Transfer Line -2 Optics Design
For CTF3

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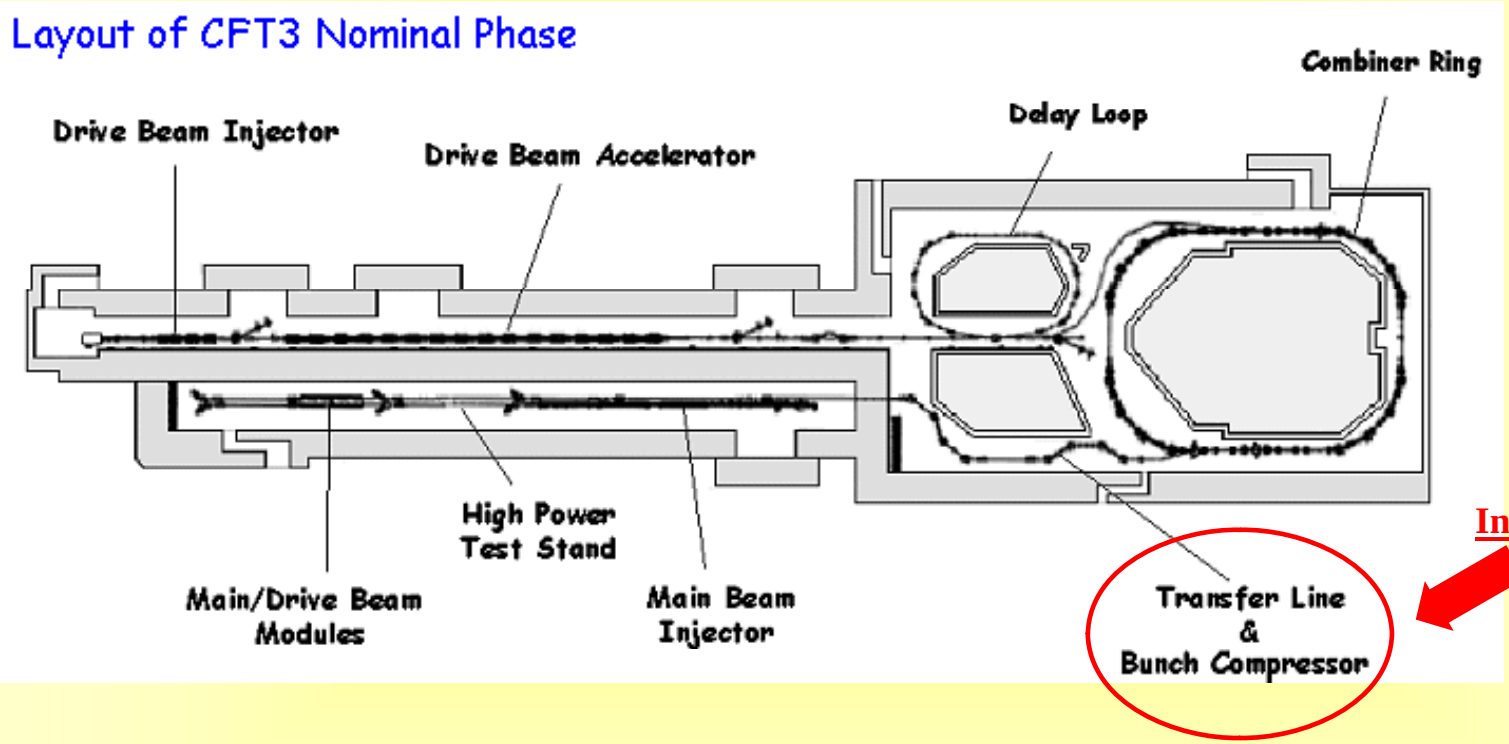
TL-2 @ CTF3



Indian Contribution

Status of Optics Design

- Optics design for required tuning range of R_{56} completed and delivered to CERN in October 2007.

- T_{566} suppression in entire range with low emittance dilution

- Studies do not include wake field/ CSR effects

Parameters required

- **R_{56} → -0.30m to +0.30m**
- **T_{566} → 0 in entire range**
- **ε blow up → <10%**

Parameters	**@ Input**	**Requirement @ Output**
Nominal energy	150 MeV	150 MeV
Maximum energy	300 MeV	300 MeV
β_x , β_y (m)	8.1, 3.5	< 20m in the separating wall
α_x , α_y	0.12, 0.31	--------
η	0.0	0.0
η'	0.0	0.0
dp/p (%)	1%	1%
Height above ground	1.35 m	0.85 m

Magnets

	Dipole – Type-1	Dipole – Type-2	Stnd. Quadrupole	Slim Quadrupole	TSL Quadrupole	Sextupole-1	Sextupole-2
Mech. length (m)	0.770	0.520	0.592	0.384	0.430	0.160	0.350
Mech. width (m)	0.794	0.794	0.819	0.340	0.650	0.420	0.420
Effective length (m)	0.518	0.268	0.380	0.300	0.295	0.100	0.246
Aperture (mm)	100×45	100×45	184	100	101	108	167
Strength	1.3 T	1.3 T	5.4 T/m	8 T/m	10.6 T/m	108 T/m	44 T/m^2
Number	02	03	26	02	16	2	12

Design of line: Modules

Module-1

Extraction of Combiner Ring to first bending magnet
Horizontal Achromat with 2π phase advance

Module-2

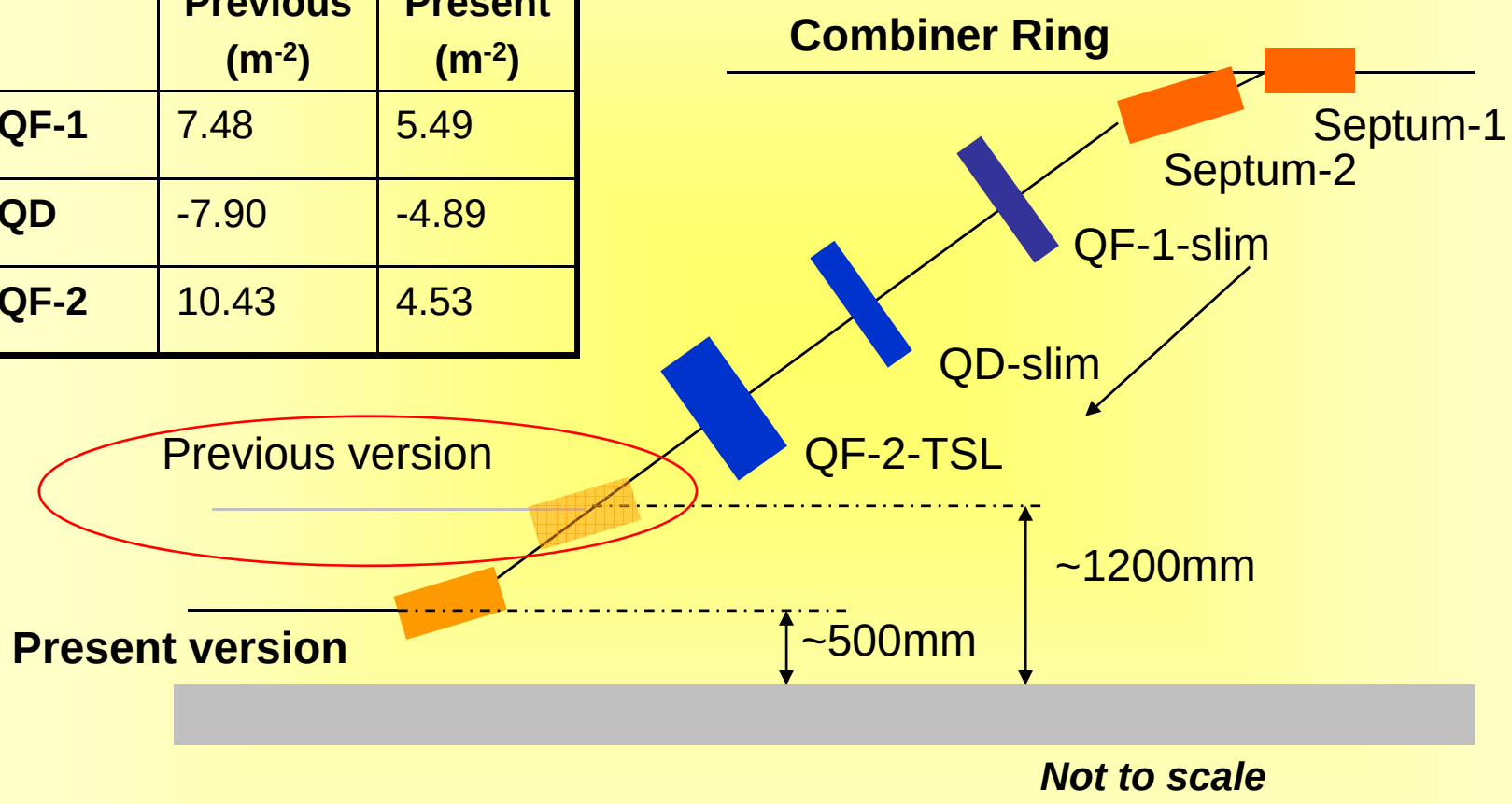
Module-1 to Module-3
Consist of a clear space for Tail Clipper
Clear element free space for Emergency Exit
Vertical Achromat
Matching triplet for module-3

Module-3

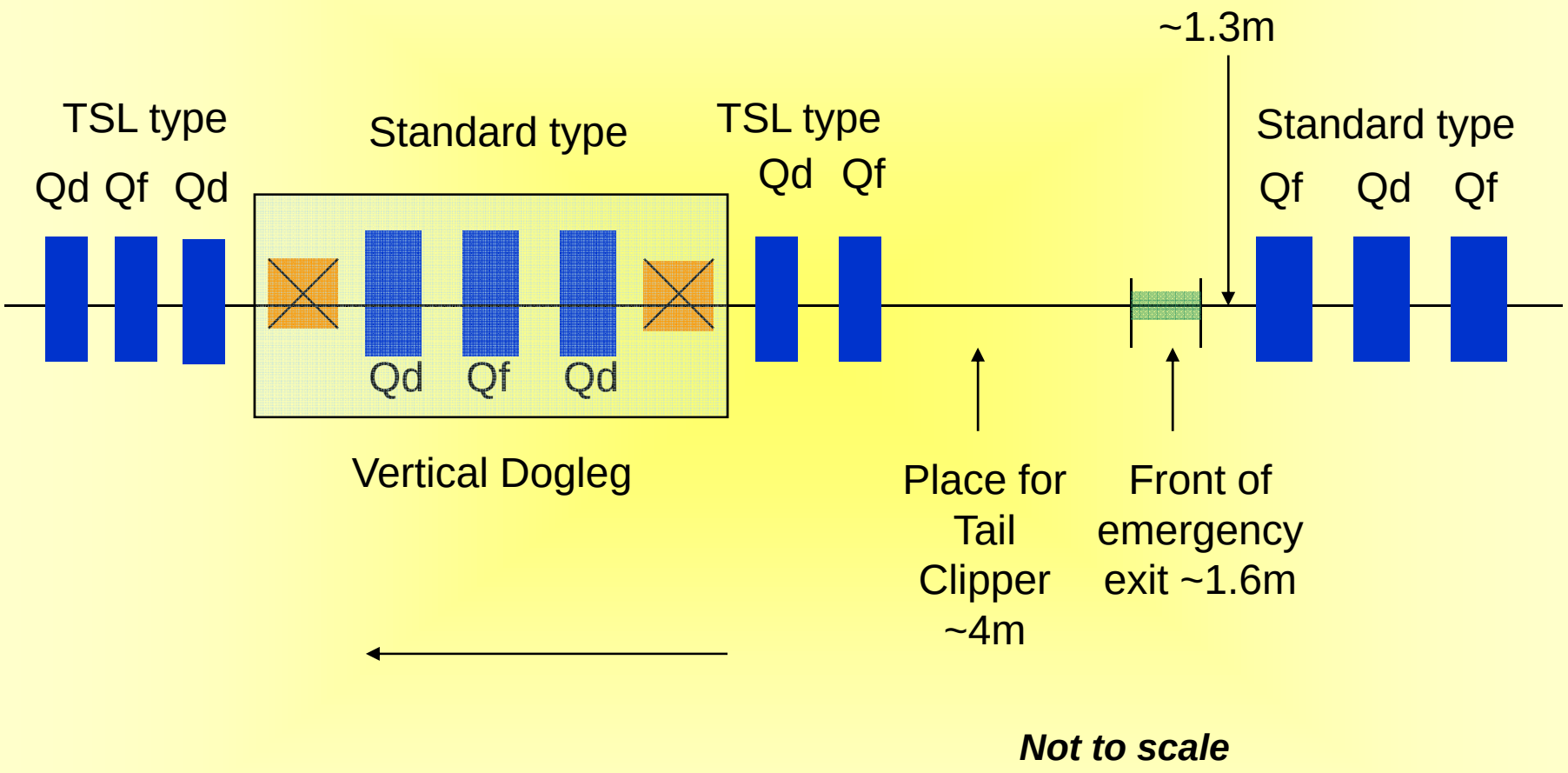
Module-2 to CLEX entrance
Tunable R_{56} arc with T_{566} suppression provision
Final matching doublet

Module-1

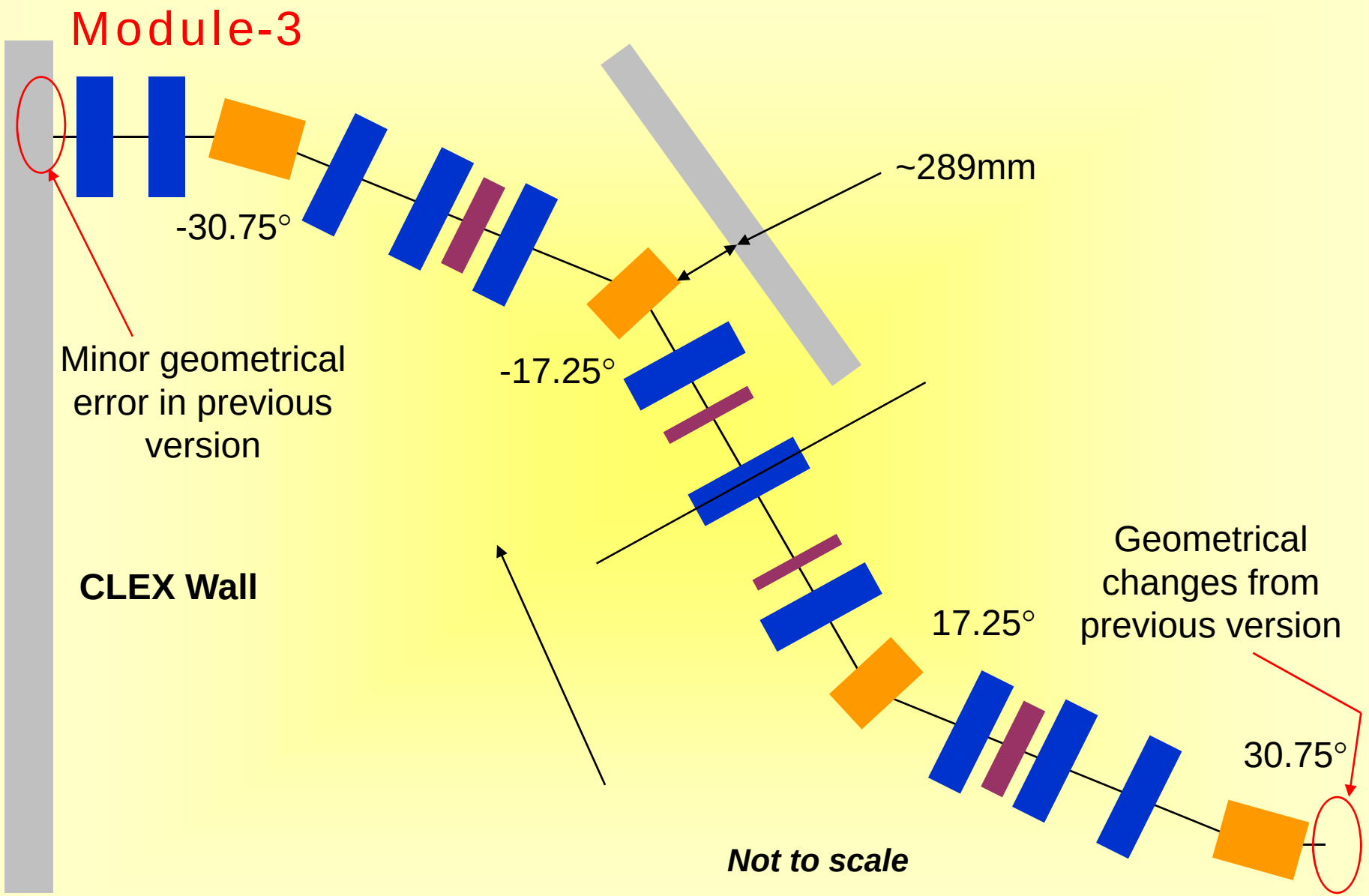
	Previous (m^{-2})	Present (m^{-2})
QF-1	7.48	5.49
QD	-7.90	-4.89
QF-2	10.43	4.53



Module-2



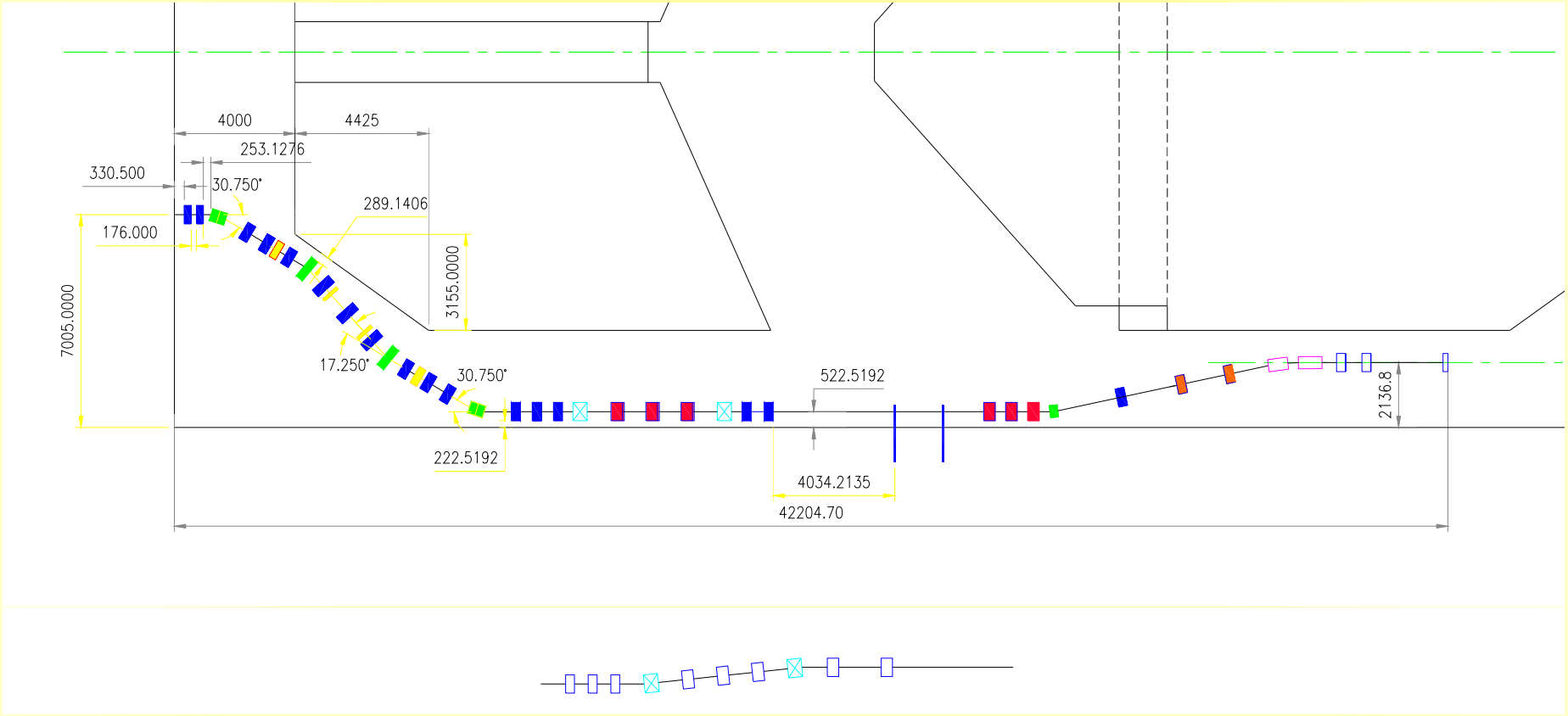
Not to scale


Module-3
-30.75°
~289mm
Minor geometrical error in previous version
-17.25°
CLEX Wall
17.25°
Geometrical changes from previous version
30.75°
Not to scale

Module-3 *Continued....*

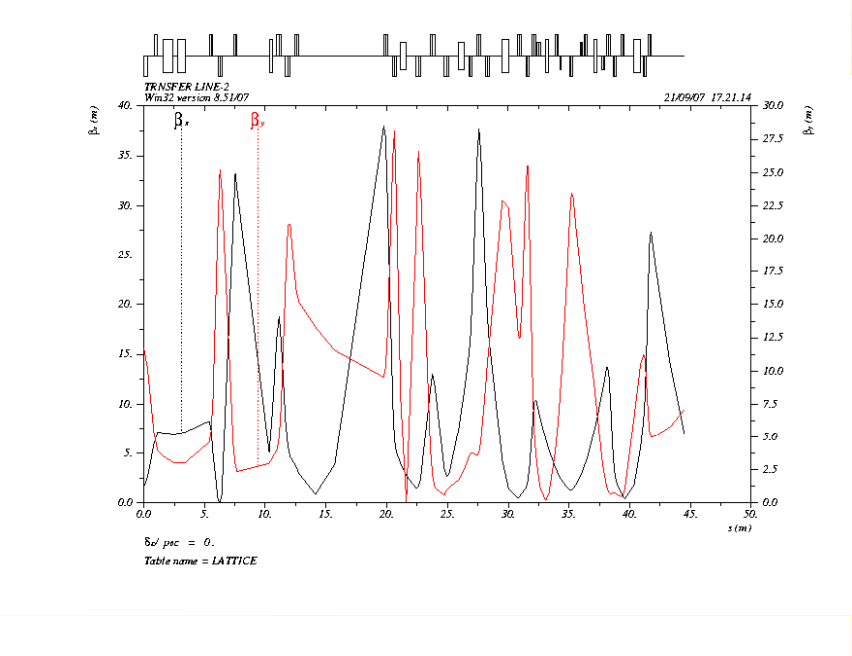
- **Mainly constrained by the building geometry**
- **Tunable R_{56} arc has a symmetry**
- **Two types of dipoles are used**
- **Four sextupoles (driven by two supplies) for T_{566} suppression**
- **Sufficient space for placing the correctors, BPMs, bellows and vacuum pumps**

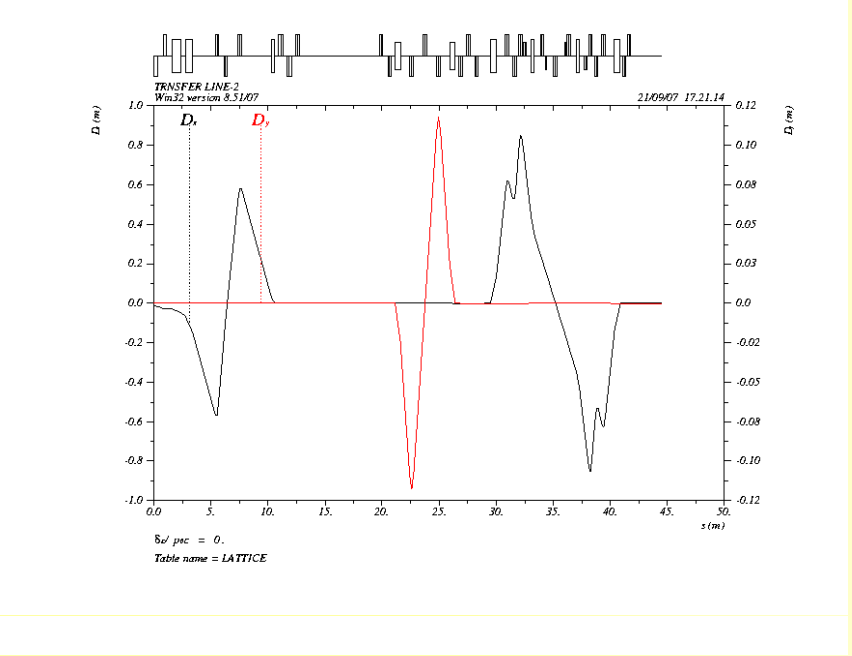
Layout of line



Beta function and dispersion

R_{56} = -0.30m

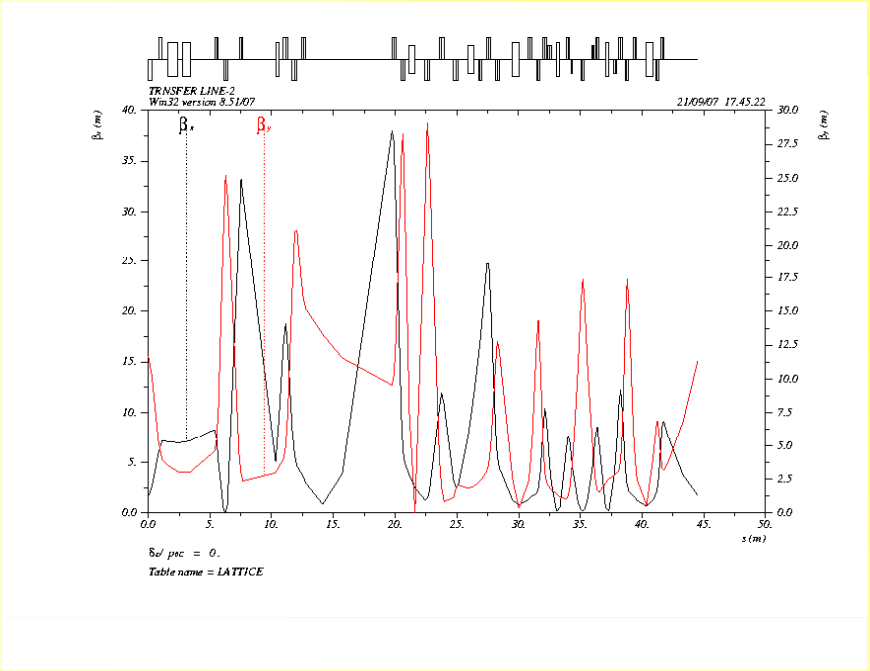


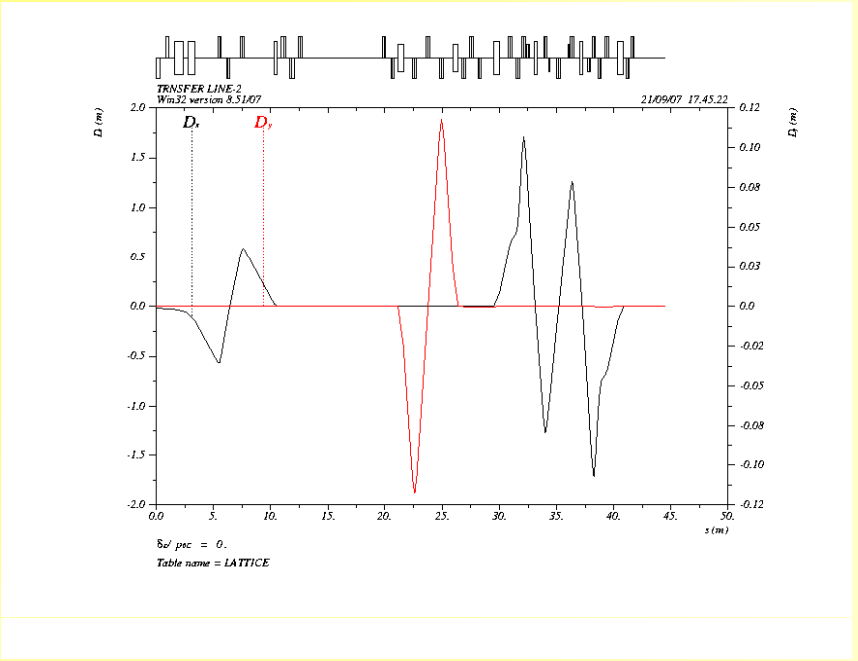


Sign convention of MAD-8

Beta function and dispersion *Continued…*

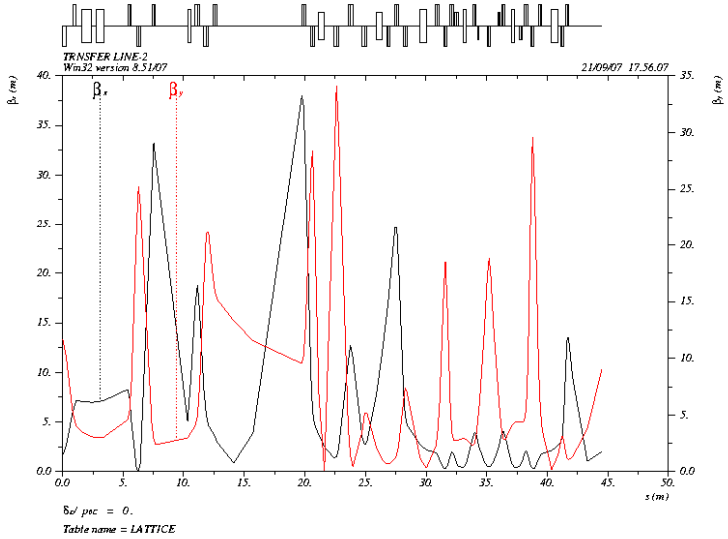
R_{56} = 0.00m

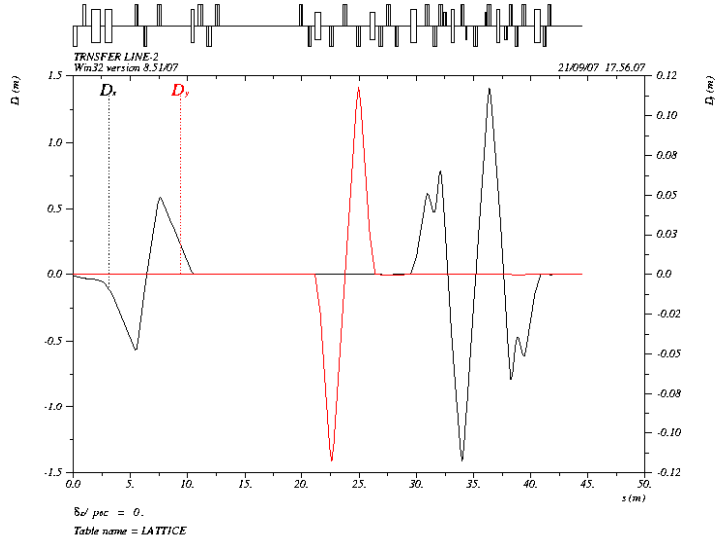




Beta function and dispersion *Continued…*

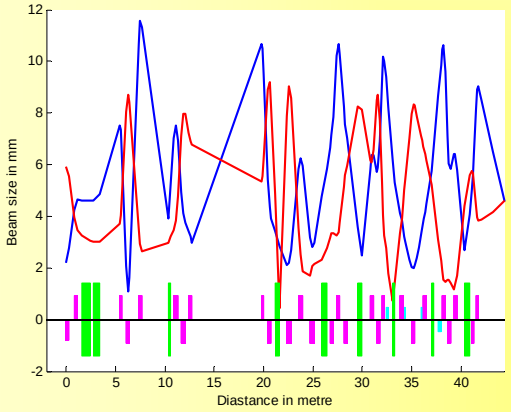
R_{56} = +0.30m



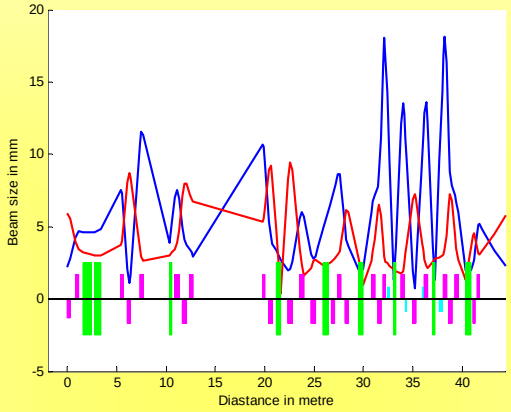


Beam size and chamber aperture

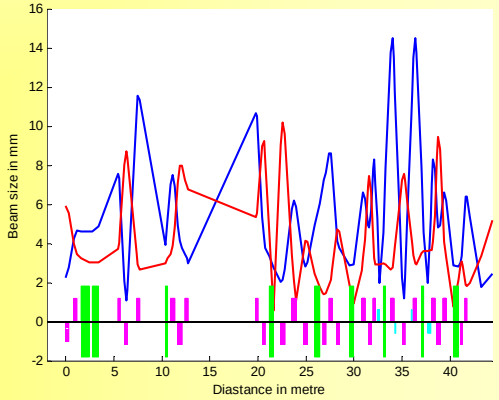
* $\beta_{x,y} < 40m$ and $D_x < 2.5m$, Thus beam size (3σ, 1% $\Delta p/p$) < 25mm



$R_{56} = -0.30m$



$R_{56} = 0.00m$



$R_{56} = +0.30m$

Module	Type of chamber	Aperture full (mm)
Module-1	Racetrack	90×40
Module-2	Circular	40
Module-3	Racetrack	90×40

T_{566} correction

Objective:

- ***T_{566} zero in entire range of R_{56} tuning***
- ***Dispersion is kept higher @ sextupoles to remain within specified strengths***
- ***Phase space distortion not too high***

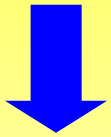
Problem:

- ***-I transformer not possible in whole range of tuning***
- ***Adjusting quadrupole strengths in module-3 for lowering aberration; a very hard task -> changes dispersion and thus R_{56}***

T_{566} correction *Continued…*

Solution:

- ***Sextupole strength decided by mainly dispersion***
- ***Aberration depends on beta function and phases @ sextupoles***
- ***Try to obtain the initial conditions @ Module-3 so that the sum of kicks due to sextupoles become minimum***

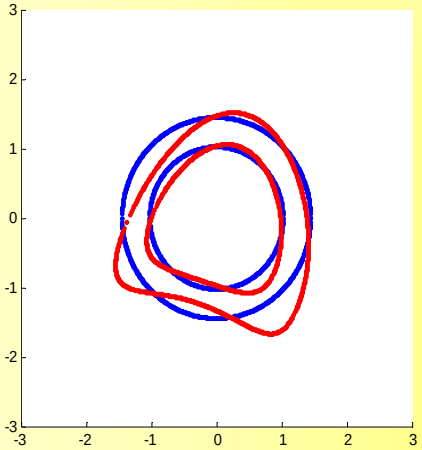


Less phase space distortion without disturbing dispersion wave

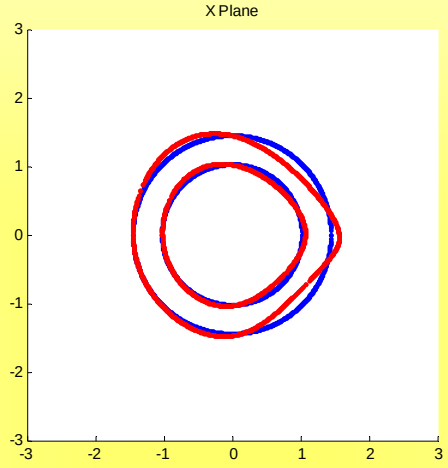
Phase space distortion

On momentum particles (2σ)

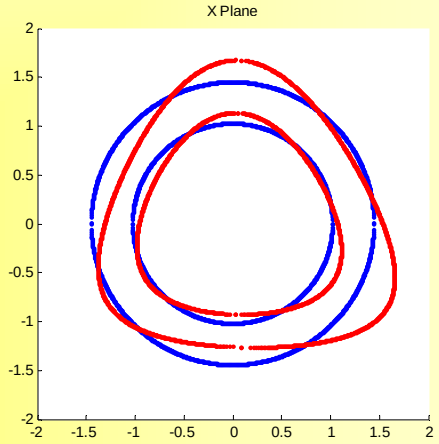
R_{56} = -0.30m



R_{56} = 0.00m

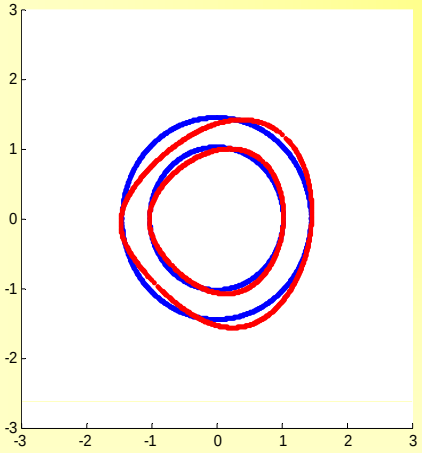


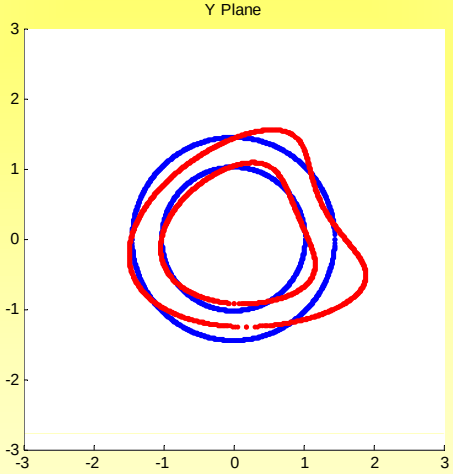
R_{56} = +0.30m

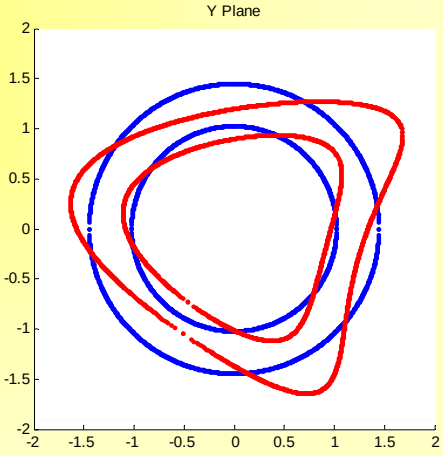


X-Plane

Y-Plane

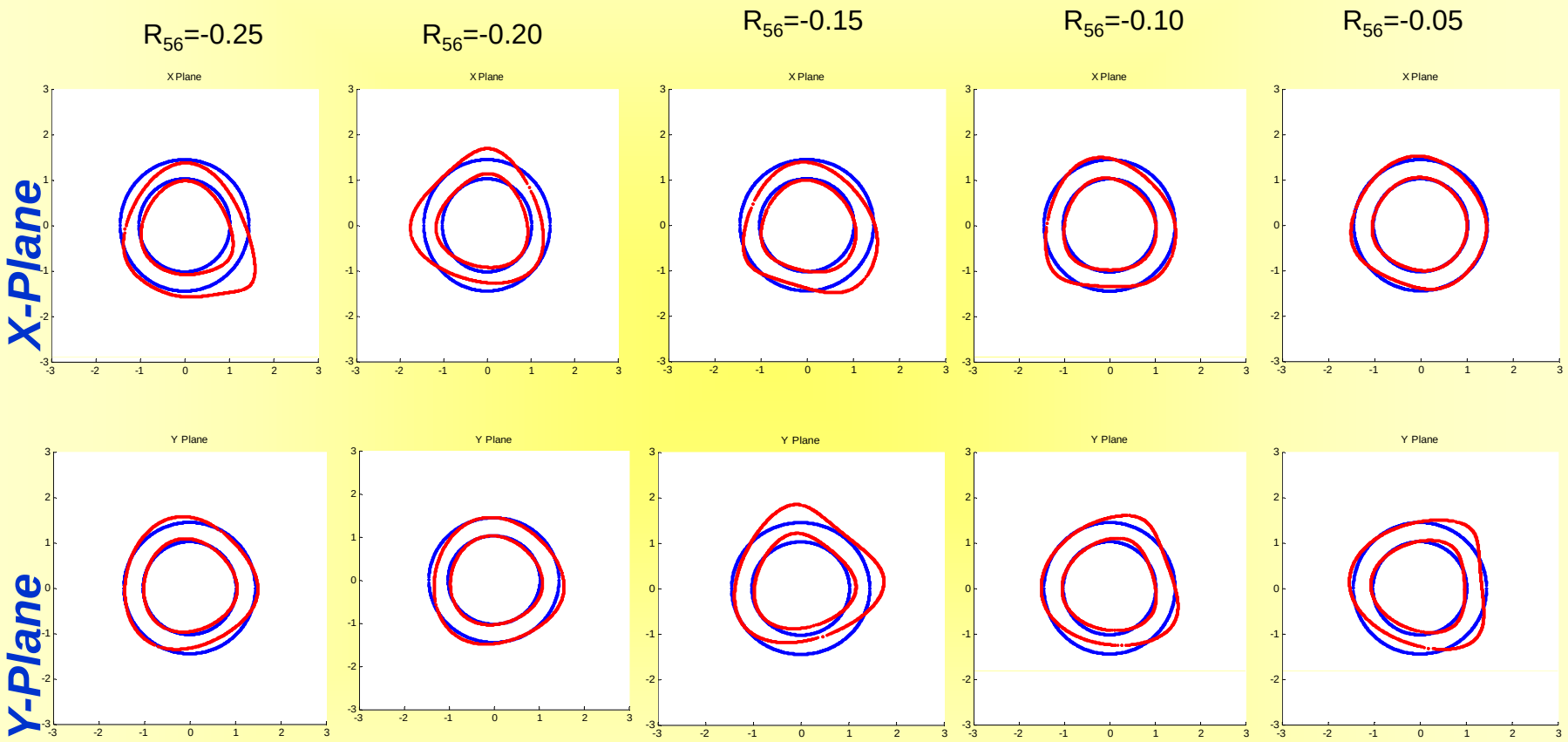






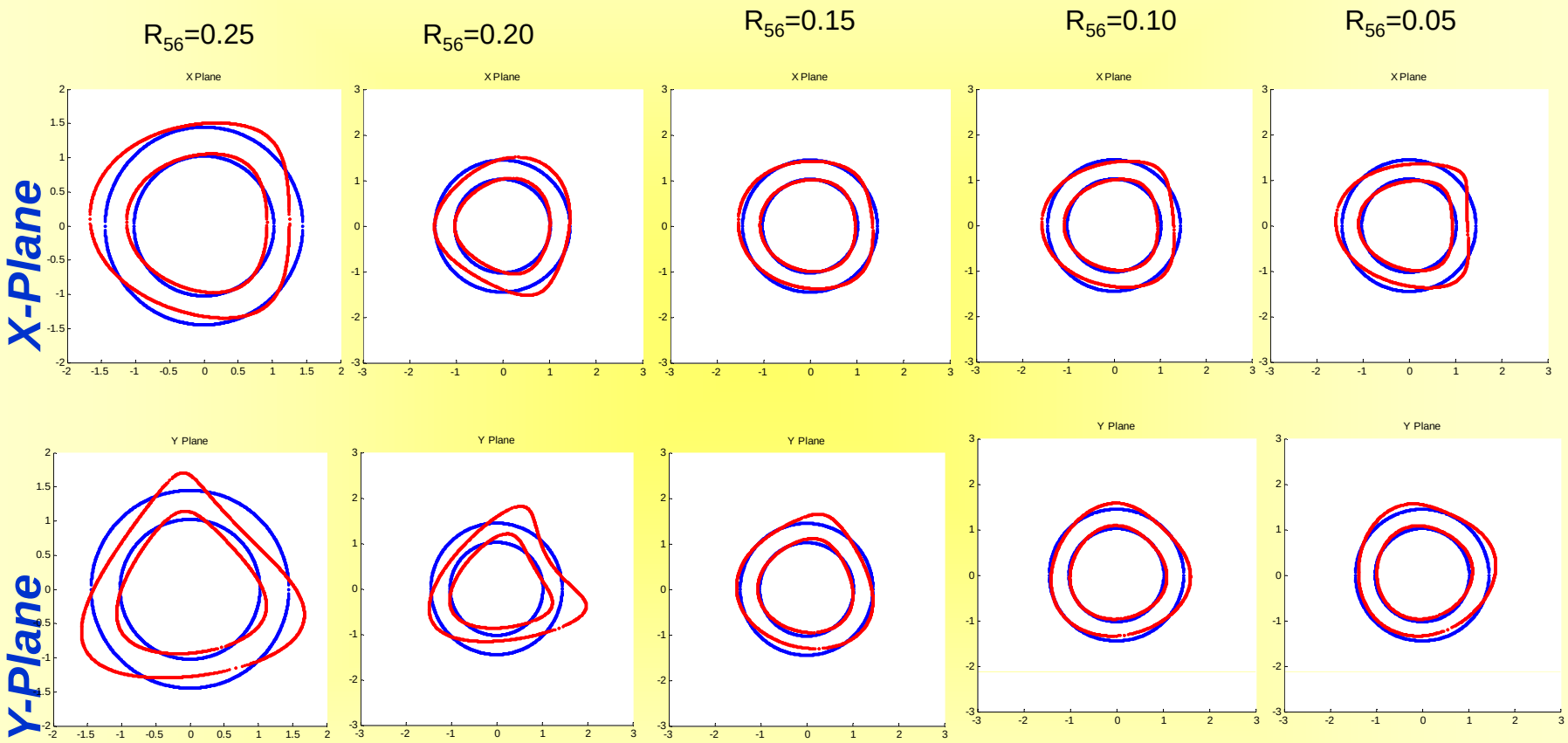
Phase space distortion

On momentum particles (2σ)



Phase space distortion

On momentum particles (2σ)



Phase space distortion *Continued...*

Off momentum particles (X-Plane)

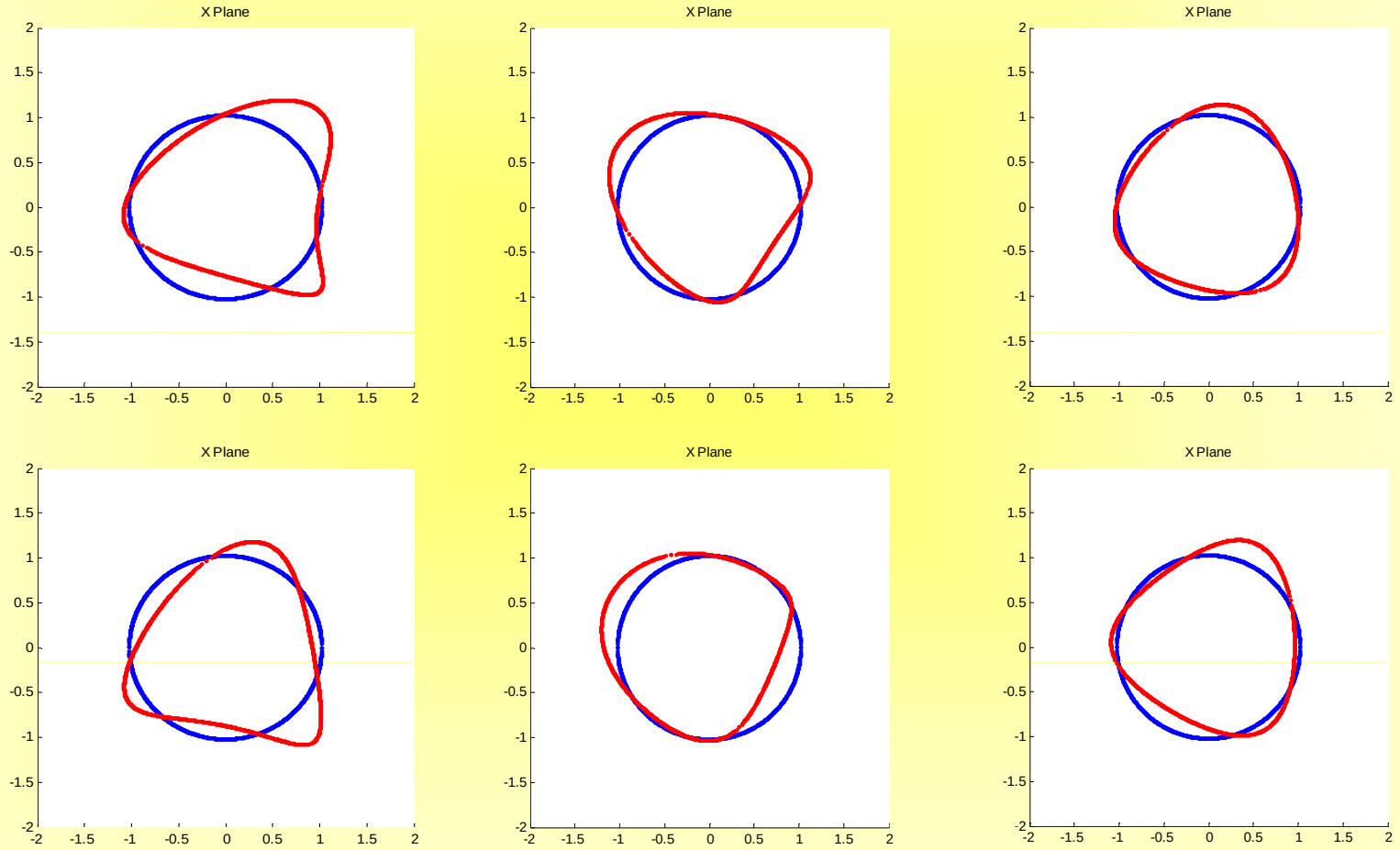
R_{56} = -0.30m

R_{56} = 0.00m

R_{56} = +0.30m

1% dp/p

-1% dp/p



Phase space distortion *Continued...*

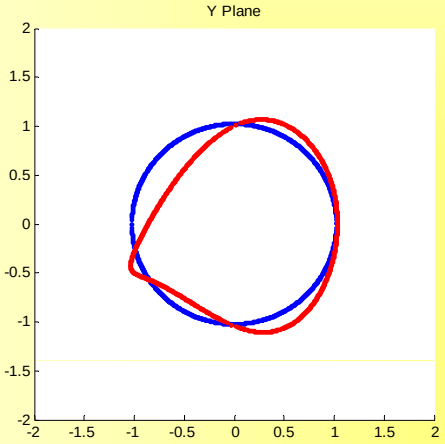
Off momentum particles (Y-Plane)

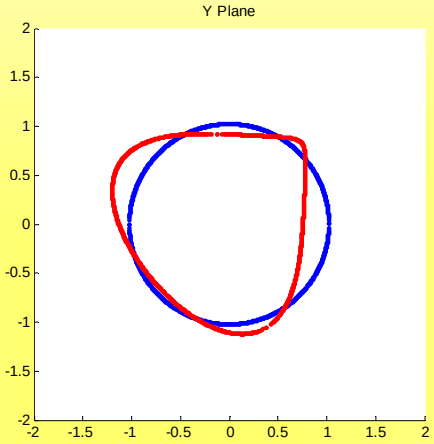
R_{56} = -0.30m

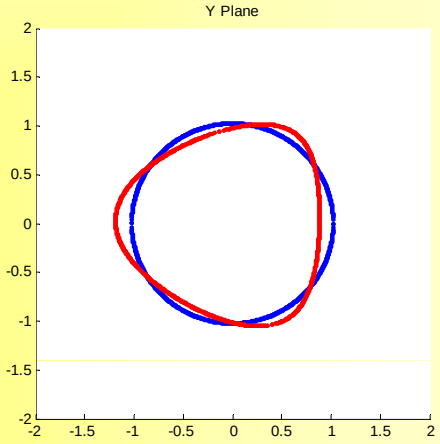
R_{56} = 0.00m

R_{56} = +0.30m

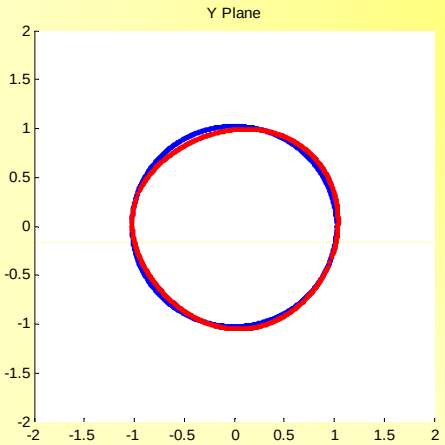
1% dp/p

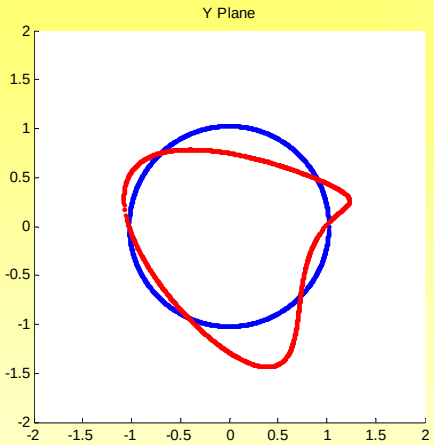


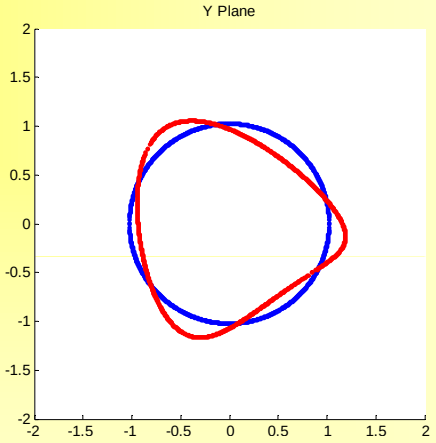




-1% dp/p







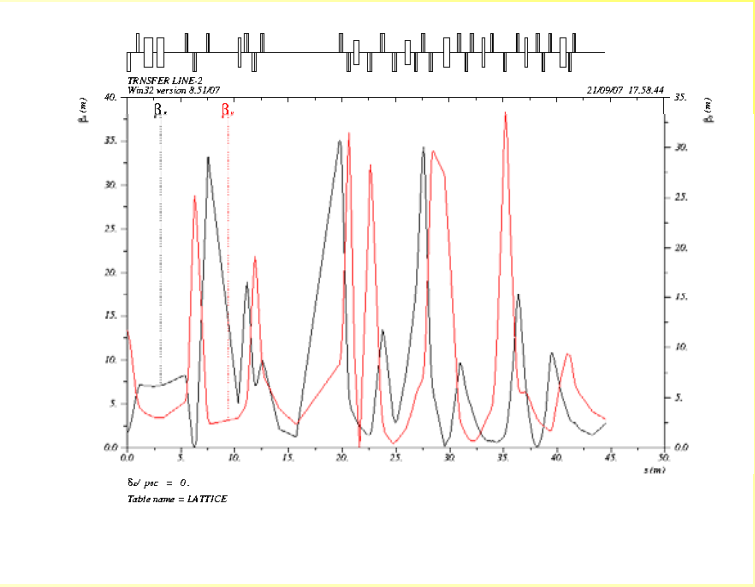
Magnets and power supplies

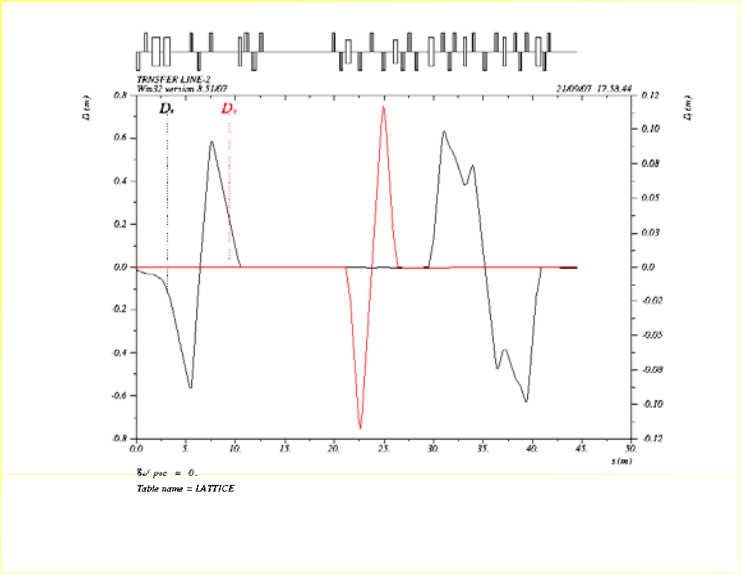
	Module-1		Module-2		Module-3	
	Magnets	**Supplies**	**Magnets**	**Supplies**	**Magnets**	**Supplies**
Dipole	**1**	**1**	**2**	**1**	**4**	**2**
Quadrupole	**3**	**3**	**11**	**10**	**11**	**7**
Sextupole	**---**	**---**	**---**	**---**	**4**	**2**
Total	**4**	**4**	**13**	**11**	**19**	**11**

Low dispersion optics

Additional optics design for easy commissioning
So far : Higher dispersion for T_{566} correction
During Initial run : Low dispersion optics in which sextupoles not switched on

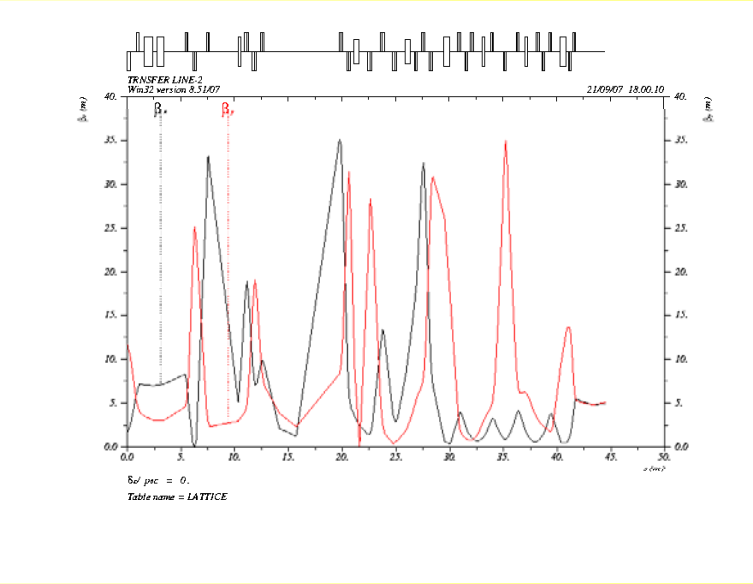
R_{56} = -0.30m

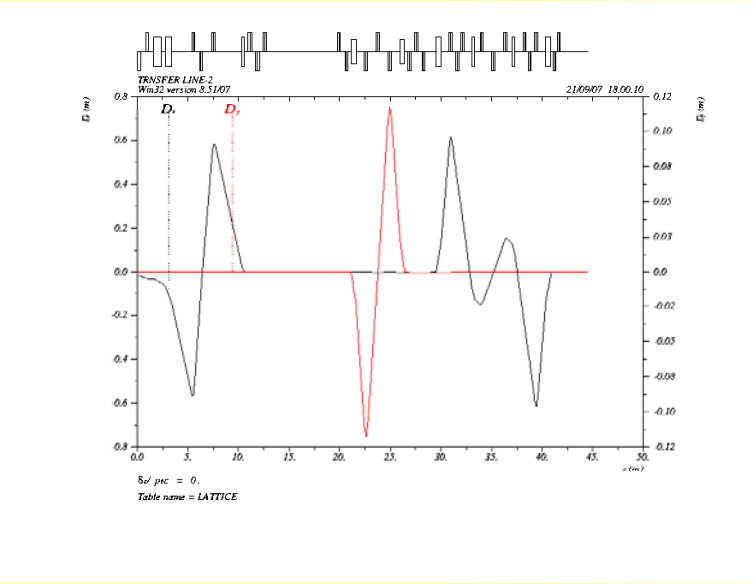




Low dispersion optics *Continued…*

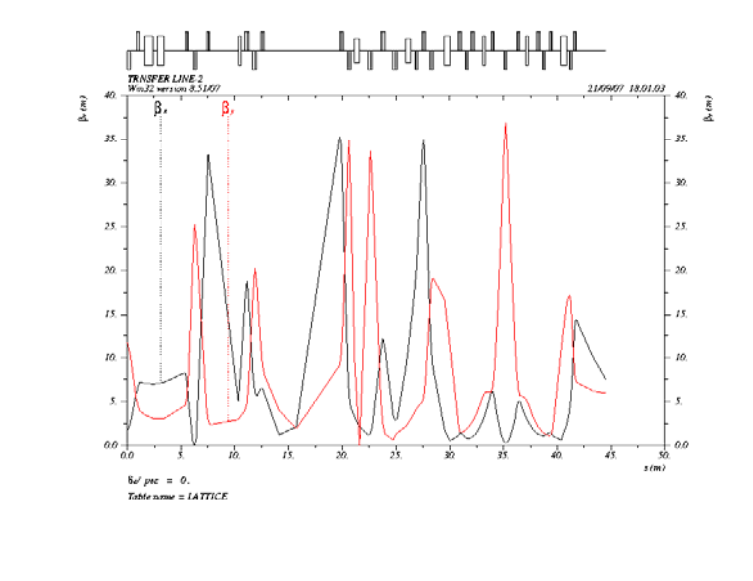
R_{56} = 0.00m

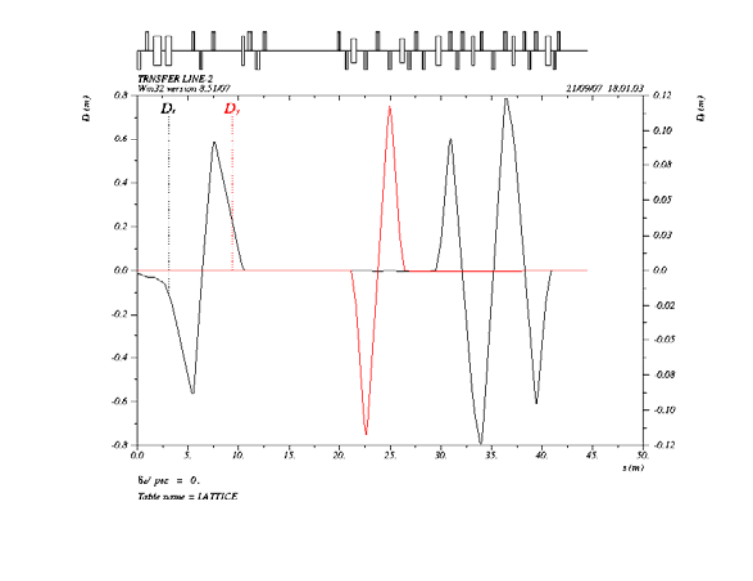




Low dispersion optics *Continued…*

R_{56} = +0.30m





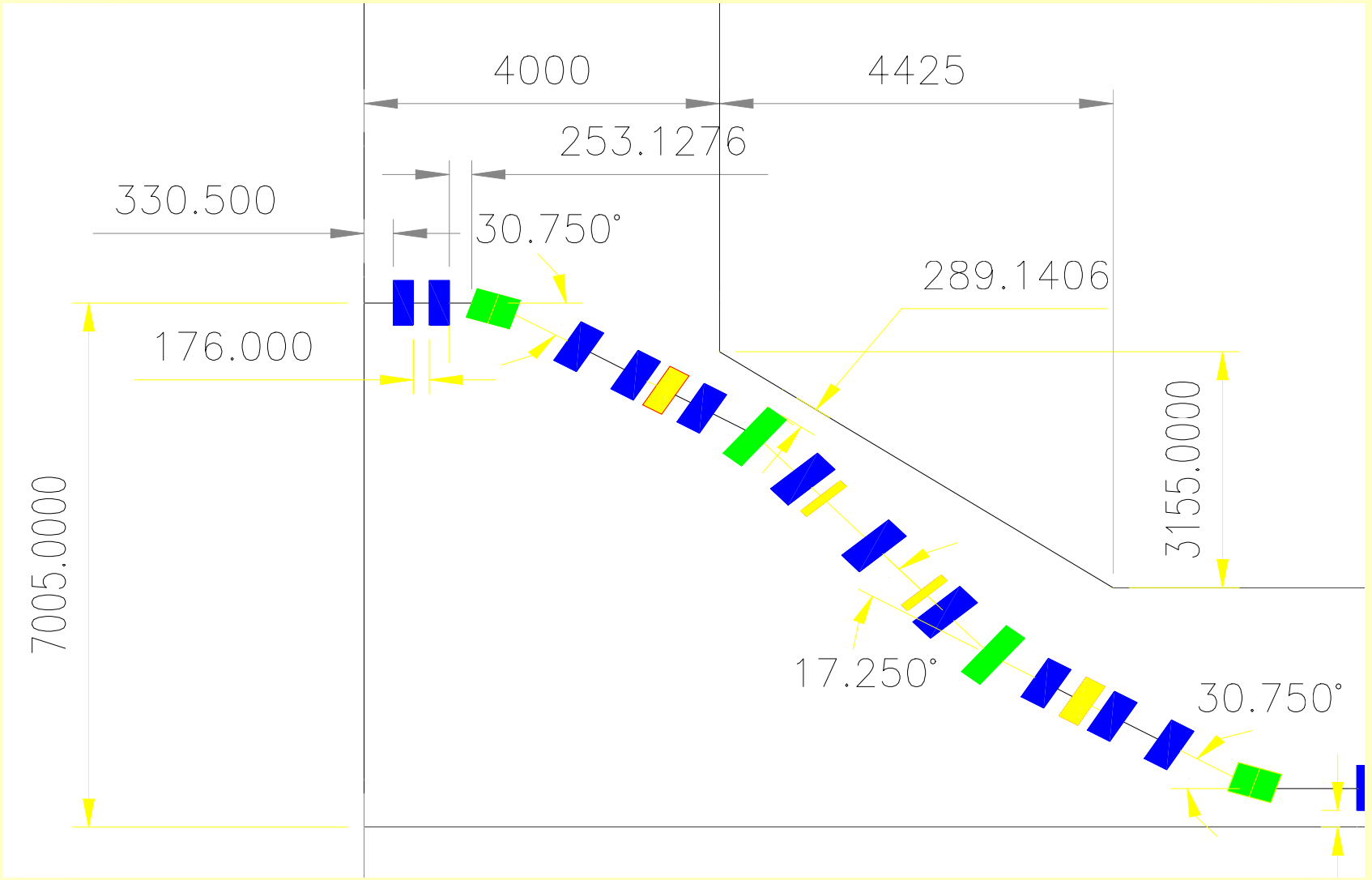
Summary

- *Optics design for entire range of R_{56} using the available magnets (five new dipoles) completed and delivered to CERN*
- *T_{566} corrected in whole range of tuning*
- *Sextupole scheme is optimized for low phase space distortion*
- *Additional Low dispersion optics for initial run (T_{566} ~ -1, while in high dispersion mode T_{566} ~ -3 to -41) incorporated.*

Acknowledgements

- ***Hans Braun***
- ***Gunther Geschonke***
- ***Frank Tecker***

Thanking you


4000
4425
253.1276
330.500
30.750°
289.1406
176.000
7005.0000
3155.0000
17.250°
30.750°