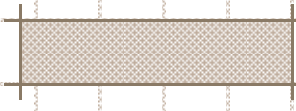


NuMI Decay Pipe & Absorber



Lessons Learned from the Design, Construction, Installation



Disclaimers

- My involvement as Project L2 for Absorber started after most of the design was completed; some parts were already in fabrication. Mostly I oversaw Installation.
- The DK shielding was part of the Tunnels & Halls, and I performed MARs simulations for that between 1999-2001. But no other involvement in DK systems design.
- I don't recall handling any major changes to the design of either the Absorber or the Decay endcaps, or any of their supporting systems. There were a few minor adjustments performed.
- I have probably forgotten some details. I did save various emails, which seemed important at the time, but which might not help the next Project
 - My earliest email inquires about a \$170k design overrun, but doesn't say anything about what led to the overrun

Tunnels & Halls – DK pipe & shielding



Dixon oversaw these details

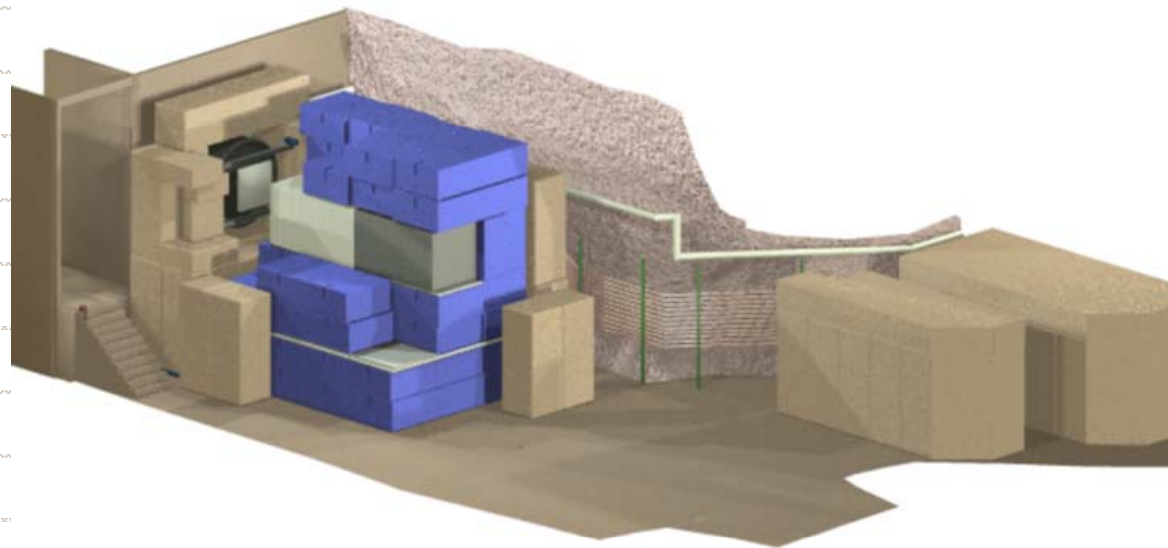


Who did What, When

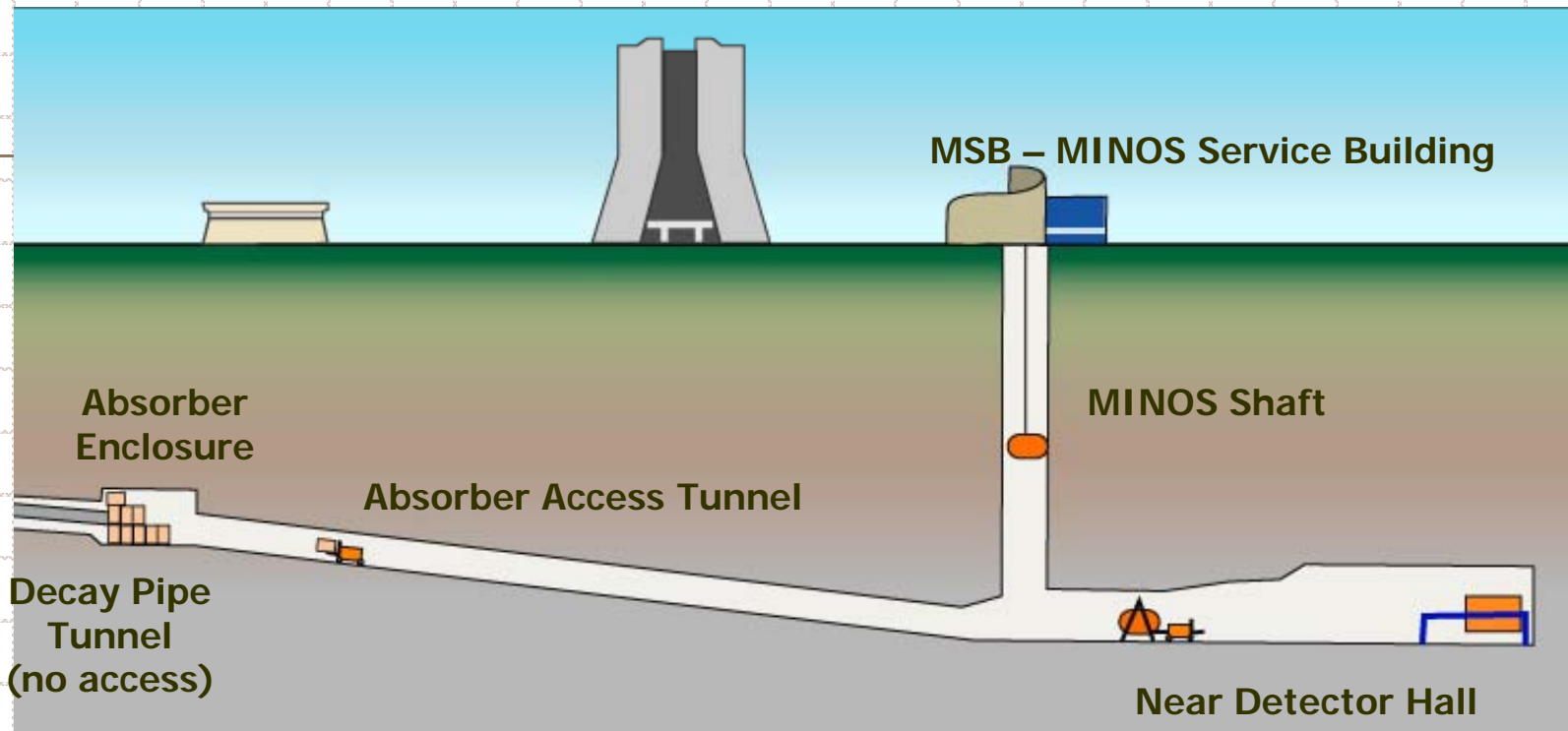
- A. Wehmann, B. Bernstein and D. Pushka handled most of the design phase. Alan performed MARs simulations of the Absorber to establish design parameters. Bob looked over initial installation scenarios. Ernie Villegas was the main design engineer for the Absorber; Dave Pushka for the DK pipe. Dave also handled all the supporting water and vacuum systems – design, construction and much of the installation.
- I took over from Alan in 2003 (the first monthly report from me was for April 2003). B.O. was March 2004, and installation began soon after. B. Bernstein was replaced by Dixon Bogert as we approached installation.
- I was also L3 for Near Detector Installation on the MINOS side of the NuMI Project – had that position from the start.

This presentation -

- Is formed by me going back through the emails I saved, the presentations from installation meetings, and the monthly reports



Physical Layout



All materials come down the shaft. The Hill is an 11% grade.

Timeline - overview

- Installation Planning – July 2003 through January 2004
 - Estimated 60 T&M crew days to install
- Design adjustments – April 2003 through Dec 2003
 - Gaps –at front wall, around piping, across the top
 - Labyrinth
 - Hadron monitor door
- B.O. March 10 2004. Some installation plans tossed and redone within days/weeks – mostly materials transport. Most other plans kept.
- Absorber stacking done May through August 2004, including the labyrinth. 80 T&M crew days.
- Jan 2005 – complete. Sep-Jan was finishing touches.

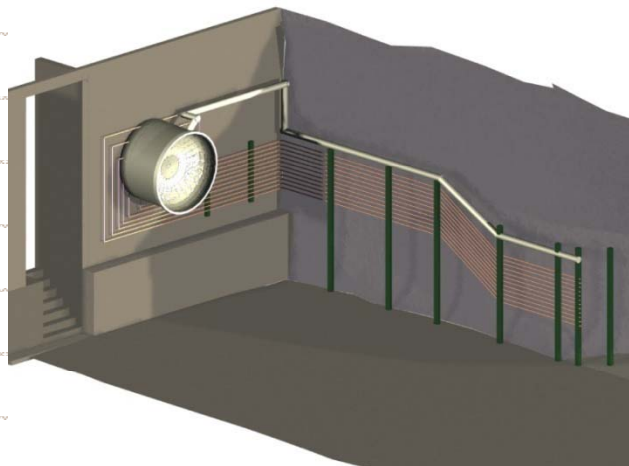
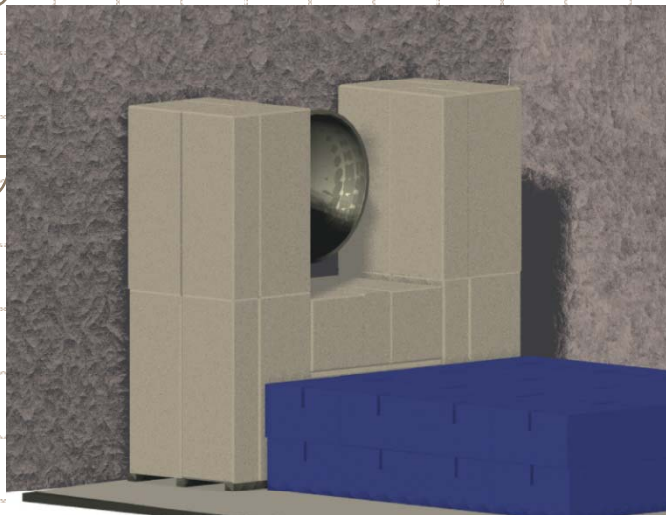
Design Adjustments

- Most of these due to gaps – literally physical gaps, not conceptual gaps in the basic design
 - Upstream wall gap, due to shelf
 - Air around core
 - Gap between steel and concrete, which was open to the ceiling
 - Gap around core piping where it exited the shielding
- Non-gap – door for hadron monitor
- Labyrinth – uneven walls, more gaps, aisle width.

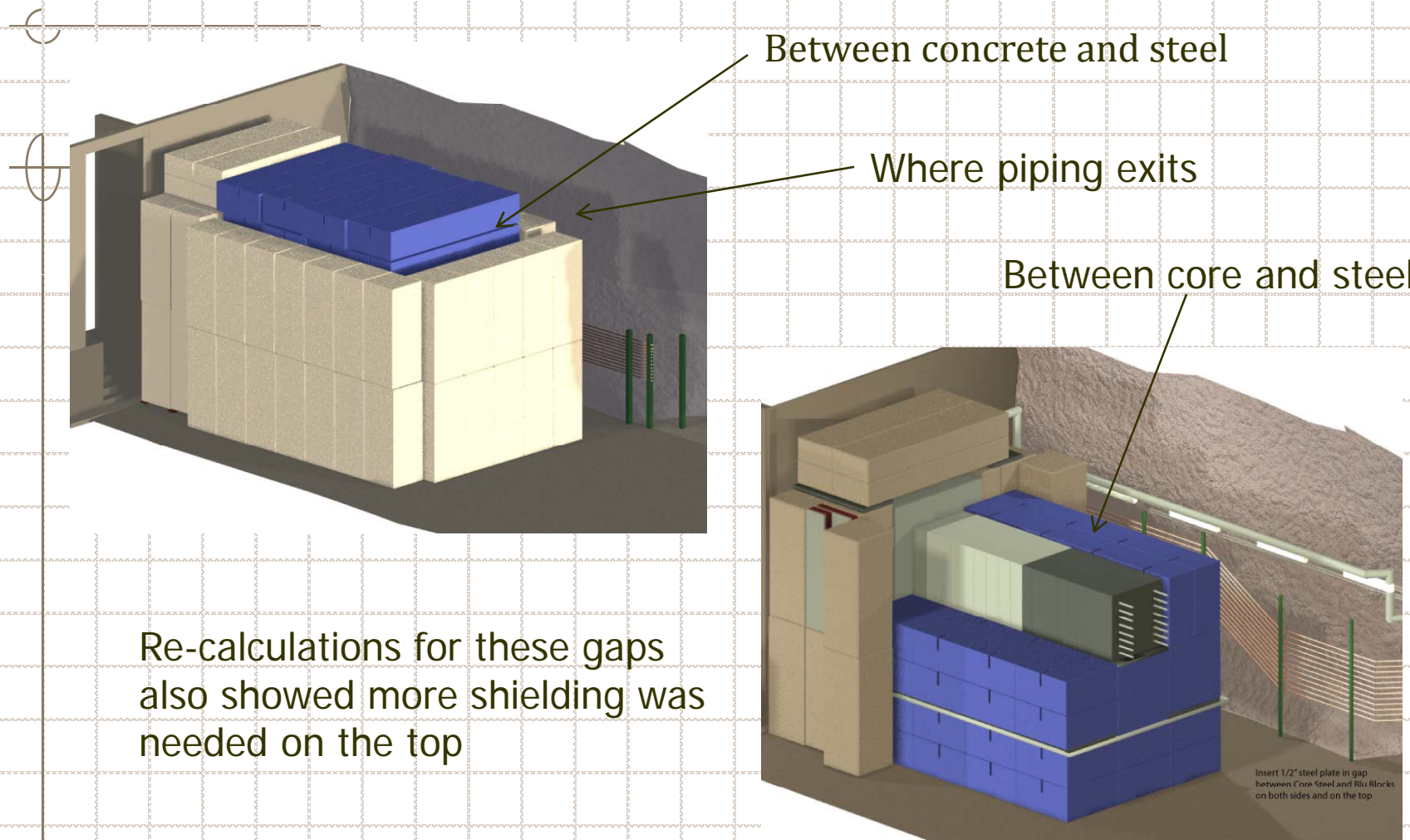
Overall, lots of thought went into the main mass of shielding, and less thought, as of April 2003, into these little details

All these gaps allowed activated air to escape. When it was all added up, it was too much.

Upstream Wall Gap



Gaps between blocks



Re-calculations for these gaps also showed more shielding was needed on the top

Installation Planning

- Basic plan –
 - Deliver blocks underground “just in time” - - very little staging space
 - No crane in enclosure – use hydraulic lift on rails
- Concerns at the time
 - Was there enough room for the hydraulic lift + beam to lift the top layers of blocks into place?
 - Fall protection – how to do it?
 - Can detector installation and absorber installation share use of the shaft crane? Davis-Bacon issues.
 - Rent or Buy a forktruck for delivering materials up the hill?

Installation Reality

- Devil is in the details, for most things....
 - Was there enough room for the hydraulic lift + beam to lift the top layers of blocks into place?
 - Yes, for the original stack. But then it turned out 18" more was needed on top – Riggers did it egyptian-style
 - Fall protection – how to do it?
 - All sorts of ideas and talk among ourselves. But after talking to the T&M guys, we just did it their way, which was to tie off to the hydraulic lift beam
 - Can detector installation and absorber installation share use of the shaft crane? Davis-Bacon issues.
 - Plenty of time to share. But ended up paying a T&M crane operator for all of the Detector installation
 - Rent or Buy a forklift for delivering materials up the hill?

Installation Reality – materials delivery

- Rent or Buy a forktruck for delivering materials up the hill?
 - We bought a used fork-truck (\$ same as renting)
 - We would operate it close to it's specs – 10-tons up 11-percent grade. Manufacturer was certain it was OK.
 - Overheated before it was half-way up, carrying a 10-ton blk. Even after the manufacturer made several modifications, it overheated after two carries of a 10-ton block.
 - Plan B, wench and cable and cart, was in place within days of the first failure of the fork-truck. This was projected as more than a x2 slower. But in the end, our projection of 60-days with a forktruck turned into 80-days with the wench/cart

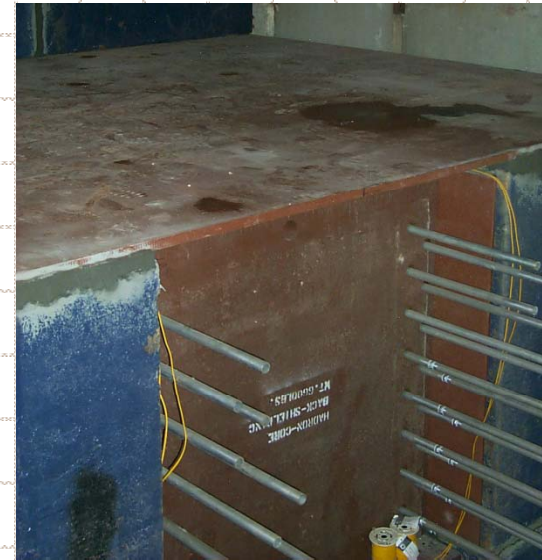
Installation Execution



Handling of Shielding Blocks



Gaps filled – but a lot of hand-work



Installation Realities – floor load

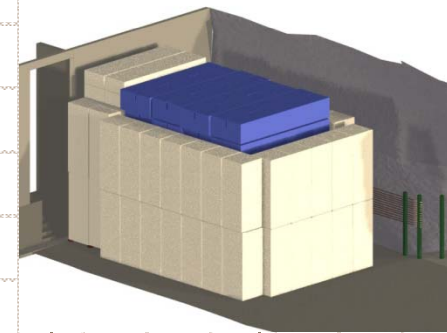
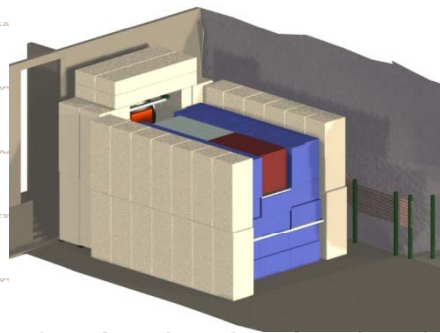
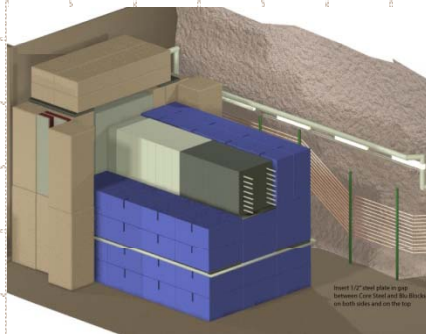
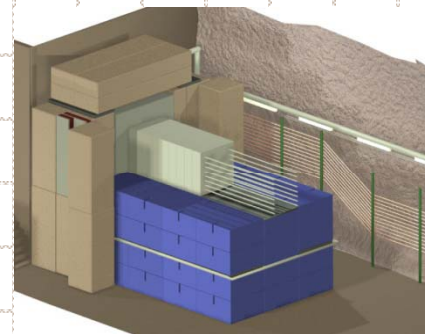
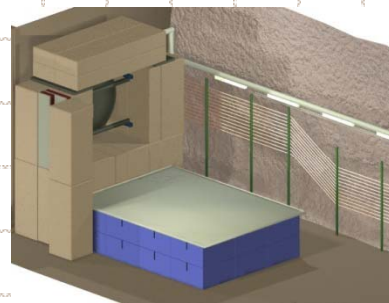
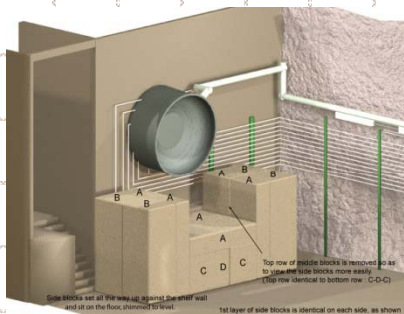
- Sump covers, designed as part of the Outfitting Contract, could not handle the load of delivered materials
- We used the big forktruck as a test load on the shaft crane, just before BO (outfitting contractor used it to help move his equipment out) – it was 125% of the rated load
- But when it first came down and landed at the base of the shaft, a flexing of the sump cover plates was observed
- Re-calculation showed that while these plates would support the specified load when distributed, they could not support it as a point load – which is what you get on the 4 tires of a forktruck, or on the wheels of the cart used to deliver detector planes
- Scramble – just after BO, before much of anything can come down, we have to reinforce the shelf these plate rest on
- We have always plated over these sump covers to distribute any load

Installation Realities – work flow was OK

- Stacking time equaled, or even exceeded, delivery time
- In the end, the additional work filling cracks and such – when block stacking was not occurring - was done in parallel with block delivery.
- Delivery of materials never held up the installation
- Timeline – a bit more detail -
- May – installation starts. By end of month all the upstream concrete section is in place, including the hadron door.
- June – Hadron rails and He box set in place. 48 blue steel blks set in place. Aluminum core installed & surveyed.
- July – core complete. All blue blocks delivered and most installed. The added top shielding is being fabricated – 78 smaller pieces in a tiled layout. installed mostly egyptian style. Cooling pipe extensions begin.
- Aug – Stacking complete, with most of this month spent on the top 18” of hand-placement. Labyrinth stacking begins.
- Sep – Labyrinth complete.

On-the-fly Drawings

- And 3-D views on demand.
 - I carried a laptop everywhere. I installed a printer underground. I purchased a relatively simple-to-use CAD program (TurboCAD)
 - The riggers REALLY liked getting these stacking views every day



Labyrinth & Utilities



Utility skids went in early and easily

Labyrinth seemed almost an after-thought. Layout started Fall 2003 and not finalized until May 2004

