International Linear Collider Machine Detector Interface

Materials for discussion at

Engineering Forum: experiences from LHC detectors conception and construction

CERN, October 13

Andrei Seryi, Hitoshi Yamamoto

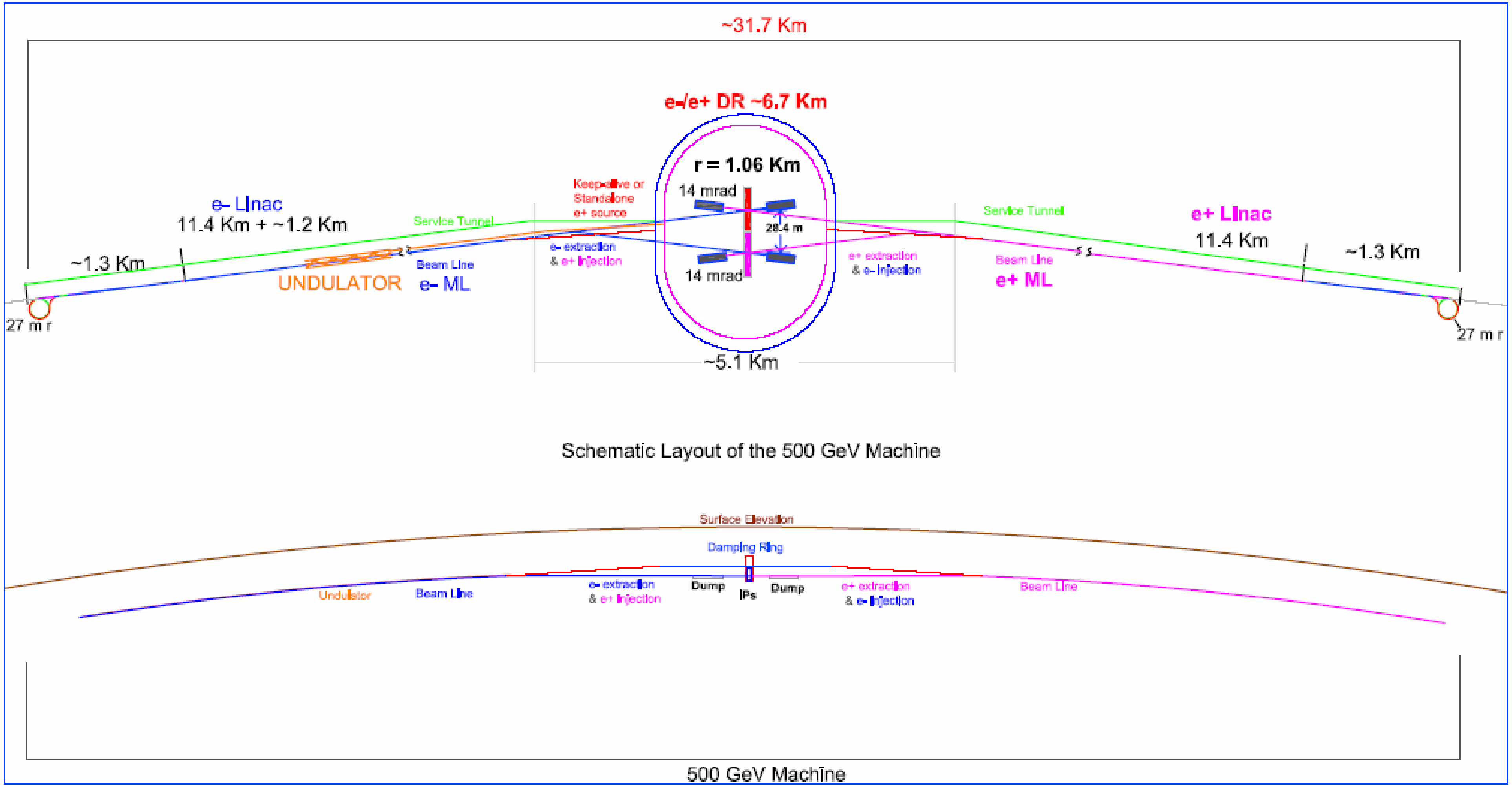
Thanks

- To many colleagues from CERN and other labs who were involved in discussion and work on the issues described in this talk
- To everyone who organized this meeting, who were guiding the tour, and who are participating in this meeting

Contents

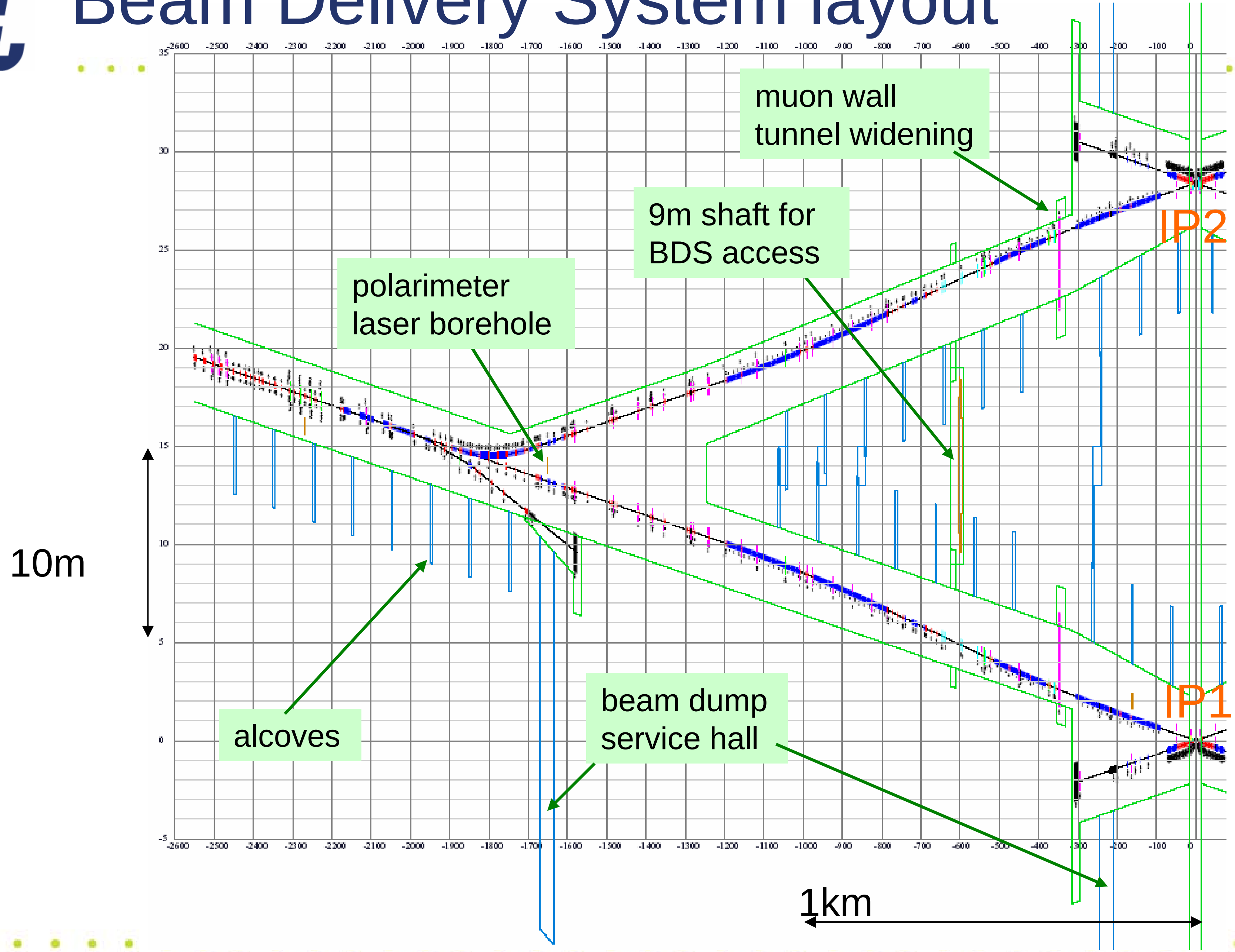
- Introduction, ILC and BDS layouts
- Detector assembly, hall sizes, arrangements, etc
  - **Adopted on-surface assembly concept for ILC**
  - **Consider pure CMS or modified CMS assembly**
- Questions associated with study of push-pull
  - **Detector design and radiation shielding**
  - **Moving detector parts**
  - **Location of services and electronics, etc**
- Goal of this meeting: learn CERN experience and consider how to best apply it to ILC

ILC layout

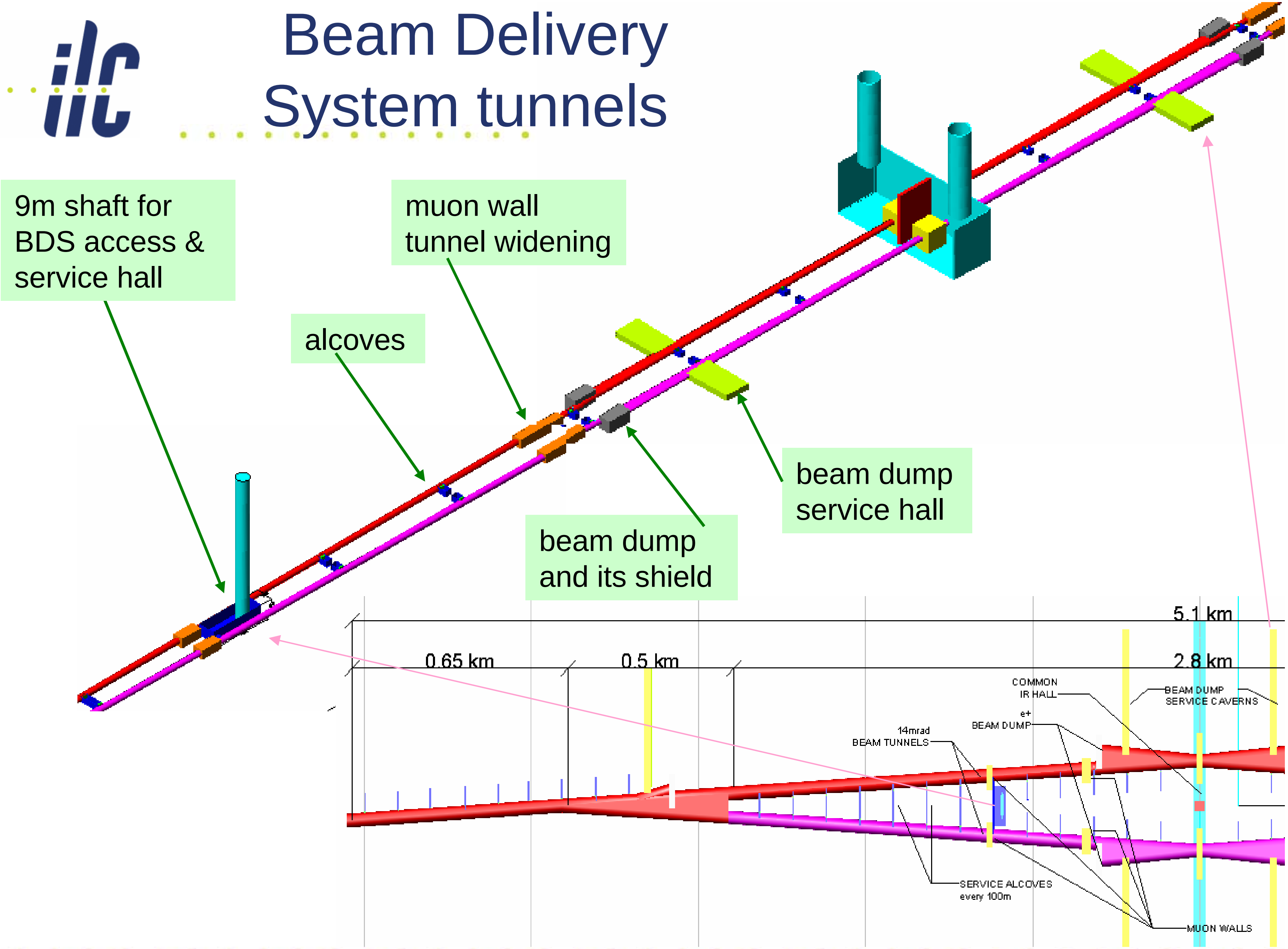


This shows central location of DR which is not yet officially accepted

Beam Delivery System layout



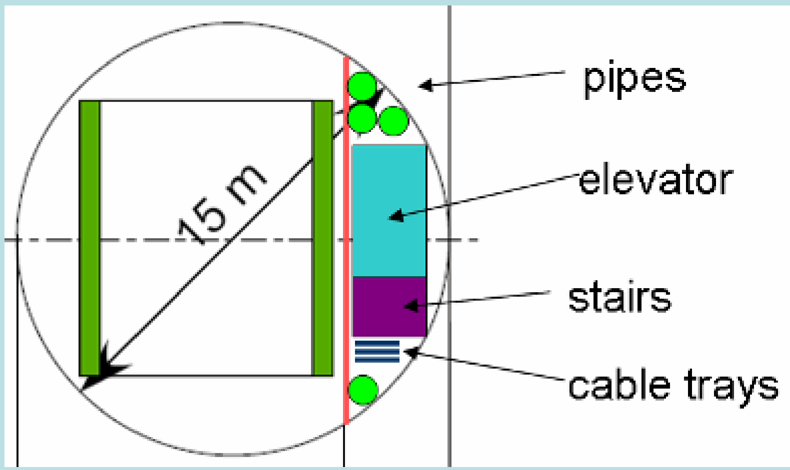
Beam Delivery System tunnels



Couple of particular features

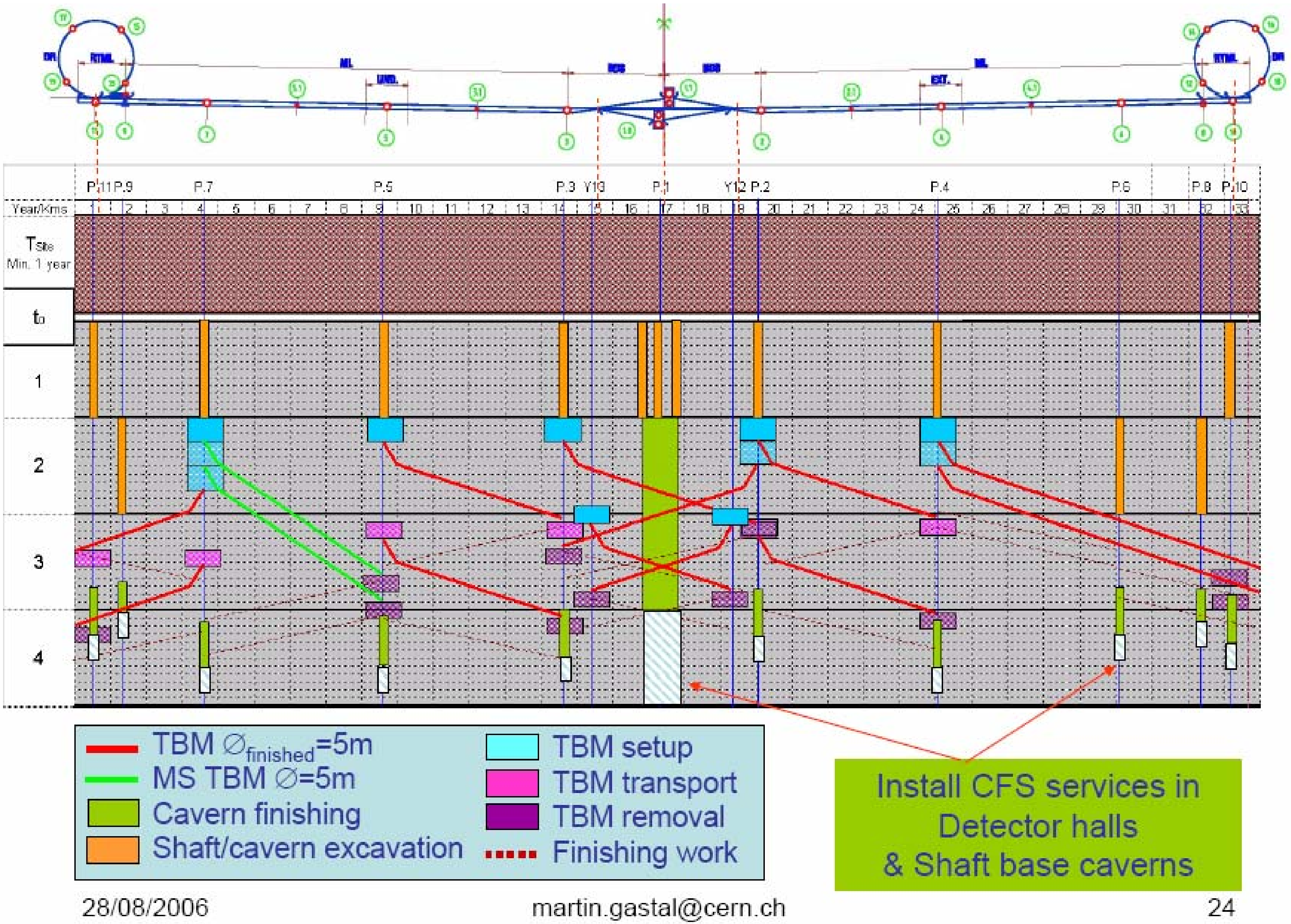
- It is worth to attract attention and discuss couple of particular assumptions:
  - **Do not include (unlike LHC) a separate service cavern for detector equipment and electronics. All what is needed is placed in the collider hall.**
  - **Do not have access shafts than those 2 in IR hall, and these shafts are equipped with elevators and stairs:**
    - (The nearest shafts for machine assess are ~600m from IP)

Picture shows a solenoid being lowered down in an IR hall shaft



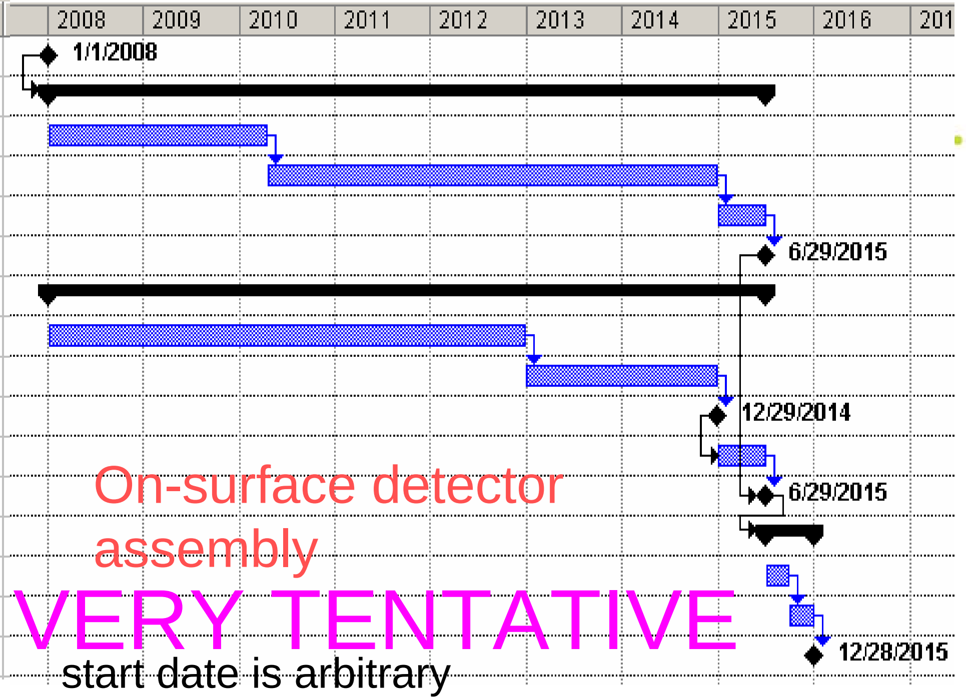
On-surface (a la CMS) assembly

- Schedules of ILC CFS work developed by Martin Gastal and his colleagues
  - **According to tentative CF&S schedule, 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”**
- Surface assembly allows to save 2-2.5 years and allows to fit into this goal
  - **The collider hall size may be smaller in this case**
  - **A building on surface is needed, but savings may be still substantial**
- Adopted on-surface assembly for ILC

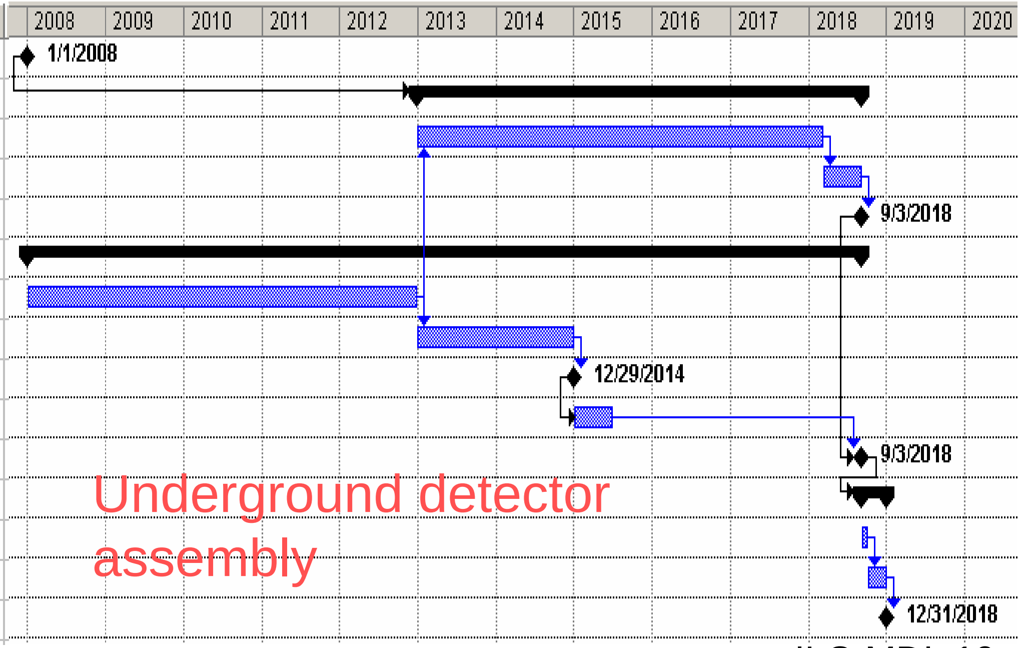


P.11 P.9
P.7
P.5
P.3 Y10
P.1
Y12 P.2
P.4
P.6
P.8 P.10
Year/Kms
T Site
Min. 1 year
t0
1
2
3
4
TBM ∅finished=5m
MS TBM ∅=5m
Cavern finishing
Shaft/cavern excavation
TBM setup
TBM transport
TBM removal
Finishing work
Install CFS services in
Detector halls
& Shaft base caverns
28/08/2006
martin.gastal@cern.ch
24

Task Name	Duration	Start	Finish
Project approved	0 days	1/1/2008	1/1/2008
⊟ **Construct detector**	**391 wks**	**1/1/2008**	**6/29/2015**
prepare surface building for detector	120 wks	1/1/2008	4/19/2010
detector assembly	245 wks	4/20/2010	12/29/2014
detector surface commissioning	26 wks	12/30/2014	6/29/2015
Detector ready for BDS	0 days	6/29/2015	6/29/2015
⊟ **Construct beamlines**	**391 wks**	**1/1/2008**	**6/29/2015**
prepare underground tunnels	260 wks	1/1/2008	12/24/2012
beamline hardware installation	105 wks	12/25/2012	12/29/2014
Start of beam commissioning	0 days	12/29/2014	12/29/2014
BDS beamline pre-commissioning	26 wks	12/30/2014	6/29/2015
BDS ready for detector	0 days	6/29/2015	6/29/2015
⊟ **Final assembly & commissioning**	**26 wks**	**6/30/2015**	**12/28/2015**
Detector underground assembly	13 wks	6/30/2015	9/28/2015
Final beam commissioning	13 wks	9/29/2015	12/28/2015
Ready for physics run	0 days	12/28/2015	12/28/2015



Task Name	Duration	Start	Finish
Project approved	0 days	1/1/2008	1/1/2008
⊟ **Construct detector**	**297 wks**	**12/25/2012**	**9/3/2018**
detector assembly	271 wks	12/25/2012	3/5/2018
detector underground commiss.	26 wks	3/6/2018	9/3/2018
Detector ready for IP	0 days	9/3/2018	9/3/2018
⊟ **Construct beamlines**	**557 wks**	**1/1/2008**	**9/3/2018**
prepare underground tunnels	260 wks	1/1/2008	12/24/2012
beamline hardware installation	105 wks	12/25/2012	12/29/2014
Start of beam commissioning	0 days	12/29/2014	12/29/2014
BDS beamline pre-commiss.	26 wks	12/30/2014	6/29/2015
IP ready for detector	0 days	9/3/2018	9/3/2018
⊟ **Final assembly & commissioning**	**17 wks**	**9/4/2018**	**12/31/2018**
Detector moved to IP	4 wks	9/4/2018	10/1/2018
Final beam commissioning	13 wks	10/2/2018	12/31/2018
Ready for physics run	0 days	12/31/2018	12/31/2018



Versions of on-surface assembly

- Accepted on-surface assembly
- Still, discuss 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"
- Details of assumptions shown on next pages
  - **would like to clarify our understanding and perhaps refine the ILC assumptions during this visit to CERN**

Table if 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

Single IR questions

- GDE is studying a design with single IR and two detector ("push-pull" case)
- Questions associated with study of push-pull
  - **Detector design and assembly**
  - **Radiation shielding**
  - **Moving detector parts and shielding**
  - **Location of services and electronics, etc**
- Detailed list of questions here:

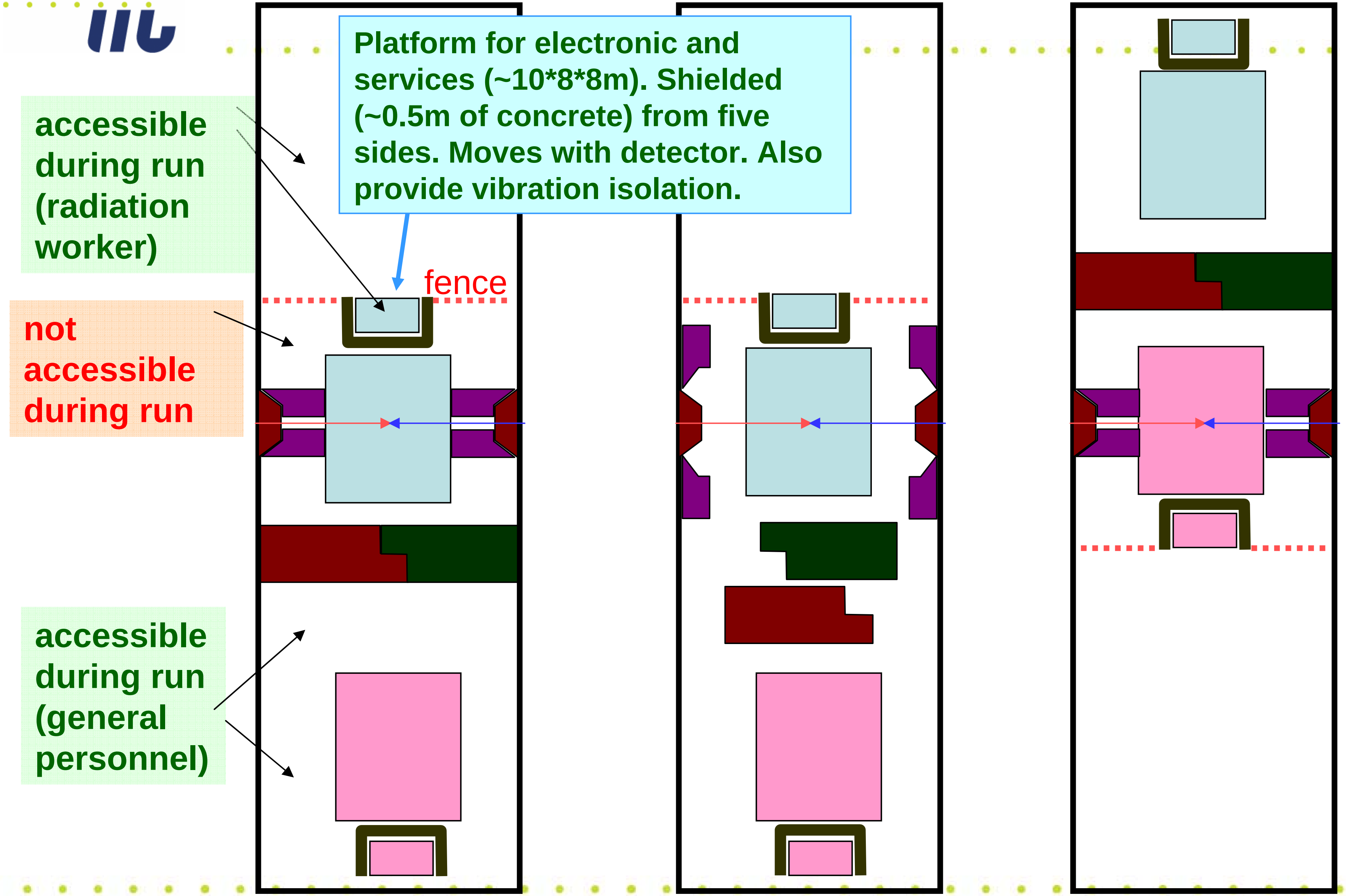
http://www-project.slac.stanford.edu/ilc/acceldev/beamdelivery/rdr/docs/push-pull/

- Some tentative conclusions are below

Example of questions

- *What is the suitable way to move (rails, air-pads) the detector?*
  - **air-pads seems as a possibility**
- *For quick change-over, do we need to make detector self shielding?*
  - **It would help, but self-shielding is not absolutely required for quick change-over**
- *What are the design changes needed to make the detector self shielded?*
  - **For GLD, self-shielding has been shown in simulations. For the fourth detector concept (double solenoid with no iron), implementing self-shielding may be difficult**
- *If there is a need in shielding wall between detectors, what is the method of its removal and assembly?*
  - **The shielding wall, if needed, can consist of two parts and move on air-pads in hours**
- *What arrangements or reinforcements (such as imbedded steel) are needed for the floor of the collider hall?*
  - **Steel plates (~5cm thick, welded) to cover the collider hall floor**
- *How the connections of electrical, cryo, water, gas, etc, systems are arranged?*
  - **Part of electronics and services can be placed on a platform which moves with detector. Flexible connections to stationary systems needed.**

Concept which does not rely on self-shielding detector



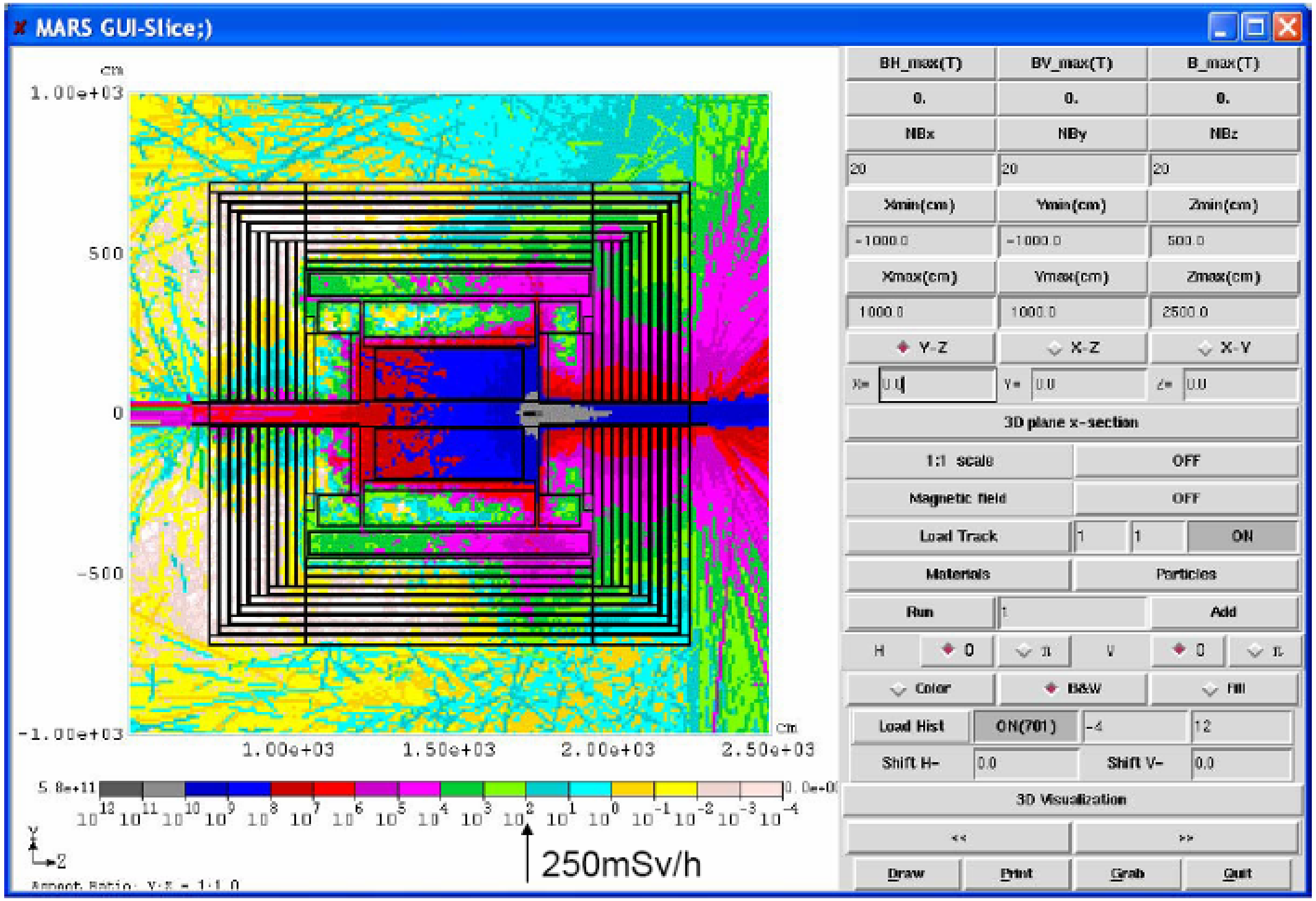
Detector assembly and its radiation safety properties

- Although not required, eliminating the shielding wall would facilitate the push-pull case
  - **In this case, If the off-beamline detector is to be accessible, the detectors should be self-shielded**
- Preliminary study indicate that most of ILC detectors can be made self-shielded even for pessimistic assumption of full beam loss (18MW)
- Question is: are there any particular constraints, due to on-surface assembly, which complicates design of self-shielded detector?

Self-shielding study of GLD

Result, target at IP+250(z=1750), x-z slice at y=0

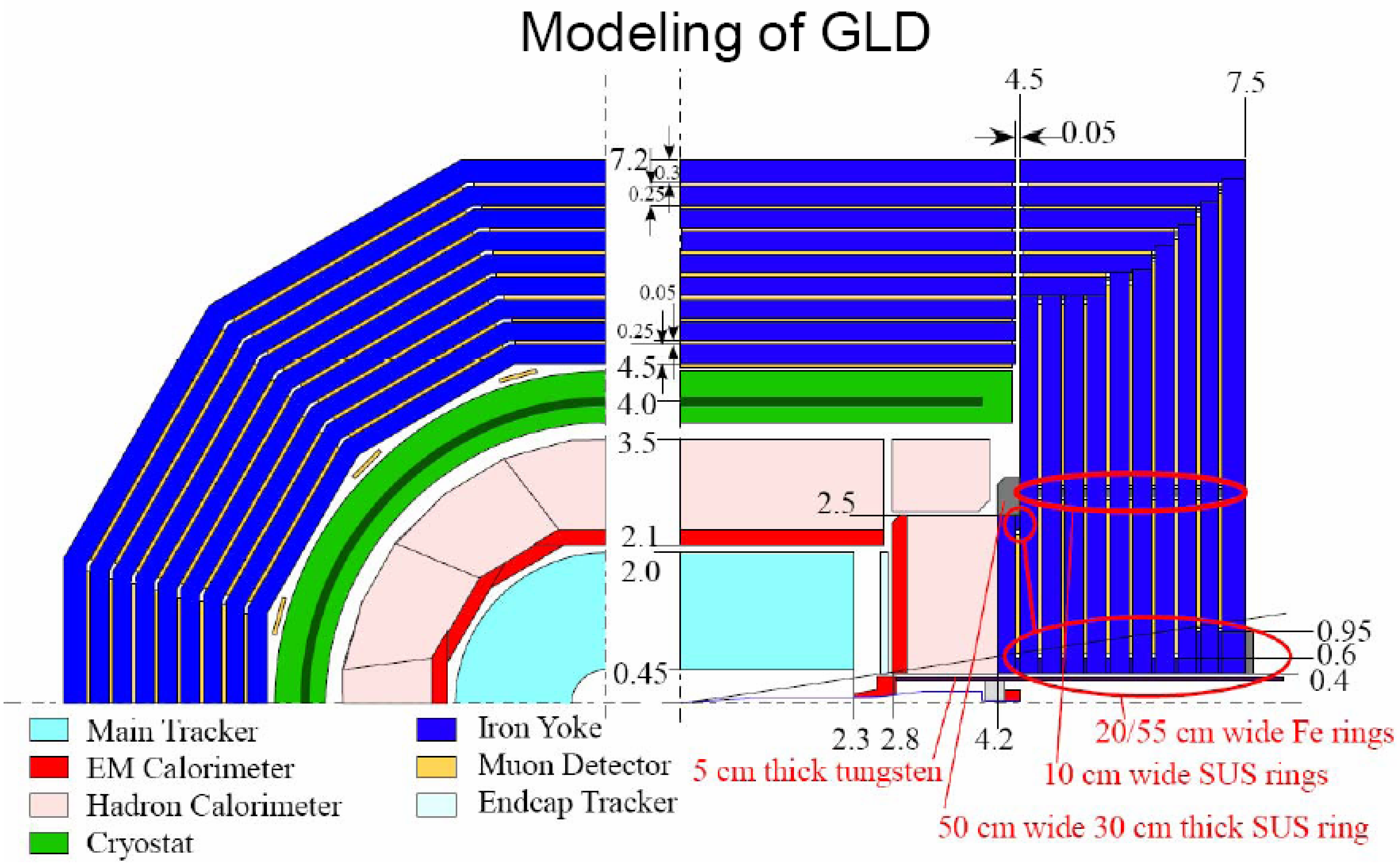
Results show that GLD can be self-shielded even if assume criteria of 25rem/h (250mSv/h) for maximum credible incident [SLAC rule] at any place (=loss of 18MW beam at thick target)



Shield around beamline was not included

T.Sanami
SLAC-RP/KEK-RC

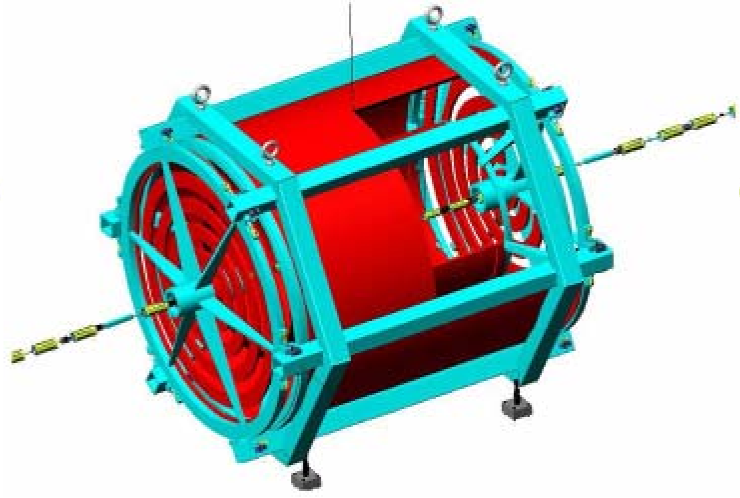
GLD modified to improve self-shielding

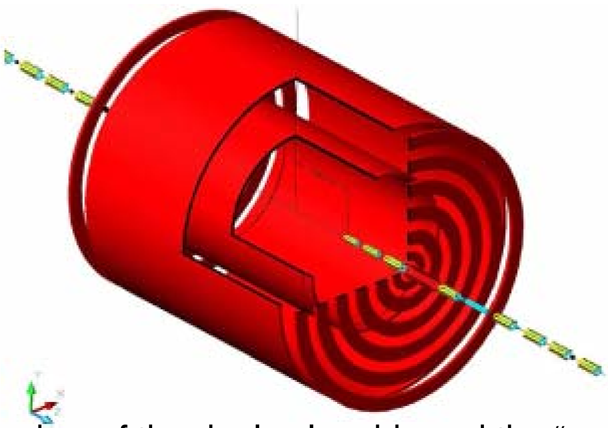


Yasuhiro Sugimoto

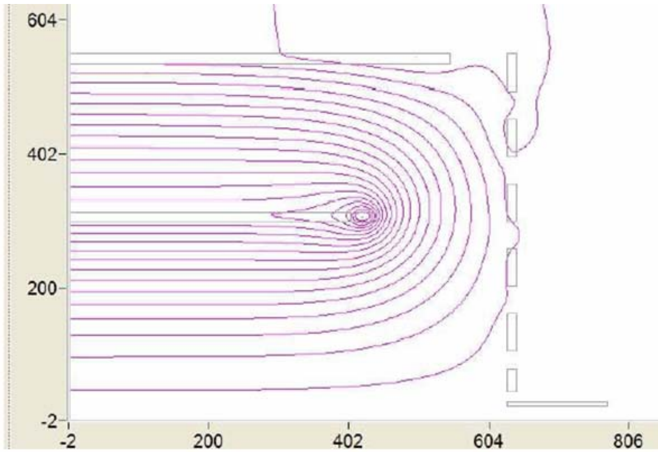
The 4th detector concept

- Featuring the dual solenoids and no need for the iron return yoke
- The calorimeter, solenoids and supporting structures give some shielding but certainly not sufficient self-shielding
- If it were to be made self-shielding, ~2-3m of concrete would need to be added around the detector. Or has to rely on external shielding wall



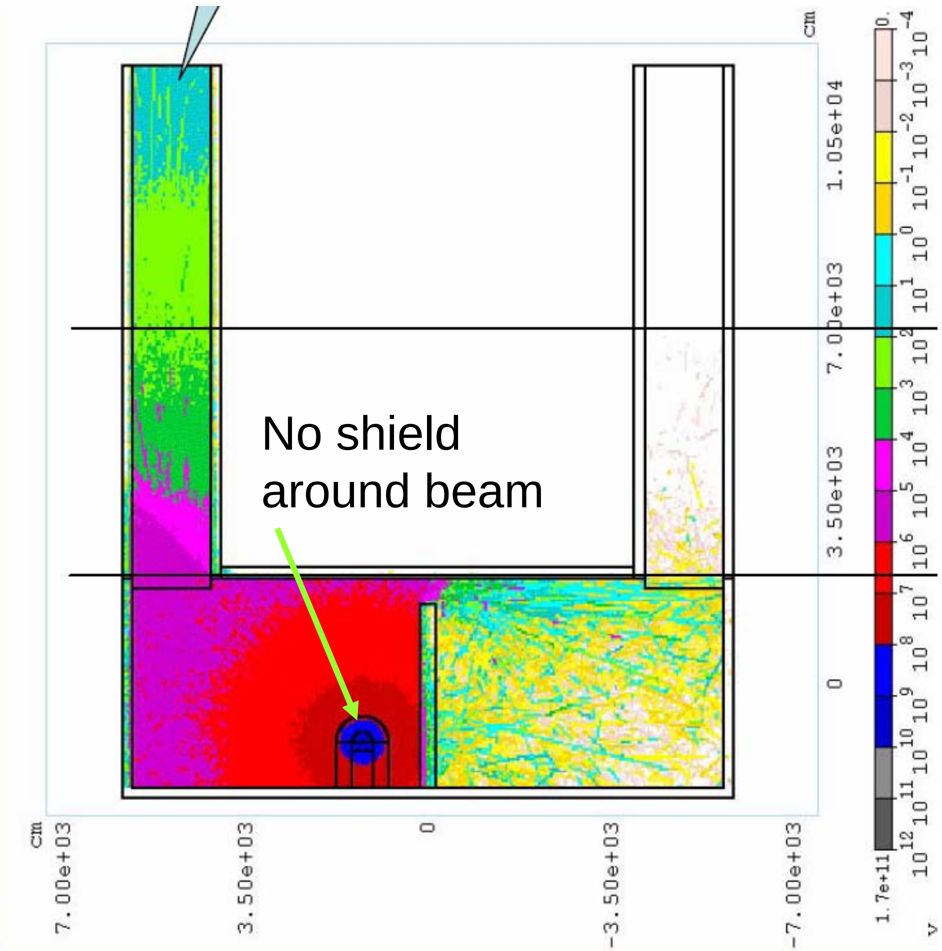


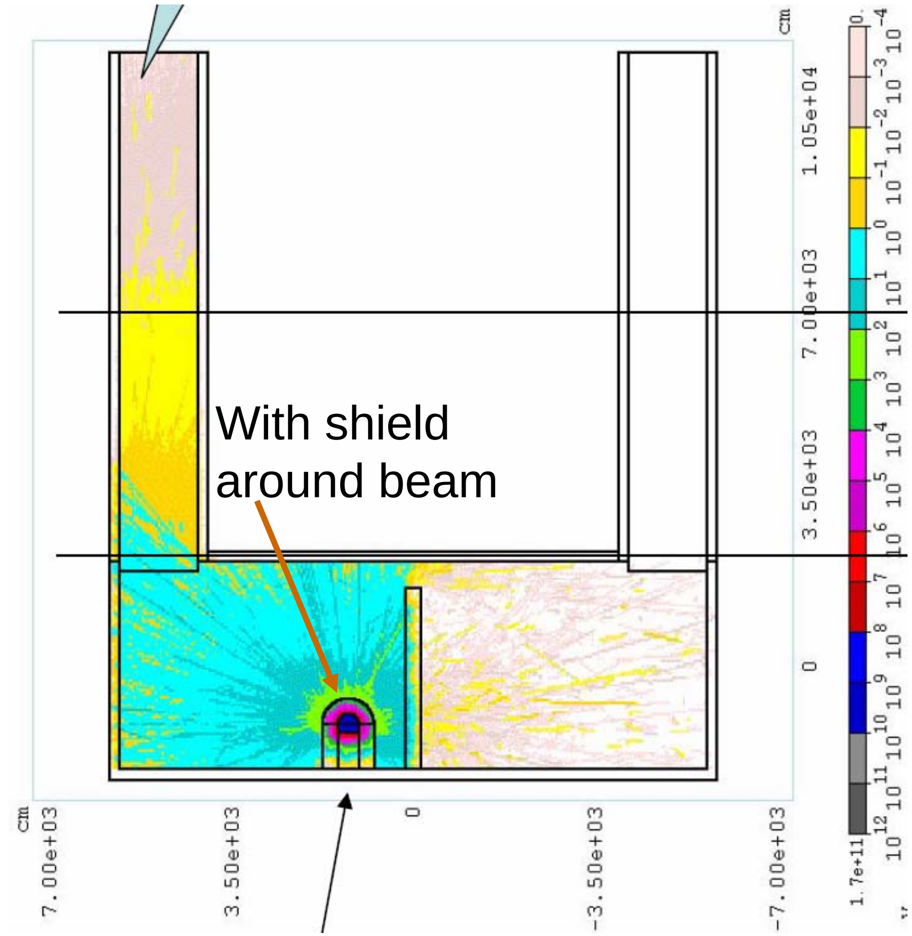
A cut-away view of the dual solenoids and the "wall of coils" that terminate the solenoid field in the 4th Concept.



Magnetic field lines of the 4th Concept, showing the dual solenoids and the "wall of coils" on the ends.

IR hall with shielding wall





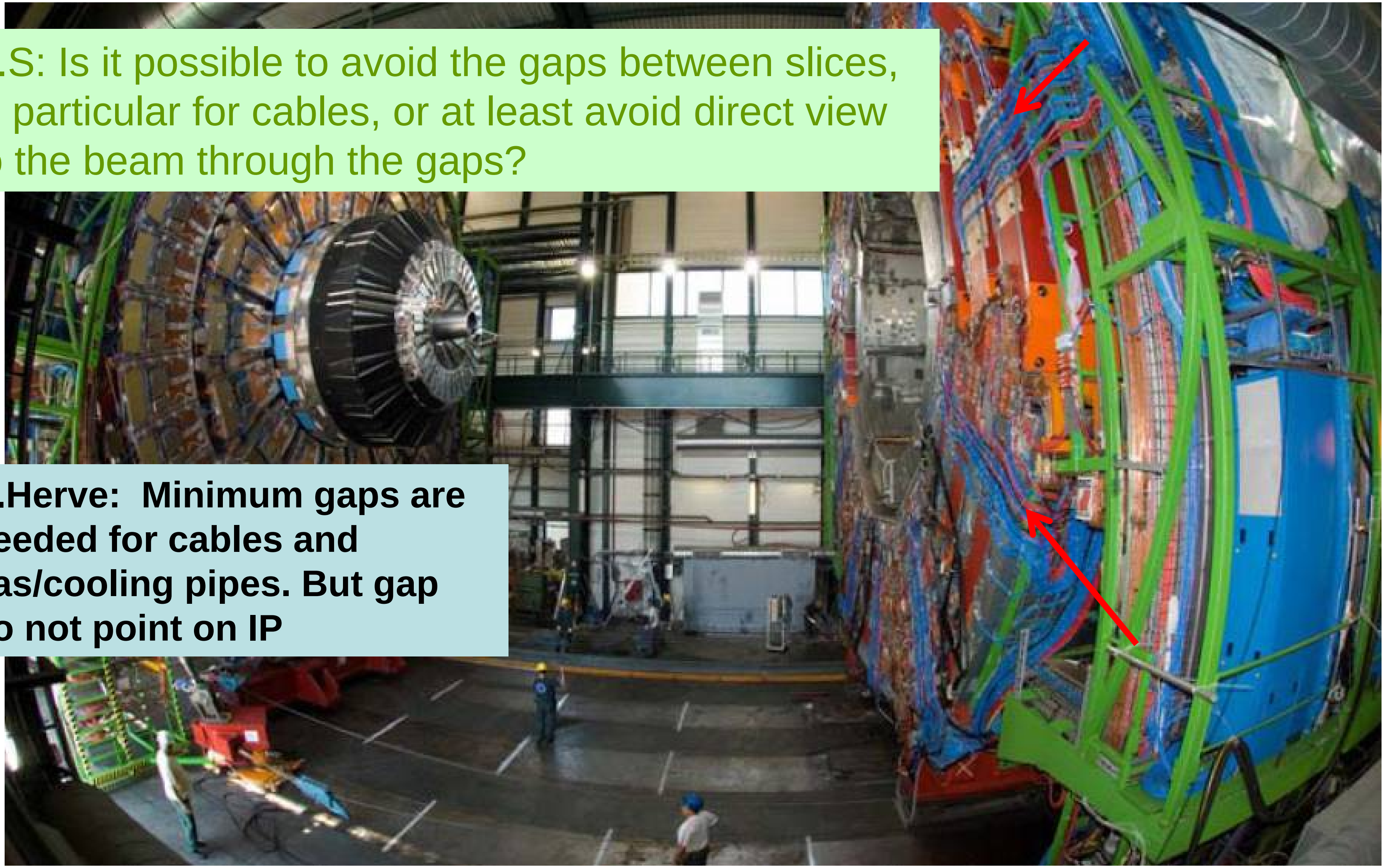
May need additional curtain wall on top of main wall. May need shaft cover.

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

RP T.Sanami and A.Fasso

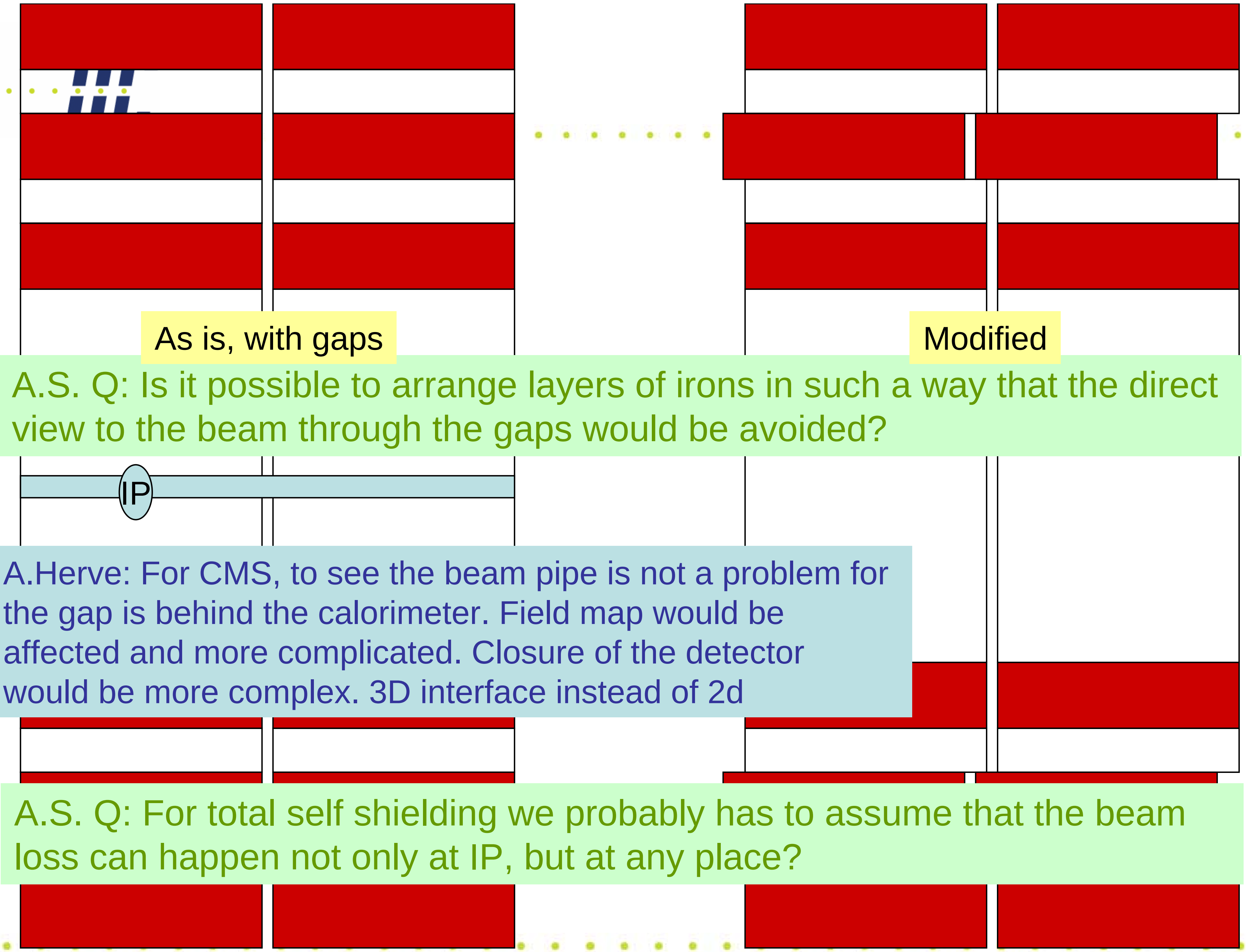
2006年9月19日

Surface assembly & self shielding



A.S: Is it possible to avoid the gaps between slices, in particular for cables, or at least avoid direct view to the beam through the gaps?

A.Herve: Minimum gaps are needed for cables and gas/cooling pipes. But gap do not point on IP



A.S. Q: Is it possible to arrange layers of irons in such a way that the direct view to the beam through the gaps would be avoided?

A.Herve: For CMS, to see the beam pipe is not a problem for the gap is behind the calorimeter. Field map would be affected and more complicated. Closure of the detector would be more complex. 3D interface instead of 2d

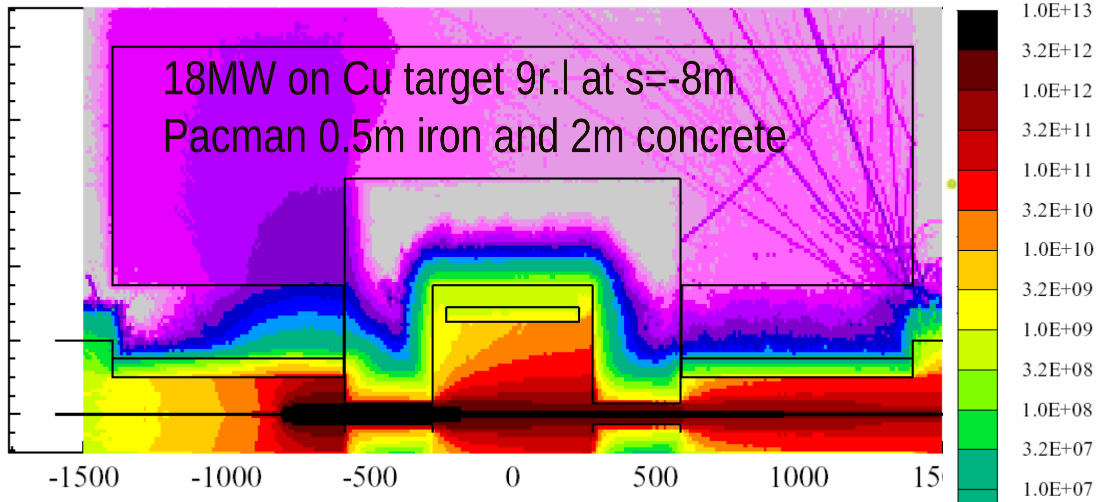
A.S. Q: For total self shielding we probably has to assume that the beam loss can happen not only at IP, but at any place?

Summary

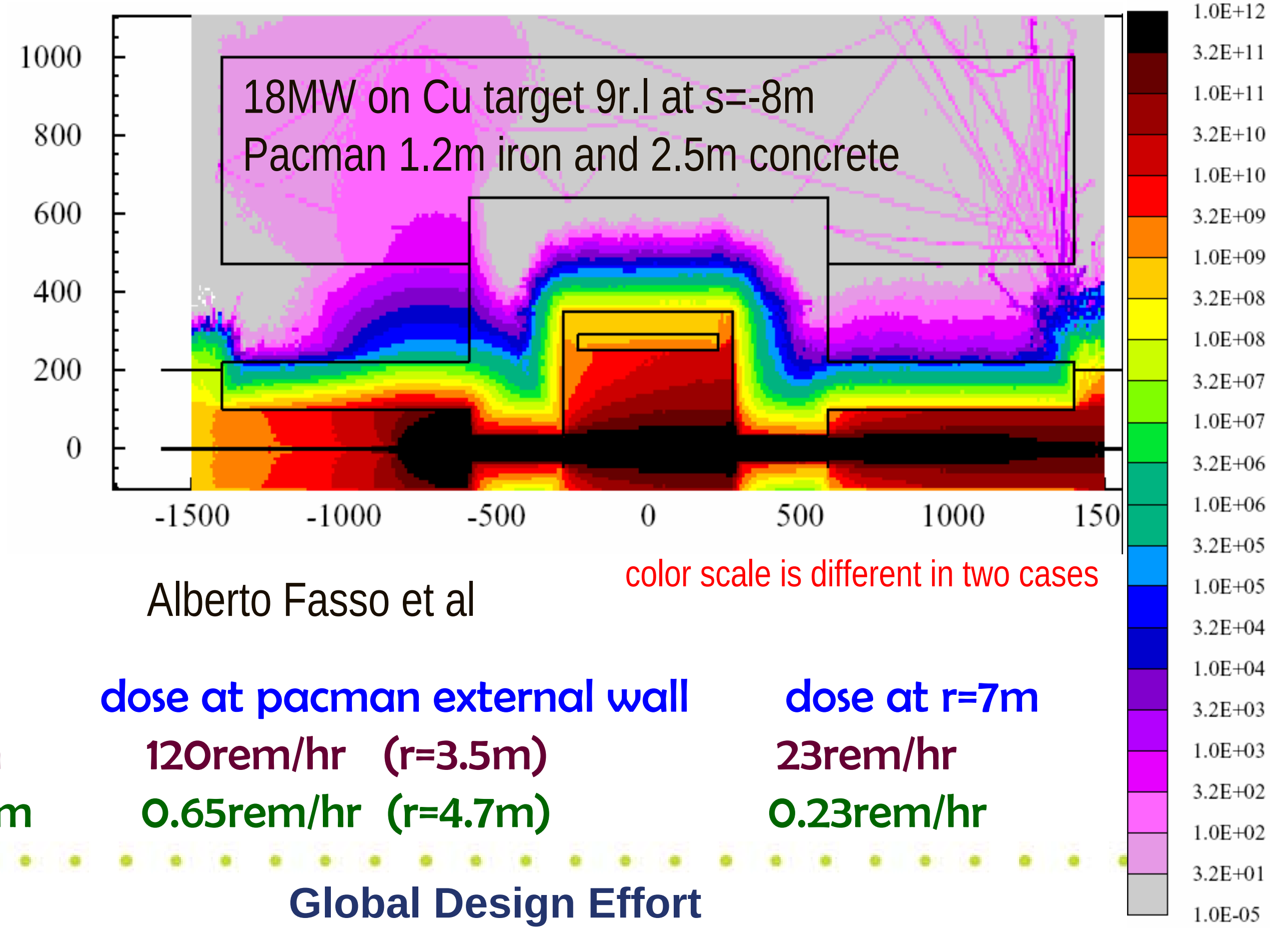
- Looking forward to discuss the issues of detector assembly, radiation safety design, IR hall arrangements, etc.

Backup slides

Self-shielding study



A proper beamline shielding can reduce the dose below 25rem/hr



Desired thickness is in between of these two cases

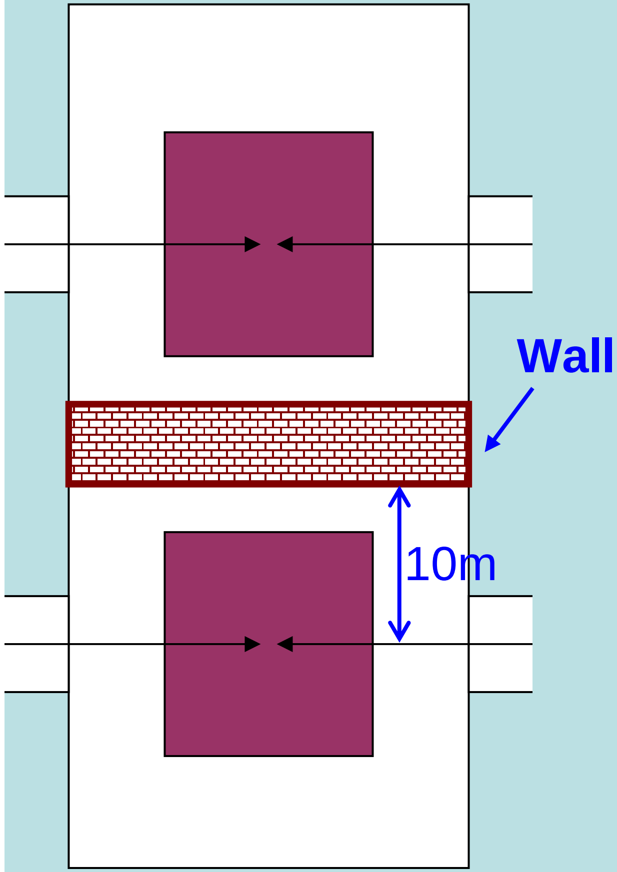
Alberto Fasso et al

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

If detector does not provide any radiation protection:

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



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