance between IF basement and crypt/dome

→ Coude tunnel opening needs to be insulated but accessible

“Temporary” solution – three layers must be removed by hand

Foam Insulation



Velcroed Vinyl



Zippered Vinyl



Installed in 2001!

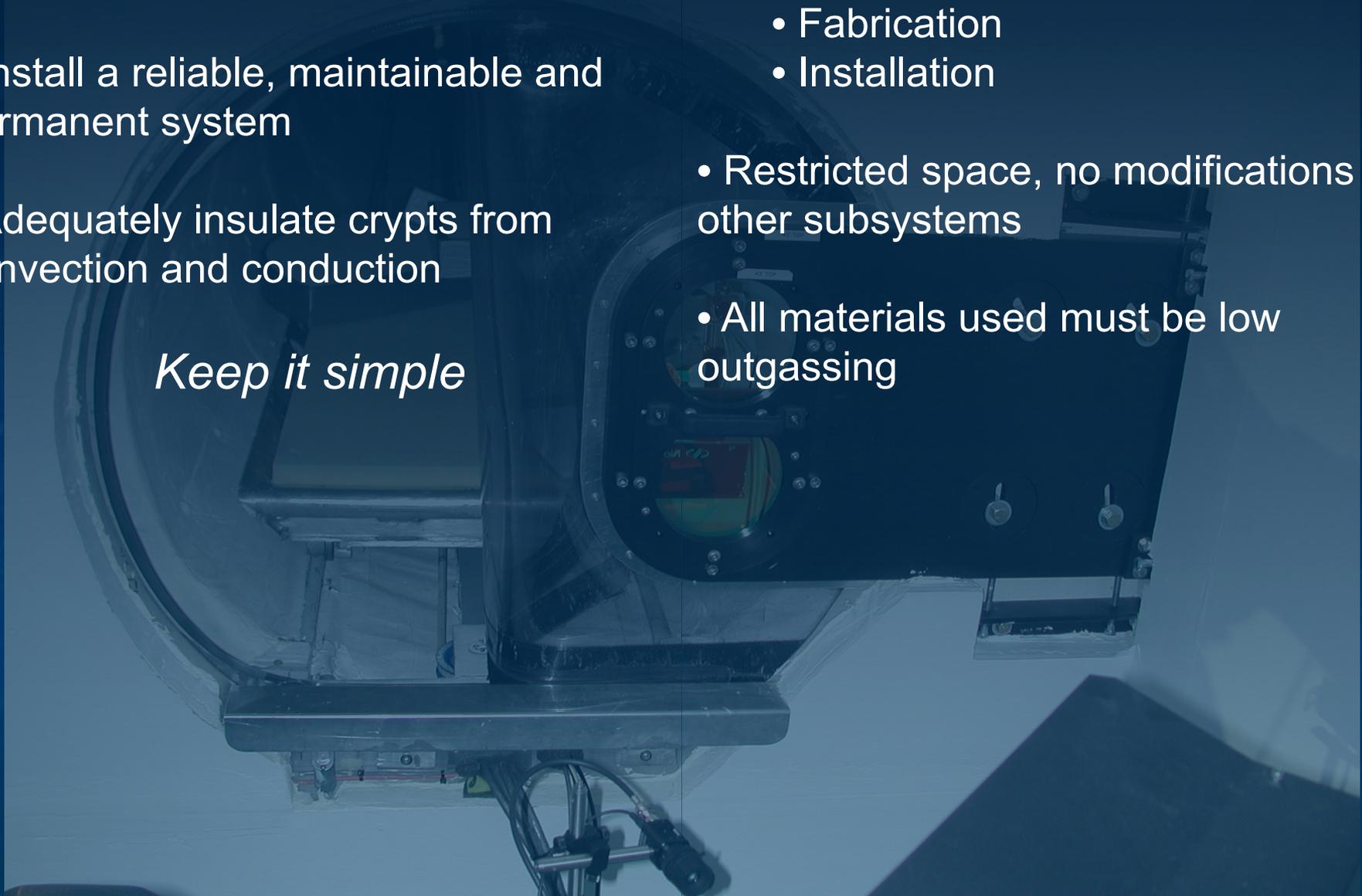
Design Goals

- Reduce time and effort required to enter code crypts
- Install a reliable, maintainable and permanent system
- Adequately insulate crypts from convection and conduction

Keep it simple

Design Constraints

- Scheduling
 - Design review (July 10th)
 - Fabrication
 - Installation
- Restricted space, no modifications of other subsystems
- All materials used must be low outgassing

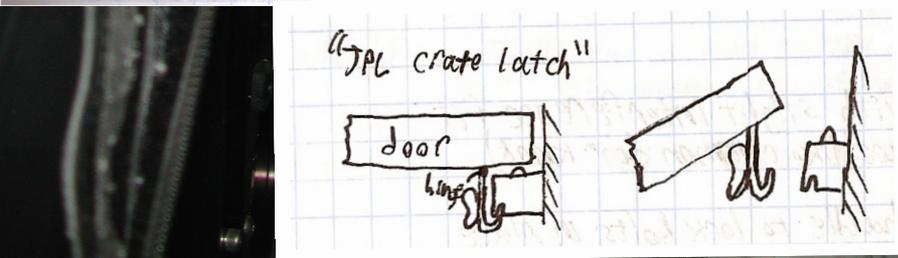
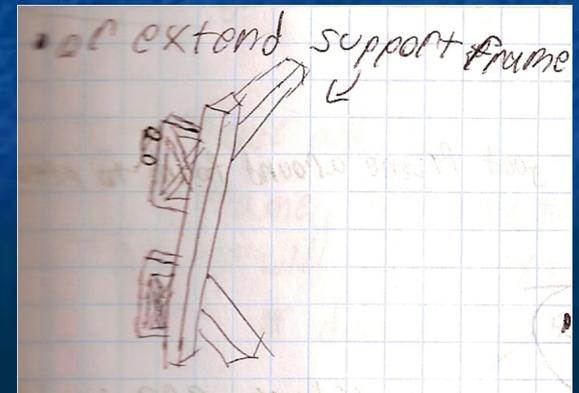
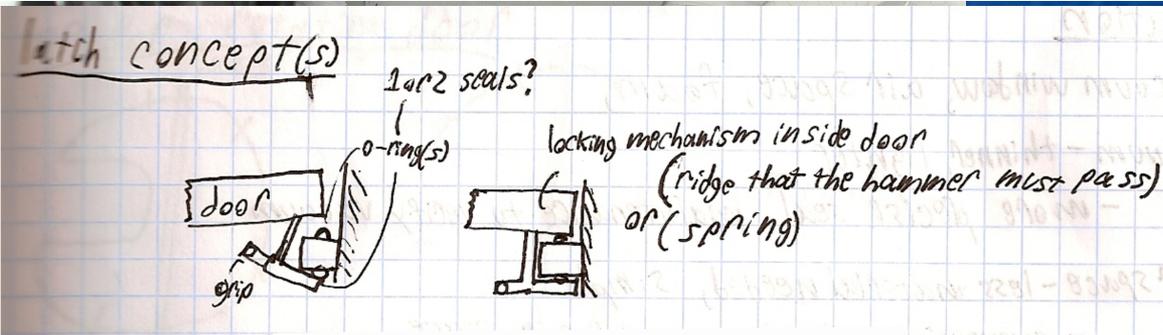
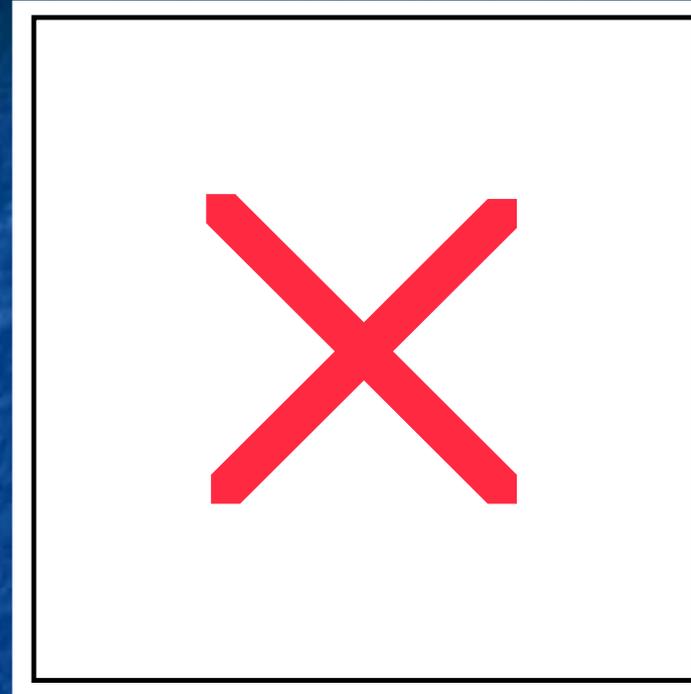
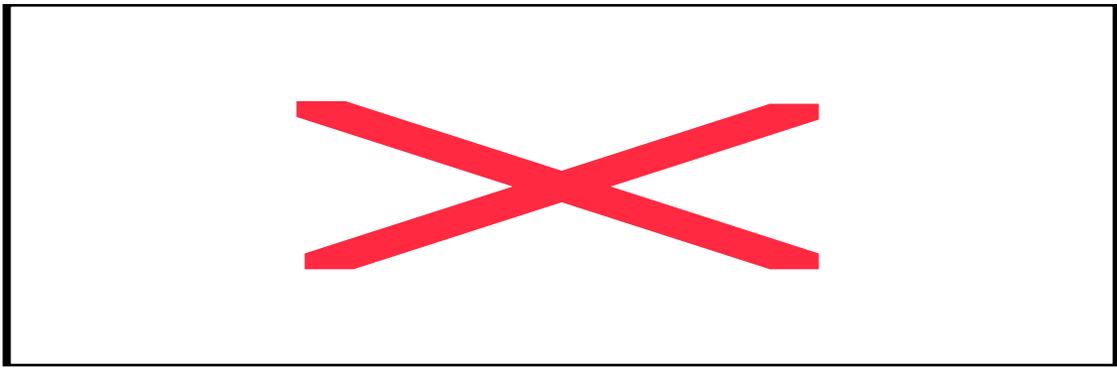


Design Process

- Preliminary Design
- Refinement of Design
- Analysis/Selection of Materials
 - (Design Review)
- Creation of Design Drawings
- Fabrication (Complete Today)
- Installation (Beginning July 29th)

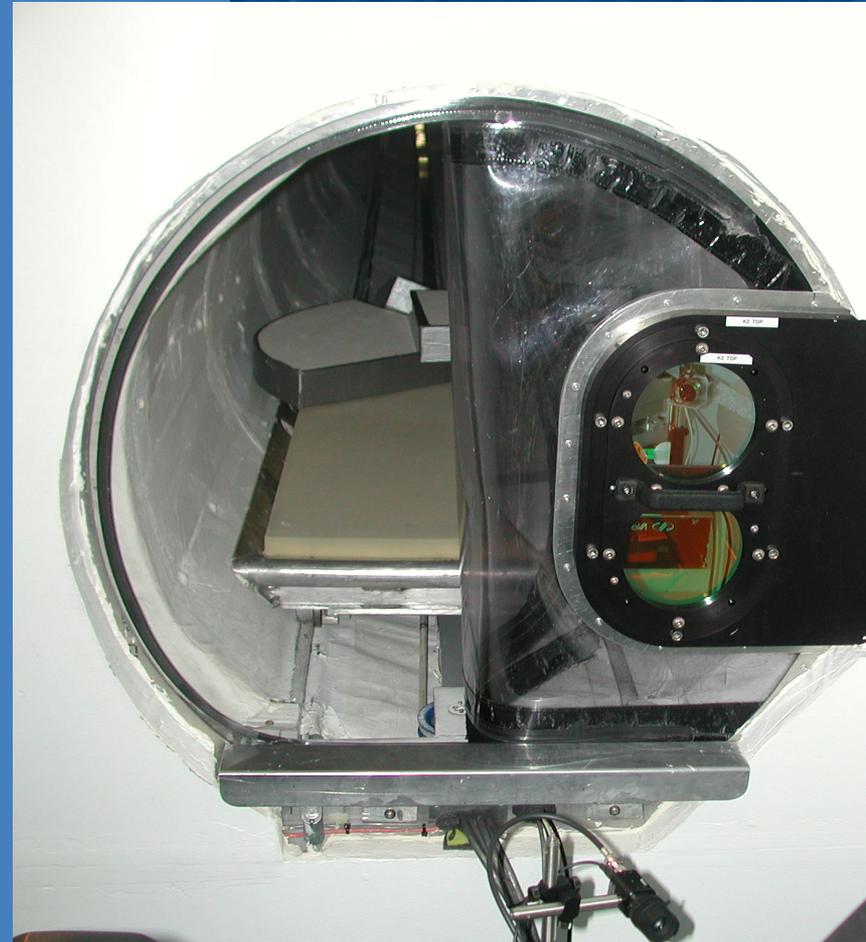
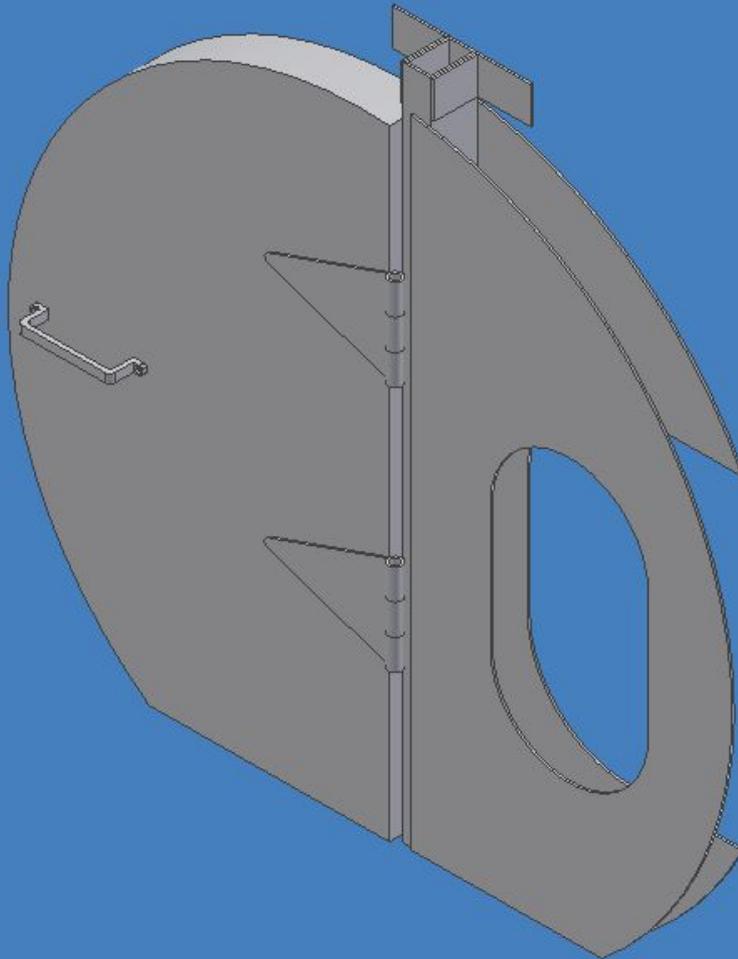
Preliminary Design

- I. Defining what's already there
- II. Learn the needs of the user
- III. Brainstorming



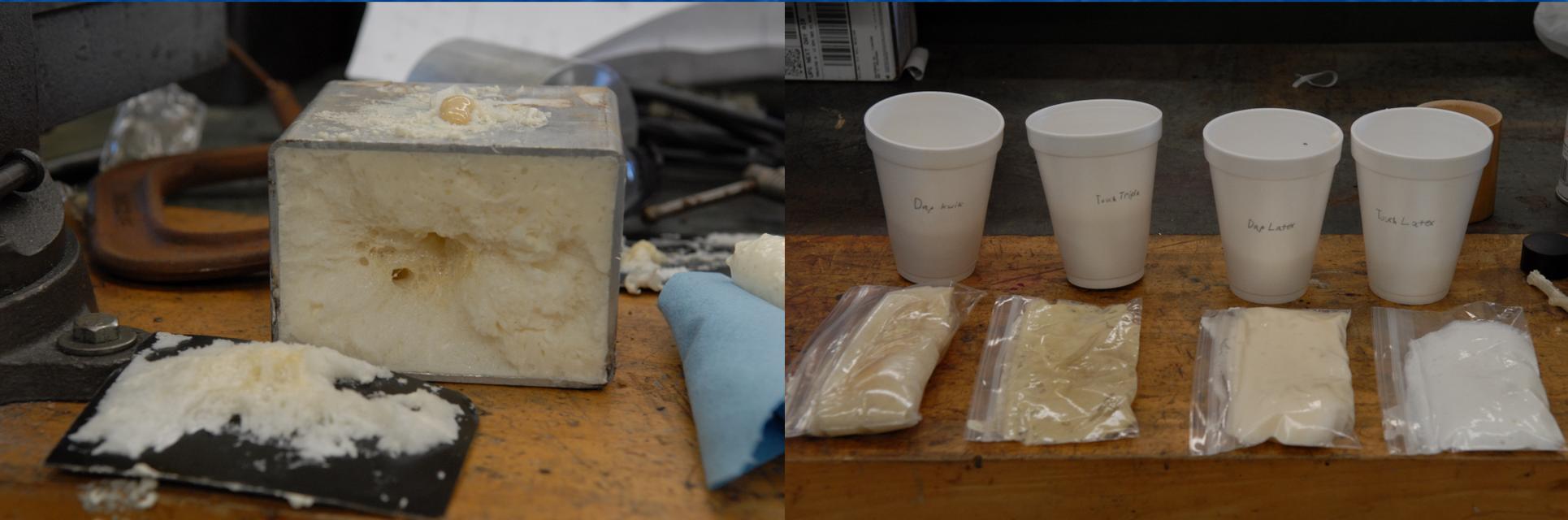
Refinement of Design

- Used Autodesk Inventor Professional to help visualize crypt entryway
 - Spent time learning Inventor during Prelim design period



Selection of Insulation

- Four expanding foam products from HPM
 - DapTex and Touch 'n Foam polyurethane and latex products
- Tests at HQ and at summit Facility
 - Latex products had yet to cure after 18 hours
 - DapTex polyurethane chosen based on price
 - Polyurethane cavity test
 - Uniformly filled cavity, mostly cured after 5 hours (center uncured)
 - Summit test: minimal expansion, mostly uncured after 2-3 days
 - 40% Less of oxygen



Fabrication

- Detail drawings
 - Based on 3D Inventor models
 - Must be accurate and clear so they can be read and used by MTs and machinists
 - Tasks take longer at the summit - it takes time to correct mistakes
- Summit work (Began last Wednesday, July 19th)
 - Scheduled around availability of summit mechanical technicians (MTs)
 - Foam does not cure at 14,000 ft.
 - Completed doors had to be sent back to HQ for insulation
 - Doors returned to summit this morning for painting



Installation

- Attended IF planning meeting for scheduling (July 20th)
 - IF installation window (Nuller run beginning August 4th)
 - Keck II installation tomorrow: Saturday, July 27th (and Sunday?)
 - Keck I installation on Monday and Tuesday
- Design has Installation in mind! Two phases:
 - Day one: door and door frame
 - Day two: removal of vinyl and installation of window mount insulation

*If we're reliant on everything getting done in one day
we could tie up the interferometer for the night!*

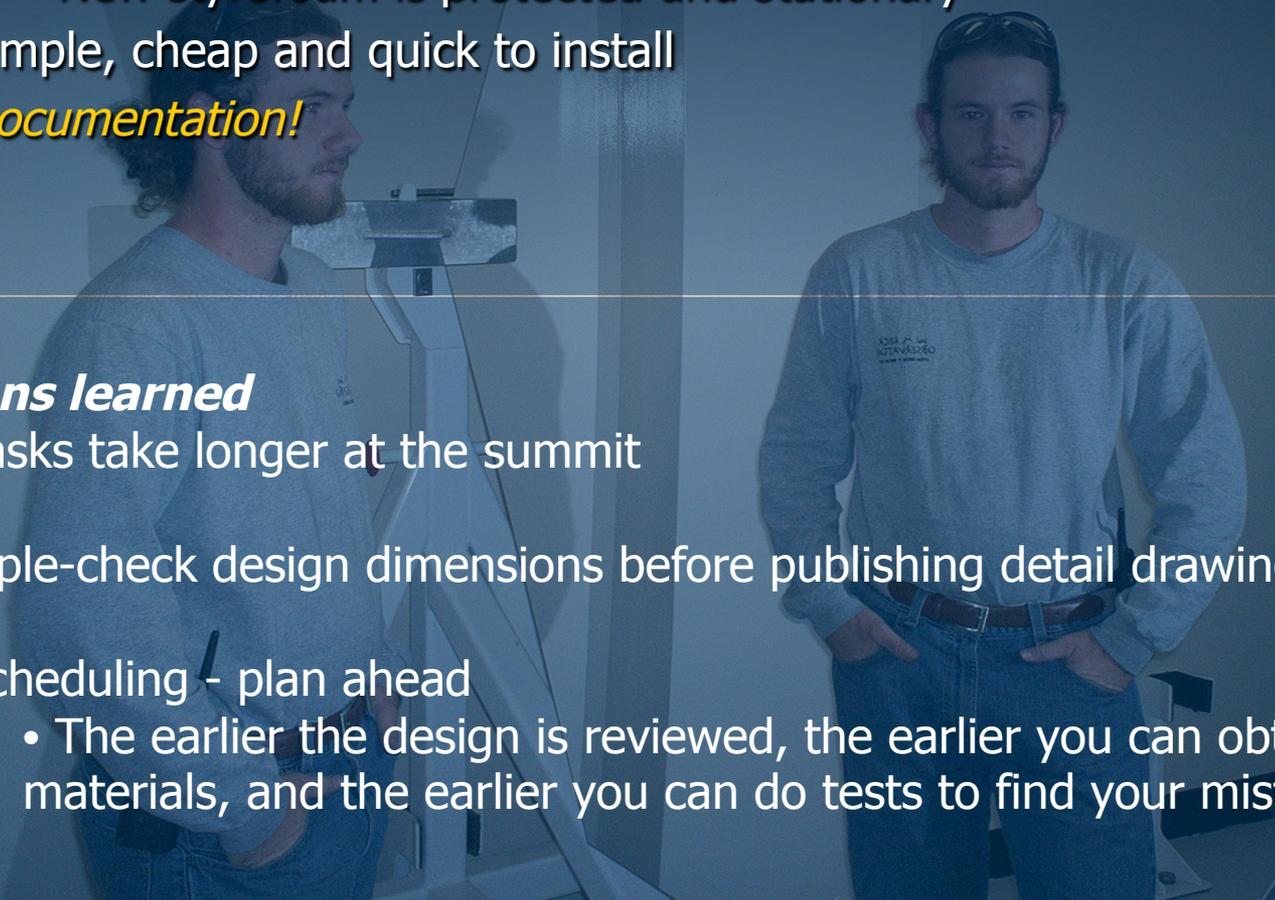
Conclusions

• ***Benefits of Design***

- Reduced complexity = improved efficiency (one-step entry)
- Eliminates vinyl material (outgassing issue)
- Durability
 - Made primarily of aluminum, not velcro, vinyl and foam blocks
 - New styrofoam is protected and stationary
- Simple, cheap and quick to install
- ***Documentation!***

• ***Lessons learned***

- Tasks take longer at the summit
- Triple-check design dimensions before publishing detail drawings
- Scheduling - plan ahead
 - The earlier the design is reviewed, the earlier you can obtain materials, and the earlier you can do tests to find your mistakes



Thank you!

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- Advisor: Jim Bell
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References

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