ILC Interaction regions : The GDE perspective

Talk based on several talks presented by BDS area leaders
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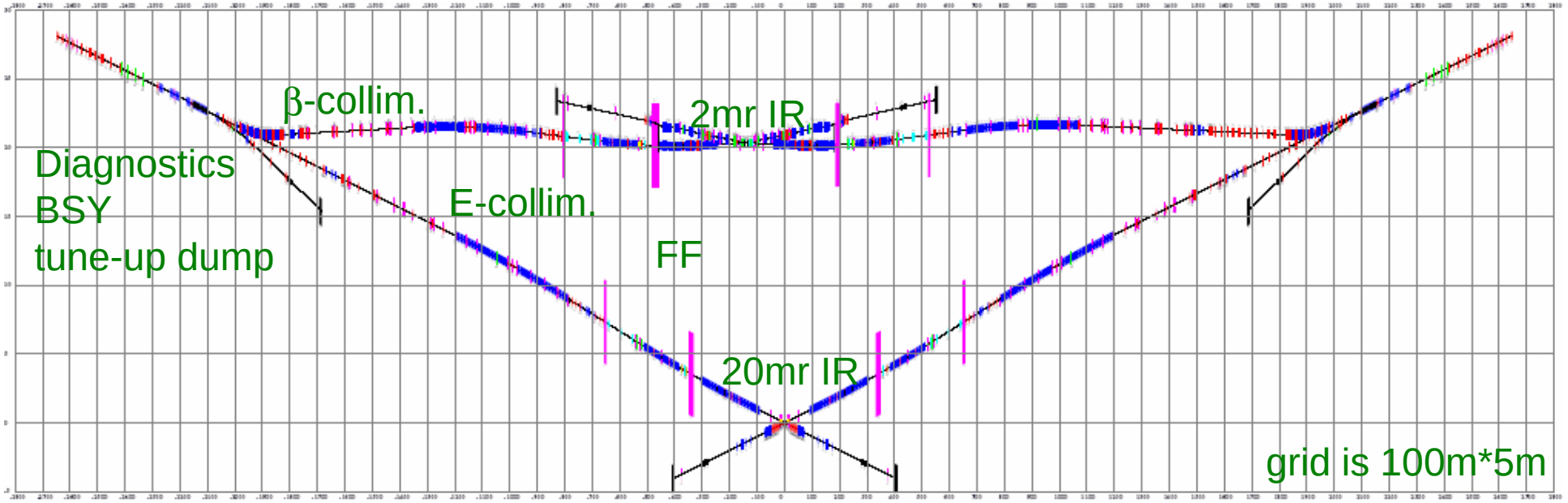
at and after Vancouver

Mini-Workshop on ILC Small angle interaction regions
Saclay, 20th October 2006

Vancouver baseline



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

Evaluation of baseline before Vancouver

- Evaluation of the differences between 20mrad and 2mrad IRs and extraction lines focused on
  - **study of physics reach**
  - **background conditions in IR**
  - **radiation conditions in extraction lines**
  - **performance of downstream diagnostics**
  - **technical feasibility of magnets**
  - **power consumption and cost**

Diagnostics requirements for physics

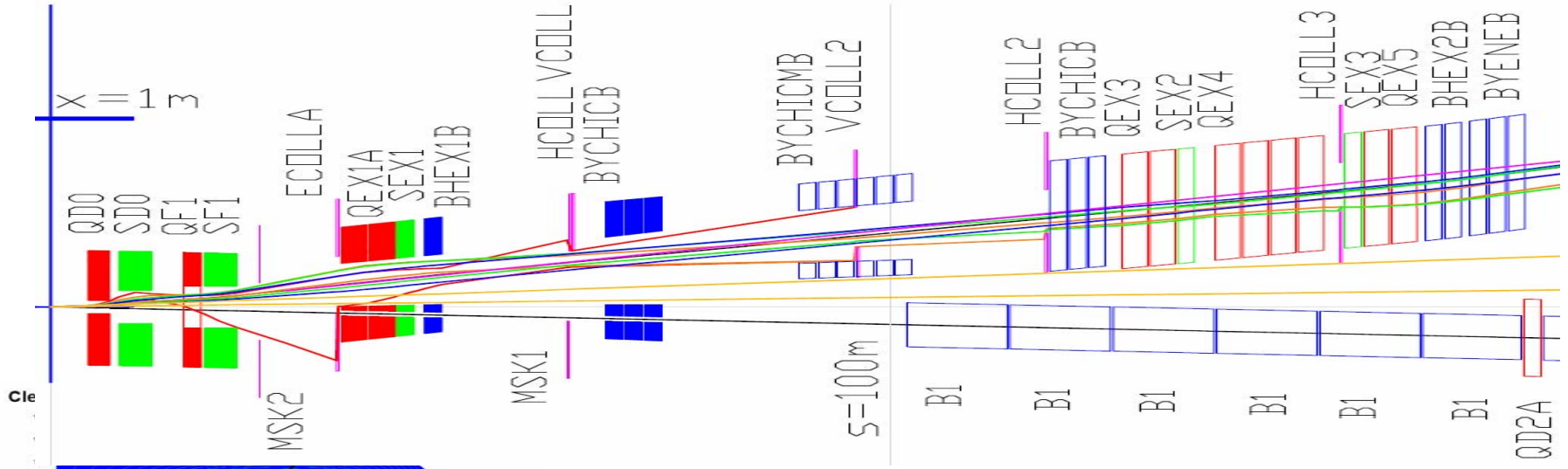
- Energy
  - **Uncertainty of 100 ppm on the absolute beam energy**
  - **relative pulse-to-pulse along the train at the 100 ppm level**
  - **use two independent and complimentary detectors: upstream is BPM based, downstream is synchrotron stripe based**
- Polarization
  - **Accuracy of 0.25% is needed**
  - **upstream and downstream polarimeters allow taking into account the depolarization due to collisions**
- Luminosity
  - **precision of 1e-3 using Bhabha rate at LUMICAL**

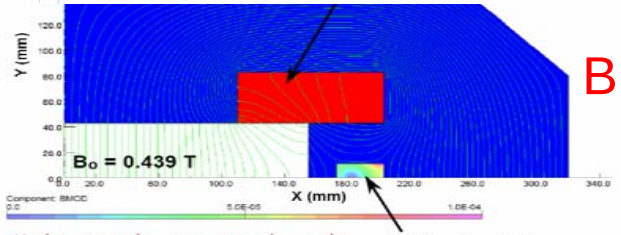
Downstream diagnostics evaluation

Comparisons for 250GeV/beam	20mr	2mr
Beam overlap with 100mm laser spot at Compton IP	48%	15%
Polarization projection at Compton IP	99.85%	99.85%
Beam loss form IP to Compton IP	<1E-7	>2.6E-4
Beam SR energy loss from IP to middle of energy chicane	119MeV	854MeV
Variation of SR energy loss due to 200nm X offset at IP	< 5MeV (< 20 ppm)	25.7MeV (~100 ppm)
The need for SR collimator at the Cherenkov detector	yes	No

comparable with the goal for E precision measurements

2 mrad extraction line magnets

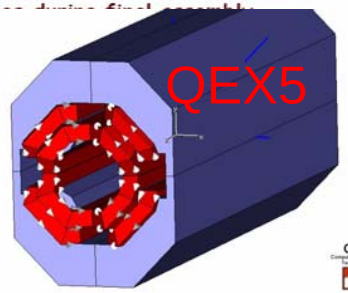


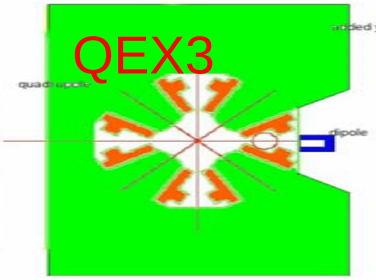


BHEX1

Make simple racetrack coils that go around poles and insert right/left cutouts with beam

|B| is about 1 gauss





- Large apertures, High fields, Photons passing nearby makes these magnet very challenging
- Power at 1TeV CM ~MW/magnet.
- Use of HTS? Pulsed magnets?

Kashikhin, Parker, Tompkins, Spencer, Kumada, Takano, Iwashita, Bondarchuk, Sugahara

Cost of different configurations:Vancouver

- The WBS includes counts, lengths, or cost fractions from different subsystems of BDS:

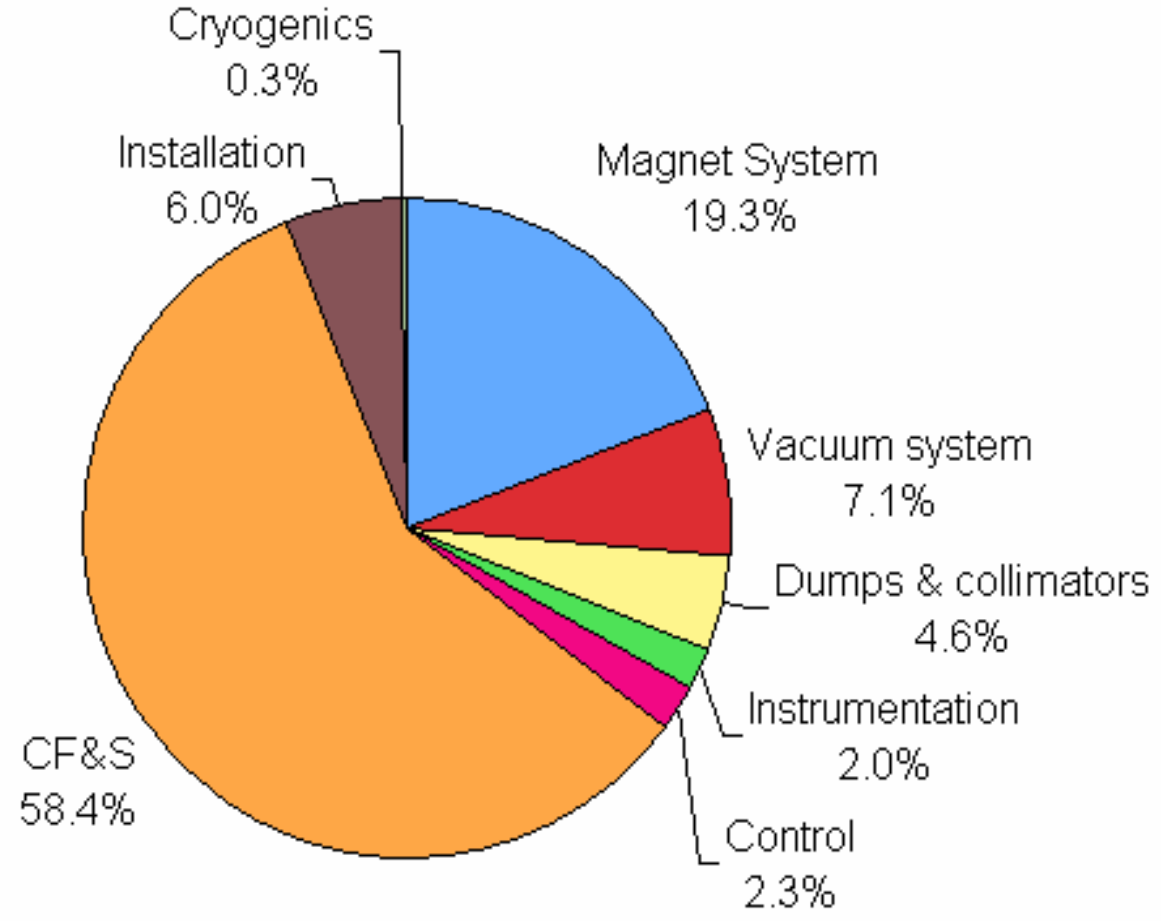
Example

				comm				spec			large			small			total	IR20	IR2
WBS	Description			BSY1	BSY2	BSYD		IRT1	IRT2		FF1	DL1		FF2	DL2				
1.6	BDS																		
		1.6.1.1	D166L1000	0	0	0	0	0	0	0	0	12	12	0	0	0	12	12	0
		1.6.1.2	D166L2000	0	0	0	0	0	0	0	0	16	16	0	0	0	16	16	0
		1.6.1.3	D20L12000	0	0	0	0	0	0	0	60	0	60	60	0	60	120	60	60

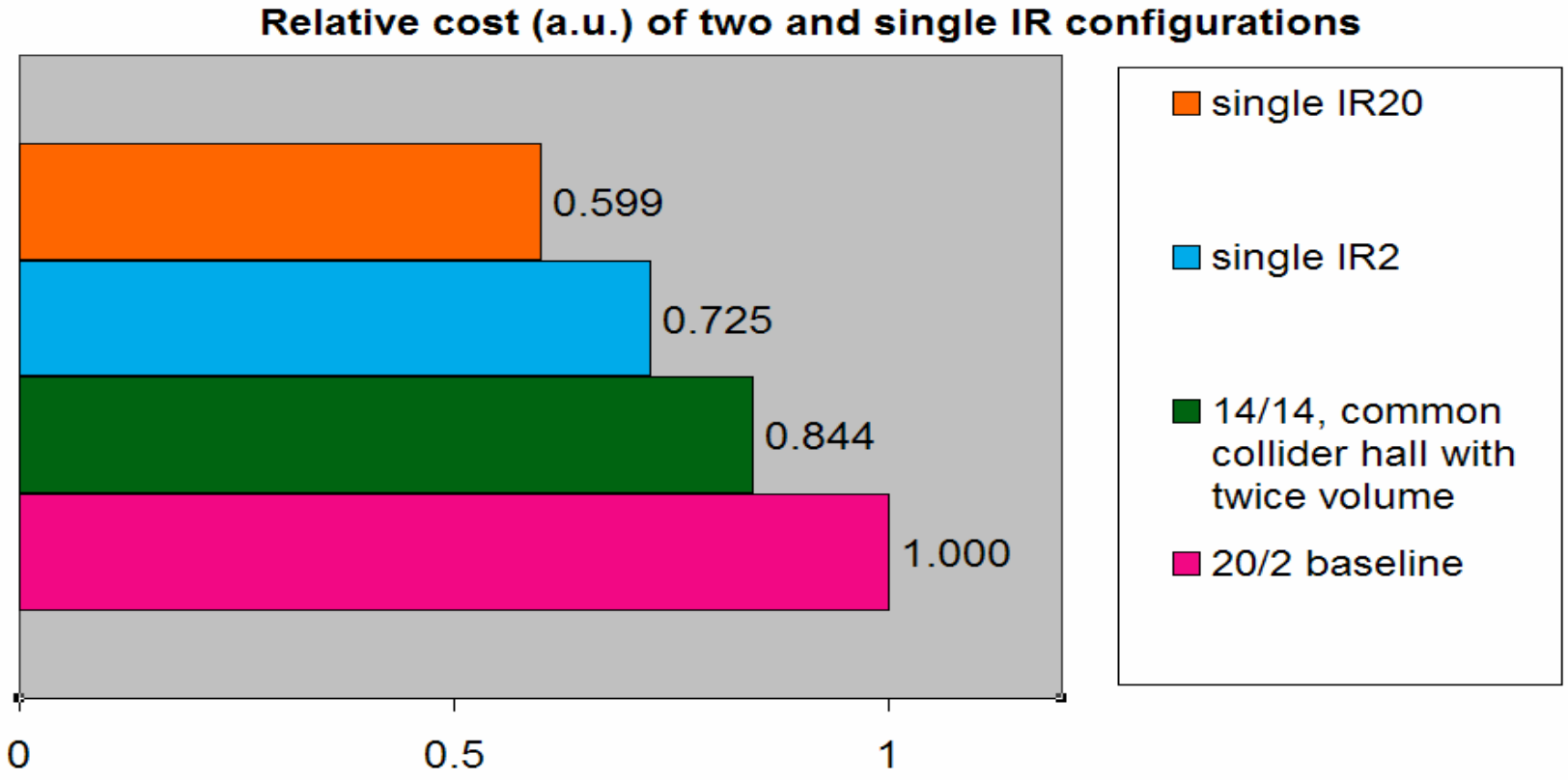
- WBS has ~240 input lines * 39columns not including the sub-WBSs
- This allows calculating the total cost and also the common cost, additional cost for 20mrad IR and additional cost for 2mrad IR

Drivers of the 2/20 baseline cost at Vancouver

- Cost drivers
  - **CF&S**
  - **Magnet system**
  - **Vacuum system**
  - **Installation**
  - **Dumps & Colls.**
- Drivers of splits between 20/2:
  - **CF&S**
  - **Magnet system**
  - **Vacuum system**
  - **Dumps & collimators**
  - **Installation; Controls (includes crab cavity)**

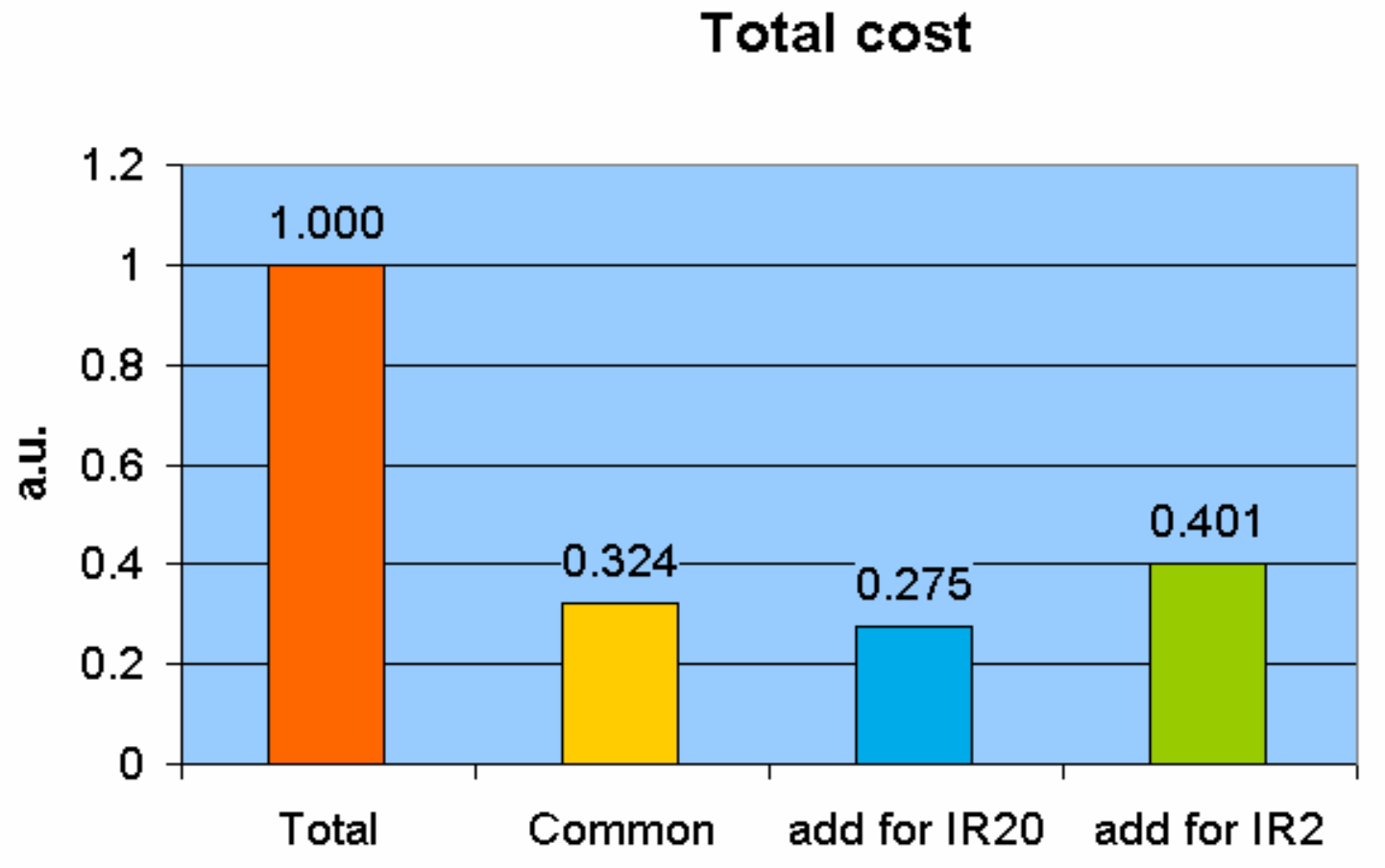


Comparison shown at Vancouver BDS talk



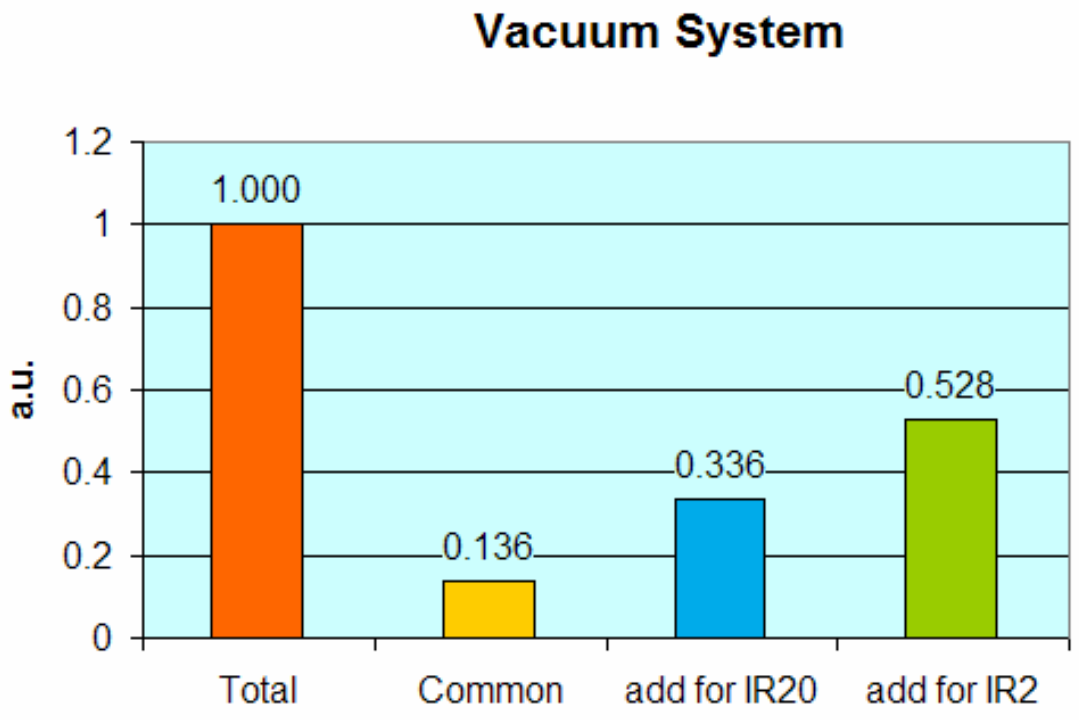
- If the baseline normalized to 1.0, the CC to 14/14 reduces the cost by 15.6%

Cost split -Vancouver



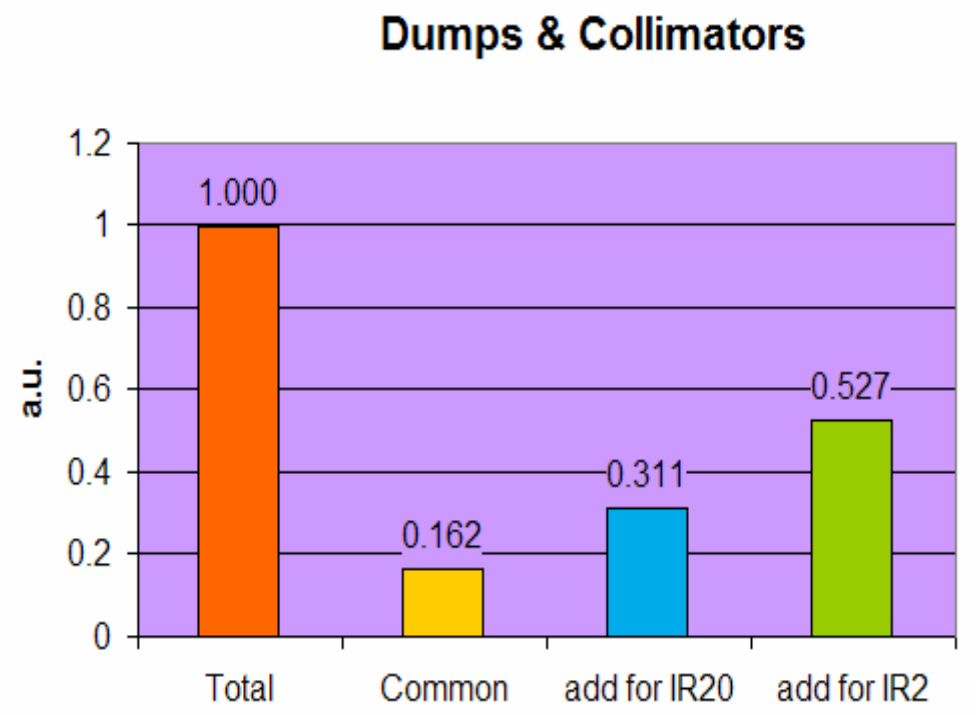
Additional costs for IR20 and IR2 are different (their ratio is ~1.5)

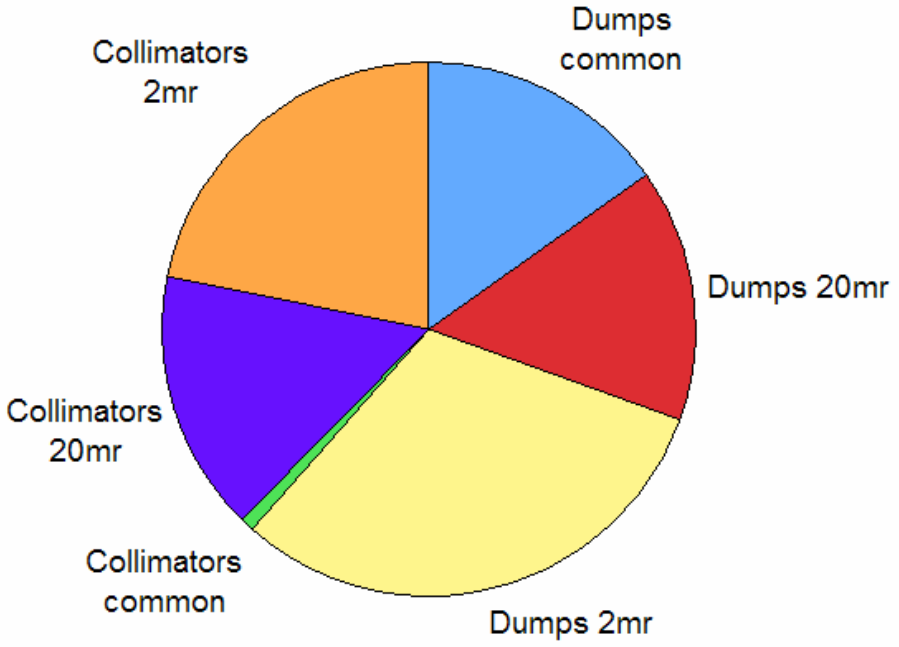
Vacuum system: BDS 20/2



Chambers of longer 2mr extraction line and additional chamber for beamstrahlung photons cause the cost difference

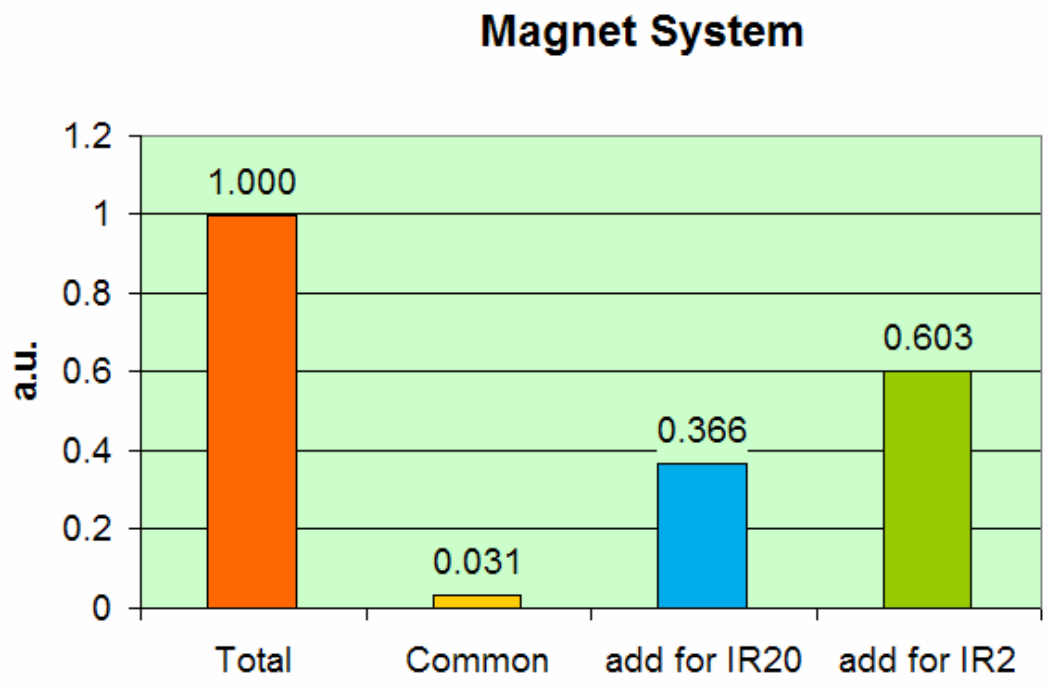
Dumps & collimators: BDS 20/2

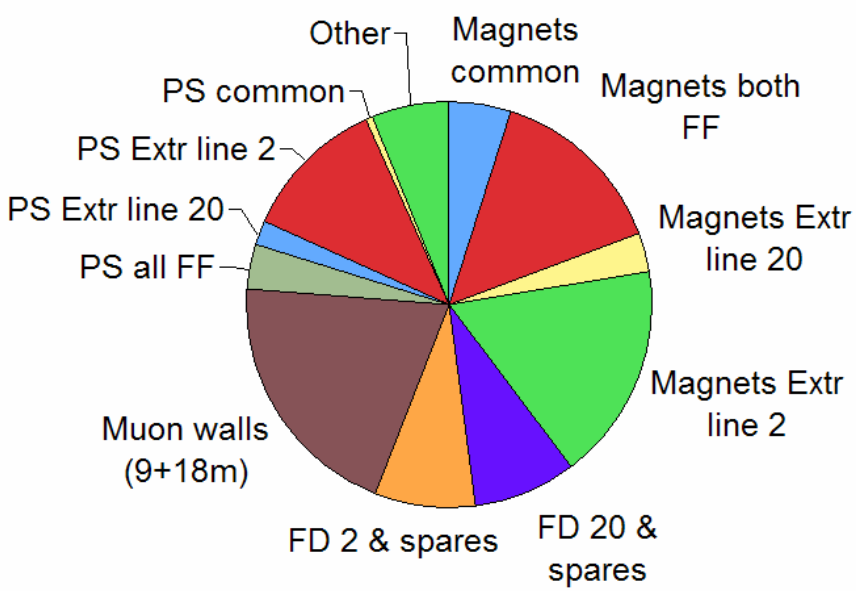




Larger number of collimators in 2mrad extraction line and additional photon dump cause the difference

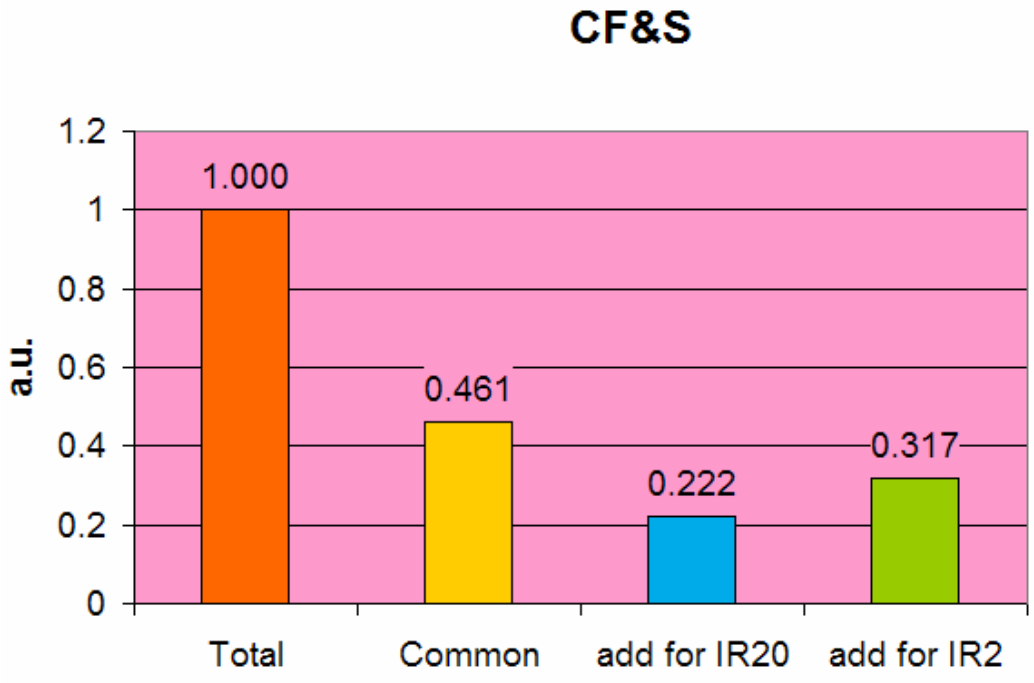
Magnet system: BDS 20/2

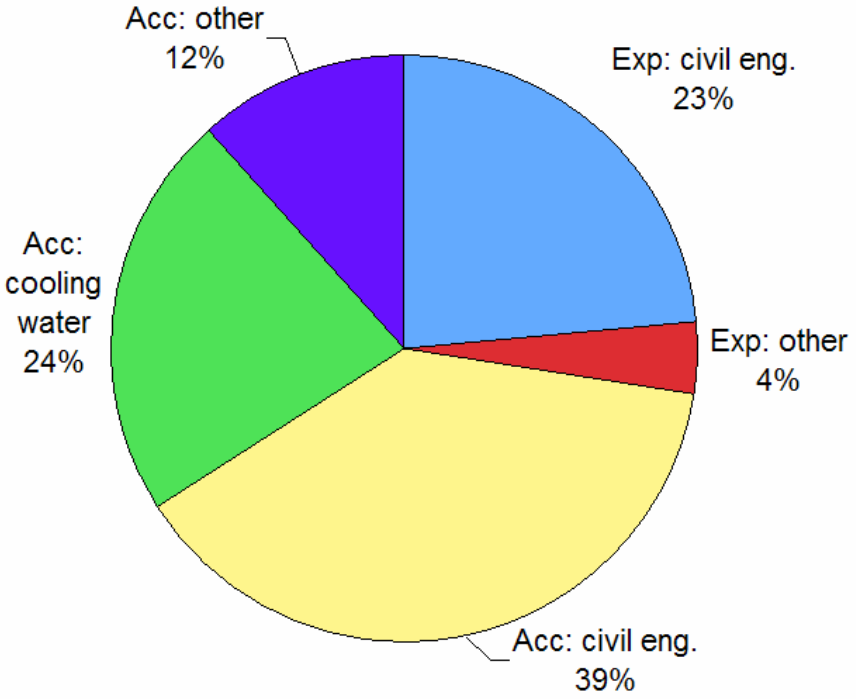




Larger number of huge extraction line magnets, and its power supplies (PS) cause the cost difference

CF&S: BDS 20/2

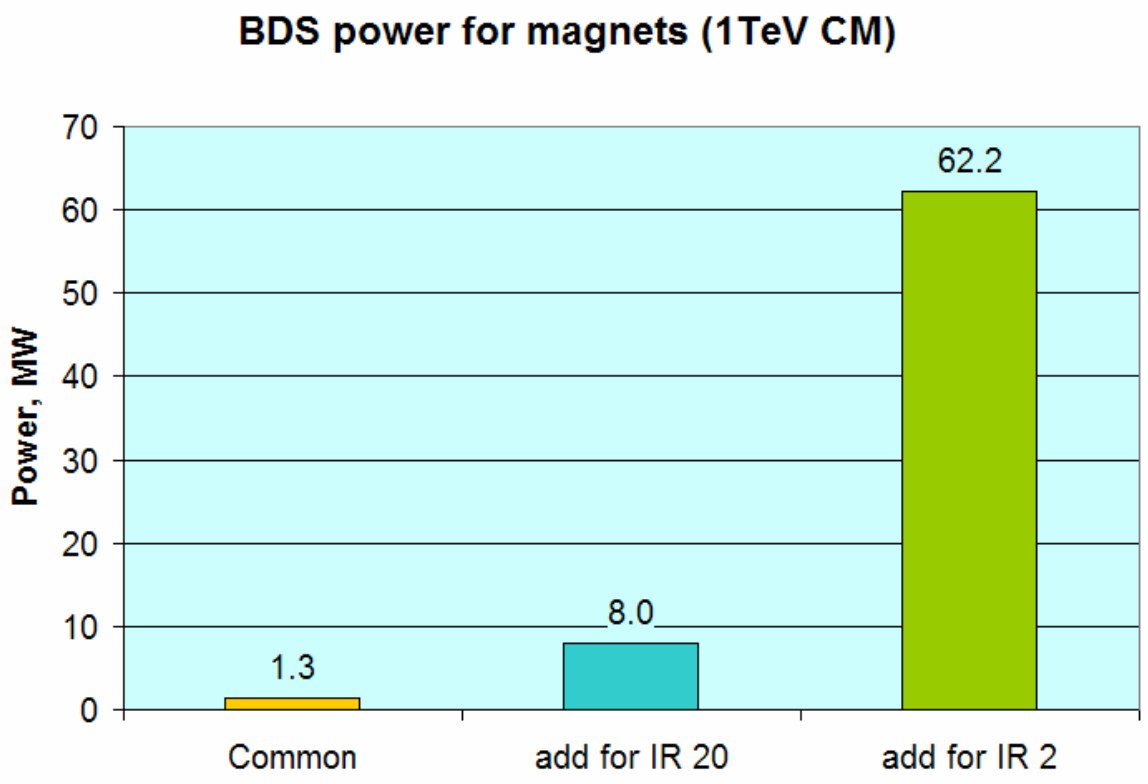




The common fraction is quite large. The difference come from beam dump halls and mostly (~90%) from cooling water

Power for magnets

Data as of Vancouver:



Larger number of big extraction line magnets, and its power supplies (PS) cause the cost difference, and also increase operation cost

Larger power => larger cooling requirements => larger Δcost of CF&S

At Vancouver

- Discussion of 20/2 baseline situation
  - **by BDS area leaders**
  - **with present colleagues from BDS group**
  - **with MDI panel**
  - **with WWS organizing committee**
  - **with EC and GDE director**
- 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
  - **Design & cost of 14/14 with common collider hall & z=0**

Cost adjustments for 14/14

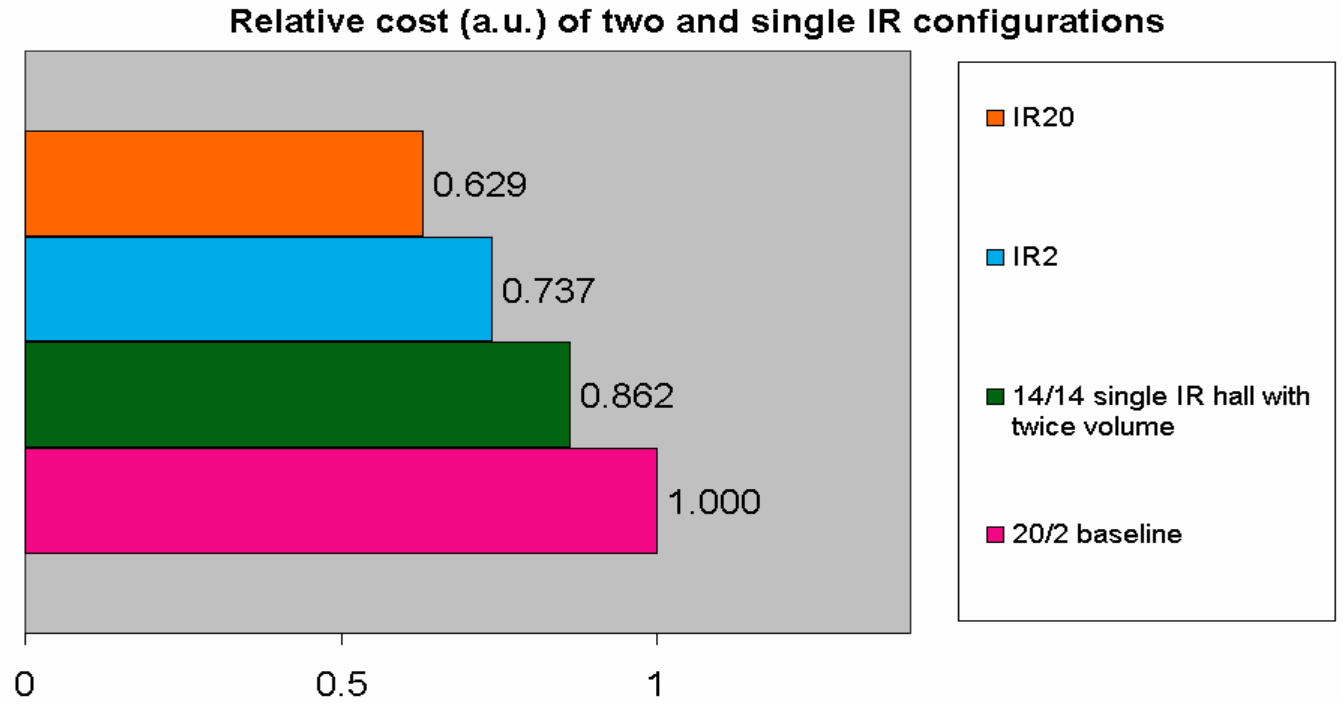
- Design of 14mr beamline is almost the same as for 20mrad
- Adjustments were estimated and included for 14/14mrad cost in wbs_1.6 to take into account:
  - **removed stretches in optics**
  - **shorter (~11mr/14mr) tapered tunnels**
  - **remove one surface building**
  - **savings due to common hall (but volume still twice the single volume)**
  - **add cost of 42% more gradient bends (for 14mrad bend), their PS, BPMs, movers, etc**
- These adjustments accounted for additional ~2% cost reduction

After Vancouver

- CCR for 14/14 configuration with single collider hall was submitted by the area leaders. Following many discussions the CCR was accepted by CCB, EC, MDI panel and WWS.

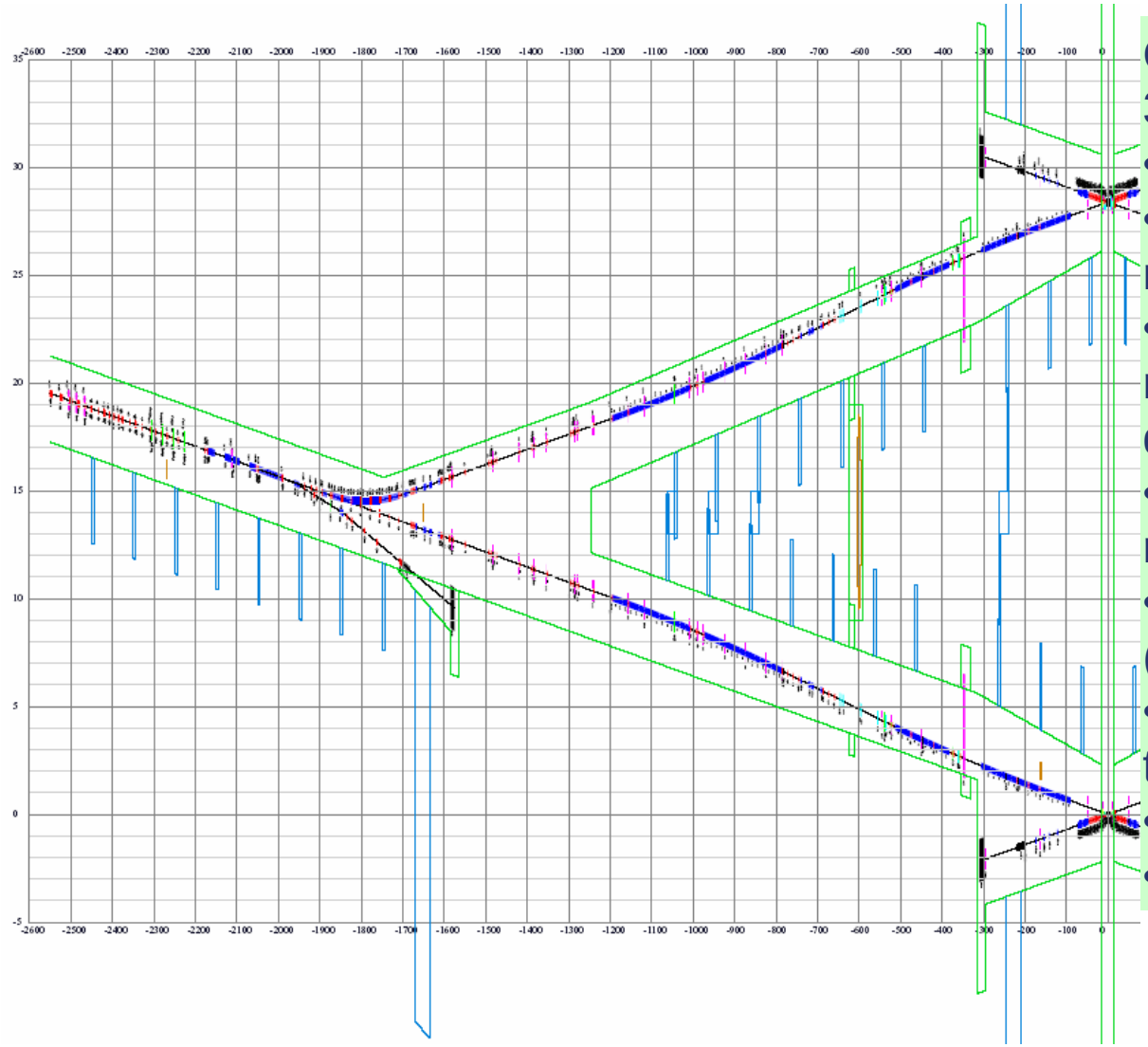
- *Minutes from MDI panel : "With this limited information (slepton search and studies on 14 mrad with anti-DID) , the MDI panel thinks that the 14mrad is acceptable as the baseline at this time. However, we would like to stress that the 2mrad crossing angle is clearly desirable than larger crossing angles for the slepton search, and R&Ds related to 2mrad should be encouraged"*

After Vancouver Updated WBS



- Included all new items missing from the Vancouver WBS
  - **Cost of kickers, sweepers & septa and antisolenoids**
  - **Updated cooling water cost with new power numbers**
  - **Updated warm magnets & PS cost**
  - **Corrected the cost of crab cavity**
  - **Added costs of missed magnets (wigglers in diagnostics)**

Tentative layout of 14/14 configuration

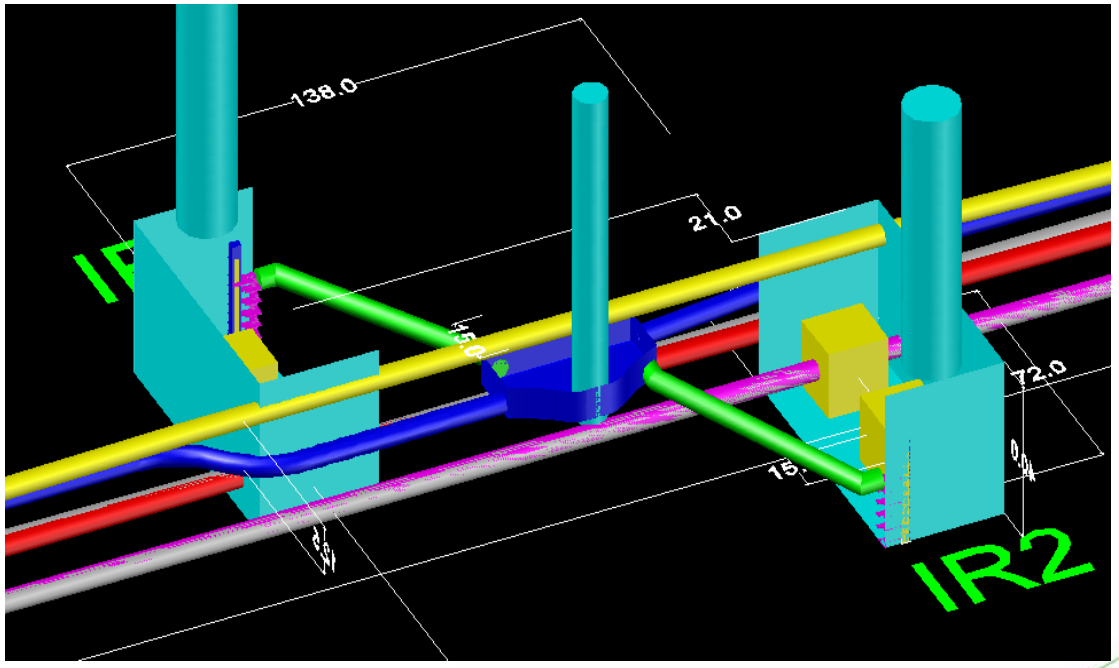


Common IR hall ~100m (L) x 30m (W) at z=0 with 28.4m ΔX
- 4m tunnels in all BDS
- Alcoves 4*6m every 100m, no service tunnel
- Small 0.8m shaft for lasers near laser wire, upstream and downstream diagnostics
- Long muon walls (9m & 18m) replaced by single 5m wall
- Passages near muon walls (main and spare one)
- 9m machine access shaft in the “BDS triangle”
- Shortened extraction line
- Shorter tapered tunnels

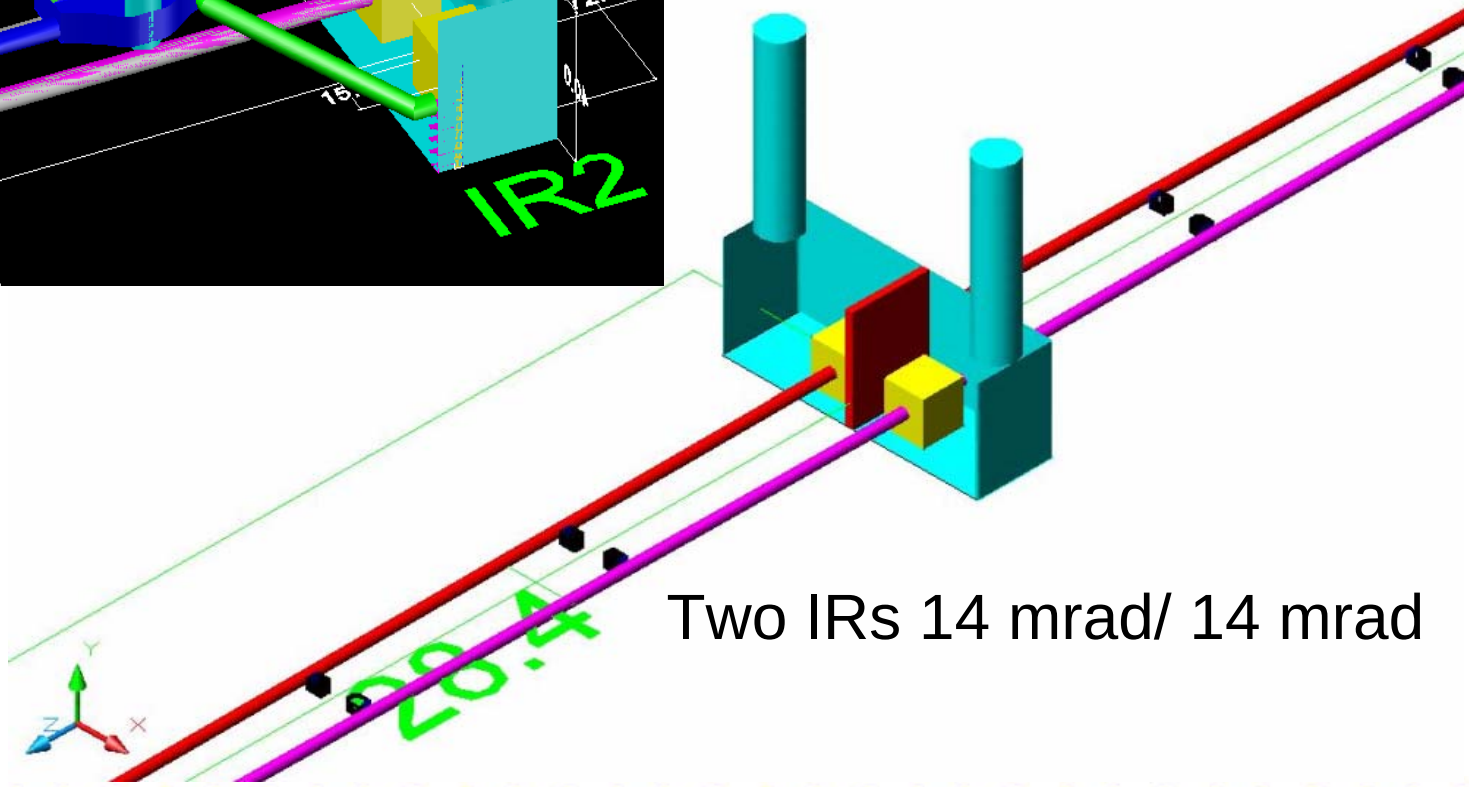
Cost reduction

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

CF&S conceptual layout



Two IRs 20 mrad and
2 mrad



Two IRs 14 mrad/ 14 mrad

Other proposed changes…..

- Reduced parameter space
  - **Significant cost savings in low Power design**
- Centralised damping rings
- No service tunnel, alcoves?
  - **Temperature for beamline stability, set a goal of <100W/m deposition into the tunnel (like in best light sources)**
- Surface assembly for the detectors → collider hall size, detector assembly procedure, crane, shaft,radiation shielding requirements.
- Reduced muon walls thickness
- BDS – curved paths upto1 TeV and straight lines for 500 GeV.
- BDS tunnel diameter?

Possibility of 1 IR and push-pull detectors

- GDE has initiated studies related to evaluation of feasibility of push-pull configurations of two detectors.
- Study plan includes to address :
  - **Organisational questions**
  - **Accelerator design questions**
  - **Detector design questions**
  - **Engineering integration questions**
- There will be detailed discussion on this topic at Valencia to get feedback from WWS and MDI.