LCU meeting 4-Nov-08

Linear Coupling correction for the LHC 'as built' (inj. energy)

F. Roncarolo

thanks to: S. Fartouk, M.Giovannozzi, W.Herr, T.Risselada

Linear coupling correction

Routines by S.Fartouk:

- **Local correction** : setting of two couples of MQS / arc in order to compensate the a2 error in the dipoles

- **Global correction** : compensate residual a2 (from not-perfect local correction or from a2 sources other than MBs)

  ➡ tilt (roll) in quadrupoles

  ➡ vertical offset in normal sextupoles

MADX simulation templates - I

Modified version of template jobs in MADX repository

Setting of a2 errors in MBs
to save cpu time: I converted all error tables in order to use **seterr** instead calling EFcomp every time I want to reload the errors - thanks to Werner's advice

```
readtable, file="/afs/cern.ch/user/g/giovanno/w1/WISE/testMADX/injection_errors-emfqcs-SEED.tfs";
call,      file="dm/Efcomp_MB.madx";
.....
......
esave, file = "errors/injection_saved_errors-SEED.tfs";
```

Done once for the 60 seeds

New piece of madx script

```
call, file=save_err_flags.madx;

system, "python read_errors.py /local/OM/myprojects/ERRORS/COUPLING/errors/
injection_saved_errors-SEED.tfs";
system, "cp -f temp/errors_on.tfs tables/errors-no_corrCASE-SEED_rmaxROLLMAX.tfs";

!!now error table is in "temp/errors_on.tfs"
readmytable, file="temp/errors_on.tfs", table=newerr;
seterr, table=newerr;
```

Some manip to apply previously defined error flags (ON_B1S etc....)

Load desired errors

At least a factor 2 faster than using EFcomp

MADX simulation templates - II

If desired, add additional a2 error sources

```
!++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
!          PUT RANDOM ROLL ERRORS IN ALL QUADS
!++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
select, flag=error, clear ;
select, flag=error, pattern=^mq;
!ealign, dpsi:=ROLLMAX*TGAUSS(1.5)/1.5;

a2max=sin(2*ROLLMAX);
a2rand := a2max*TGAUSS(1.5)/1.5;

value, Rr;
Efcomp,  radius = Rr, order= 1, dksr:={0, a2rand};
```

For instance: ROLLMAX = 1.5mrad
--> a2 ~ 30e-4

Printout optics + k values useful to calculate coupling
Apply corrections

- ✓ Correct MB errors with MQS sector by sector
  printout optics + k values useful to calculate coupling
- ✓ Correct residual a2 + feed down errors
  printout optics + k values useful to calculate coupling

Without correction

Local correction 1

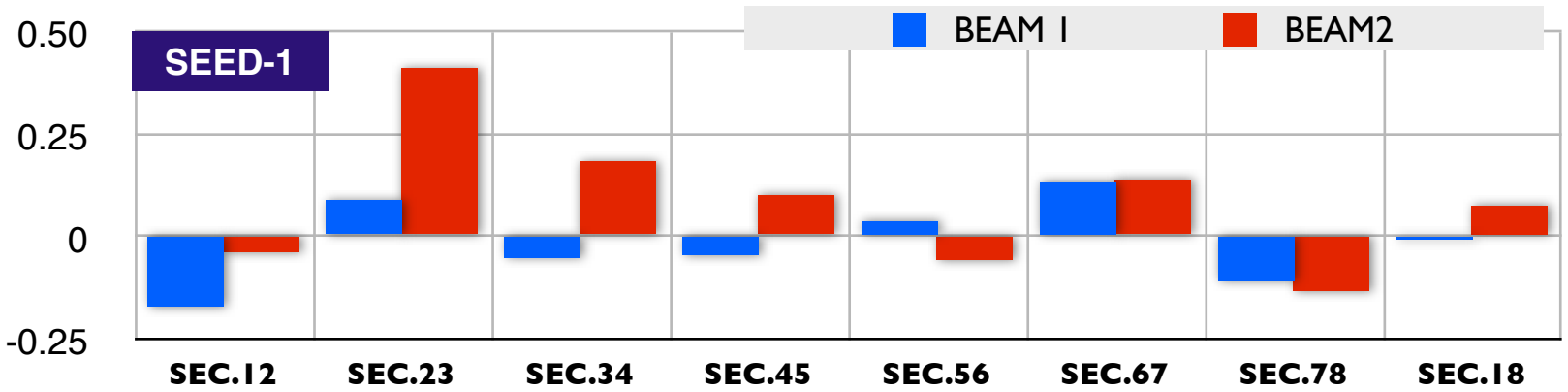
Global correction 2

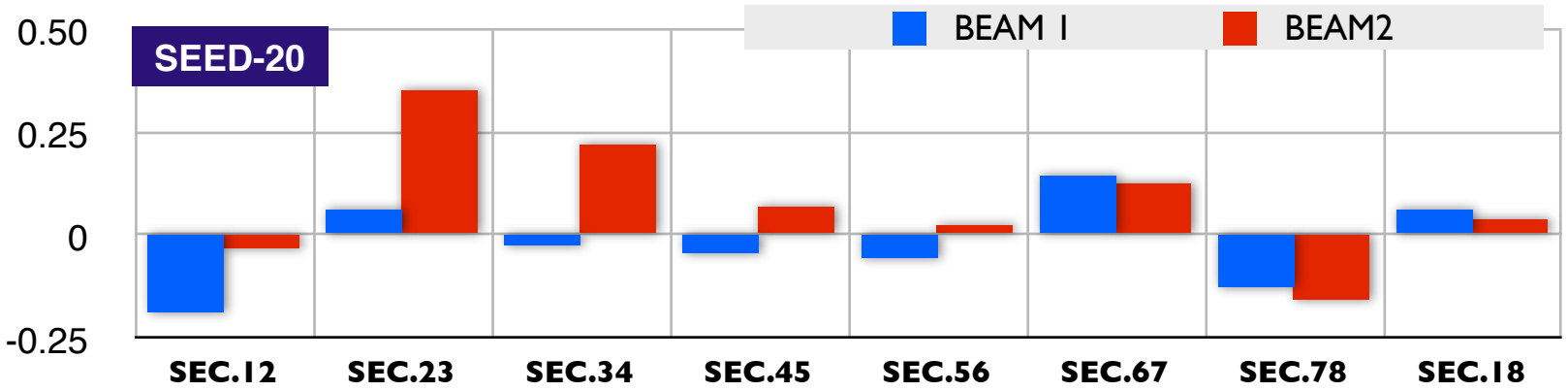
3 traces on most of the plots that will be shown

Average a2 per sector (from mag meas files)

SEED-1	MEAN	RMS	MEAN	RMS
SECT12	-0.1688	0.80802	-0.03596	0.93996
SECT23	0.08616	0.86881	0.40840	0.99546
SECT34	-0.0504	0.96716	0.18005	1.06774
SECT45	-0.0437	0.85611	0.09945	0.88083
SECT56	0.03630	0.80121	-0.05743	0.79291
SECT67	0.13455	0.98436	0.13812	0.91012
SECT78	-0.1052	1.21582	-0.12950	0.98454
SECT81	-0.0052	0.88786	0.07827	0.87580

SEED-20	MEAN	RMS	MEAN	RMS
SECT12	-0.1901	0.80970	-0.03216	0.88652
SECT23	0.06347	0.91875	0.35590	1.01731
SECT34	-0.0238	0.89437	0.22193	1.08214
SECT45	-0.0435	0.89689	0.06962	0.92265
SECT56	-0.0562	0.79469	0.02212	0.89974
SECT67	0.14631	0.98349	0.12821	0.92301
SECT78	-0.1263	1.17684	-0.15460	0.97137
SECT81	0.06004	0.82355	0.03579	0.95625





Variables in the plots

In the following plots: **Without correction** | **Local correction** | **Global correction**

$$|C^{\pm}| = \left| \sum_{s_i=0}^{s} \sqrt{\beta_x(s_i)\beta_y(s_i)} \cdot e^{j(\mu_x(s_i) \pm \mu_y(s_i))} \mathrm{KS1L(s_i)} \right|$$

COUPLING

Remark: for Beam2 I need to reverse sign of KS1L (calc. with TWISS) for MQS to get consistent results (to be understood...)

ΔD_y

Differences w.r.t to nominal optics with no errors, no corrections

$\Delta\beta_x \quad @ \quad \beta_{max}$

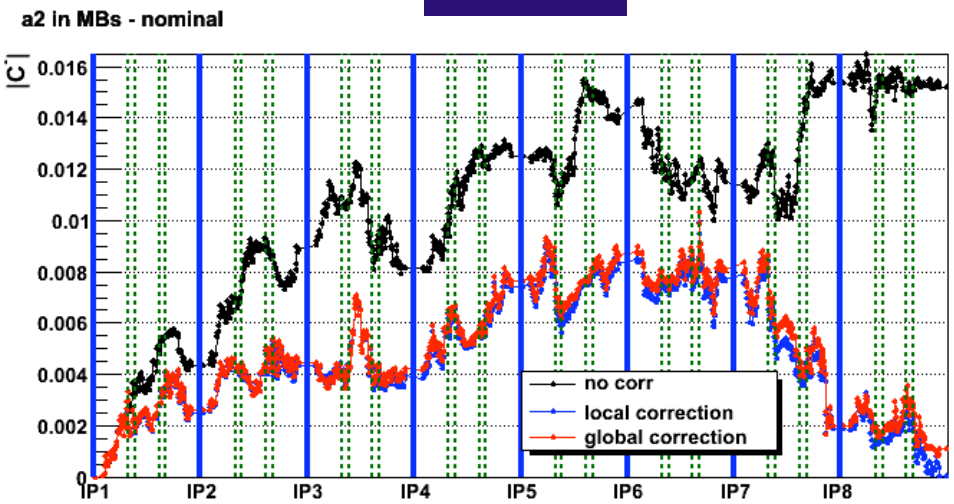
All other optics parameters of course available even if not shown

REMINDER: all done at 450 GeV

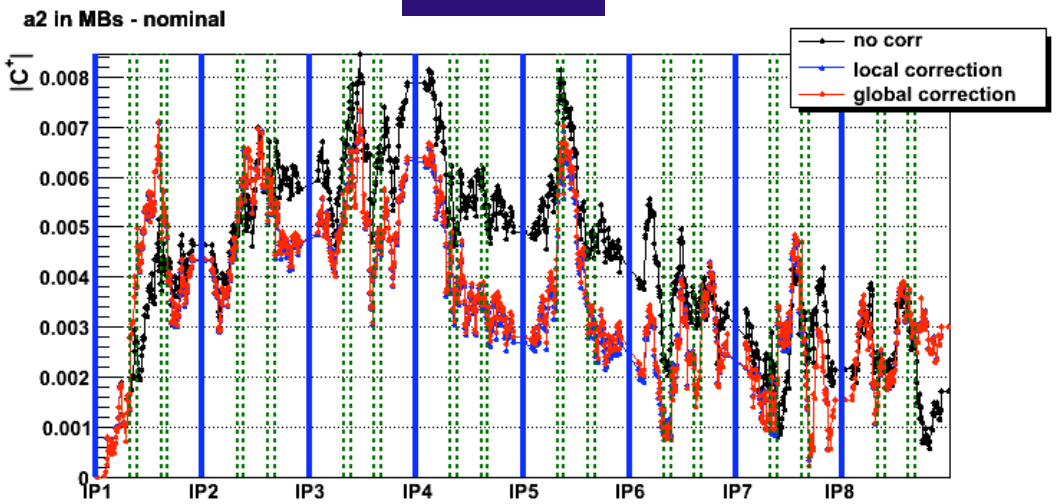
a2 in MBs only, BEAM 1

= MQS locations

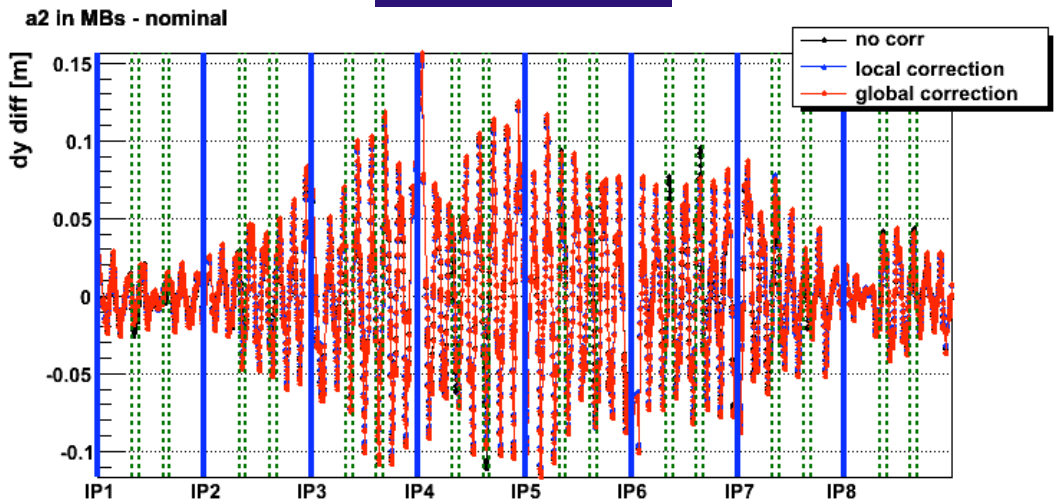
C-



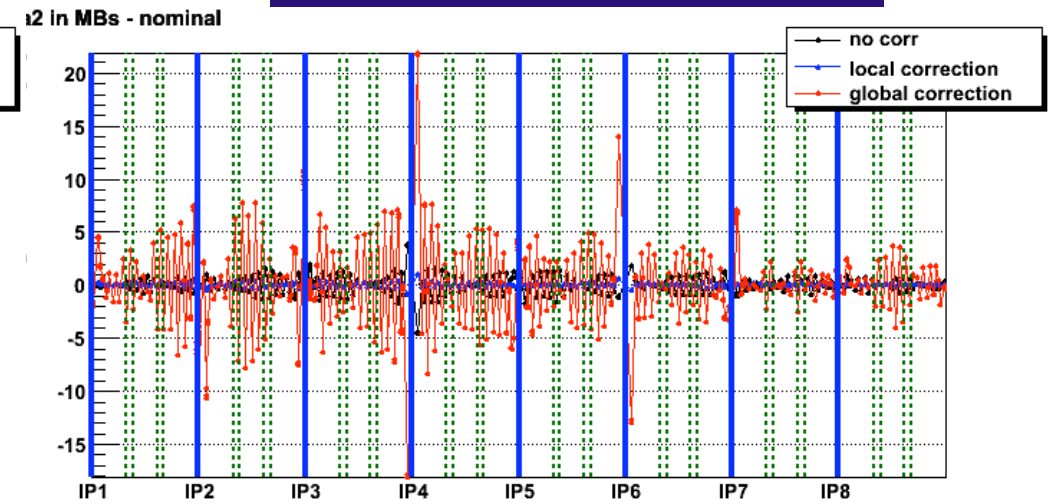
C+



Delta DY



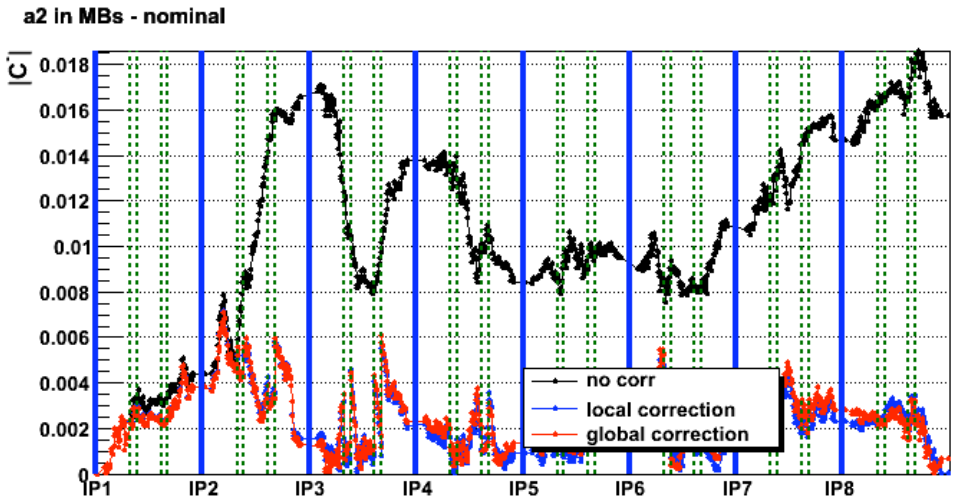
Delta Betax @ Beta max



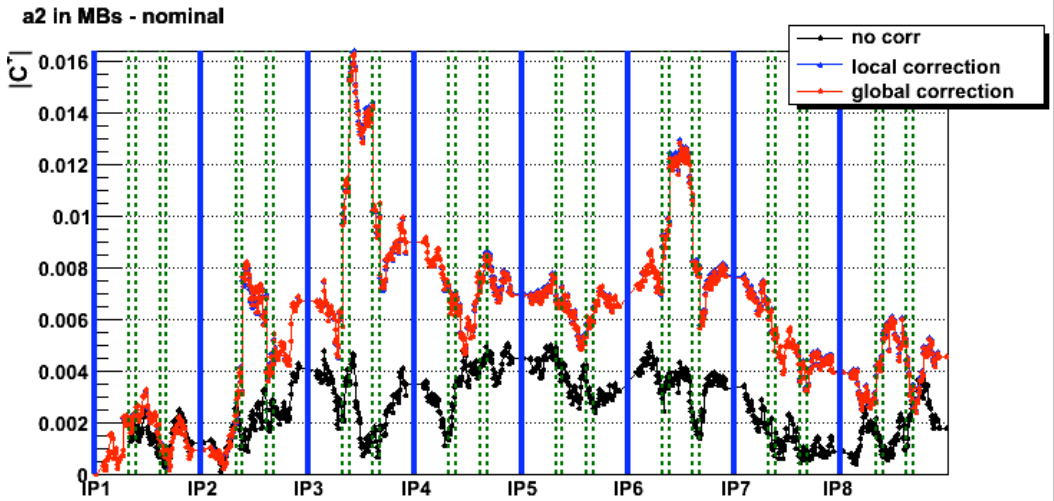
a2 in MBs only, BEAM 2

= MQS locations

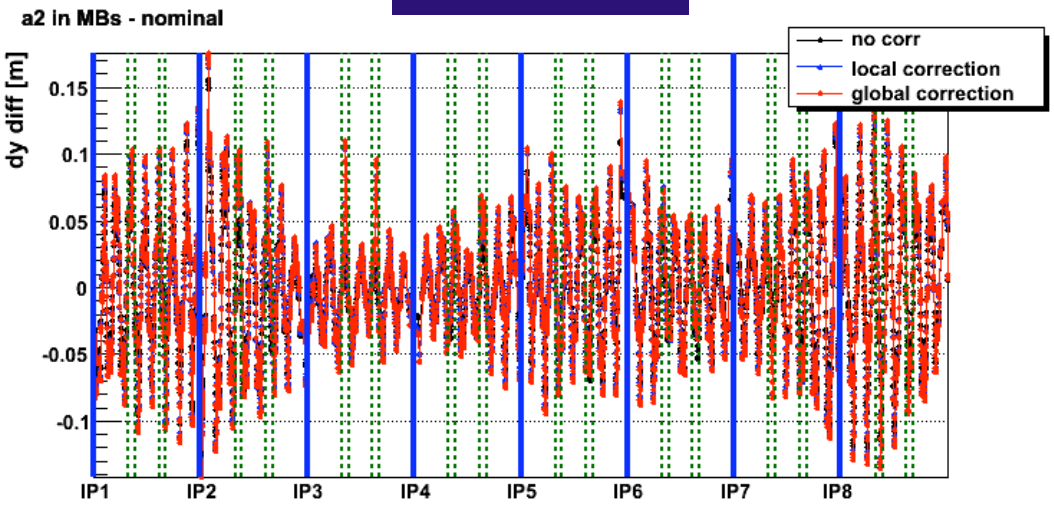
C-



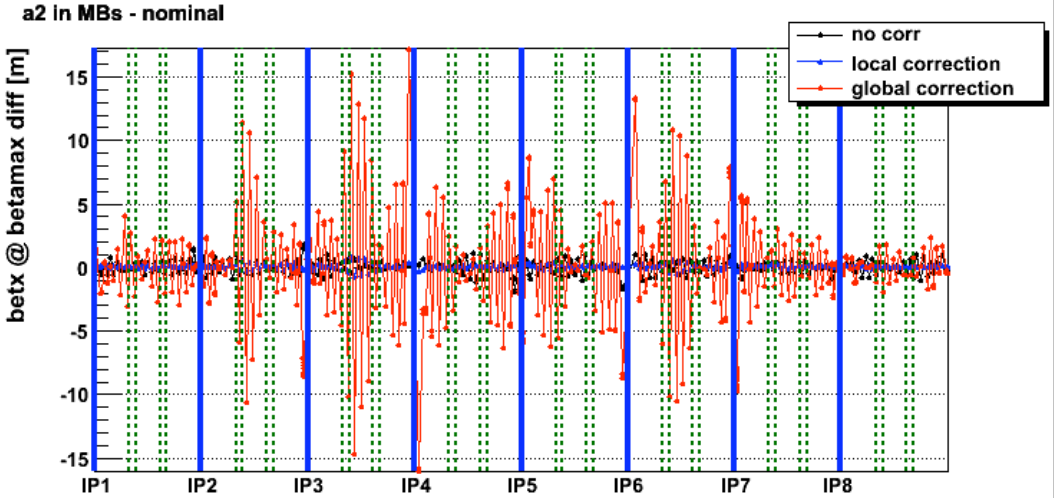
C+



Delta DY



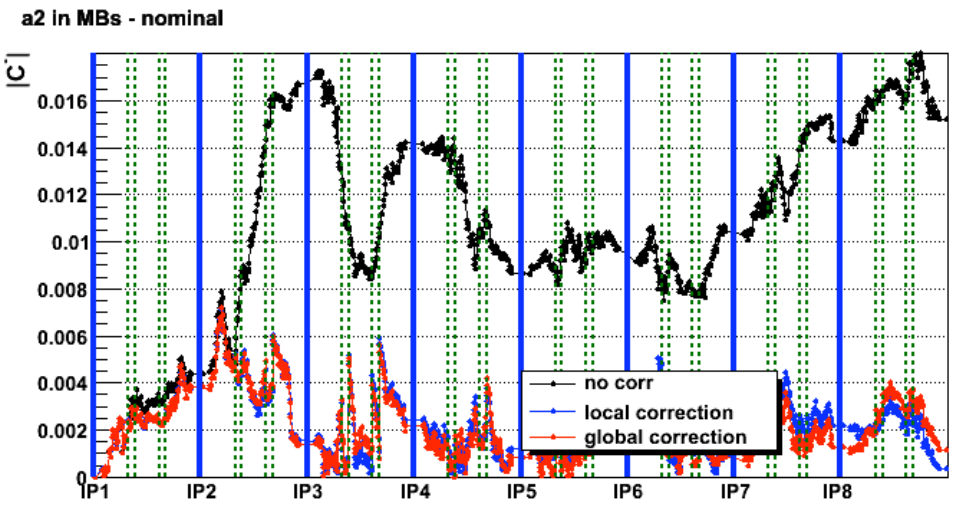
Delta Betax @ Beta max



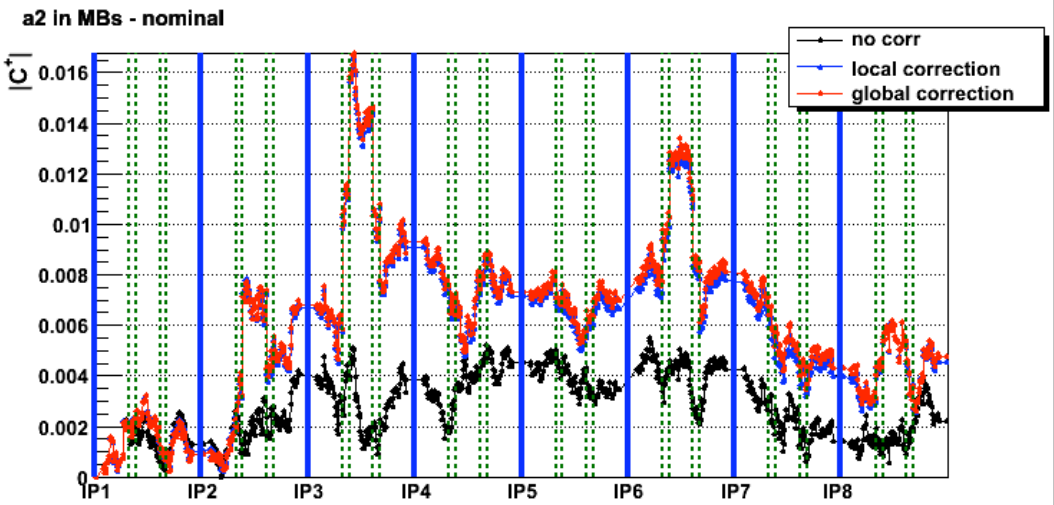
a2 in MBs + rollmax = 5mrad, BEAM 2

= MQS locations

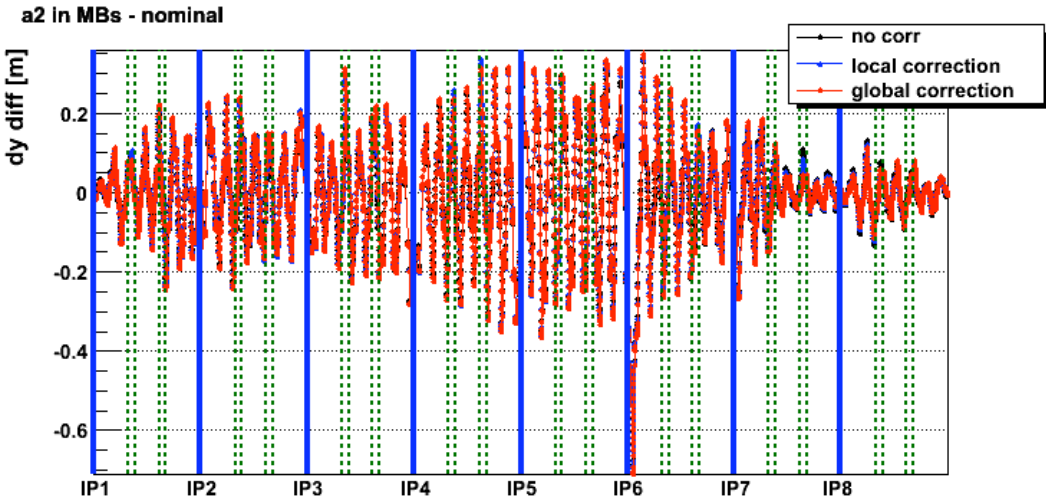
C-



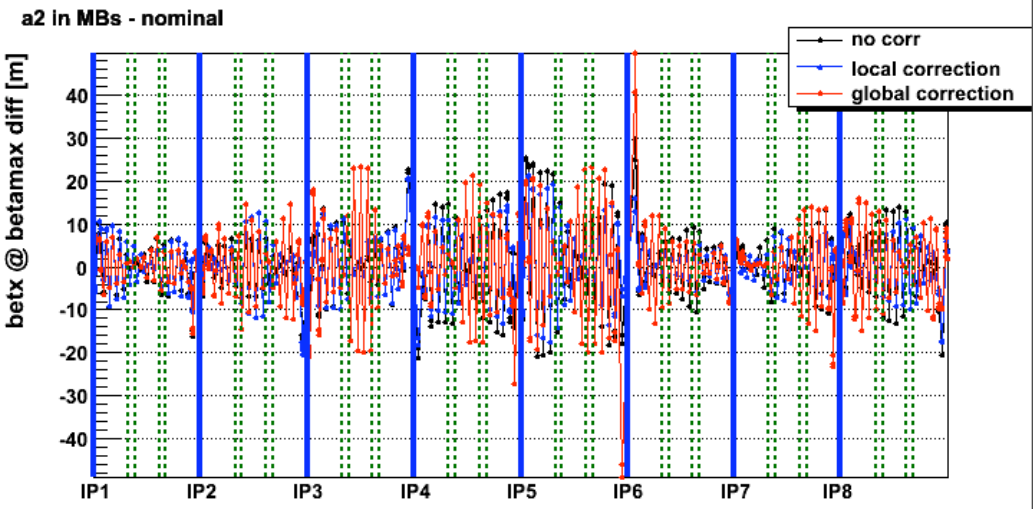
C+



Delta DY



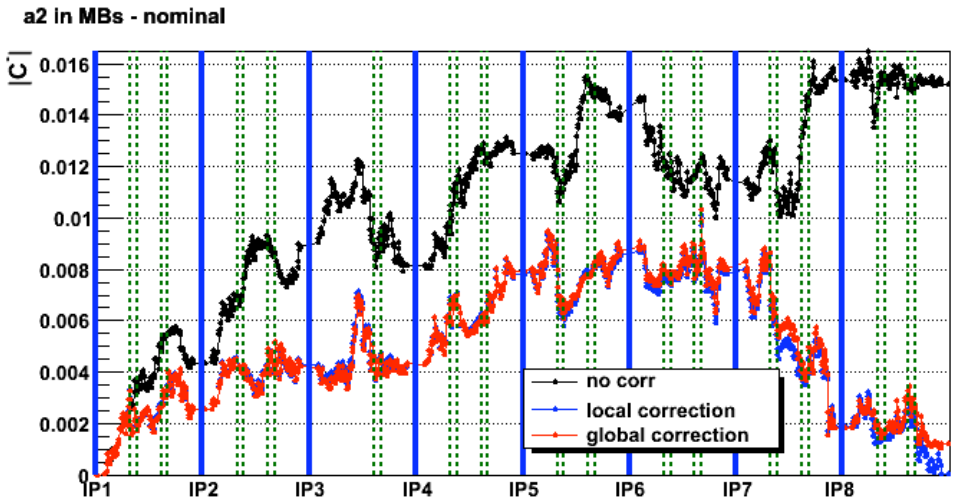
Delta Betax @ Beta max



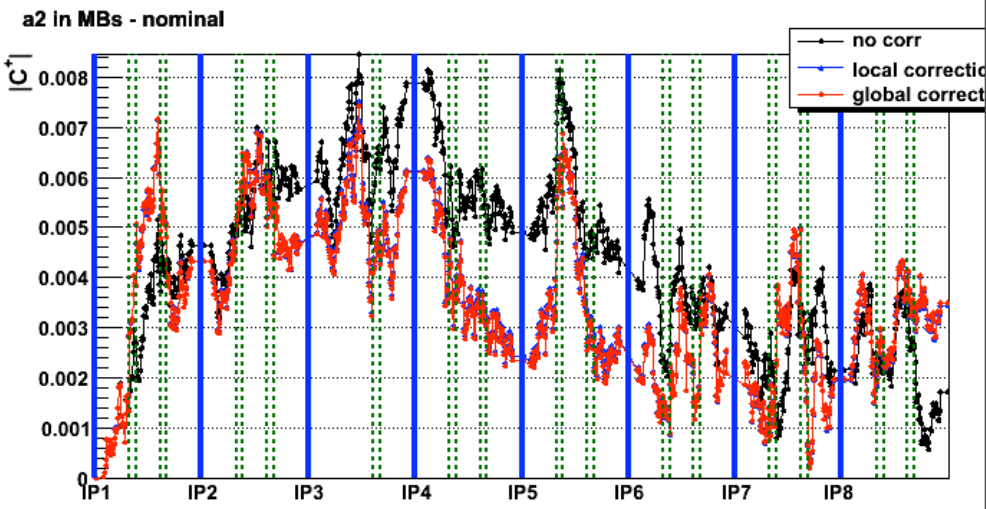
a2 in MBs, no MQS 23/27R3, BEAM 1

= MQS locations

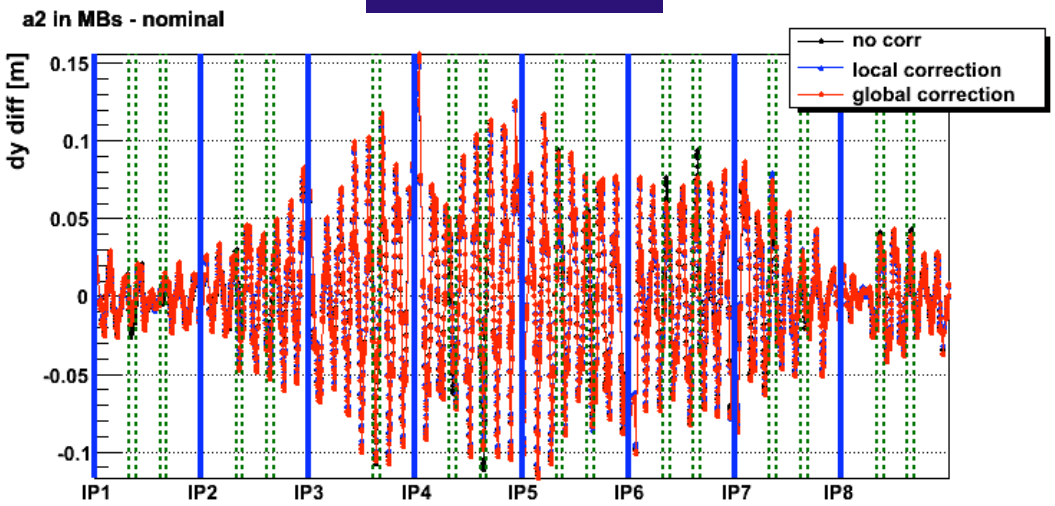
C-



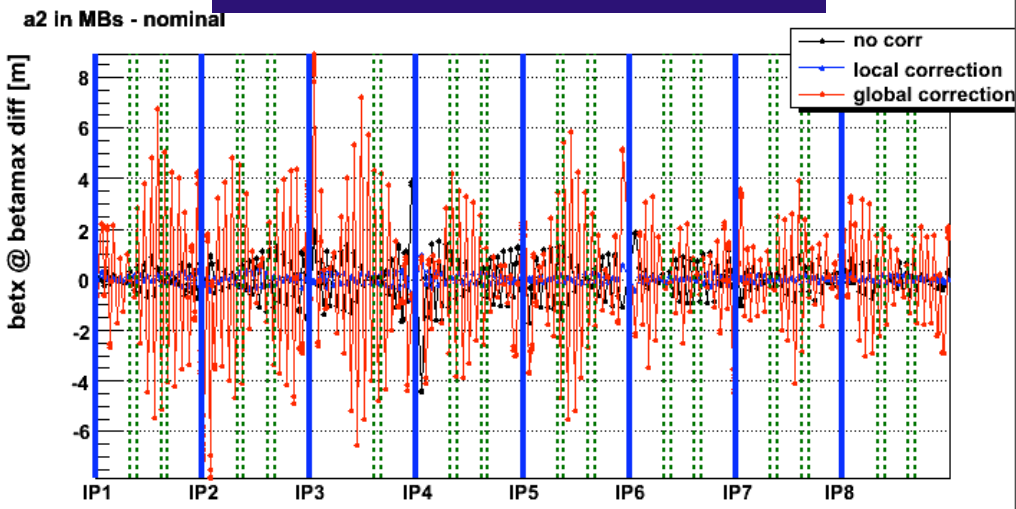
C+



Delta DY



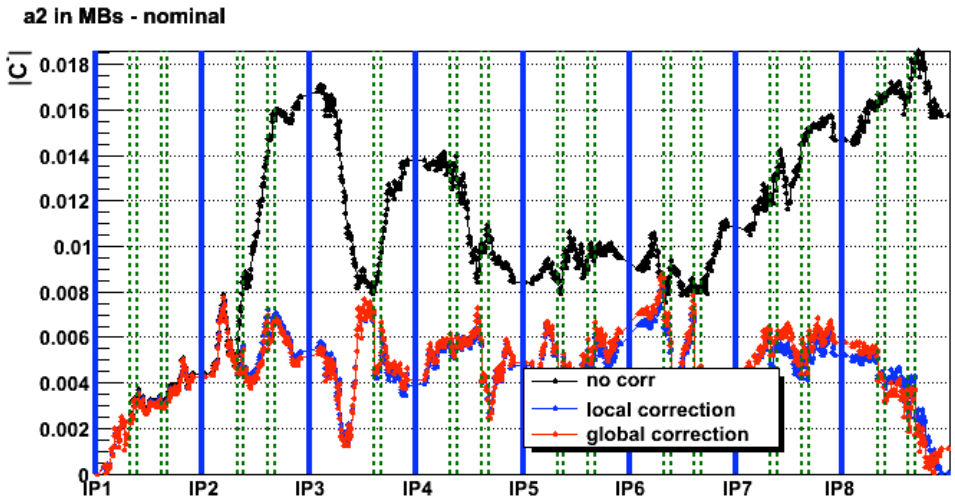
Delta Betax @ Beta max



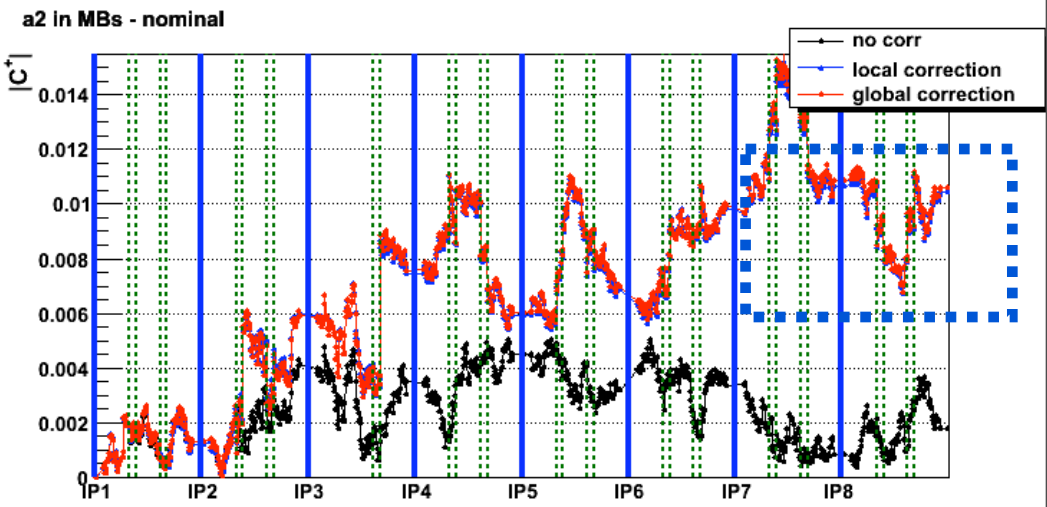
a2 in MBs, no MQS 23/27R3, BEAM 2

= MQS locations

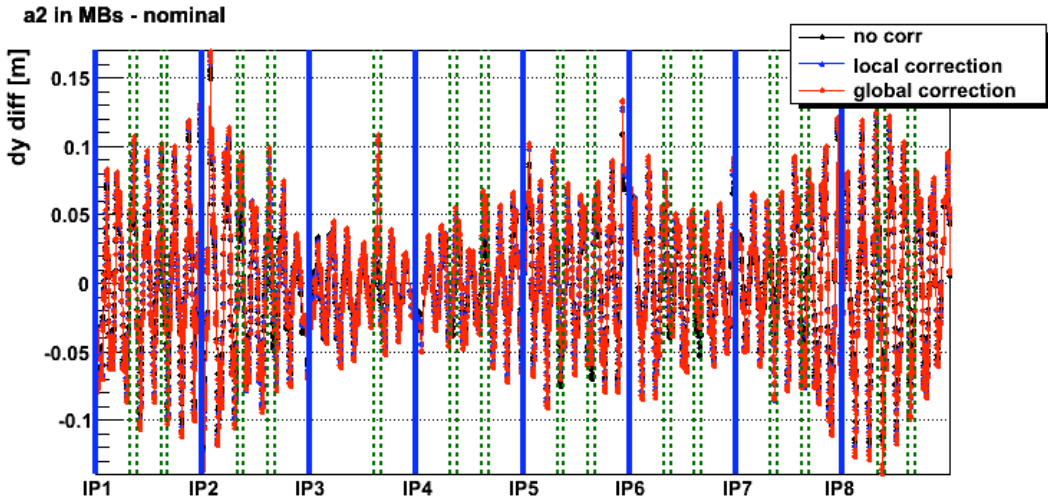
C-



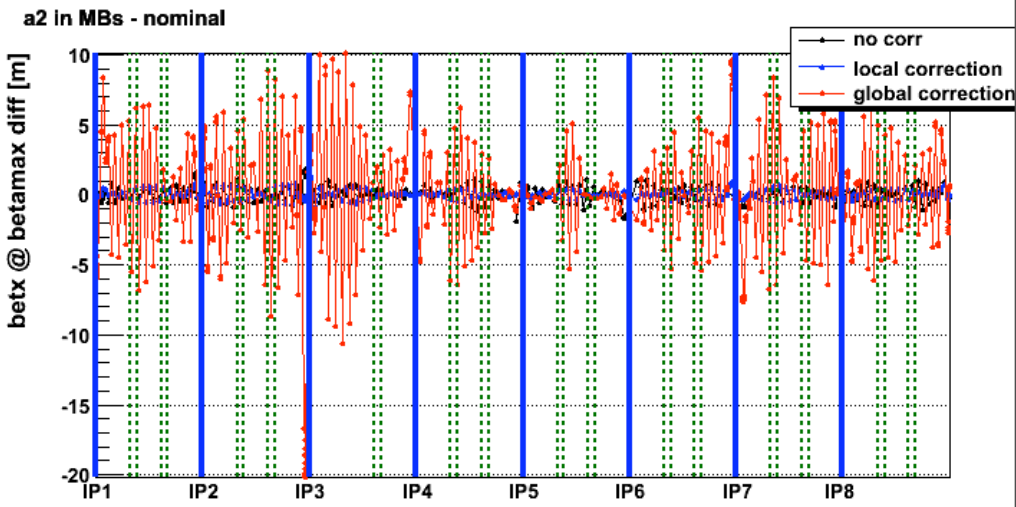
C+



Delta DY



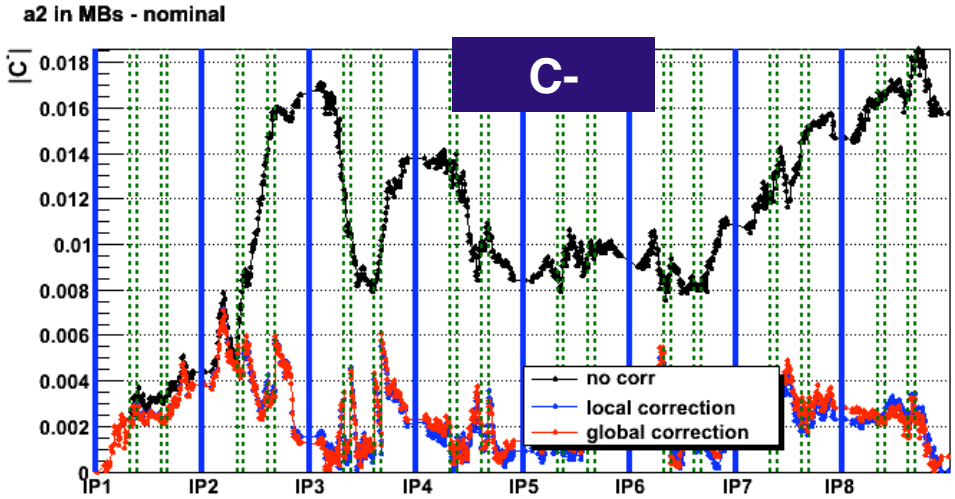
Delta Betax @ Beta max

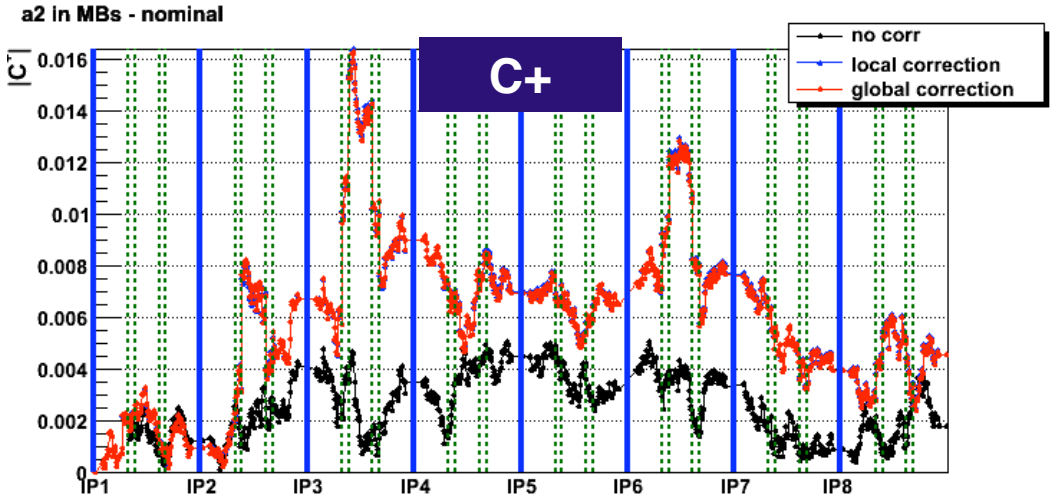


BEAM 2 with and without MQS 23/27R3

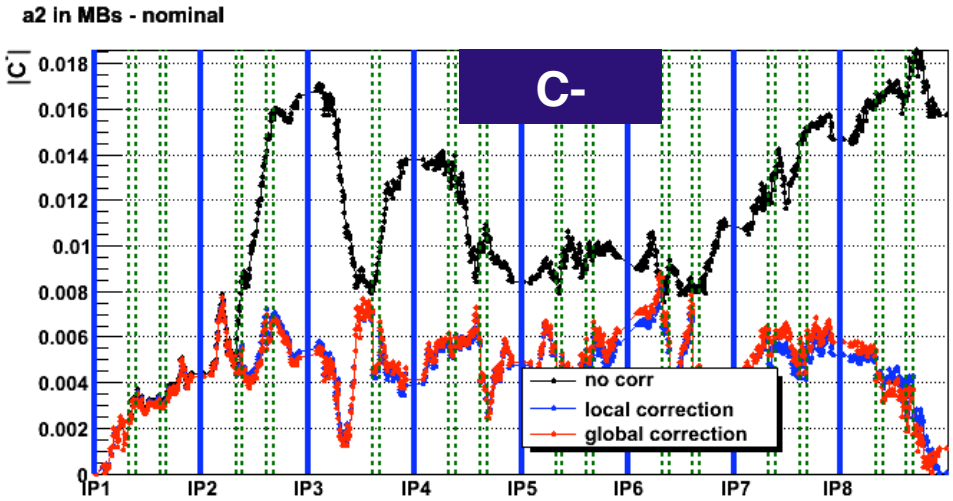
= MQS locations

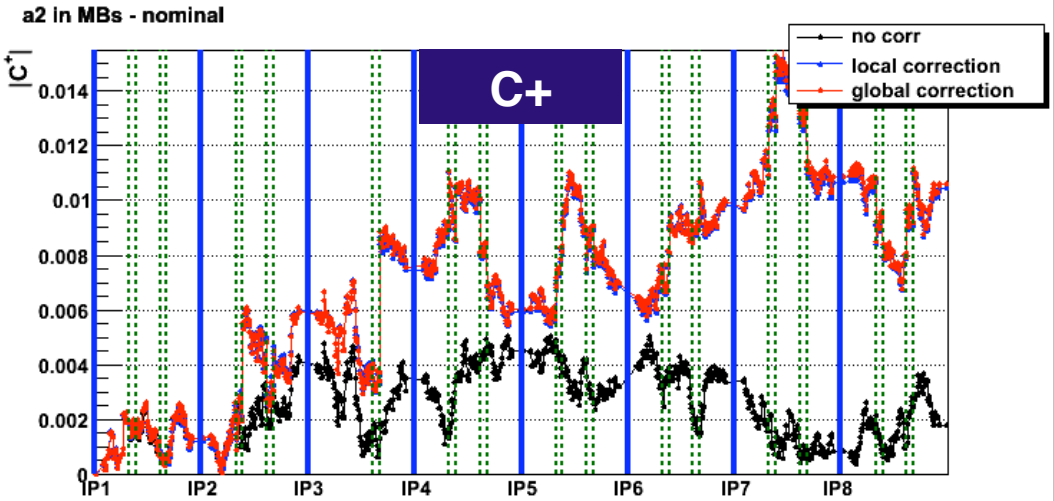
WITH ALL MQS





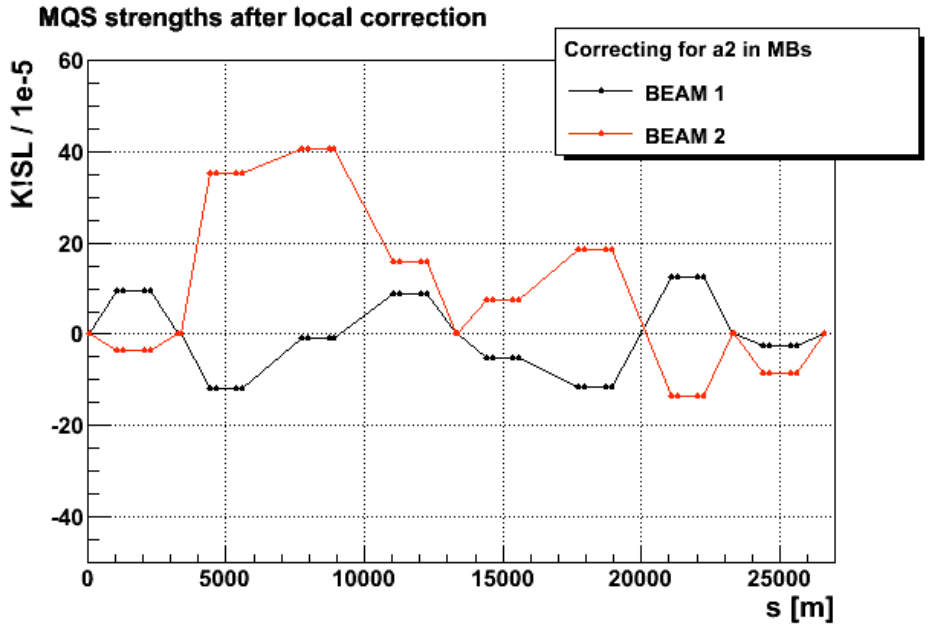
WITHOUT MQS 23/27 R3



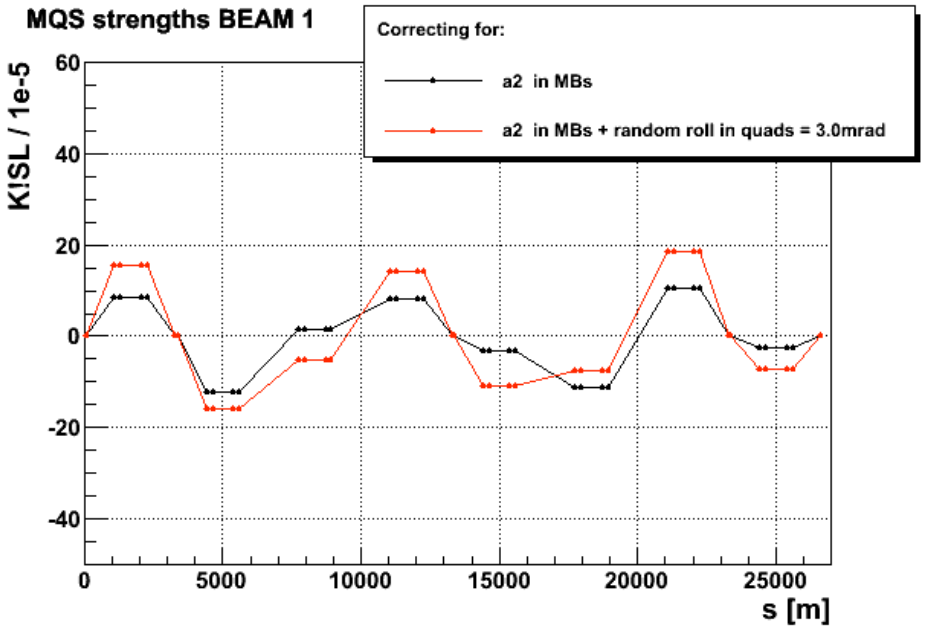


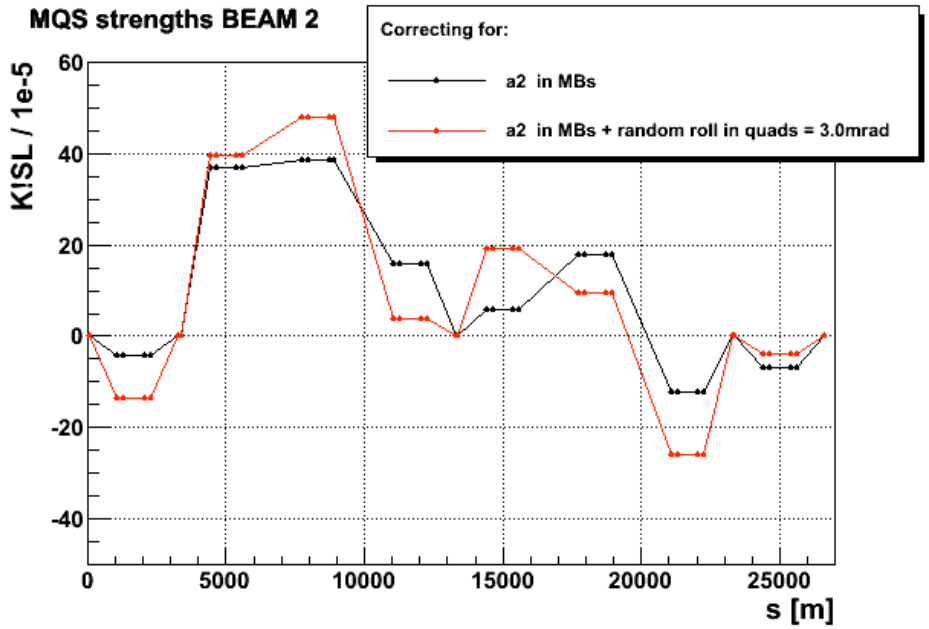
MQS corrector settings

After LOCAL correction



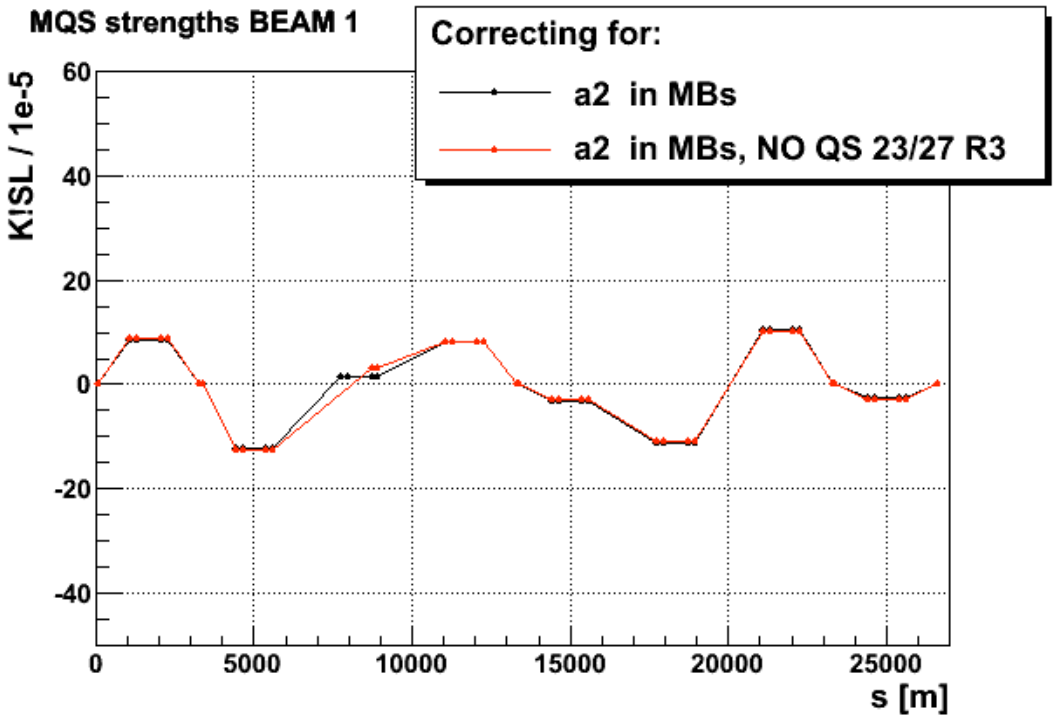
After GLOBAL correction

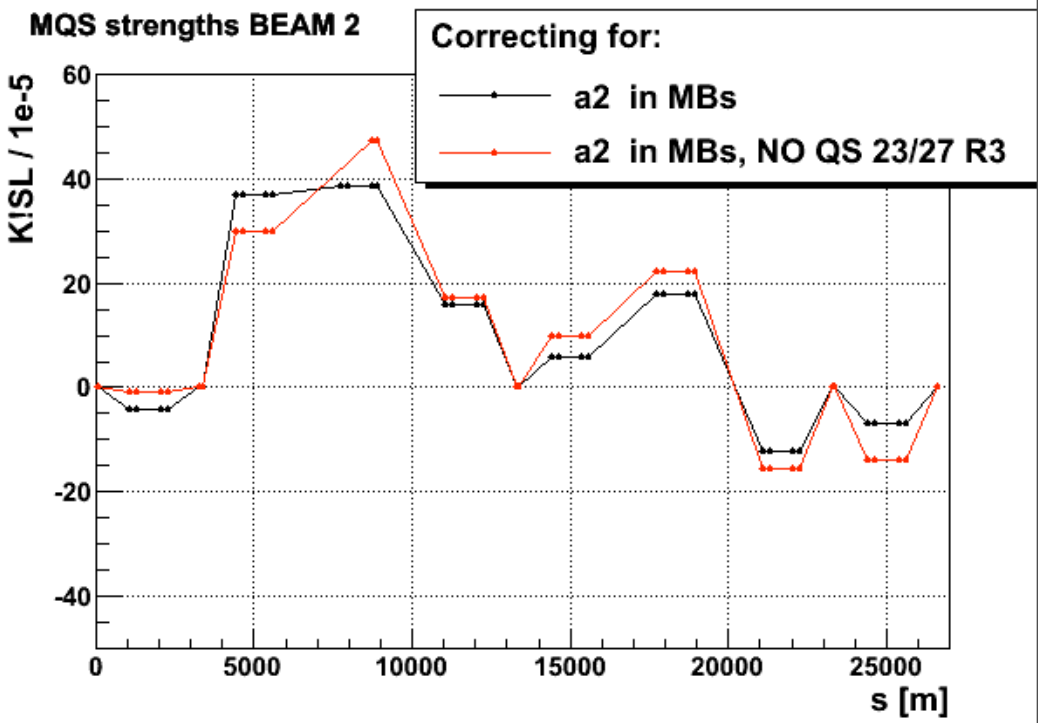




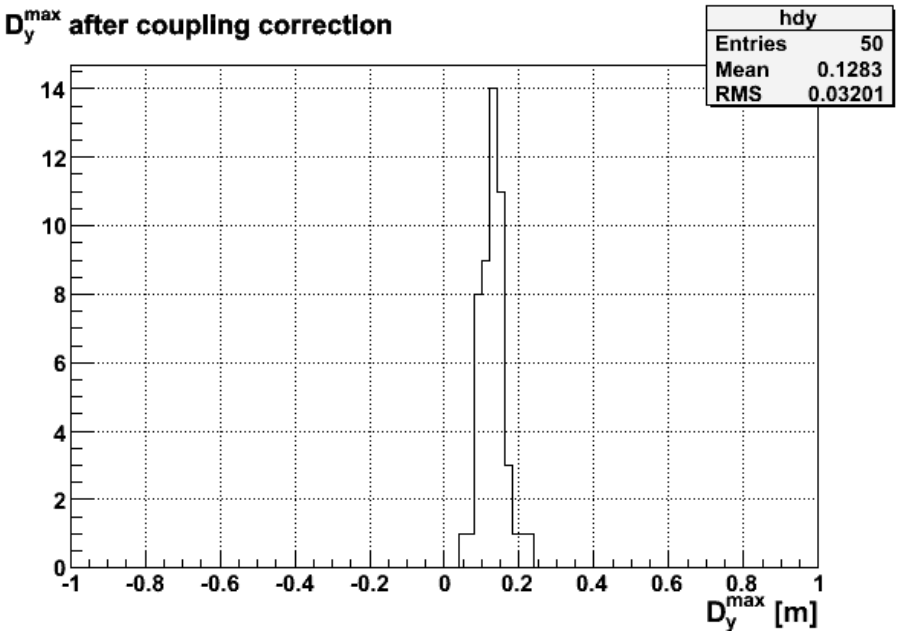
MQS corrector settings without MQS in R3

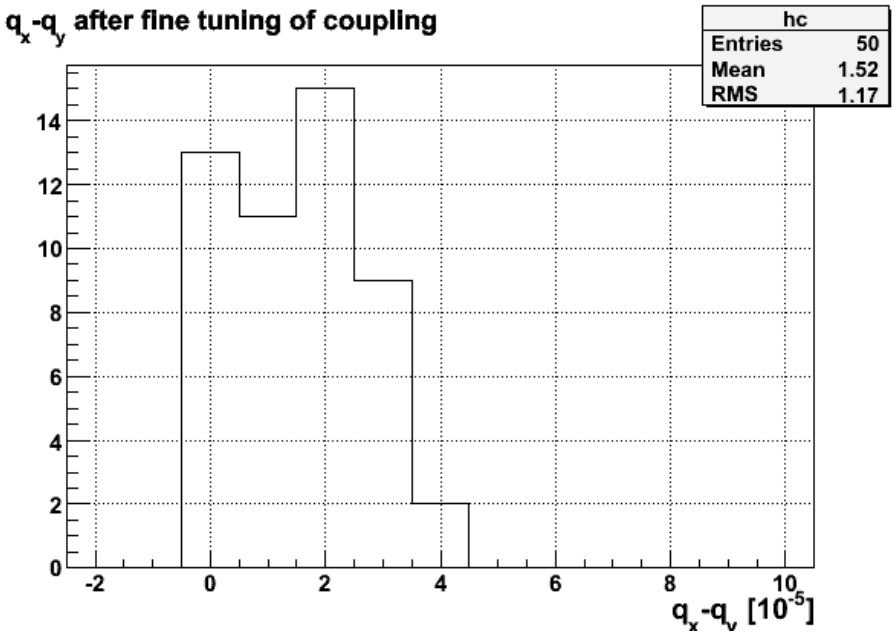
After GLOBAL correction



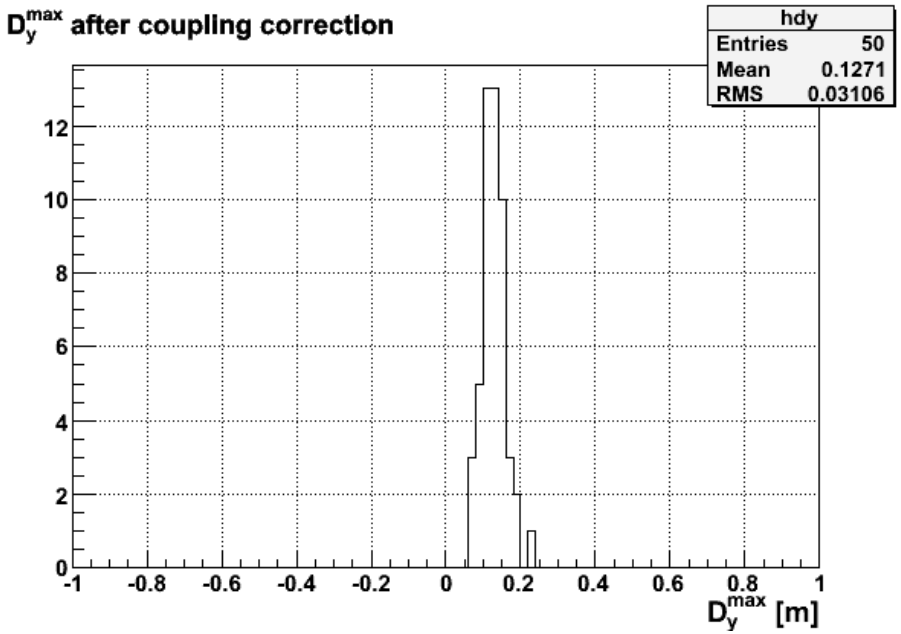


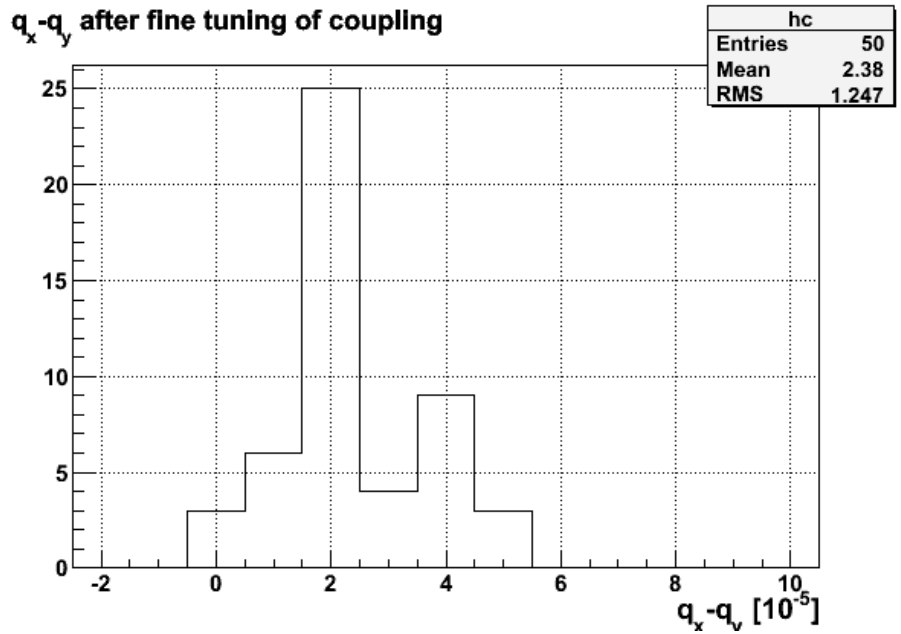
Some statistics over the error 'SEEDS' (preliminary)





Without QS-23-37 R3





Conclusions

- linear coupling local and global correction do their job
- residual c+ if QS23-27 R3 missing
- need to understand why for beam 2 I've revert the kqs sign for calculating c+ and c-

To be done

- add feed down from sextupoles
- more statistics on seeds
- 7 TeV ?
- put in OM ?
- translate to PTC ?