Beam Delivery,
MDI related updates

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for BDS Area

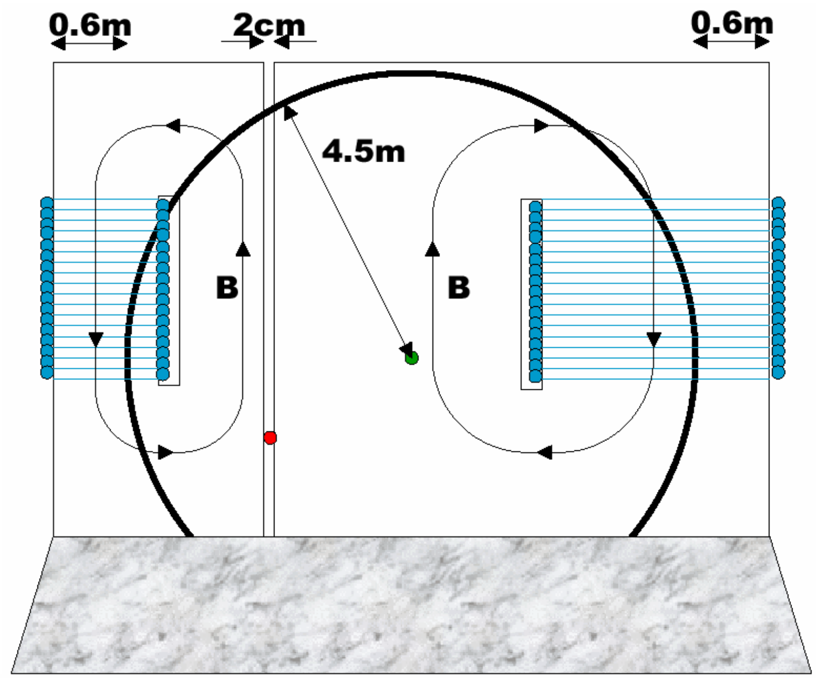
GDE/LCWS meeting at Bangalore
March 10, 2006

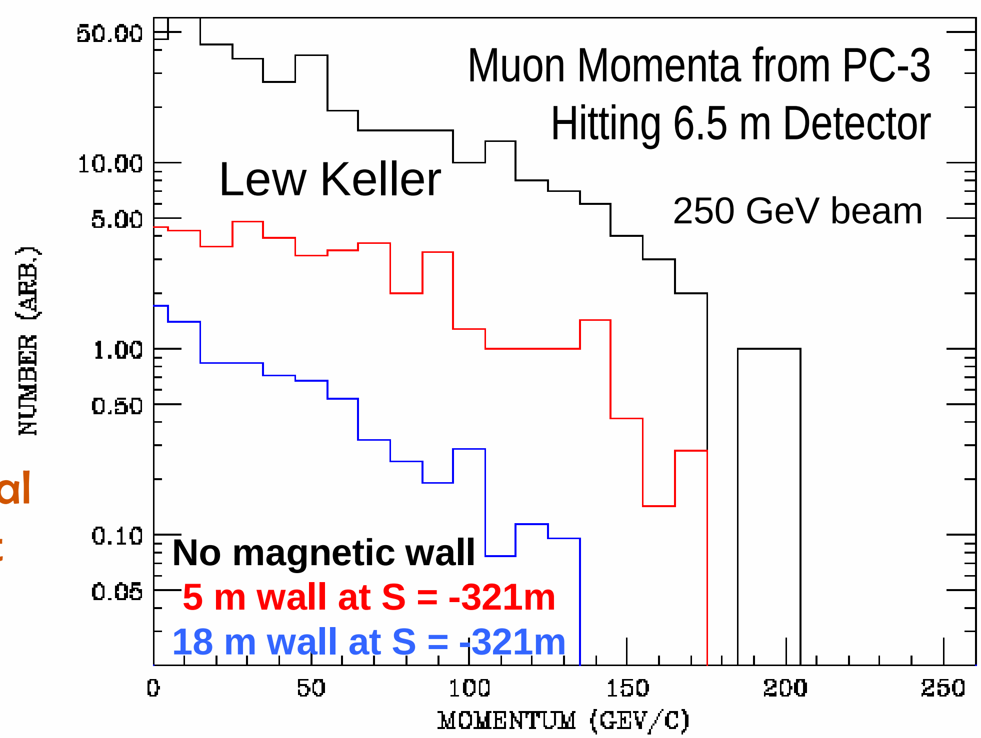
Contents

- Will review several MDI related issues that were discussed after Frascati GDE meeting. Use slides from talks given at GDE meetings at KEK in January and Fermilab in February
- Muon walls and detector tolerance to muons
- Low E positron transport in BDS
- IR layout and radiation physics
- Concepts of upgrade to $\gamma\gamma$ and back to e+e-
- Extraction lines & linac orientation
- Updates on IR magnet designs
- Updates on crab cavity developments
- Missing bends and E upgrade

Muon walls

- BCD: two walls, 9m and 18m per branch, to reduce muon flux to less than 10muons/200bunches if collimate 0.001 of the beam
- Predictions of halo ~1e-6 - 1e-5
- Min one 5m wall needed for PPS
- Approach: consider installing single 5m wall, space in tunnel for full set
- The 5m wall allow to collimate 2e-5 before reaching 10μ/200bunches
- Before the CCR can be considered =>
  - ask Accel. Phys. Tech. System to evaluate predictions of halo population
  - ask Installation Tech. System to evaluate possibility to install additional wall if muon rate will exceed the limit
  - ask MDI panel to evaluate the 10μ/200bunches detector tolerance



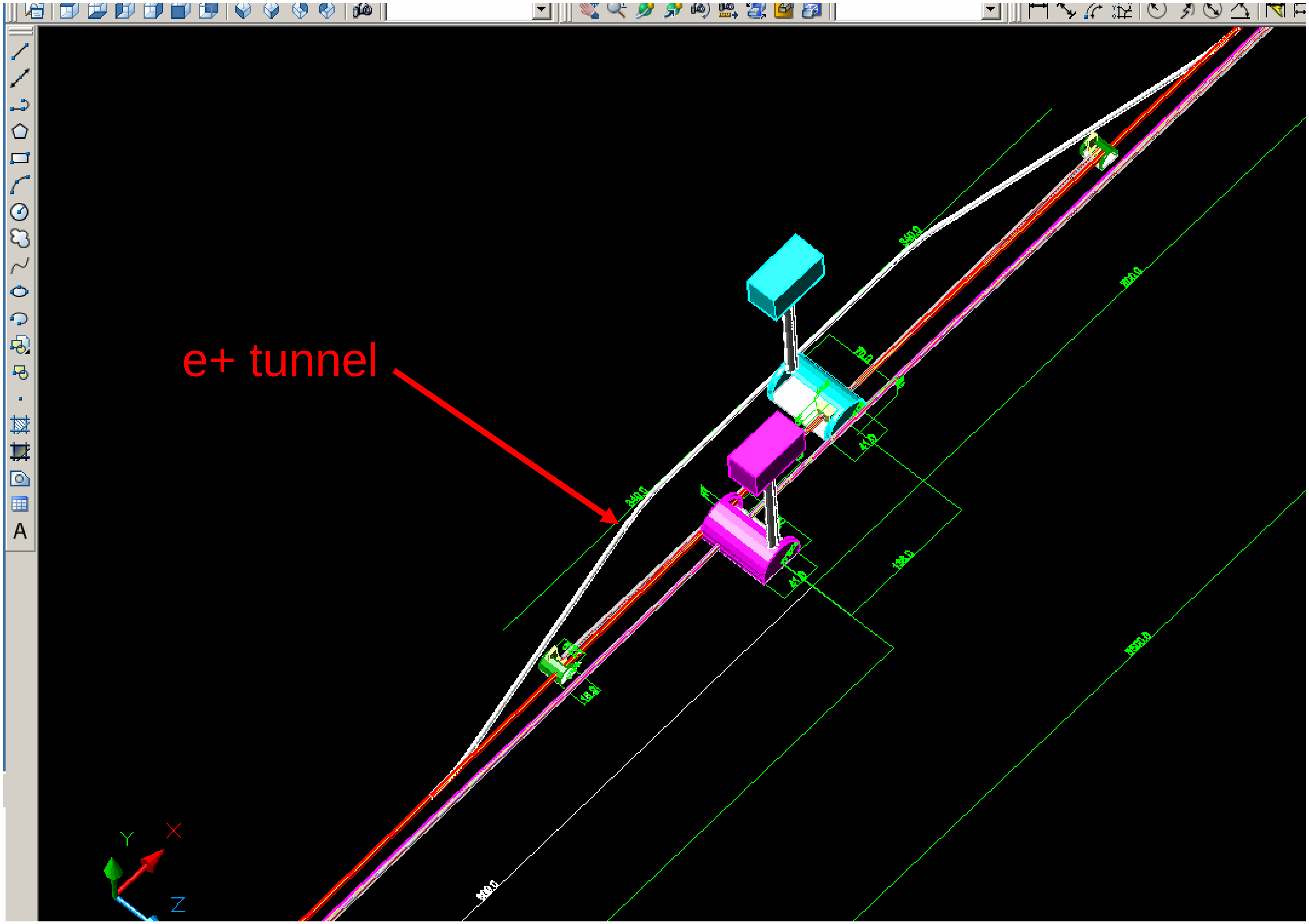


Low energy e+ transport in BDS

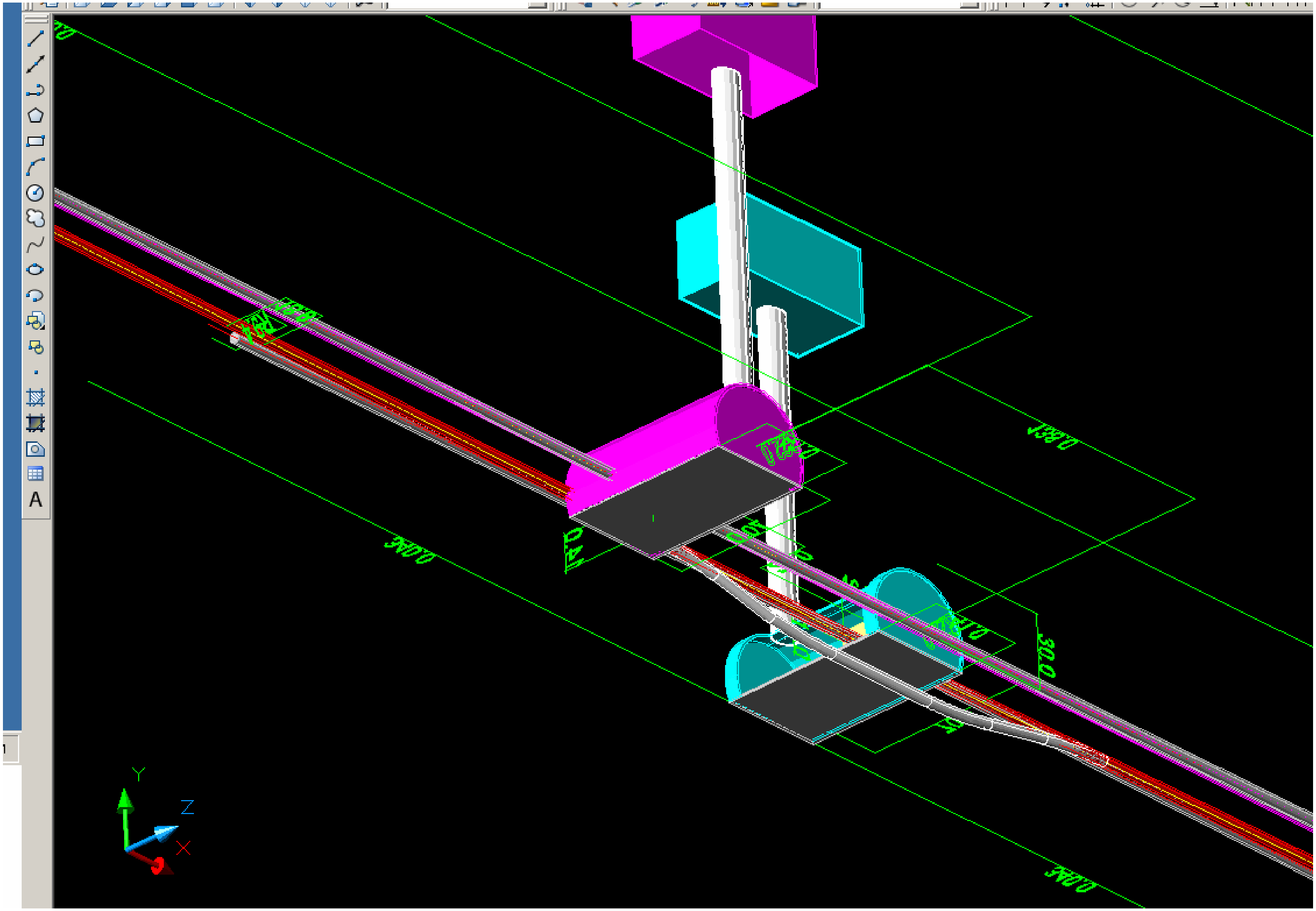
- Layout (cost) & interference with detector and BDS are the main questions
- Options for e+ transport:
  - option 1: separate tunnel ~ 0.7-0.8km long going around larger crossing angle IR
  - option 2: going under the IR hall (the e+ beamline is 21 m under the IP beamlines). This is similar to TESLA (where dh was 17m)
  - option 3: going from tunnel of 1st IR to tunnel of 2nd IR and back
- Info on e+ beam (tbc)
  - Energy range considered: 250MeV-1GeV (5GeV also was discussed)
  - Power 20kW – 80kW
  - Energy spread 10% – 2.5%

e+ transport, option 1 (around IR)

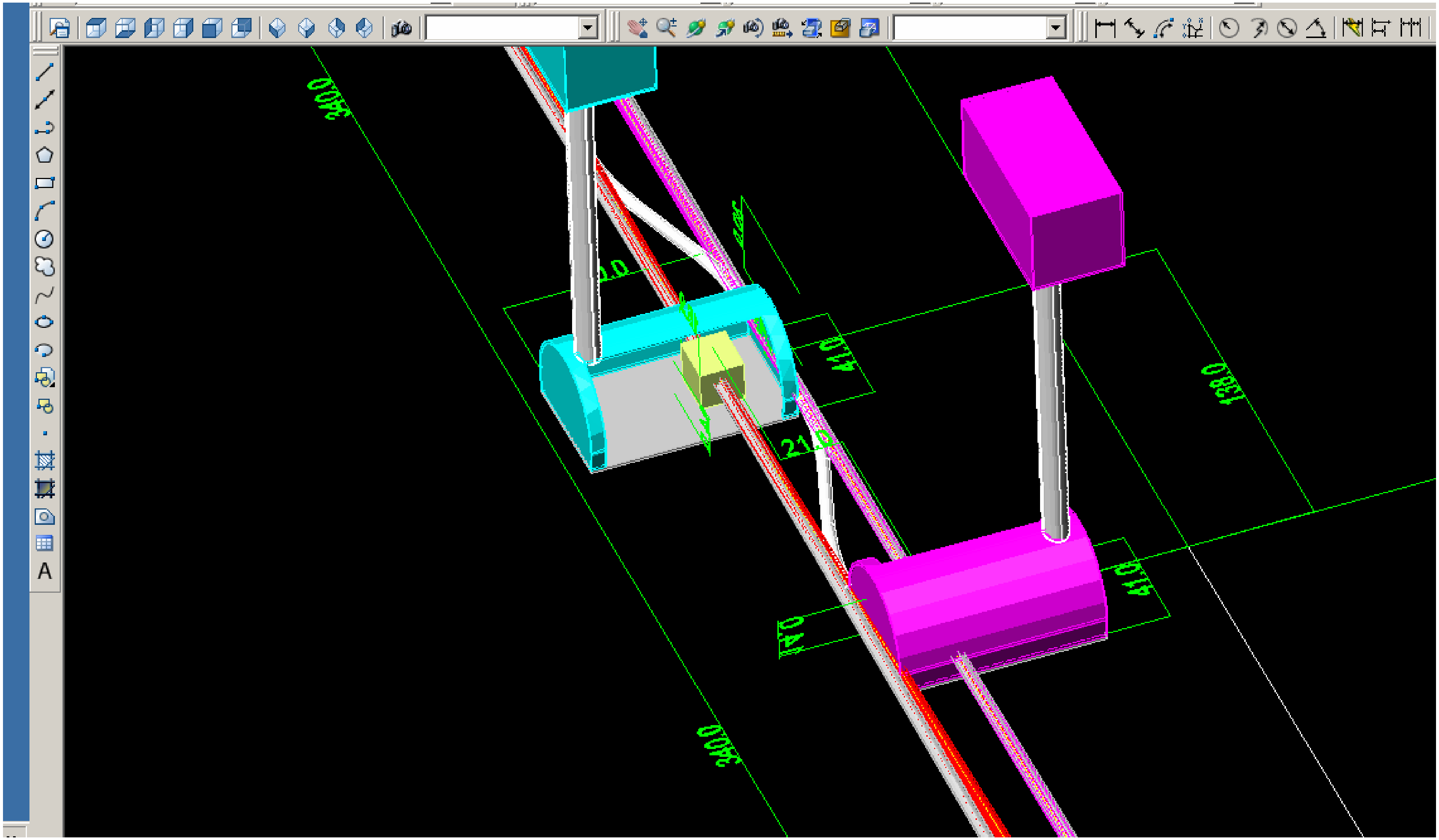
Layouts by Fred Asiri et al.

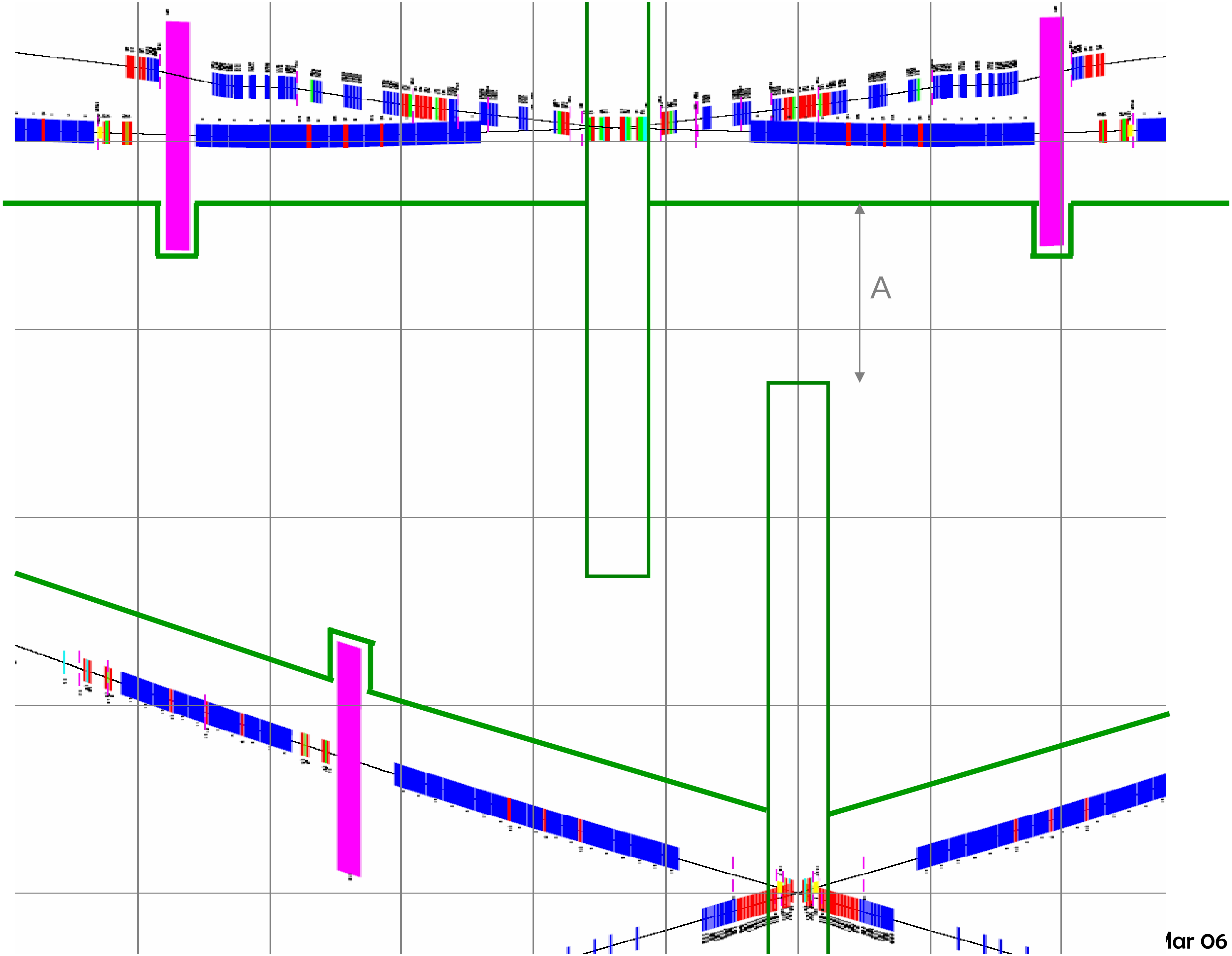


e+ transport, option 2 (under IR hall)



e+ transport, option 3 (between tunnels)

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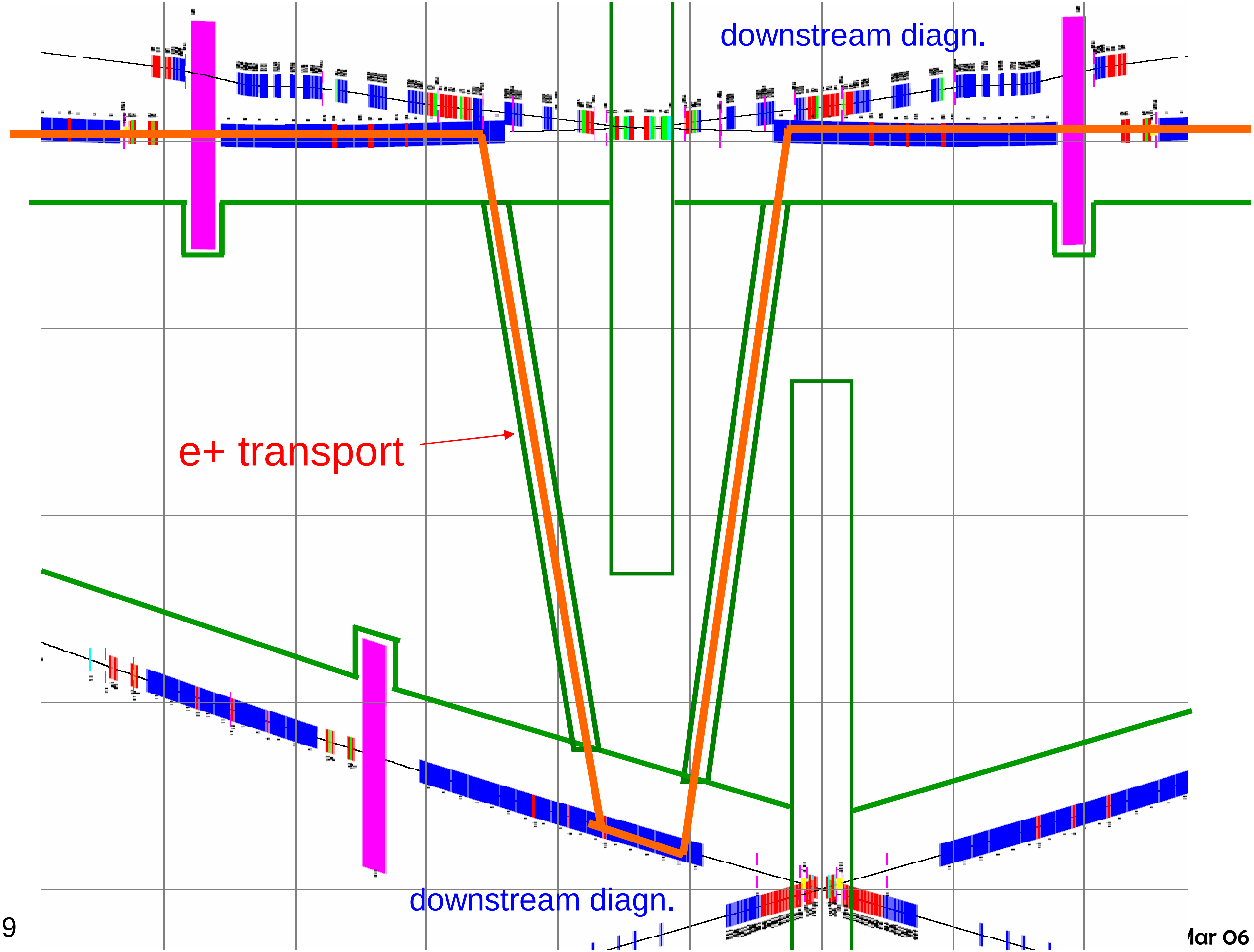
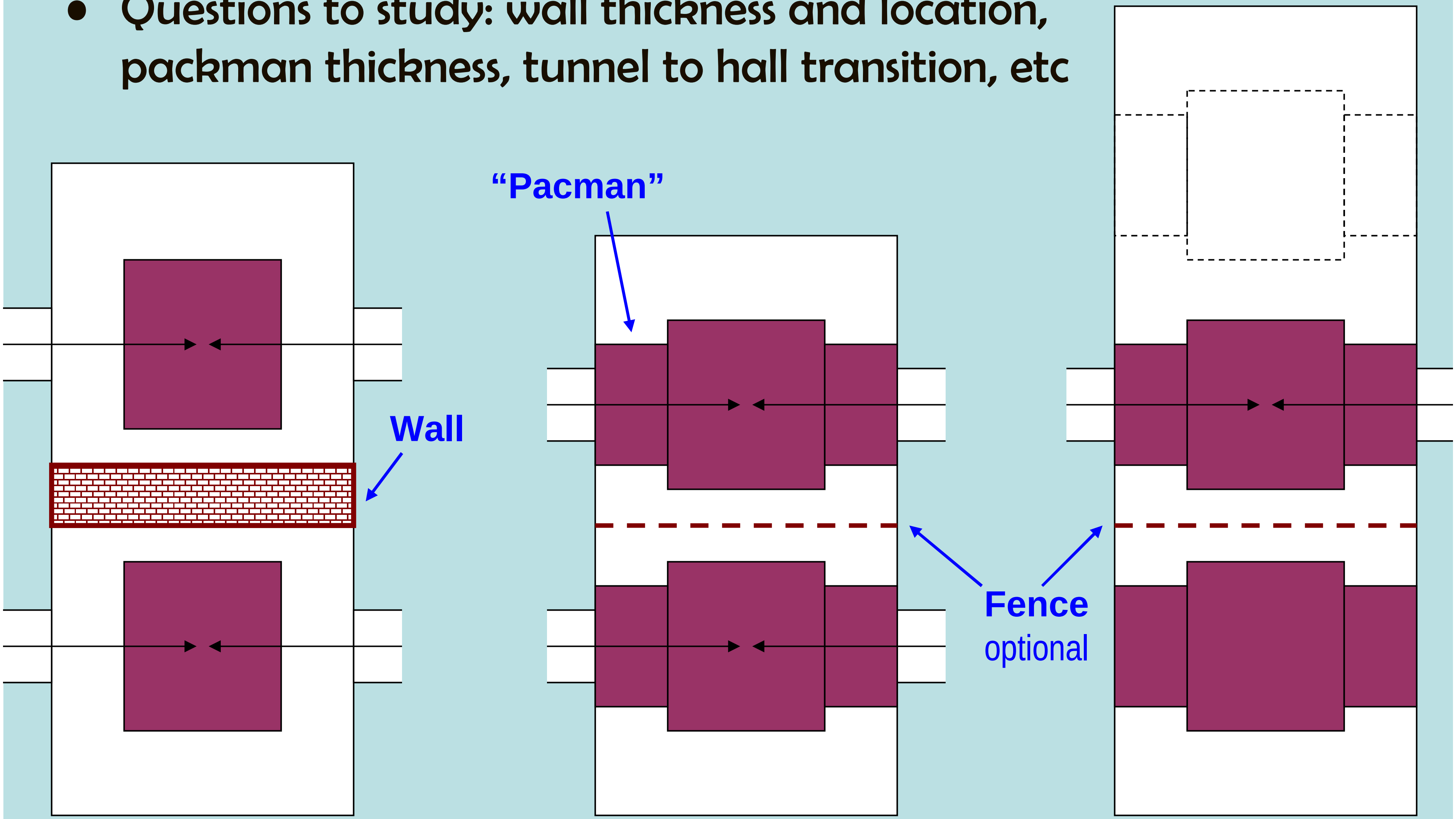

downstream diagn.
e+ transport
downstream diagn.

Options of e+ transport

- Option 1 (around IR)
  - pro: minimal interference with considered options of IR layout (two or one IRs, different or same z) and IR operation
  - con: longer additional tunnel
- Option 2 (under IR hall)
  - pro: smaller length of additional tunnels
  - con: difficult construction; structural stability of IR hall; difficult to provide support for BDS magnets in region of tunnel separation; difficult maintenance; additional shielding of detector required, etc…
- Option 3 (between tunnels)
  - pro: minimize additional tunnel length
  - con: losses of e+ beam near IR => potential background;
    contradicts to the option of both IRs at the same z=0;
    if one of IRs is off, its detector could be accessed, but the downstream diagnostics cannot be accessed without switching off the linac;
  - require additional shielding of detector
- Option 1 suggested for baseline, 2&3 may be considered for AC

Separate & single hall options, Rad. phys. and PPS

- Questions to study: wall thickness and location, packman thickness, tunnel to hall transition, etc

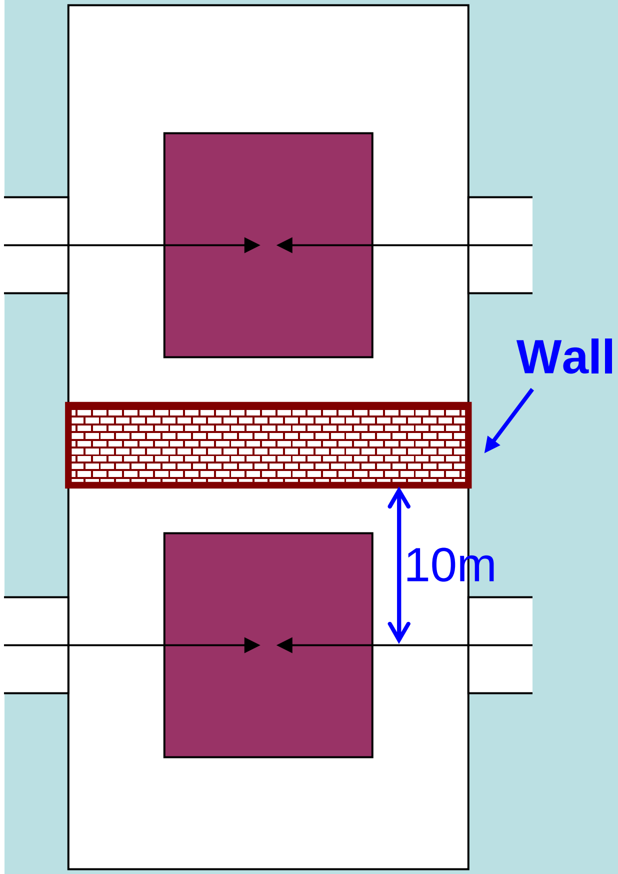


IR design and Radiation safety design criteria

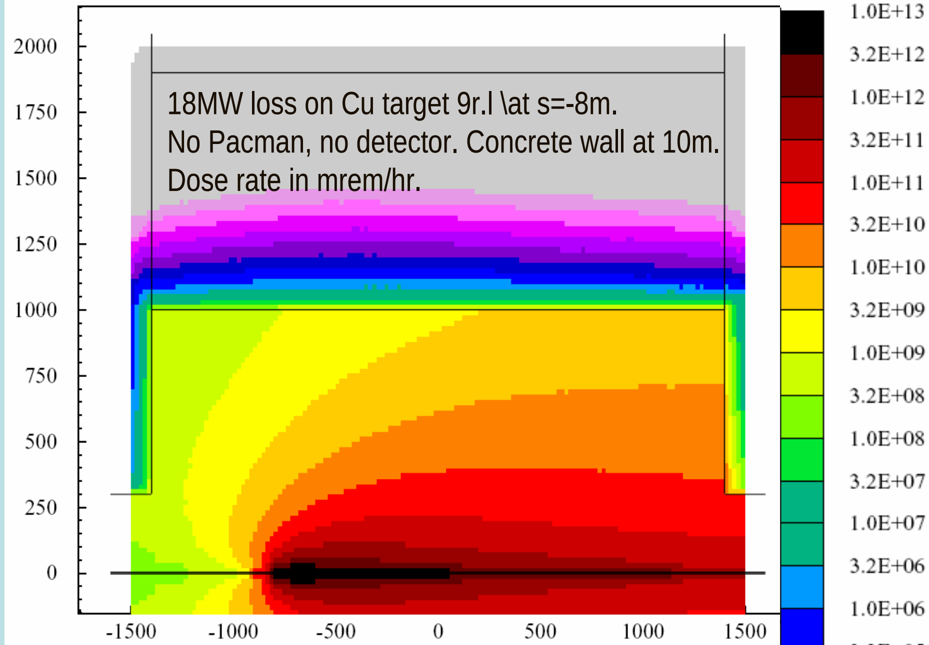
- IR design requires the radiation safety criteria to be defined
- Started the work on "ILC radiation guidance document"
  - beam containment policies and devices, conditions for occupancy
- For IR region, in particular, defines
  - Normal operation: dose less than 0.05 mrem/hr (integrated less than 0.1 rem in a year with 2000 hr/year)
  - Accidents: dose less than 25rem/hr and integrated less than 0.1 rem for 36MW of maximum credible incident (MCI)
- The team presently includes N.Mokhov, D.Cossairt, L.Keller, S.Rokni, A.Fasso and will be augmented with colleagues from all regions

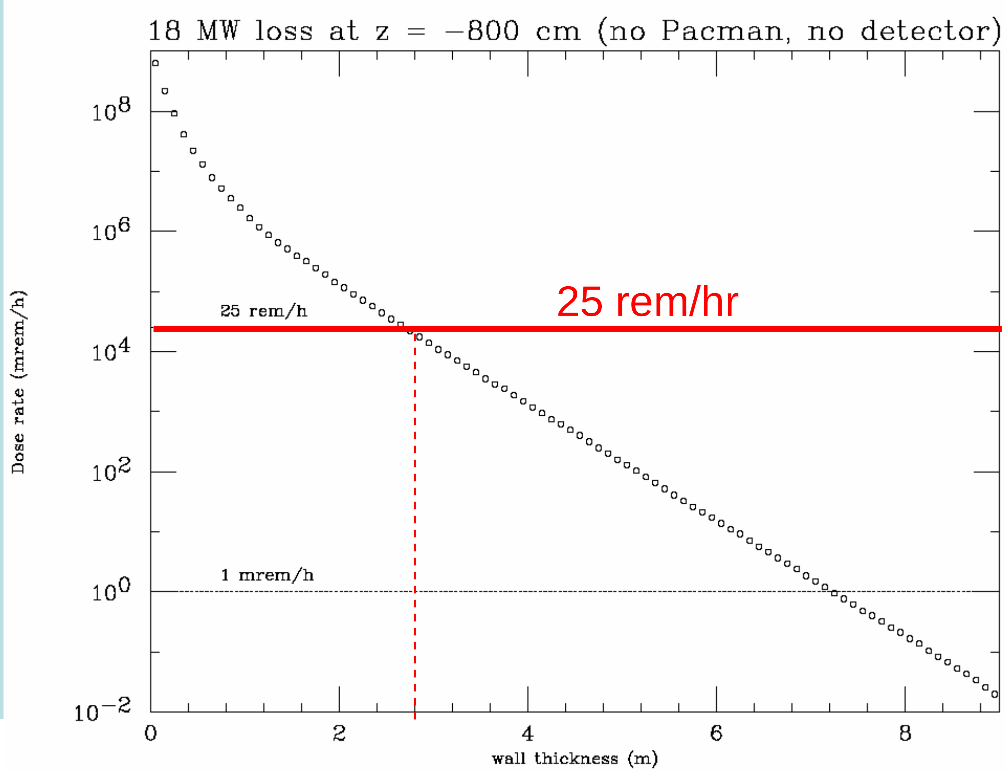
Hall with shielding wall

- For 36MW MCI, the concrete wall at 10m from beamline should be ~3.1m



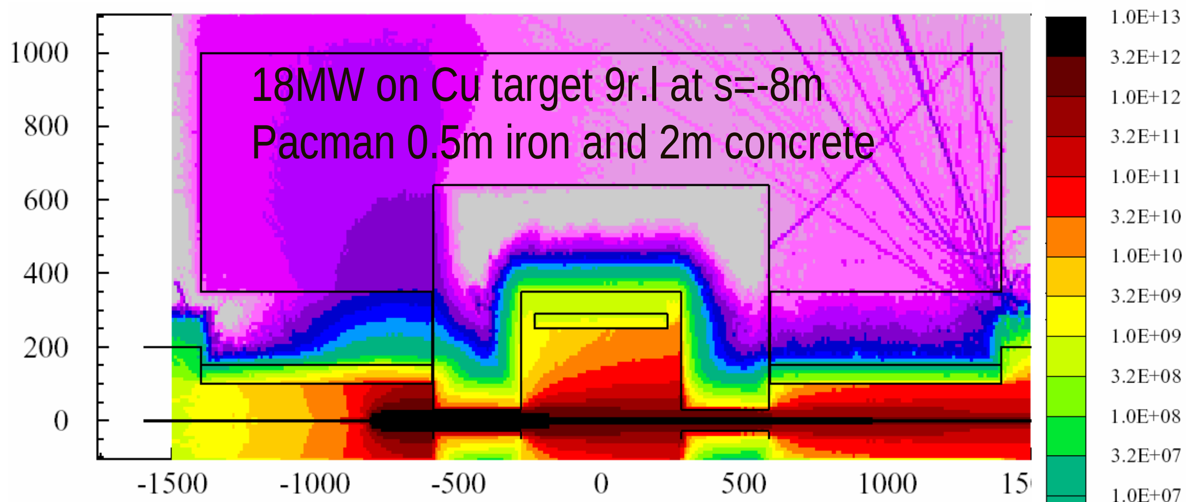
Alberto Fasso et al

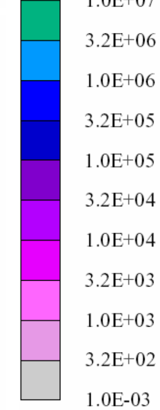




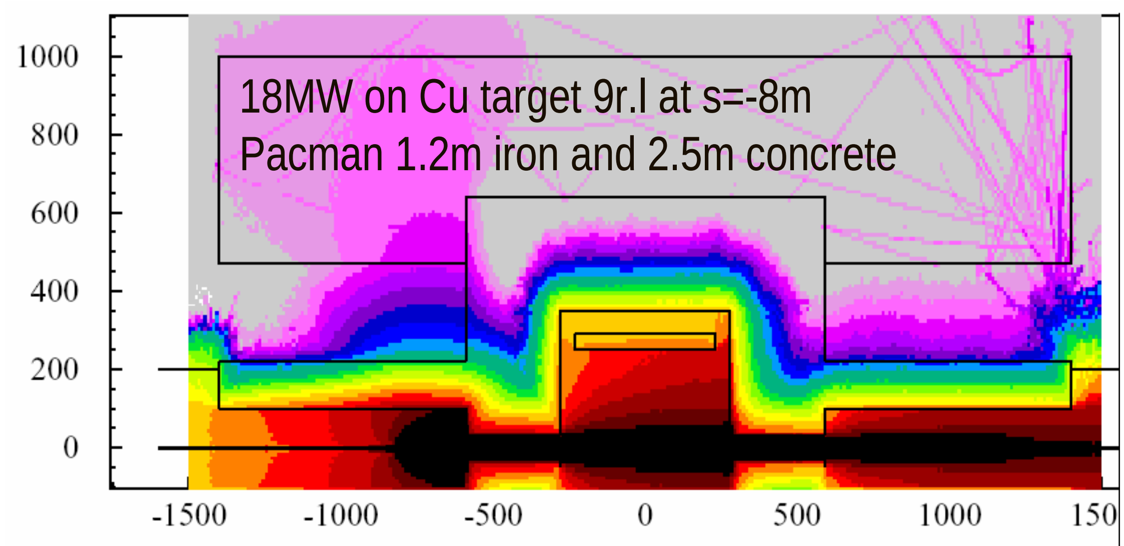
Self-shielding

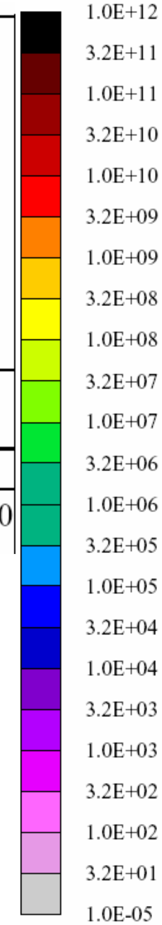
Adjusting pacman to reduce dose below 25rem/hr





Desired thickness is in between of these two cases





color scale is different in two cases

18MW at s=-8m:

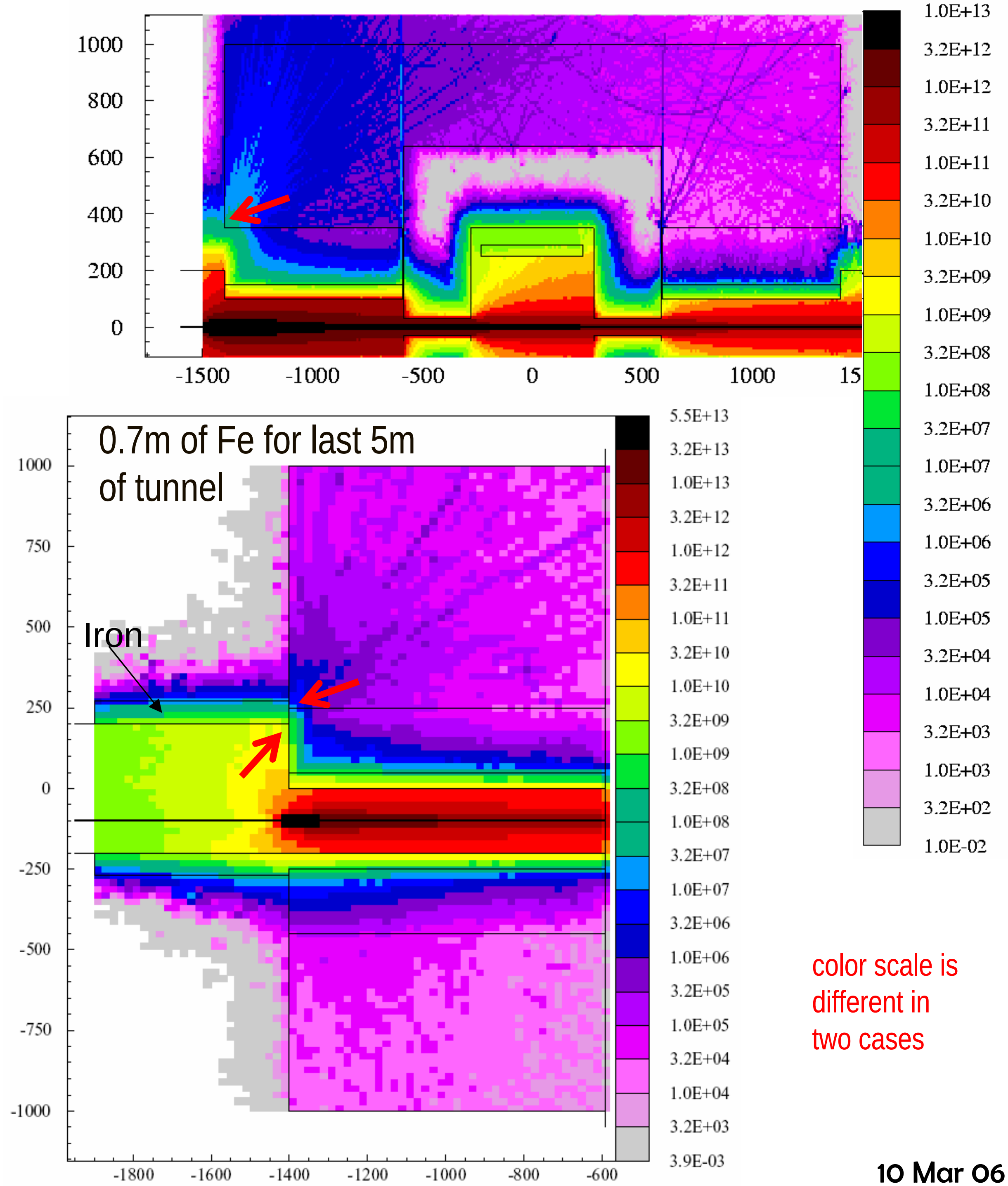
Packman	dose at pacman external wall	dose at r=7m
Fe: 0.5m, Concrete:2m	120rem/hr (r=3.5m)	23rem/hr
Fe: 1.2m, Concrete: 2.5m	0.65rem/hr (r=4.7m)	0.23rem/hr

Self-shielding

Improving tunnel-to-pacman transition, add iron in tunnel and model non-axial symmetrical case

In next iteration will add iron in the marked corners and expect dose to reduce below 25rem/hr

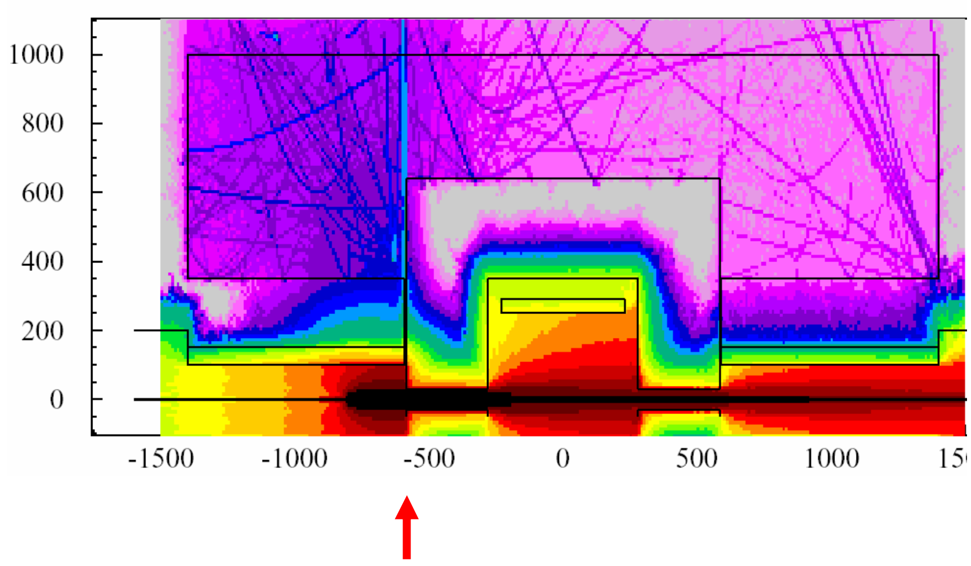
Proper “tunnel plug” can be designed

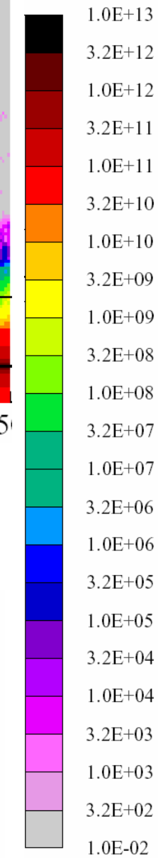


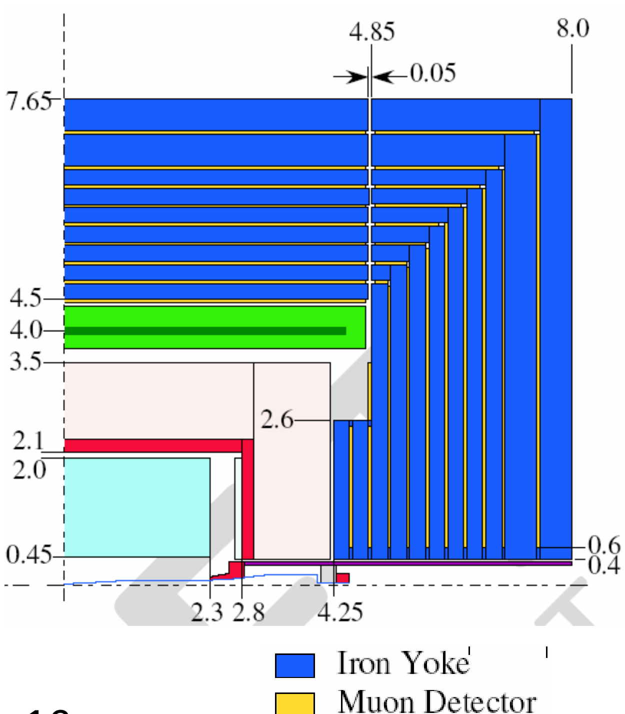
color scale is different in two cases

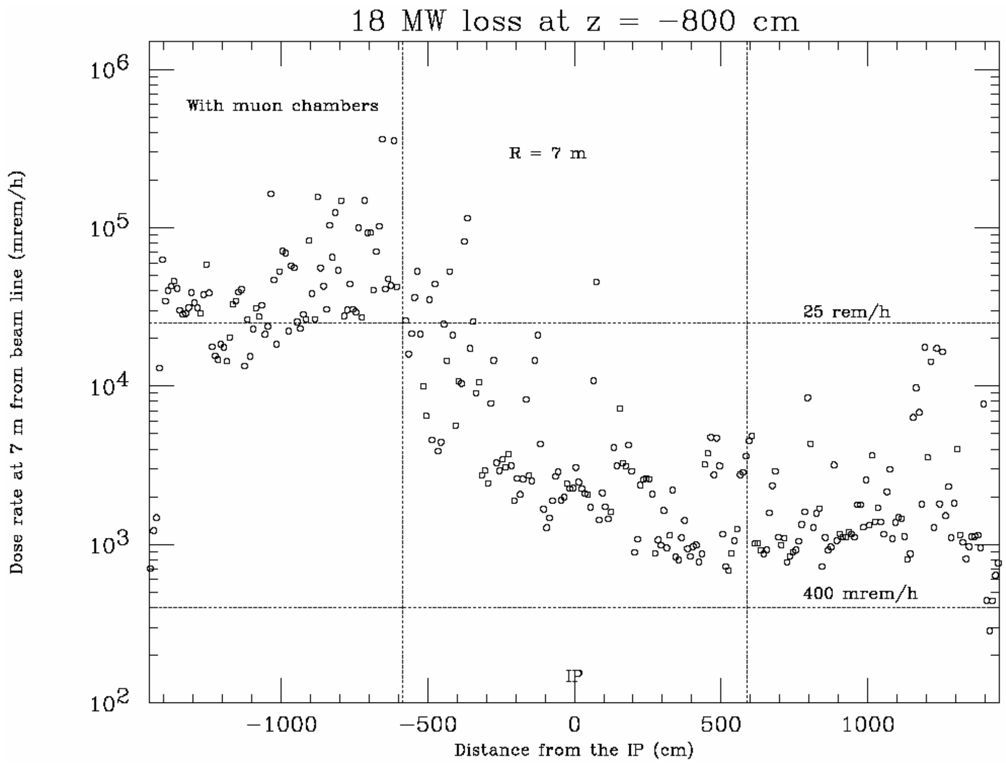
Muon gaps

- 18MW loss on a Cu target (9r.l) placed at s=-8m
- Pacman is 0.5m iron and 2m concrete
- With muon chambers (with gap ~5cm)
- Dose rate shown is in mrem/hr

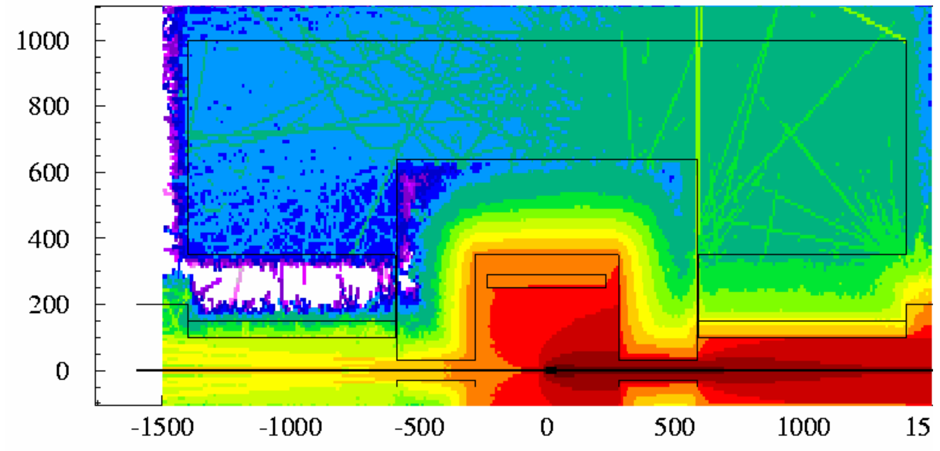








Preliminary conclusions from all cases

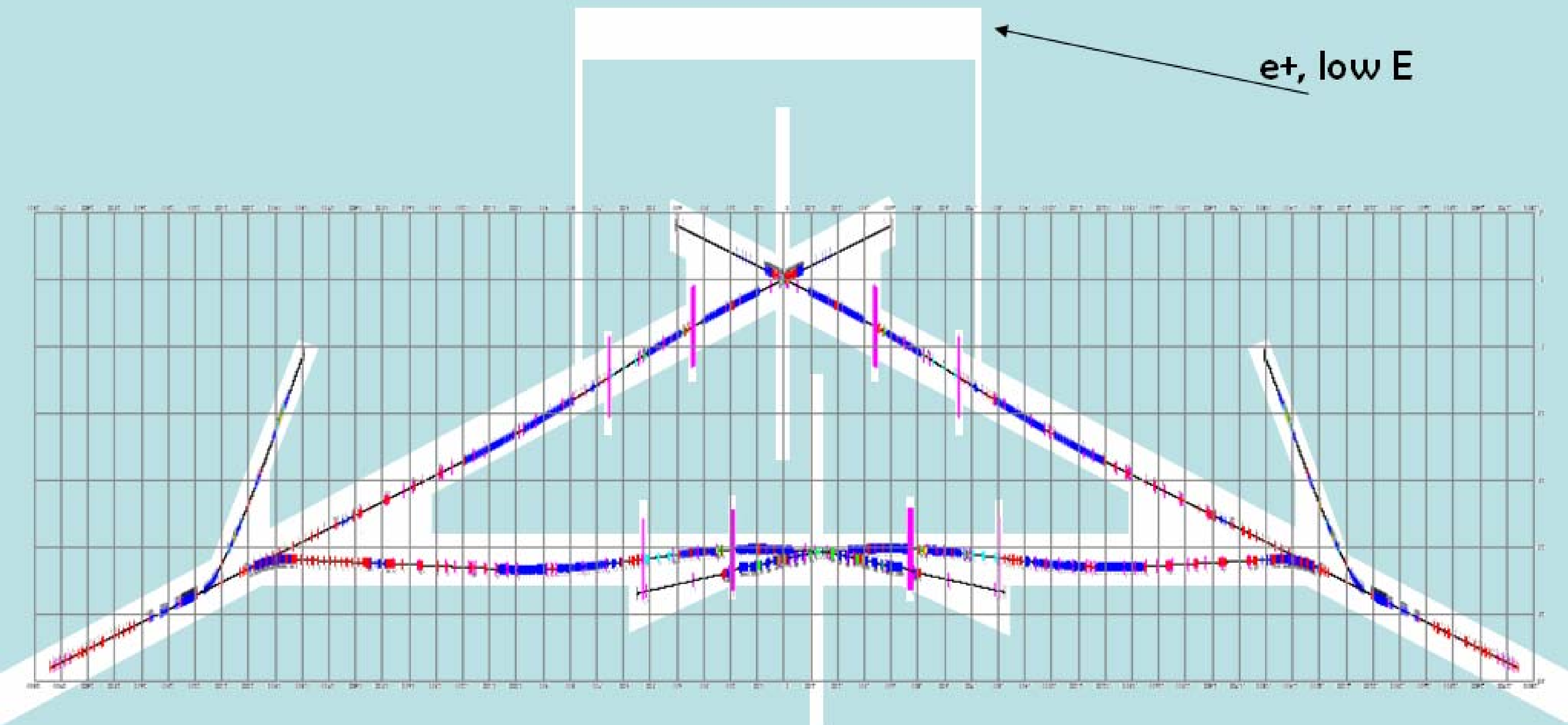


- Self-shielding detectors
  - issue of gaps (muon chambers) need to be solved
  - entrance of tunnel should be covered by iron as well
  - distance helps (fencing out the working detector)
  - if issue of gaps can be solved, ~3m pacman is needed to meet 25rem/hr MCI requirement
  - accurate model of detector is very important
  - studies will continue
- Non self shielding detector
  - concrete wall at 10m from beamline should be ~3.1m

Upgrade from e+e- to $\gamma\gamma$ and back to e+e-

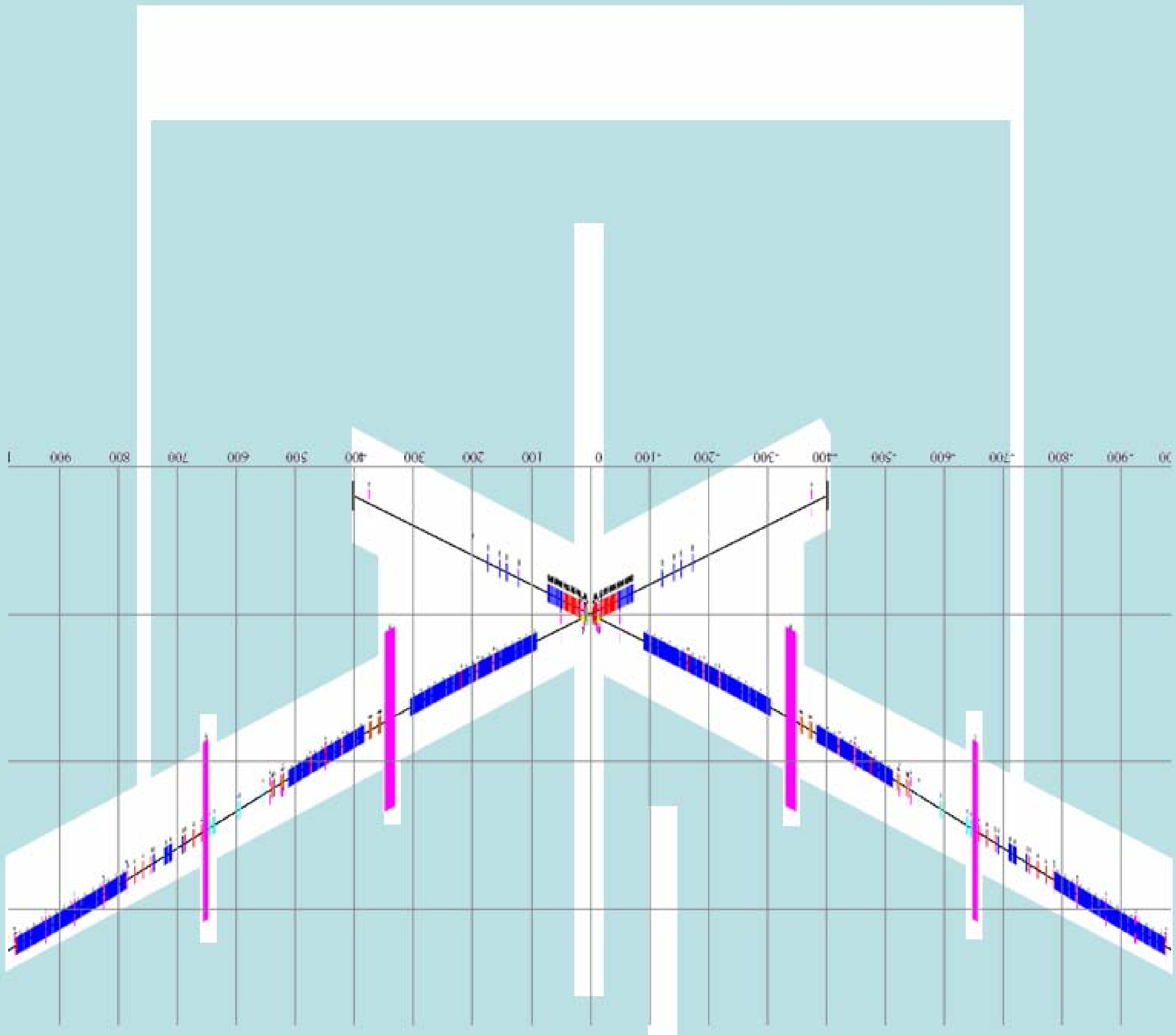
- Assume that 25mrad is needed for $\gamma\gamma$ to attain its max potential
- Reversibility of upgrade may be essential
  - e.g. e+e- run => $\gamma\gamma$ run => E upgrade and next e+e- run
- Consider concept for 20mrad or 14mrad IR upgrade

Baseline layout 20mrad IR and 2mrad IR

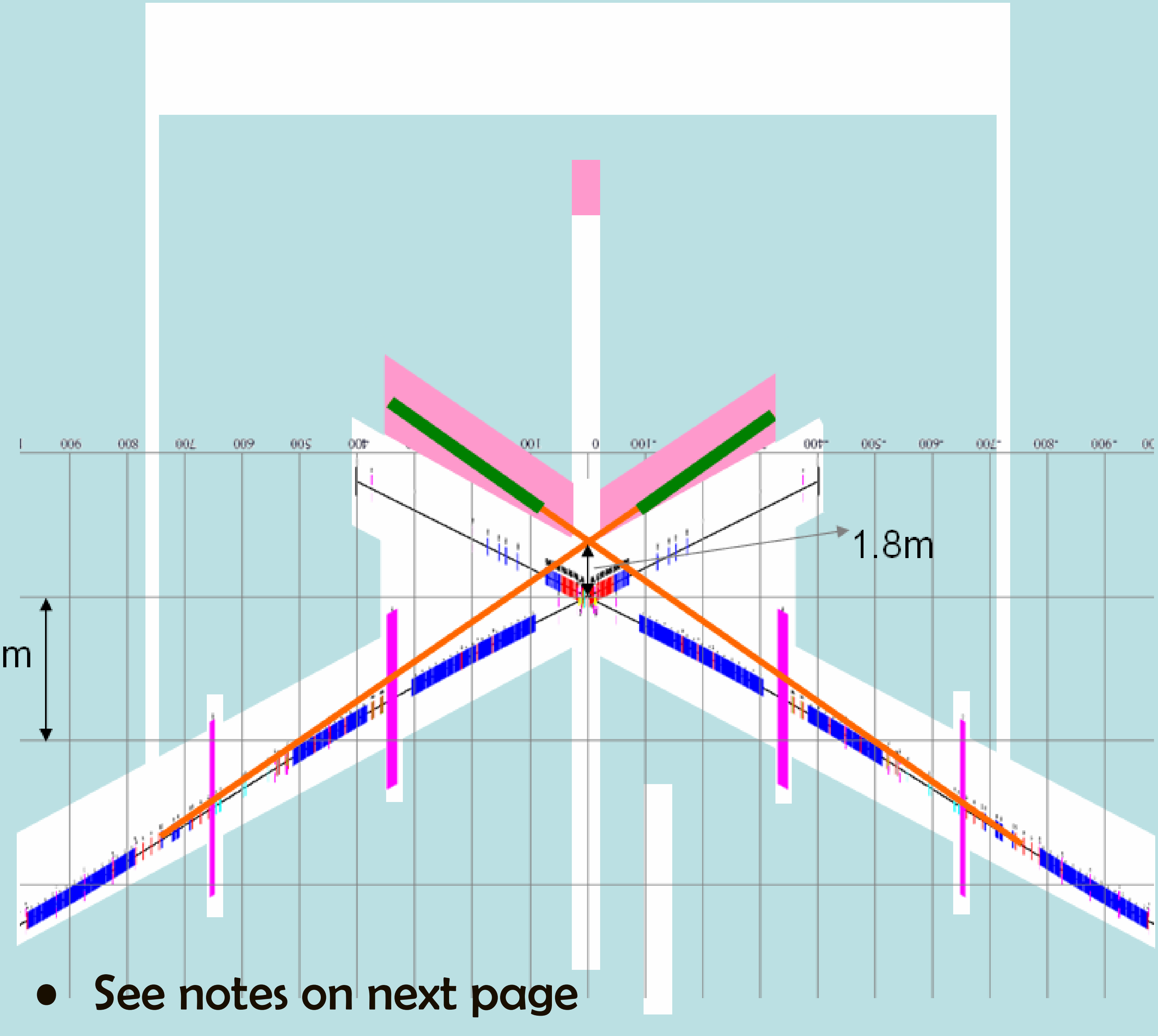


- Grid size: 100m * 5m
- (Beamline is not placed near external walls, as suggested above)

20mr IR



20mr => 25mr



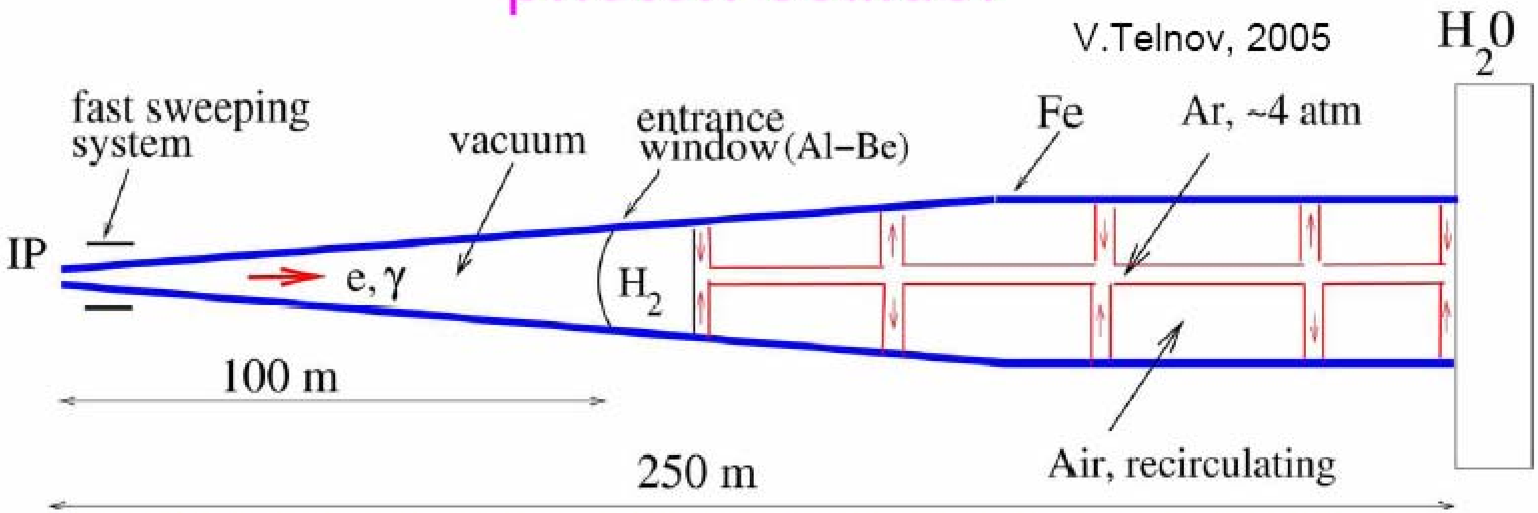
- See notes on next page

Upgrade of 20mr to $\gamma\gamma$ 25mr and back

- Install bend after energy collimator of modify E-coll bend to create additional 2.5mrad
  - Will need to study if this affects collimation efficiency and whether this is an issue for $\gamma\gamma$
- Pink area show tunnels that need to be built for $\gamma\gamma$ in the upgrade or from start
- Detector and IP moved by about 1.8m, FF elements moved
- Build new ~0.25km gas dump followed by water dump for $\gamma\gamma$ (next slide) in a new tunnel, do not dismantle either the water dump for e+e- or extraction line
- If the $\gamma\gamma$ beam dump and new tunnel need to be much longer, the positron transfer tunnel should go above the projected path of $\gamma\gamma$ dump
- In back conversion $\gamma\gamma$ to e+e-, move FF beamline and detector back, continue to use e+e- water dump.

Assumed this dump for $\gamma\gamma$ (feasibility to be studied)

Possible scheme of the beam dump for the photon collider



The photon beam produces a shower in the long gas (Ar) target and its density at the beam dump becomes acceptable.

The electron beam without collisions is also very narrow, its density is reduced by the fast sweeping system. As the result, the thermal load is acceptable everywhere.

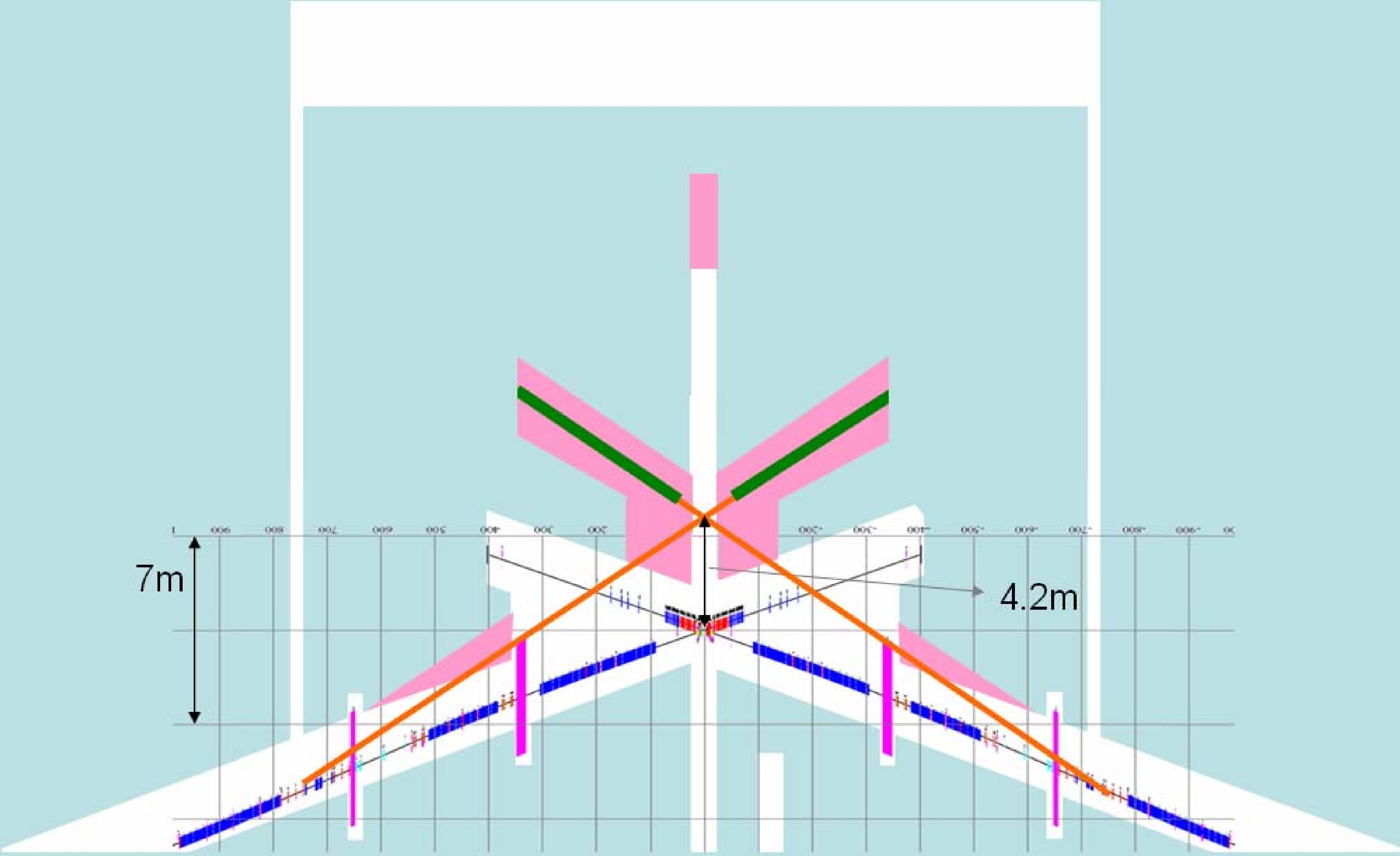
The volume with H_2 in front of the gas converter serves for reducing the flux of backward neutrons (simulation gives, at least, factor of 10).

In order to reduce angular spread of disrupted electrons some focusing after the exit from the detector is necessary.

Needs detailed technical consideration!

November 17, 2005 Valery Telnov, ECFA Study, Vienna 18

14mr => 25mr



- additional angle is 5.5mrad and detector need to move by about 4.2m

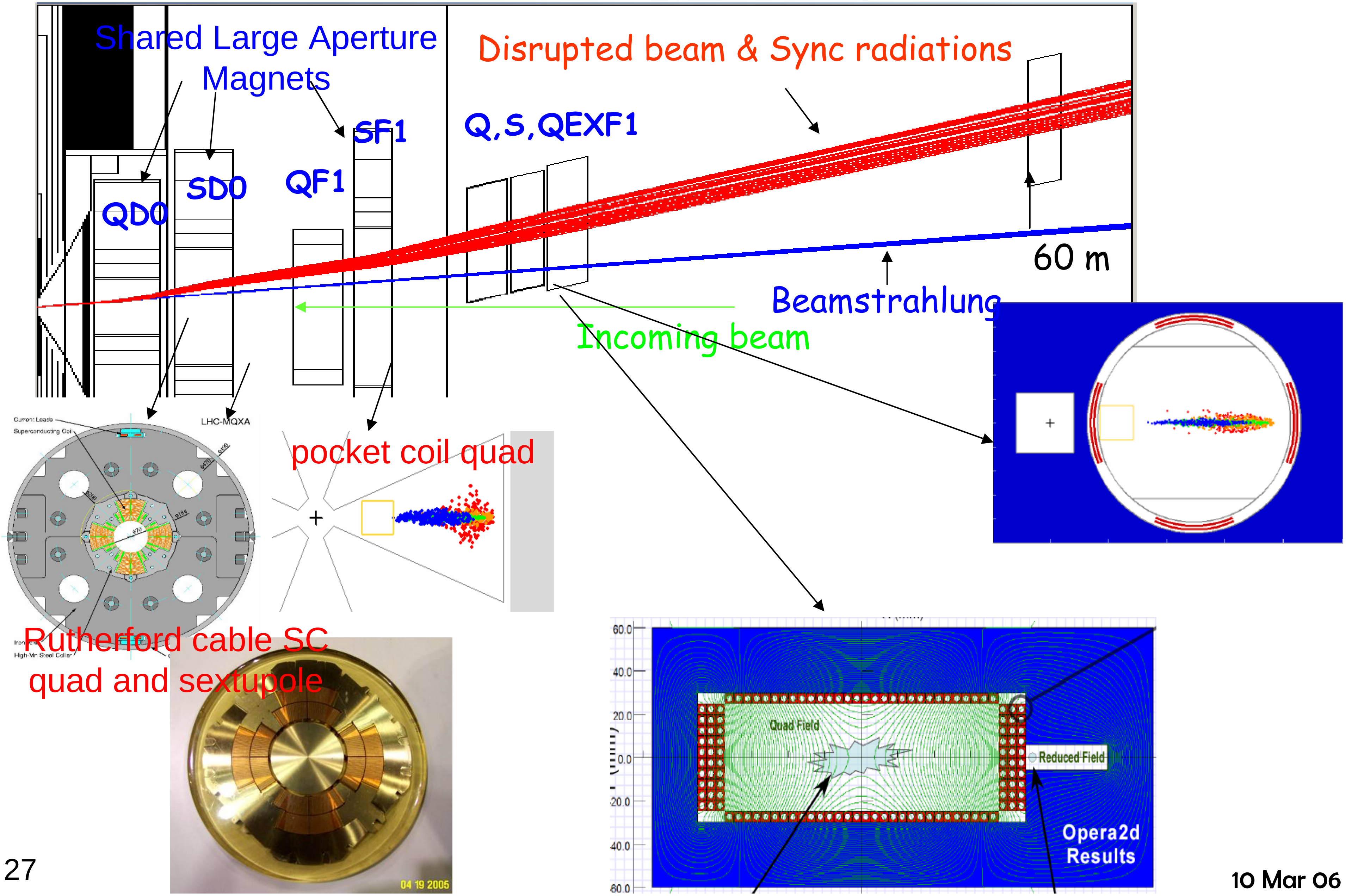
Upgrade of 14mr to $\gamma\gamma$ 25mr and back

- Additional comments
- Tunnel in FF area may need to be wider
- The gg dump is in separate tunnel – may ease radiation issues and upgrade back to e+e-

Extraction line and linac angles

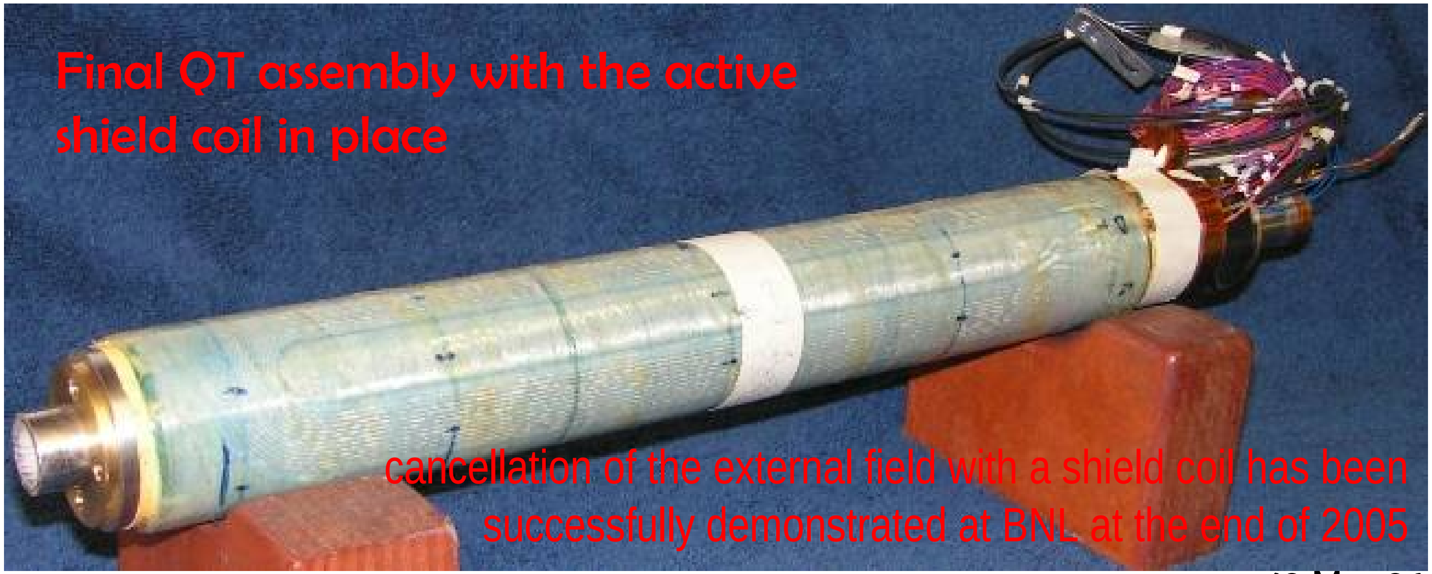
- Extraction line study
  - Detailed studies of extraction lines is ongoing.
  - Synchrotron radiation of disrupted beam in chicanes reach 0.76MW for 1TeV CM in 2mrad beamline. Protection collimators with up to 1TGy/yr peak dose which can severely limit the lifetime even for metals (N.Mokhov, A.Drozhdin et al)
- Linac angles are fixed to 20mrad after discussion at KEK GDE Areas meeting in January and following CCR (Configuration Change Request) by the Executive Committee

2mrad IR: Fermi and possibly Saclay will look on feasibility and cost estimates

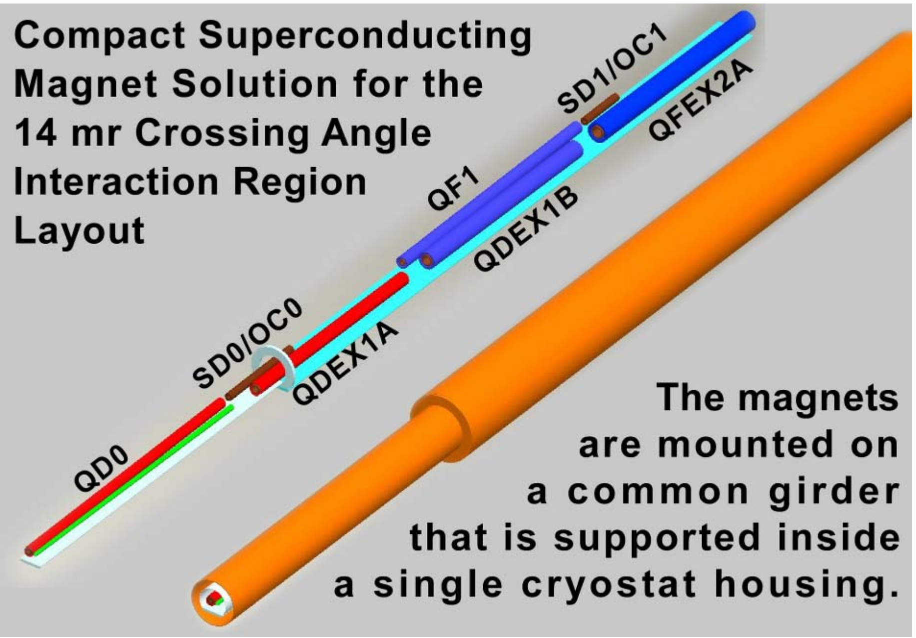


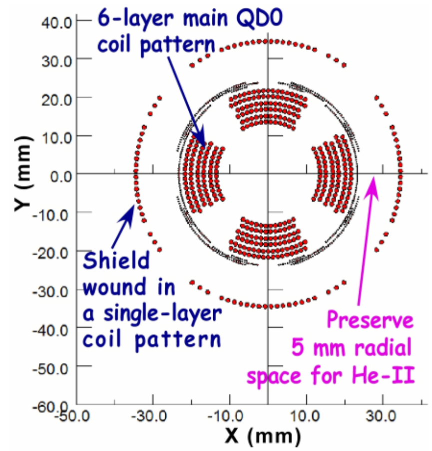
Progress on 14mrad solution, BNL

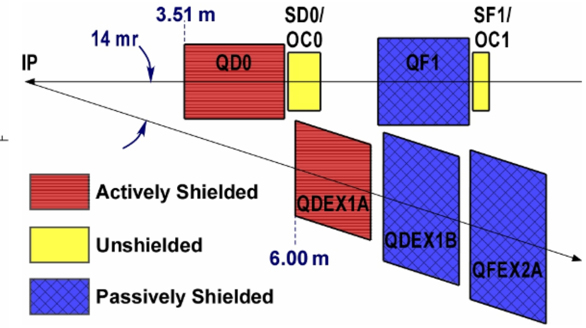
- Brief summary from Brett Parker:
- Working on support structure, cryostat design, verified space for He-II cooling, will start modeling temperature distribution with E deposition calculations
- Close to winding a short sectupole (SD0 prototype) on top of the OC0 coil we have already wound.
- Integrated both DC and pulsed (1ms) heating elements into the coil to directly measure how much energy deposition (mJ/gm) is needed to cause a quench.
- Will measure the magnetic centers for the octupole and sextupole windings

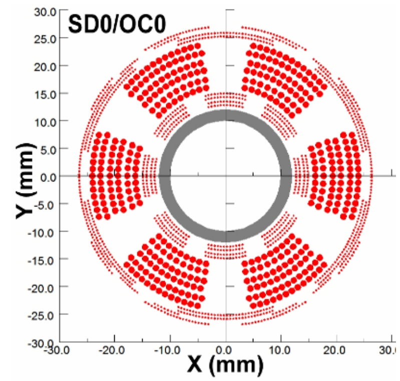


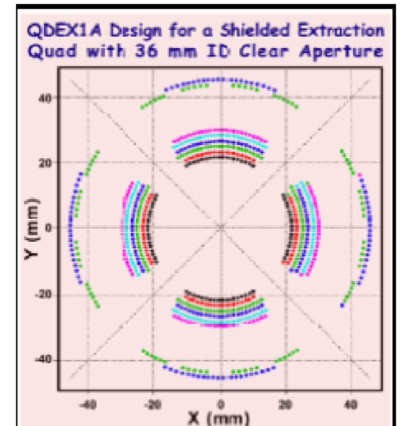
14(20)mrad, BNL

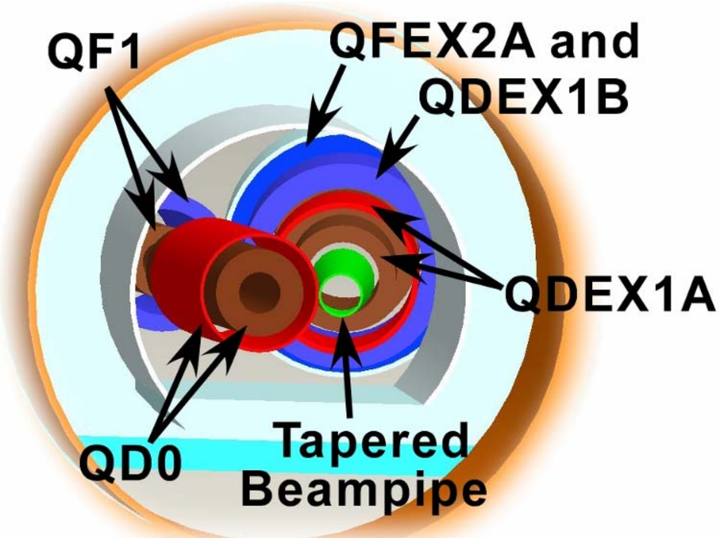


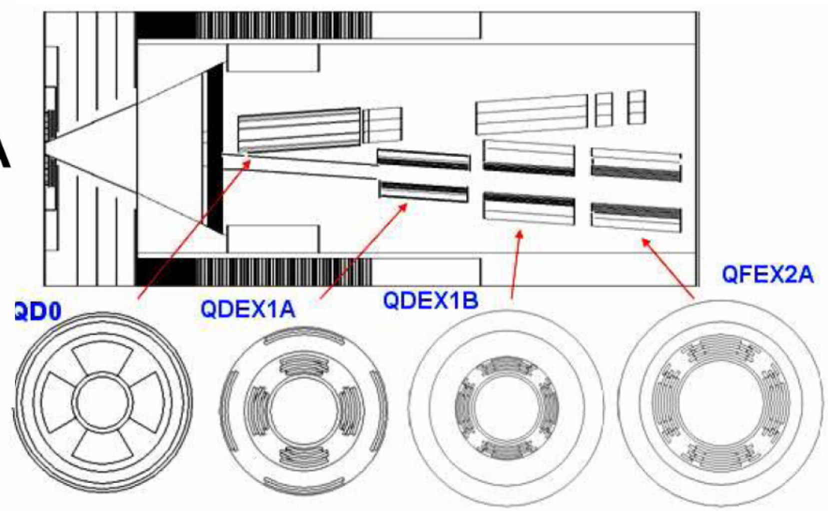


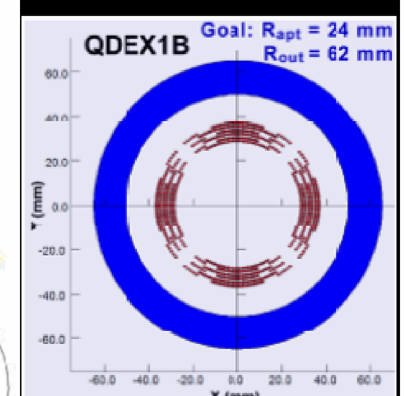




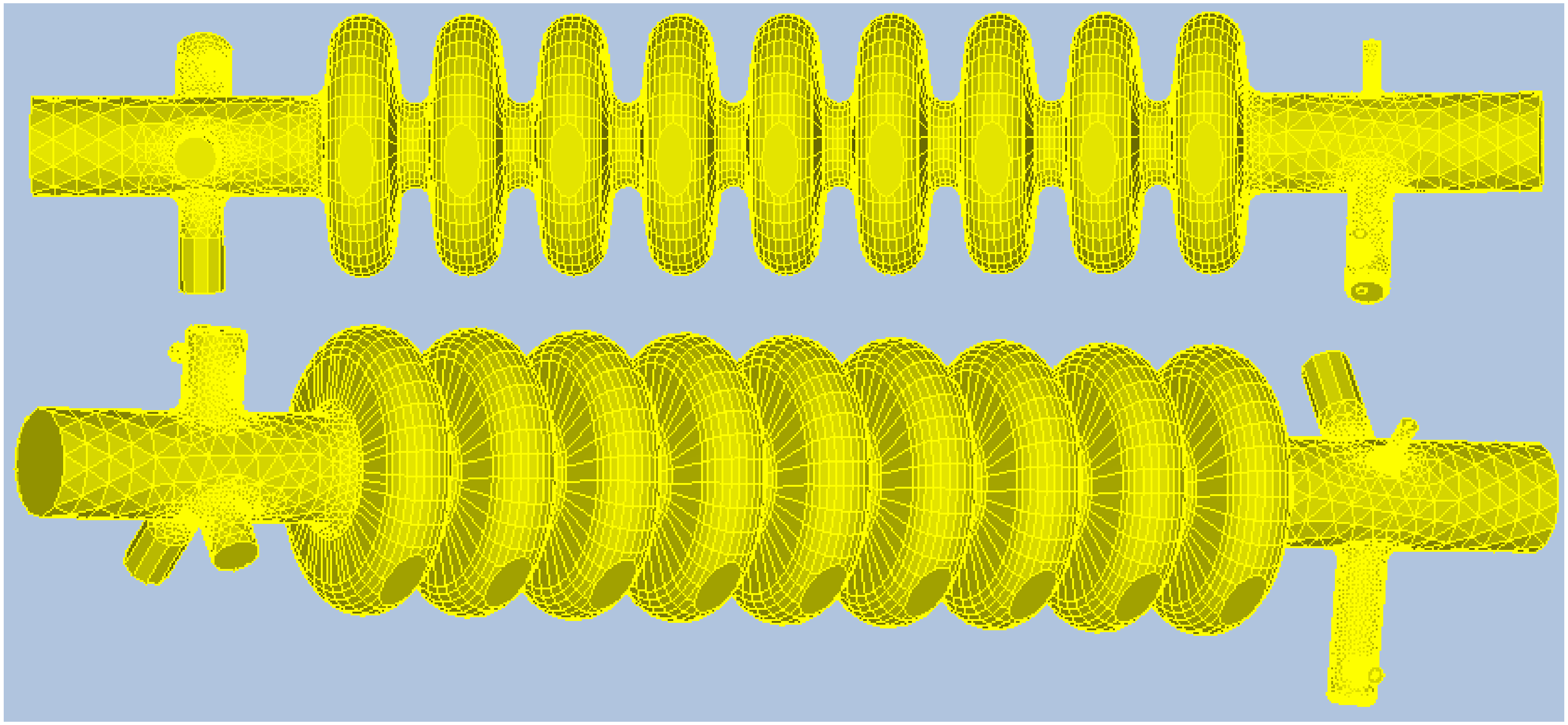








Model of 3.9GHz deflecting (crab) cavity designed by Fermilab

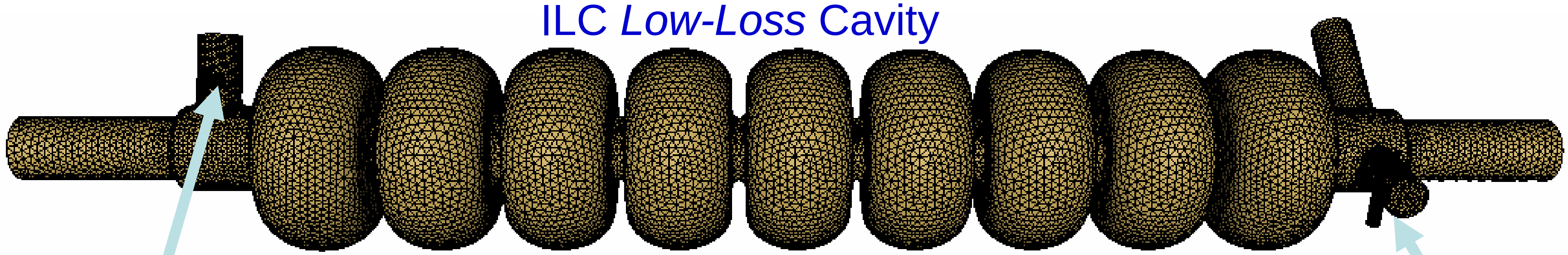


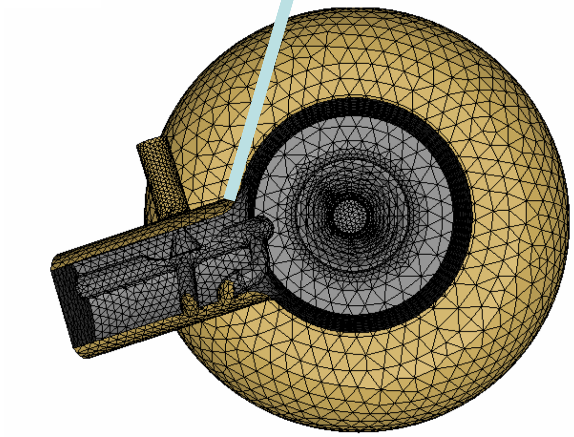
Collaboration is being formed to work on ILC crab cavity systems: Fermilab, Daresbury, SLAC, …

The 3.9GHz deflecting cavity designed at Fermilab. Several simplified models have been manufactured. Complete design with all couplers exist now. Design is being verified with various tools including parallel codes (see next page), and then a prototype will be built. The phase stabilization system is being designed.

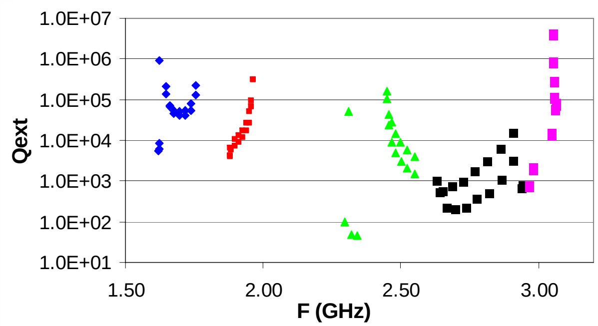
Parallel Electromagnetic Codes - SLAC

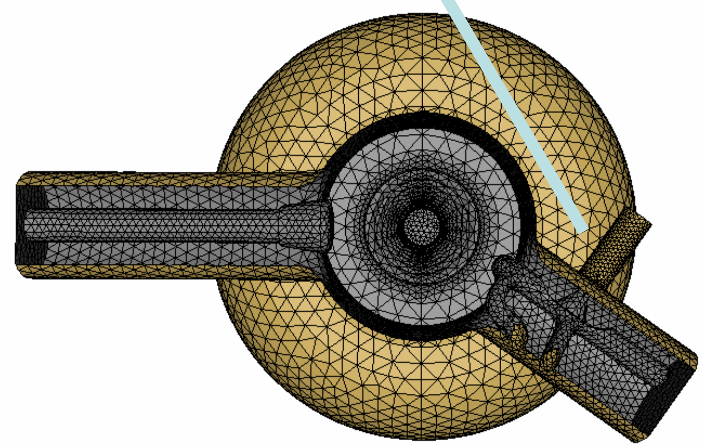
ILC *Low-Loss* Cavity





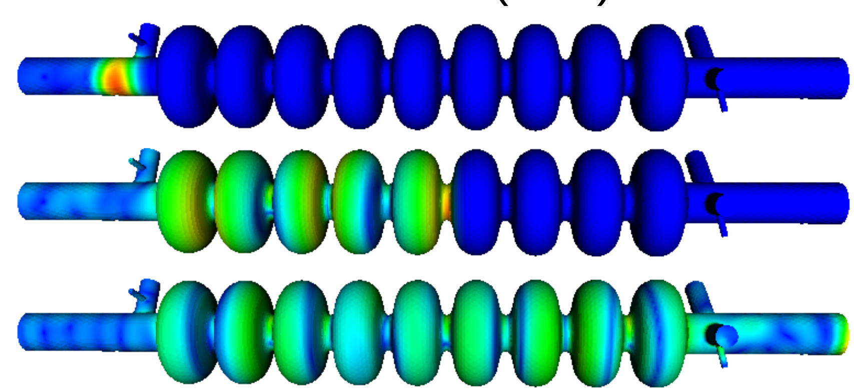
HOM Damping (Omega3P)





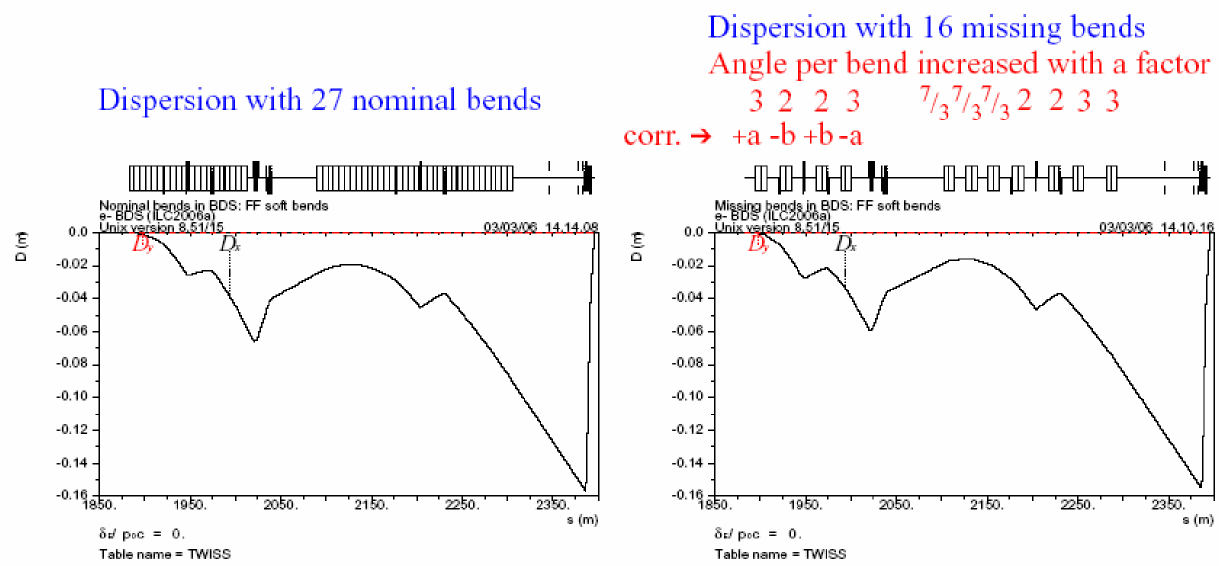
Parallel codes capable of simulating complex 3D cavities in time and frequency domains were applied to the optimization of HOM damping in ILC Low-Loss cavity. The plan is to apply the same capabilities to the design of the 3.9 GHz crab cavity.

Wakefields (T3P)



Missing bend strategy at 500GeV CM

Example shows one of possible configuration in the FF part (Y.Nosochkov)



- Additional corrections to the B5 bend angles, a = 4.01% and b = 14.26%, cancel the residual IP dispersion η_x^* = 78 μm (caused by missing bends) and maintain the X-position of IP.

- At 500GeV CM will install 50% or even less number of bends to cut the cost. These bends need to be installed after the energy upgrade.
- Bends will be split and arranged in strings so that decreasing the energy much below the nominal 500GeV CM will be done by switching off the strings.

Summary

- We discussed updates on several MDI related design issues

- Important issues to be focused on:
  - Taking into account real life constraints,
  - how to build a consensus toward two or one IRs?
  - … two or one detector?
  - … push-pull or normal?
  - … how to ensure that community support is not decreased if the number of IRs and detectors goes to minimum?