Magnetic LAr1-ND Possible Configurations and Physics Topics

(Work in progress)

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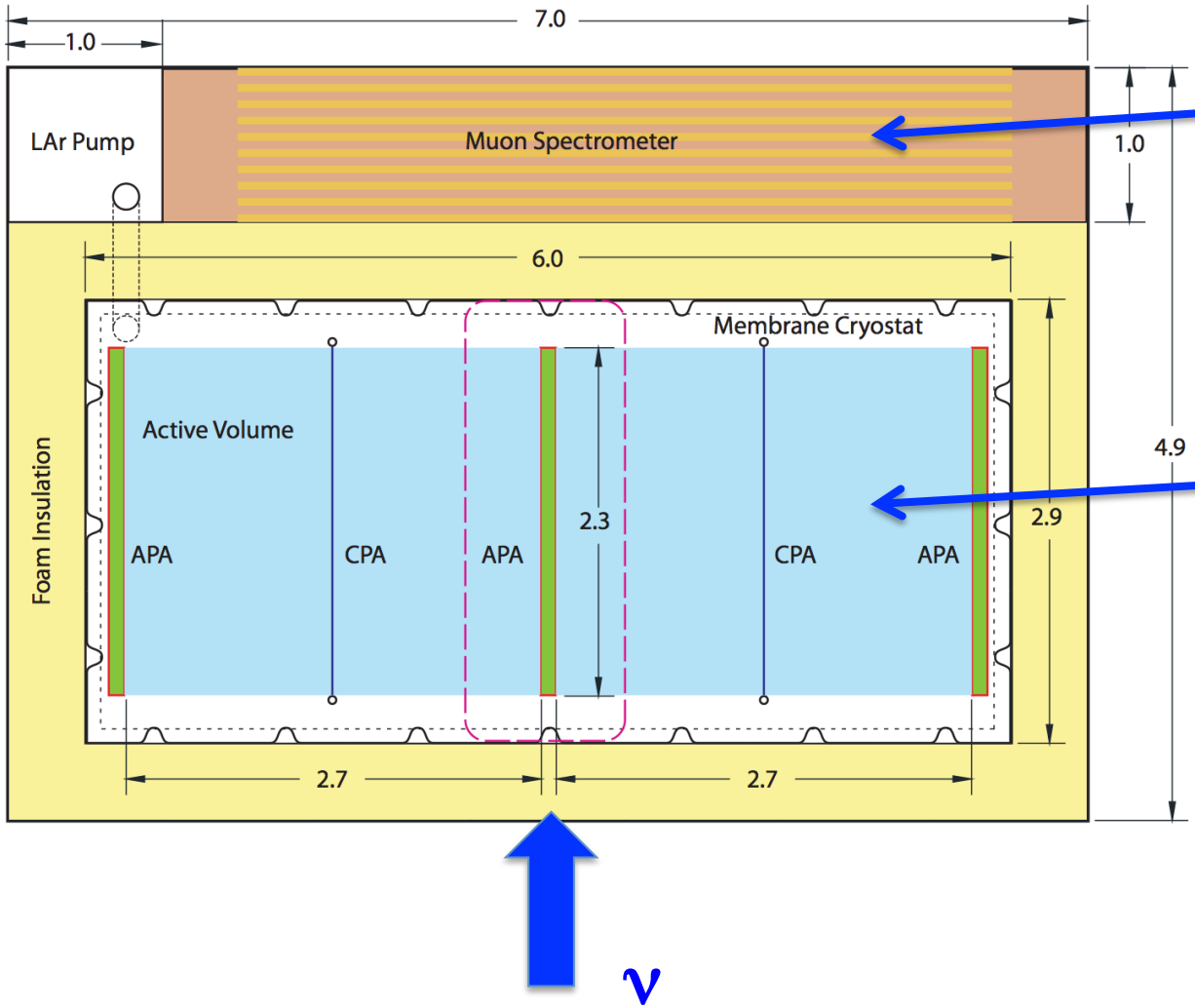
LAR1-ND Top View

Present concept



Measure Muon Through Range

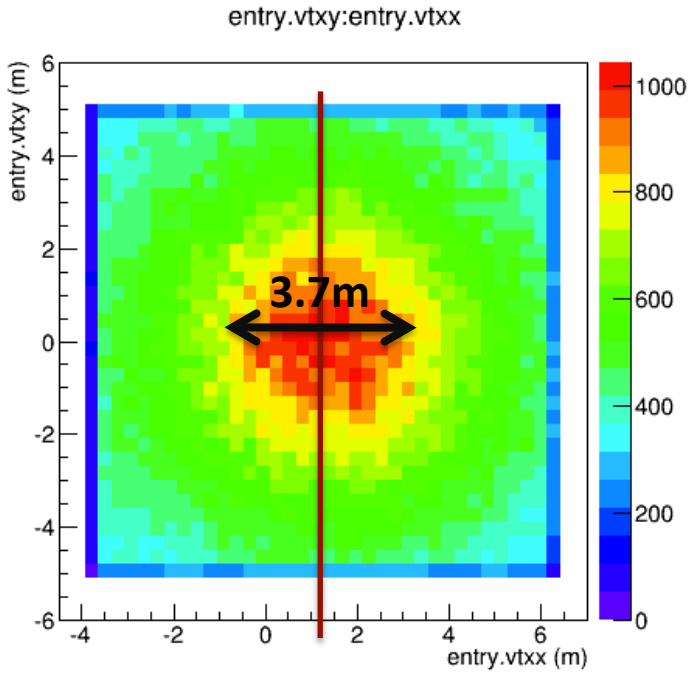
TPC in Membrane Cryostat (LBNE design)

TPC: 2.3m deep
5.7m wide

Muon Spec: 1m deep

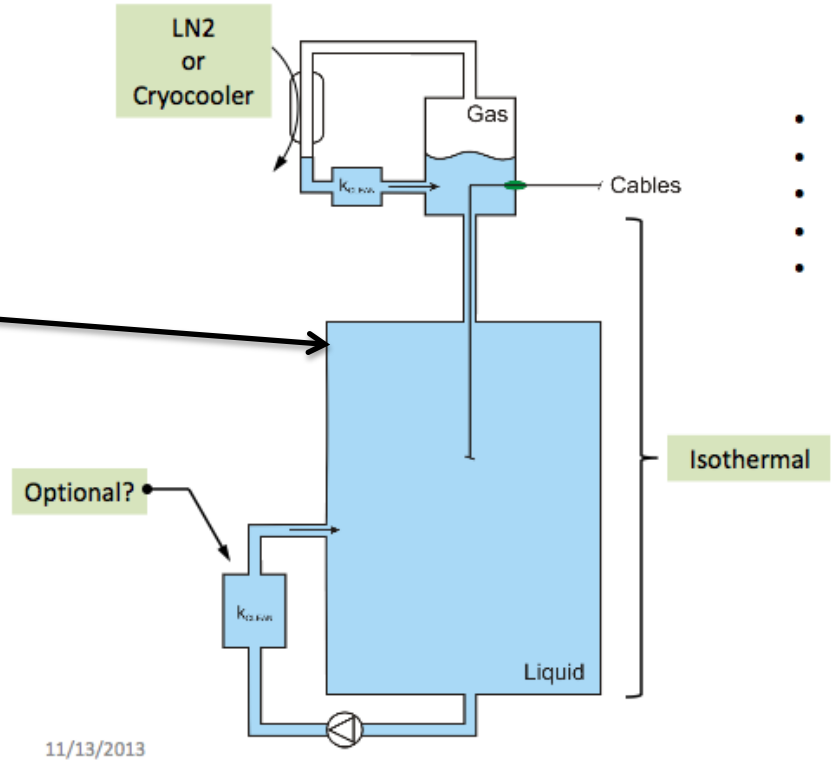
Pit Dimensions and Assumptions

- Pit dimensions: (in its present configuration)
  - Width: 7m Length (along beam) 4.9m Height: 8.5m
- Vacuum cryostat thickness + dead space around TPC:
  - 30cm.
- Coil thickness:
  - 20cm.
- Top/Bottom Return Yoke thickness:
  - 65cm each.
- TPC area perpendicular to beam:
  - 3.7m x 3.7m.
  - Beyond this ν flux density decreases.



Pit Dimensions and Assumptions

- Ullage:
  - Craig's new scheme. Docdb 1107.v4
  - Gas/liquid interface in separate vessel
  - No ullage within cryostat
  - **Reduces height of magnet**



Possibile Configurations

- Magnetized TPC of **maximum depth** along beam.

- Magnetized TPC + instrumented return yoke **upstream** of TPC:
  - Provides an additional iron target: more tonnage for CC interactions.
  - With muon momentum measurement in downstream TPC.

- Magnetized TPC + instrumented return yoke **downstream** of TPC:
  - Provides muon momentum measurement through range in downstream instrumented yoke for events near downstream boundary of TPC.
  - Basically original setup but magnetized iron.

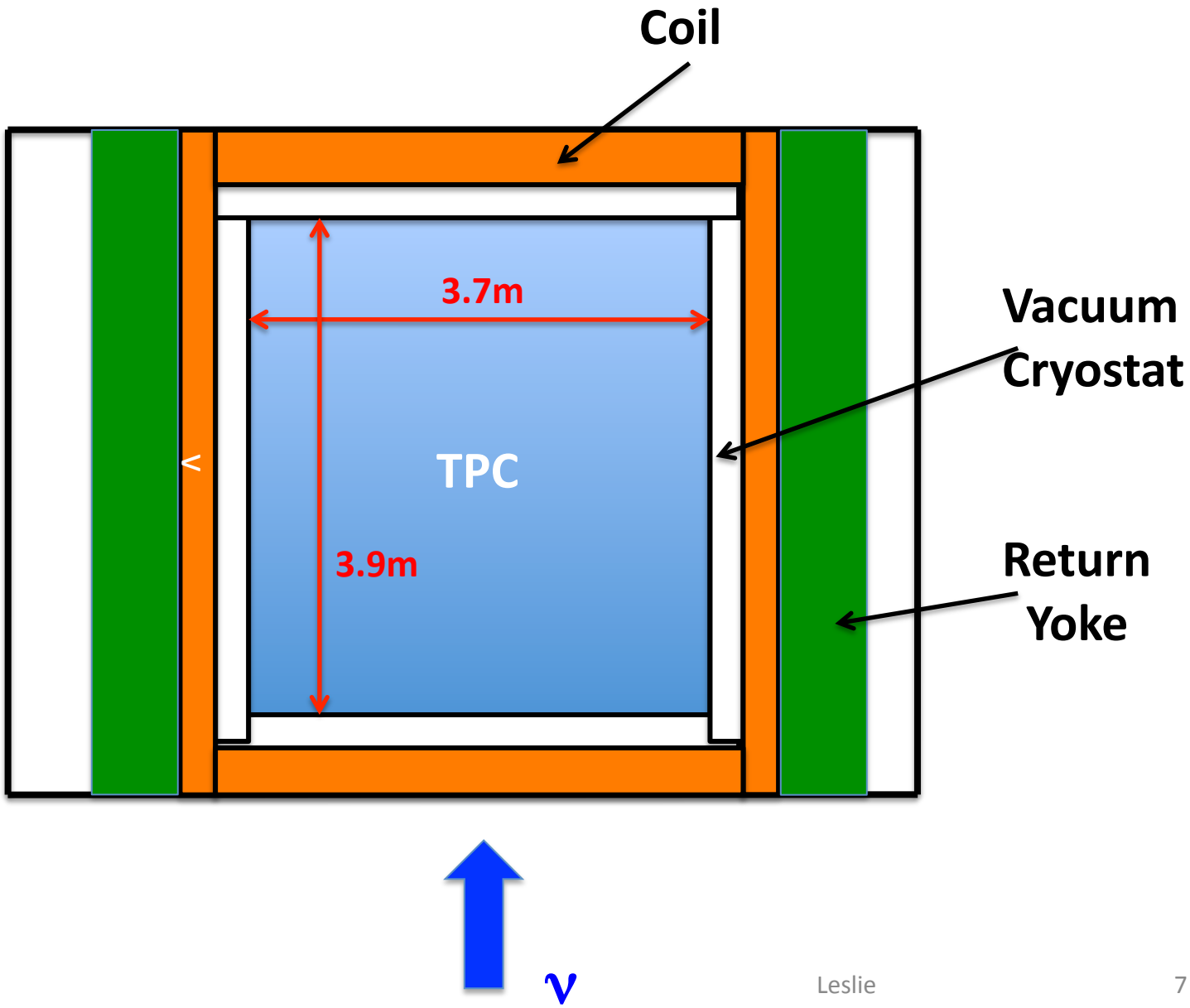
Possibility: Instrumentation of yoke done with Double Chooz Outer Veto scintillator modules (if available).

Maximum TPC Depth
Return Yoke on sides

Item	Width(m)	Depth(m)	Height(m)
TPC	3.7	3.9	3.7
Cryostat 2x0.3	**0.6**	**0.6**	**0.6**
	4.3	4.5	4.3
Ullage	0.0	0.0	0.0
	4.3	4.5	4.3
Coil 2x 0.2	**0.4**	**0.4**	**0.0**
	4.7	4.9	4.3
Pit	7.0	4.9	8.5
Spare	2.3	**0.0**	4.2

Maximum TPC depth

Top view

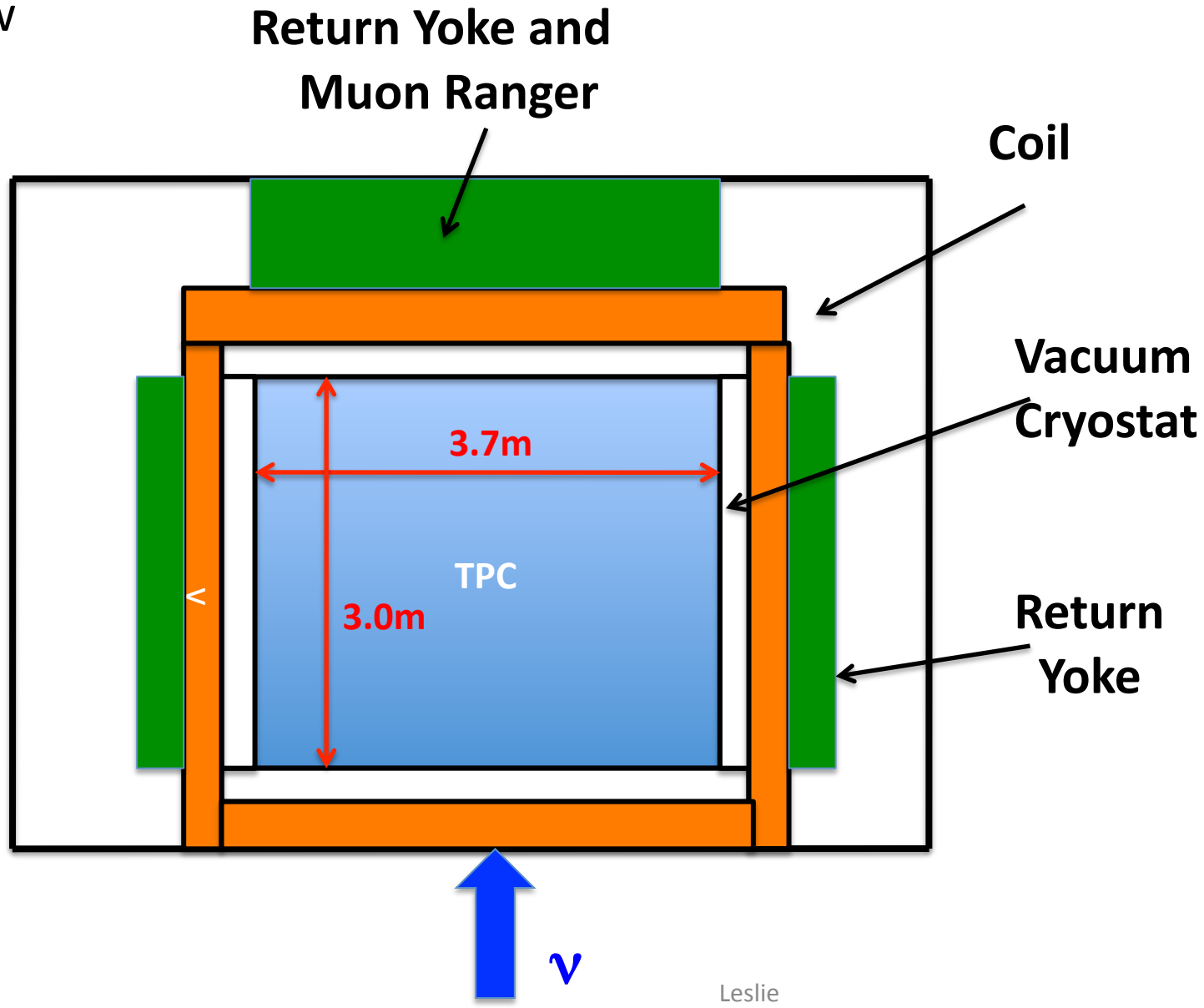


Return Yoke in Beam

Item	Width(m)	Depth(m)	Height(m)
TPC	3.7	3.0	3.7
Cryostat 2x0.3	**0.6**	**0.6**	**0.6**
	4.3	3.6	4.3
Ullage	0.0	0.0	0.0
	4.3	3.6	4.3
Coil 2x 0.2	**0.4**	**0.4**	**0.0**
	4.7	4.0	4.3
Pit	7.0	4.9	8.5
Spare	2.3	**0.9**	4.2

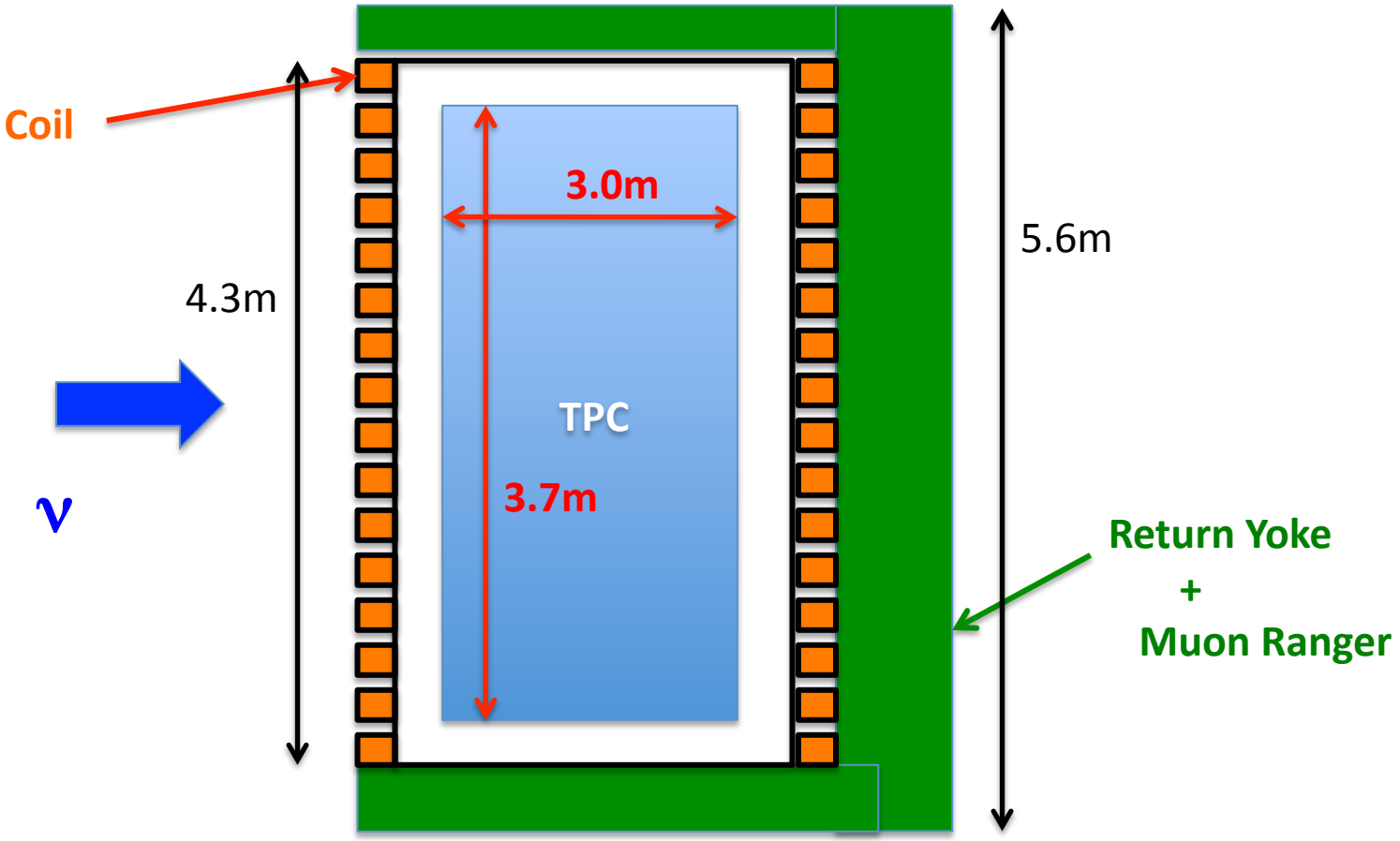
Muon Ranger (magnetized) downstream

Top view



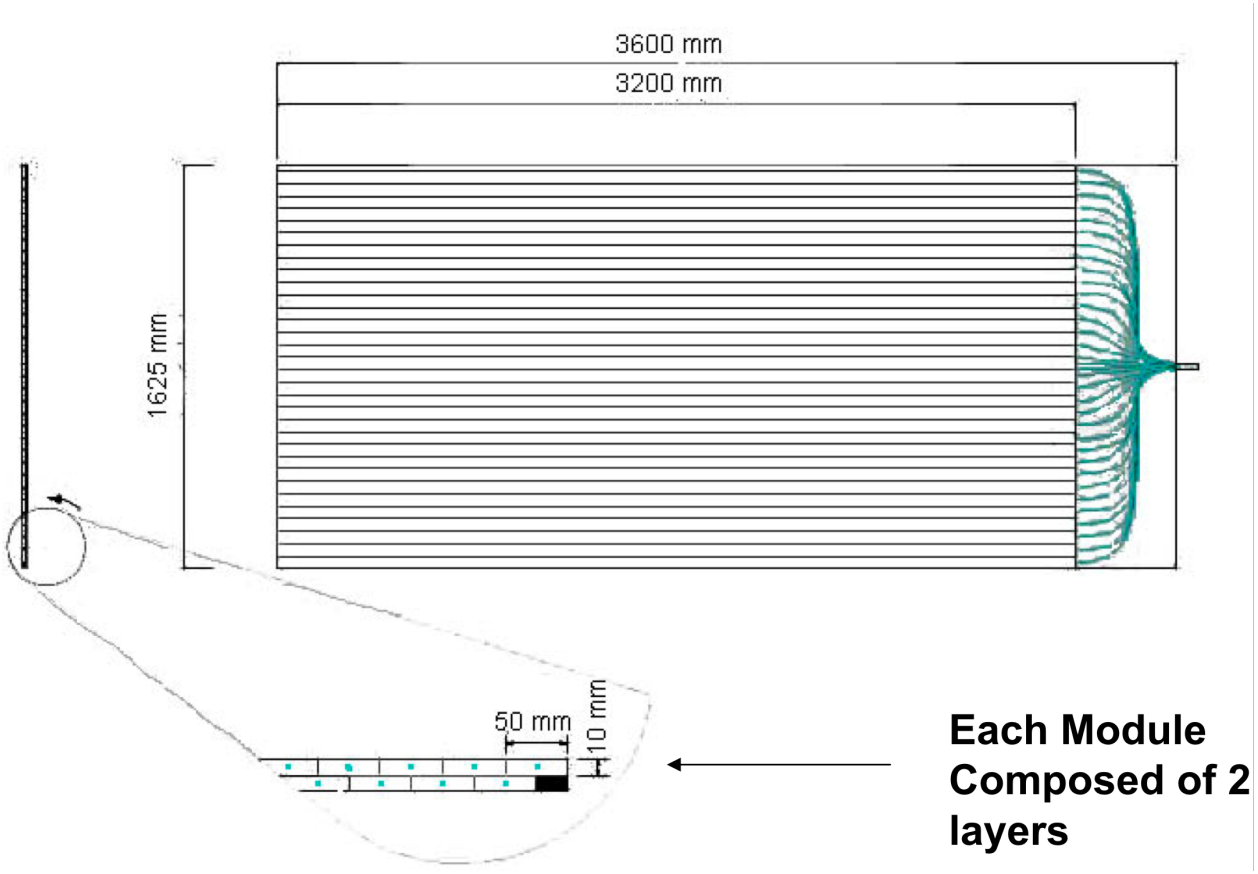
Muon Ranger (magnetized) downstream

Side view



Double Chooz Outer veto module

Built by Chicago. PMT's + Readout by Nevis



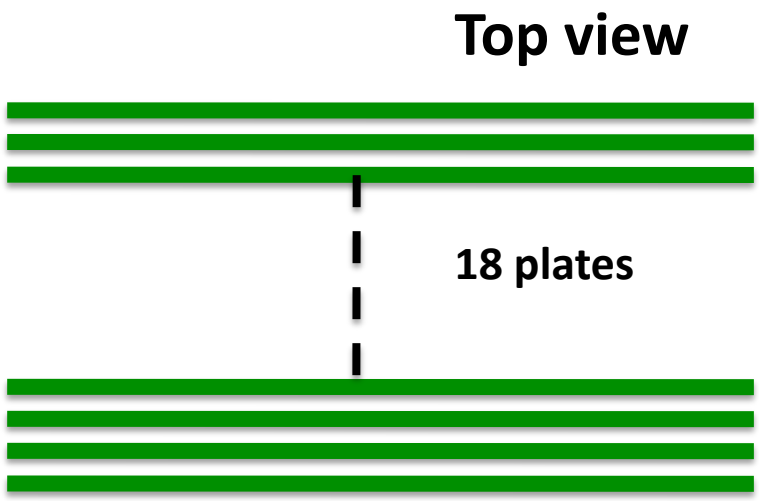
Each layer: 32 strips 5 cm x 320 cm x 1cm
The 2 layers are staggered by half a strip
Read by Hamamatsu H8804 64 channel Multi-anode pmt's.
One pmt per module.

Instrumented Return Yoke

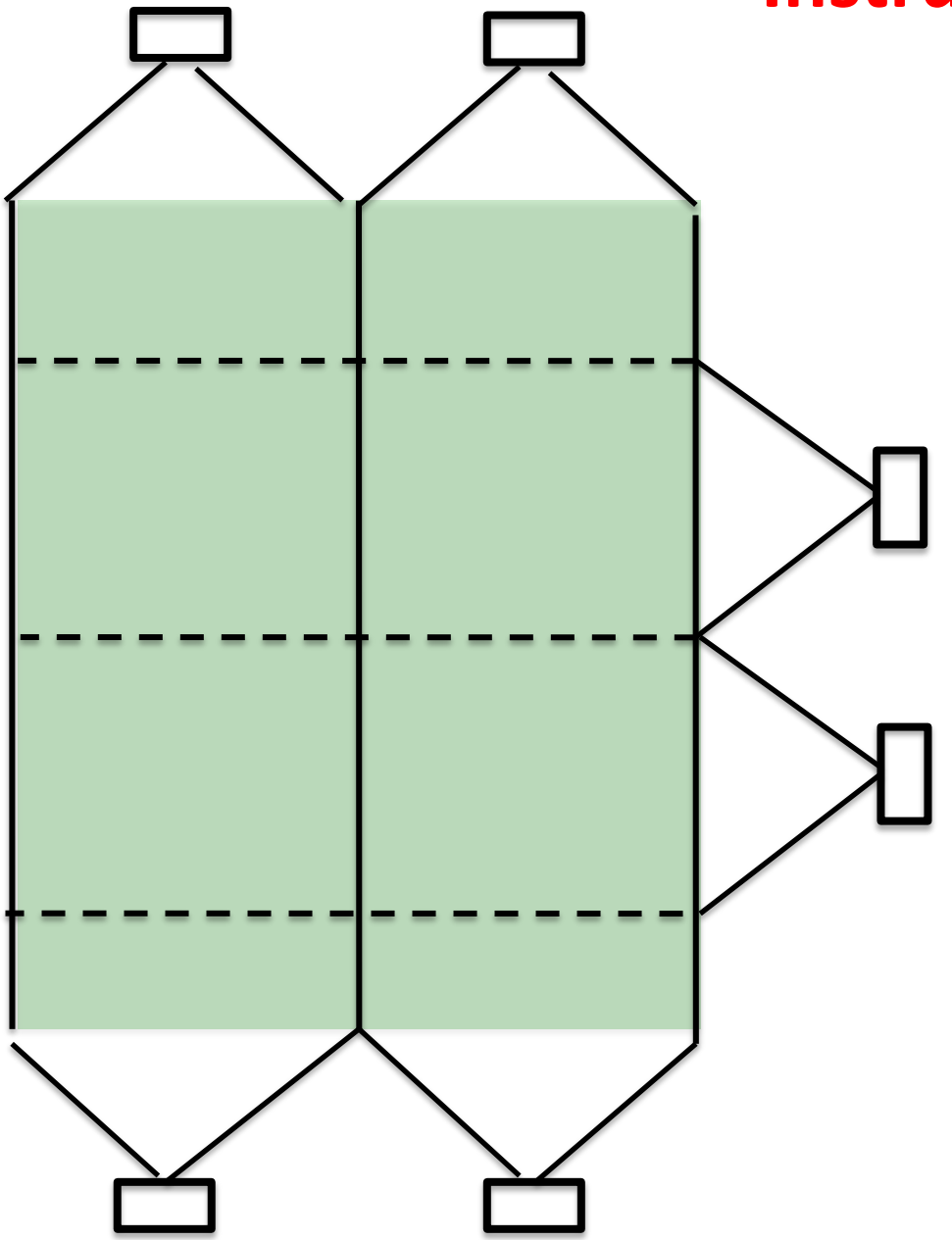
Along beam, magnetized TPC covers 4.0m
Pit = 4.9m. → 0.9m for magnetized yoke.

Make it out of 2.5cm plates spaced by 2.5cm.

90/2.5 = 36 → 18 plates. And 18 gaps.



Instrumented Return Yoke



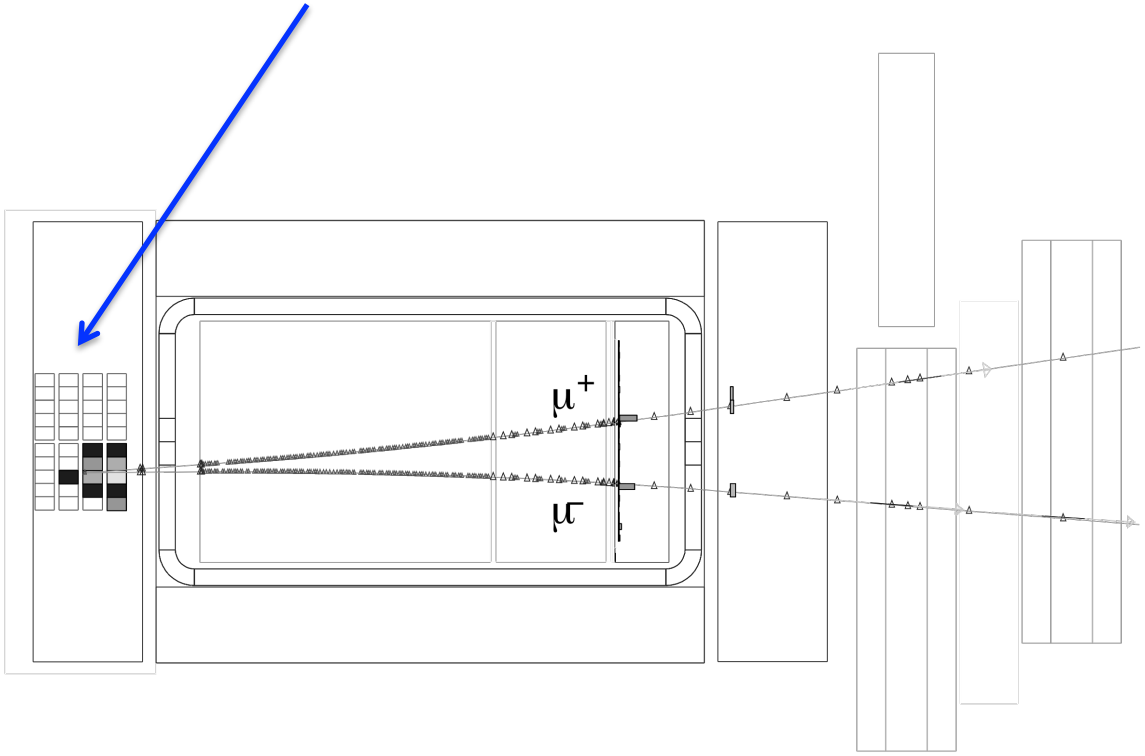
We need to cover the TPC area;
3.7mx 3.7m with modules 3.25m x 1.625m

For horizontal strips the modules can be inserted from the side and therefore 2 x 1.625m would cover most of the TPC (3.2m x 3.2m)
(Or 3 to be safe)
18 modules.

For vertical strips the modules have to be inserted from above the Top and Below the Bottom cover plates and have their light guides and PMT's outside these plates.
This implies a coverage of 3.7m x 5.6m.
Need 2 x2 modules.
36 modules

54 modules in all.

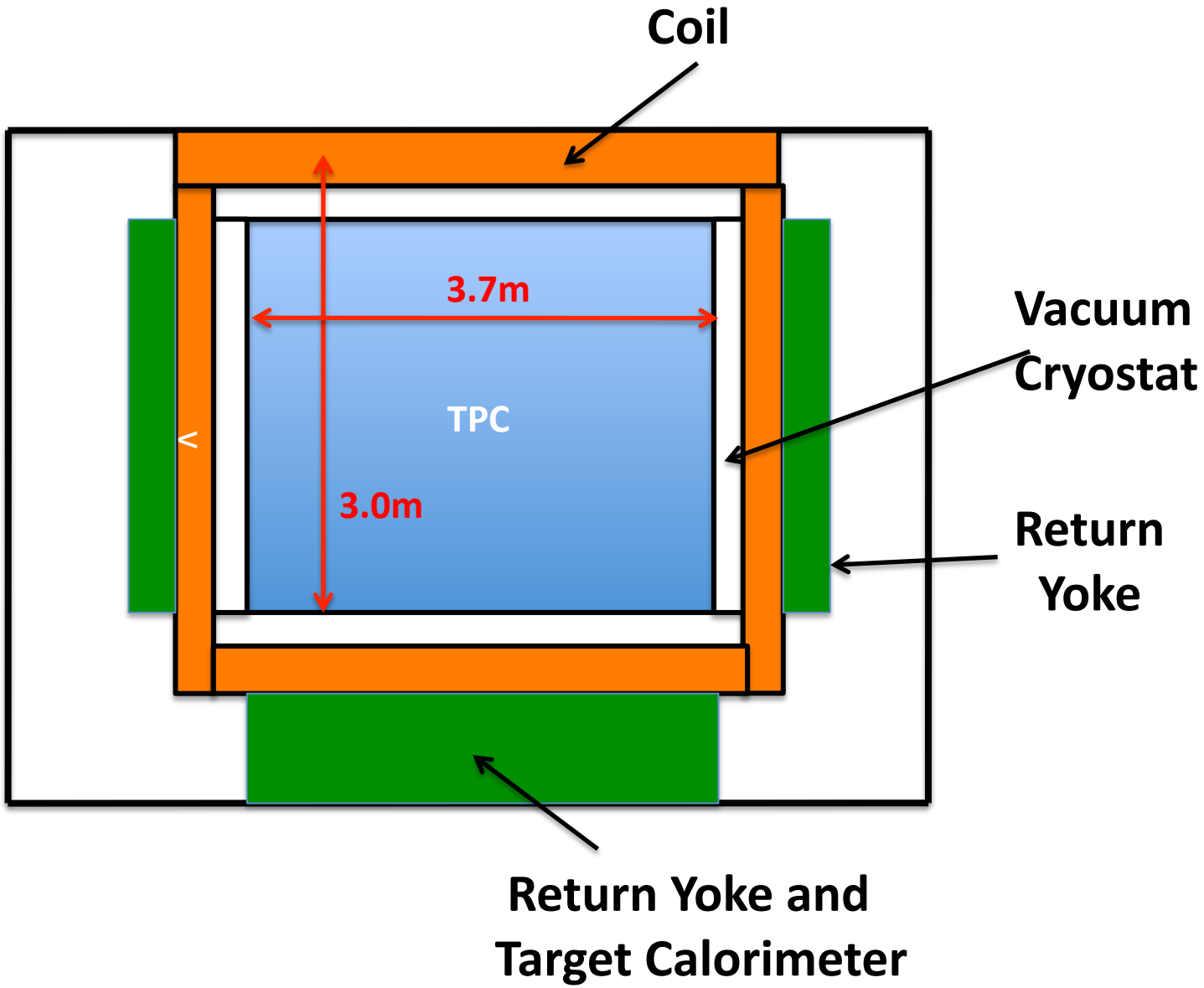
NOMAD Upstream Iron/Scint. Target



10 times the Main target: 27 tons vs 2.7 tons

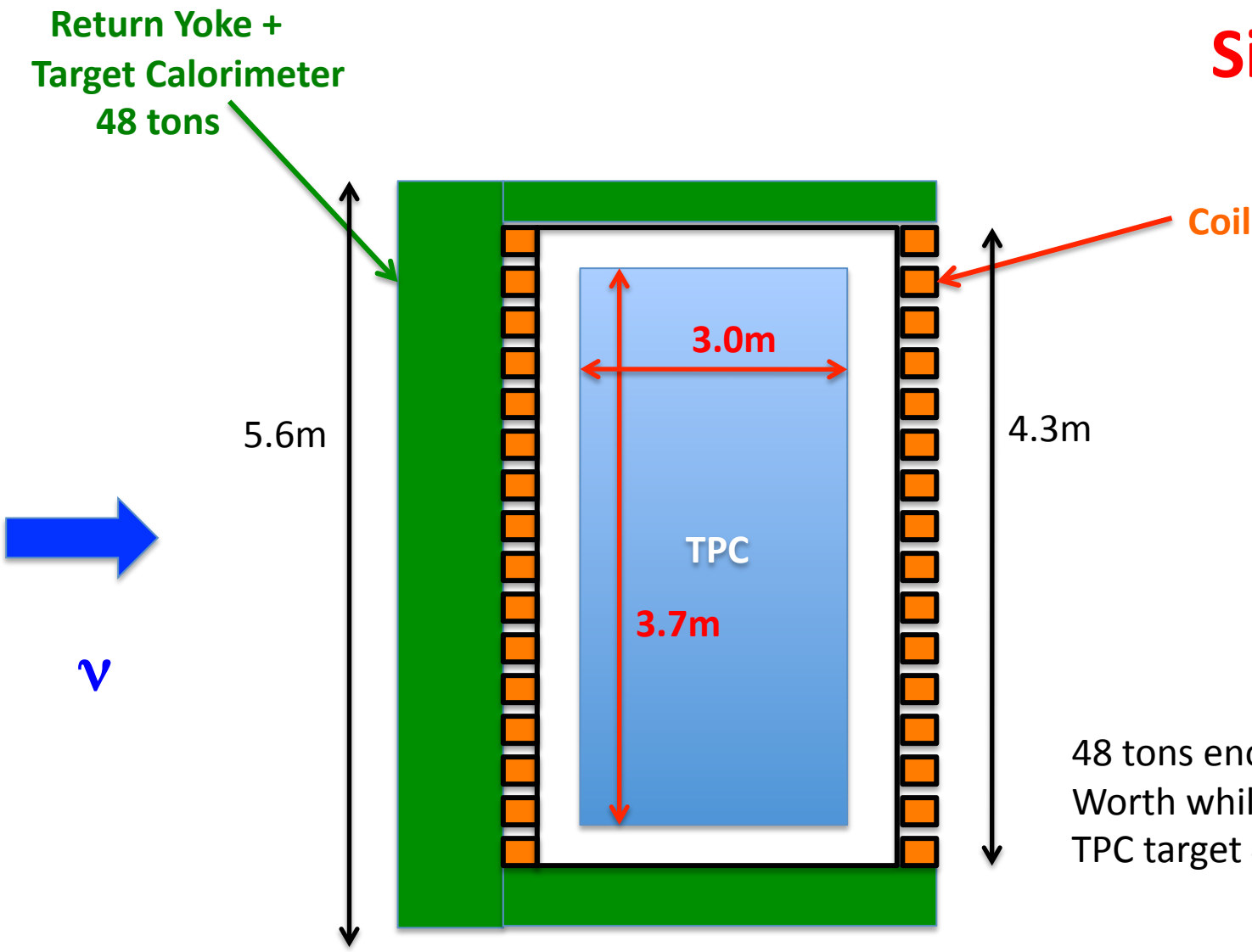
Calorimeter Target upstream

Top view



Calorimeter Target upstream

Side View

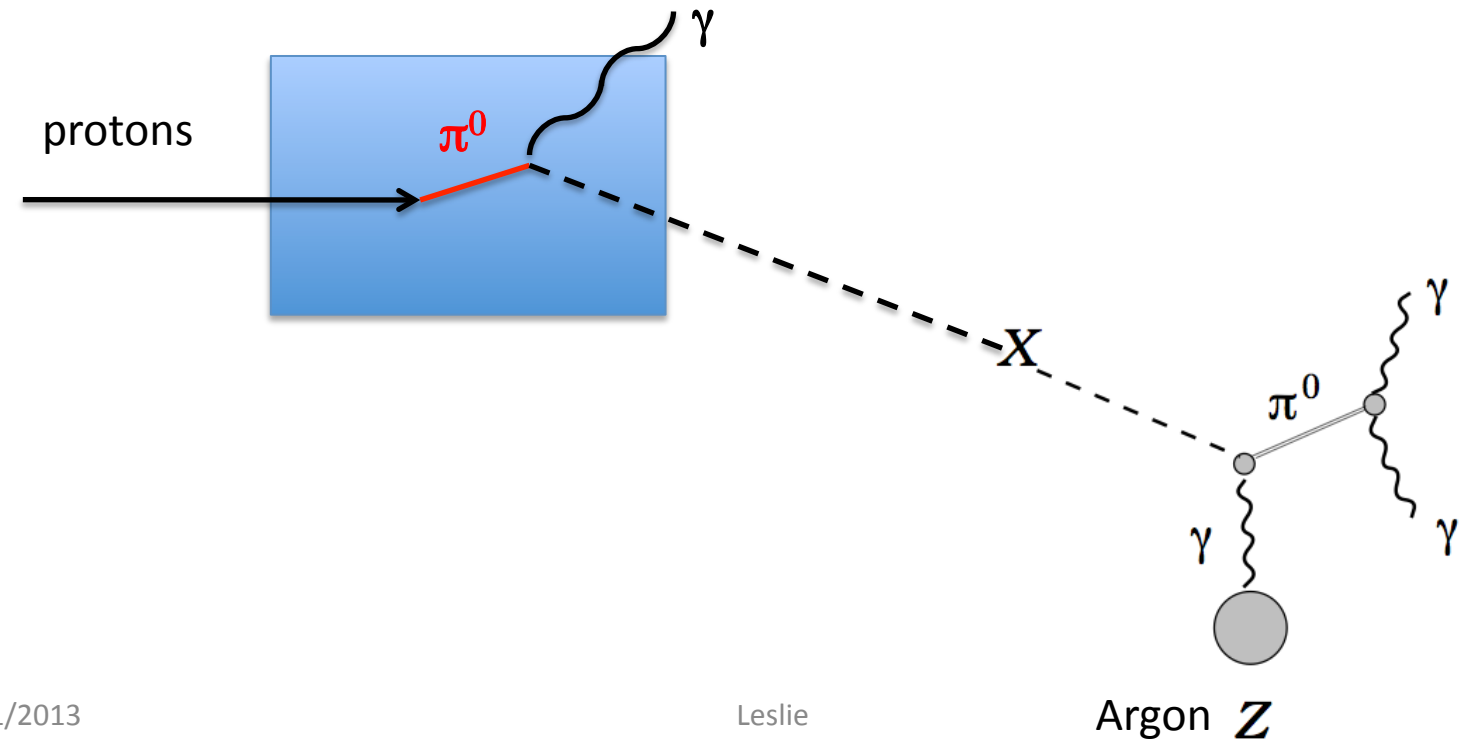


48 tons enough to make it
Worth while relative to
TPC target 40 tons?

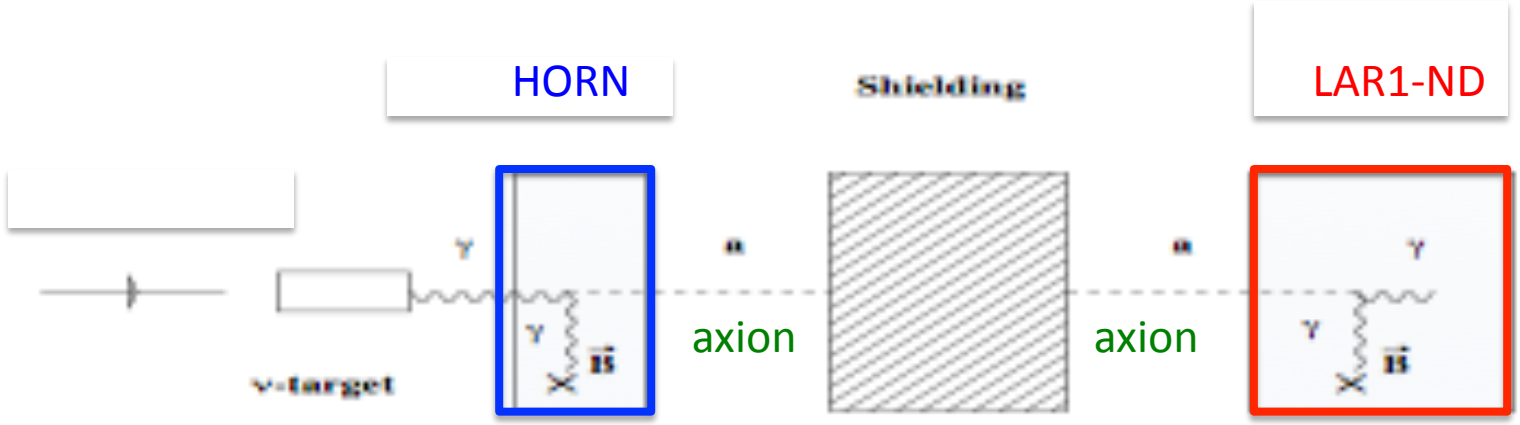
NOMAD physics analyses → Gauge Boson

- Variant on Richard's suggestions
- Pizero, eta produced in Proton target.
- Decays to long-lived particle. $\pi^0,\eta \rightarrow \gamma$ **X**

- Detected in **LAr1-ND** via Primakoff effect.
- Observe **forward pizero.**



Light pseudo-scalar: axion.



- Pizero, eta produced in Proton target.
- Decays to photons.
- Photon-Photon in B field of HORN $\gamma + \gamma$ **of HORN** → **axion**
- Detected in LAr1-ND via axion + γ of **TPC magnet** → Forward γ.

Particle production topics (need (or better with) sign of particle).

- **K^+, K^0_s** production in CC and NC.
- Λ^0 production and polarization in CC and NC.
- Backward going **protons and π^+**
- **Bose-Einstein** correlations of same sign pions:

  Enhancement of number of identical bosons emitted close to one another.
  → radius of pion emission region.
- Can we produce/see **$\rho^0(770)$** and/or ρ^+ ?