TRIUMF shielding requirements and design

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Shielding from the TRIUMF point of view

- Experiment is concerned with shielding as it protects our electronics and detectors from radiation

- The lab is concerned with shielding for other reasons:

    1. Protecting the accelerator from additional radiation caused by the experiment, especially if it could cause activation of the nearby material (which would make maintenance difficult and pose a safety hazard)

    2. Protecting humans in any nearby spaces.

- Need to demonstrate that our plan (both removing existing shielding and adding new shielding) will stay compatible with these requirements

Human safety

- Human safety specifications very clearly laid out in TRIUMF policy note Document-544 with maximum acceptable doses for “accessible areas”

- E-hall is not an accessible area, it is an exclusion area. Nearest low-occupancy accessible area is probably corridor outside the maze; nearest high-occupancy accessible area is in the main control room.

  - Requirement: the nearest low-occupancy uncontrolled area (e.g. corridor) must have a dose rate < 10 μSv/h

- No realistic possibility that the addition of DarkLight to the e-linac will meaningfully change the radiation levels in these places. But we will still need to **demonstrate** this convincingly.

Activation hazards

- Requirement: The residual radiation field must be <100 μSv/hour at 50 cm from the shielding/experiment/ beamline, 8 hours after the beam has been turned off.

- Note we were also asked to consider long-term activation of the targets and build handling this appropriately into our decommissioning plan

Determining shielding specifications

- General approach is to use FLUKA to model both prompt and activation radiation

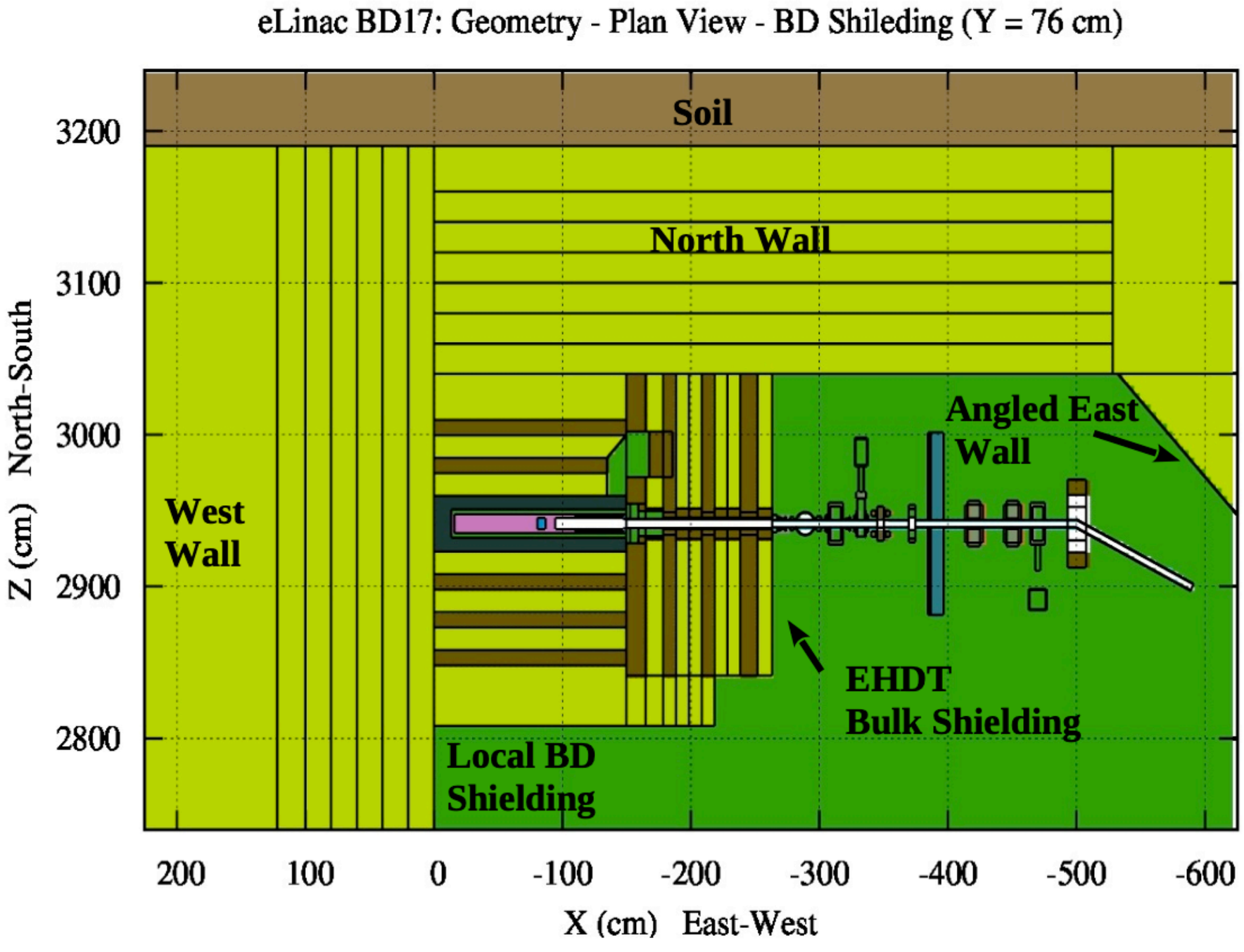
- Model of e-hall and dump with existing shielding already exist and detailed studies were done when e-linac was being designed

- Ideal scenario would be to use the same models and simply add the DarkLight apparatus, re-run, and reproduce existing plots. We would be able to descope to 10 kW since we will never run at higher power than this at the existing dump.

    - Note that we will have to do all of this all over again for the new beam dump configuration for 50 MeV running - but since we would not run through the target at highest powers we are probably fine with whatever shielding we design now

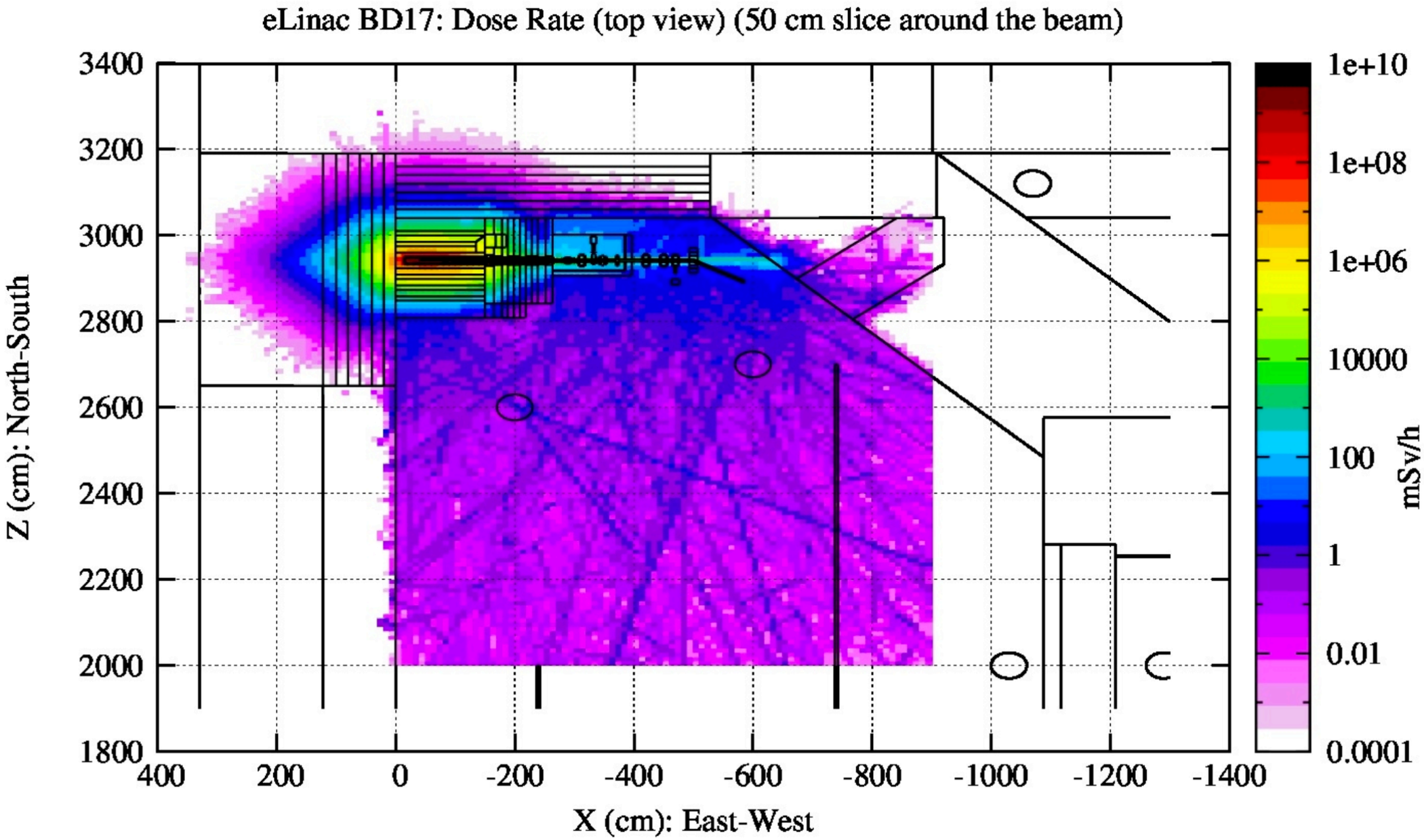
Existing simulations

Existing FLUKA geometry near beam dump + DL site



Existing simulations

FLUKA model of total prompt radiation near the existing beam dump for 100 kW beam

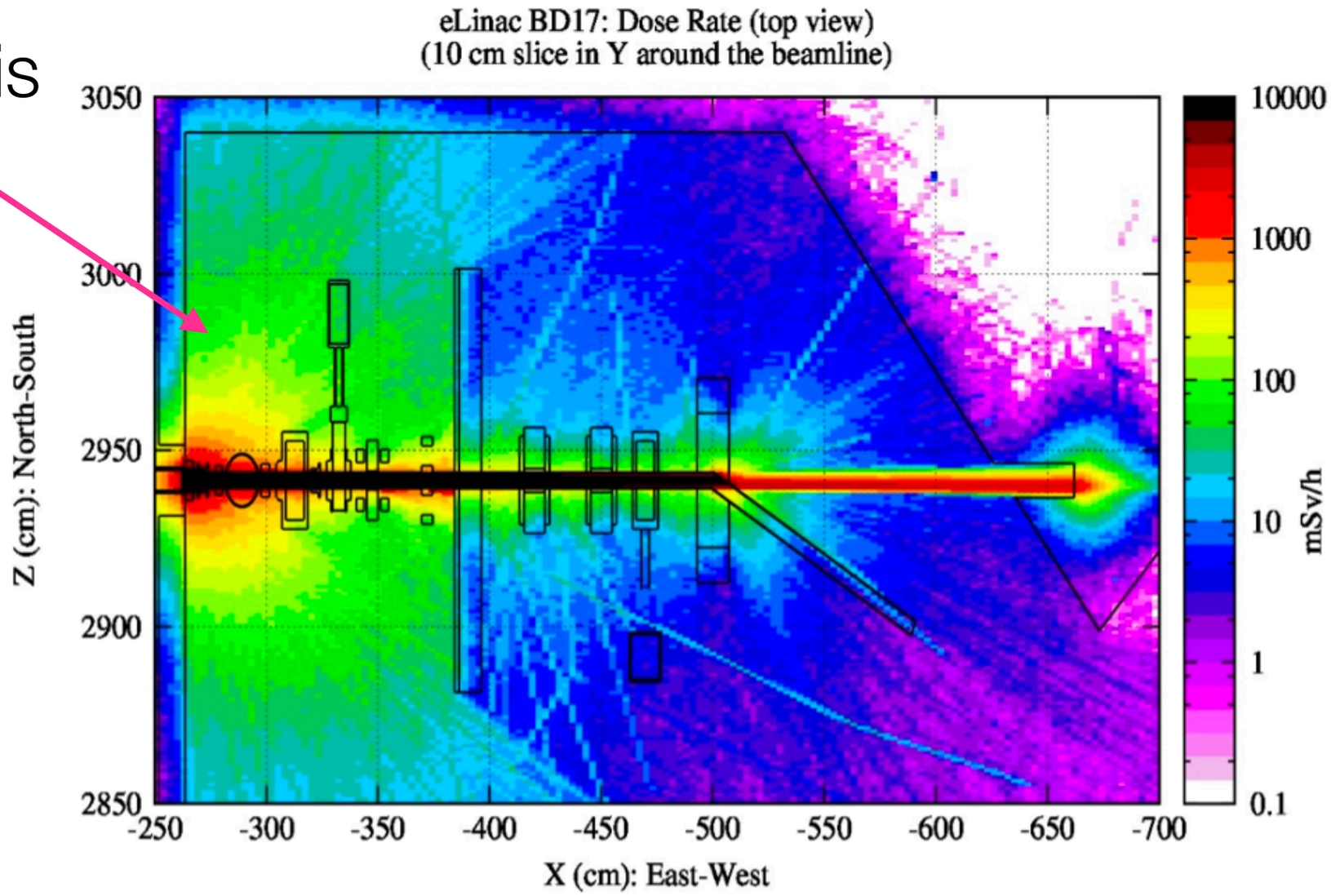


The current shielding wall

Added because of this

Will not be needed at 10 kW; needed at 100 kW

Note one of the components it was added to protect is camera upstream



Very likely DL will be asked to add camera so current diagnostics can be removed to make room - consider dose limit ~ 1 mSv/h in our design

The required documents

- We will have to deliver the following:
  - Shielding design note with all simulation details
  - Safety analysis report (SAR) is a briefer summary more focused on communication: describes modifications of the existing facility, equipment to add, shielding design, expected doses, etc.
- Examples of both can be circulated to you if interested

Next steps

- As discussed in the design review, previous TRIUMF FLUKA expert has left the lab

- Stephanie and I are meeting next week with a student who has worked with FLUKA before (tested the design for FLASH) and is willing to help us out here. If we can obtain the models and scripts from previous studies, it shouldn't be too difficult to modify them to include DL

- Note though that results shown here date from ~2013 and I am not sure whether they were used in FLASH studies: no guarantees of how easy it will be to obtain code to start from