Dimensions and Magnetics

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Our Story Thus Far

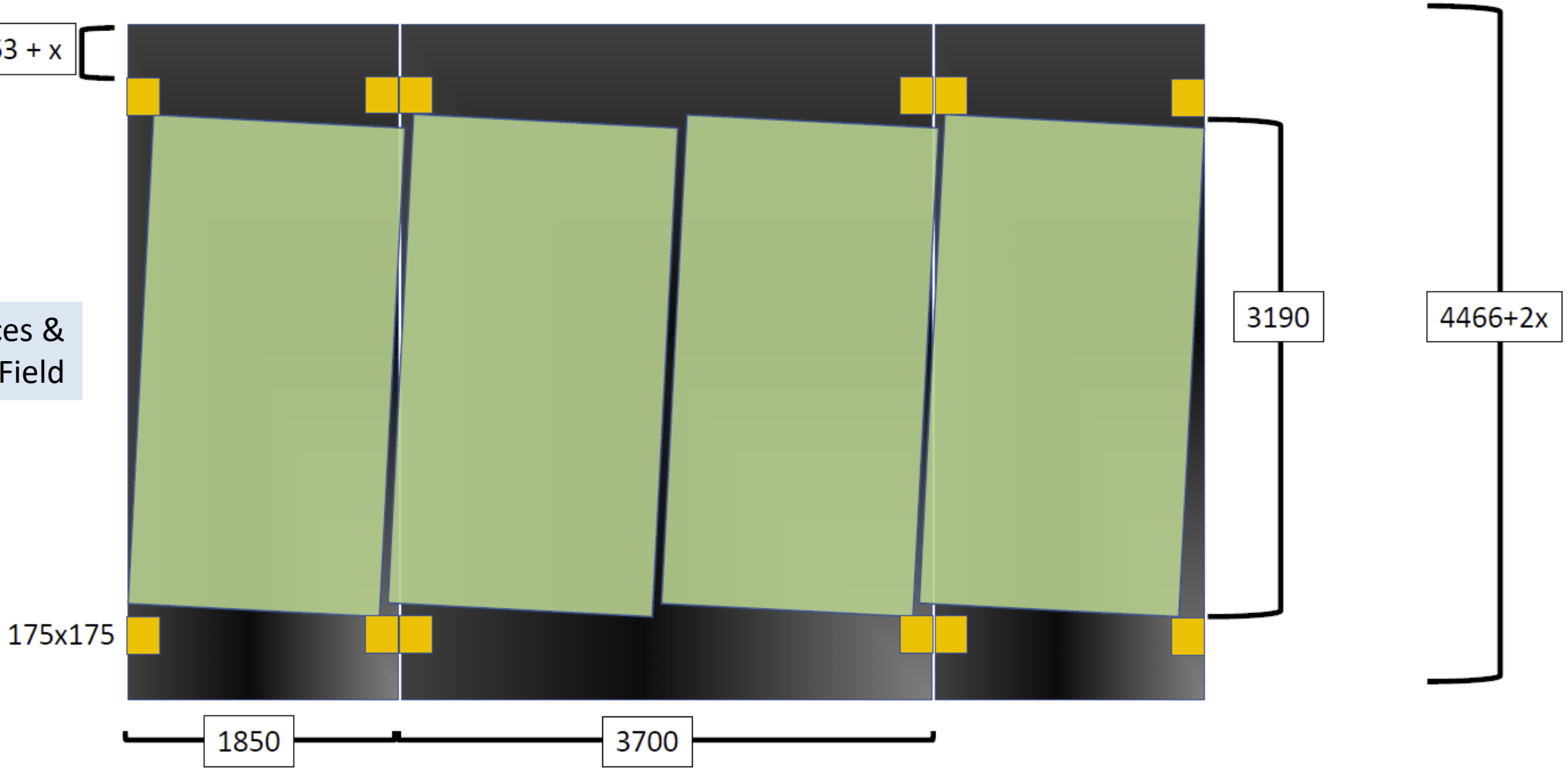
- Our magnet is complicated because we want it to do several things in tension
  - Large (and ideally uniform) field inside
  - Small field outside

- We had a scare a few weeks ago when a “minor” modification to remove interferences caused a loss of 80% of the field
  - This was tracked down to too little steel above and below the coils.

- I promised a non-interfering design with acceptable field (next slide)

A Workable Design

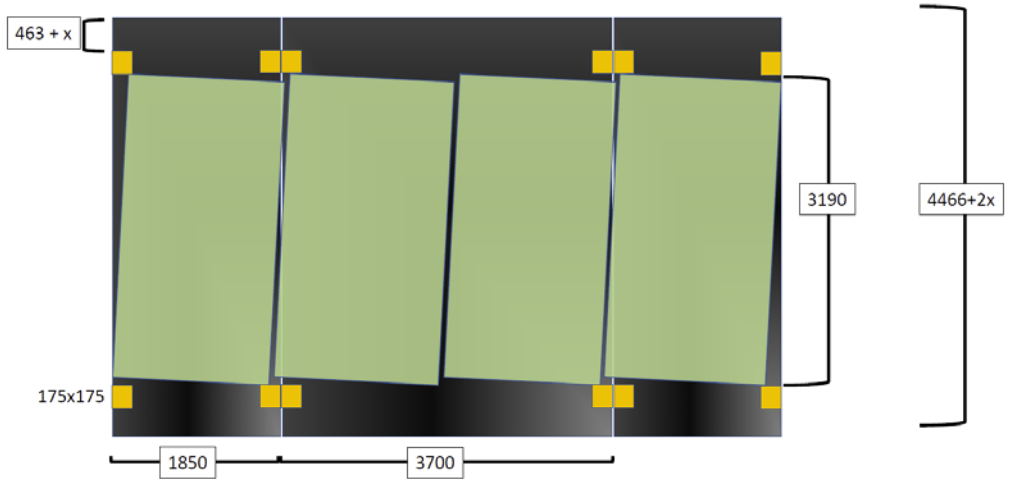
No Interferences &
Reasonable B-Field

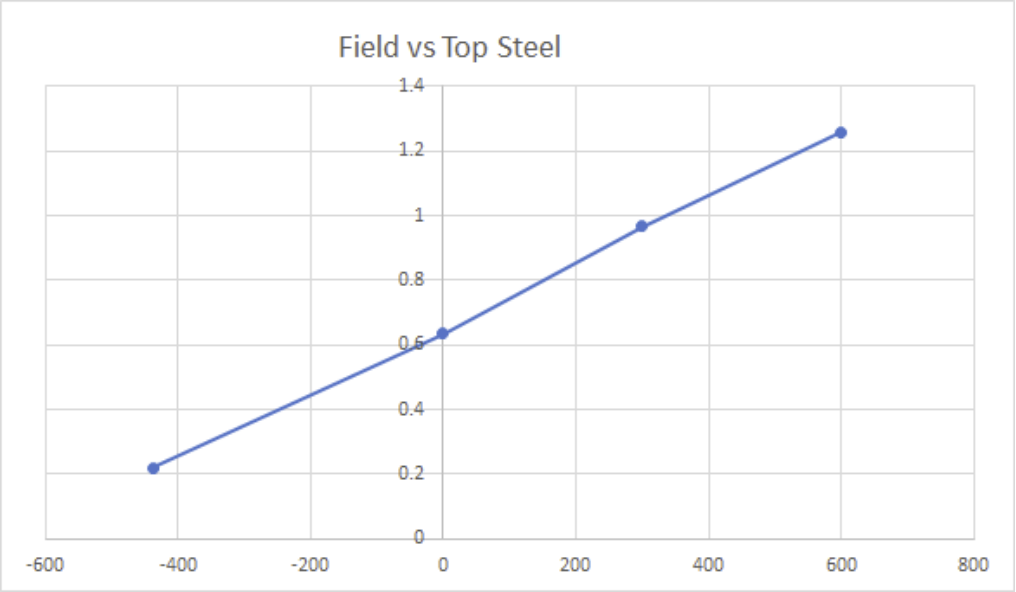


All dimensions in mm

What Is This x?

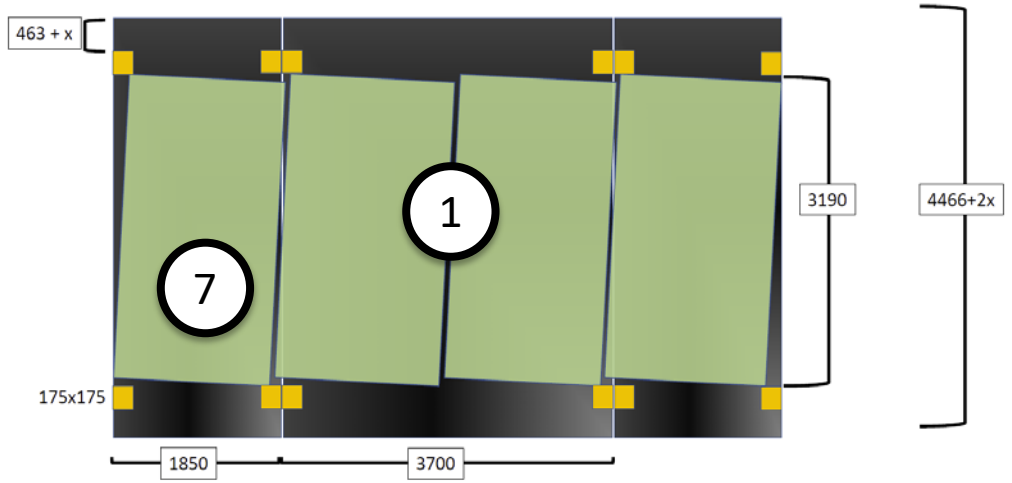
- The one undetermined dimension
  - Everything else can be designed and drawings created while we settle on x.
  - It's vertical, so we should have called it y
- We have modeled this with a simplified model (13 planes, looking only at the center point)
  - As expected the field is ~linear in x
- We're looking at models around x = 300
  - About two feet (29 inches) of steel above and below the coils





Is The Field OK?

Field varies between 1 and 1.5 T throughout the active region



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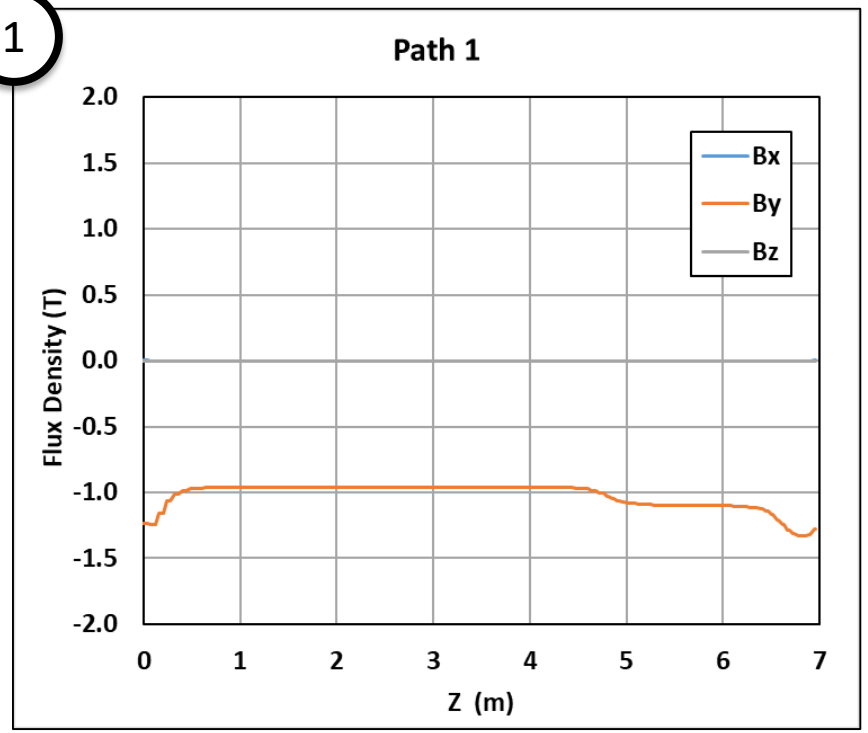

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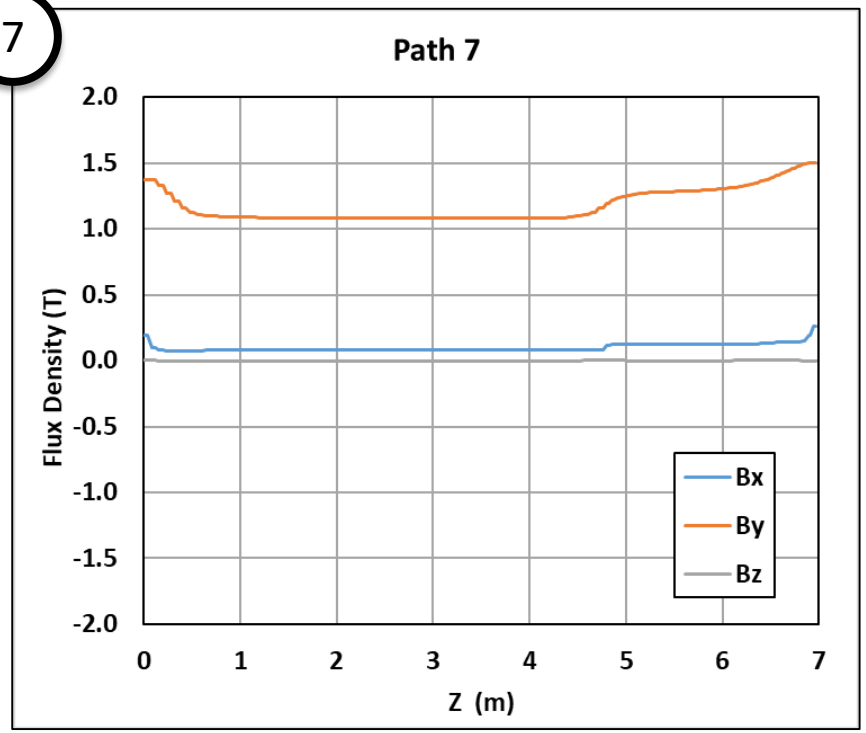
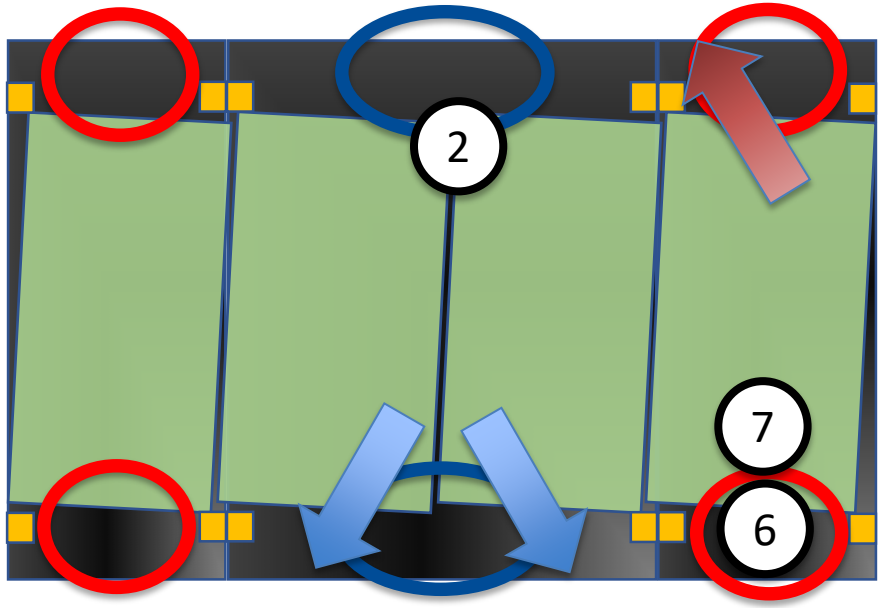


What About the Bad Field Spots?

Path 2 is better than it was (about half field)
Path 6 is still tilted, but it is now off the detector
Path 7 (on detector) is pretty good



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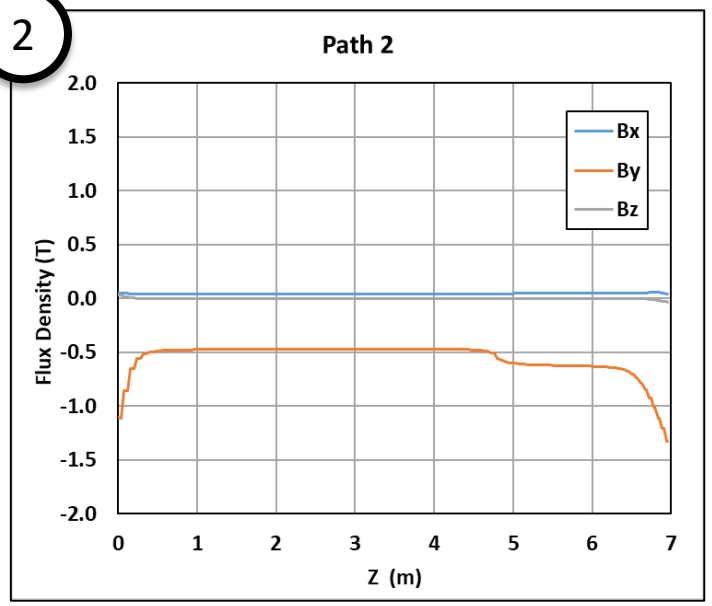

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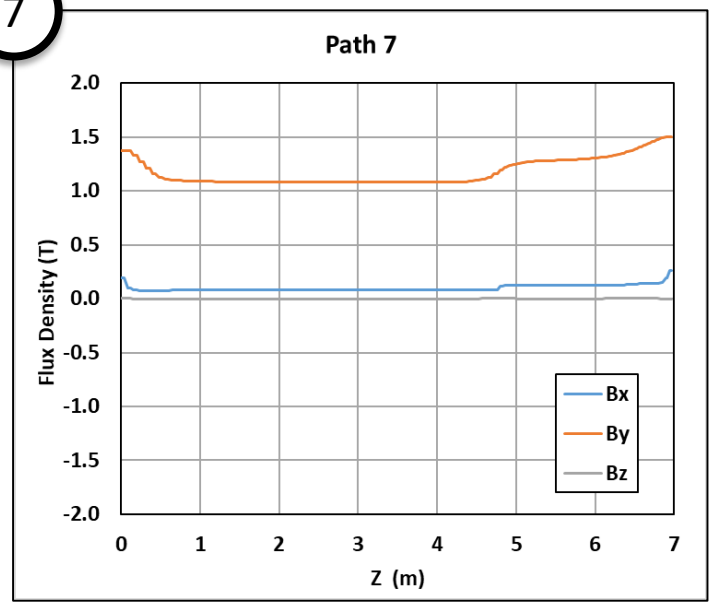

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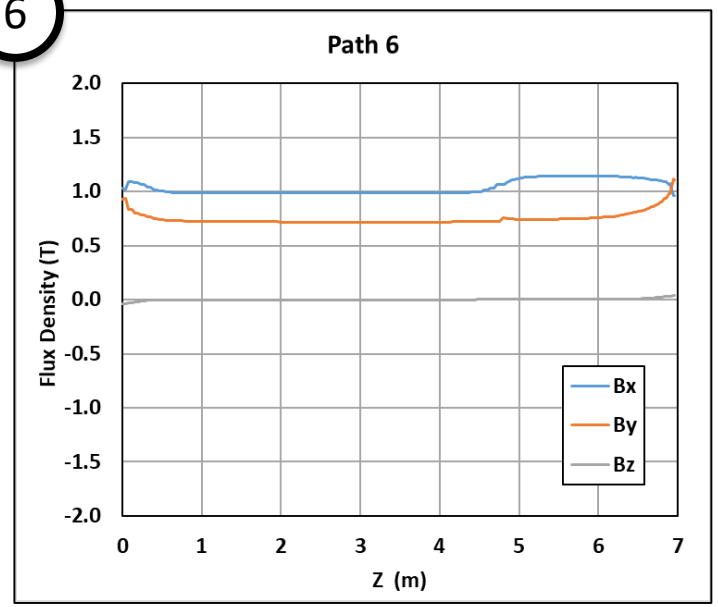


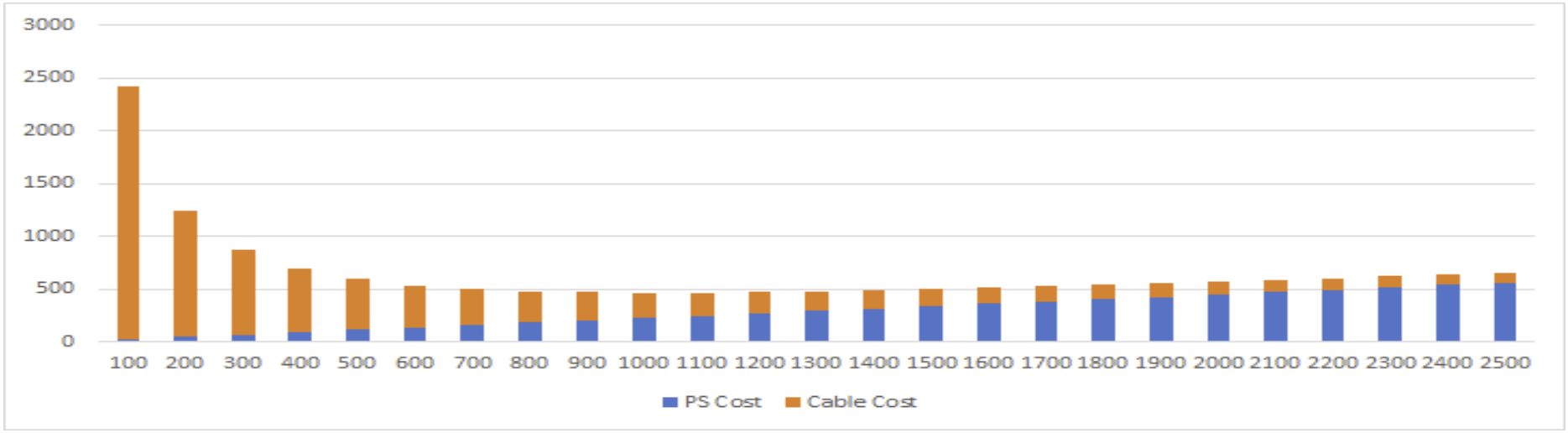
Water Cooling

- For a number of reasons we would like to air-cool this
- We will not be able to defend this on the PDR timescale – we're on the edge of what is feasible/practical/allowed
- Water cooling does the following:
  - Allows more current per unit of copper – saves on coil material
  - Increases the power and thus power supply cost
- I've asked Vic to design a closed-loop system where the heat is transferred from the copper to the steel via water.
  - That will make PRISM motion simpler and safer

A typical electronics heatsink.
Looks very similar to TMS.

Estimated $\Delta T = 0.2$ C

Value Engineering



- There is a tradeoff between spending money on copper and spending it on power supplies
- This minimum is (unless you buy a crazy amount of copper) fairly flat
- There is a similar optimization with additional steel top and bottom and current in the coils
  - This is also fairly flat (steel is 20 ± 40% cheaper)

PDR Decisions

- Dimensions are set except for “x”, which will be around 300mm (about two extra feet of steel top and bottom – uncertainty on this is about ±4 inches). Active area dimensions are set.

- The magnet will be water-cooled. Air-cooling will be listed as an opportunity in the risk register.

- A radical magnet redesign could prove advantageous, but we will stick with the design shown
  - The issue with a redesign is not “will this work” but “can we do better?”
  - We probably cannot put a defendable design together in two weeks
  - We almost certainly can’t determine how much field is in the argon on that timescale (n.b. Dan promised us a spec on this requirement in early 2021)
  - This will be listed in the risk register as an opportunity (i.e. we may switch, but not right now)

- Any new detector between LAr and TMS (as discussed in the Wednesday ND meeting) is not part of the TMS scope

Summary

- We have a near-final design
  - Field is more uniform than before
    - Overall a good thing, but
      - This means the field has gone down where it was highest (and up where it was lowest)
      - We have lost the nice feature of moderately more field in front (where we need it) than the back (where we don't)
  - We have a proposed KPP of 98% charge identification.
    - If we can't meet this, we can add coils or top/bottom steel or both

- In the next few days we will
  - Finalize the remaining dimension
  - Produce a magnetic field map based on the final design

- A number of open issues have been settled pre-PDR
  - At this point, we need a decision more than we need an optimal decision