# Compact Photon Source for Hall D Progress and Plans

**Sean Dobbs**
Florida State U.

KLF Collaboration Meeting
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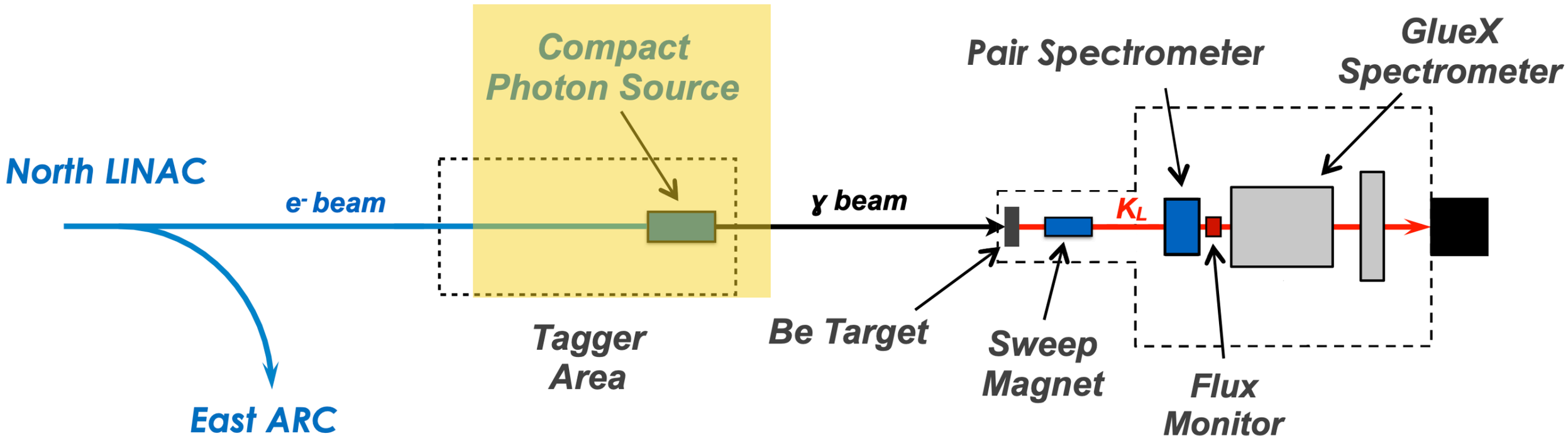
# KLF Beam Line




- KLF in Hall D requires an intense photon beam to generate the $K_L$ beam
  - The CPS concept fits this requirement well
  - Conceptual Design for Hall C CPS published! NIMA 95, 163429 (2020)
- Some modifications will be needed to the base CPS design
  - Joint effort with CPS Collaboration (1st meeting last week!)

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# A conceptual design study of a Compact Photon Source (CPS) for Jefferson Lab

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## ARTICLE INFO

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## ABSTRACT

This document describes the technical design concept of a compact high intensity, multi-GeV photon source. Capable of producing $10^{12}$ equivalent photons per second this novel device will provide unprecedented access to physics processes with very small scattering probabilities such as hard exclusive reactions on the nucleon. When combined with dynamic nuclear polarized targets, its deployment will result in a large gain in polarized experiment figure-of-merit compared to all previous measurements. Compared to a traditional bremsstrahlung photon source the proposed concept presents several advantages, most significantly in providing a full intensity in a small spot at the target and in taking advantage of the narrow angular spread associated with high energy bremsstrahlung compared to the wide angular distribution of the secondary radiation to minimize the operational prompt and activation radiation dose rates.

# Optimized CPS Baseline Design (not final)

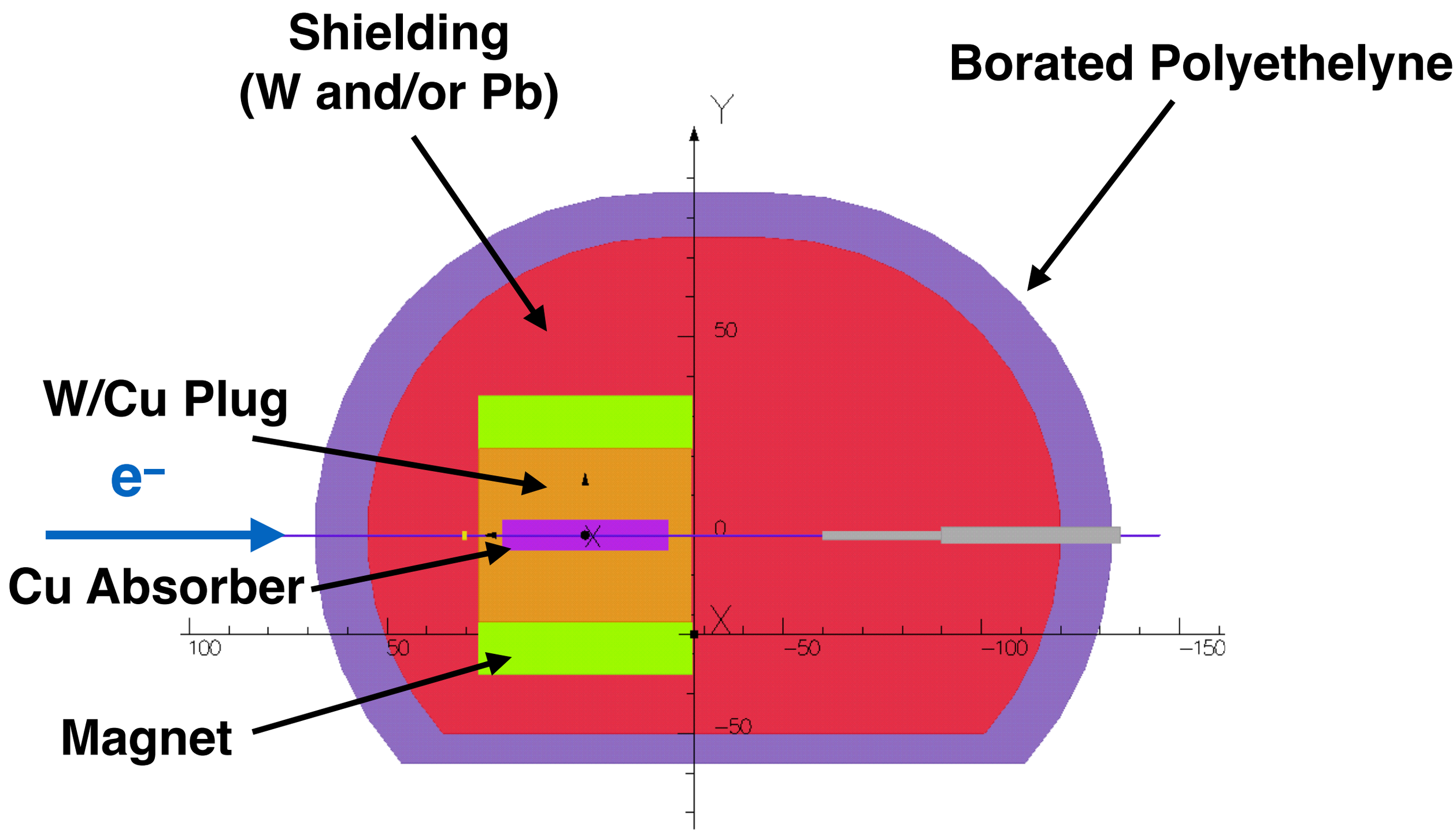


**Figure: B. Wojtsekhowski, Feb. 2020 CPS Collab. Meeting**

# CPS Simulations

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## Detailed simulations were performed

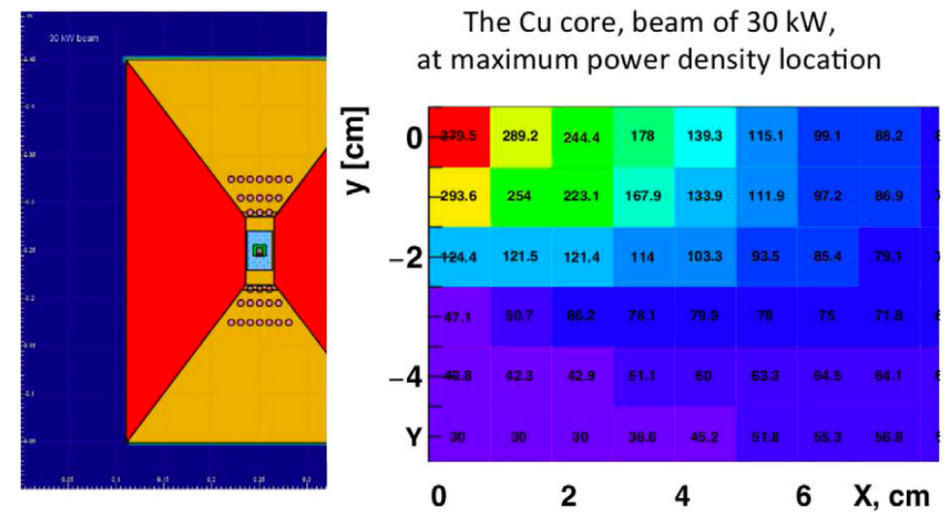
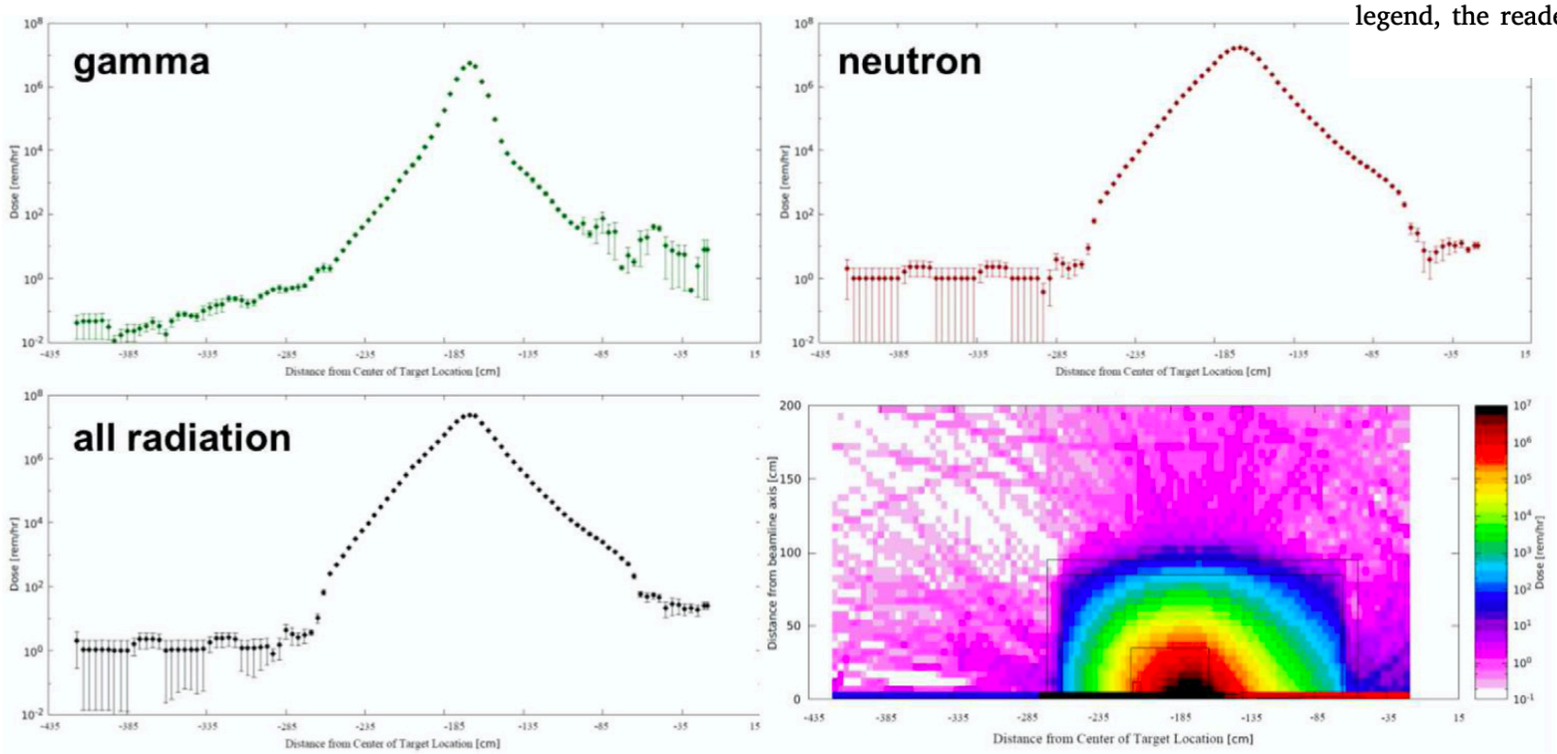



**Fig. 7.** Left panel: the cross section of the absorber with the water cooling channels (the copper is shown in light blue and the W-Cu(20%) is shown in gold). Right panel: the temperature map for 1 cm by 1 cm elements at the longitudinal coordinate of the power deposition maximum. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

## Radiation dose & activation




## Power deposition

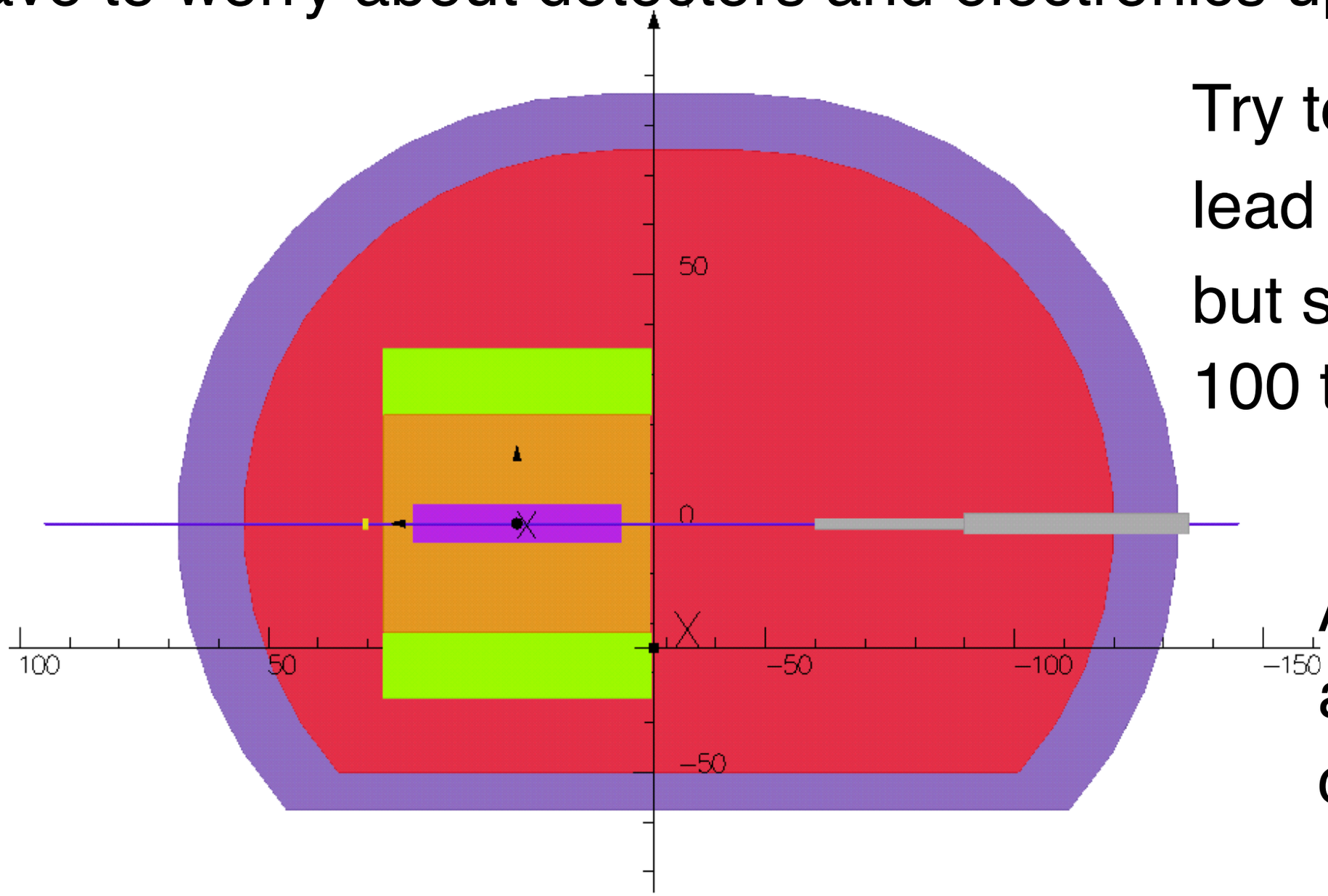
# Modifications for CPS in Hall D: Electron Beam

- KLF Electron Beam parameters:
  - 12 GeV $e^-$ @ 5 uA → 60kW power (x2 CPS)
    - Low repetition rate for $K_L$ TOF: 64 ns bunch spacing
    - Default configuration: twice longer magnet than XC
  - Study possible rasters: 1 x 1 mm, 2 x 2 mm, 5 x 5 mm?
    - 2 cm x 5 mm would yield magnet length similar to Hall C design (B. Wojtsekhowski)
      - May be challenging to deliver
      - Coordinate studies with accelerator group
  - Additional challenge: Beam on Be target over 67 m

# Modifications for CPS in Hall D: Shielding

Don’t have to worry about target 2m downstream as in XC

Do have to worry about detectors and electronics upstream

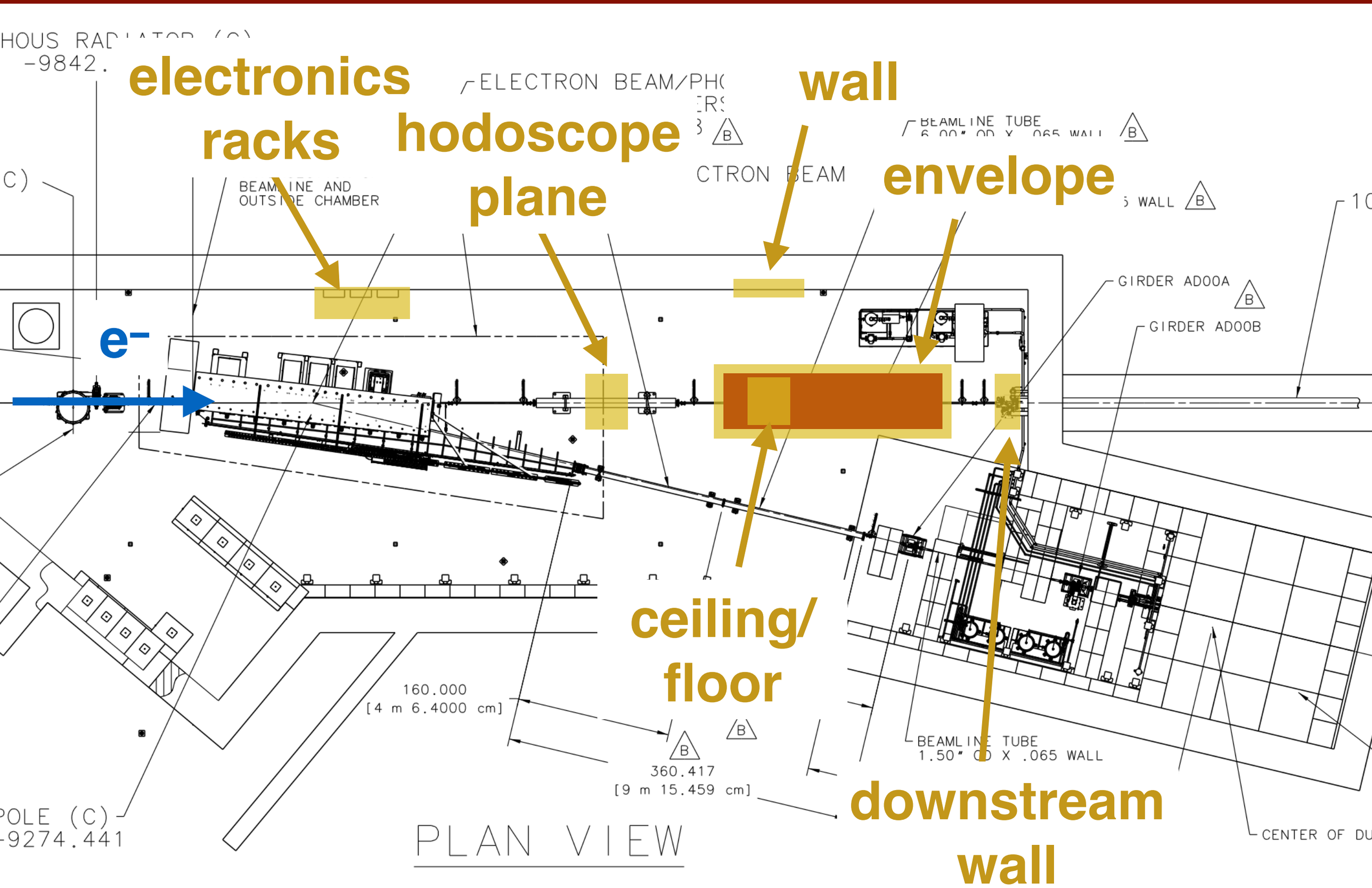



Try to use only lead shielding, but stay within 100 t limit

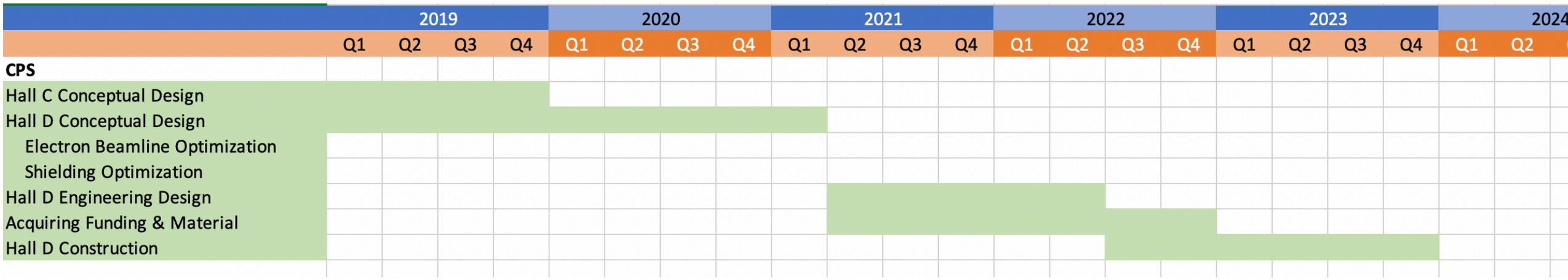
Also think about collimation

**Figure: B. Wojtsekhowski, Feb. 2020 CPS Collab. Meeting**

# Hall D Tagger Hall



# Rough CPS Timeline




- Made an initial pass at timeline of major tasks based on experience of Hall C CPS group
- Also depends on availability of support from Hall D and other major projects (e.g. FCAL-II, FY19-21?)

# Summary

- CPS concept provides ideal photon source for KLF
  - Hall C conceptual design published
- Next steps are simulations to optimize design for Hall D
  - Study electron beam properties, decide on raster
  - Determine radiation dose limits
  - Optimize shielding
- Iterate beam simulations with target geometries to optimize beam delivery
  - Think about stability with respect to mechanical changes
- Refine timeline of activities

# Backups

# KLF Electron & Photon Beam Requirements

- KLF Electron Beam parameters:
  - 12 GeV $e^-$ @ 5 uA → 60kW power (x2 CPS)
  - Low repetition rate for $K_L$ TOF: 64 ns bunch spacing
  - Raster: 1 x 1 mm, 2 x 2 mm, 5 x 5 mm?
  - Further coordination with APEL
- Distance from CPS radiator to Be target: 67 m
  - Beampipe radius: 12.4 cm
  - Be target radius: 3 cm
  - Target radius (extra 24 m d.s.): 3 cm

# Simulation Plans

- Optimize electron beam raster + collimation
- Confirm power density deposition
- Optimize radiation shielding, measuring radiation levels at:
  - Tagger Hall walls, ceiling, floor
  - 1ft envelope around CPS
  - Tagger hodoscope plane
  - Eventually:
    - Tagger ramp door
    - Site boundary