MDI Questions to the Detector Concepts

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LDC: Answers to MDI Questions

The LDC* concept group

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Abstract

In this document we summarize first answers to the questions posed by the ILC world-wide study group to the detector concepts on MDI issues. The questions collected in this document reflect the state of knowledge within the LDC community at the time before snowmass.

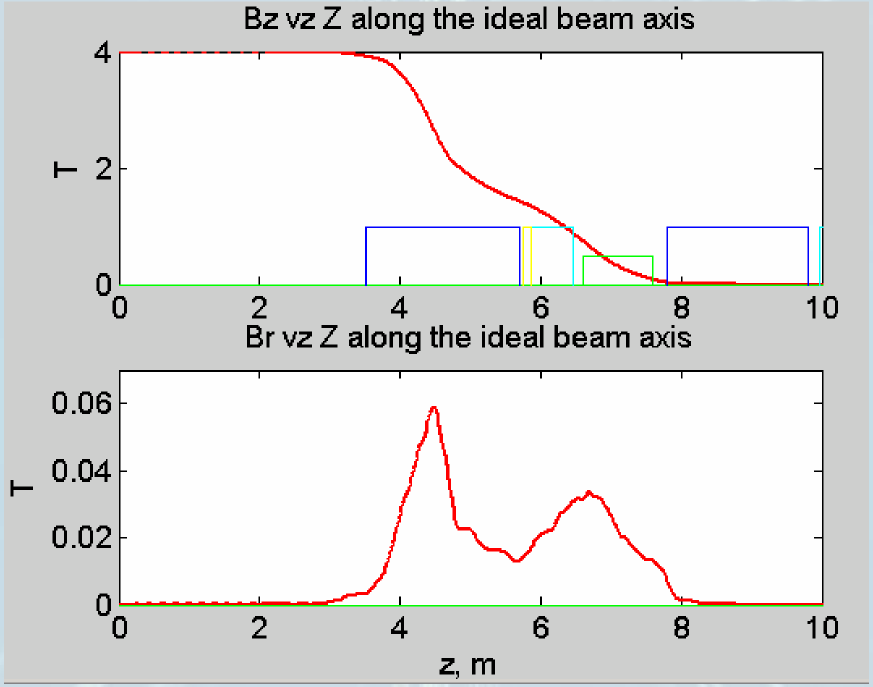
LDC answers to MDI questions of the worldwide study

Latest draft available at http://www.ilcldc.org

Question 1

1. What factors determine the strength and shape of the magnetic field in your detector? Give a map of the field, at least on one axis, covering the region up to +- 20 m from the IP. What flexibility do you have to vary the parameters of this field map?

Field map of the TESLA detector coil



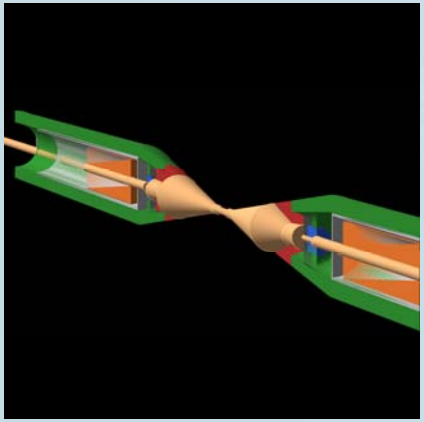
What are the requirements on the field (tracking)?
What flexibility do we have (requirements and realisation)?

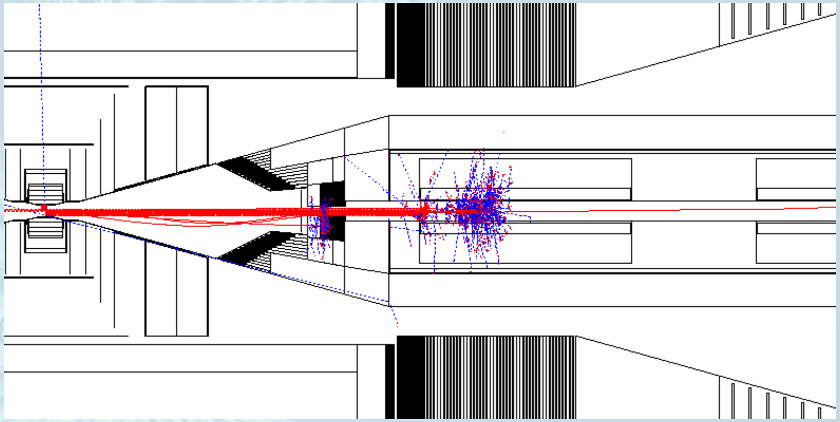
Question 2

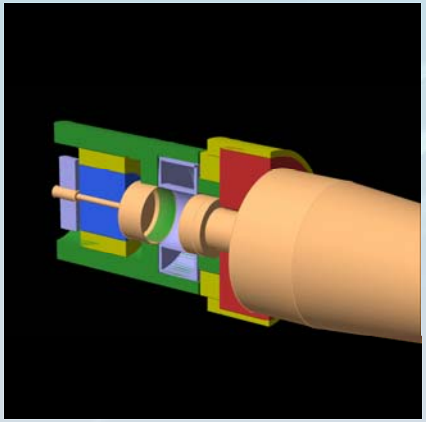
2. Provide a GEANT (or equivalent) geometry description of the detector components within 10 metres in z of the IP and within a radial distance of 50cm from the beam pipe.

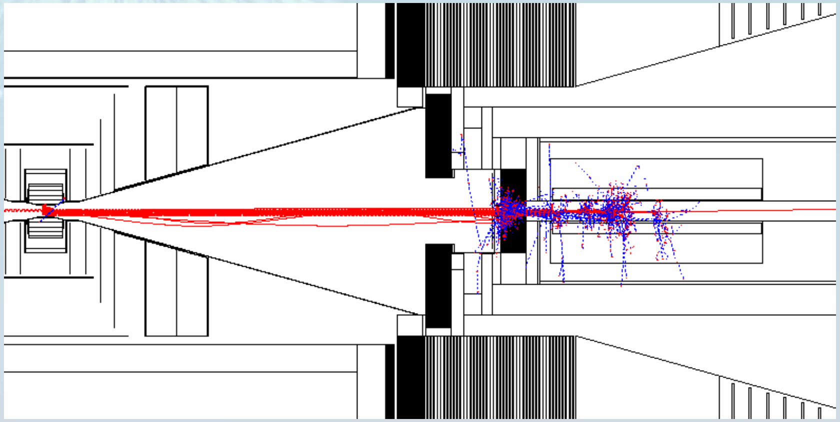
Question 2: Answered

Exist for abs(z) < ~5m in Geant4 and Geant3 for different crossing angles (0, 2, 20 mrad).









Question 3

3. Would you mind if the baseline bunch-spacing goes to ~150 ns instead of ~300 ns with ~1/2 the standard luminosity per crossing and twice as many bunches?

Question 3: Answered

- No strong reason why 150 ns should be significantly worse than 300 ns
- Careful attention to the number of integrated events per sub detector
- Assuming that backgrounds etc. scale with luminosity, the total occupancy of the detectors should not change
- Time resolution in detectors (e.g. TPC) is sufficient to separate bunches

Question 4

4. For each of your critical sub-detectors, what is the upper limit you can tolerate on the background hit rate per unit area per unit time (or per bunch)? Which kind of background is worst for each of these subdetectors (SR, pairs, neutrons, muons, hadrons)?

Question 4: Partially Answered

- For some subdetectors quite detailed numbers exist: e.g. occupancies on CCD vertex detector
- For most of the other detectors I am not aware of detailed numbers
- Some ongoing work: e.g. Adrian Vogel is looking into the neutron backgrounds for the TPC

- We should start an effort here to collect the numbers and put them into tables
- We should identify open tasks and should see on which timescale reliable answers could be provided

- We always assumed that the uncertainty in the background numbers could be high and that the subdetectors should be able to absorb substantially more background. So the question is now, whether it makes sense to give ‘quasi-precise’ numbers here?

Question 5

5. Can the detector tolerate the background conditions for the ILC parameter sets described in Feb 28, 2005 document? Please answer for both 2-mrad and 20-mrad crossing angle geometries. If the high luminosity parameter set poses difficulties, can the detector design be modified so that the gain in luminosity offsets the reduction in detector precision?

ILC Parameter Sets

		nom	low N	lrg Y	low P	High L
N	$\times 10^{10}$	2	1	2	2	2
n_b		2820	5640	2820	1330	2820
$\varepsilon_{x,y}$	μm, nm	9.6, 40	10,30	12,80	10,35	10,30
$\beta_{x,y}$	cm, mm	2, 0.4	1.2, 0.2	1, 0.4	1, 0.2	1, 0.2
$\sigma_{x,y}$	nm	543, 5.7	495, 3.5	495, 8	452, 3.8	452, 3.5
D_y		18.5	10	28.6	27	22
δ_{BS}	%	2.2	1.8	2.4	5.7	7
σ_z	μm	300	150	500	200	150
P_{beam}	MW	11	11	11	5.3	11
L	$\times 10^{34}$	2	2	2	2	4.9!

Question 5: Partially Answered

- All background simulations for the LDC (i.e. TESLA) detector have been performed using TESLA nominal or quasi-realistic bunches
- In the ILC nominal parameter set the luminosity is lower than at TESLA, so at least pair induced backgrounds are lower

- Background simulations for all the parameter sets can be done, but:
  - Detailed study of detector backgrounds for the ILC parameter sets is time consuming: 5 parameter sets x 2 energies x 2 crossing angles x some BX for each detector configuration!

- Second part of the question can only be answered after we know about the background conditions in the high lumi set

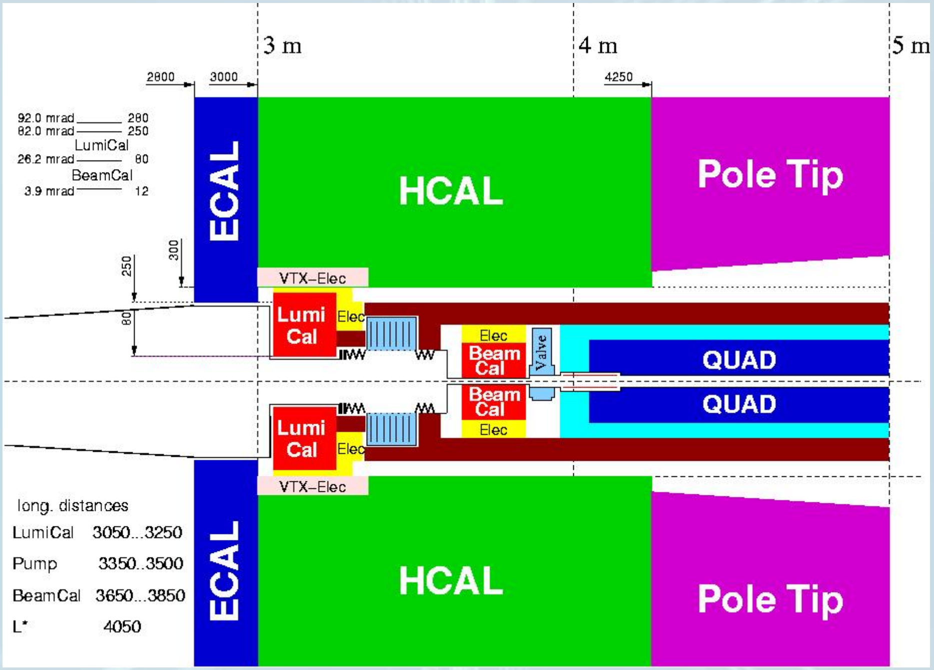
- Work has started to evaluate the ILC parameter sets, expect results after Snowmass

Question 6

6. What is your preferred L*? Can you work with 3.5m<L*<4.5m? Please explain your answer.

Question 6: Answered

- The TDR design foresaw L*=3m.
- The Achim Stahl forward region design required L*≥4.05m



- New developments in the background simulations may require other L*s.

Question 7

7. What are your preferred values for the microvertex inner radius and length? If the predicted backgrounds were to become lower, would you consider a lower radius, or a longer inner layer? If predicted backgrounds became higher, what would be lost by going to a larger radius, shorter length?

Question 7: Partially Answered

- Current value (r=1.55 cm) was obtained by optimising physics requirements (e.g. charm tagging) and machine constraints (pair backgrounds).
- Physics case is currently being re-visited, in particular under the new aspects of charge reconstruction of heavy flavour states.
  - → S. Hillerts talk from this morning
- Machine constraints will need to be restated once the ILC interaction region design (crossing angles, etc.) and ILC parameter sets have been finalised.

Question 8

8. Are you happy that only 20 mrad and 2 mrad crossing angles are being studied seriously at the moment? Are you willing to treat them equally as possibilities for your detector concept?

Question 8: Answered

- The two proposed schemes (2 mrad and 20 mrad) seem a good starting point
- Good coverage of the range of problems found in a small and a large crossing angle regime
- We feel however that we should reserve to option to re-visit the chosen crossing angles as more results on backgrounds, impact on physics, and impacts on machine designs are better understood.
- LDC is currently studying both options.

Question 9

9. Is a 2 mrad crossing angle sufficiently small that it does not significantly degrade your ability to do physics analysis, when compared with head-on collisions?

Question 9: Answered

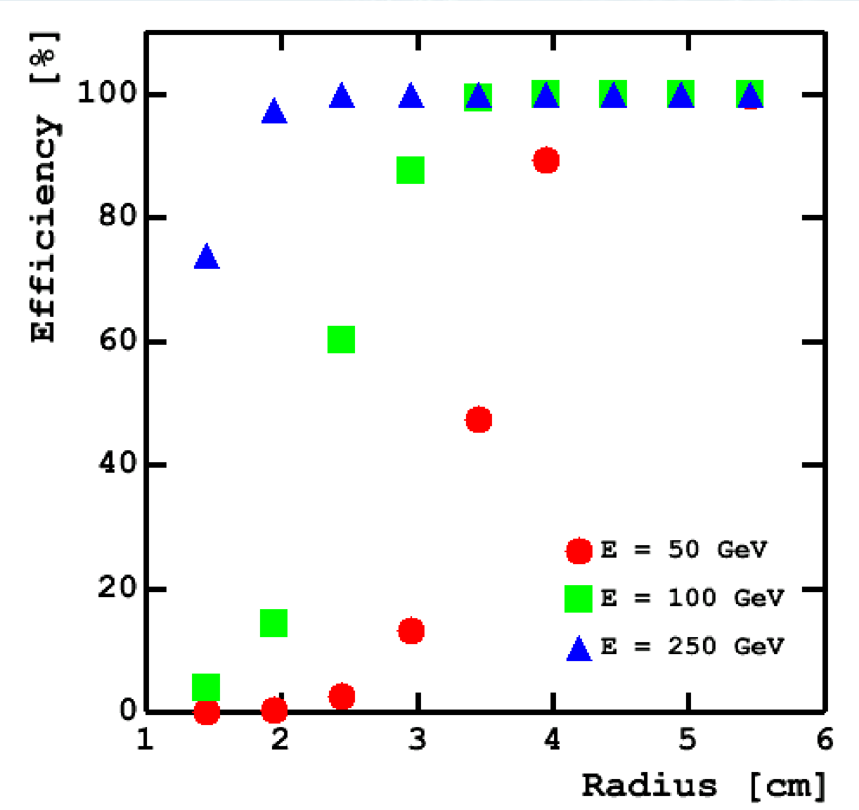
- ITRP studies indicate that small crossing angle has no strong impact on physics
- Maybe an effect on the instrumentation of the forward region?

Question 10

10. What minimum veto and/or electron-tagging angle do you expect to use for high energy electrons? How would that choice be affected by the crossing angle? How does the efficiency vary in polar angle in each case?

Question 10: Partially Answered

- Experts in the Forward Calorimeter Collaboration (Lohmann et al.) are working on this:



- Studies for crossing angle geometries are under way.

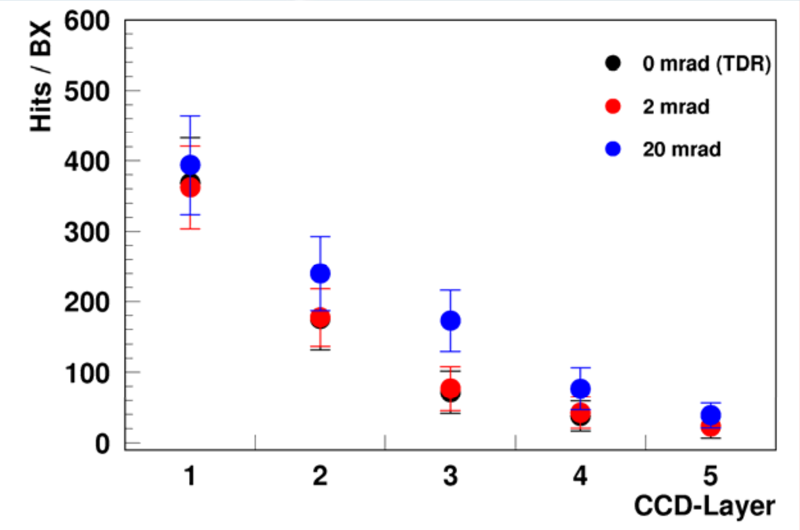
Question 11

11. What do you anticipate the difference will be in the background rates at your detector for 20 mrad and for 2 mrad crossing angle? Give your estimated rate in each case.

Pair Background

Vertex Detector:

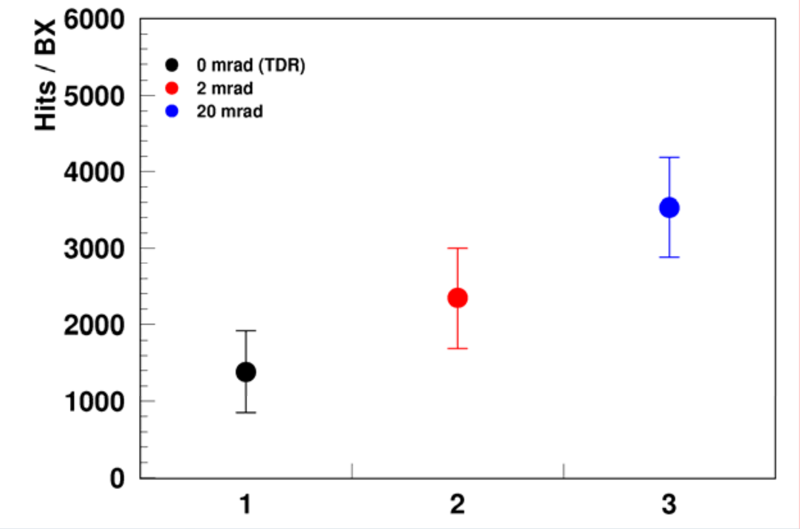
• 20 mrad: backscattering out of the BeamCal holes produces more hits and asymmetries in layers 2-4



TPC:

• 2 mrad: factor of 2 more hits than in TDR geometries: geometrical (L*) effect

• 20 mrad: another factor of 2: more deposited energy on the BeamCal results in more backscattering



Question 11 cont.

- What about other background sources?
- Detailed studies on the LDC (TESLA) detector:
  - Neutrons in the detector → under study (A. Vogel)
- Other backgrounds studied w/o full LDC detector simulation:
  - Synchrotron Radiation → under study, extraction line WGs
  - Muons → under study (BDIR WG)
  - Hadrons → have been studied, seem not to be an issue

- Warning: we might miss background sources
- Second warning: changing detector geometries could change results significantly

Question 12

12. What is your preliminary evaluation of the impact local solenoid compensation inside the detector volume, as needed with a 20 mrad crossing angle, on the performance of tracking detectors?

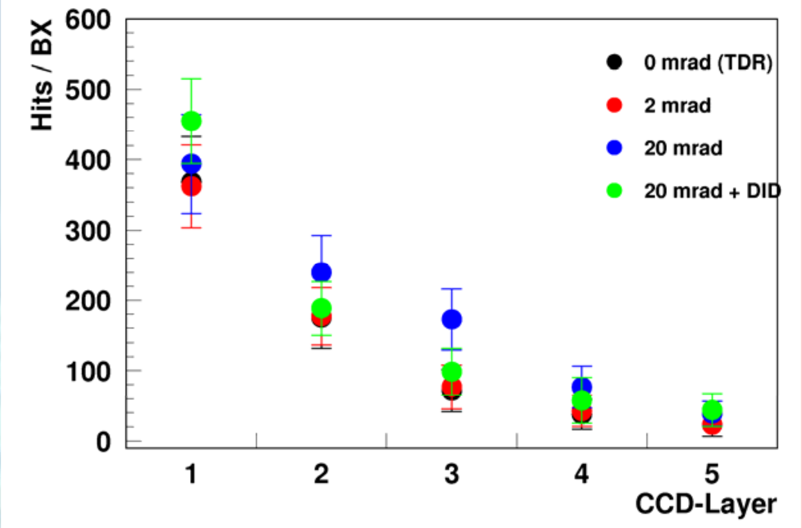
I have a partial answer, focused on the background situation

Question 12: Partially Answered

Pair Background

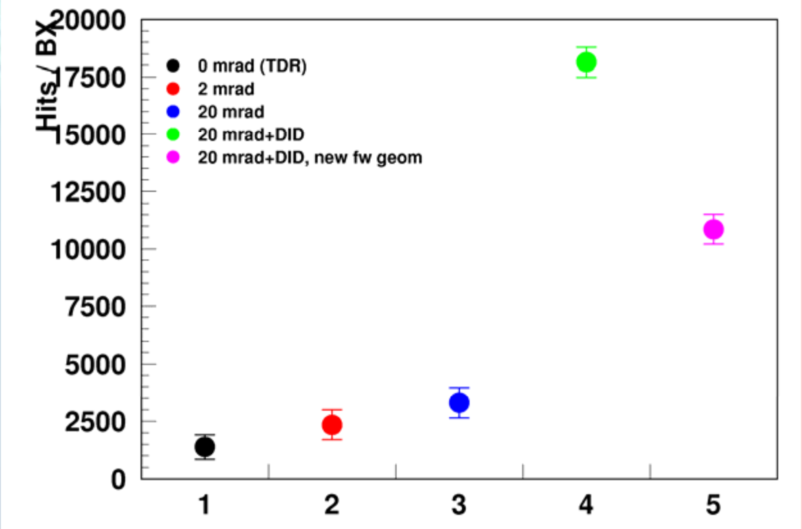
Vertex Detector:

- DID guides charged particles into the inner VTX layer; small effect, but potentially dangerous



TPC:

- DID increases TPC hits by a factor of 5 in present forward region geometries



Question 13: Partially Answered

13. Similarly, what is your preliminary evaluation of the impact of compensation by anti-solenoids mounted close to the first quadrupole?

- We need detailed field maps for all the overlapping fields now: solenoid, DID, compensating solenoids, quadrupoles. Simulations should be straight-forward then.
- What about the mechanical constraints, anti-solenoids produce some 15 tons of force on the mask.

Question 14: Answered

14. Do you anticipate a need for both upstream and downstream polarimetry and spectrometry? What should be their precision, and what will the effect of 2 or 20 mrad crossing angle be upon their performance?

- The question should be answered in common by all concepts. The POWER group is probably the correct contact for this.

Question 15

15. Is Z-pole calibration data needed? If so, how frequently and how much? What solenoid field would be used for Z-pole calibration? Are beam energy or polarisation measurements needed for Z-pole calibration?

Question 15: Partially Answered

- Z-pole data is very useful for detector calibration
- No detailed study exists, but taking into account LEP experience and folding in the increased detector granularities and requirements we anticipate:
  - one run with 10 pb^{-1} at the beginning of the year
  - additionally ≈1 pb^{-1} per year
- Larger data samples might be needed at ILC start to establish base calibration
- Other means of calibration (Z or WW events) might be possible, detailed studies are needed.

Question 16

16. Would you like the e-e- option to be included in the baseline, and if so what minimum integrated luminosity would you want?

- We feel that e-e- shoud be included as an option, but not be considered as the basline (scope document)

Question 17: Answered

17. What will be your detector assembly procedure?

- Described in detail in the TESLA TDR (N. Meyners, K. Sinram)
- Updated for new forward region design in LC-DET-2004-034
- Comment: depends on how the geometry of the detector evolves!

Question 18: Answered

18. What size is required for the detector hall?

- See TESLA TDR.

The LDC MDI Question Matrix

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Answered		●	●			●		●	●					●		●	●	●
Partially answered, but needs more work	●			●	●		●			●	●	●	●		●			