Cellular Design for a Large Liquid Argon TPC Detector

Presented by Carl Bromberg (with minor edits)
for Hans Jostlein

- Design goal
- Cellular Design
- Additional Possibility:
  - Light Detection
  - Tracking by light

Very speculative

Only briefly mentioned

LArTPC 50KT Structure

The cold tank is subject to large forces:

- Internal pressure
- Hydrostatic pressure
- Weight of detector components
- Thermal expansion forces

The strongest roof is that of the warm dome due to its shape

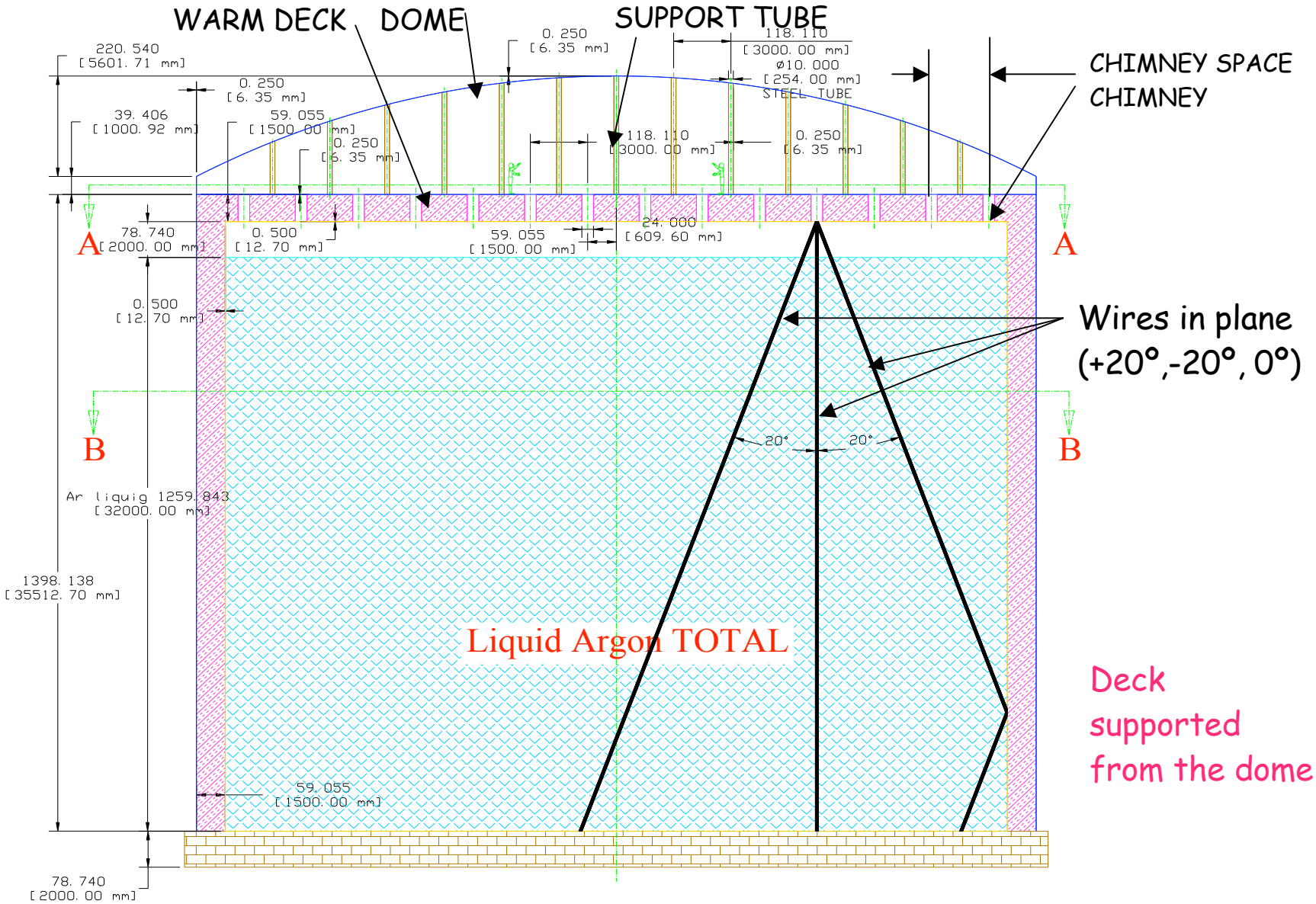
- The Romans invented that

Hence: Support the roof of the cold tank from the warm dome

- Forces may be in tension or compression; buckling issue
- Cold tank roof must be able to move a few inches up and down
- To allow for thermal expansion of warm versus cold tank

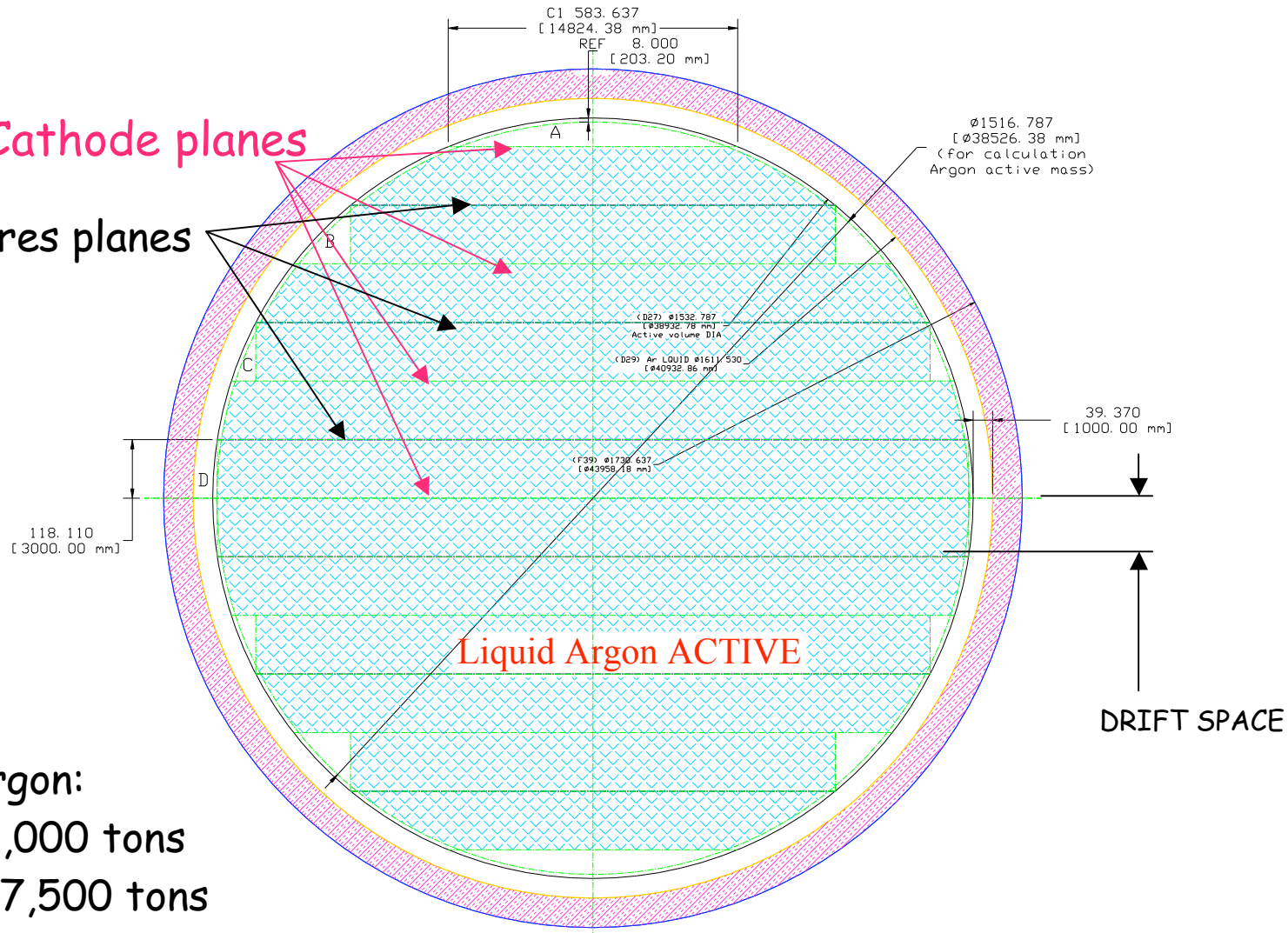
This eliminates the huge cold trusses that would otherwise be needed.

LArTPC 50KT (wire plane section)



Deck supported from the dome

LArTPC 50KT. (section B-B)



Cathode planes

Wires planes

Liquid Argon:
Total-59,000 tons
Active-47,500 tons

SECTION B-B

David Finley's Clever Wire Layout

For a design with angled wires, attached to the tank top, bottom, and sides,
there will be some wires that do not reach all the way to the top,
Hence cannot easily be read out.

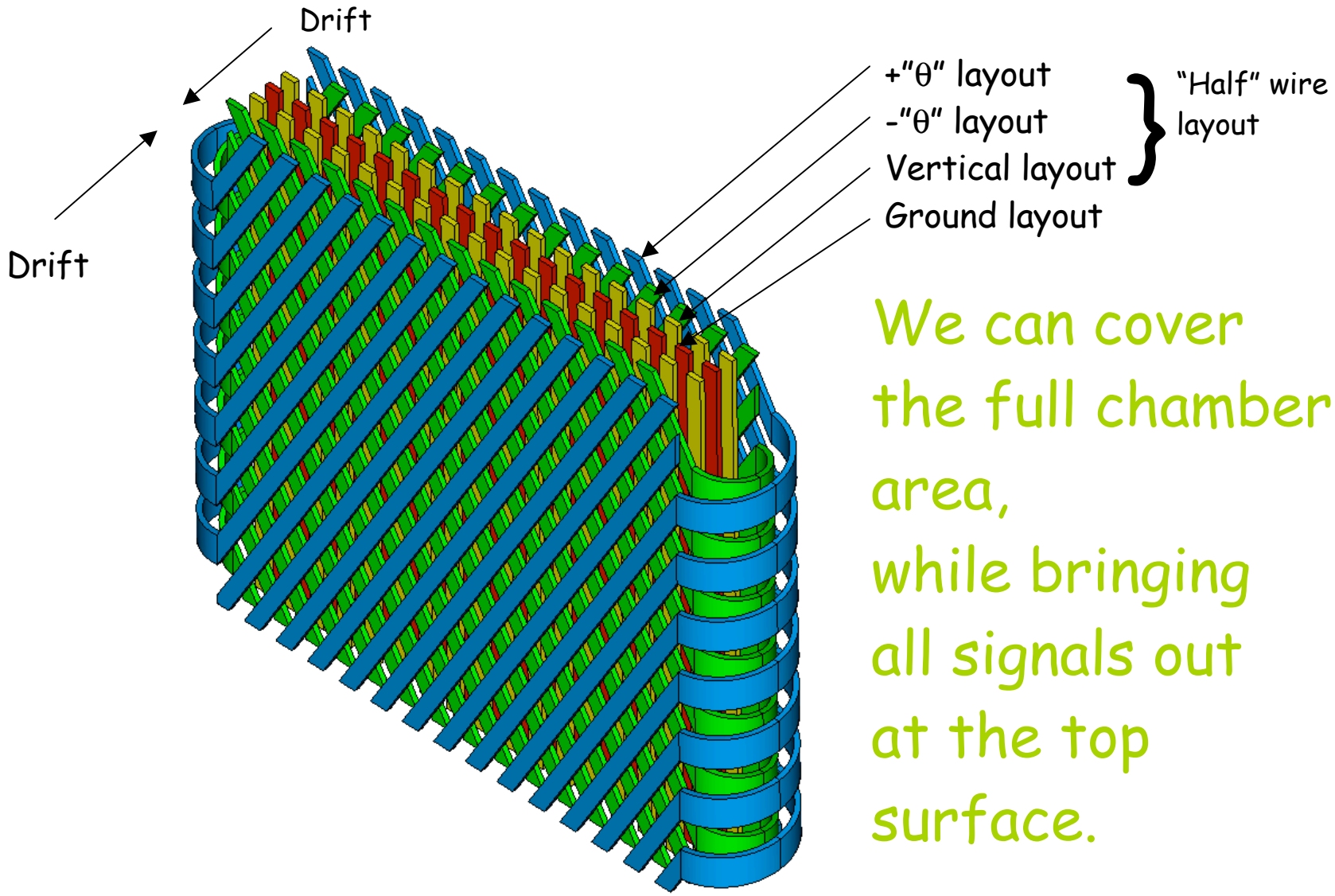
Each set of wire planes has 3 planes to detect electrons drifting in from the left,
and 3 planes for electrons drifting in from the right.

For each plane in the left triplet,
there is a corresponding plane, with the same DC potential, in the right triplet.

Dave's clever idea:
Connect the short wires on the left, that did not reach the top,
to the set of short wires on the right that start not at the tank bottom,
but higher up on the wall.

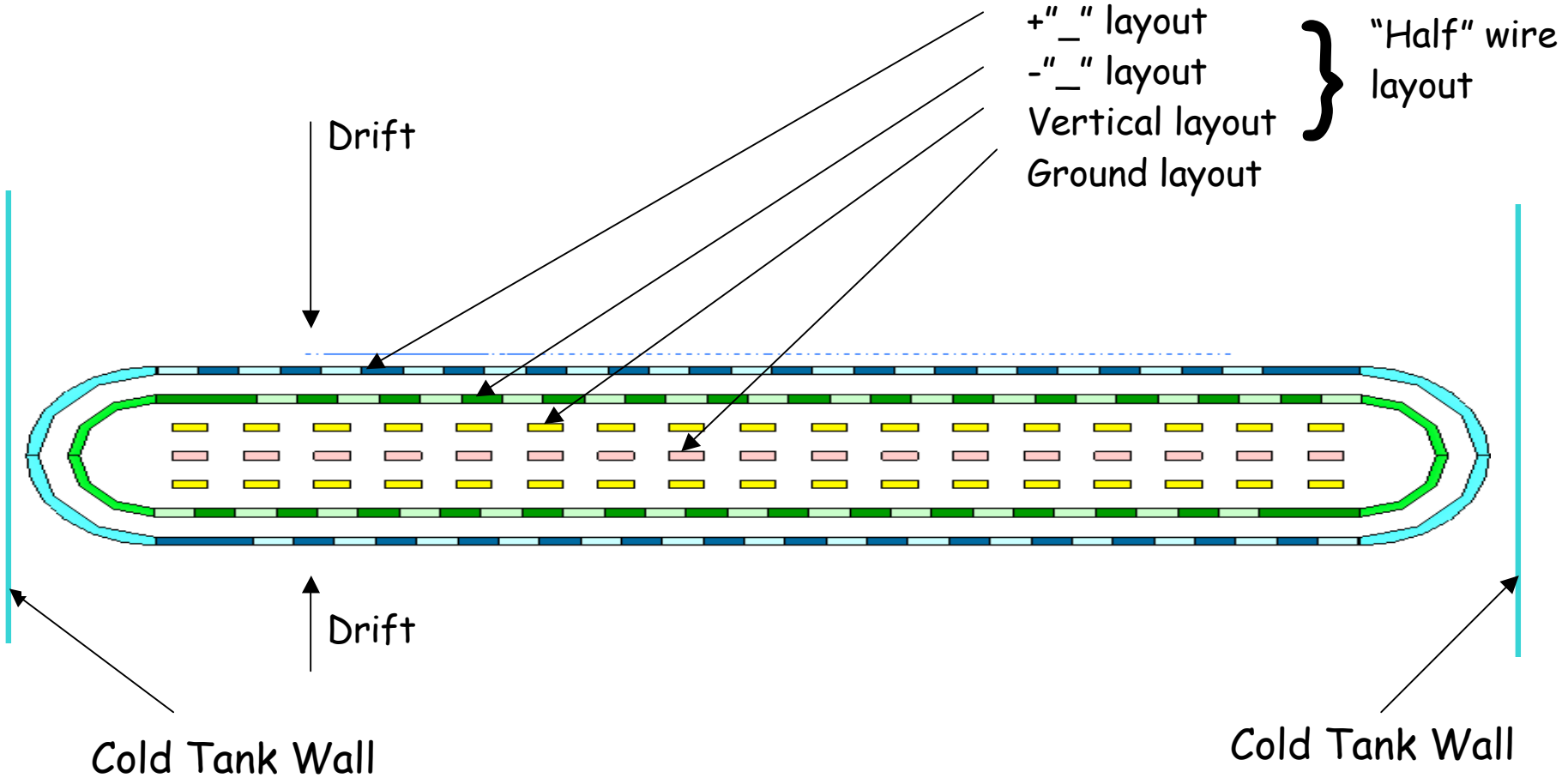
Voila: Complete coverage.

Clever Wire Layout

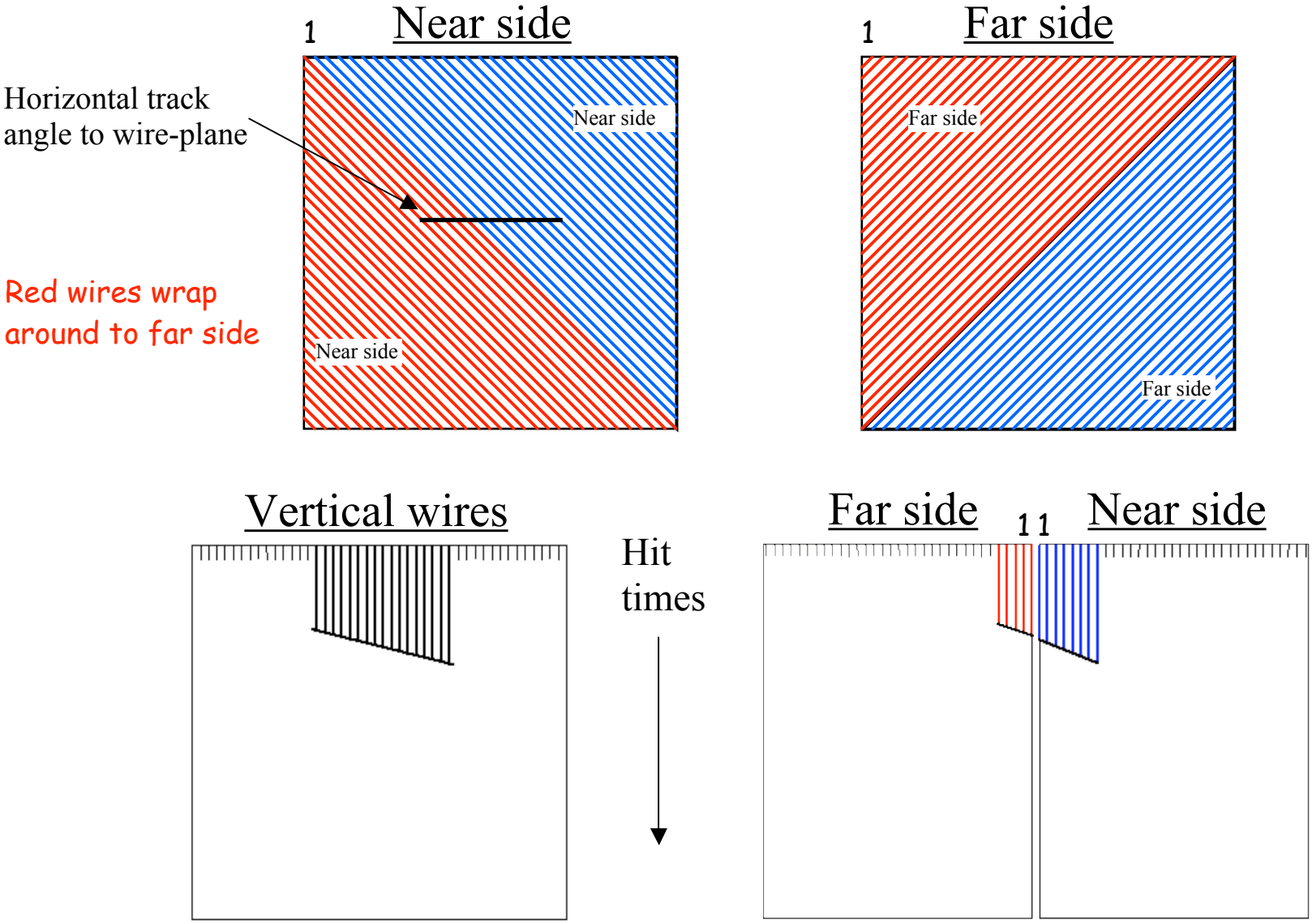


We can cover the full chamber area, while bringing all signals out at the top surface.

LArTPC 50KT. WIRE LAYOUT



Matching track segments



Some large tank issues

Differential thermal contraction - perhaps manageable

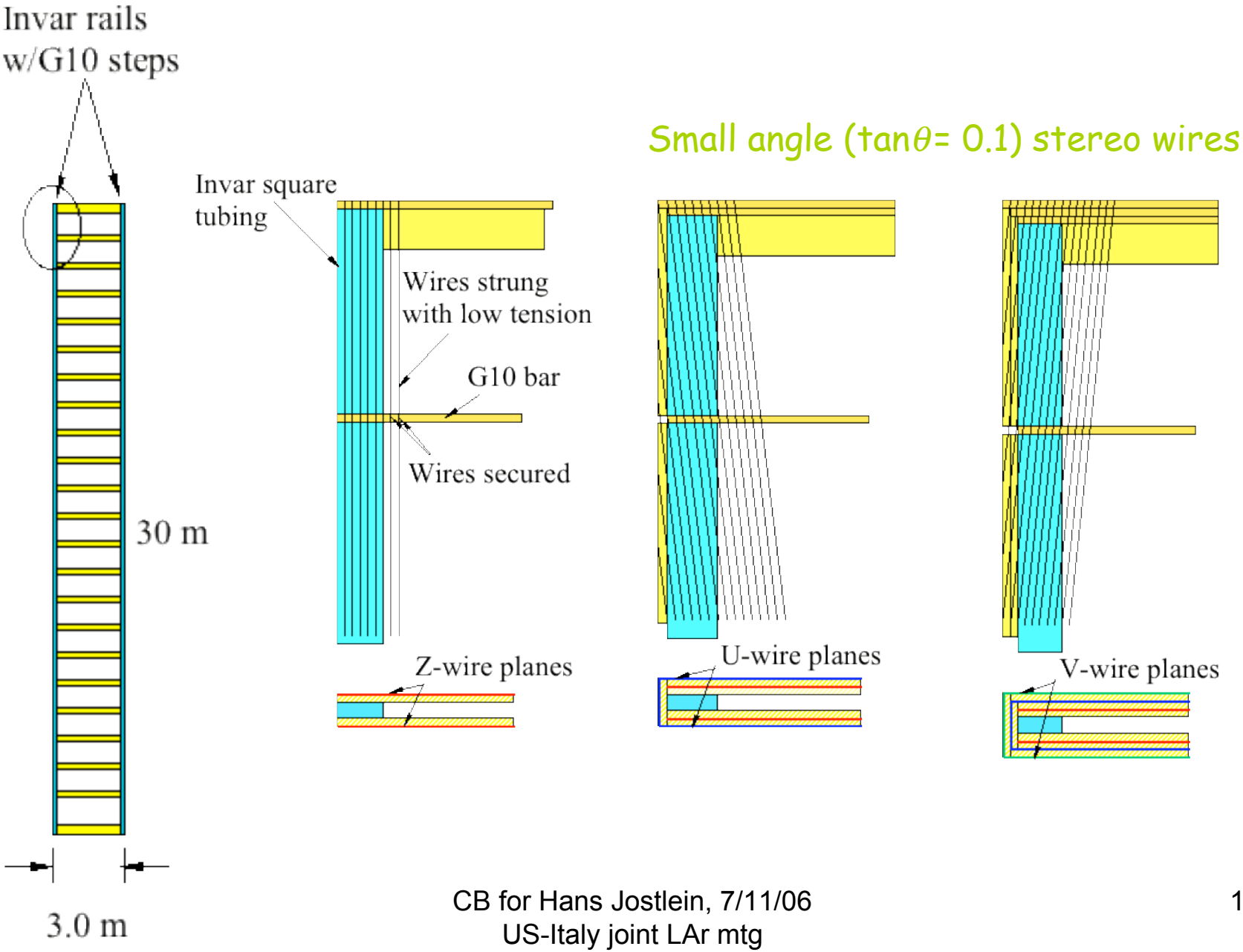
Construction difficulties - but not impossible

- Wires strung in-situ by "craftsmen"
- High risk of disaster for people/wires
- Stringing the wires waits until tank is done
- First fill is the first test of the wire integrity
- Could take up to 1 year to install all the wires
- Wire breakage issues before and after filling

Challenge: avoid the issues while keeping tank concept

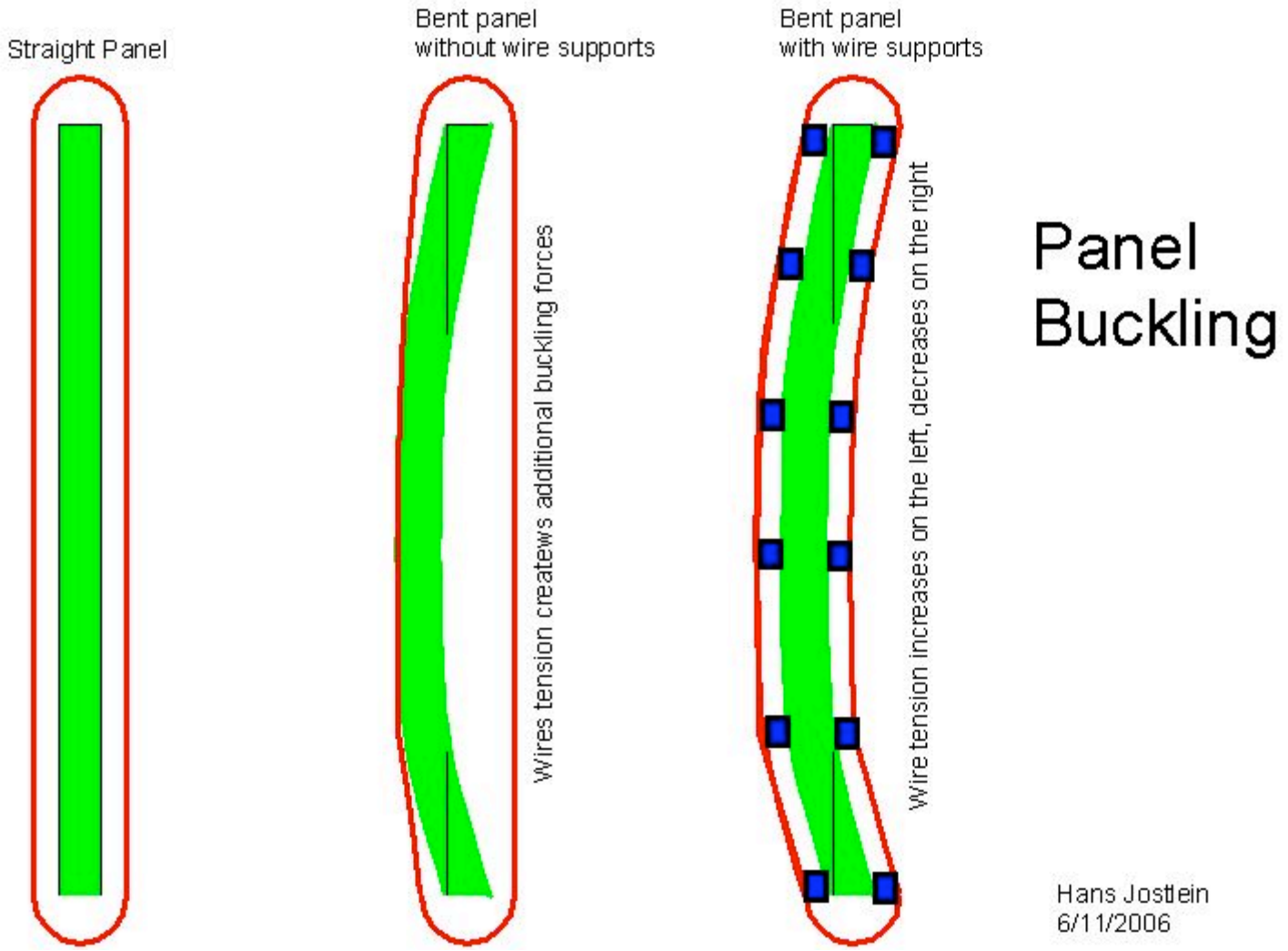
"Ladders" may be the answer

Wire ladders: tank & wires independent

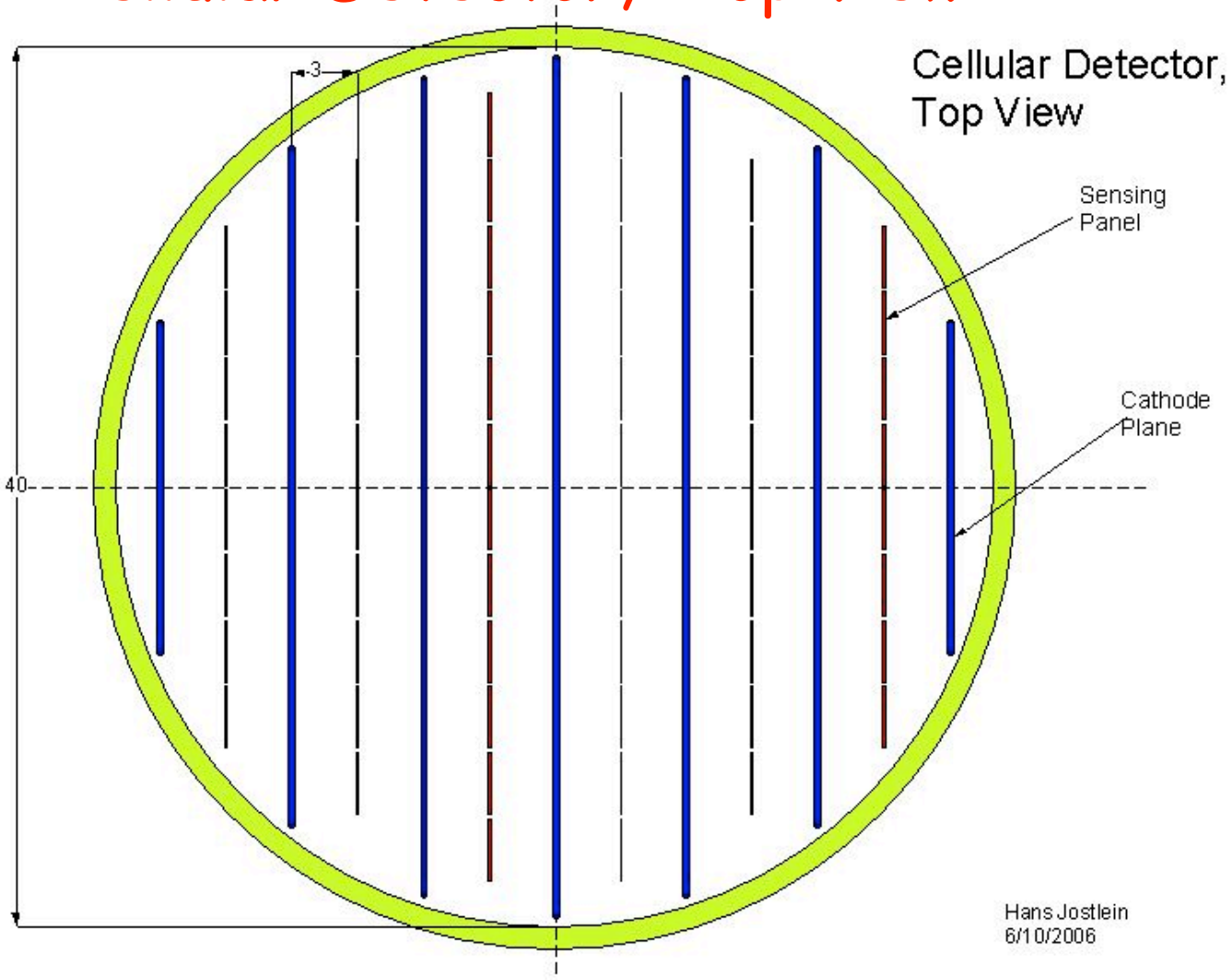


Small angle (tanθ= 0.1) stereo wires

Ladder Buckling



Cellular Detector, Top View



Cellular Detector

What do we gain ?

Ladders are made off-site and shipped (by truck or cargo plane) to the detector site

Ladders are made while the tank is being built

Ladders are fully tested and cold-shocked

Ladder installation is fast and low-risk

Ladders provide ideal platform for plug-in electronics

Ladders largely decouple tank design from wire requirements

Ladders result in the same number of channels as free standing wires

Possible Additional Capability: Light Detection

Why detect light ?

ICARUS has always incorporated Photo tubes

- Used for triggering
- Timing with respect to neutrino beam spill
- Readout sparsification
- Event absolute location

Light Collection