DUNE ND MEETINGS

DUNE ND MEETINGS

- General forum for discussing (Phase I) DUNE ND

- Topics include:

  - Discussion that spans across the detector consortia, including infrastructure

  - Physics studies and software/computing developments that impact ND design

    - Including studies for DUNE ND preliminary technical design report

  - Major developments from ND consortia

    - Should be presented and discussed within the consortium first

  - Periodic updates/status from ND consortia and subsystems

  - Phase II discussions remain with the Phase II organization

- Initial cadence of ~1/month

ND-LAr/TMS vertical alignment

PHASE I ND REQUIREMENTS

- The DUNE ND Requirements task force has concluded and produced its initial report

  - Many thanks to the committee for this important work!

- The draft report has been presented to the LBNC in the June meeting

  - They will provide feedback in the coming weeks

- We would like to finalize the report shortly there after

- Please have a look at the report (docdb 30591)

  - Thanks to those who have provided feedback already

  - Further feedback welcome until 12 July

Chair: Mike Kordosky
- **Physics Working Groups**
  - Long Baseline: L. Pickering
  - Cross Sections: L. Muntenau
  - Exotics: J. Justo-Albo
  - Computing/Software: M. Muether
- **ND consortia:**
  - ND-LAr: P. Ochoa Ricoux
  - TMS: D. Naples
  - SAND: M. Tenti

ND-LAr/TMS vertical alignment

VERTICAL ALIGNMENT OF ND-LAr and TMS

From P. Tennessee (May ND TB Meeting)

Geometric centers of all detectors are currently on beam centerline

- Allowing a vertical offset would reduce cost by shrinking platforms under TMS and ND-LAr

- What accuracy is necessary for physics goals?
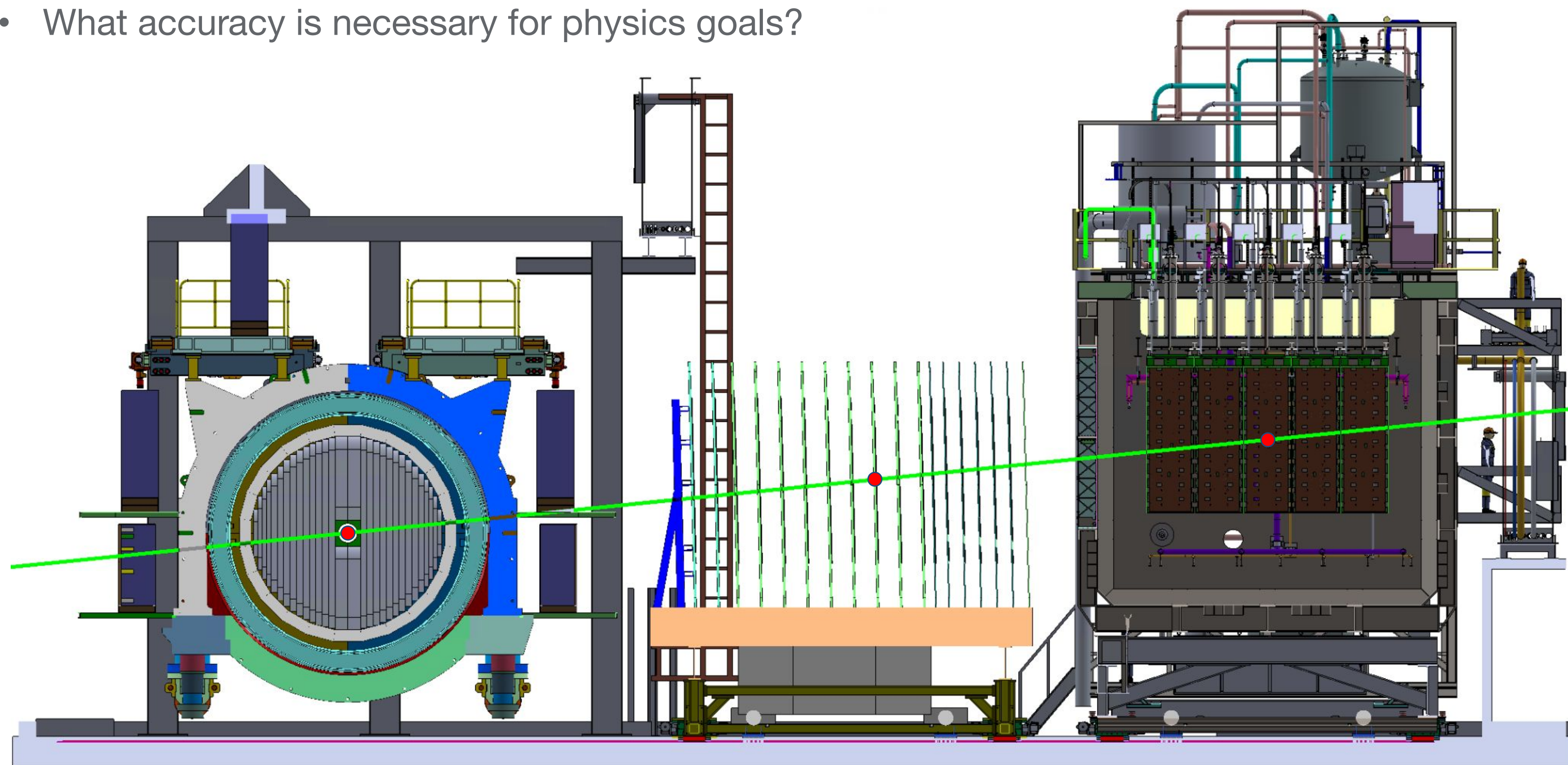
GOAL

- We would like to specify the vertical positions of ND-LAr, TMS

  - Specify = nominal ± tolerance

  - Horizontal positions are largely irrelevant/moot since:

    - Along the beam direction, the detectors are highly constrained but we many eventually ask similar questions

    - Transverse to the beam, the detectors move with DUNE-PRISM . . these are DUNE-PRISM accuracy requirements

- Ideally, we would perform a simulation to maximize acceptance, etc.

  - We don't have this . . and even so, there would be ambiguity in what it means to "maximize acceptance"

- We have operated based on simple geometric considerations thus far

  - Several "reasonable" ways to specify a geometric consideration that lead to different nominal positions

  - See how much they quantitatively vary the implied vertical position

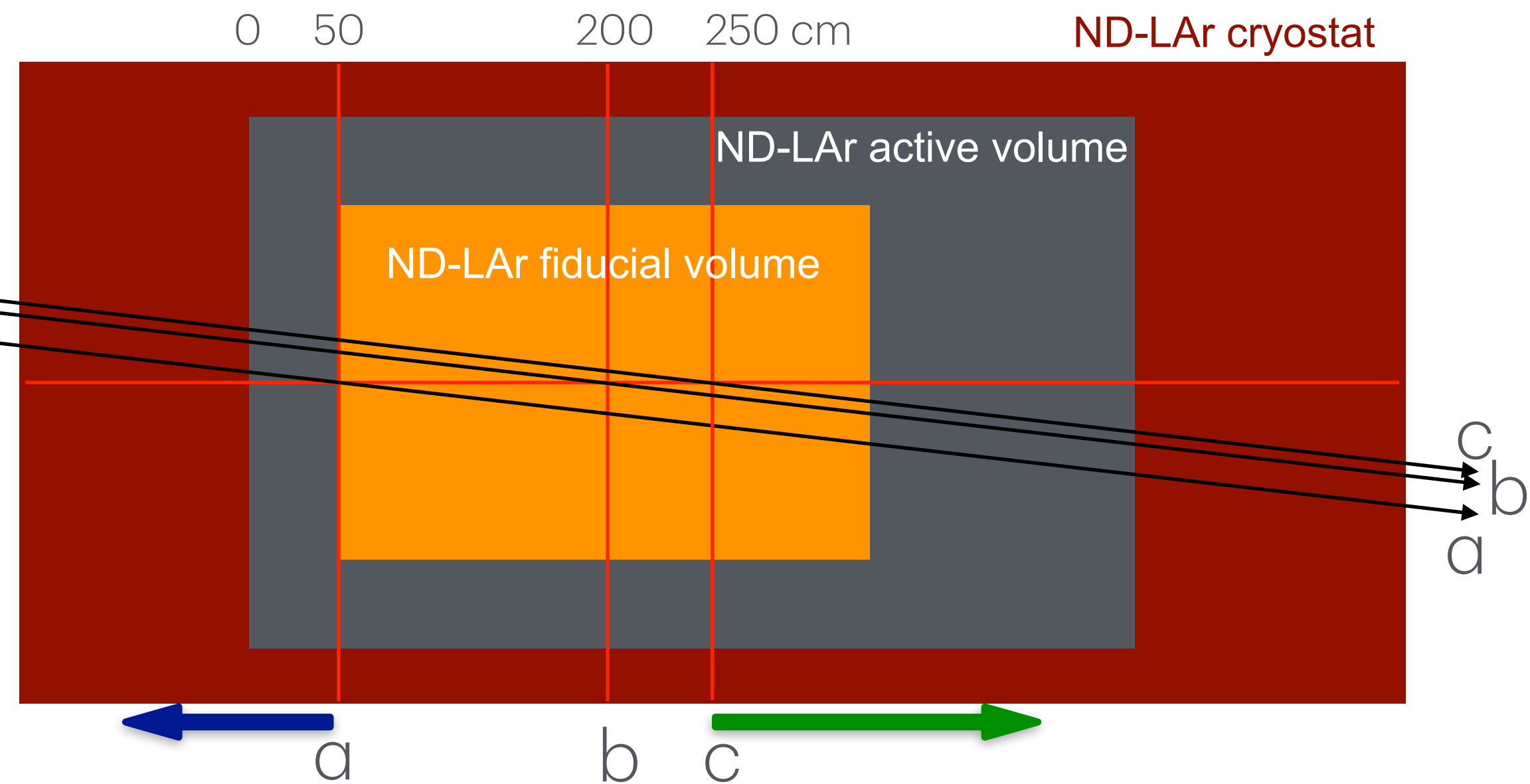   - This can

STEPPING TOWARDS OUR SITUATION

- If the beam were truly horizontal, we would center both detectors vertically along the beam axis

    - I think this is "obviously" what we would do

    - We would still need a tolerance

- But the beam is tilted 5.79°

    - If we could orient the detector in any way

        - "Just" tilt the detectors by the same amount

- But we keep the detectors horizontal . . . .

    - What does it mean to be "centered"?

ND-LAr/TMS vertical alignment
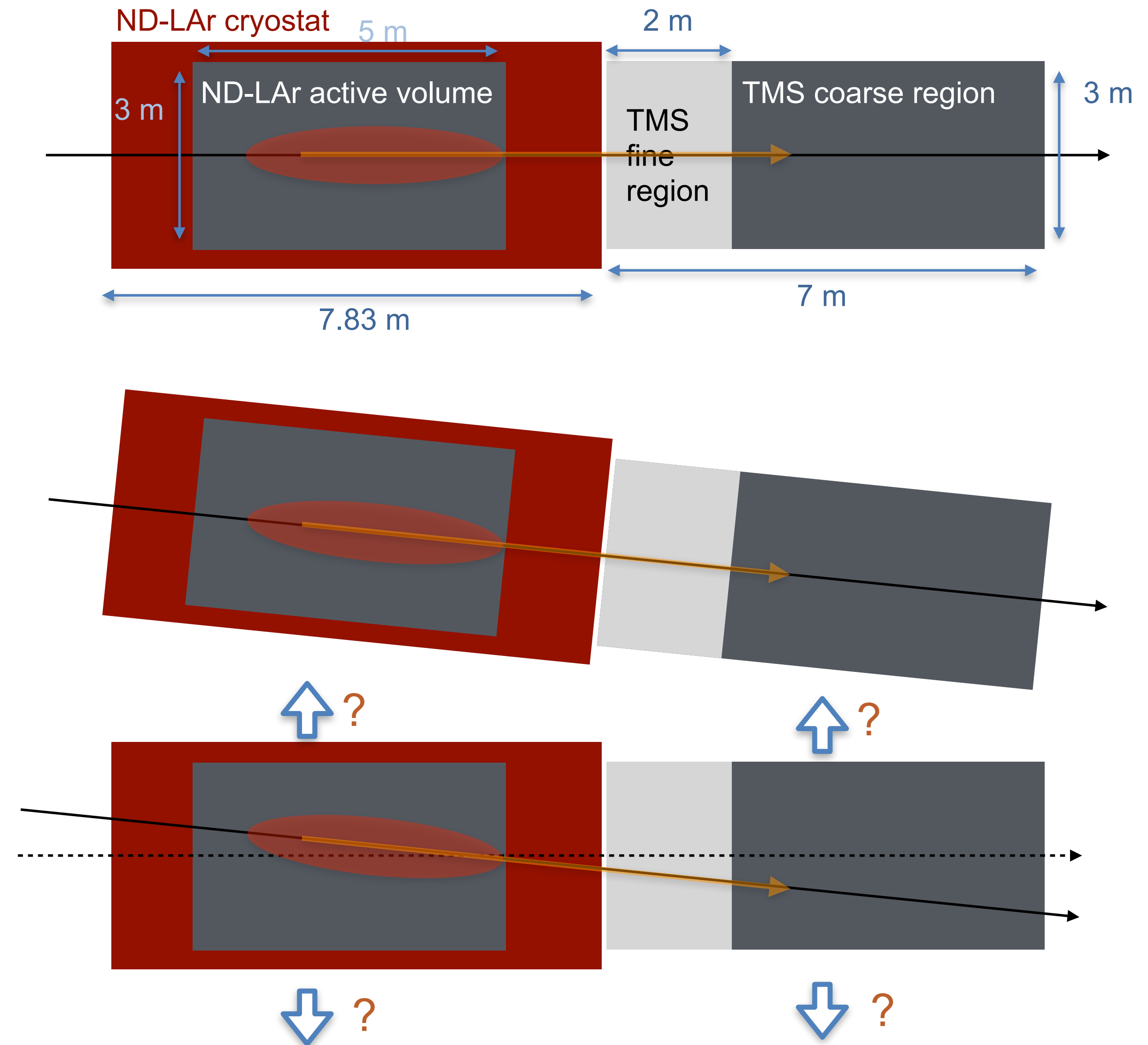
CENTERING:

- "Centering" means different things for ND-LAr and TMS

- For ND-LAr, there is a "fiducial volume" in which we want to contain a neutrino interactions

  - Particles go roughly in the direction of the beam but some can go at wide angles and even backwards.

    - There should be a "buffer" around the interaction point so that particles can range out in all direction

  - Hence a "fiducial volume": interactions within this volume have sufficient buffer of active LAr:

    - 50 cm from upstream face and top/bottom, 150 cm from back end (due to higher energy particles going forward.

- For TMS, there is no "fiducial volume" since we are looking at muons come from ND-LAr

  - They pass through the front face of the detector and go where they may

    - We want to maximize the possibility of intercepting that muon and its path through the TMS

  - Relevant alignment is with respect to ND-LAr

    - If ND-LAr is offset with respect to the beam, TMS should follow
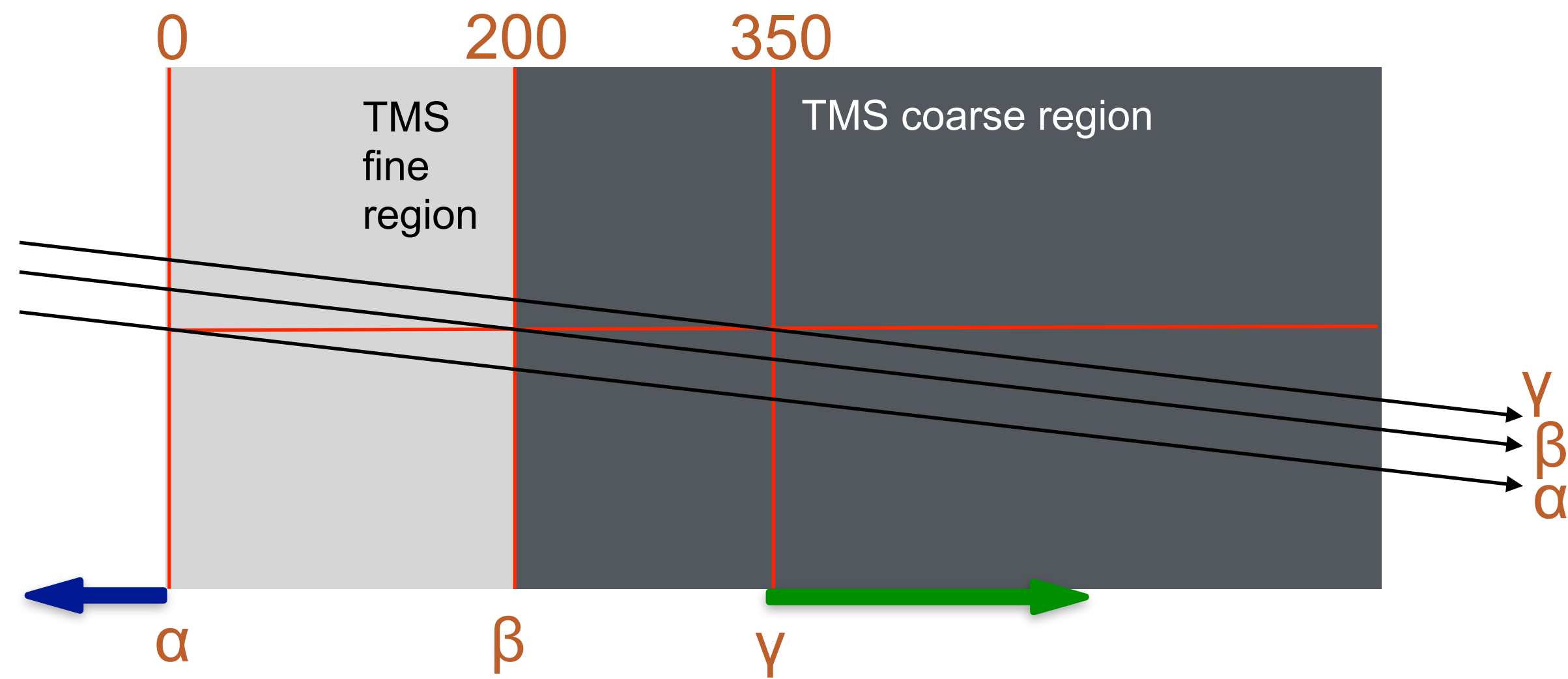
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ND-LAr

- Three possible points to center:
  - a.) start of ND-LAr fiducial volume
    - 50 cm downstream of upstream edge of active volume
  - b.) middle of ND-LAr fiducial volume (+150 cm)
    - 200 cm downstream of upstream edge of active volume
    - **"nominal"**
  - c.) middle of active volume (+200 cm)
    - 250 cm downstream of upstream edge of active volume

- Given upstream containment, centering further upstream of a.) doesn't make sense
- Given downstream containment of higher-energy "forward" particles, centering further downstream of c.) doesn't make sense

- Results
  - a.) Raise detector +15 cm from nominal
  - b.) "Nominal"
  - c.) Lower detector -3 cm from nominal
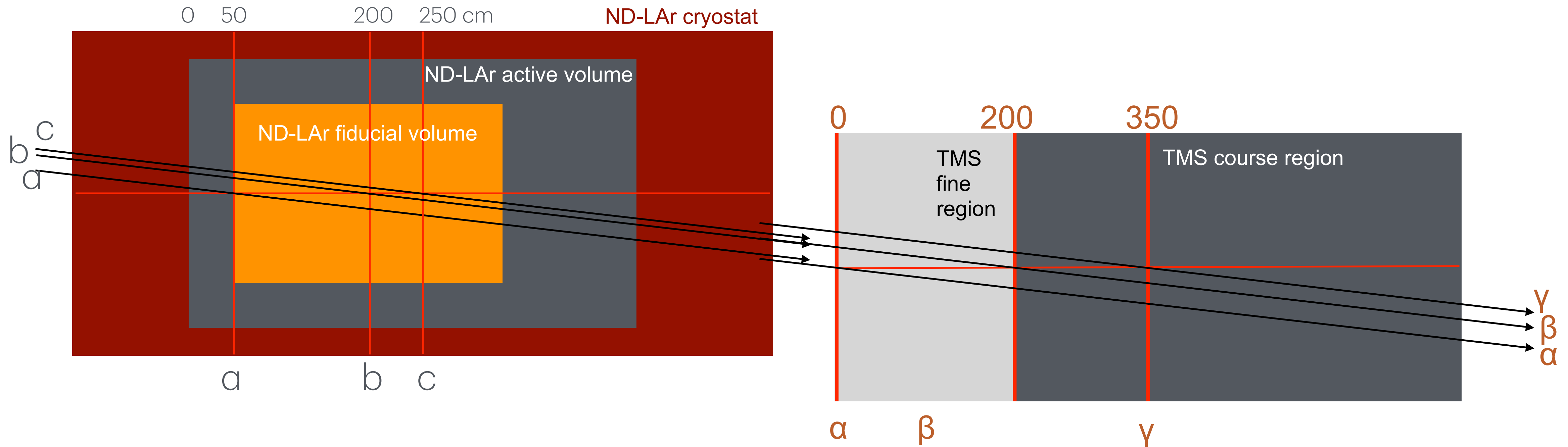
ND-LAr/TMS vertical alignment

TMS

Three possible points to center:

- α.) start of TMS (0 cm)

- β.) transition between fine/coarse region (+200 cm)

  - **Current nominal**

- γ.) middle of overall TMS (+350 cm)

**Doesn't make sense to center outside of the detector, so upstream of α doesn't make sense**

Given entry of muons from upstream centering further downstream of γ doesn't make sense

- Results

  - α.) Raise detector +20 cm from nominal

  - β.) Nominal

  - γ.) Lower detector -15 cm from nominal

ND-LAr/TMS vertical alignment
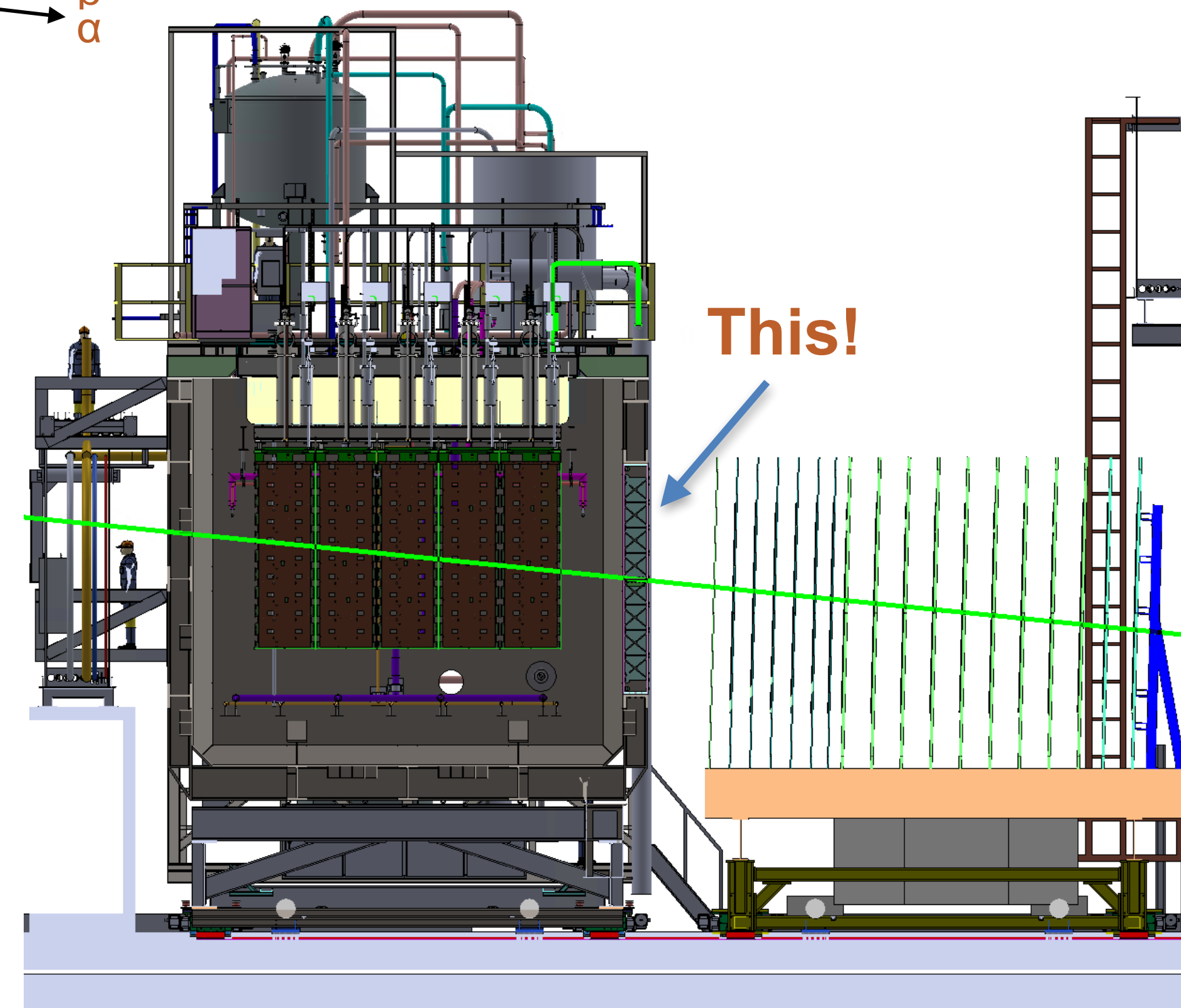
ND-LAR + TMS

- The beam axis does not directly pertain to TMS alignment

  - What matters is that it intercepts muons coming out of ND-LAr

  - However the beam axis also gives the axis on which the muons from ND-LAr will be centered

- Translate the range from the previous slide as TMS relative to ND-LAr (instead of beam axis)

- Redefine nominal b' (β') so that they are centered between a(α) and c(γ) to center tolerance
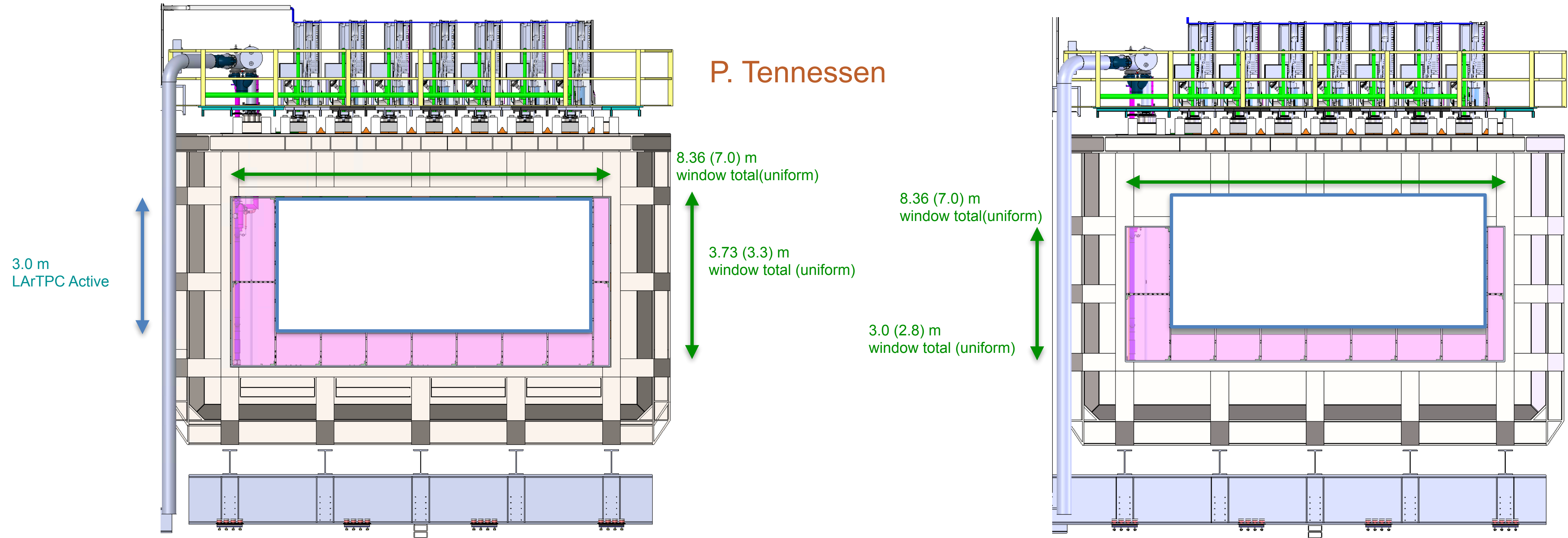
MUON WINDOW

P. Tennessen

This!
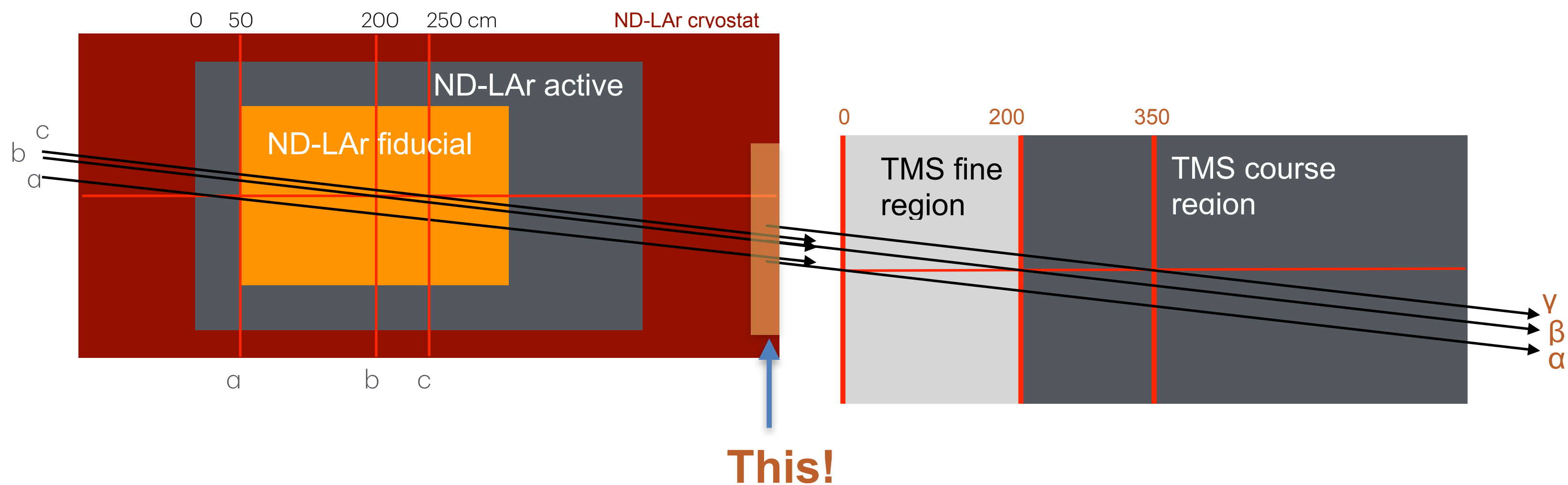
- A key feature of the ND-LAr cryostat is the downstream low-mass "window"

  - Skeleton steel structure to minimize energy loss for muons exiting ND-LAr and entering TMS while still providing mechanical support

  - Window vertical alignment should follow ND-LAr (like TMS)

SLAC Stanford University U.S. DEPARTMENT OF ENERGY Office of Science

ND-LAr/TMS vertical alignment

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CURRENT/PROPOSED CONFIGURATION

P. Tennessen

8.36 (7.0) m
window total(uniform)

3.73 (3.3) m
window total (uniform)

3.0 m
LArTPC Active

8.36 (7.0) m
window total(uniform)

3.0 (2.8) m
window total (uniform)

- Proposal:

  - Due to structural margin and construction issues, reduce window height from 3.73(3.3) m → 3.0(2.8) m

  - Slight downward offset of window by 14 cm → 116(164) cm above(below) beam axis

ND-LAr/TMS vertical alignment

PROPOSALS:

- Position ND-LAr vertically so that the nominal beam-axis passes through center of the detector 100 cm from the upstream edge of the fiducial volume (150 cm from upstream edge of active volume) with ±9 cm tolerance

- Position the Muon window such that a ray extending with 5.79 downward tilt from the vertical center of the ND-LAr active volume 150 cm from the upstream edge of its active volume passes 14 cm above the vertical center of the window, which has 2.8 (vertical) x 7 (horizontal) m^2 uniform area.

  - (Tolerance/area requirements to be defined)

- Position TMS vertically so that a ray extending with 5.79 degree downward tilt from the vertical center of the ND-LAr active volume 100 cm from the upstream edge of its active volume passes through the vertical center of TMS 175 cm from its upstream with +18/-18 cm tolerance