Tuning of IR4 in 2005

Last IR4 study : 1993 (LHC Project Note 93)

The new (2001) IR4 design was approved under the condition that there was no beam screen in the magnets.

The tuning with beam screen is investigated for optics V6.5.

Why tuning IR4 ?

Phases between IP1 and IP5 for :

    - coherent B-B effects

$$\pi(1+2k)$$

    tunability $0.25*2\pi$

  - non-linear chromaticity correction

$$\pi(1+2k \pm 0.12)/2$$

    tunability $\sim 0.1*2\pi$

Why tuning IR4 ?

Tunes adjustment

      Same adjustment for both ring with
      QF QD (powering per octant)

Different adjustment for both ring with
 IR1, IR4 , IR5, IR6, MQT's
 tuning of IR6 IR1 and IR5 less than IR4.

B2 problem

IP1-IP5 phase split :

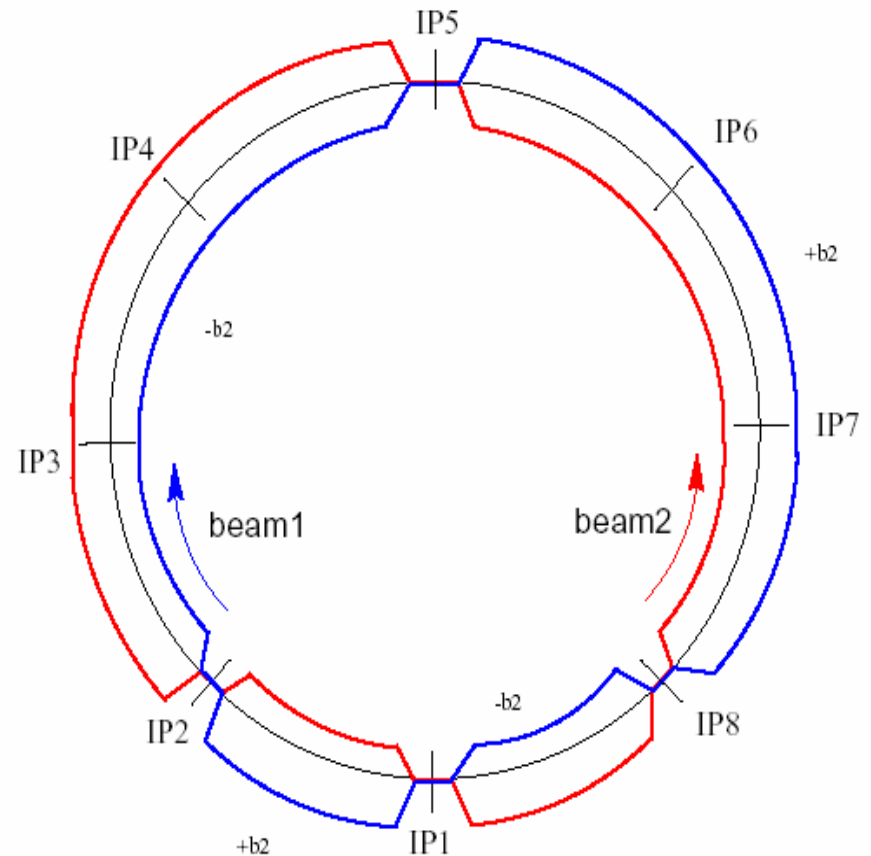$$\Delta\mu = b2\ \beta\ /\ 8\ R$$

With present b2,outer = -1.3,

$$\Delta\mu = 0.11$$

Tune split :

$$\Delta Q = (b2,outer + b2,inner)\ \beta\ /\ 4R$$

b2,outer = -1.3, b2,inner=1.1

$$\Delta Q = 0.035$$

Boundary conditions

N1(s)= position of primary collimator adequate

to protect the chamber at position s

- present value in DS   is 6.67 (max. C.O. 4mm)
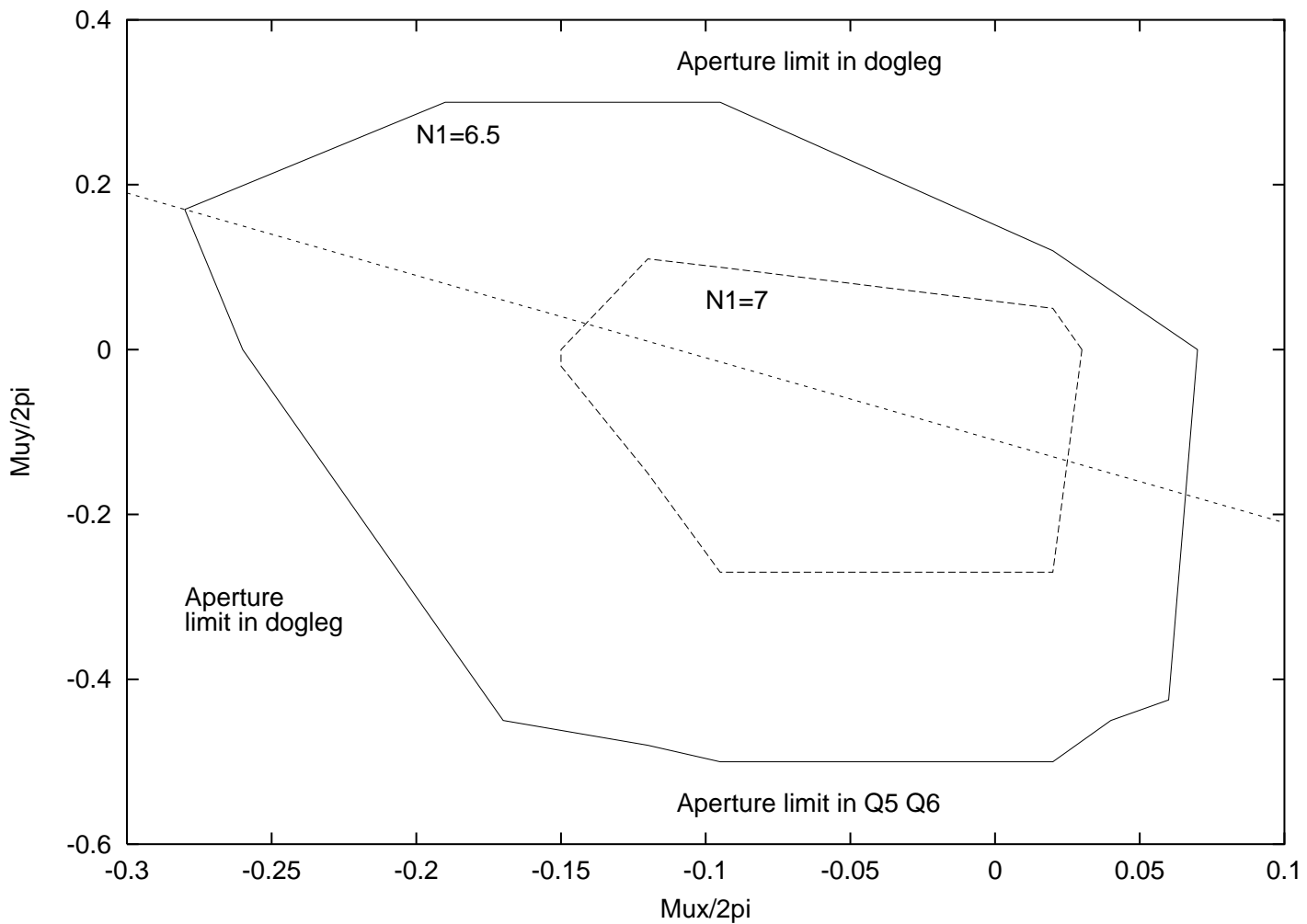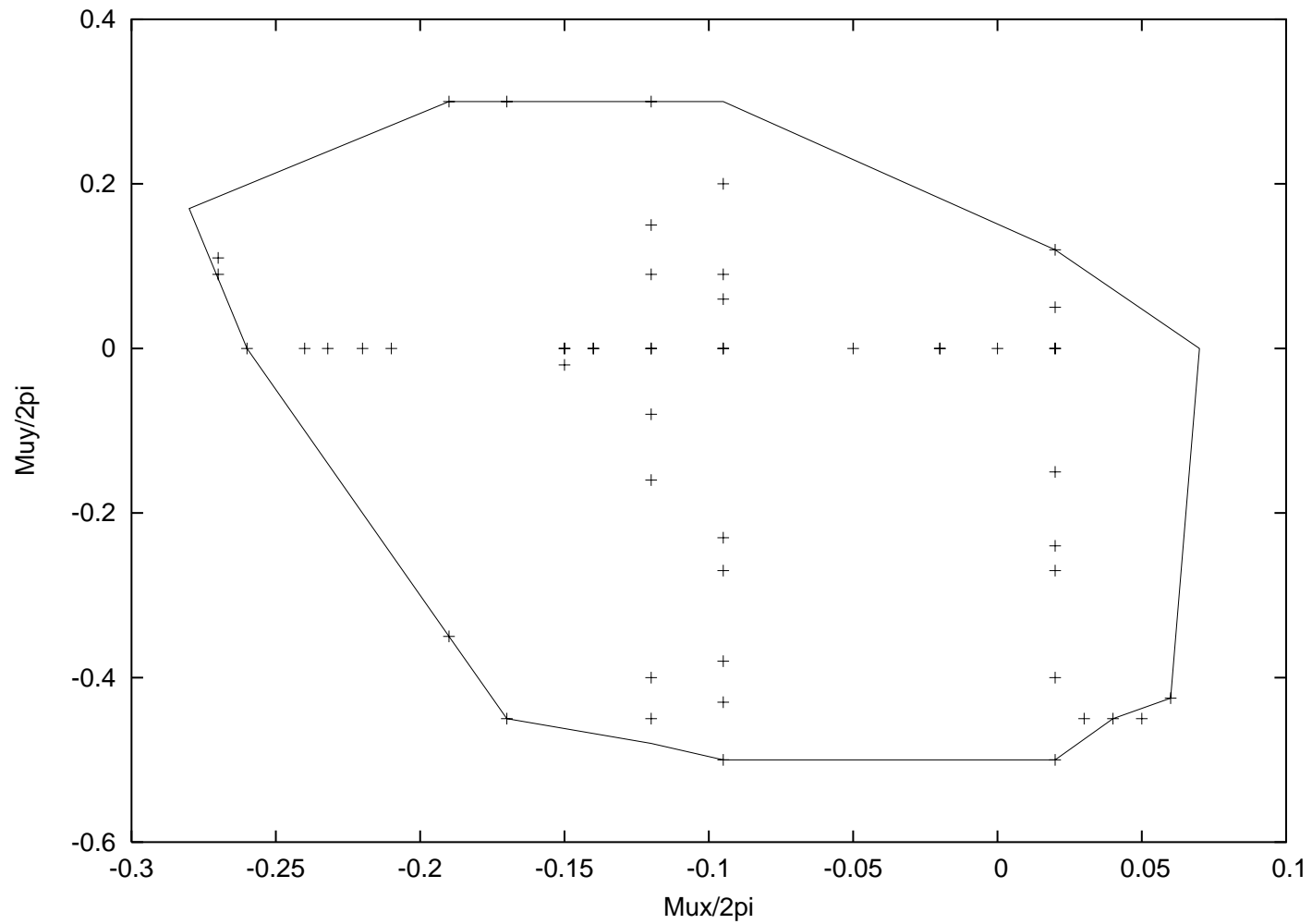
- accepted minimum value of 6.5

Kmax (DS) = 0.00875m-2,
Kmax(ins.) = 0.00685m-2
Kmax (QT) = 0.00514m-2

Closed orbit 3.45mm

Tuning diagram

Aperture limit in dogleg

N1=6.5

N1=7

Aperture
limit in dogleg

Aperture limit in Q5 Q6

Muy/2pi

Mux/2pi

0.4

0.2

0

-0.2

-0.4

-0.6

-0.3   -0.25   -0.2   -0.15   -0.1   -0.05   0   0.05   0.1

For all points : kqtl < 0.00187m^{-2} (35% from nominal)

Conclusion

Tuning of IR4   sufficient if :

- min N1 = 6.5
- Max. C.O. 3.45mm
- Difference in b2s < 1 unit
- IR4 not used for non-linear chrom.

Otherwise :
 - update IR1 IR5 tuning
 - special quadrupoles in IR4 ??