Beam Delivery System / Machine Detector Interface

BDS Area leaders

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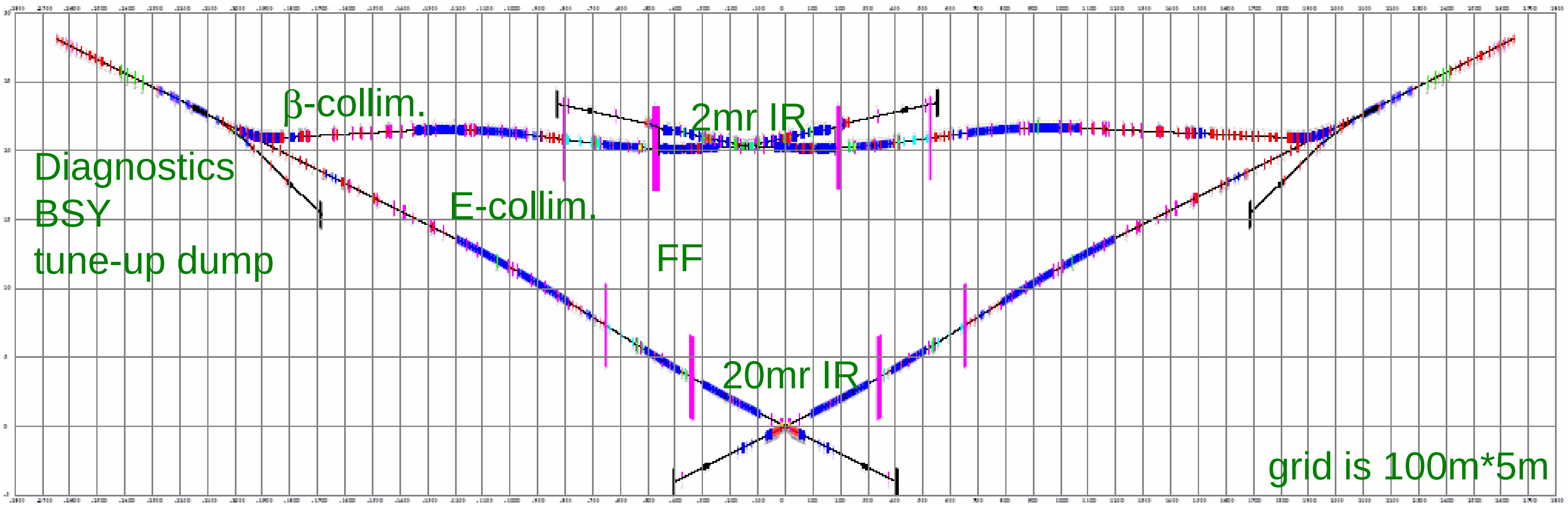
Valencia GDE meeting, November 6-10, 2006

Vancouver to Valencia

- Configuration change control requests after Vancouver
  - **Baseline configuration to 14/14, single collider hall**
  - **5m muon walls instead of 9+18m**
  - **On surface detector assembly**
- Evaluations by WWS, MDI panels & CCB
- Further cost optimizations
  - **Shorter BDS and shorter extraction lines**
  - **Single IR – evaluation of push-pull**

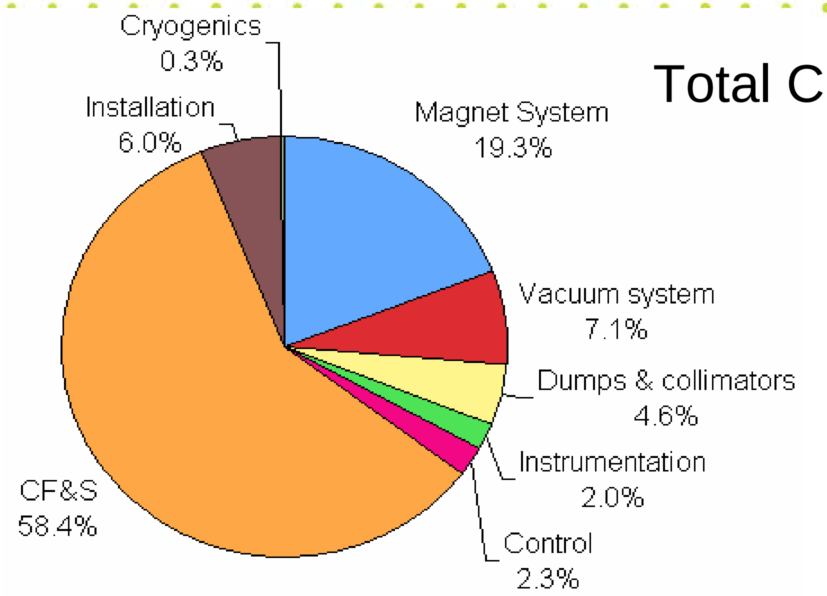
Vancouver baseline

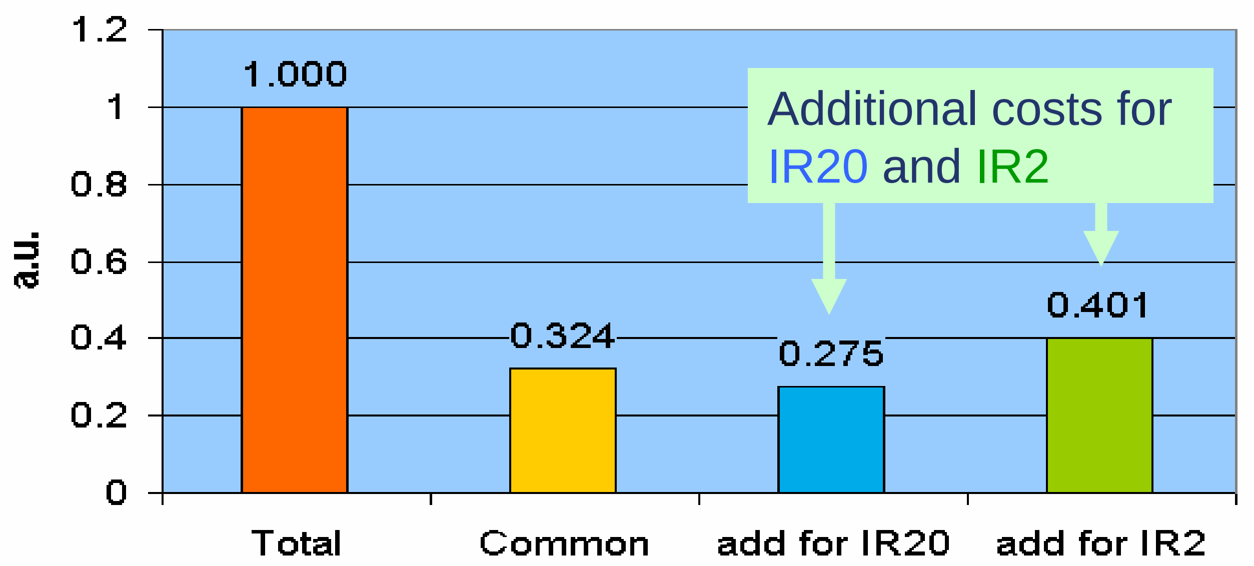


- Two IRs with 20mrad and 2mrad crossing angle
- Two collider halls separated longitudinally by 138m

Vancouver cost

- Cost drivers
  - **CF&S**
  - **Magnet system**
  - **Vacuum system**
  - **Installation**
  - **Dumps & Collimators**





CCR to 14/14 from 2/20 (1)

- After the first cost estimates and performance evaluations, it was decided to cut the Gordian knot of the cost, technical and non-technical issues and propose to change the baseline to two IR with 14/14 configuration. CCR submitted on 28th July.
- Reasons to change
  - **To reduce the cost**
    - Large cost saving from 2 mrad extraction line magnets
    - Common collider hall
  - **To improve the performance**
    - Improved radiation conditions in the extraction lines
    - Better performance of downstream diagnostics
    - Easier design and operation of extraction optics and magnets
    - Reduced back scattering from extraction line elements and possibly better overall background
- Impact on physics reach minor

CCR to 14/14 from 2/20(2)

- Design & cost of 14/14 with common collider hall & z=0
  - **Design of 14mr beamline is almost the same as for 20mrad**
  - **In the 14/14 cost estimation, the following adjustments were estimated and taken into account:**
    - removed stretches in optics
    - shorter (~11mr/14mr) tapered tunnels
    - remove one surface building
    - savings due to common hall (but volume still twice the single volume)
    - add cost of 42% more gradient bends (for 14mrad bend), their PS, BPMs, movers, etc
- The cost reduction in this configuration is ~16%
- The CCR was discussed in MDI meeting on August 15th. Conclusions send to WWS and CCB. WWS commented on the CCR.
- CCB considered the CCR for 14/14, and on September 8th issued a recommendation for EC to adopt the CCR. The EC approved it on 21st September.

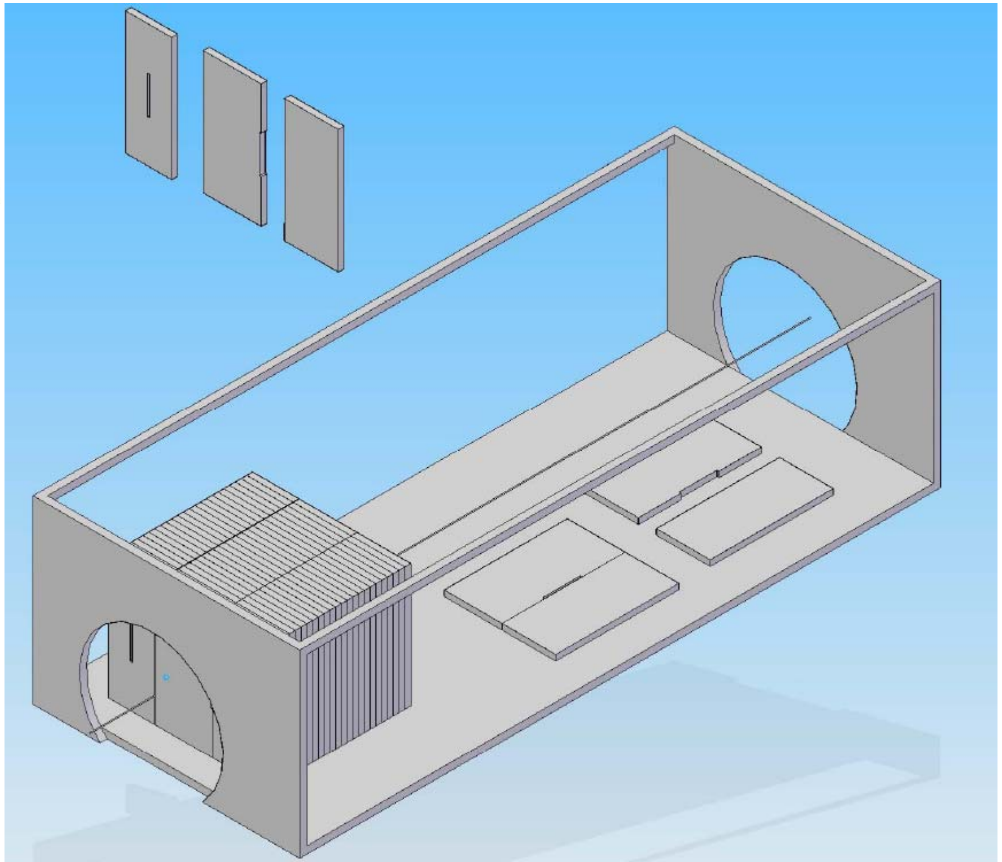
From minutes of MDI panel

(abridged quote)

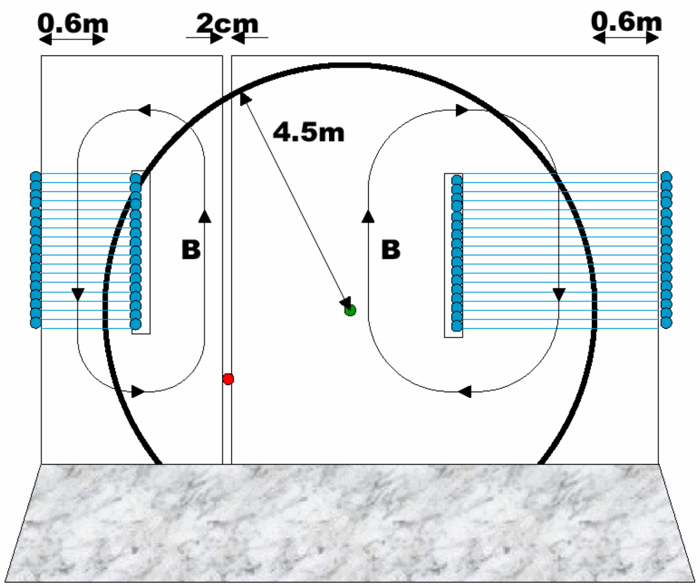
- The (physics) mode most affected by crossing angle is the slepton pair production where the slepton-LSP Δm is small. The main background is 2-γ processes and an efficient low-angle electron tag by BEAMCAL is needed to veto them.
- For a large crossing angle (14 or 20mrad), anti-DID is needed to collimate the pair background along the outgoing beam. For 14mrad crossing with anti-DID, the … background is expected to be comparable to the 2mrad case while the signal efficiency reduces by about 30% to 40%. This is mainly due to the 2nd hole of BEAMCAL that is needed for the large crossing angle which will force additional cuts to remove the 2-photon and other backgrounds.
- This is not based on a complete analysis but on a study of the pair background distribution on the BEAMCAL: that for 20mrad crossing with anti-DID was found to be essentially the same as the 2mrad case. A complete analysis is needed for 14mrad with anti-DID, also covering different values of the mass difference (namely, for different SUSY parameter space). Backgrounds considered here is mainly the pair background and a lesser extent Bhabha events. More studies are sorely needed in this area.
- With this limited information, the MDI panel thinks that the 14mrad is acceptable as the baseline at this time. However, we would like to stress that the 2mrad crossing angle is clearly desirable than larger crossing angles for the slepton search, and R&Ds related to 2mrad should be encouraged.

Muon walls

- Purpose:
  - **Personnel Protection: Limit dose rates in one IR when beam sent to other IR or to the tune-up beam dump**
  - **Physics: Reduce the muon background in the detectors**



Scheme of a muon wall installed in a tunnel widening which provides passage around the wall



Baseline configuration:
18m and 9m walls in each beamline

Muon walls CCR

- Reduction of 18m muon spoilers to 5m and elimination of 9m muon spoilers – CCR submitted 8th September
- Considered that
  - **The estimation of 0.1% beam halo population is conservative and such high amount is not supported by any simulations**
  - **The minimum muon wall required for personnel protection is 5m**
  - **Detector can tolerate higher muon flux**
  - **Cost of long muon spoilers is substantial, dominated by material cost and thus approximately proportional to the muon wall length**
- The caverns will be built for full length walls, allowing upgrade if higher muons flux would be measured
- MDI panel accepted this change
- CCB approved this request on 23rd September; contingent upon continuation of detailed detector studies to ensure that the occupancy due to muons does not affect the high precision physics measurements

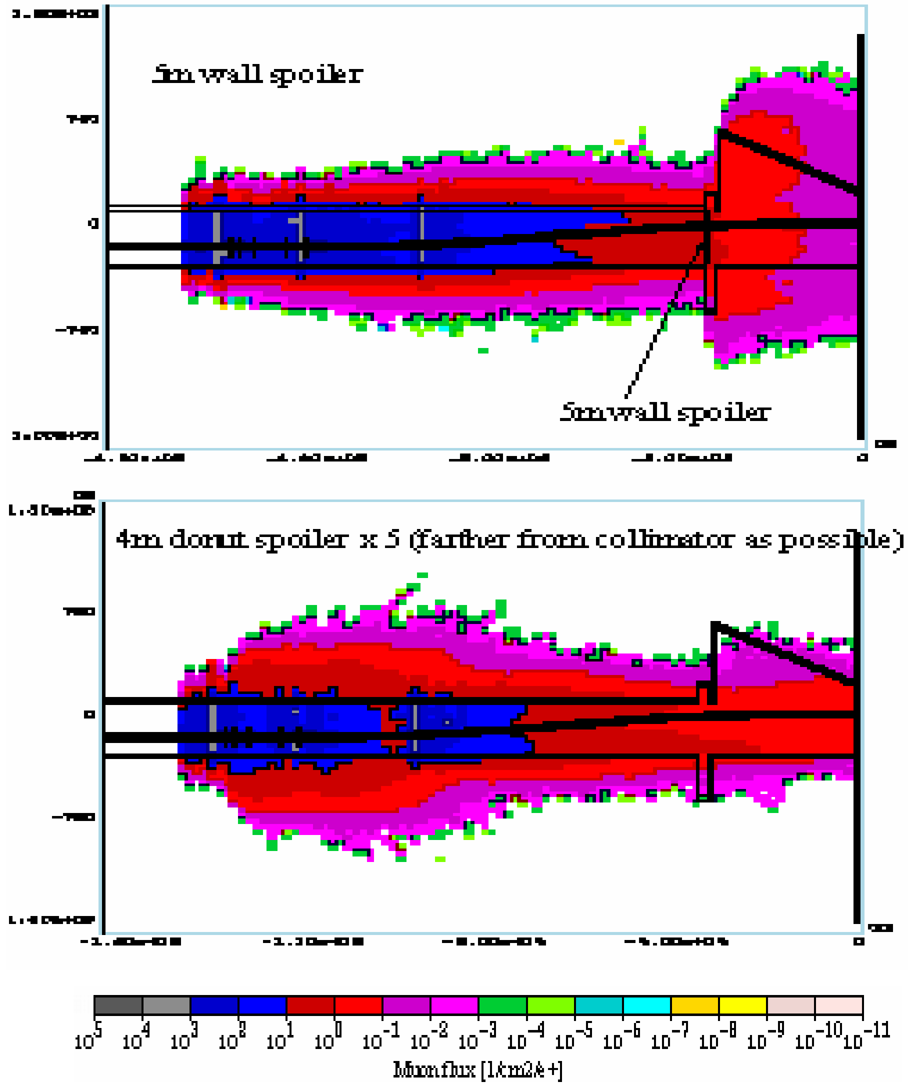
Alternatives for Muon walls

Could local "doughnut" type muon spoilers like those in SLC be substituted for the 5 m magnetized wall?

- Compared to a 5m magnetized wall, a series of eleven, four meter long, 1.4 m diameter magnetic spoilers will reduce the number of muons/bunch in a 6.5 m radius detector but will increase the number of muons/bunch in a 2.0m radius TPC.

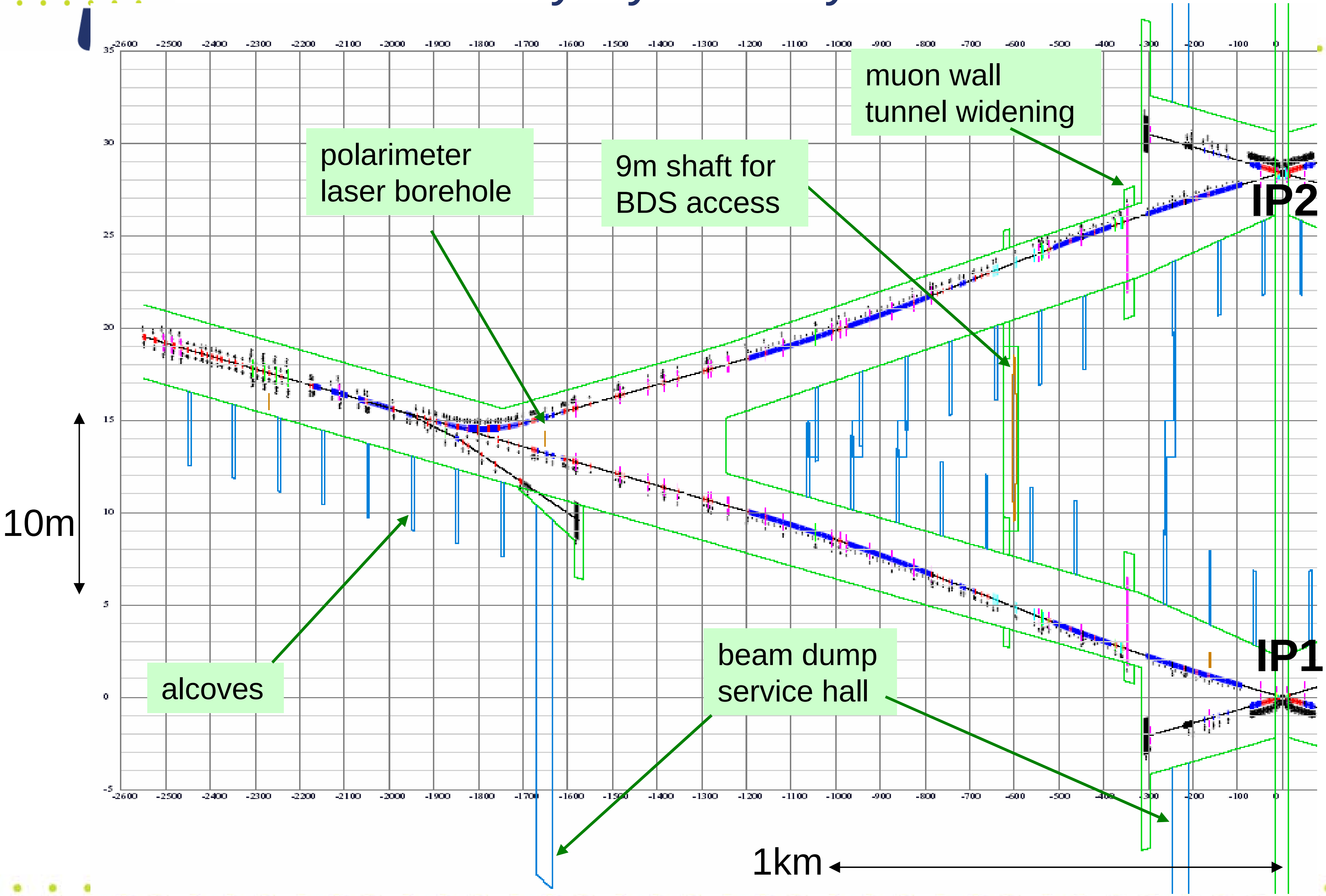
- Other approach - to replace copper collimators and absorbers to carbon ones. Muons background reduces about 23 times –magnetized wall or doughnuts may not be required!

Detector tolerances and cost implications need to be studied in details.

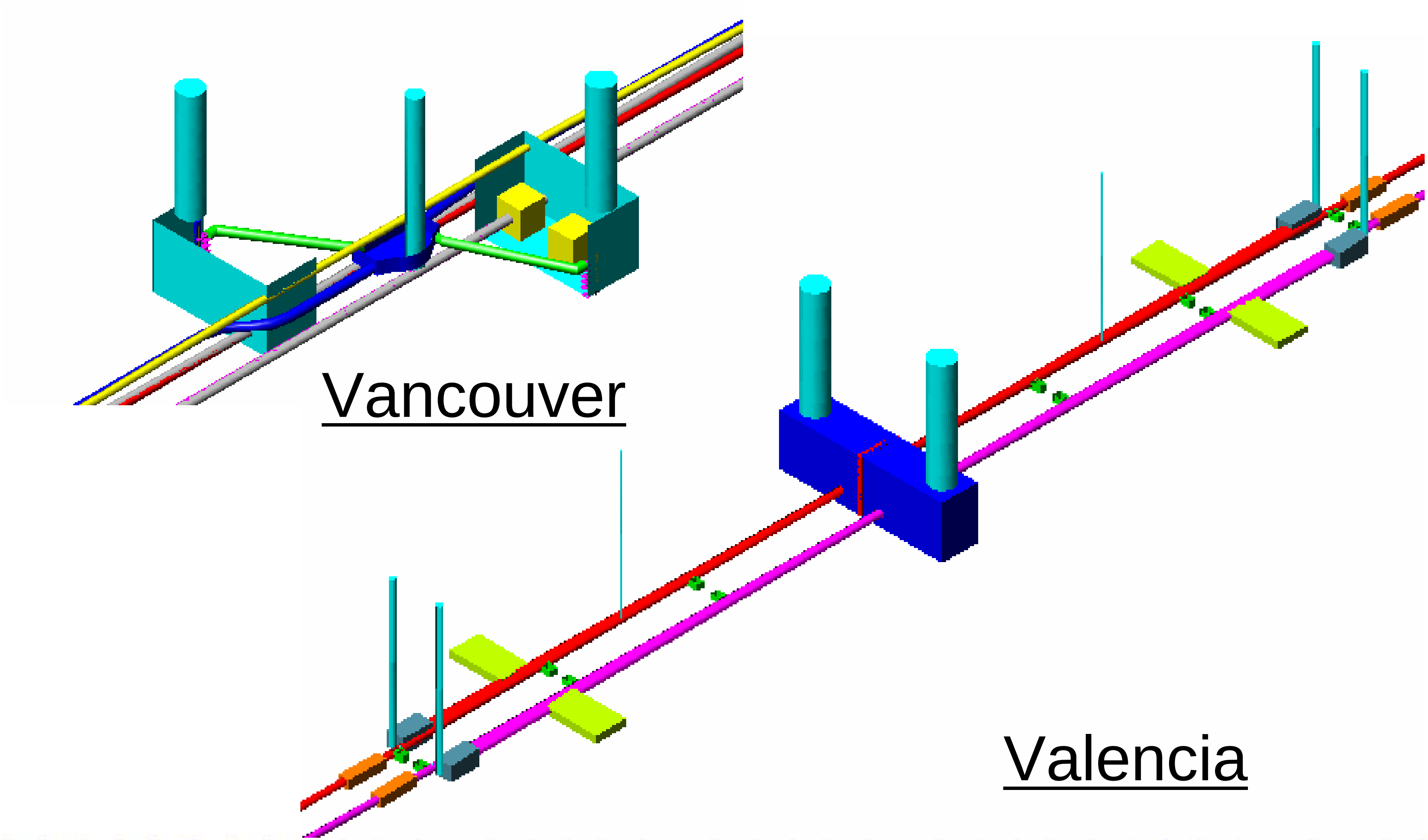


L. Keller, N. Mokhov, N. Nakao, S.Striganov

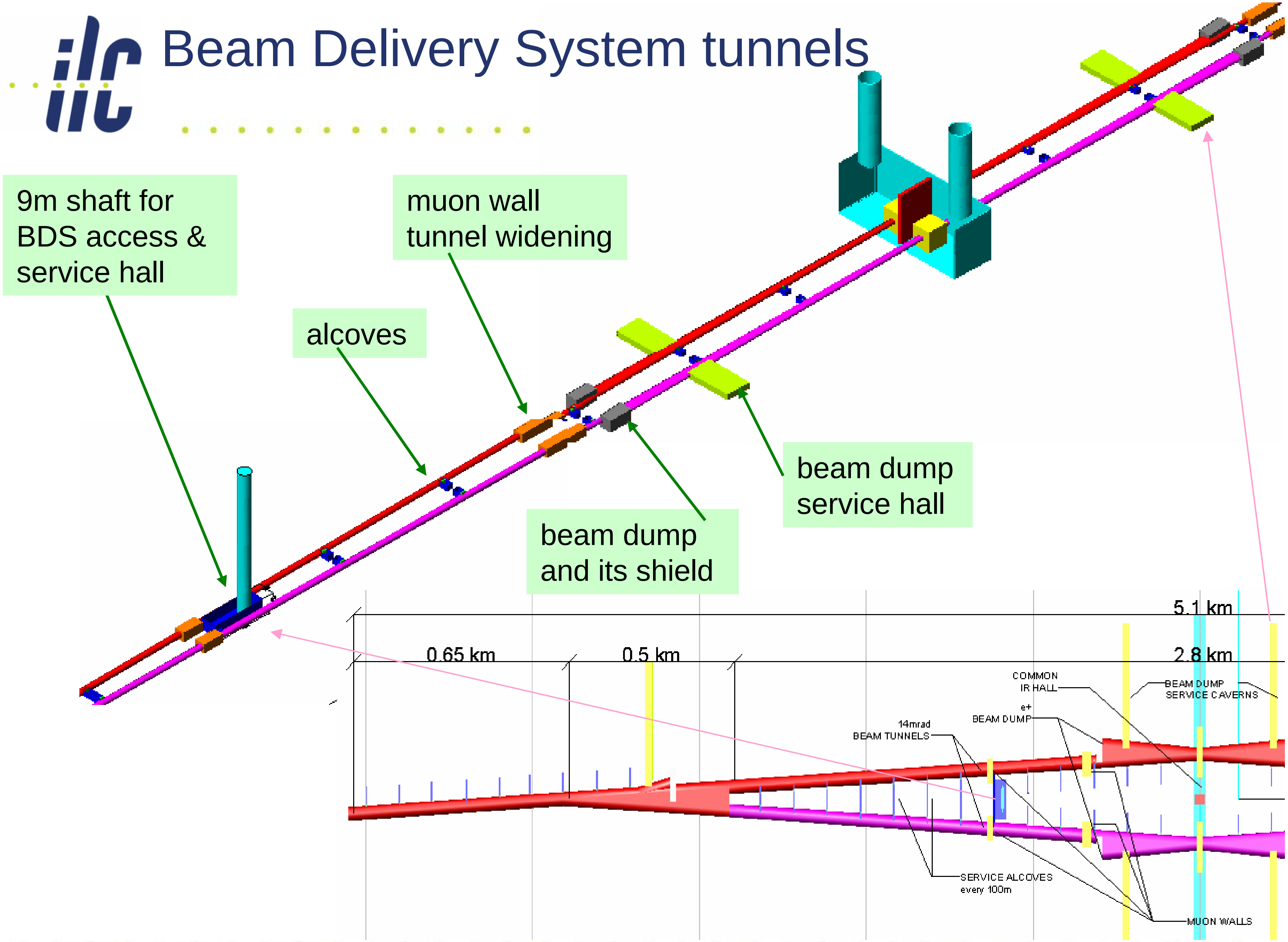
Beam Delivery System layout for new baseline



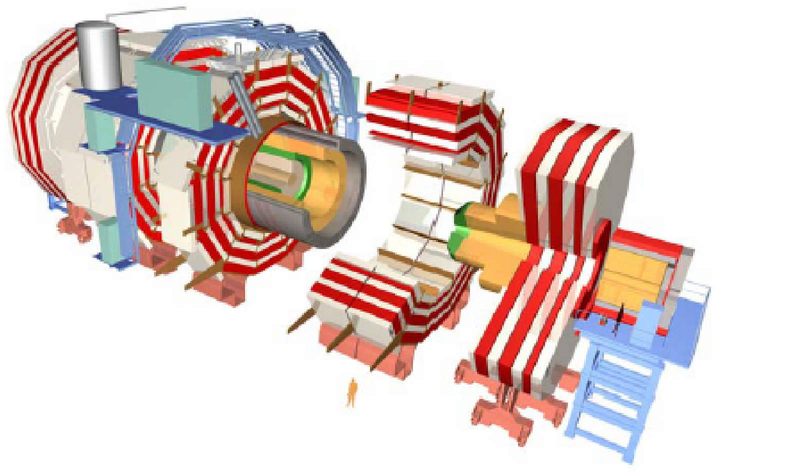
CFS designs for two IRs

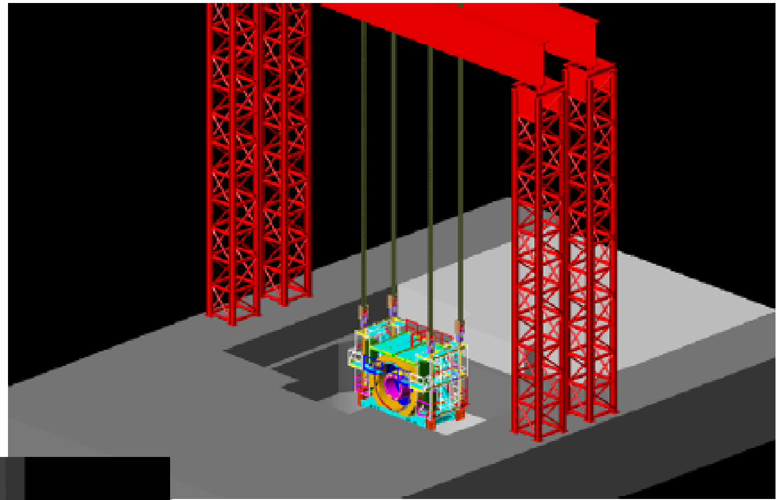


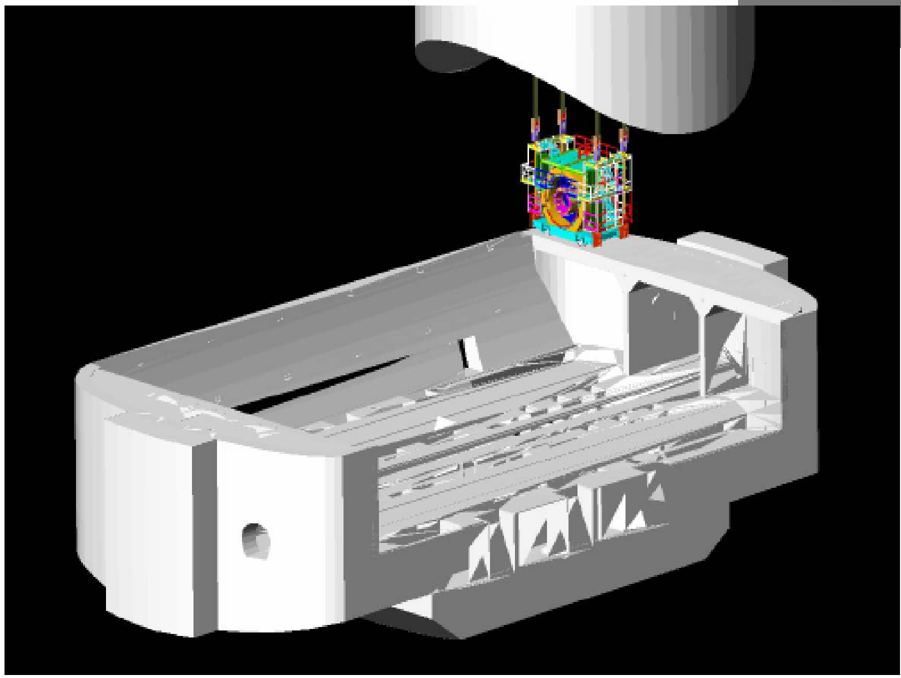
Beam Delivery System tunnels



On-surface assembly : CMS approach







CMS assembly approach

- Assembled on the surface in parallel with underground work
- Allows pre-commissioning before lowering
- Lowering using dedicated heavy lifting equipment
- Potential for big time saving
- Reduces size of required underground hall

On-surface assembly CCR(1)

- Change request to specify on-surface detector assembly procedure for ILC detectors submitted on 21st September
  - **The present BCD does not explicitly specify the method of underground assembly. It is implicitly assumed that the detectors are assembled underground.**
  - **Vancouver WBS considered the underground halls sized at 32m (W) x 72m (L) each to allow underground assembly of the largest considered detector.**
- According to tentative CF&S schedule worked out by M. Gastal, CERN, the detector hall is ready for detector assembly after 4y11m after project start
  - **If so, cannot fit into the goal of "7years until first beam" and "8years until physics run"**

On-surface assembly CCR(2)

- Surface assembly allows to save 2-2.5 years and allows to fit into this goal
  - The collider hall size may be smaller (~40-50%) in this case
  - A building on surface is needed, but savings may be still substantial
- Discussing possible variations :
  - pure CMS assembly (config B)
  - modified CMS assembly (config A)
    - Assemble smaller (than CMS) pieces on surface, lower down and perform final assembly underground
    - May affect schedule (?), but preliminary looks by a small bit less expensive than "B"
- The change request not intended to specify all the details for the schedule, hall sizes, capacity of cranes etc.
  - Such optimisation is being done in details by BDS, CF&S and Detector concept groups.
- CCB approved this CCR on 2nd November.

Table of IR assumptions

Item	SiD	LDC	GLD	CMS	Vancouver WBS (for each hall)	For Valencia Config.A (for single common hall)	Config.B (for single common hall)	Determined by
Parameters that define the underground hall volume								
IR Hall Area(m) (W x L)	28x48 (18x48)	30x45	25x55	26.5x53 max	32x72	25x110	25x110	Detector concepts
Beam height above IR hall floor (m)	7.5	8	8.6	8.79m	8.6	8.6	8.6	Concepts, BDS
IR Hall Crane Maximum Hook Height Needed(m)	5m above top of detector	19	20.5	18m	30	20.5	20.5	Detector concepts
Largest Item to Lift in IR Hall (weight and dimensions)	100t PACMAN shielding	55t, 3m x 3m x 1,5m, E/HCAL end cap quadrant	Pieces of yoke 400t	20t instal tool 7x4m		400t	100t	Detector concepts
IR Hall Crane	100t/10t aux.	80t (2x40t)	400t	20t	20t x 2	400t+2*20t	100t+2*20t	Detector concepts
IR Hall Crane Clearance Above Hook to the roof (m)	TBD by engineering staff	6	TBD	5 m	5	14.5 (includes arch)	12.5 (includes arch)	CF&S group
Resulted total size of the collider hall (W x L x H)	28x48x30 (18x48x30)	30x45x25	25x55x35	53x26x25	32x72x35	25x110x35	25x110x33	Concepts & CF&S group
Parameters that define dimensions of the IR hall shaft and the shaft crane								
Largest Item; Heaviest item to Lower Through IR Shaft (weight and dimensions)	Coil package 600t – size End-dors 2000t each/halfs	Central Part ~2000t; 12-14m x 7m;	270t coil 9*9m Iron-15m	1950t		9*9m 400t	4*16m 2000t	Detector concepts

continued at next page=>

http://www-project.slac.stanford.edu/ilc/acceldev/beamdelivery/rdr/docs/BDS_CFS_Valencia.doc

IR Shaft Size(m)	9 may work	ϕ18,4 (16x9)	20 Surface 16 Hybrid	20.4m	15	16	20	Detector concepts
IR shaft fixed surface gantry crane. If rented, duration	1kt * 1.5years?	2kt * 1.5years?	2kt*1.5yr/ 400t	2kt * 1year	1kt * 1.5years?	None	2kt* 1.5years	Detector concepts
Surface hall crane should serve IR shaft		Yes				Yes	Yes	Detector concepts
Other shafts near IR hall for access	TBD	Yes		Yes 12m	9m in service cavern, one per two halls	No	No	Detector concepts & BDS area
Elevator and stares in collider hall shaft	Cost decision	?		no	No	Yes	Yes	Detector concepts & BDS area
Parameters that define dimensions of the surface assembly building and its crane								
Surface Assembly Building Area(m) (W x L)	TBD	30 x 60	TBD	23.5 x 93 inner, 23.5 x 140 outer	25 x 100	25x200	25x200	Detector concepts
Largest Item To Lift in SurfAsm. Bldg. (weight and dimensions)	100t	70t *;7,5x7 inner vac tank 60t one coil module 55t; 3m x 3m x 1,5m E/HCAL end cap quadrant		120t 13x7 inner vac tank 60t one coil module		400t	100t	Detector concepts
Surface Assembly Crane	100t/10t aux. (TBD)	2x80t* min 2x60t	400t	80t x 2	80t x 2	400t + 2*20t	100t + 2*20t	Detector concepts
SurfAsm. Crane Maximum Hook Height Needed(m)	20m TBD	19 m *		18.3 m	18	18	18	Detector concepts
SurfAsm. Crane Clearance Above Hook to the roof (m)	ME/Civil to determine	5 m to ceiling*		5.7 m to outside	5	8	6	CF&S group
Resulted volume of surface assembly building (m) (W x L x H)		30 x 60 x 24		23.5 x 100 x 23.5 outer	25 x 100 x 23	25 x 200 x26	25 x 200 x24	Concepts & CF&S group

Participation by MDI members (Oct. 12,13)

- **Tour of ATLAS, CMS and ALICE**
- **Presentations on:**
  - **Radiation protection issues**
  - **CMS services**
  - **ATLAS installation**
  - **CMS installation + infrastructure**
  - **ILC MDI :present status and understanding – H. Yamamoto and A. Seryi**
  - **Assembly and installation of an ILC detector – N. Meyners**
- **Extremely useful information from CERN colleagues based on real experience.**

Cost of new baseline

- **Cost of 14/14 mrad configuration is being updated after all these changes**

- **The costs will be updated for two IR case (14/14) and single IR case with push-pull**

Further work baseline cost

- Optimizing the IR hall requirement and detector assembly procedure
  - **considering pure-CMS and modified CMS approach**
- Optimizing CF&S design
- Working on installation model and refining the cost
- Reviewing systems for possible cost reductions
- Discussing other possible cost saving strategies

Single IR questions (1)

- GDE suggested evaluation of push-pull at the end of September.
- Questions to be evaluated
  - **Organisational and historical questions**
  - **Accelerator design questions**
  - **Detector design questions**
  - **Engineering integration questions**
- Detailed list of questions to be studied developed:

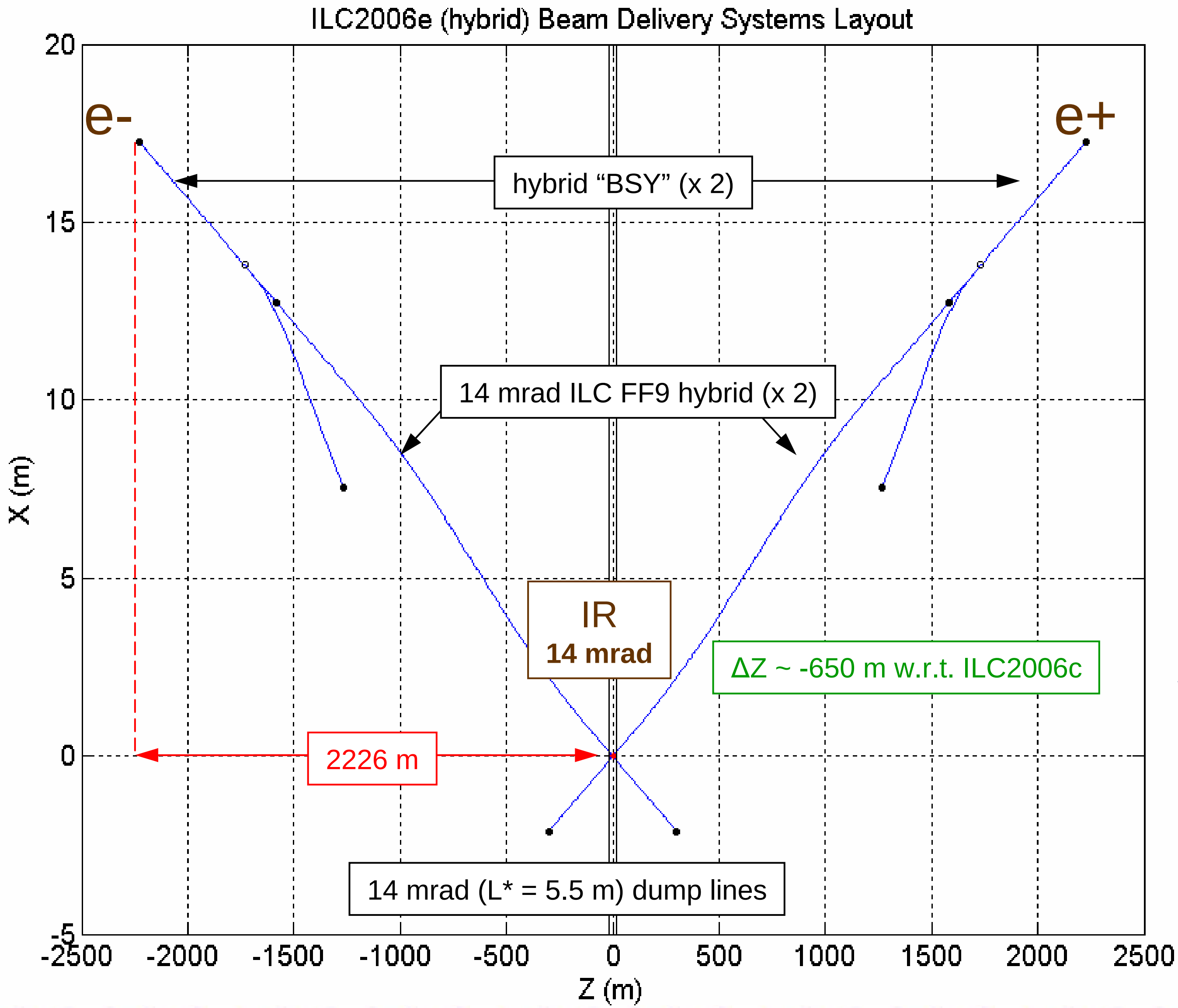
http://www-project.slac.stanford.edu/ilc/acceldev/beamdelivery/rdr/docs/push-pull/

- Technical evaluation of push-pull option started by an extended task force, which include detector and accelerator experts in ILC community and beyond.

Single IR questions (2)

- Detector task force phone meetings
  - **Oct 24:** http://ilcagenda.cern.ch/conferenceDisplay.py?confId=1214
  - **Nov 2 :** http://ilcagenda.cern.ch/conferenceDisplay.py?confId=1226
- Accelerator design meetings
  - **Several :** http://ilcagenda.cern.ch/categoryDisplay.py?categId=9
- So far discussed mostly the accelerator design and detector integration questions
- Preliminary conclusions from detector concept groups; detailed studies and engineering design are needed.
- BDIR/GDE/WWS/MDI session – Wed, 8th Sep
  - **Report from the Push-Pull Study Group – A. Seryi on behalf of extended task force.**
  - **Followed by discussion on Push/Pull issues**
- 8th Nov GDE, Main MDI issues – B. Barish, General issues

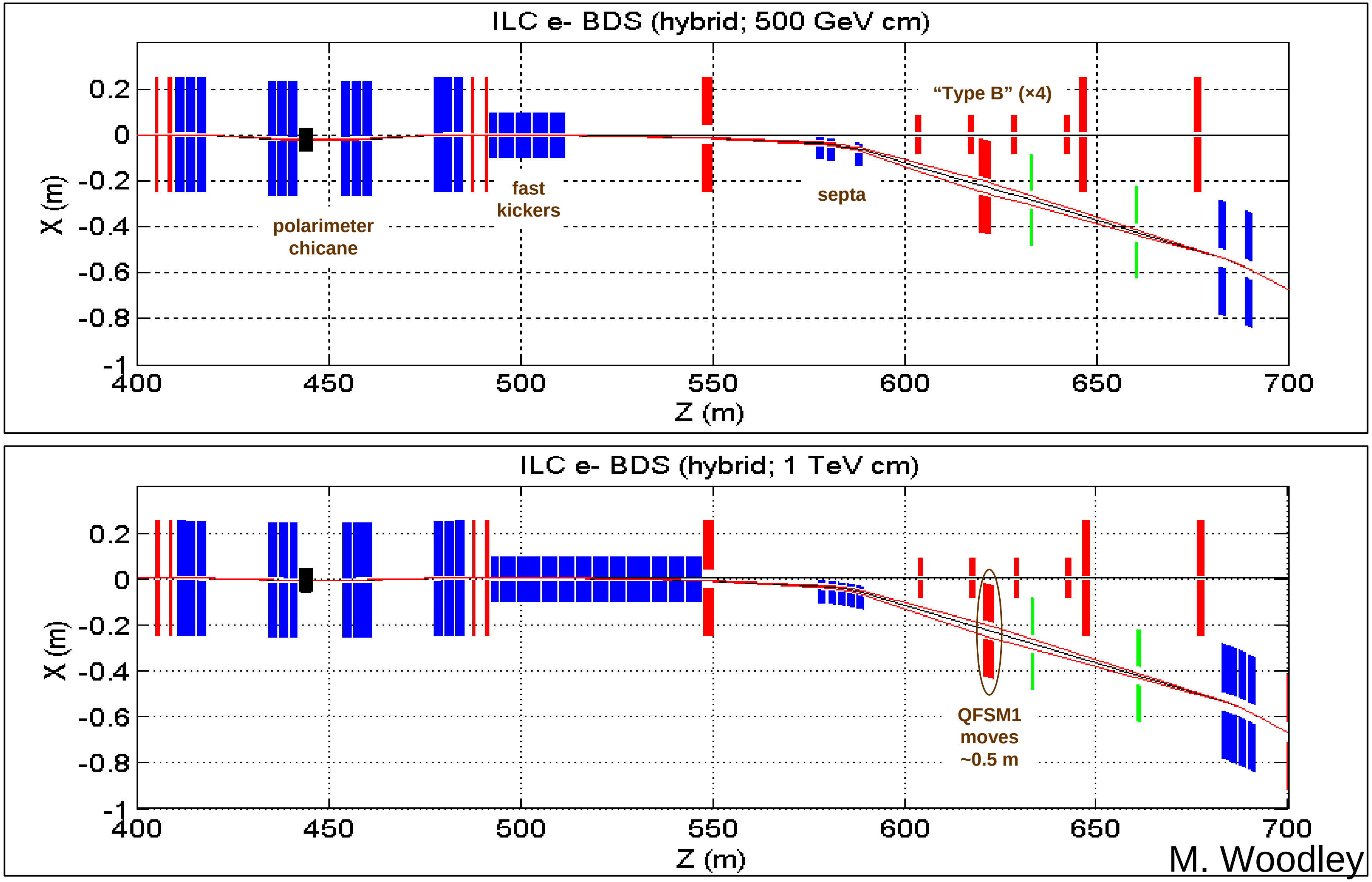
Single IR BDS Hybrid configuration



- Upgrade to 1 TeV CM involves adding magnets only … no geometry changes
- Total BDS Z-length is 4452 m (2 IRs:5100m)
- Removed dedicated energy error dianostics (MPS) and replaced with polarimeter chicane (some issues)

M. Woodley

Single IR BDS Hybrid configuration



Detector design and radiation safety properties

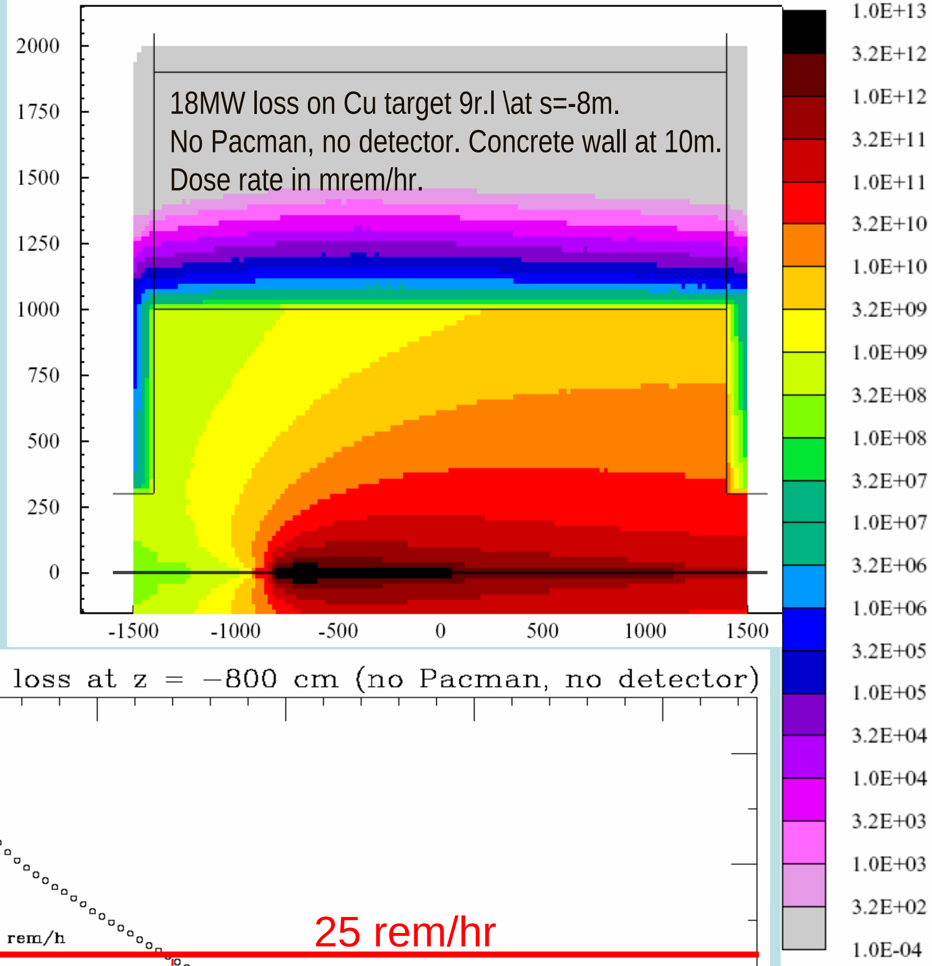
- If the detector electronics or services, or the off-beamline detector need to be accessed during run, the detector need to be self-shielded, or a shielding wall should be used
- Preliminary study indicates that some of detectors considered for ILC can be made self-shielded even for pessimistic assumption of full beam loss (18MW)
- There is significant concern that safety rules may become tighter in time, and that larger gaps (for cables, etc.) would be needed in detector
- Assume the design with shielding wall, while considering self-shielding as possible improvement

Shielding wall

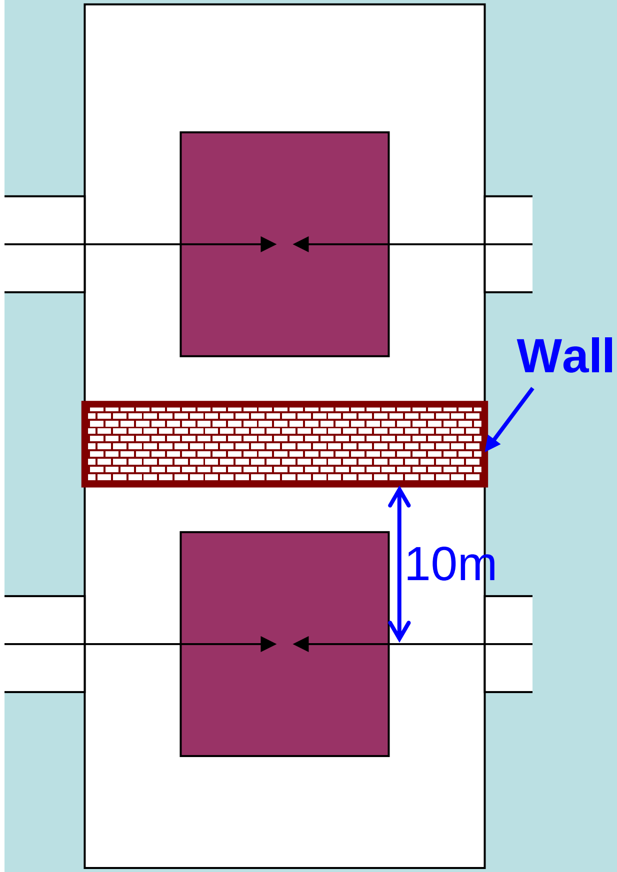
- Recent studies show that if detector does not provide any shielding, a 3m concrete wall is needed
- If partial shielding is provided by detector, the wall may be thinner
- The wall does not have to be full height
- A curtain wall (movable on crane rails) may or may not be needed to block the gap above the wall

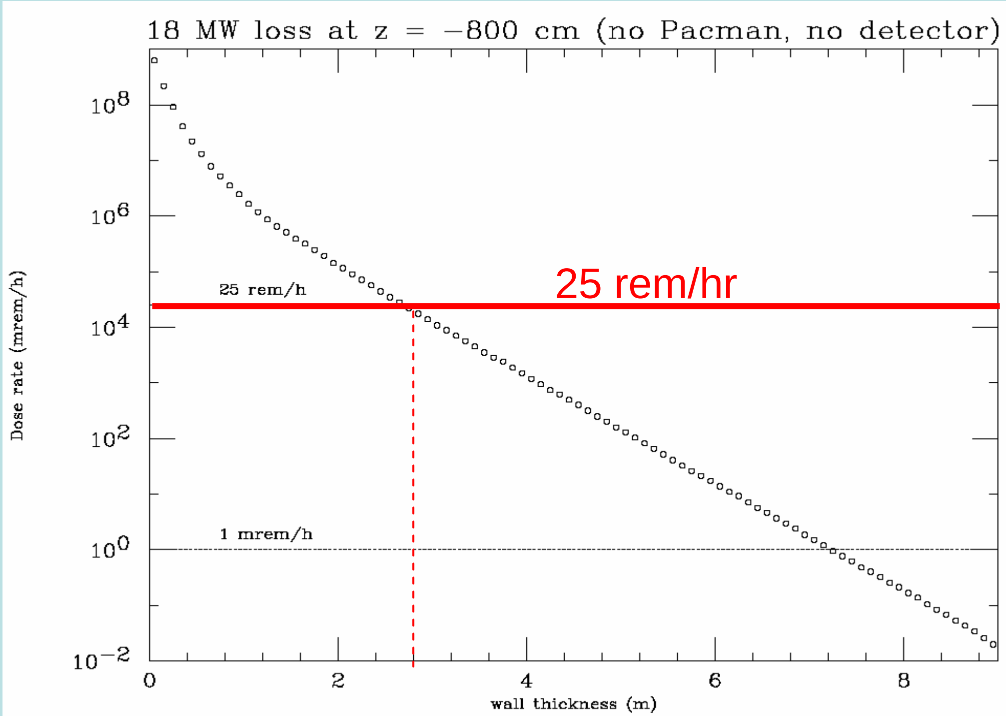
If detector does not provide any radiation protection:

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

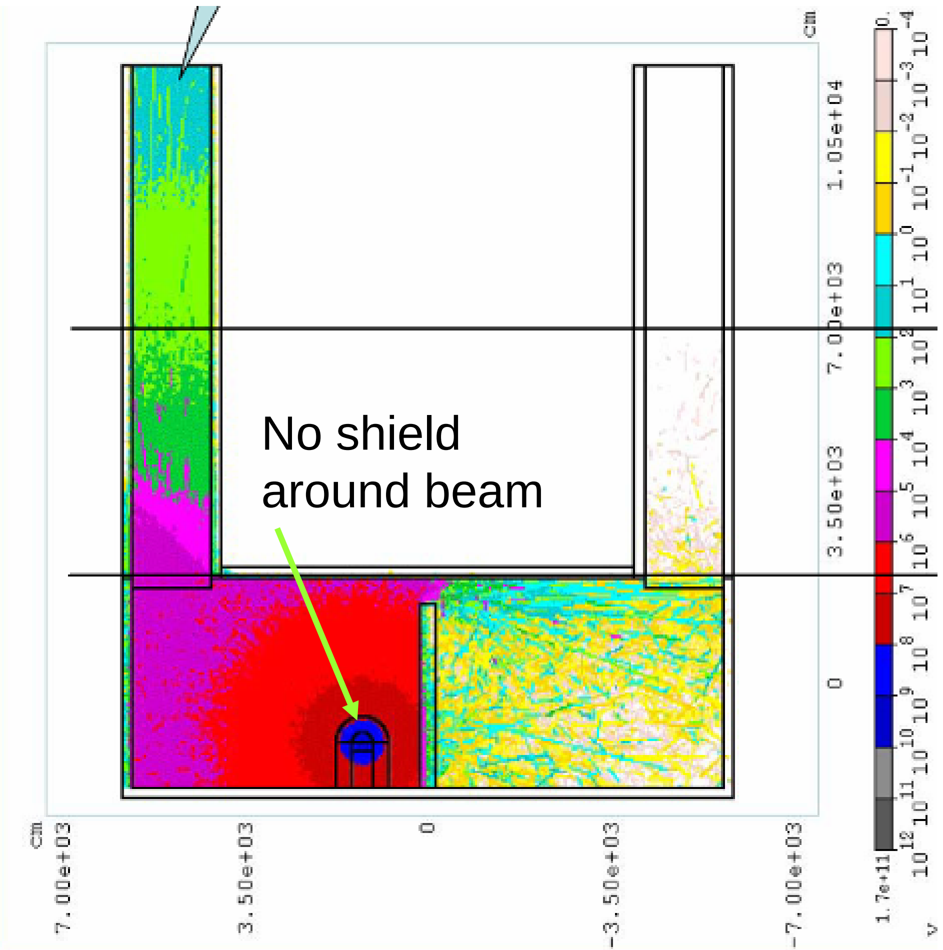


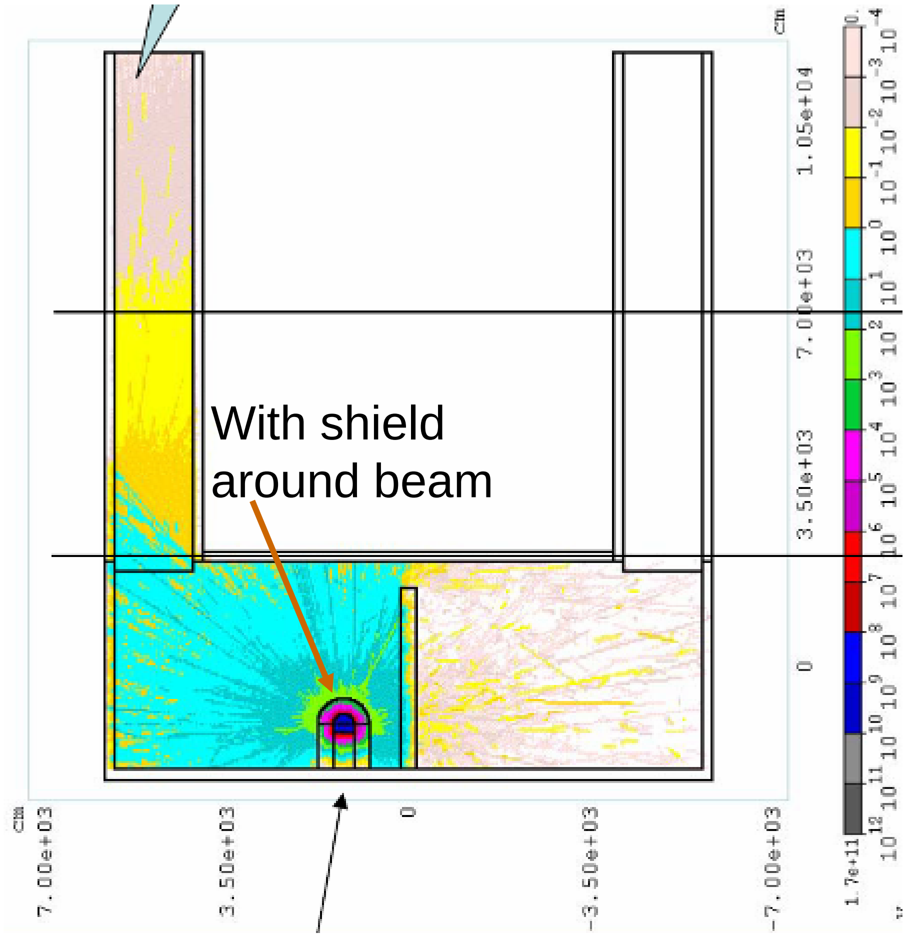
Alberto Fasso et al





IR hall with shielding wall





May need additional curtain wall on top of main wall. May need shaft cover.

Do not need full height wall. The height could be decrease from what shown.

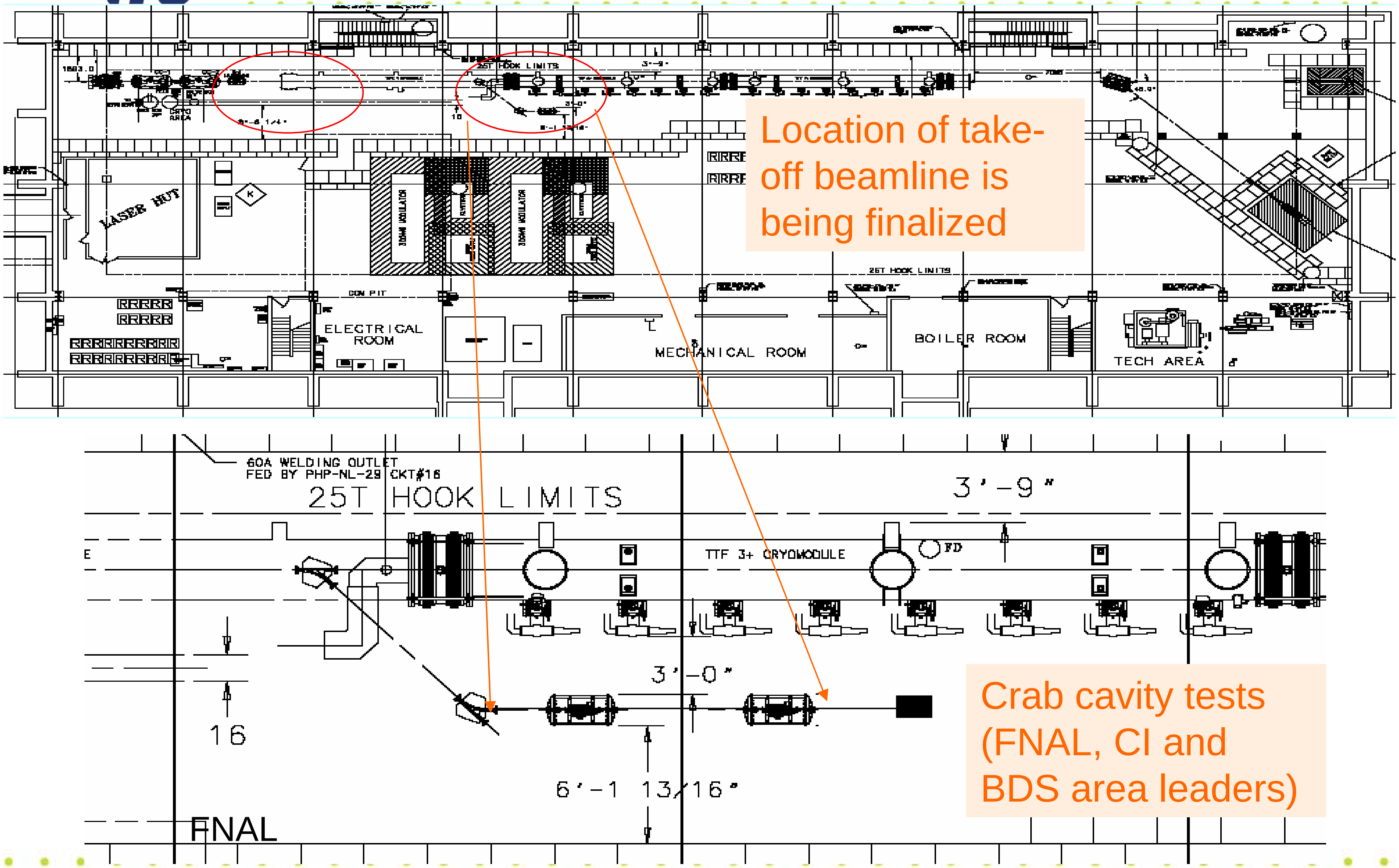
RP T.Sanami and A.Fasso

2006年9月19日

BDS Test facilities : update

- Moving ESA program to the SABER is being investigated
  - **It is essential to have a high energy test facility continuing past 2008, with similar capabilities as ESA**
- ATF2 and ESA (to possibly be replaced by SABER) facilities complement each other and cover most of the needs of BDS
- Other test facilities being discussed :
  - **tests of crab cavities at the new facility at Fermilab**
  - **integrated IR probably to be developed at BNL**

Tests of crab cavities at the new facility at Fermilab



Location of take-off beamline is being finalized

Crab cavity tests (FNAL, CI and BDS area leaders)

Summary

- Several configuration changes since Vancouver
  - **3 Change requests to Vancouver baseline, all approved by CCB and accepted by WWS and MDI panel**
- Cost reduction strategies continuing
- Detailed evaluation of on-surface assembly for each detector concept
- Evaluation of single IR, push-pull detectors, parameter space
  - **Detailed discussion sessions with GDE, MDI and WWS at this workshop**
- Final configuration for the RDR to be finalised at this workshop