Scintillator Structural Integration & Structural Issues

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- The northern wood
- Issues and old solutions
- New solution
- Container
- Alternative plan if…

Particle Board in the North Woods

- Potlatch plant less than about an hour from US sites (less than 20 miles from Cliffs-Erie site)
  - Twice the capacity of the Gaylord plant described yesterday
    - 50kt is two weeks worth of production
  - $0.14/lb
    - Quote same as GP FOB northern Minnesota (but GP assumes rail so limited to 4' wide boards)
  - Particle board presses can make 24' x 8' boards up to 9/8" thick
    - Anything you buy started as a board this size
  - Rho = 0.6 is standard for their thicker product
    - Can be made in custom mix to different properties

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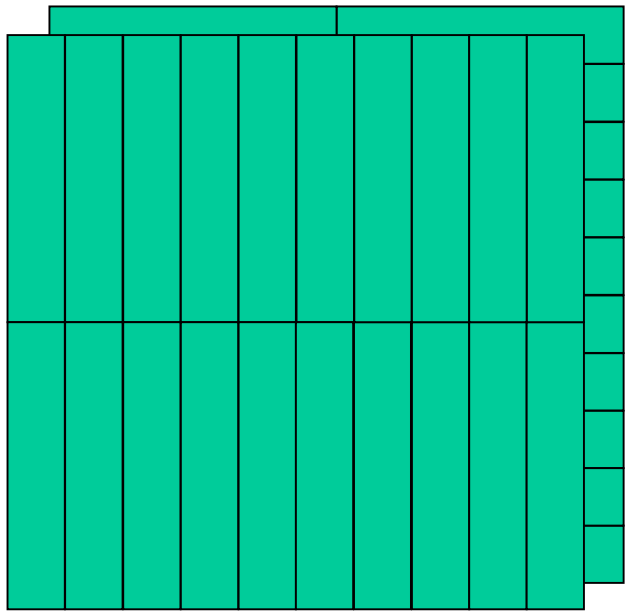
My SLAC Strawman (Costed by Brajesh's Talk)

- Use 10m long strips with MINOS geometry
- 2 Single ended readout with 0.7mm fibers and mirrors
  - 60% like MINOS ND
- Put modules end to end to make 20m square
  - 15cm of particle board between layers
  - Alternating views



Integration Guidance

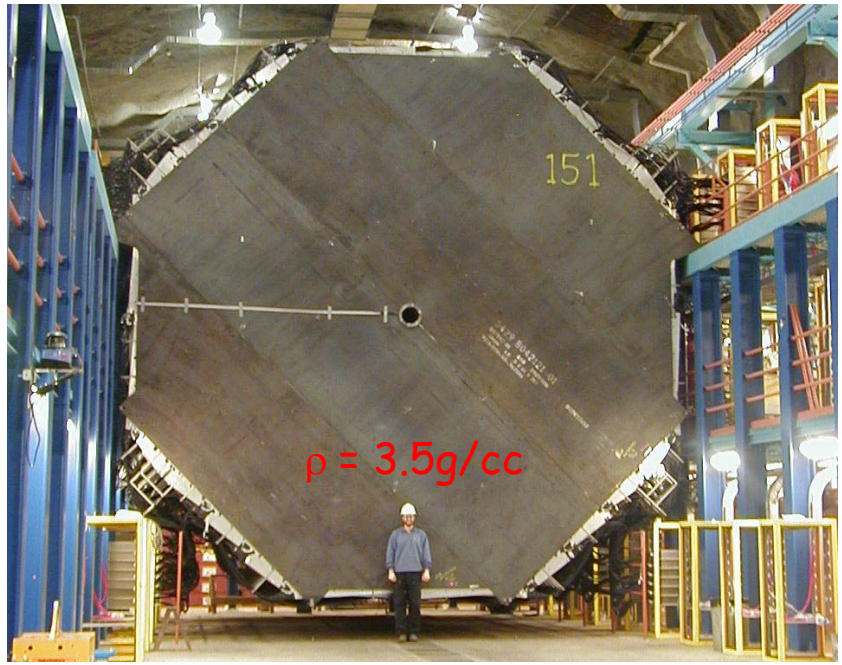
- Scintillator likes to be long to minimize readout channel count
- Would like readout on outer edges
  - MINOS experience says fiber cables & modules snouts are not particularly vulnerable (none damaged in MINOS other than initial light leaks – caught in QA tests)
  - Would like access to electrical connections, PMTs, and frontends
  - No or few cracks in absorber/readout
- Under-detector access possible but will cost more for under-beam structure – might want anyway
- Can we make structurally successful full planes of particle board with full planes of scintillator?
  - Walls of wood are 6" – 8" thick depending on density

Some Structural Concerns

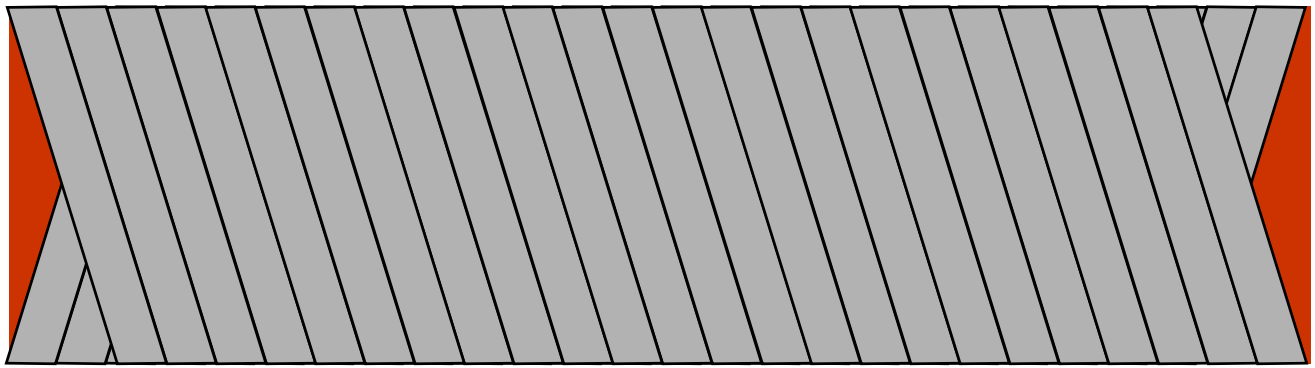
- Can the material stand the compressive loads?
  - Vic & Tom Chase say the materials more than fine at 20m tall based on vendor spec sheets
- What about structural stability?
  - When will it buckle?
    - What are requirements on the vertical alignment of planes?
  - Thermal/hydroscopic expansion must be accommodated within this structure over a reasonable range of environmental conditions

MINOS Solutions

- Planes needed to be vertical to roughly 0.5"
  - Planes surveyed and shimmed as needed
  - Construction survey says we made and landed planes to 3mm tolerance without issue
- Interconnections
  - Interconnecting bolts through slots
  - Interconnecting collar in the middle
  - Connections spaced 4m
- Structure broken into two 14.5m supermodules for stability in case of thermal expansion for $\Delta t=20°C$



Concept for 12m modules



- 12m modules allow some flexibility relative to 10m
- A 12m square is poor from a fiducial point of view
- Top-only readout concept from Leon & Tom Chase
  - All PMTs on snouts at top of modules
  - Can intersperse walkways, raceways, supports for shield, & PMTs/electronics in "corn rows" on the top of the detector
  - These installed incrementally every "n" planes
    - Very similar to the MINOS ND installation plan
  - No side access needed
  - Modules cross at 45 degrees
- Area 11m x 40m
  - Structure is the height of a 3 story house – within John's "common practice" criterion
  - Only 8% worse fiducial than 20mx20m square (with 1.5m cut)

Interconnections for wood planes

- Walls in a building connected to others at ceiling by joists
  - These replaced by plane-to-plane connections in this design
- Could make connection with drilled holes and MINOS bolts (w/washers)
  - Only penalty is the time to drill and making them fit in gaps between modules & part costs
    - Would need either gaps or bypasses
  - Made in commercial screw machines so very cheap
- Could use concepts common in wood construction
  - Air nailers, joint brackets, mending plates…

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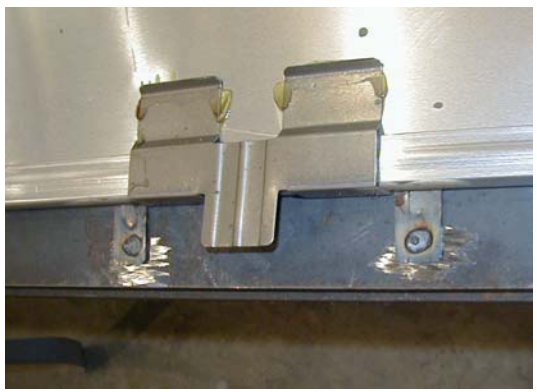
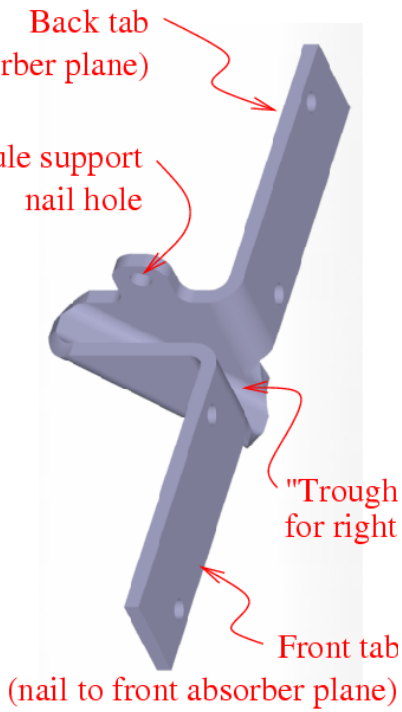
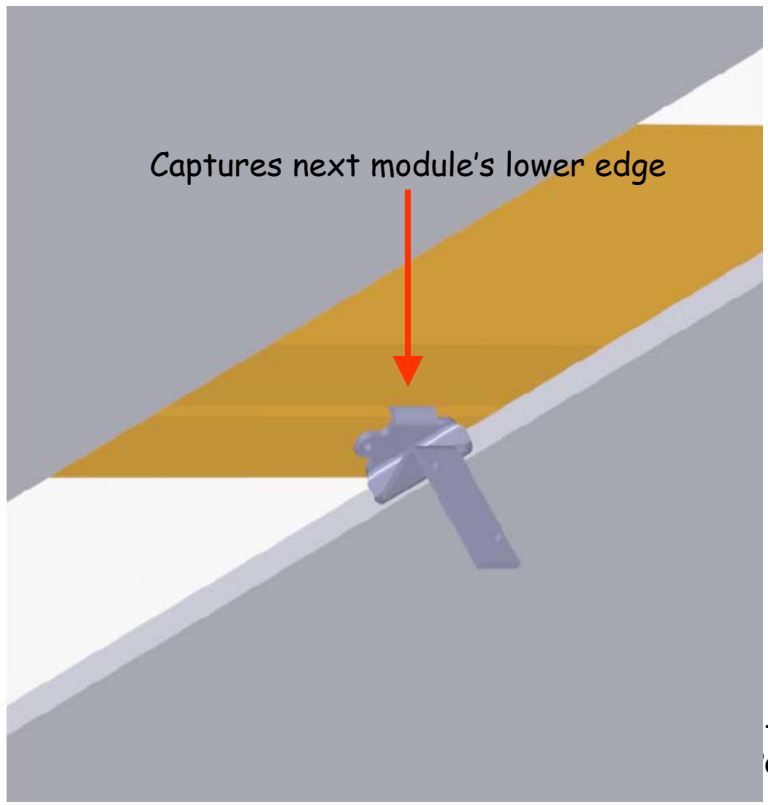
Tie bracket: designed to minimize the gaps

- This bracket ties the planes together
- Made from stamped & folded steel - just like MINOS hclips
- Creates less than a 3mm gap in modules – no bypasses needed
- Standard mending plates for connection within a face

Capture top edge with H clips





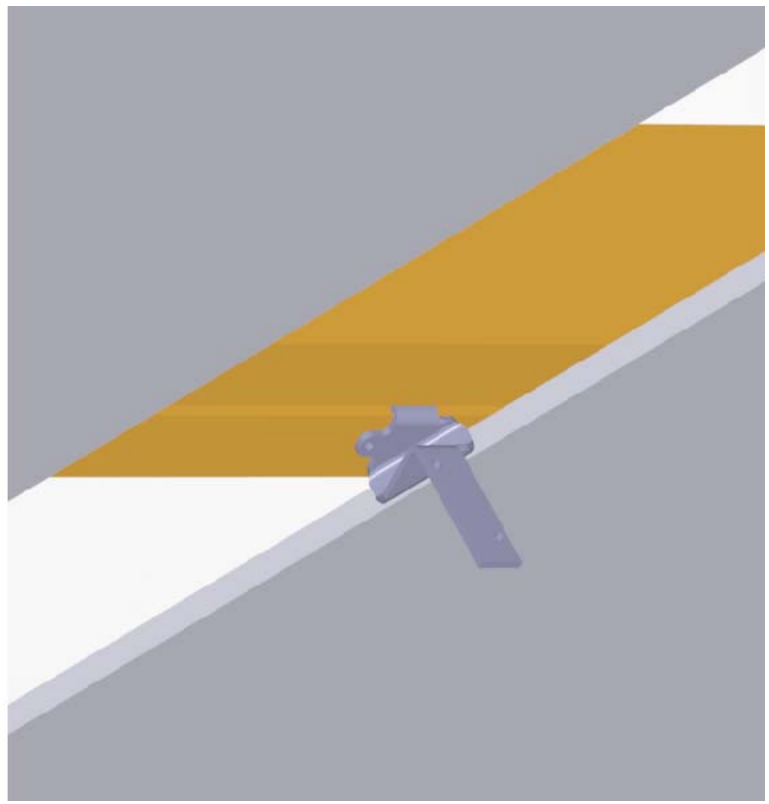


Units of walls

- The walls in this design are make in bricks
  - 12'(h) x 24' (w) x 8" (t) sections
  - Made on the floor from 7 boards
  - Placed in position directly from billets into fixture (either roller bearings or vacuum fixture), jigged, & nailed into bricks
- To help against pull out, edges are made from single sheets laid on top/side
  - Similar role to studs in a house
  - Front & back capture the inner boards – reduced nailing

Expansion?

- The anchor bracket acts as a simple expansion joint and by provides shimmed 3mm voids every 200mm
- Buckling treated by aligning the brick vertically, landing on lower brick, & then nailing in position
  - Can shim out tolerance built up as required

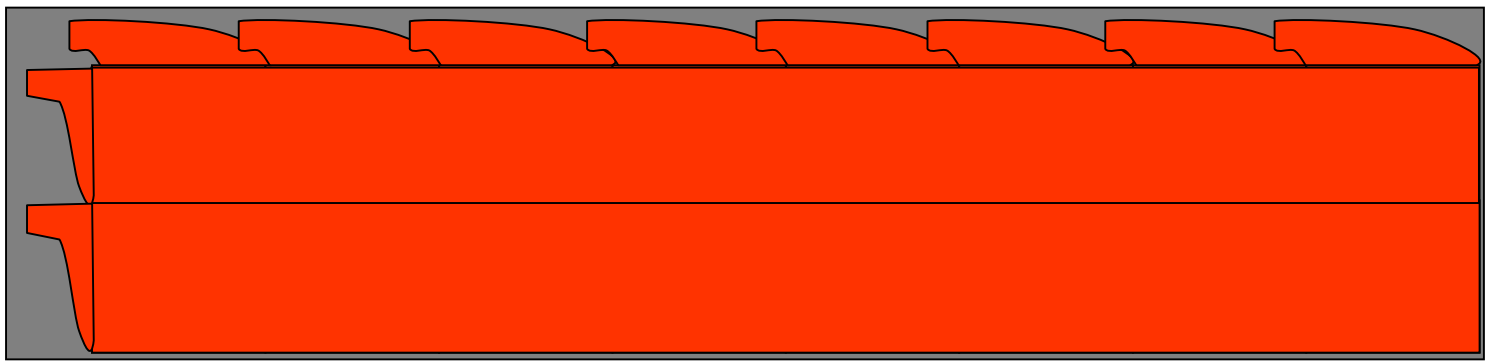


Brick installation

- We can lift the bricks with a lift truck (or a strongback from a gantry) and attach
- Scintillator picked from horizontal and installed vertical using an articulated vacuum lifter off of bridge (or gantry)
  - We use one of these to lift every piece of MINOS FD steel (27ft x 6ft x 0.5" – 1.5t each) we stage to send down the shaft at Soudan
- Can install multiple planes at different sections of face simultaneously
  - More on this later in costing of the installation effort

Containerized Scintillator

- A container-based design would increase the number of modules by factor 3.5
  - Can be done but also increases the number of channels
  - Modules are 2.5m or 6m so one can reduce the light yields and save some scintillator costs for the shorties
- Snouts and conduit bring fibers to edges of the detector for easy access
  - 30m x 30m face is "simple" – good fiducial properties



Longer Strips?

- Can make a half version of the strawman efficiently
  - e.g. 30m x 15m
- Has top and side readout