SiD MDI Issues

Philip Burrows

John Adams Institute

Oxford University

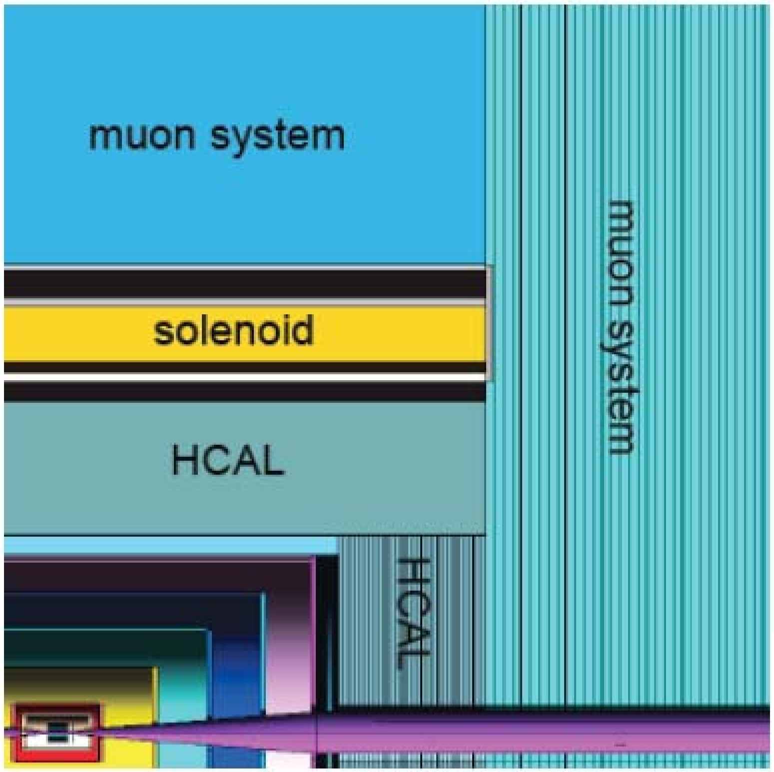
Thanks to: Marty Breidenbach,

Tom Markiewicz, Andrei Seryi

Outline

- **RDR cost driver:**
  detector footprint
  IR hall size + layout
- **‘Self-shielding detector’ radiation study ongoing (Fasso)**
- **Push-pull in single IR -> Markiewicz**
- **Improved design of forward region (BNL/Oregon)**
- **Backgrounds -> Buesser**

SiD



Draft Detector Outline Document (DOD) available

SiD BARREL	Technology	Inner radius	Outer radius	Z max
Vertex detector	Pixel	1.4	6.1	6.25
Tracker	Silicon strips	20.0	126.5	± 167.9
EM calorimeter	Silicon-W	127.0	140.0	±180.0
Hadron calorimeter	RPCs	141.0	250.0	± 277.2
Solenoid	5 Tesla	250.0	330.0	± 277.0
Muon chambers	RPCs	333.0	645.0	± 277.0

SiD FORWARD	Technology	Inner Z	Outer Z	Outer radius
Vertex detector	Pixel	71.9	172.0	71.0
Tracker	Silicon strips	26.7	165.4	126.5
EM calorimeter	Silicon-W	168.0	182.0	127.0
Hadron calorimeter	RPCs	182.0	277.0	140.7

SiD Footprint + IR Layout
(status 3/3/06)

- **On-beamline configuration:**
  - **closed-up for beam running**
  - **open for access**

- **Assembly space**
  - **ground area for assembly/installation**
  - **pit height for assembly**

- **Self-shielding issues**

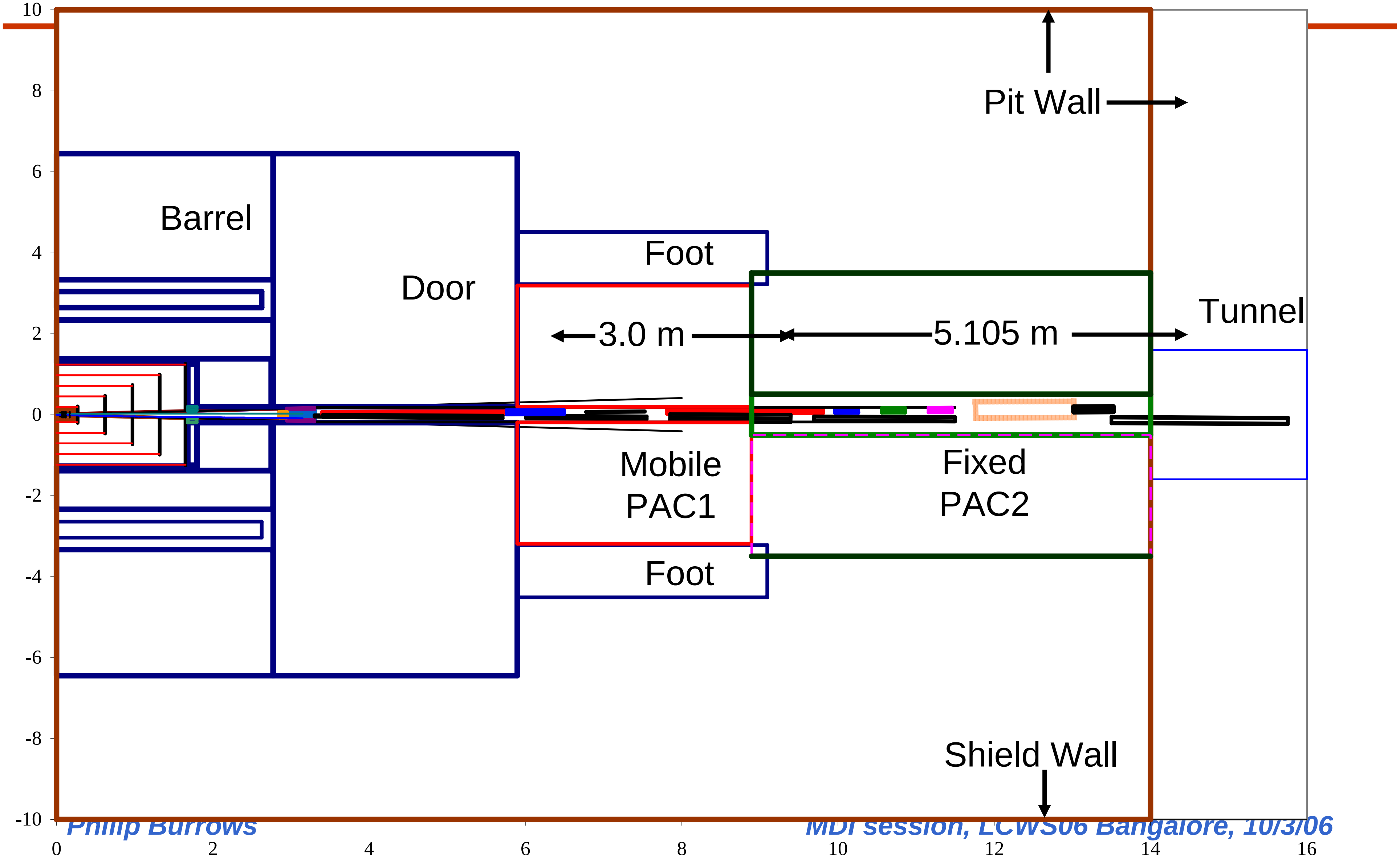
On-beamline considerations

SiD Dimensions from 2005-05 files

- **Barrel radius = 6.450m**
- **Barrel half-length = 2.775m**
- **EC Yoke = 3.12m thick**
- **EC Yoke ends at 5.895m = 2.775+3.120m**

Define closed-up, on-beamline footprint

SiD closed, on beamline, in 20m x 28m area



Some radiation safety considerations

Current SiD working philosophy influenced by SLD/SLC:

Detector should be self-shielding to allow external access during beam operations

Beamline at either end, between tunnel and detector, should be shielded with 'Pacman':

- **c. 3m iron/concrete rings (1m iron, 2m concrete)**
- **Pac1 comes in two halves which are retractable, to allow opening of endcap and detector access**
- **Pac2 is fixed**

Detector access considerations

Door support leg overhang

– 3.2m ~25% door height (=barrel diameter=12.9m)

Door opening

– 3.0m

Free space to walk around door ends

– 1.9m

Reserved radius

– 8.0m (6.45 iron + 1.55m services)

Free space between dressed barrel & pit walls

– 2.0m

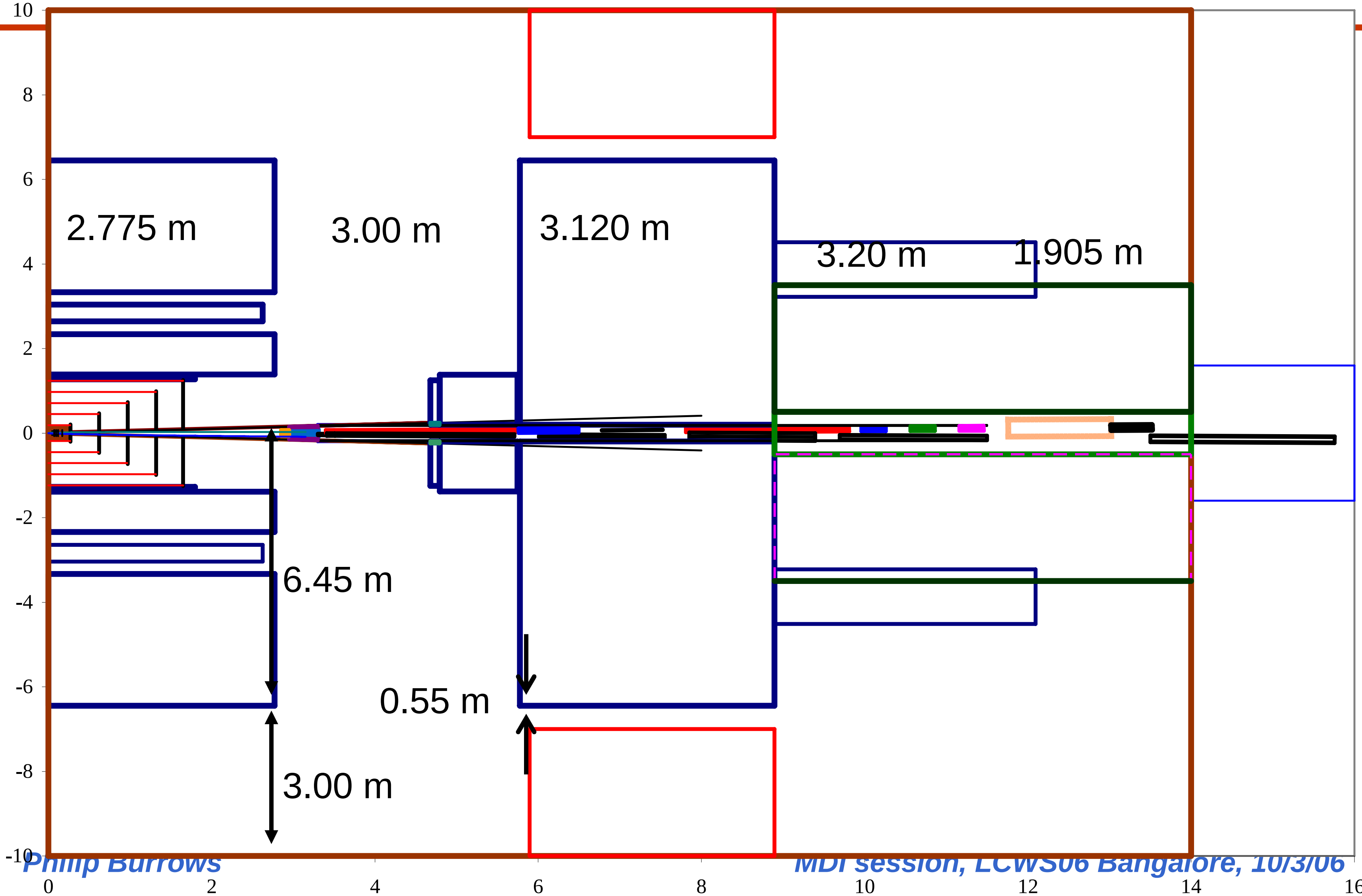
PACMAN annulus

– 3.0m [1m Fe, 2m concrete]

Other

– Tunnel diameter 3.2m
– Assumed beam height=Barrel radius + 1m

SiD open, on beamline, in 20m x 28m area

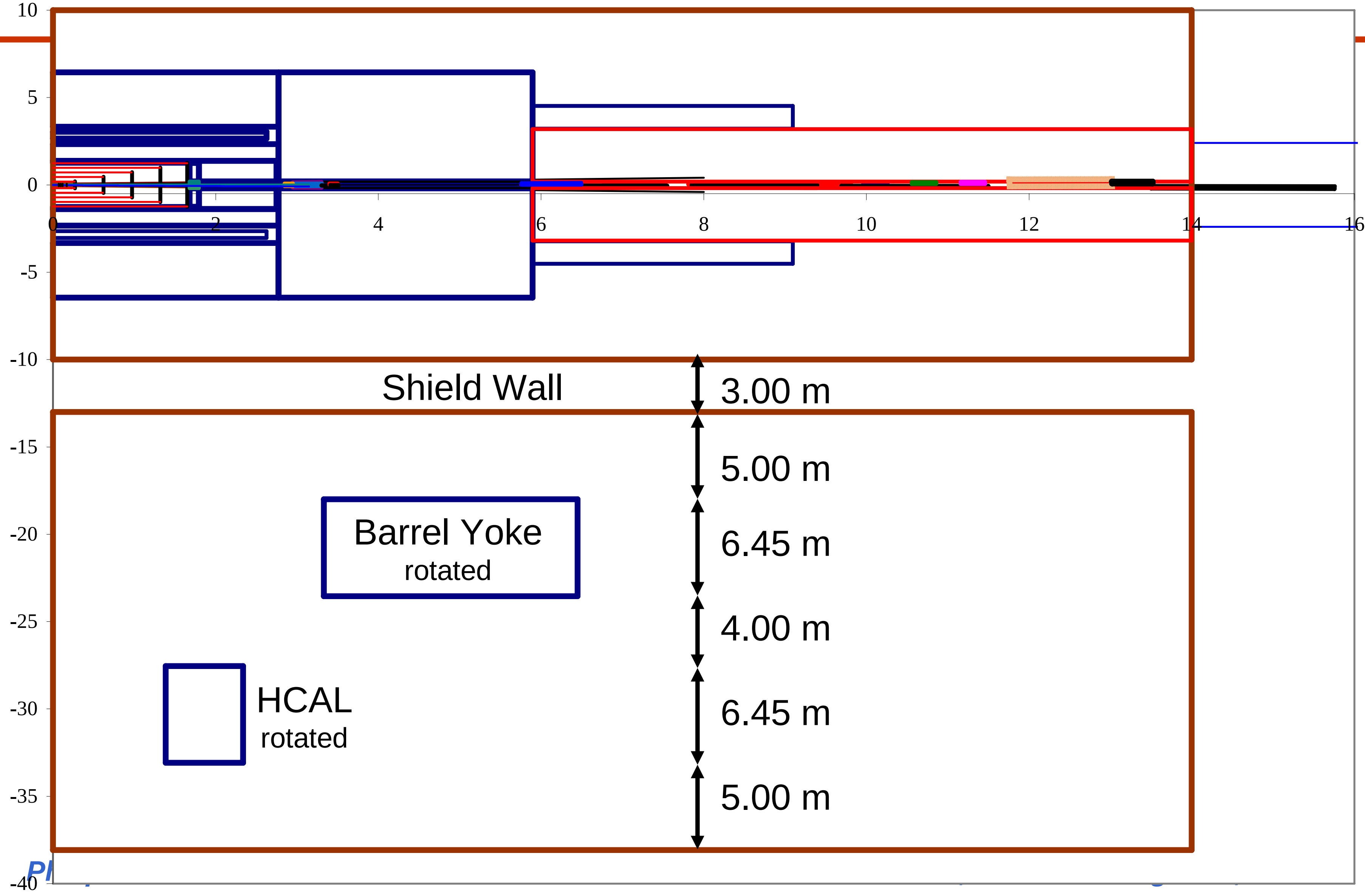


Detector assembly considerations

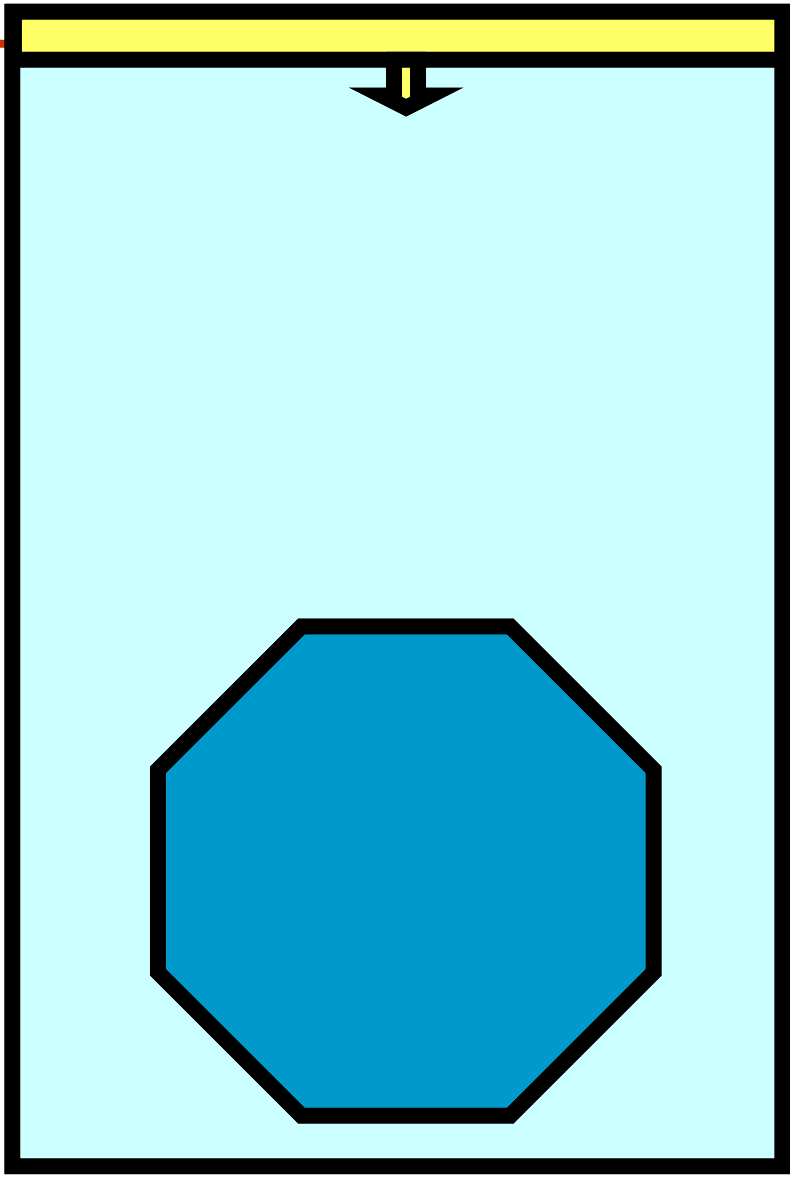
Garage assembly requirements:

- 3m shielding wall between beamline position & garage
  - assuming self-shielding
  - wall needed for commissioning only
- 5m free space between shield wall & rotated barrel yoke
  - 2m free + 2m assembly fixture + 1m free
- 4m free space between rotated barrel yoke & rotated barrel HCAL
  - 1m free + 2m assembly fixture + 1m free
- 5m free space between rotated barrel HCAL & pit wall
  - 2m free + 2m assembly fixture + 1m free

SiD garage space for assembly



Elevation view



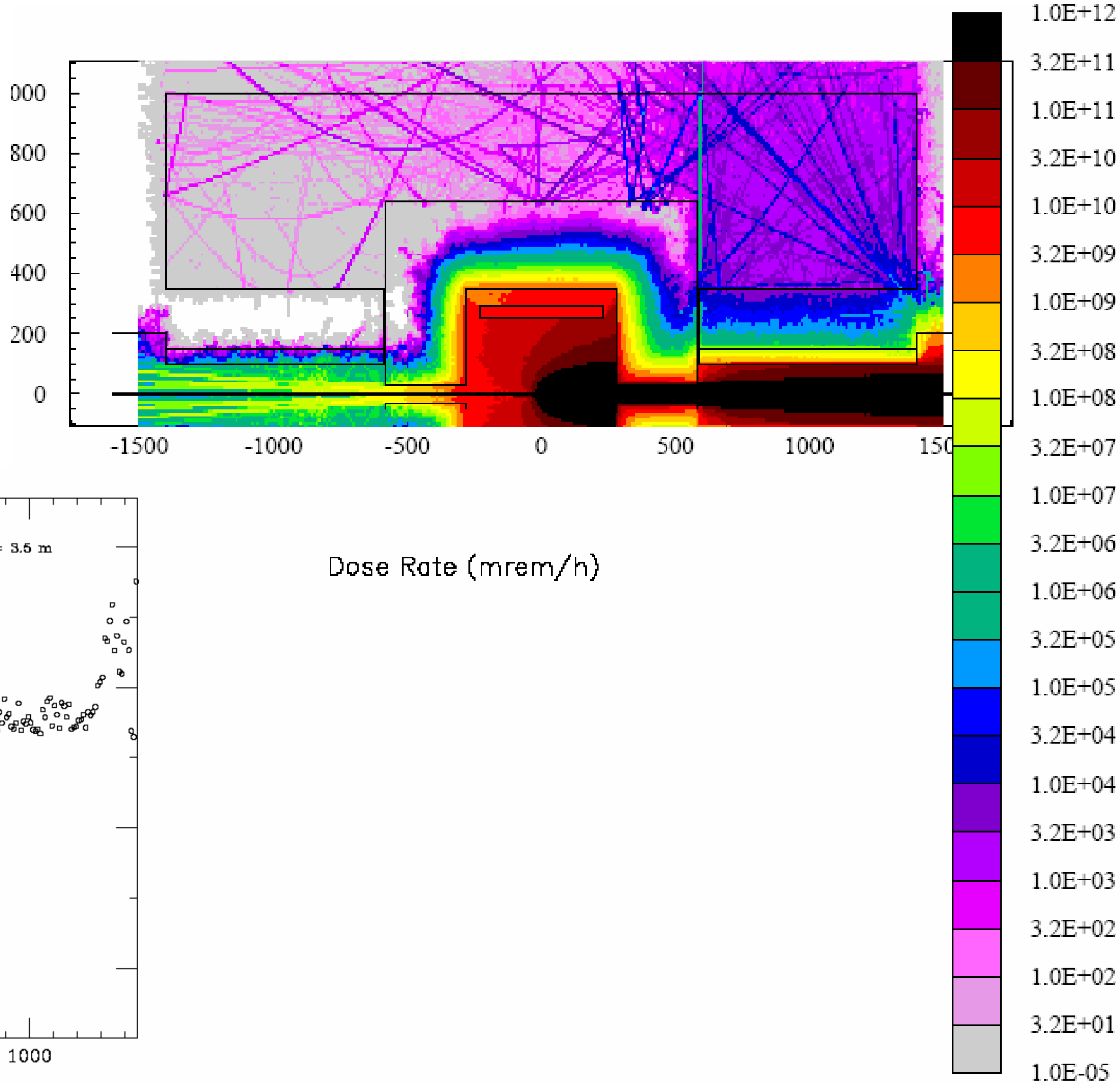
Pit Elevation: 33m

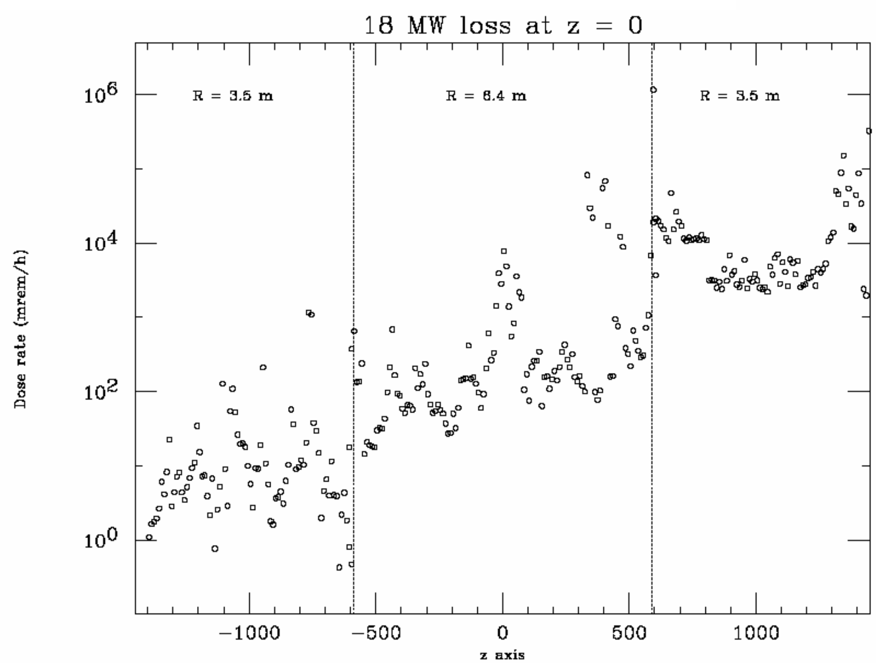
- **1.000 Barrel-floor**
- **12.90 Detector diameter**
- **12.90 Free space above detector**
- **6.000 Crane bridge and hook**

Some comments

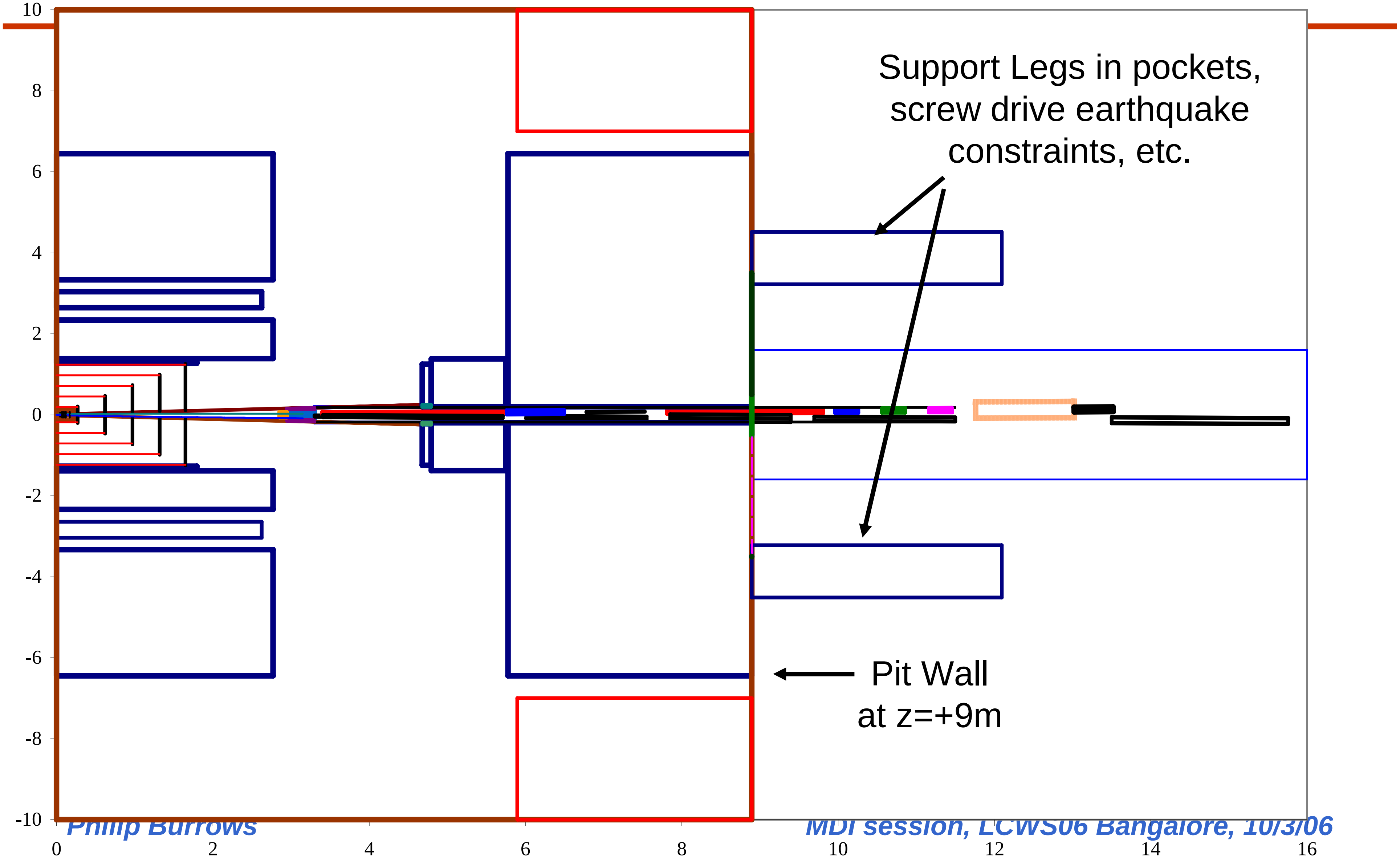
- Design by physicists (not engineers!)
- Self-shielding radiation issues under dedicated study
- Endcap feet can probably be halved (3m -> 1.5m)
  - details depend on earthquake regulations
  - slide into ‘slots’ in Pac2/pit wall
- 55cm clearance between Pac1 and endcap marginal?
- Allow Pac2 to open?
- Current model probably ‘luxurious’:
  - Reduce pit length and do away with Pac2?
  - Reduce size of garage area?
- Access shaft(s) locations, cranes …
- Push-pull (see Markiewicz)

Radiation study ongoing (Fasso et al)

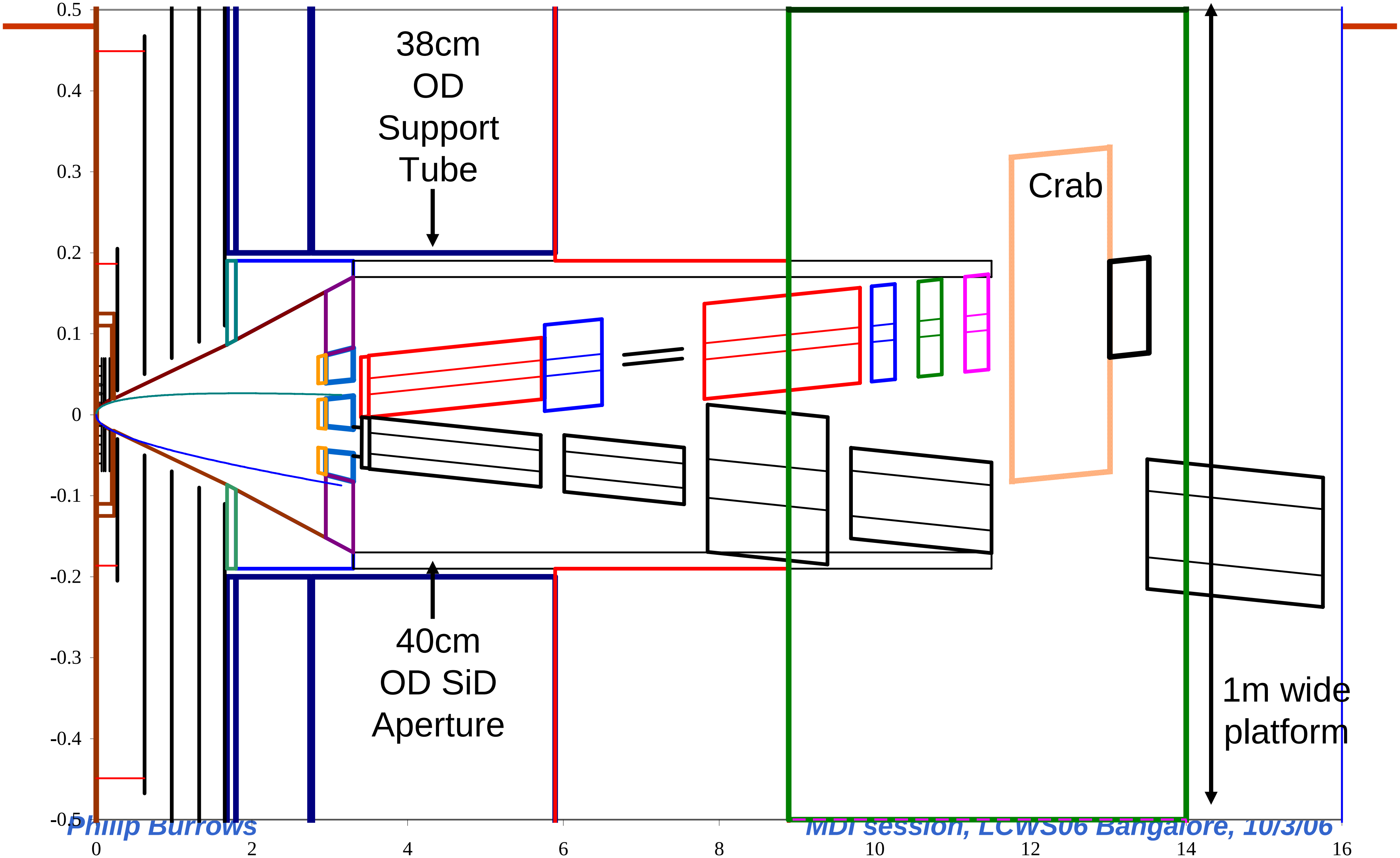




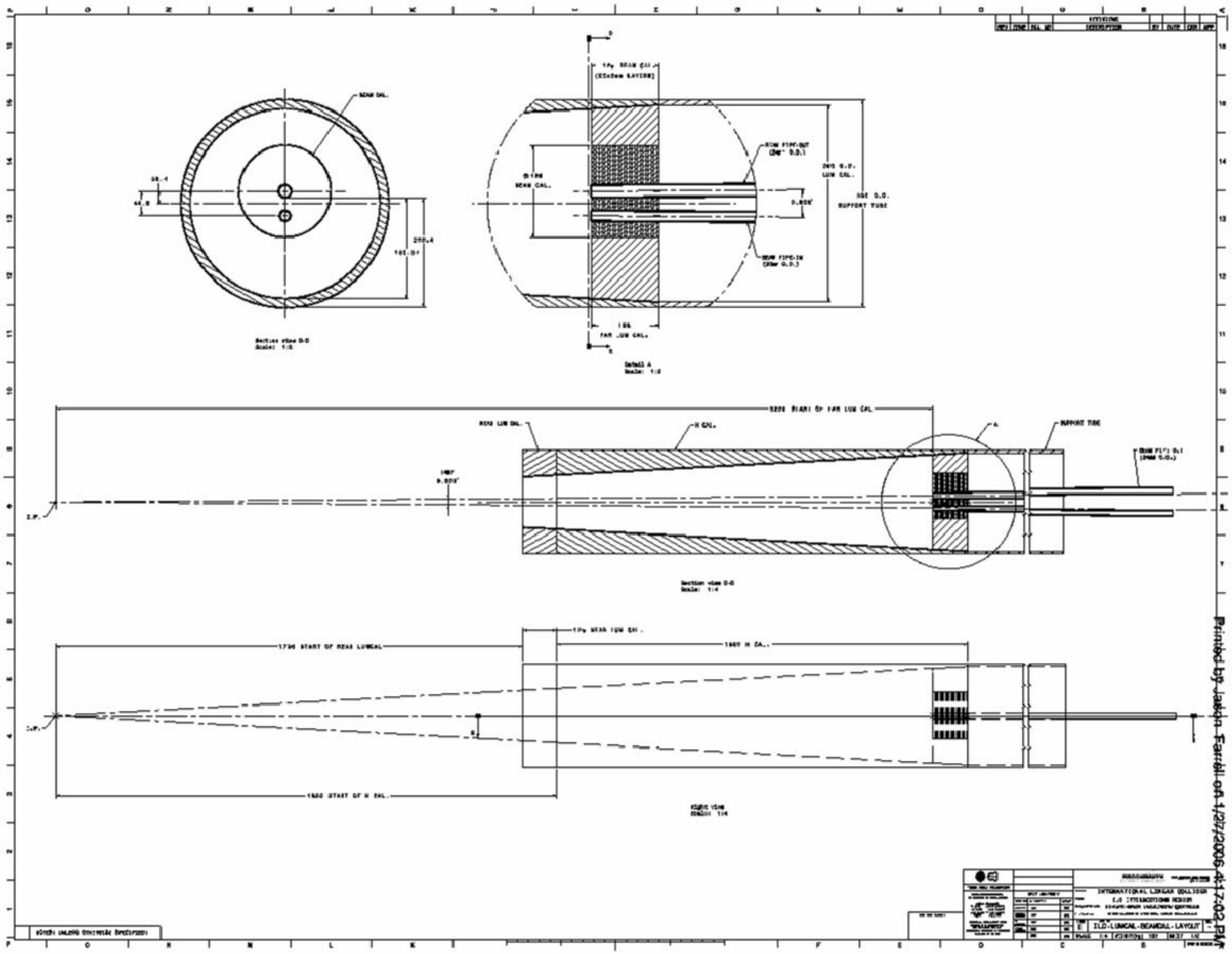
SiD Open in a 20m x 18m Data Pit



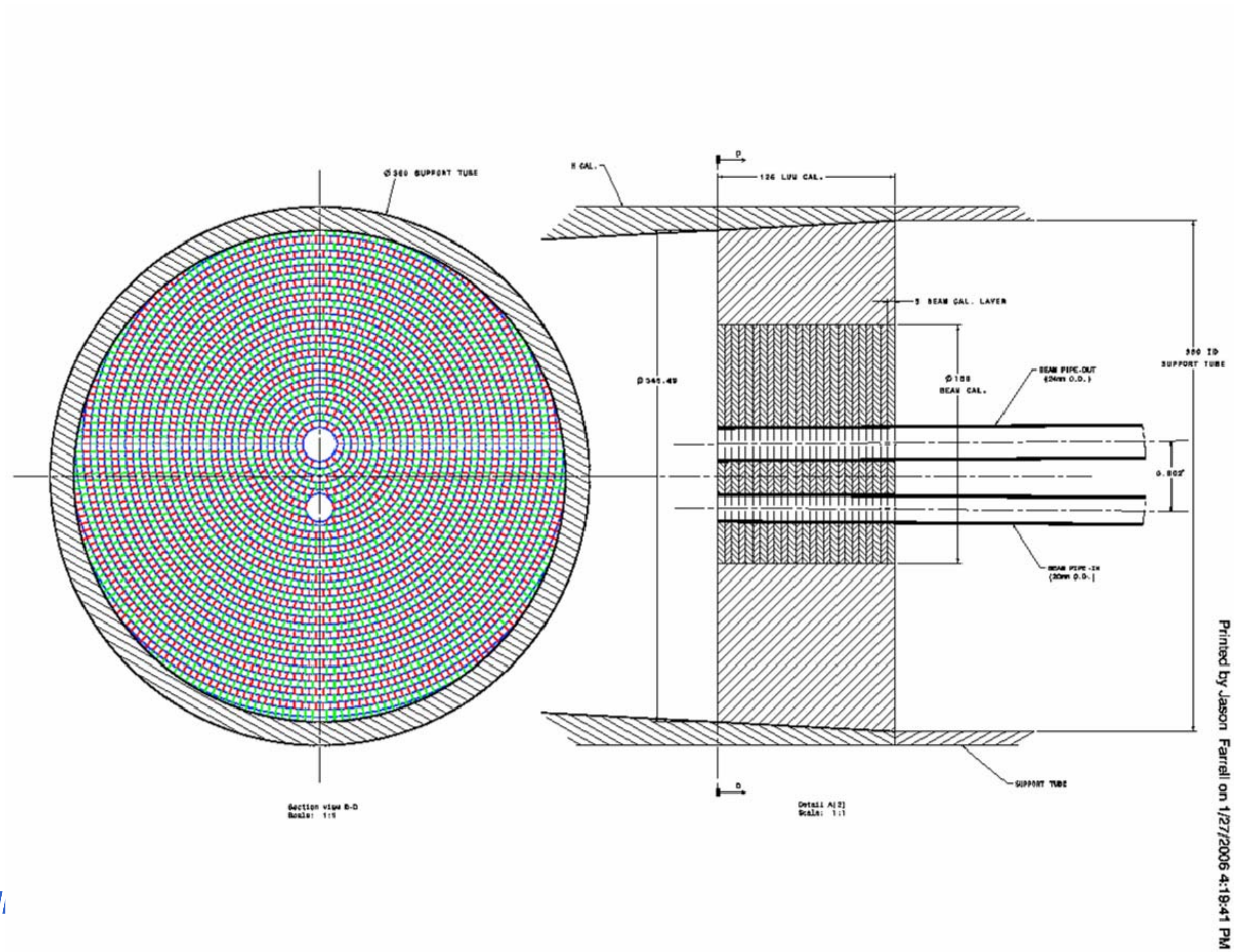
Inner radius detail



Forward region layout

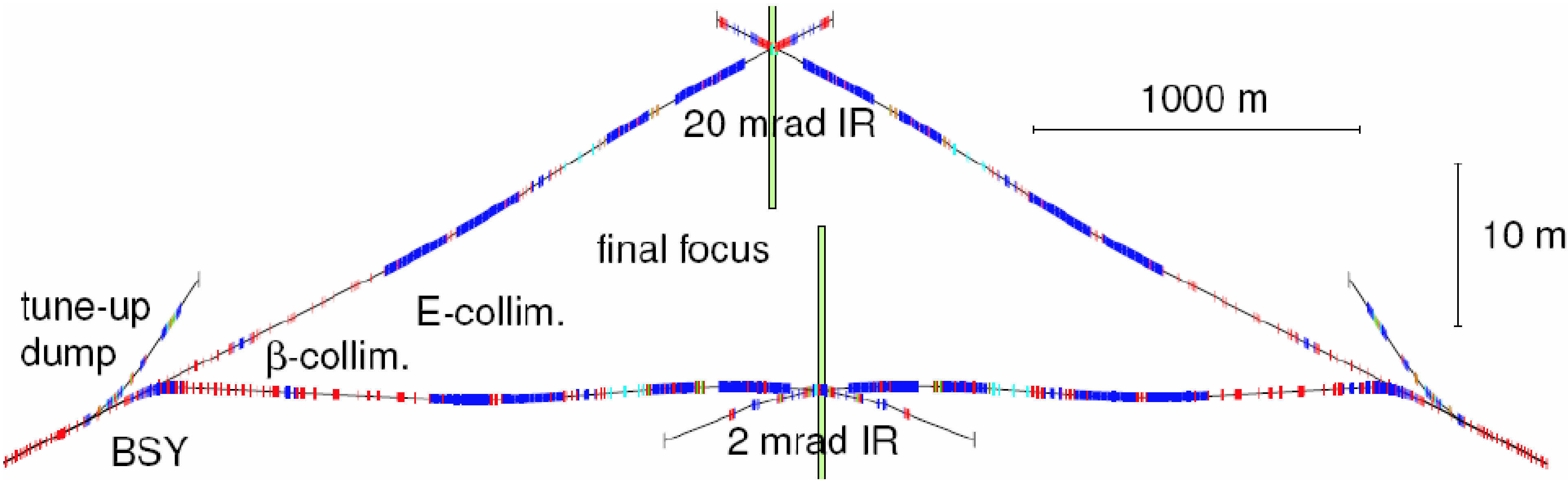


Beamcal layout



Spare slides follow

Baseline (BCD) BDS Layout



two Beam Delivery Systems
two detectors
two IR halls
IRs separated longitudinally in z:
one 2 mrad and one 20 mrad Xing angle

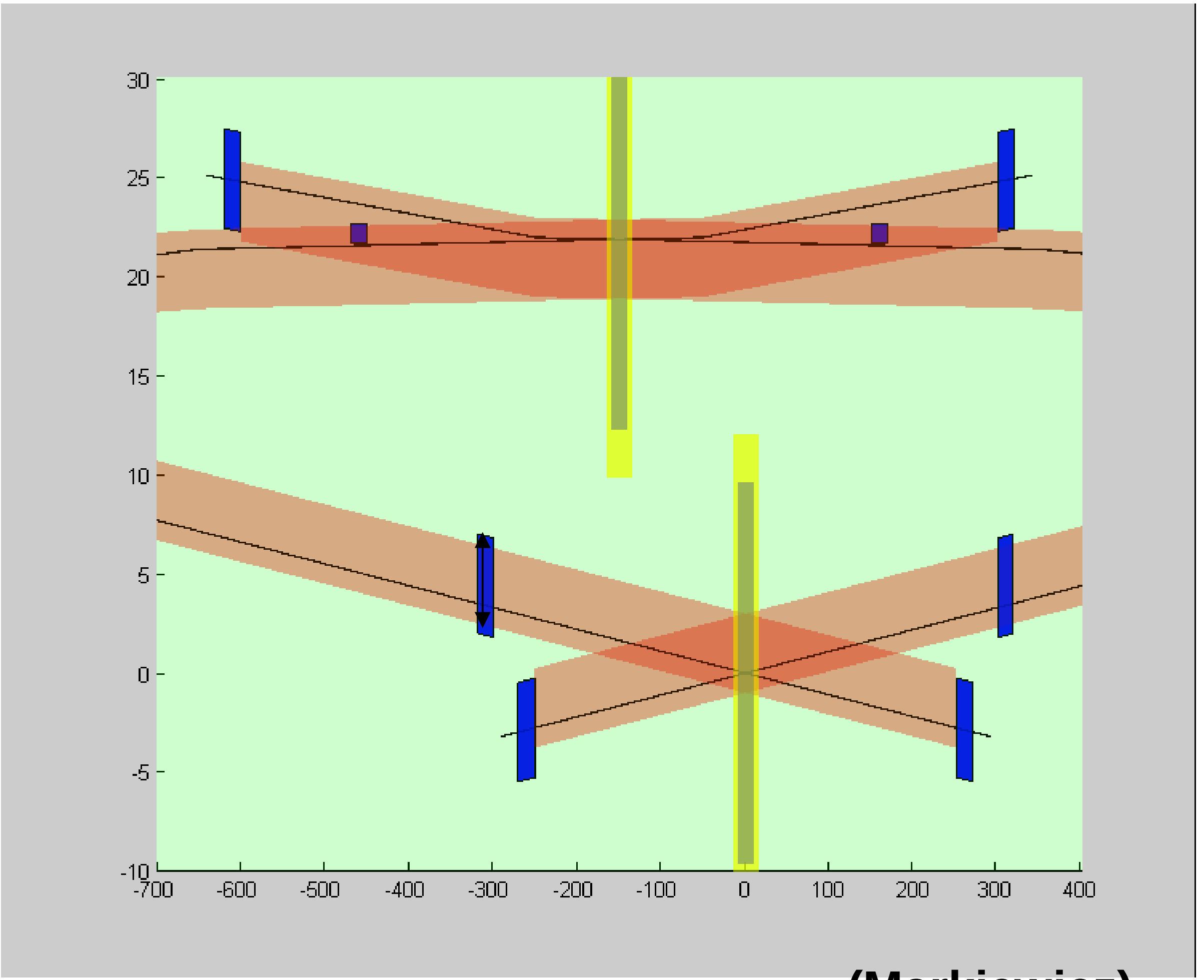
Baseline IR hall configuration

Need to maintain ~5m concrete shielding between one IR hall and tunnel to other IP

NB z separation =

N * bunch sep/ 2 c

Need to understand SiD footprint vis a vis assembly/installation procedures + detector access



(Markiewicz)

Alternative (ACD) 1

- two Beam Delivery Systems
- two detectors
- single IR hall at z=0
- one 2 mrad and one 20 mrad Xing angle

Note:

any bunch spacing allowed

less transverse space flexibility between detectors:

installation/access issues for detectors?

vibrational coupling between detectors?

Alternative (ACD) 2

- one Beam Delivery System
- two detectors with push-pull capability
- single IR hall at z=0
- Xing angle TBD

Note:

any bunch spacing allowed

can be upgraded to BCD config. later

one/two detectors allowed – decide later?

compatibility with gamma/gamma depends on Xing ang.

Previously existing cost estimates

(Markiewicz, Frascati)

	TESLA TDR	USLC TOS	GLC 200302
2nd IR including beam lines, tunnels, IR halls and dumps	250M€	229M$	$303 \cdot 10^8$¥

Cost to be firmed up as part of RDR exercise

Conclusion from GDE 'white paper'

(Markiewicz, Frascati)

If civil cost proportional to volume of excavation we neglect any gain from having one large IR rather than 2 smaller IRs

Cost(BCD)=Cost(ACD1)

Cost of 2nd IR Hall only ~ 30M€, 58M$, $78 \cdot 10^8$¥

Cost Increment(ACD2)-Cost(Minimal)
<< Cost(Detector)

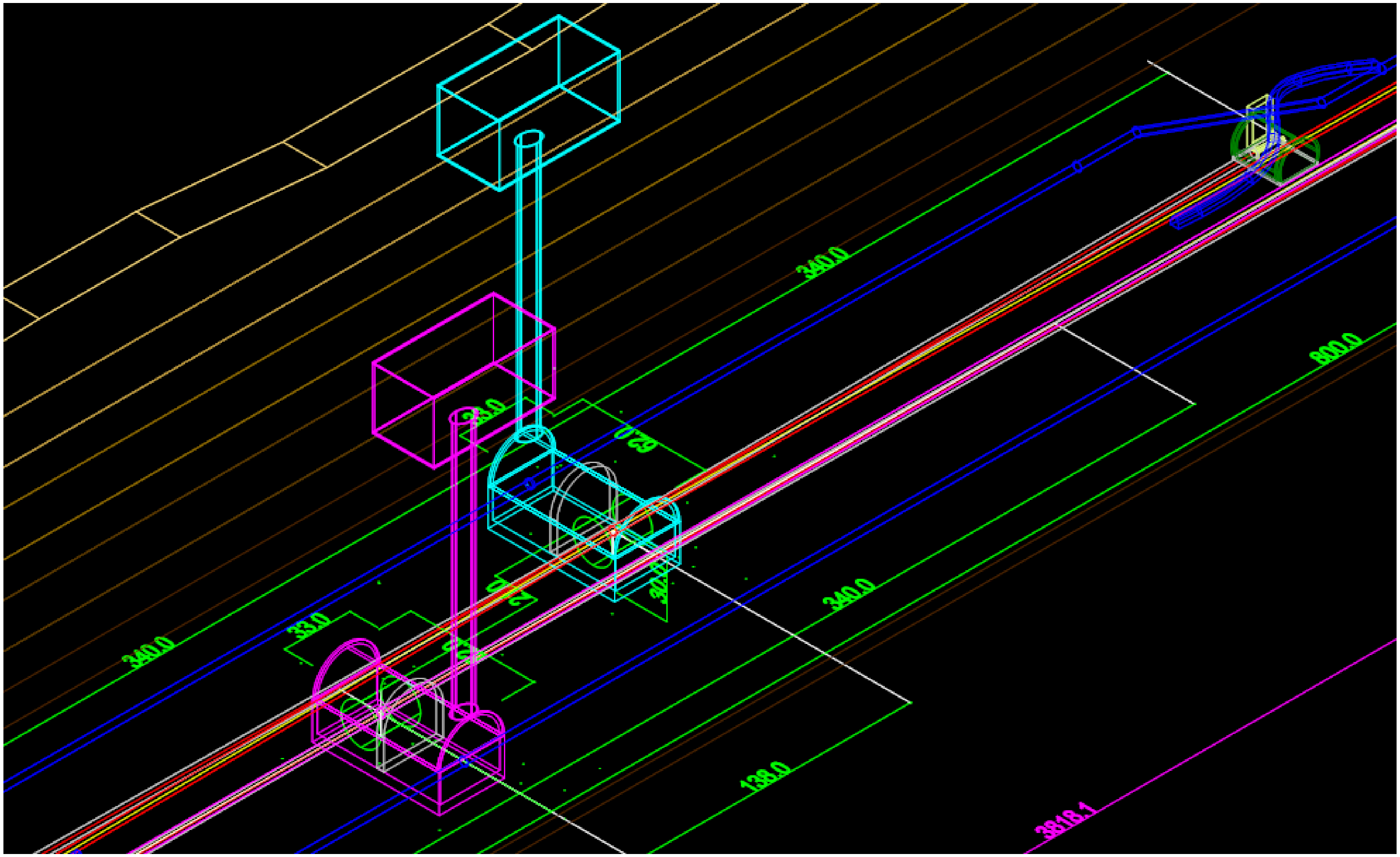
Cost numbers not internationally agreed upon

Sub costs related to IR (Halls vs. dumps vs. beamline CF vs. beamline hardware) vary greatly

Parametric cost model for civil construction

(Asiri, Snowmass)

Eg.
deep site,
2 IRs



Costs for IR hall:

$3k/sq ft deep

$1k/sq ft surface

Current status of 1 or 2 detectors

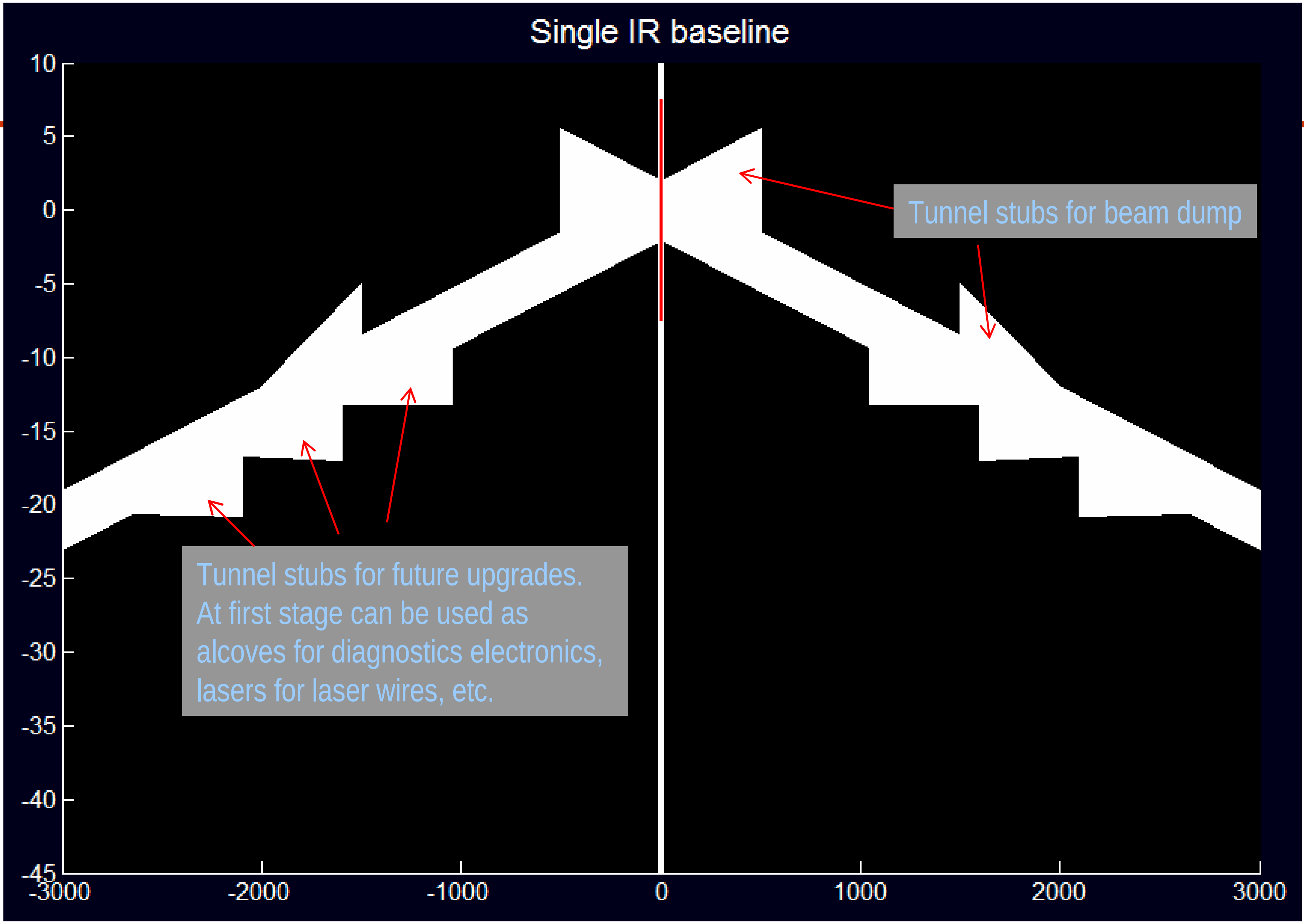
ALL RDR CONFIGURATIONS ASSUME TWO DETECTORS!

- **The baseline is 2 BDS + 2 IR halls**
- **ACD1 is 2 BDS + 1 IR hall**
- **ACD2 is 1 BDS + 1 IR hall with 2 detectors in push-pull mode**
- **Any decision to down-select to 1 detector can only be taken after RDR costings are known**

‘Minimal configuration’

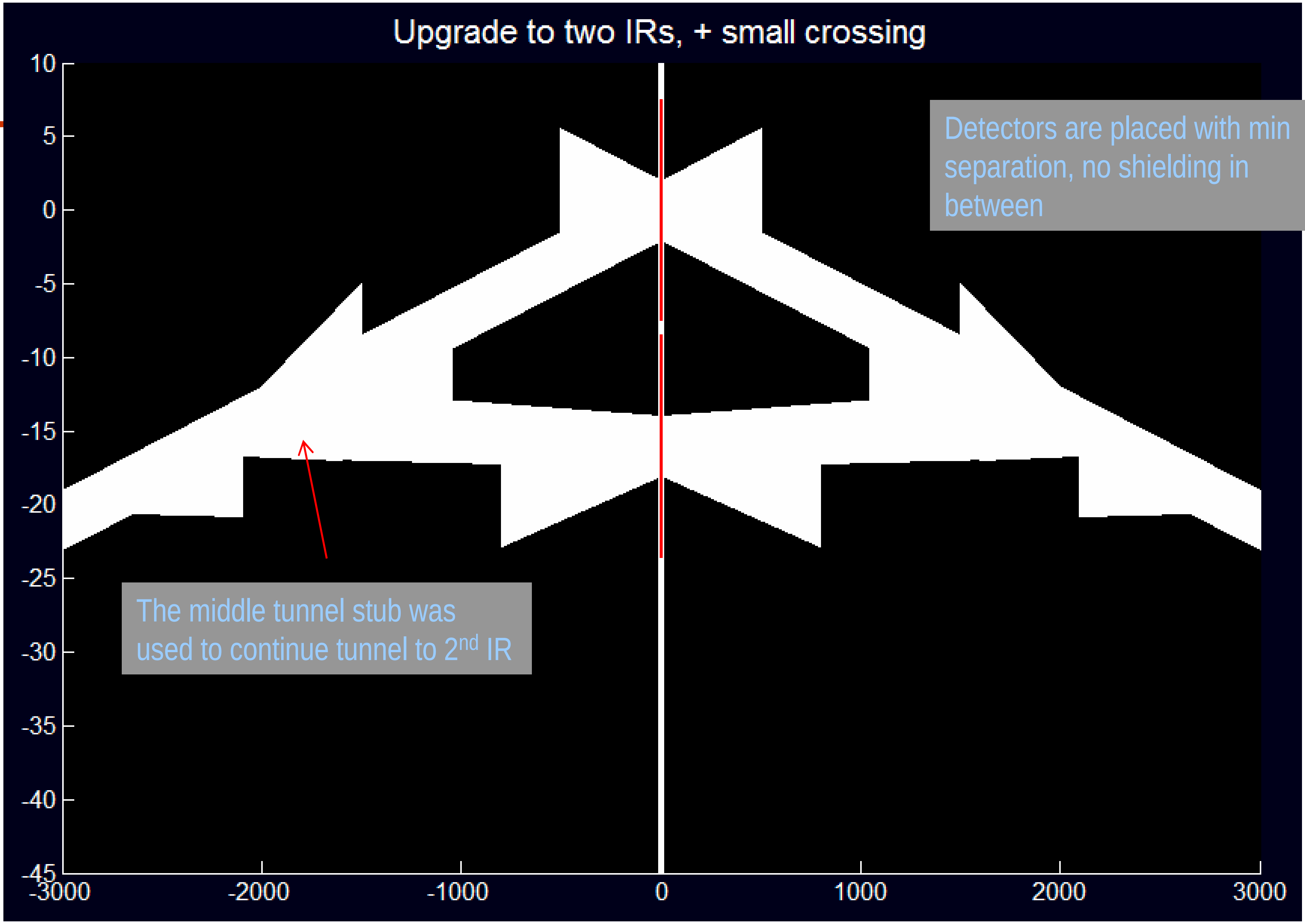
- one Beam Delivery System
- one detector
- single IR hall at z=0
- Capability to construct second BDS, IR hall, detector later
- BDS AG (nee WG4) has started to consider such a configuration

How this might work: eg. single IR with 14mrad Xing



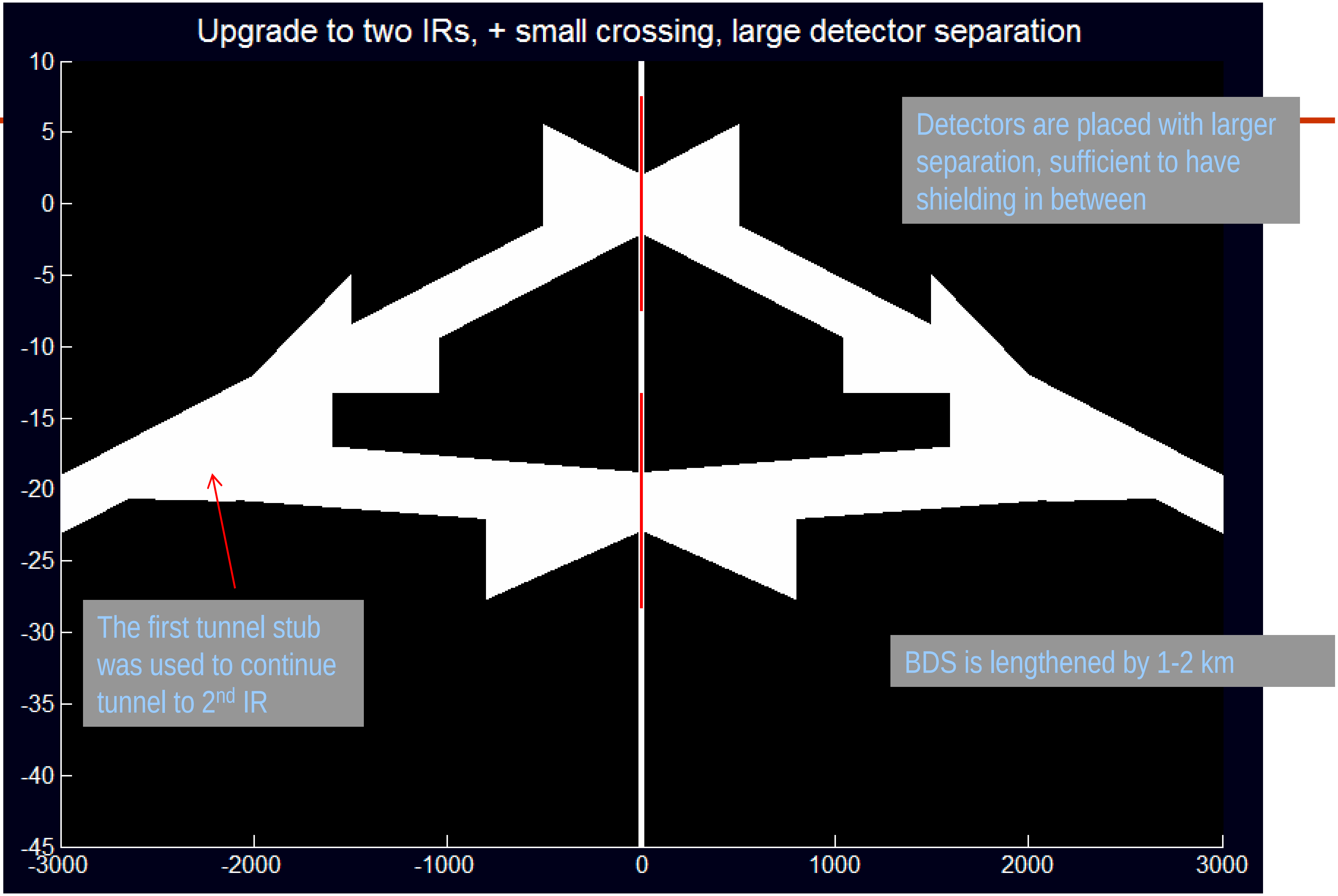
(Seryi)

Upgrade A: 14mrad & small Xing



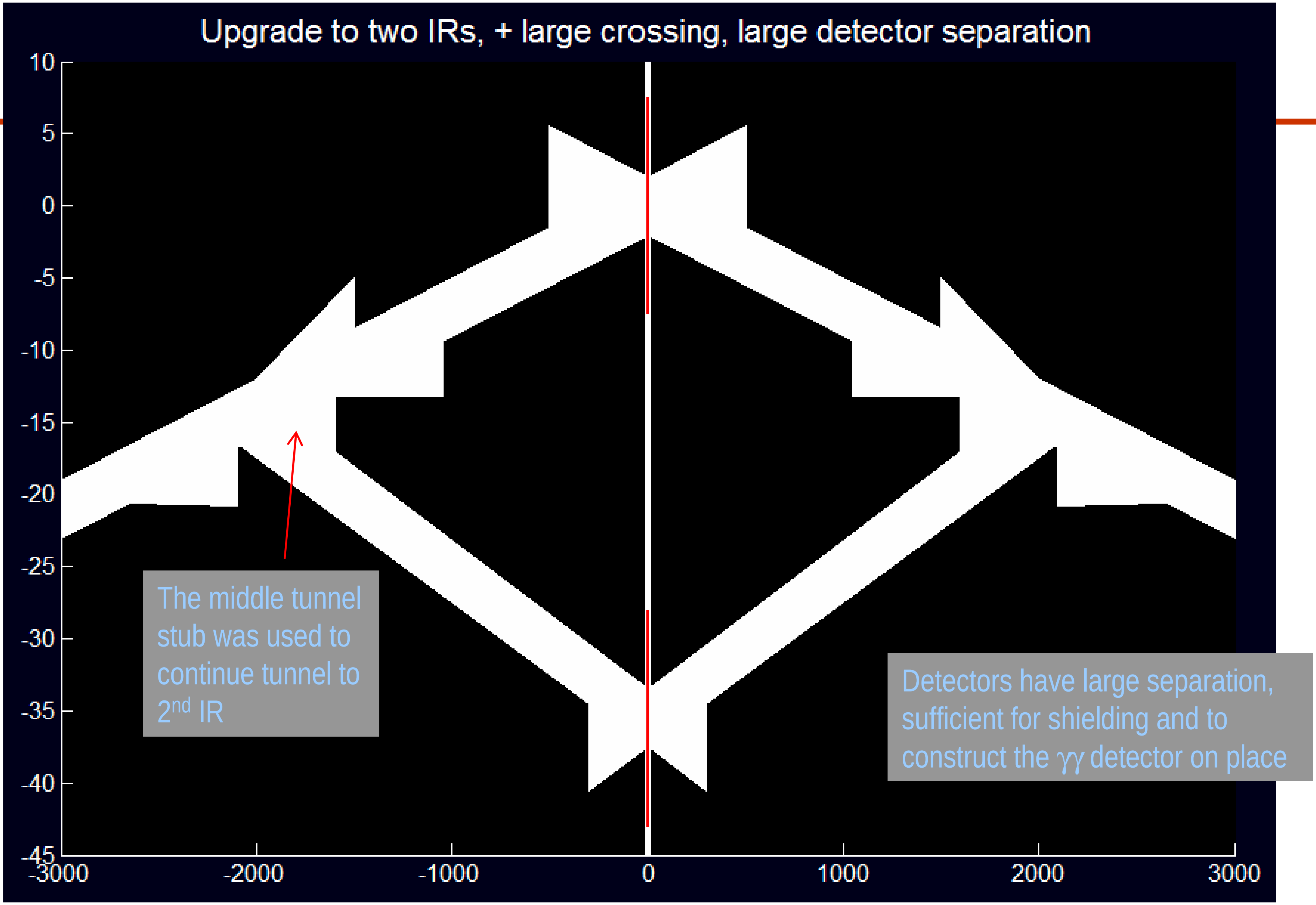
(Seryi)

Upgrade B: 14mrad & small Xing



(Seryi)

Upgrade C: 14mrad and larger Xing



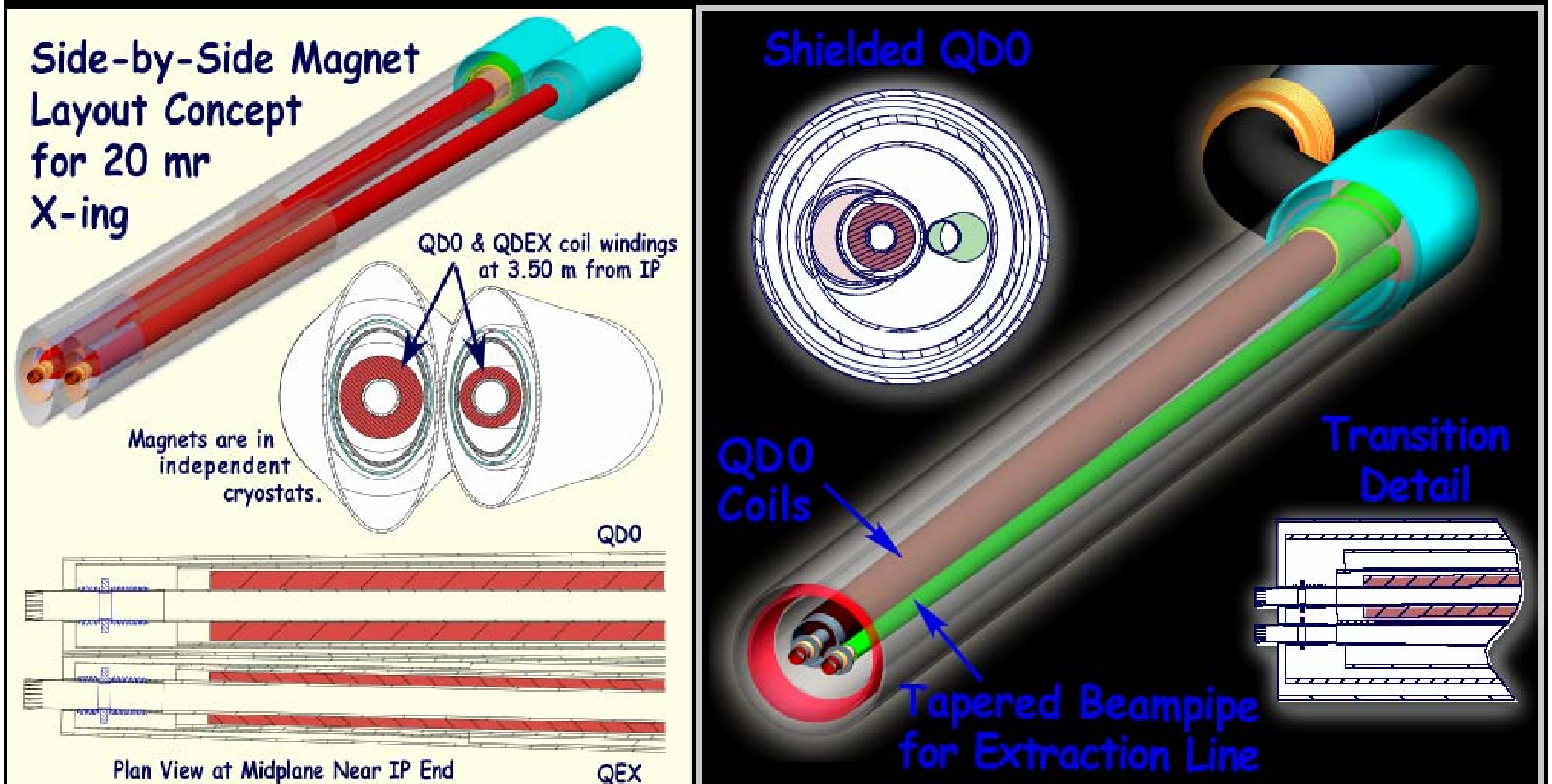
(Seryi)

Intermediate crossing angle

- **Snowmass detector concepts requested investigation of ‘intermediate’ Xing angle between 2 and 20 mrad**
- **14 mrad emerged as current minimum for ‘large’ angle**
- **If 2 BDS possible configs: 14 + 20**
  14 + 2 (?)
  14 + 14
- **If 1 BDS: 14 mrad offers flexibility for upgrades**
- **14 mrad may be compatible w. gamma/gamma (?)**

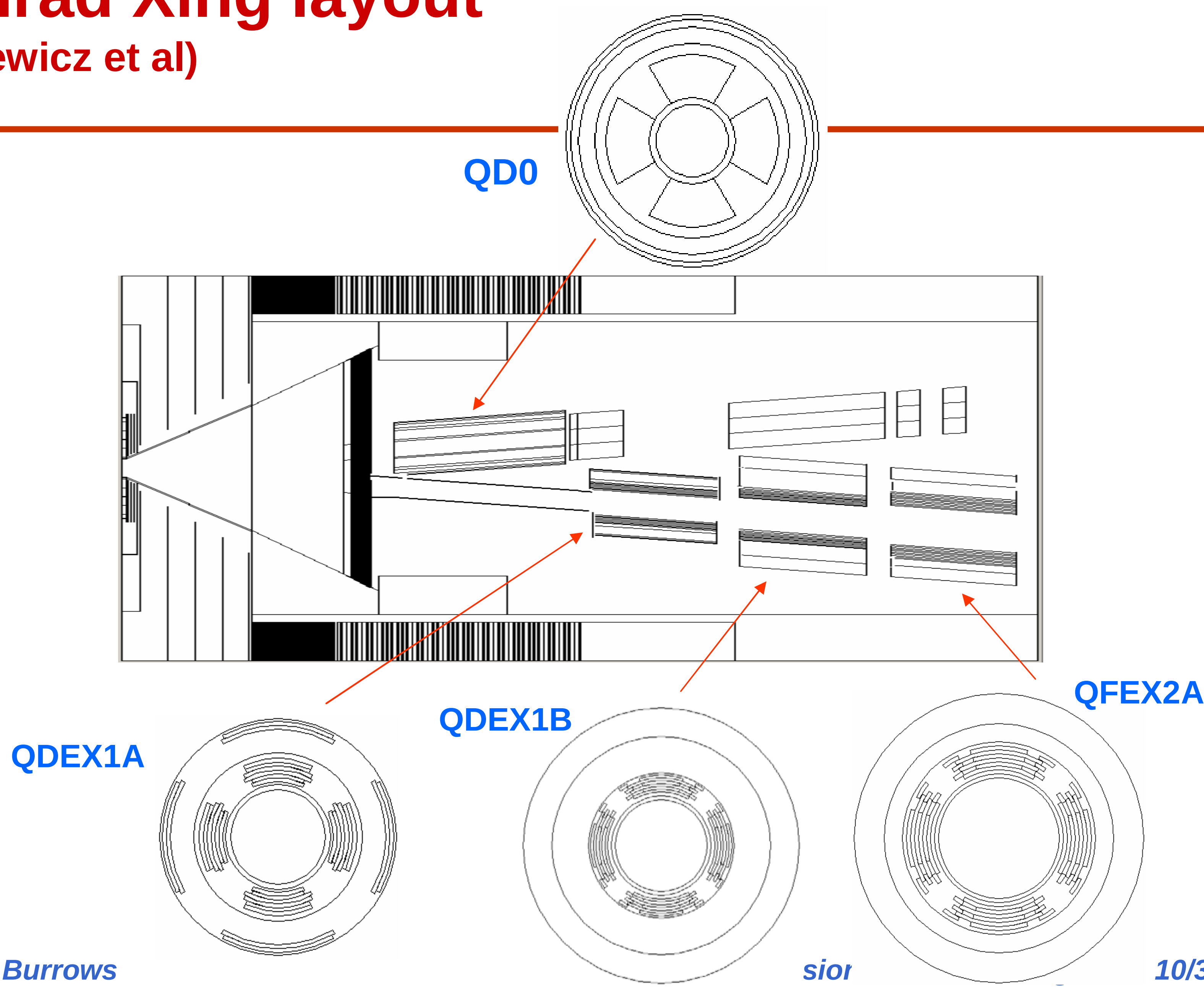
Compact quad design developments

Since Snowmass'05 new compact shielded superconducting magnet designs were developed that replace the previous "side-by-side" magnet layout for 20 mr crossing angle.



"Recent Progress Designing Compact Superconducting Final Focus Magnets"
presented by: B. Parker

14 mrad Xing layout
(Markiewicz et al)



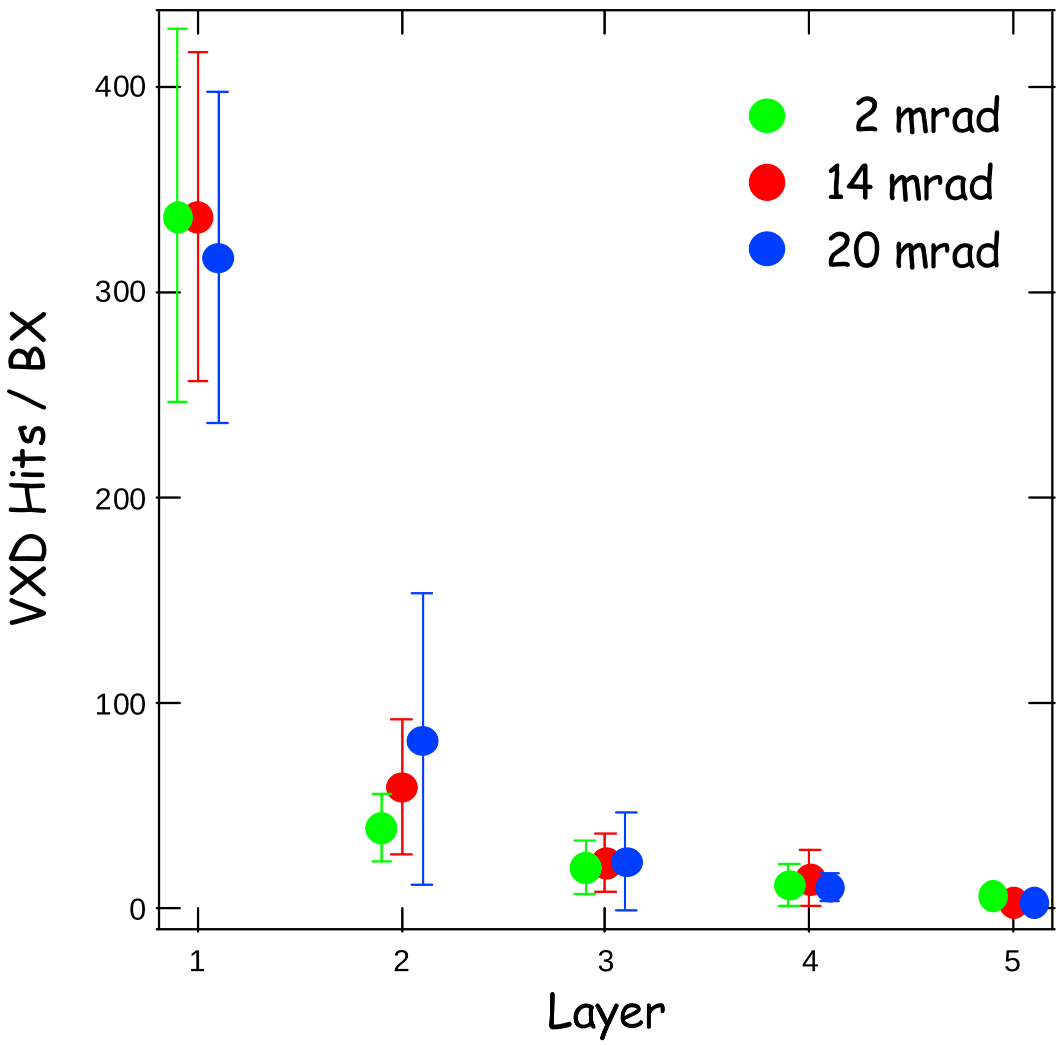
Power Lost in Extraction Line Magnets

Nosochkov

E_{cm} (GeV)	Params	Δy (nm)	Snowmass 20mrad	14 mrad 0.75/1.25mrad
500	Nom.	0	0W	0/0W
500	Nom.	200	3W	0.9/0.4W
500	High	0	1.9 kW	2.0/1.3 kW
500	High	120	11 kW	16/5 kW
1000	Nom	0	190W	250/110W
1000	Nom	100	2.4 kW	2.3/1.4 kW
1000	High	0	98 kW	n/a
1000	High	80	280 kW	n/a

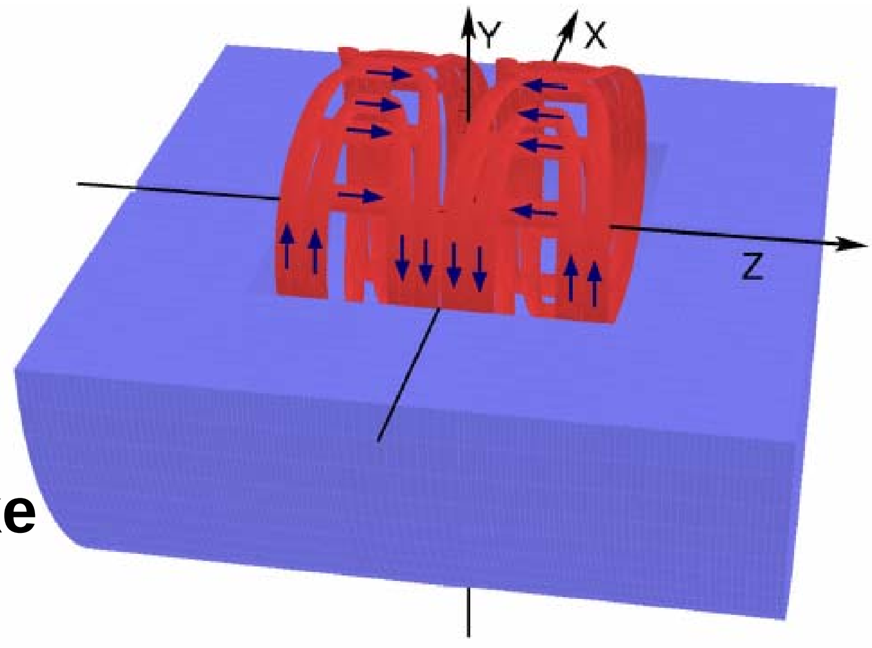
VXD Hit comparison – 2, 14, 20 mrad

ILC 500 GeV Nominal beam parameters



Maruyama

DID and anti-DID
(Seryi et al)



Detector Integrated Dipole=

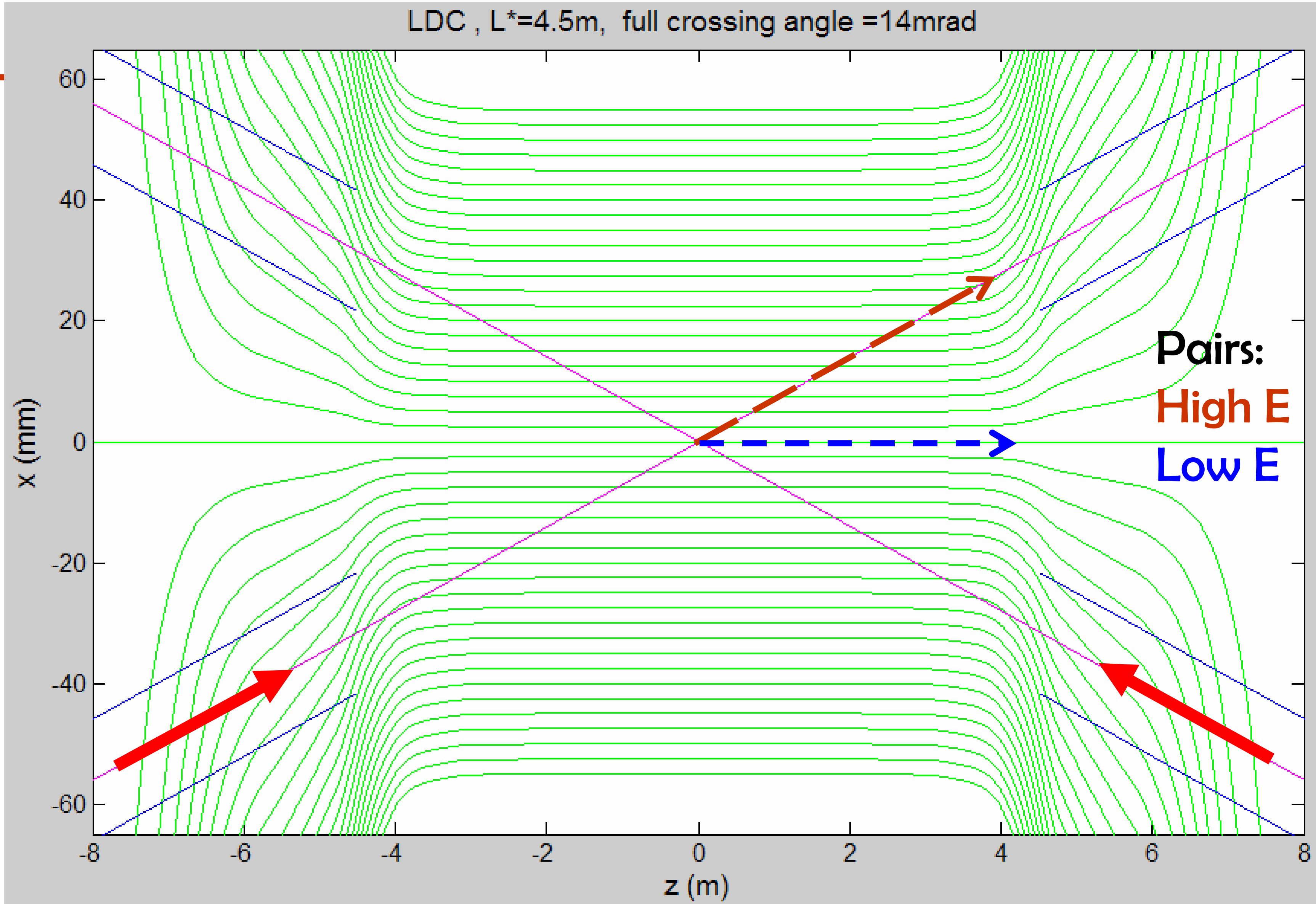
Dipole coils wound on detector solenoid, giving small sine-like transverse field

(anti-)DID allows aligning the detector solenoid field lines along the (outgoing) incoming beam trajectory

=> anti-DID effectively zeroes the crossing angle for the outgoing beam and pairs, while the effective angle for the incoming beam is increased 1.5-1.6 times

Decreased SR, in 14mrad, ease the use of anti-DID

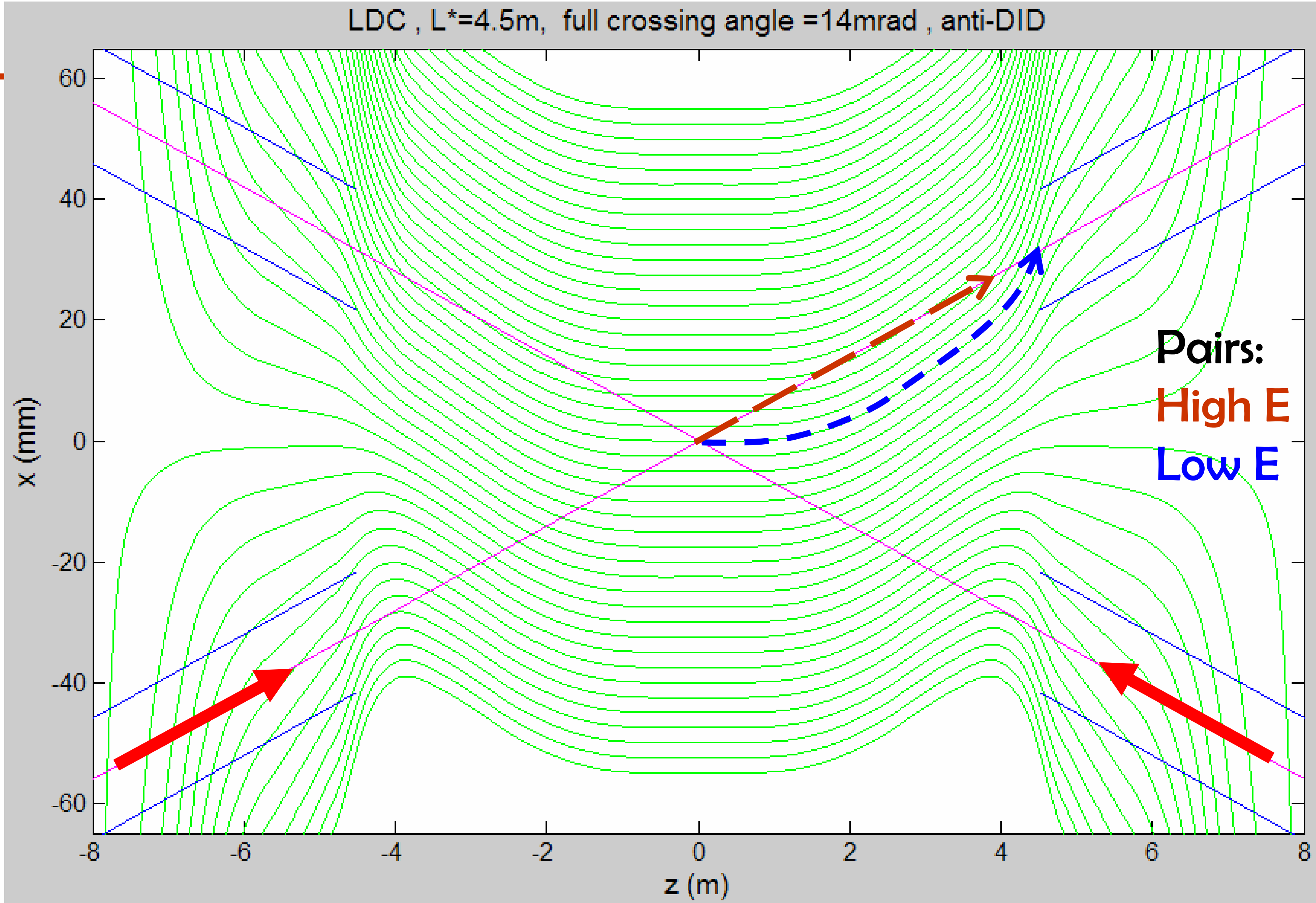
Field lines in LDC



Seryi

Fringe and internal field of QD0 not included

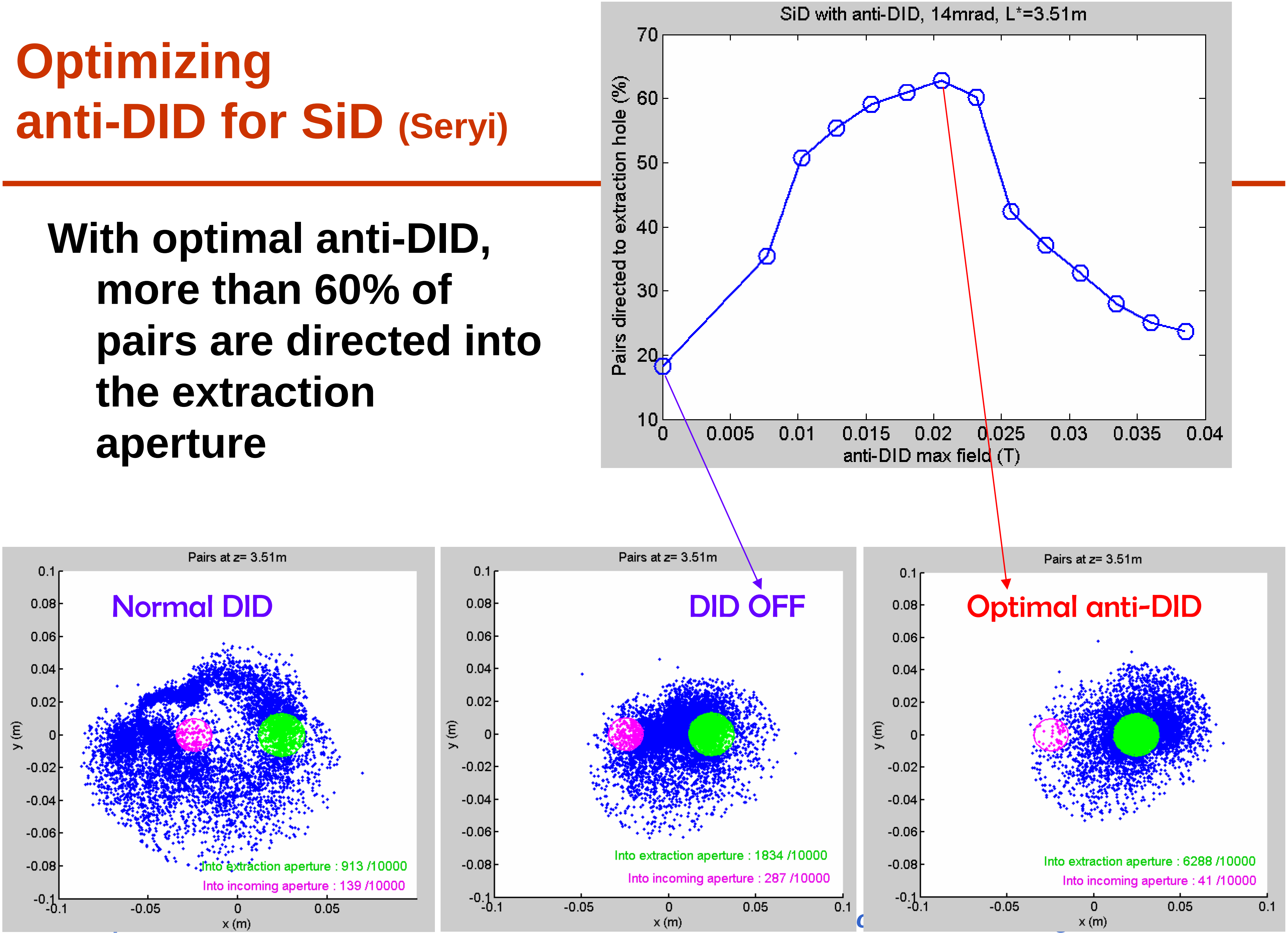
Field lines in LDC with anti-DID



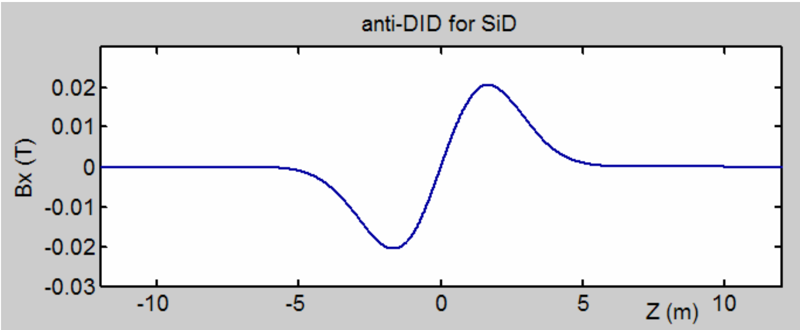
Seryi

Optimizing anti-DID for SiD (Seryi)

With optimal anti-DID, more than 60% of pairs are directed into the extraction aperture

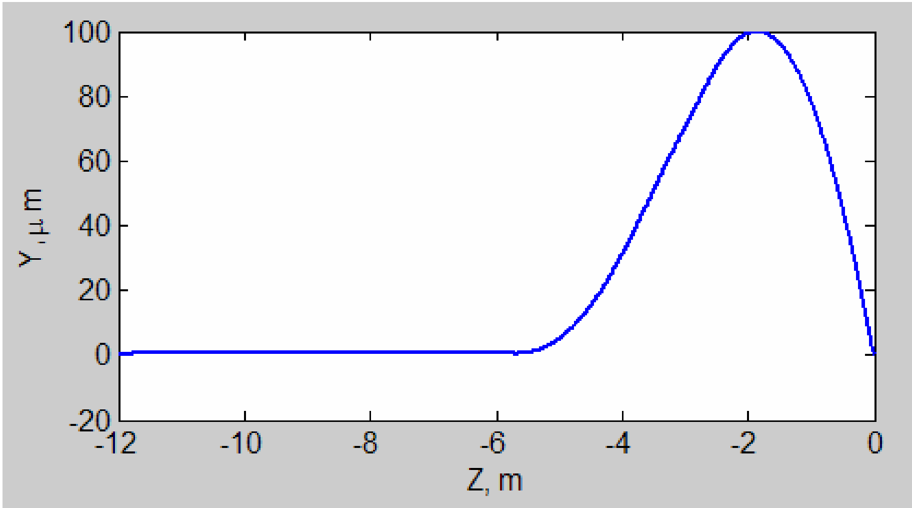


Incoming beam in SiD with anti-DID
(Seryi)



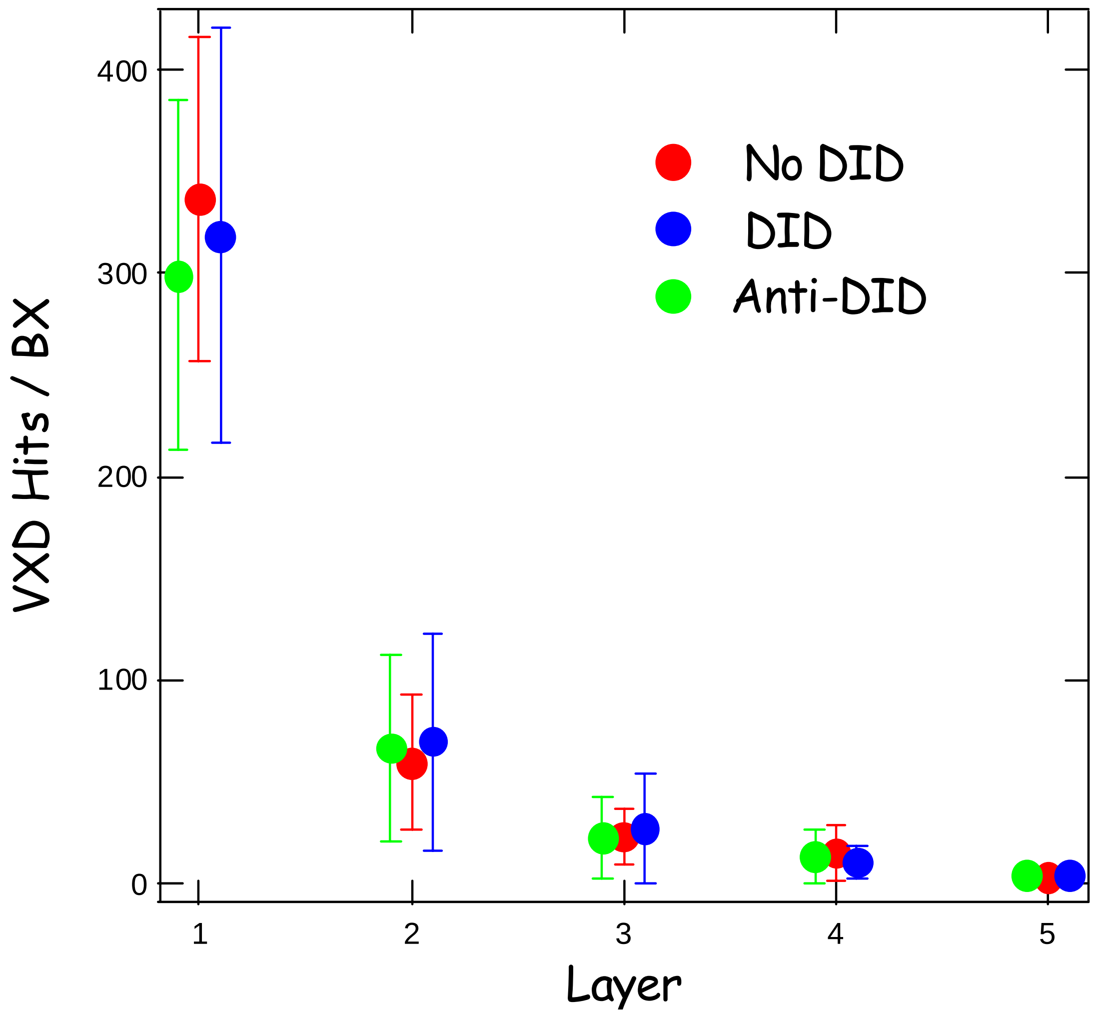
Optimal anti-DID for SiD

Anti-DID increase SR effects for incoming beam, but for 14mrad the impact is negligible (~ 0.2% on Lumi)



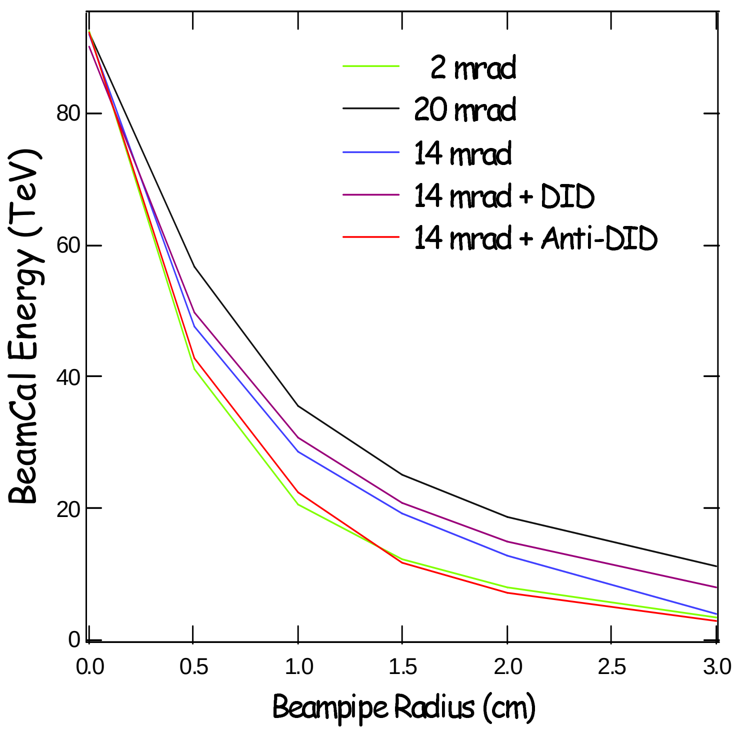
SiD, L*=3.5m, 14mrad	IP Y, μm	IP Y', μrad	$\Delta\sigma_{SR}$, nm	Lum, %
anti-DID with 0.0205 T	0	-102	0.32	99.8

VXD hits: 14 mrad crossing – DID/Anti-DID



Maruyama

Beamcal + Tracker Backgrounds (LDC)



Pair energy into BeamCal is smaller in 14 mrad crossing.

Anti-DID can further reduce the energy to the 2 mrad crossing level.

# of secondary photons generated in BeamCal is also smaller.

 # photons/BX into Tracker

14 mrad	14 mrad + DID	14 mrad + Anti-DID	2 mrad
1800	1900	830	720

Maruyama

MDI issues, suggested strategy

- → **ILC baseline now under 'change control' regulations**
- → **Costings will be pursued vigorously: first pass Vancouver**
- → **MDI panel to interface to GDE, with concepts represented**

Dedicated SiD design + study of very forward region for 2, 14, 20 mrad in concept report

Which (if any) Xing angle does SiD prefer?

Verify by study that SiD tracking OK with (anti-)DID

Continue to monitor backgrounds as BDS/IR design evolves

Current status of 14 mrad scheme

(Markiewicz, Seryi et al)

Optics modified for 14mrad case:

- L*extr is increased to 6m, to give room for incoming quads.
- Space allocated for crab-cavity increased to 4m and also
- two options for photon aperture based on photon angles 0.75mrad and 1.25mrad considered

The optics provide all the same functionality as previous 20mrad version

- Downstream energy spectrometry
- Polarimetry with R22=-0.5
- Similar beam losses along the beamline as in 20mrad desigm

Backgrounds

- VXD backgrounds unchanged
- TPC backgrounds improved relative 20 mrad