dapnia

cea saclay

Modelisation of the ILC Interaction Region, and Magnets studies

I: ILC IR

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II: ILD Solenoid

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III: Nb3Sn Quadrupole

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EUROTeV Meeting

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ILC IR: 0 and 14 mrad crossing angle

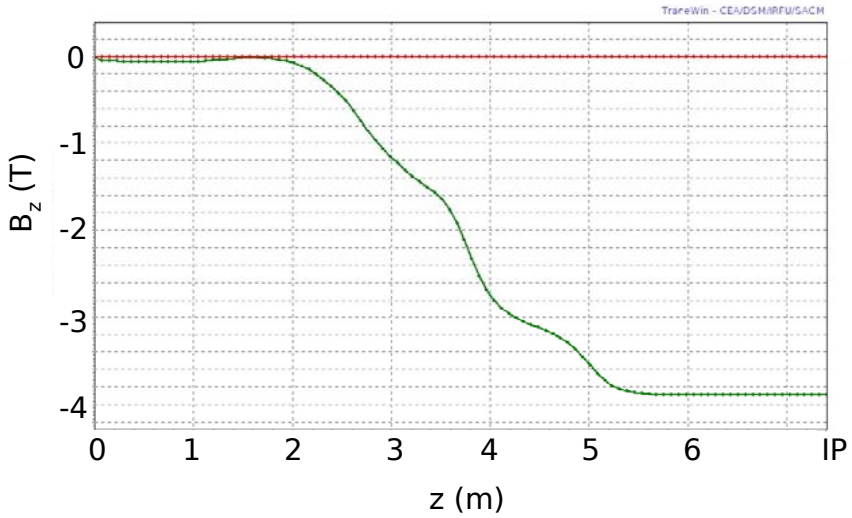
• The long term goal is to compare the **operability** and **tunability** of the 0 mrad and 14 mrad ILC Interaction Region

• The short term goal is to provide an 'effective' modelisation of the beam transport through the IR which includes many magnets (solenoid, final doublet, antisolenoid, antiDID, correctors, etc…)

	Solenoid 14 mrad	Solenoid+QD0 0 mrad	Solenoid + QD0 14 mrad
Matrix model with thick S+Q elements	**X**	**X**	
Matrix model with Q-Slices	**X**	**X**	**X**
Analytic model	**X**		
Field map integration	**X**	**X**	**?**

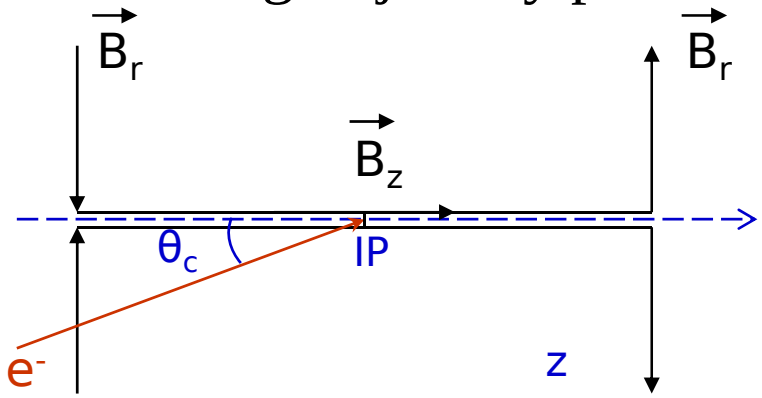
ILC IR: 0 and 14 mrad crossing angle

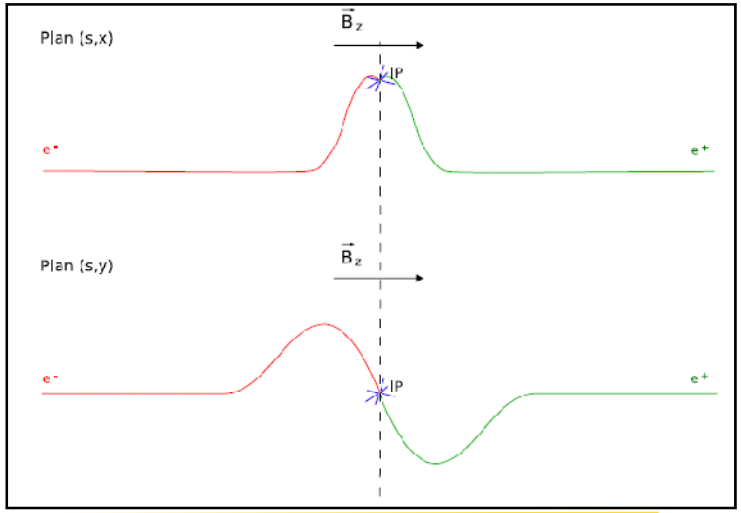
- Solenoid with 14 mrad angle



ILD 4T Solenoid
Bz along axis

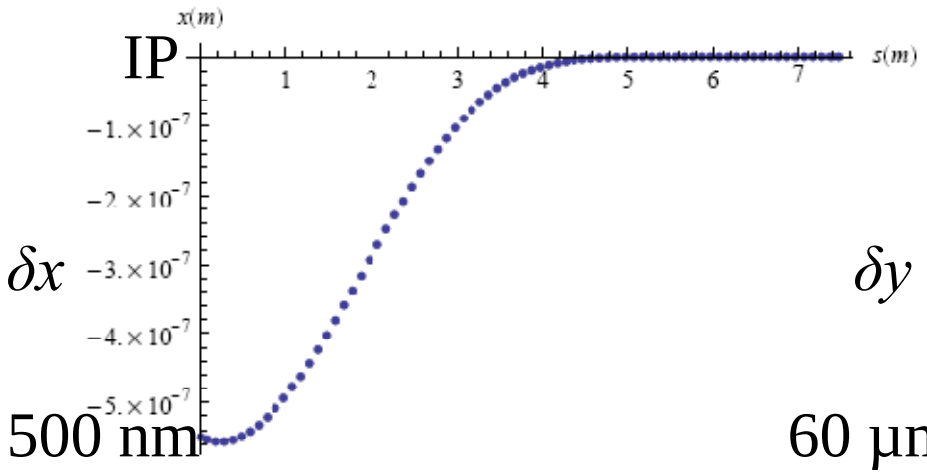
If the incoming trajectory points to the IP the vertical offset is cancelled.





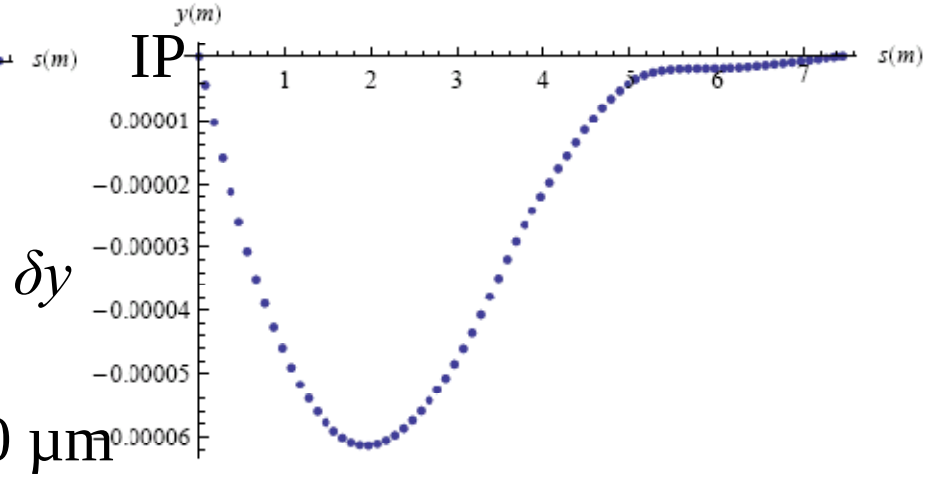
ILC IR: 0 and 14 mrad crossing angle

• Solenoid alone with 14 mrad angle:
all 4 models describe the compensation of δy^*



δx

500 nm



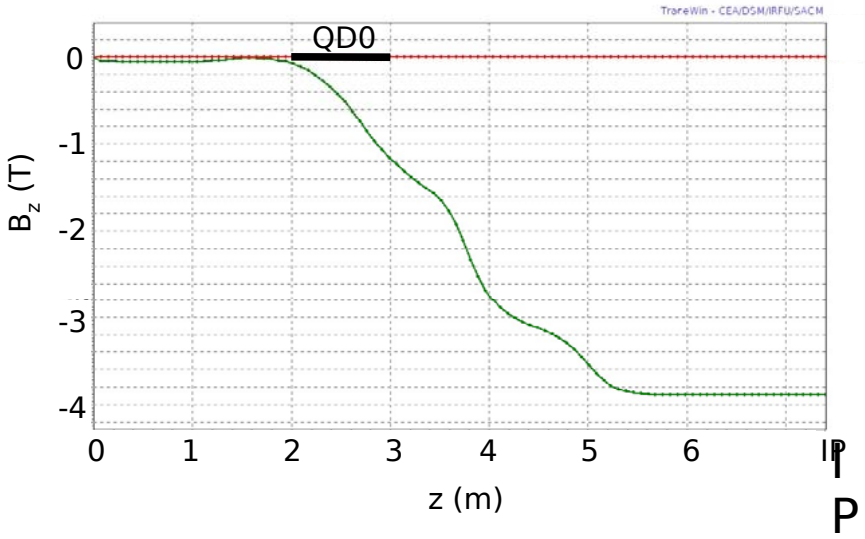
δy

60 µm

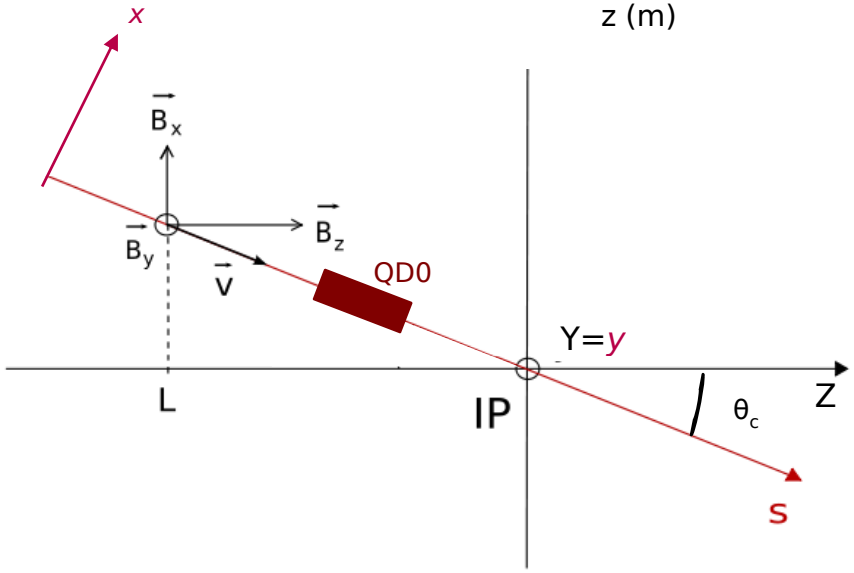
• Field map integrations and the analytic model with linearly decreasing fringe field, in agreement and predict $\delta y^* \sim 6$ nm. This is due to the non-zero δx on the way to the IP.
• Matrix transport models do not see this effect.
• BETA predicts 130 nm / 30 µm maximum orbit deviation.

ILC IR: 0 and 14 mrad crossing angle

- Solenoid + QD0 with 14 mrad angle



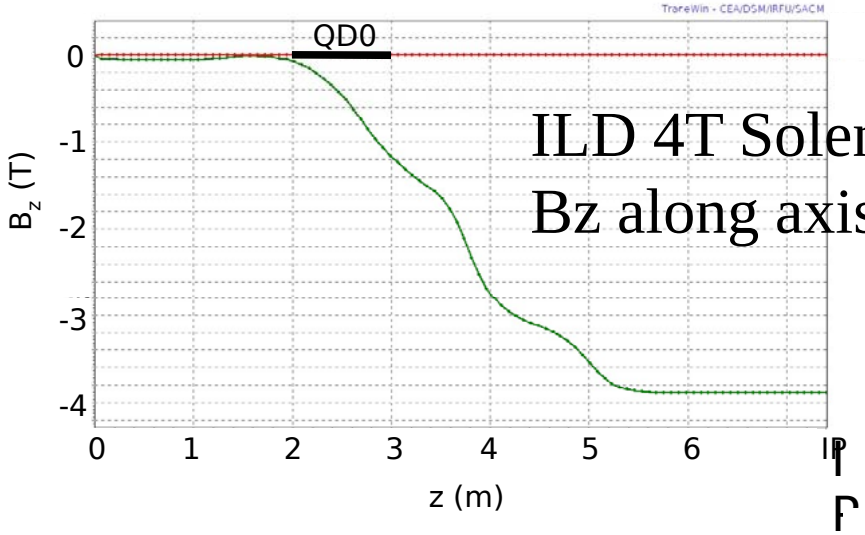
ILD 4T Solenoid
Bz along axis

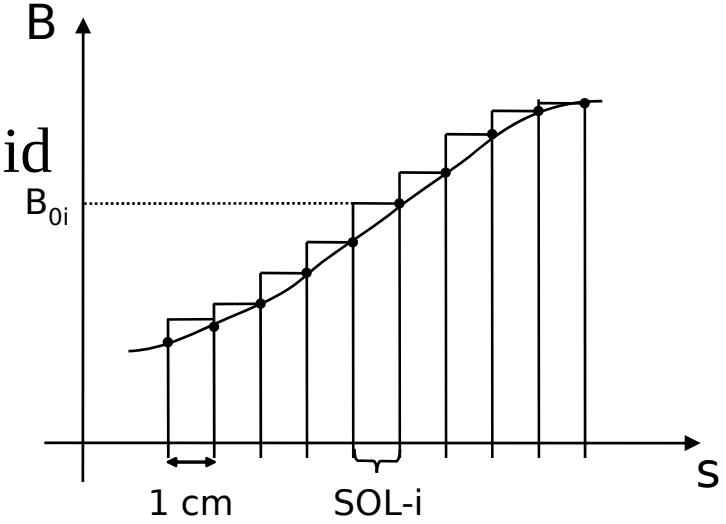


The incoming trajectory no longer points to the IP because QD0 is embedded in the fringe field.

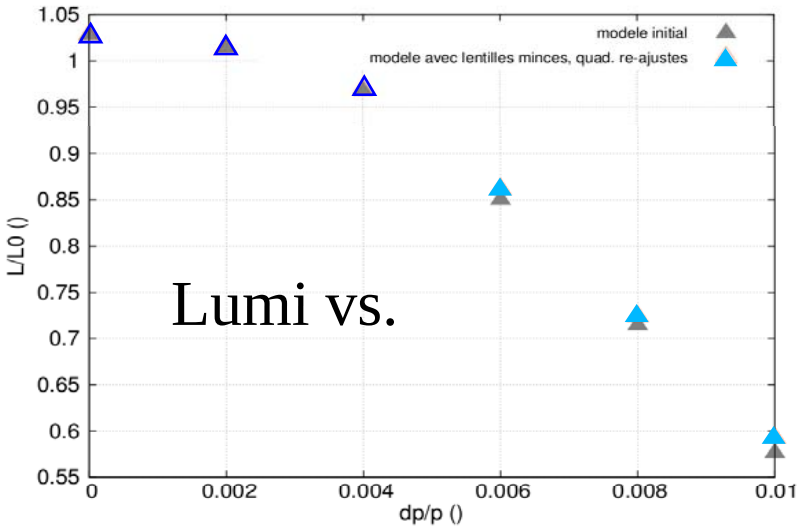
ILC IR: 0 and 14 mrad crossing angle

- Solenoid + QD0 with 0 mrad angle



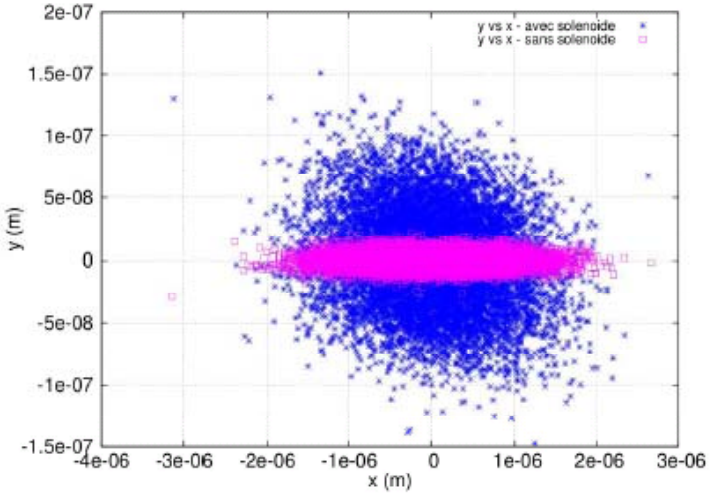


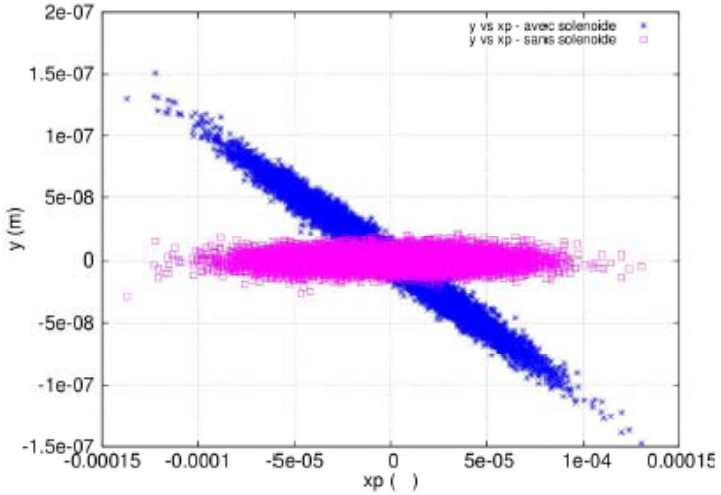
No orbit deviation at first order.
This case is used to benchmark the Matrix Transport model with QD0 slices against Matrix Transport with S+Q thick elements (DIMAD) and the Field Map integration.

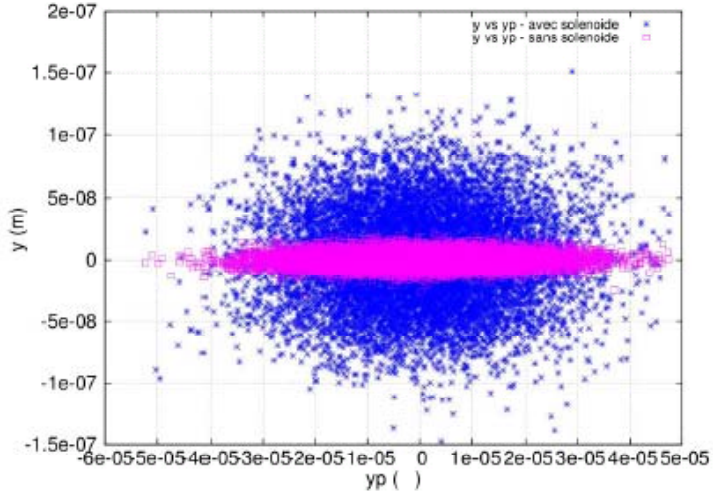


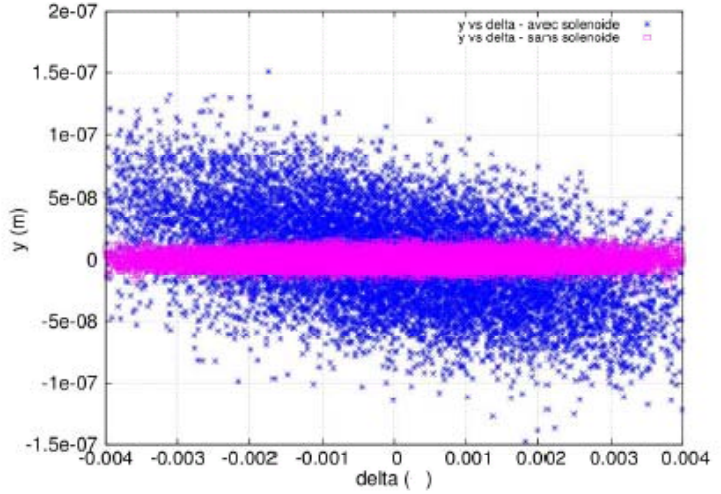
ILC IR: 0 and 14 mrad crossing angle

- Solenoid + QD0 with 0 mrad angle : the coupling effect



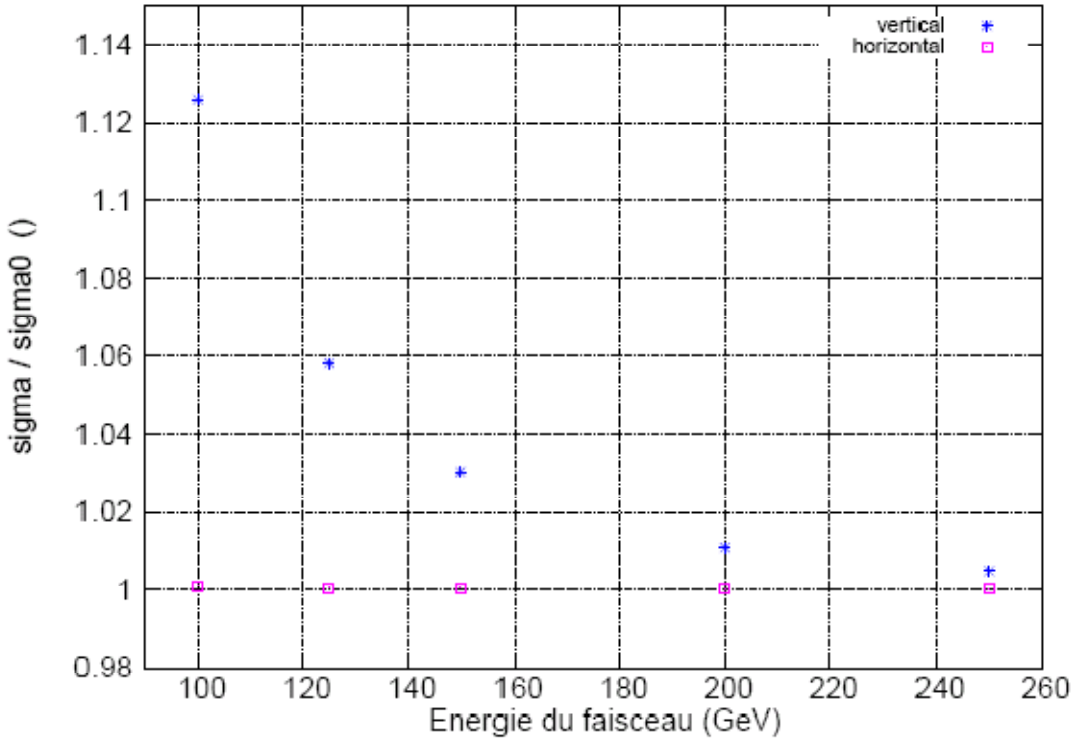






ILC IR: 0 and 14 mrad crossing angle

- Solenoid + QD0 with 0 mrad angle : the coupling effect



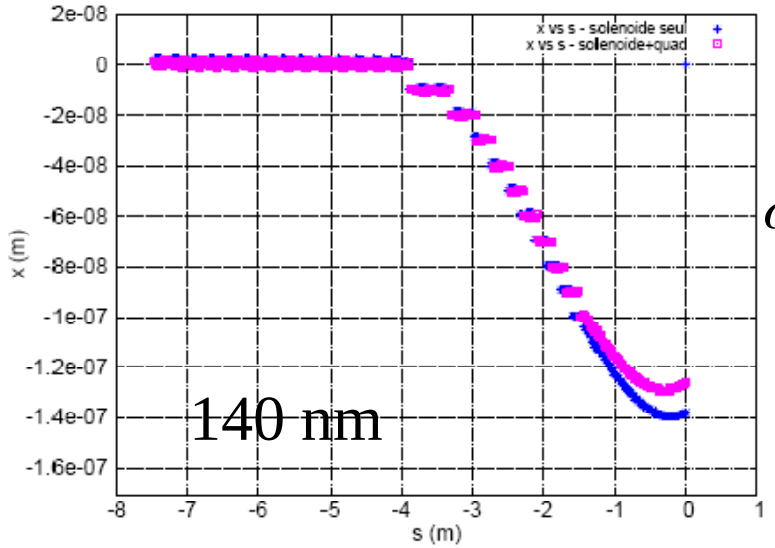
Correction of the coupling effect with 3 skew quads.

ILC IR: 0 and 14 mrad crossing angle

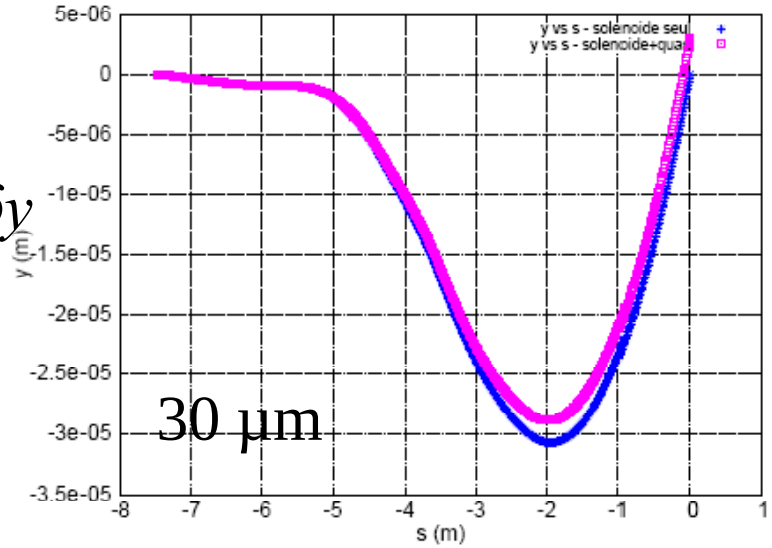
- Solenoid + QD0 with 14 mrad angle:
  only with the matrix transport model and QD0 slices

IP IP

δx



δy

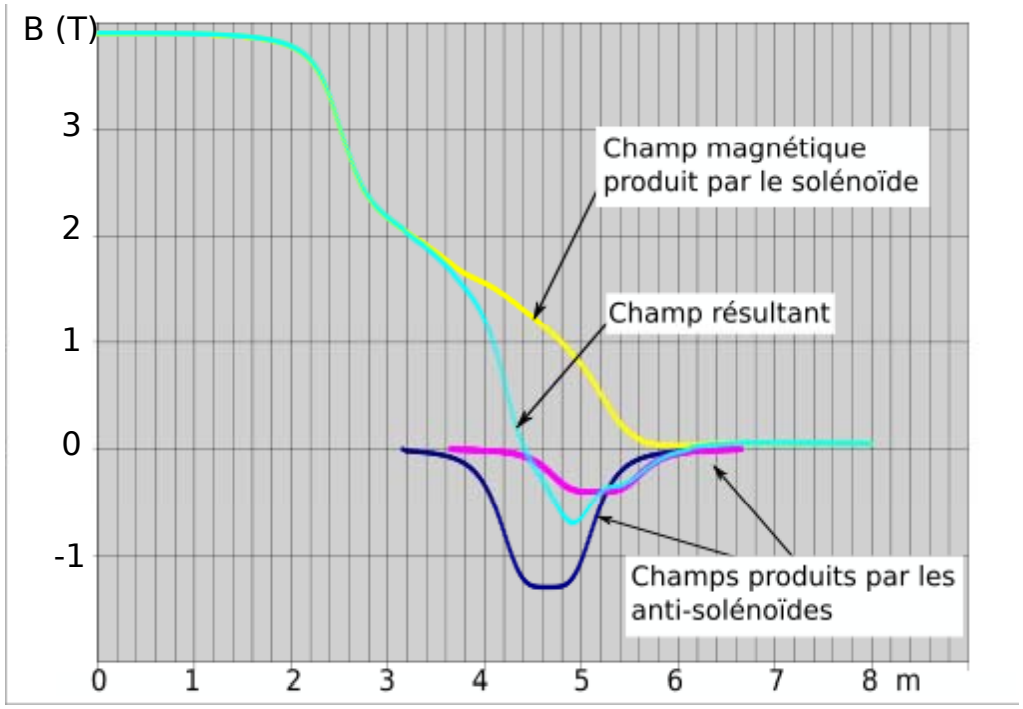


The predicted single bunch offset is $\delta y^* = 3$ µm.
The field map integration code are not yet ready to include the crossing angle.

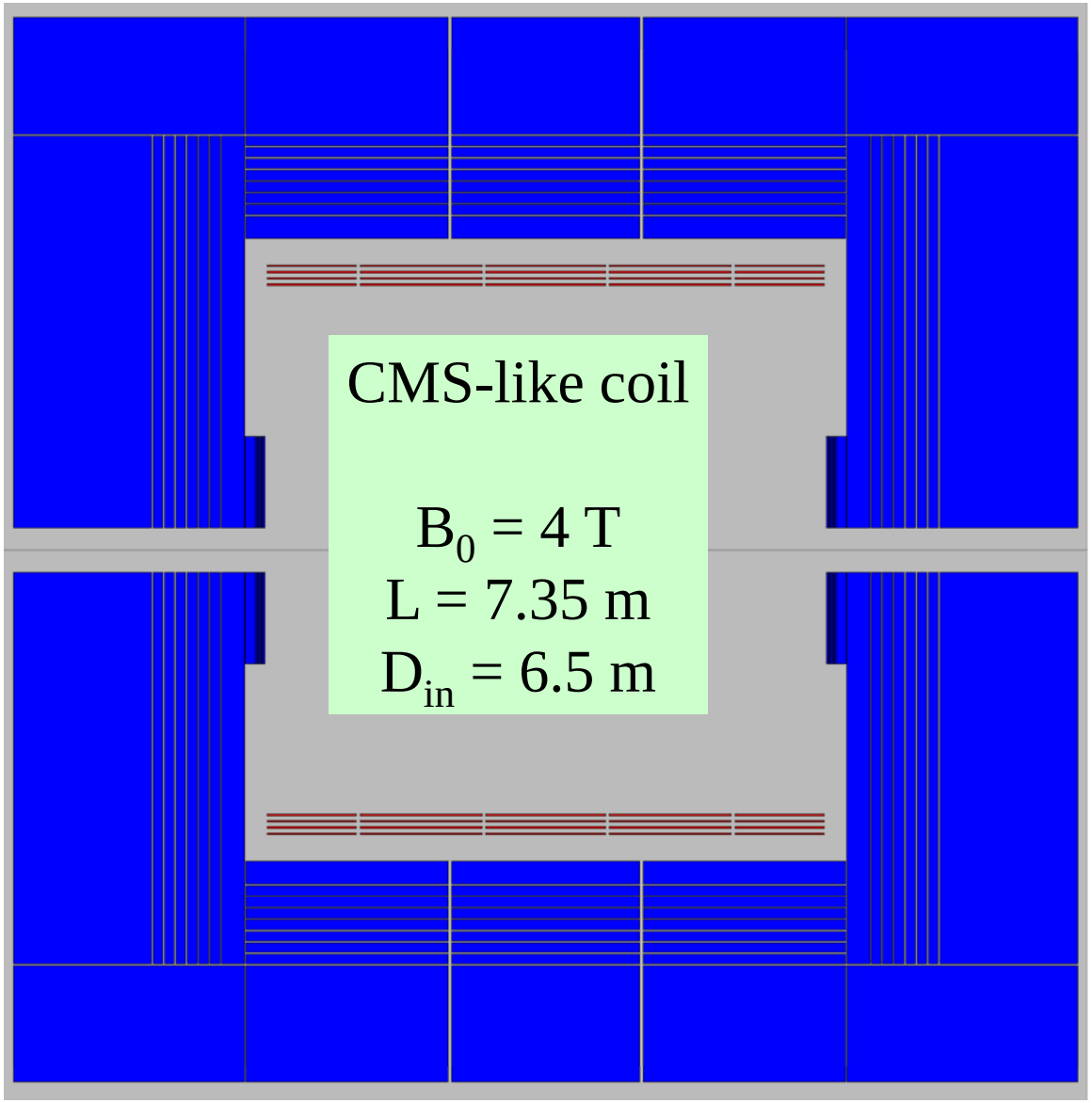
ILC IR: 0 and 14 mrad crossing angle

Next steps:

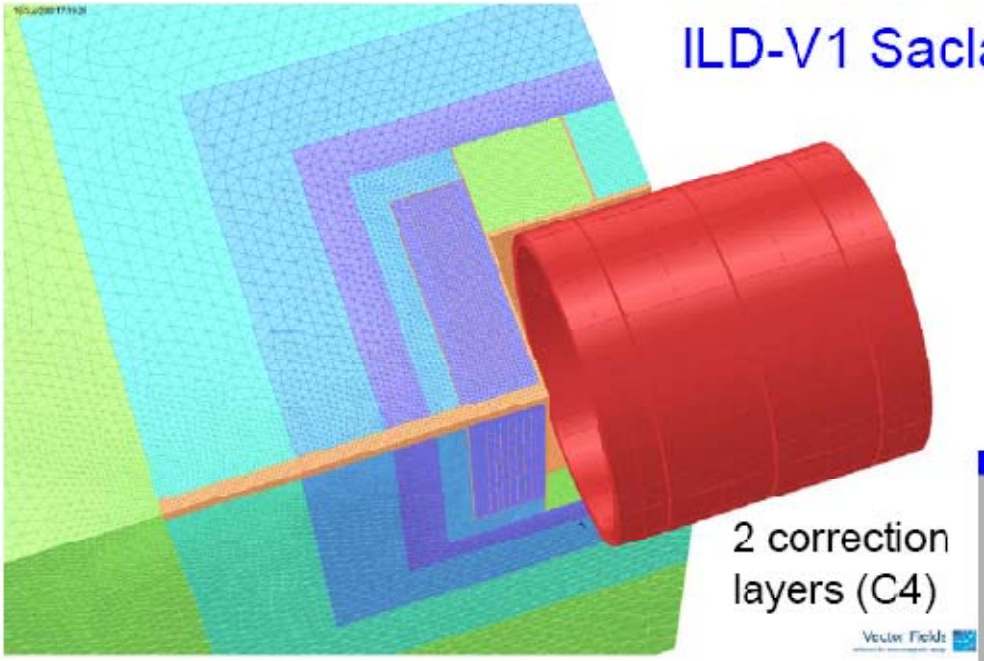
1. Establish a reference model for the beam transport.
2. Extend field map integration method to the 14 mrad case.
3. Check the beam size coupling effect at 14 mrad.
4. Include anti-solenoid fields for local coupling correction.
5. Include anti-DID.

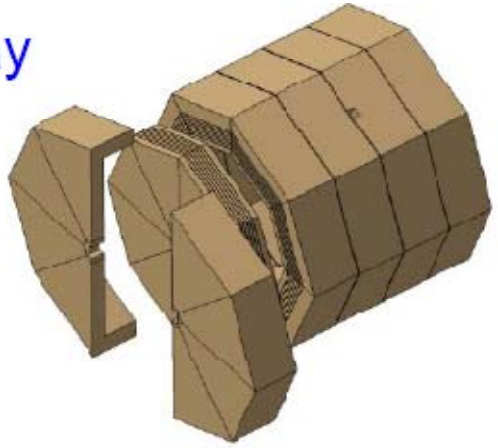


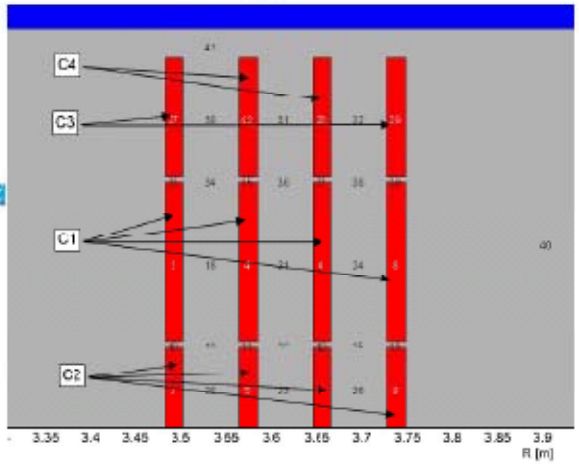
ILD Solenoid



ILD Solenoid



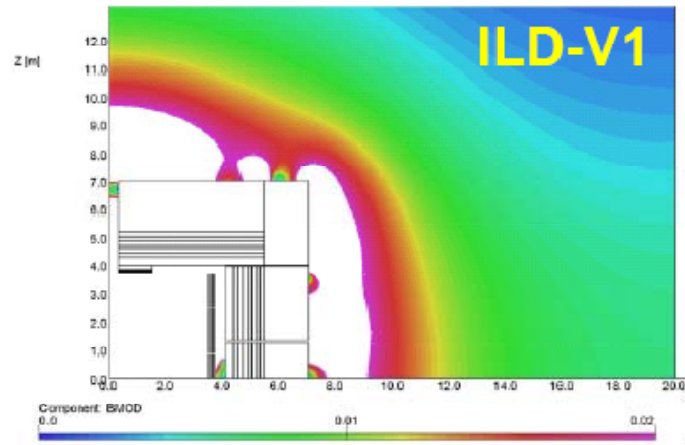




Current distribution :	2 correction layers			
12948	12948	12948	12948	12948
32136	12948	12948	12948	32136
32136	12948	12948	12948	32136
12948	12948	12948	12948	12948

	NI(A)	J(A/m²)	S(m²)	N(spire)	I par spire(A)	I(correction)	I-Icorrection	Longueurs (m)
C1	1294834	39980092	3.24E+01	100	12948			1.65
C2	647417	40377096	1.60E+01	50	12948			1.65
C3	946847	40377096	2.35E+01	73	12948			1.2066
C4	2350006	92996184	2.53E+01	73	32136	19188	12948	1.2066

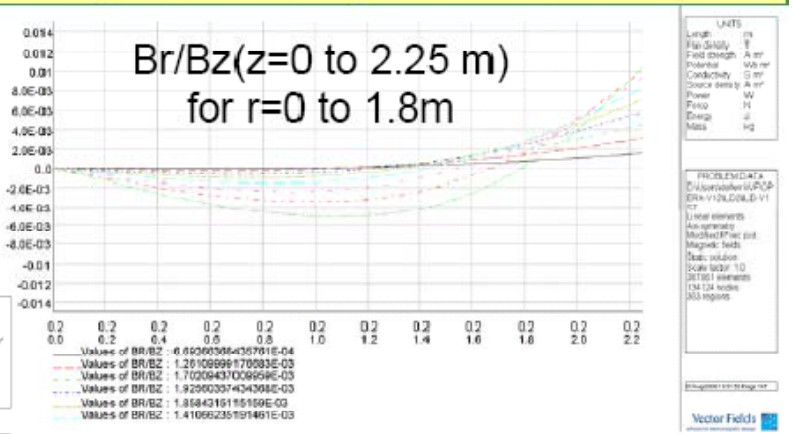
ILD Solenoid

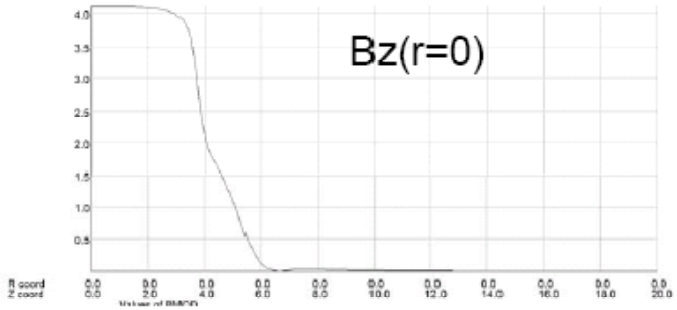


ILD-V1 configuration

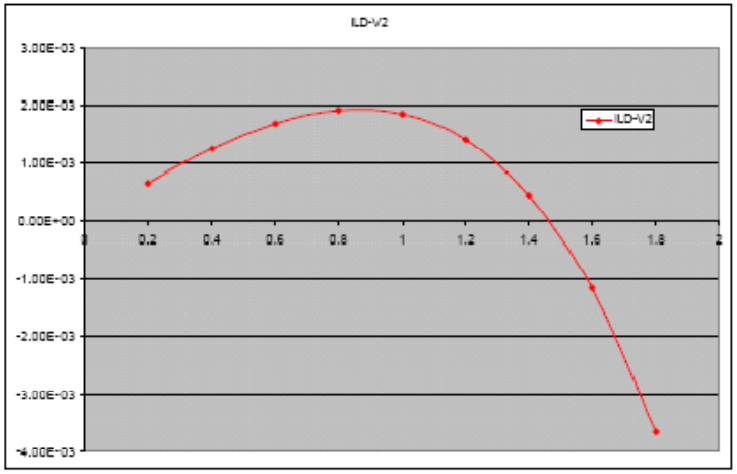
Iron : up to R=7m, up to Z=+/-7m (~3m thickness)

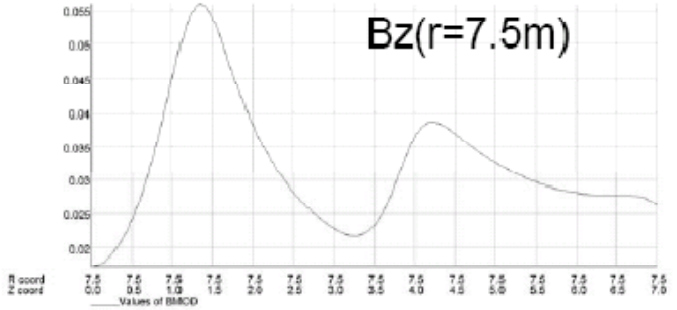
Coil : 4 layers ,7.35 m length subdivided in 5 parts



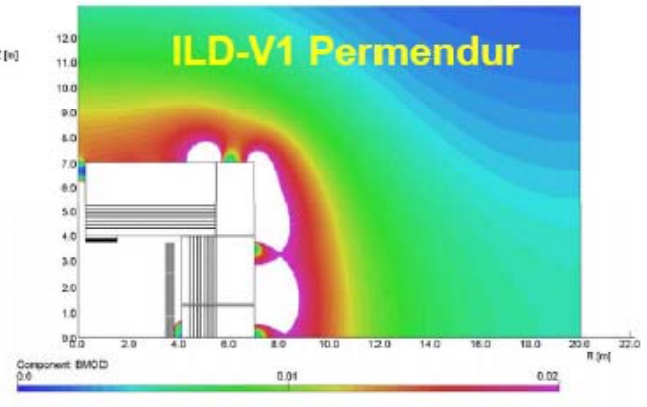


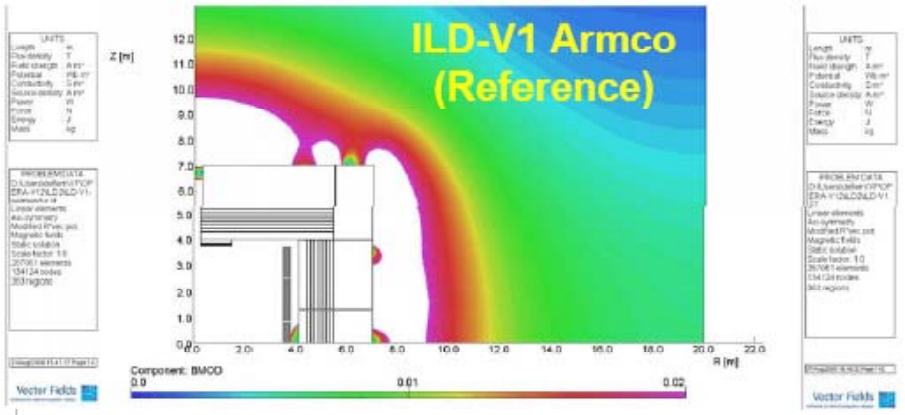
∫(Br/Bz) vs r (z=0 to 2.25 m)

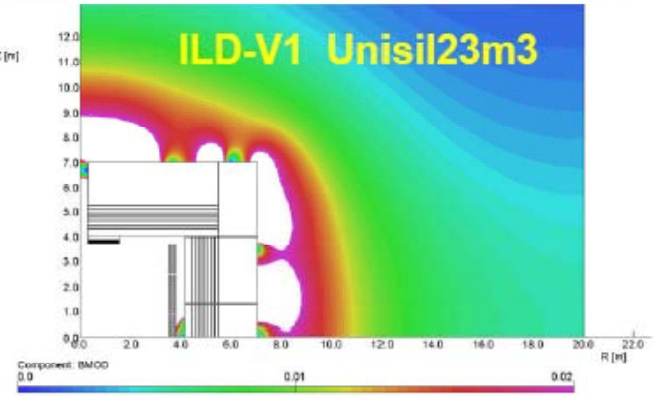


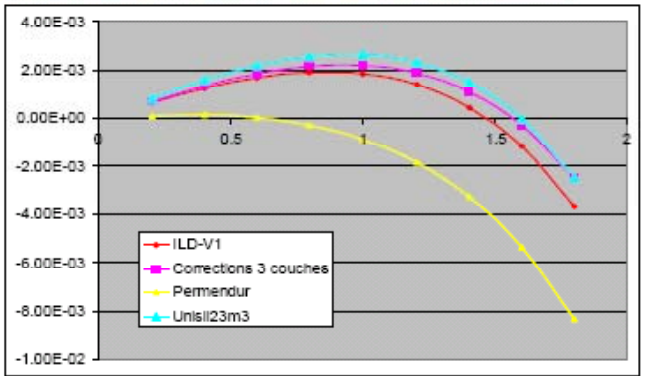


ILD Solenoid



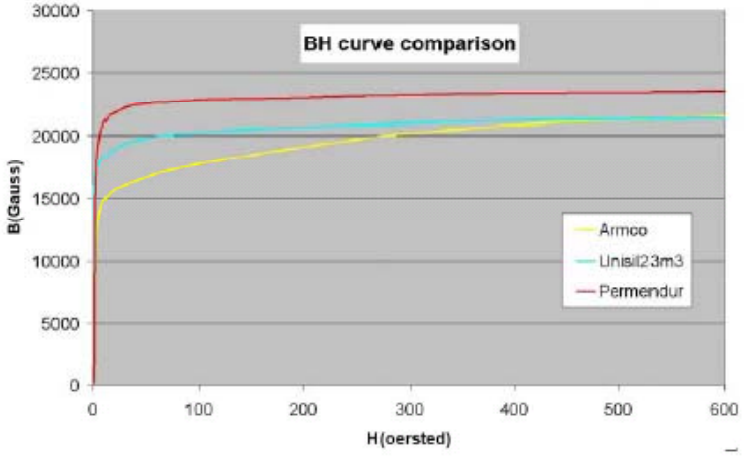






Material influence on stray Field and B_r/B_z integrals

(Currents are fixed – ILD-V1 2 correction layers distribution)



* Integrals are not optimized for *permendur. Correction current have to be lowered*

Nb3Sn Quadrupole Prototype

Main goals :

- Get an experience in the *Nb_3Sn technology* keeping in mind the industrialization process.
- Build a 1-m-long model, 56-mm single aperture with no magnetic yoke based on the design of LHC arc quadrupole magnets

Gradient	**211 T/m**
Current	**11870 A**
B_{peak}	**8.3 T**

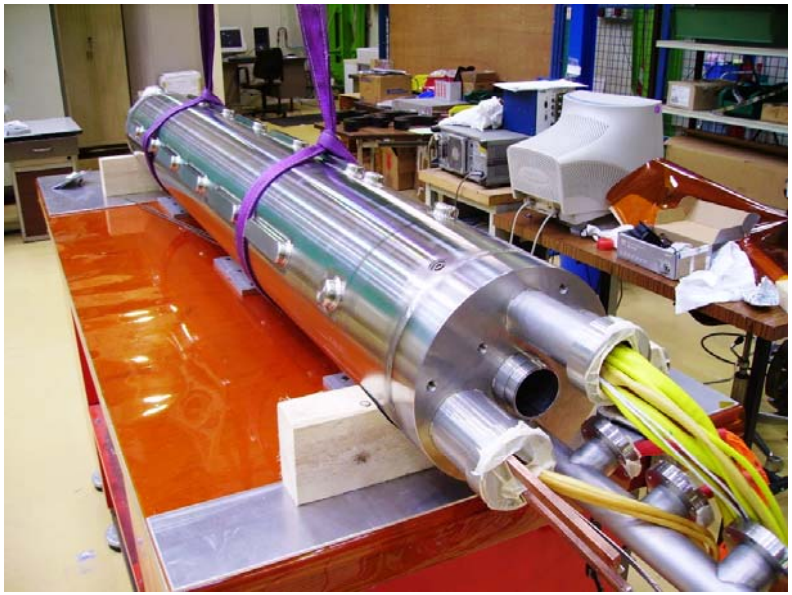
• 8 pole pieces have been manufactured, 5 met specs.

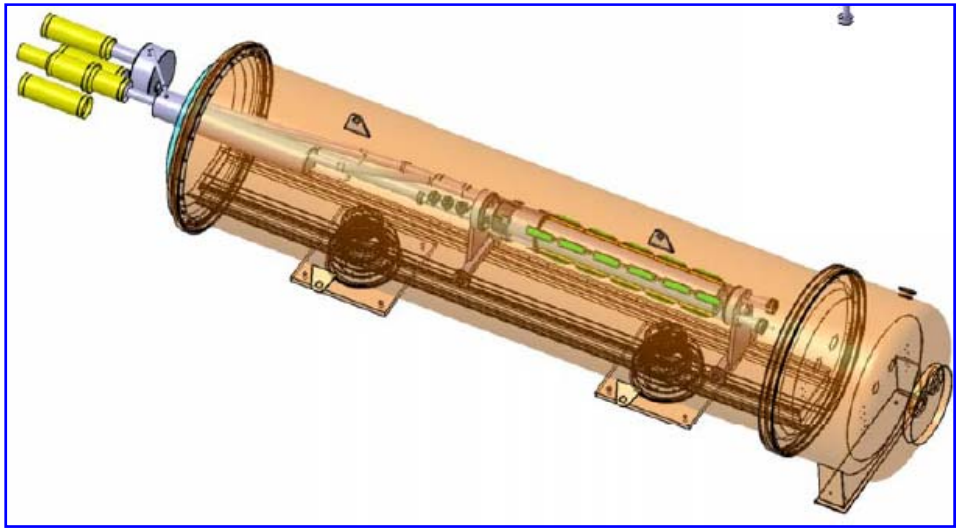
• The best 4 poles have been assembled and collared late 2007 with ACCEL tooling

Nb3Sn Quadrupole Prototype

- The cold test with high gradient will take place in the fall of 2008.

Gradient	**211 T/m**
Current	**11870 A**
B_{peak}	**8.3 T**





- The foreseen test of quadrupole embedded in a 4 T solenoid will not take place.

Outlook

I: ILC IR Modelisation

IR

New PhD student (R. Versteegen) will continue the work for the next 3 years

II: ILD Solenoid

Coil optimisation and 3D magnet studies are well supported

III: Nb3Sn Quadrupole

Magnet prototyping will continue, supported by SLHC (NbTi Quad, D = 130 mm and Bpeak = 10 T) and by EuCard (Nb3Sn Dipole, D = 100 mm and B = 13 T)