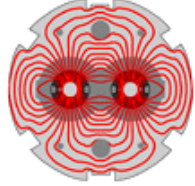


Measurements at 40cm and Computer Aided Segment By Segment corrections

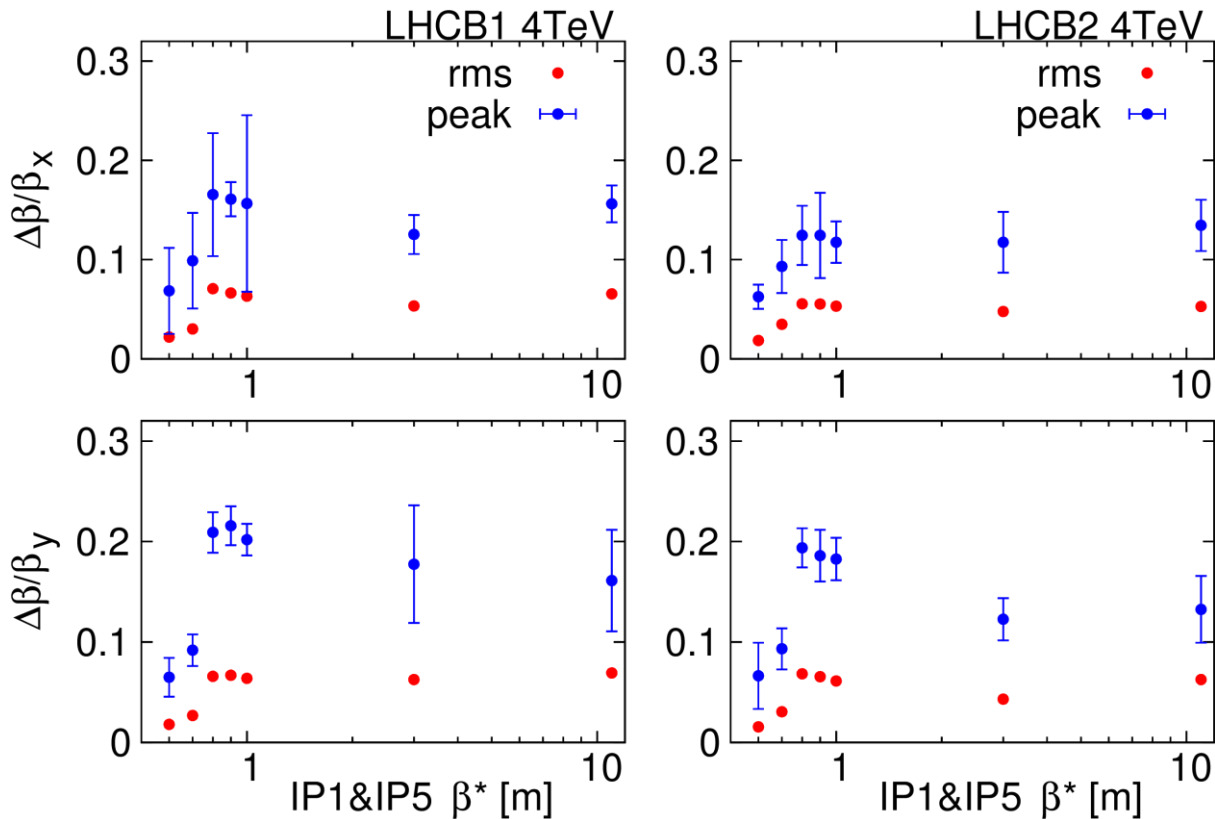


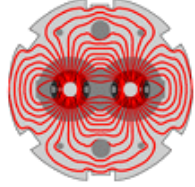
Piotr Skowroński

Local Corrections aka Segment-by-Segment



- ◆ The correction strategy:
 - First local errors around IRs are corrected with S-b-S
 - The global correction is applied only afterwards
- ◆ This method proved itself leading to beating below 7%

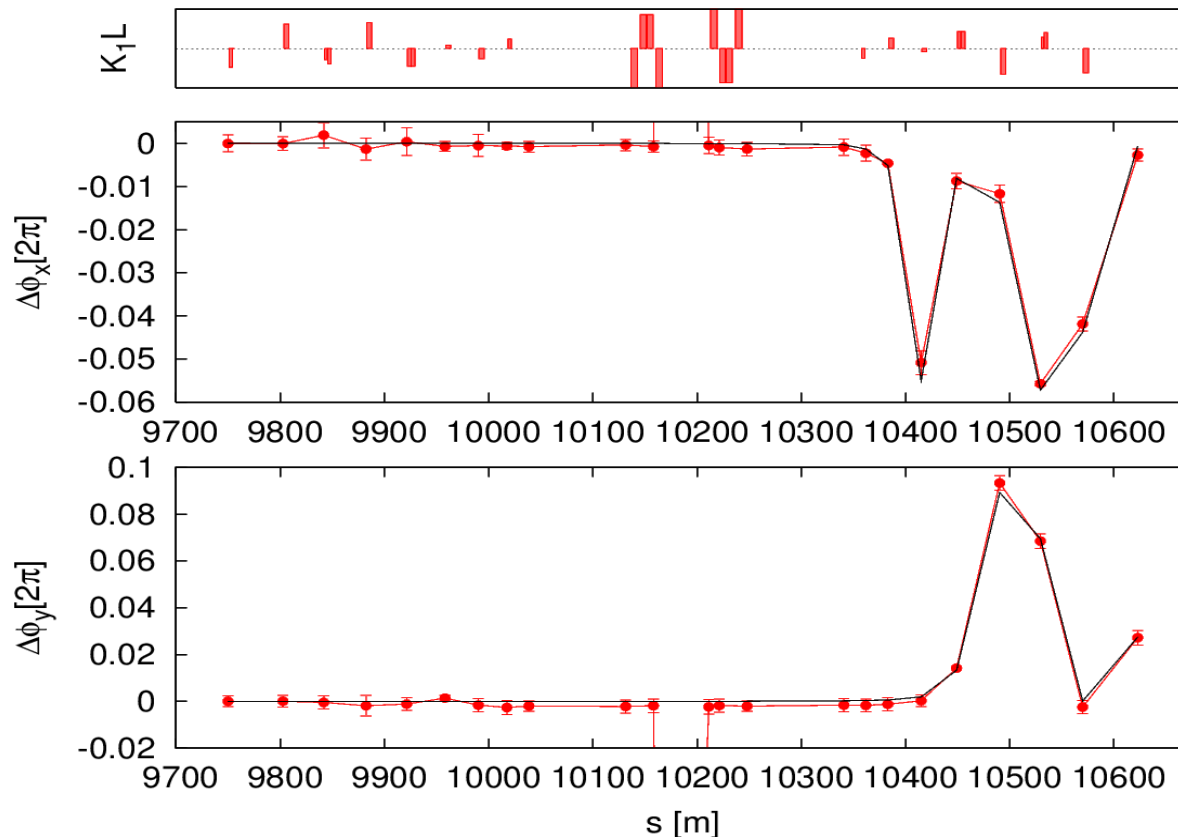




◆ The approach

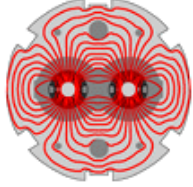
- Measured phase error for a given segment is generated
- Quadrupoles setting reproducing the error pattern is searched
 - ◆ The setting applied with negative sign removes the error

**IP5 Beam1
Nominal 60cm**





Automatic Segment matching



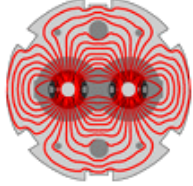
- ◆ The local corrections were found manually
 - Often not easy to get, and hence (precious MD) time consuming

- Need for automatic or semi-automatic algorithm

- ◆ Simultaneous **matching** of both beams with MADX
 - Common correcting quads at IRs

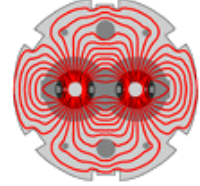


The automatic tool



- ◆ Input: location of the beam measurement results for both beams
 - The tool creates local copy for safety of the data
- ◆ The tool uses the madx files generated the SbS analysis tool
 - They are automatically stream edited such that they can be called one after another from the matching script
 - ◆ Remove name clashes
 - ◆ Path substitution to the local directory, etc
 - Decided not to create a new template/mask to avoid additional maintenance item
- ◆ Using the provided measurement results
 - Define the ranges for both lines
 - Create madx files with
 - ◆ Variables
 - ◆ **vary** commands, one for each beam and one for the commons variables
 - ◆ **constraint** commands
- ◆ Matching done with use_macro mode

The matching script



```
call, file="Beam1/sbs/t_IP__IPNO__.madx";  
call, file="Beam2/sbs/t_IP__IPNO__.madx";
```

```
system, "python genphases.py __IPNO__";
```

```
beam, particle = proton, sequence=LHCB1, energy = 450.0, bv=1;  
use, period=LHCB1, range=__RANGEB1__;  
twiss, beta0=b1, chrom;  
call, file="phases0b1.seqx";
```

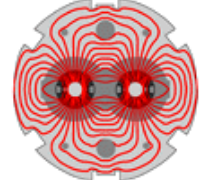
```
beam, particle = proton, sequence=LHCB2, energy = 450.0, bv=-1;  
use, period=LHCB2, range=__RANGEB2__;  
twiss, beta0=b2, chrom;
```

```
call, file="phases0b2.seqx";  
call, file="phases.seqx";
```

```
system, "python genconstraints.py __IPNO__";
```

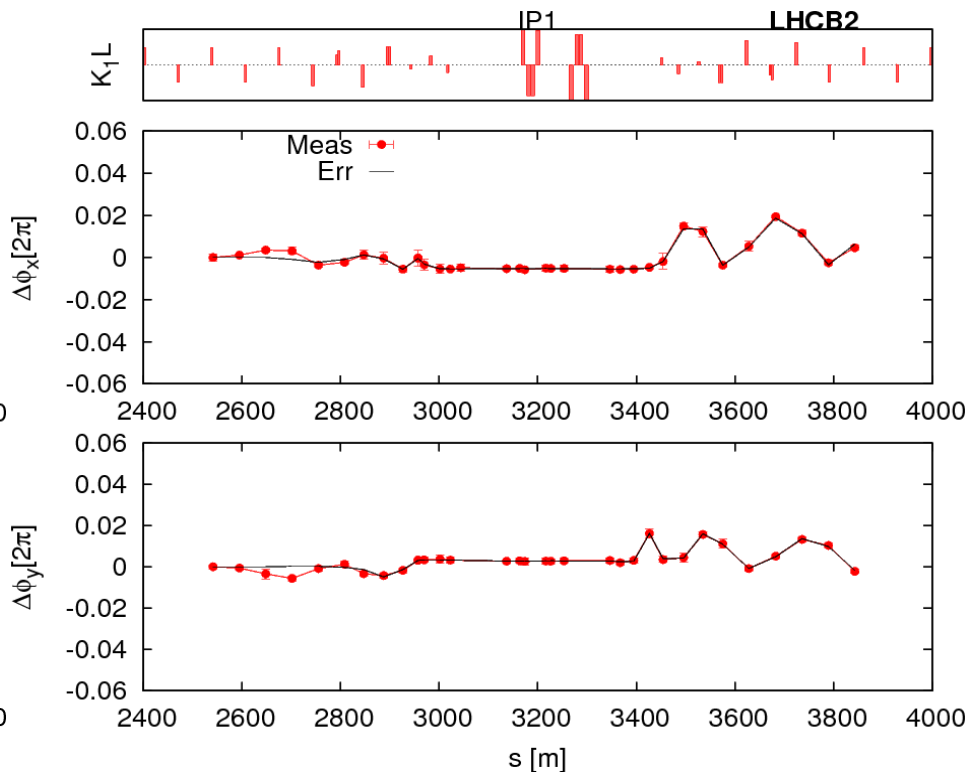
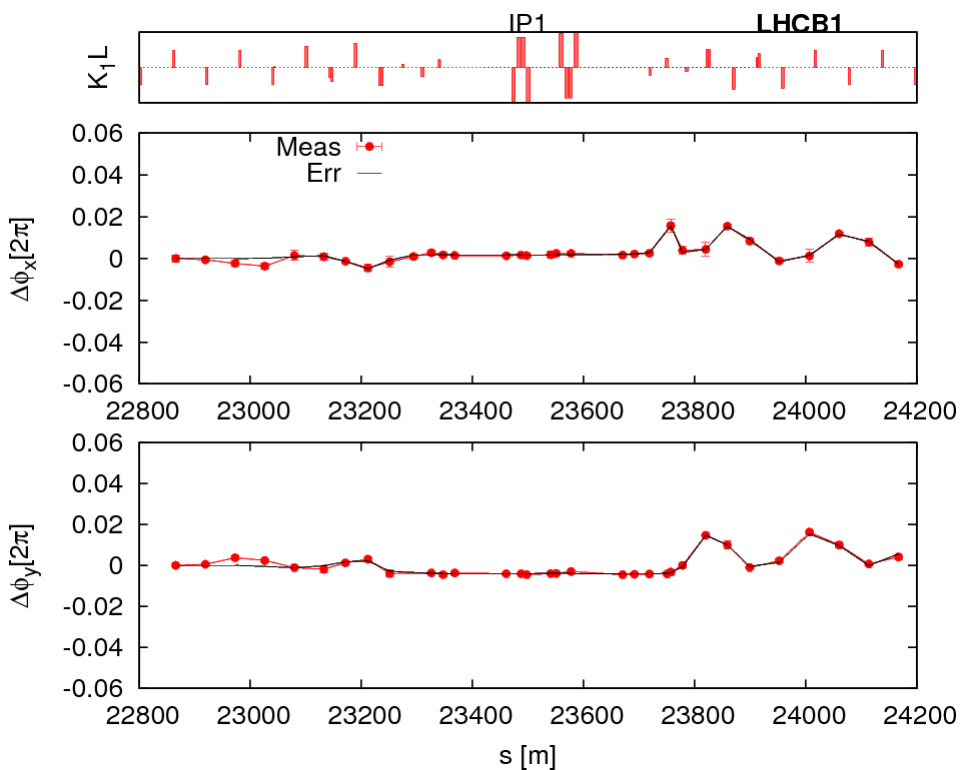
```
system, "python genvariables.py __IPNO__";  
call, file="svariables.seqx";  
call, file="dvariables.seqx";  
call, file="genchangpars.seqx";
```

```
match, use_macro;  
call, file="variablesb1.seqx";  
call, file="variablesb2.seqx";  
call, file="variablesb2.seqx";  
mab1: macro =  
{  
    beam, particle = proton, sequence=LHCB1, energy = 450.0, bv=1;  
    use, period=LHCB1, range=__RANGEB1__;  
    twiss, beta0=b1, chrom, file="Beam1/sbs/twiss_IP__IPNO__cor.dat";  
  
    call, file="dumpb1.seqx";  
    system, "gnuplot dumpB1.gplot";  
    system, "./mergedump.sh 1";  
};  
  
call, file="constraintsb1.seqx";  
  
mab2: macro =  
{  
    beam, particle = proton, sequence=LHCB2, energy = 450.0, bv=-1;  
    use, period=LHCB2, range=__RANGEB2__;  
    twiss, beta0=b2, chrom, file="Beam2/sbs/twiss_IP__IPNO__cor.dat";  
  
    call, file="dumpb2.seqx";  
    system, "gnuplot dumpB2.gplot";  
    system, "./mergedump.sh 2";  
};  
  
call, file="constraintsb2.seqx";  
  
lmdif, tolerance:=1e-24, calls:=120;  
  
endmatch;  
  
call, file="genchangpars.seqx";
```



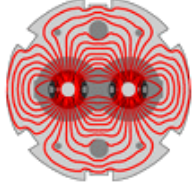
- ◆ For vast majority of the cases a satisfactory result is found within 120 matching iterations
 - Matching takes around 90 seconds
- ◆ For illustration, the remaining S-b-S plots in this presentation show automatically calculated correction

ATS 40cm IP1

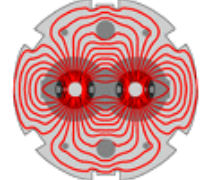




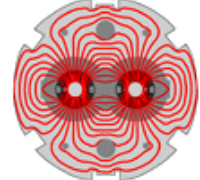
Future developments



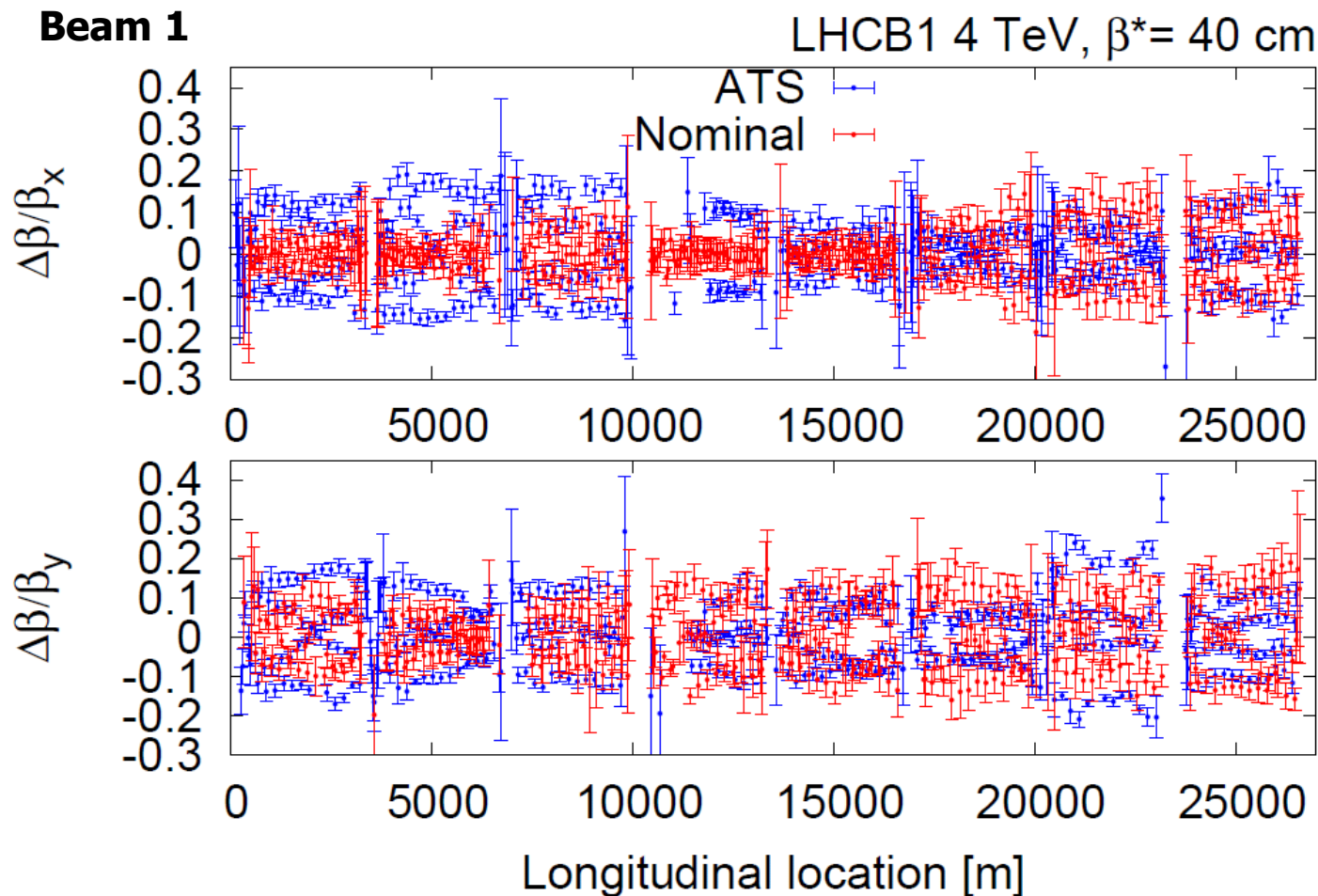
- ◆ The tool shall be integrated into the beta-beat GUI
 - Invocation with a simple button
 - User friendly selection of variables
 - ◆ The tool uses all the available correction knobs, while normally only 2 to 4 the most important knobs are sufficient to obtain a good result
 - User friendly selection of constraints
 - Integrated data display
 - Automatized knob generation
- ◆ Study all available data, find corrections and look for systematic effects

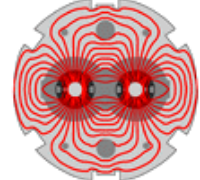


Measurements at 40cm (and 20cm)

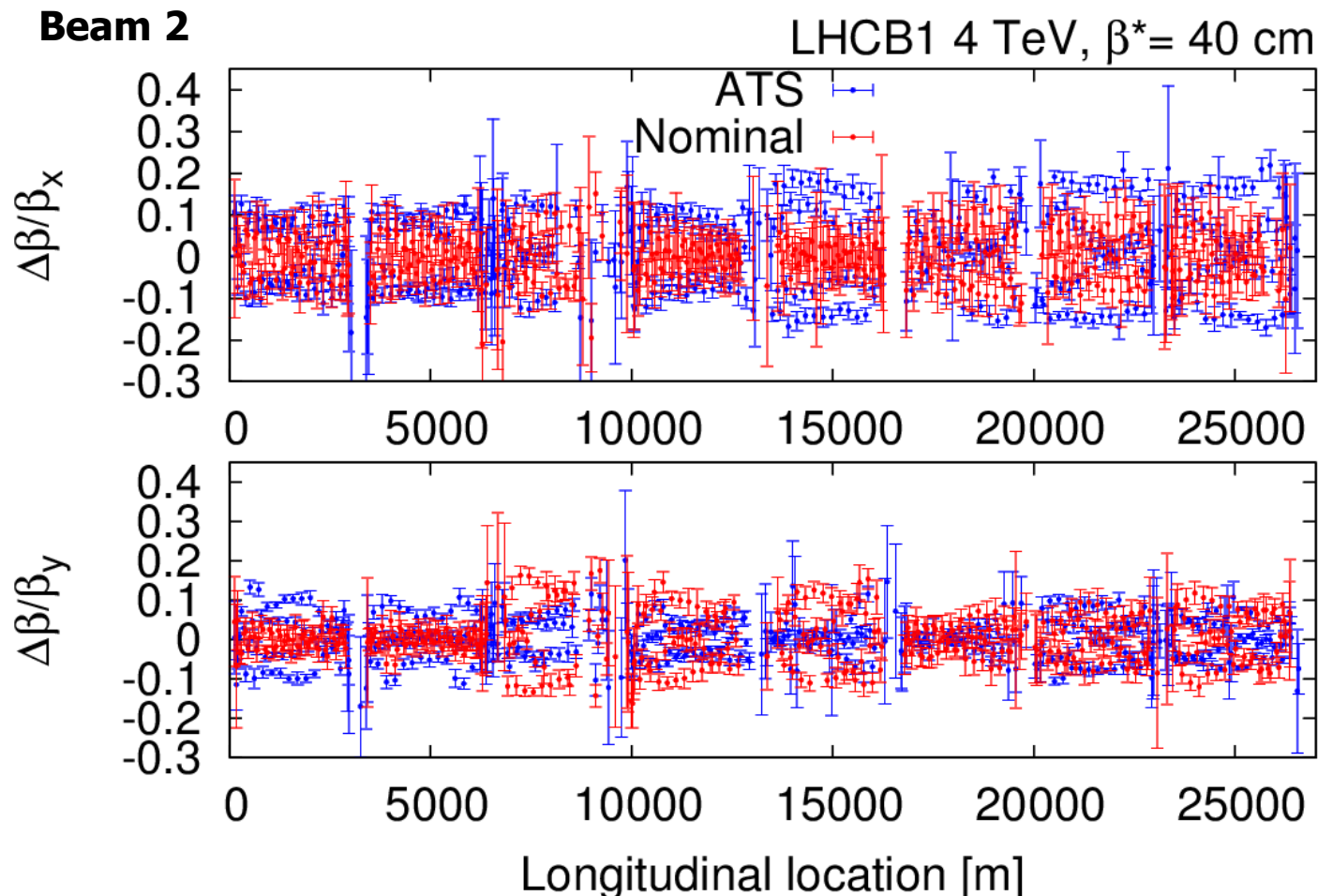


- ◆ The nominal and ATS optics were measured at 40cm
- ◆ Beta-beating is quite similar for both of them

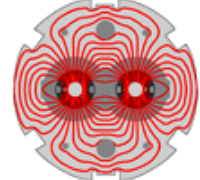




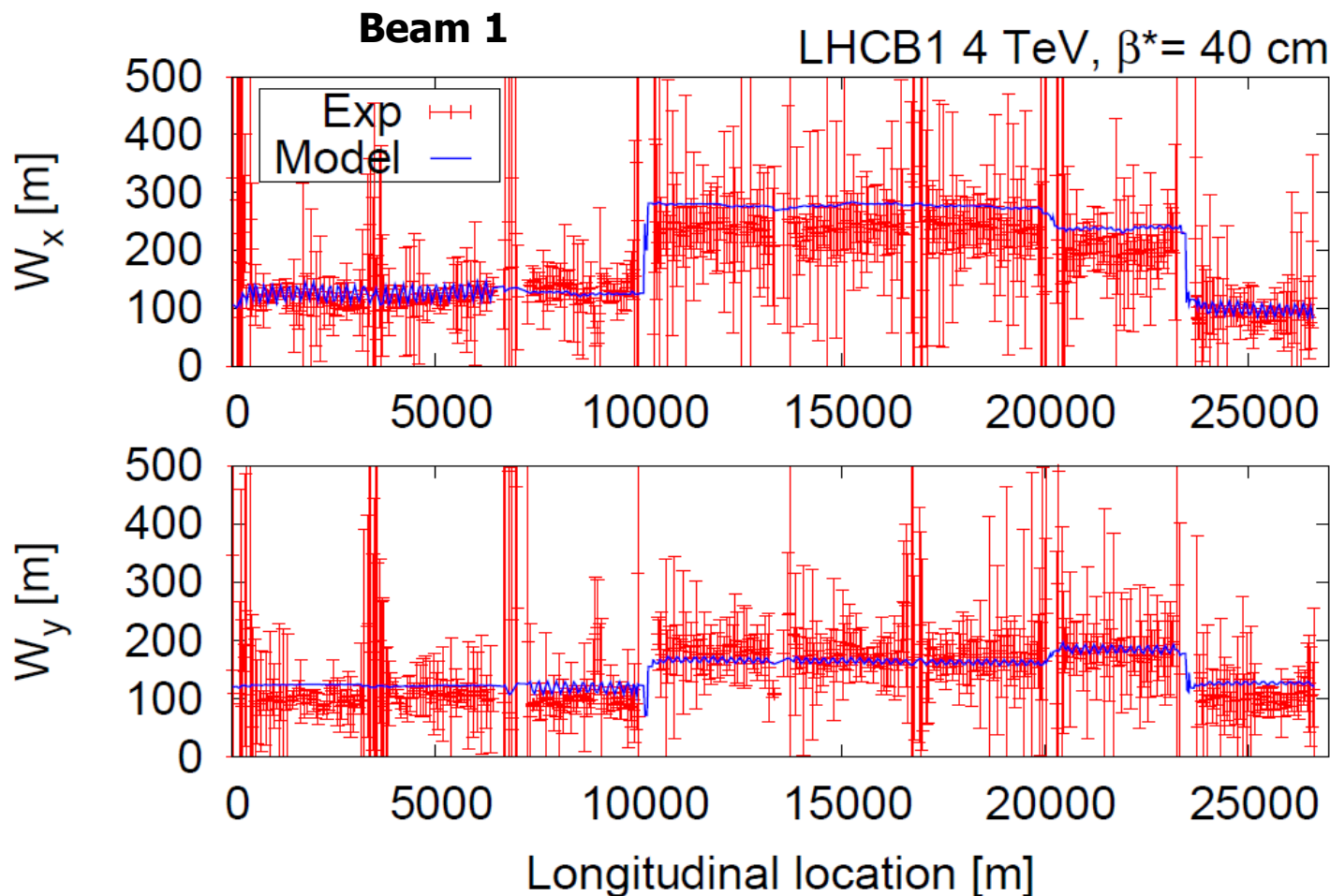
- ◆ The nominal and ATS optics were measured at 40cm
- ◆ Beta-beating is quite similar for both of them



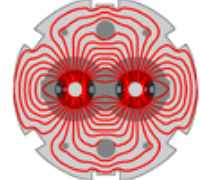
Chromatic β -beating



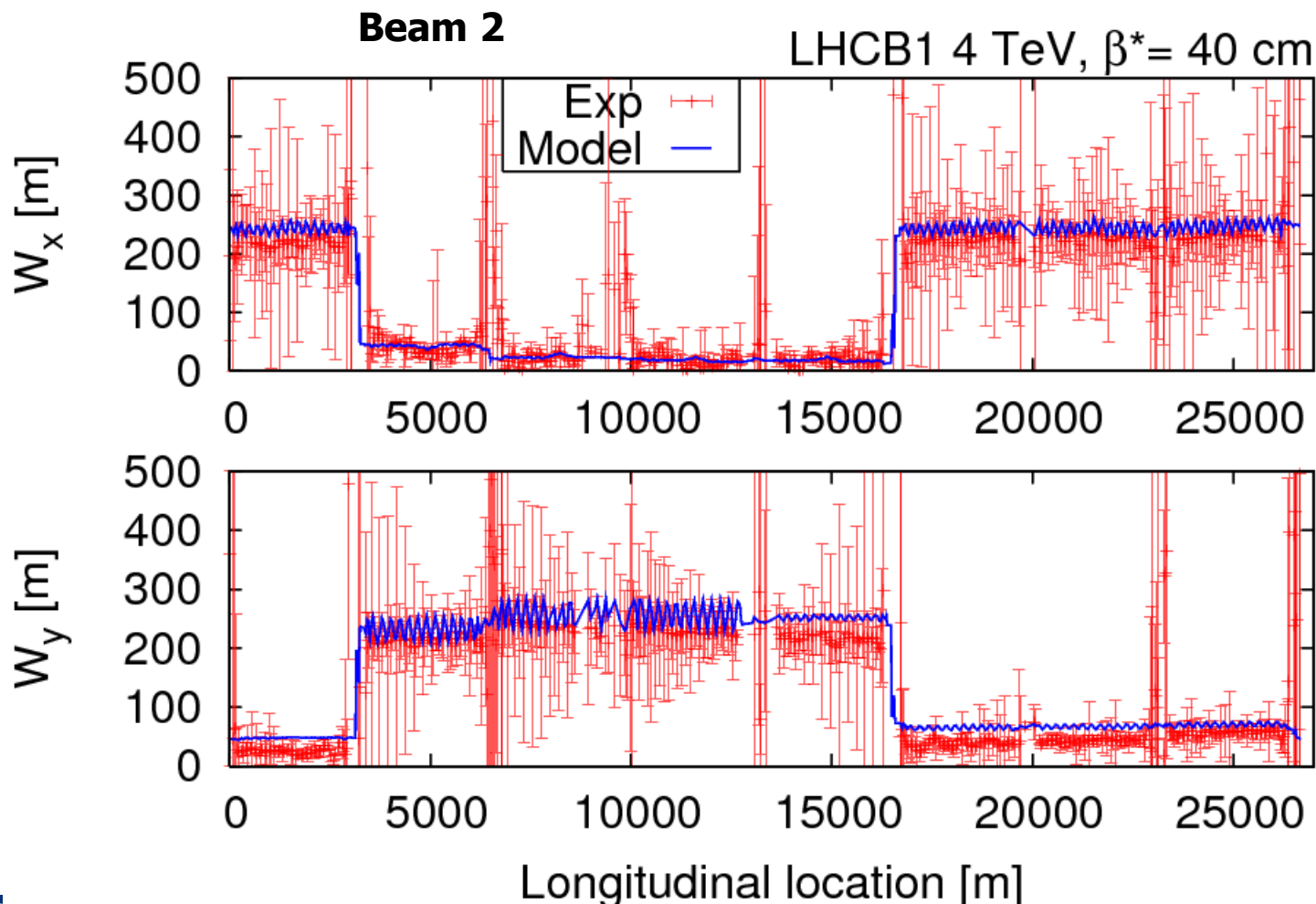
- ◆ Well predicted by the model
- ◆ Measurement and model at 40cm for the nominal optics
 - ATS was not measured with off-momentum

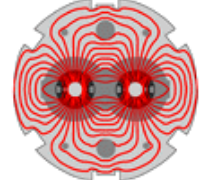


Chromatic β -beating

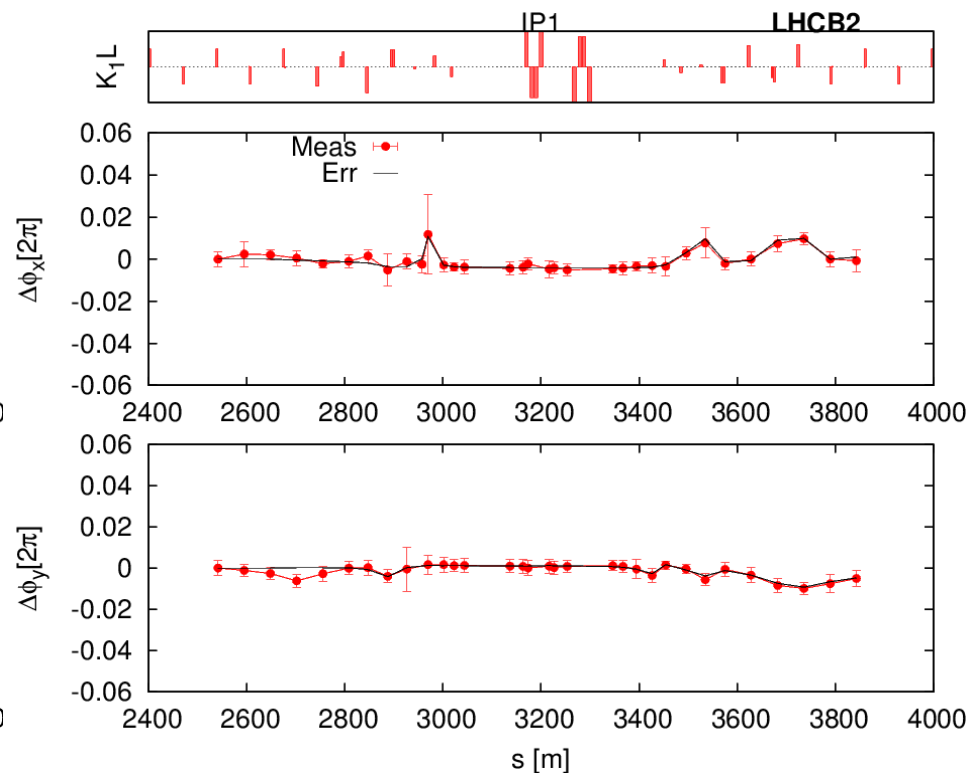
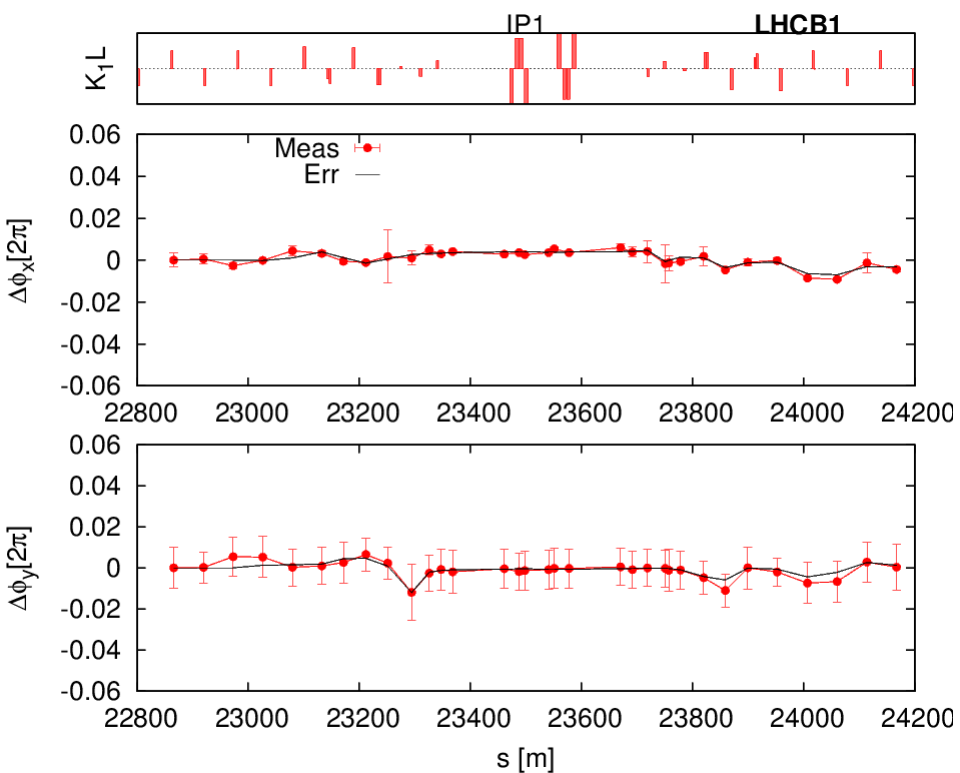


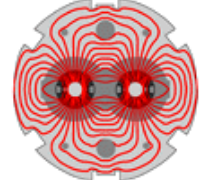
- ◆ Well predicted by the model
- ◆ Measurement and model at 40cm for the nominal optics
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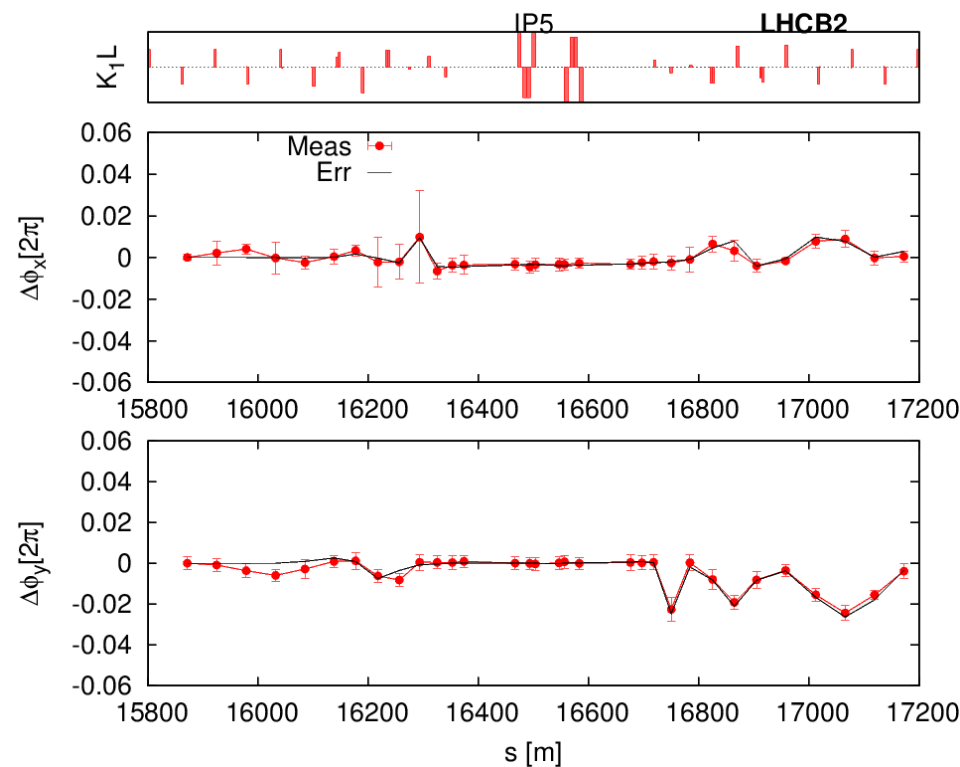
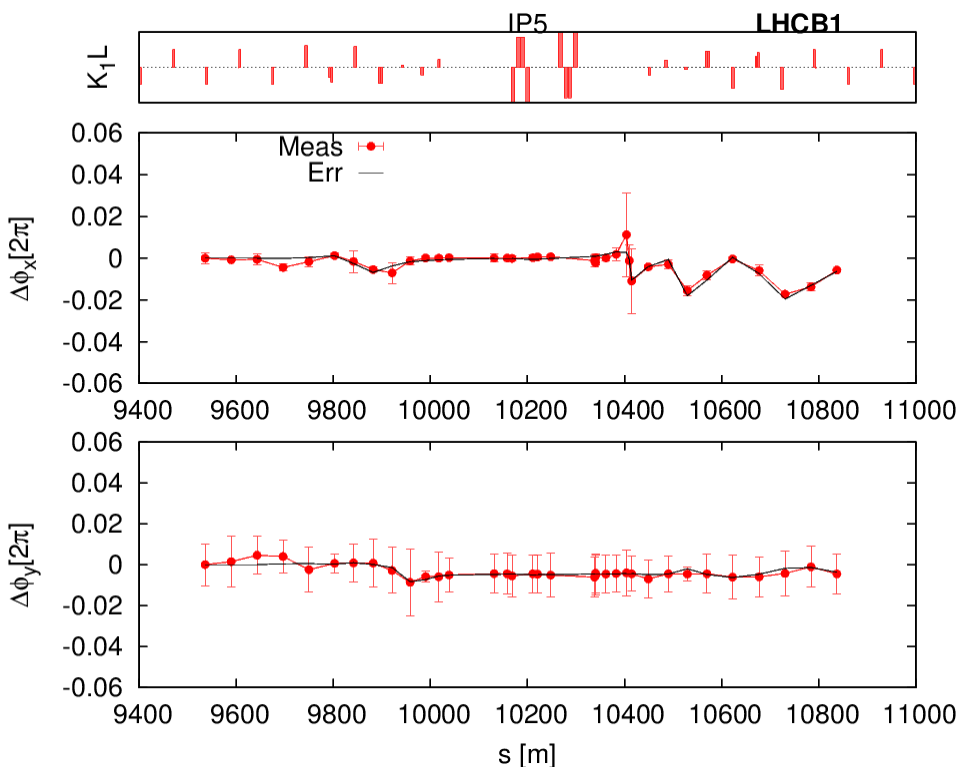


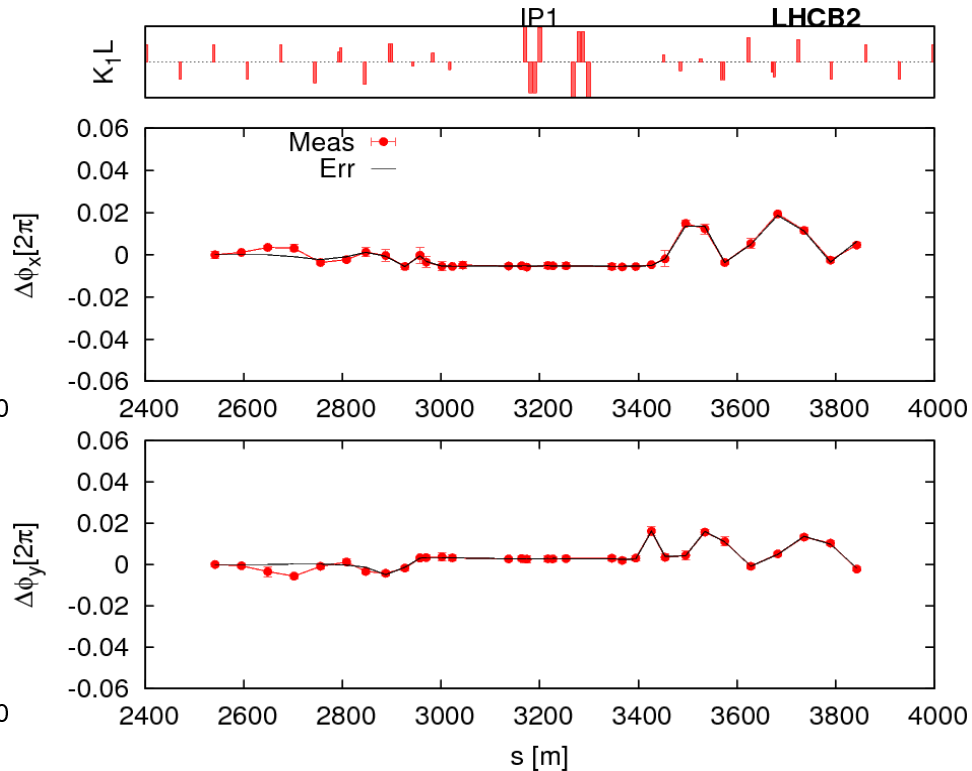
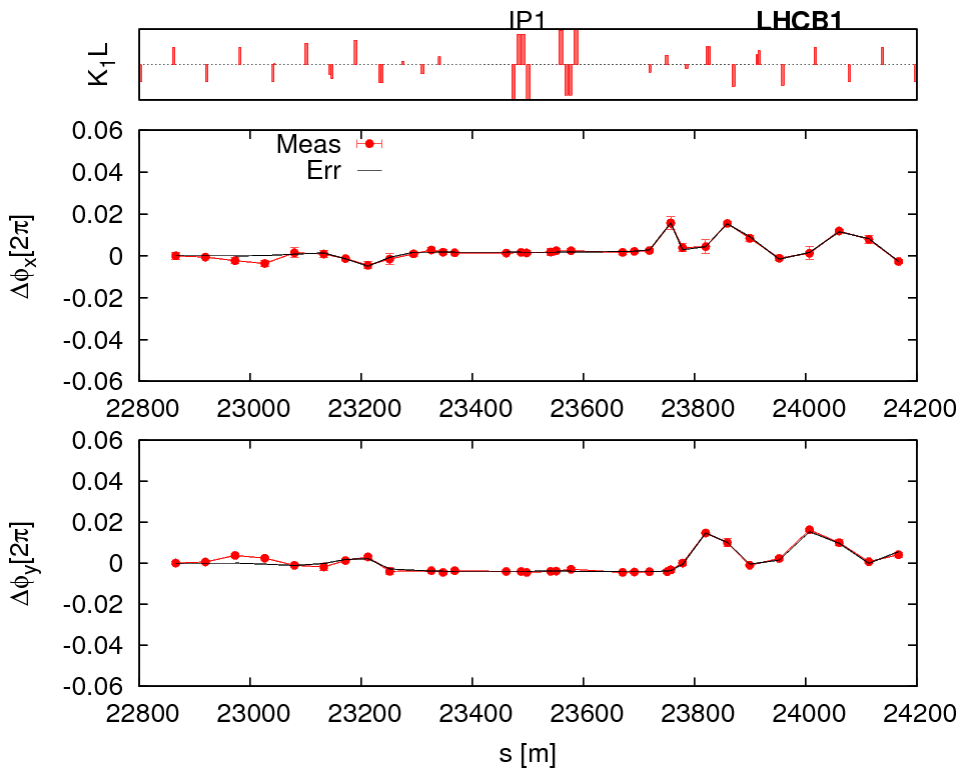
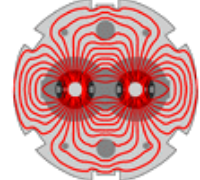
◆ Corrections done at 60cm well preserved at 40cm

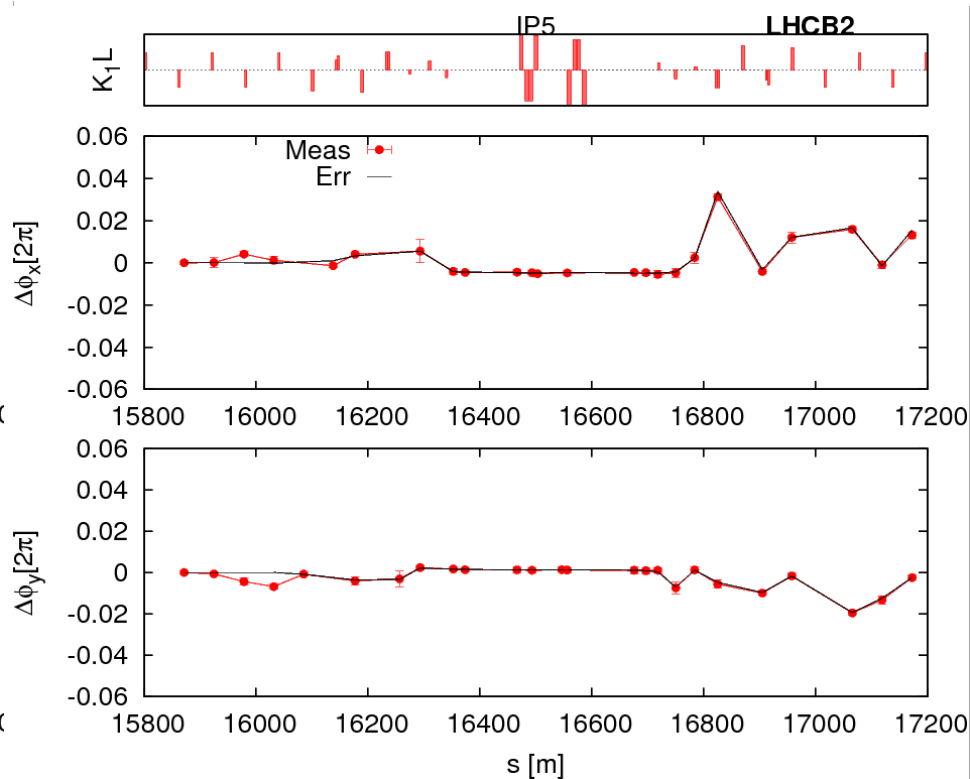
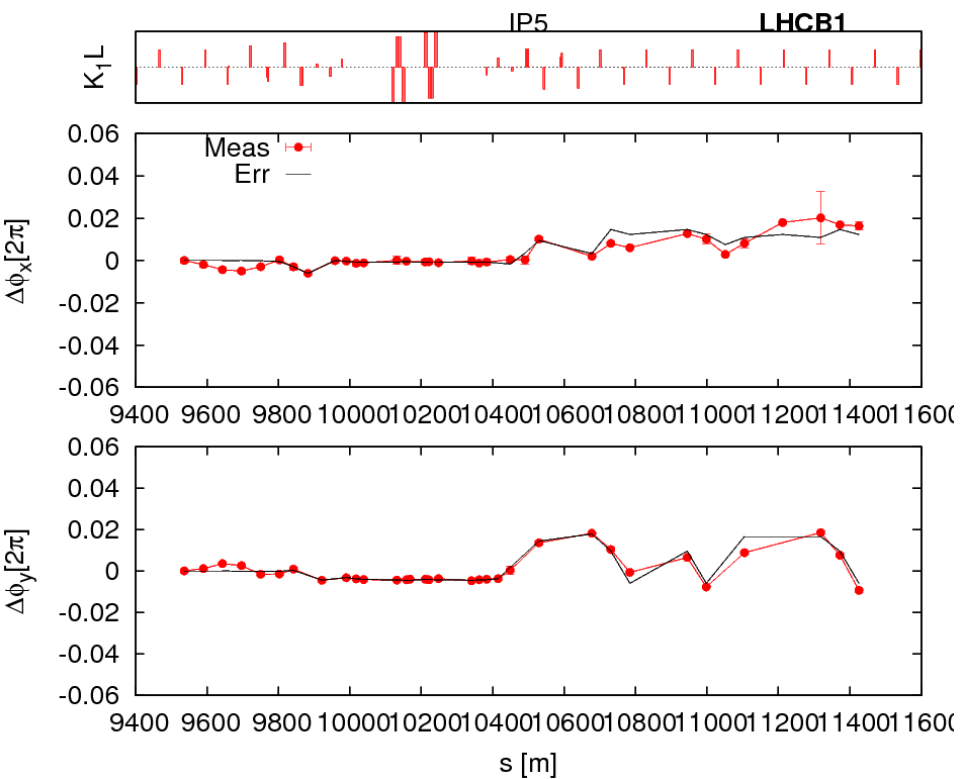
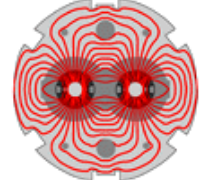




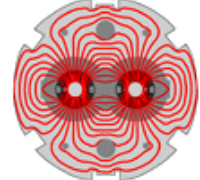
- ◆ Correction at 60cm quite well preserved at 40cm





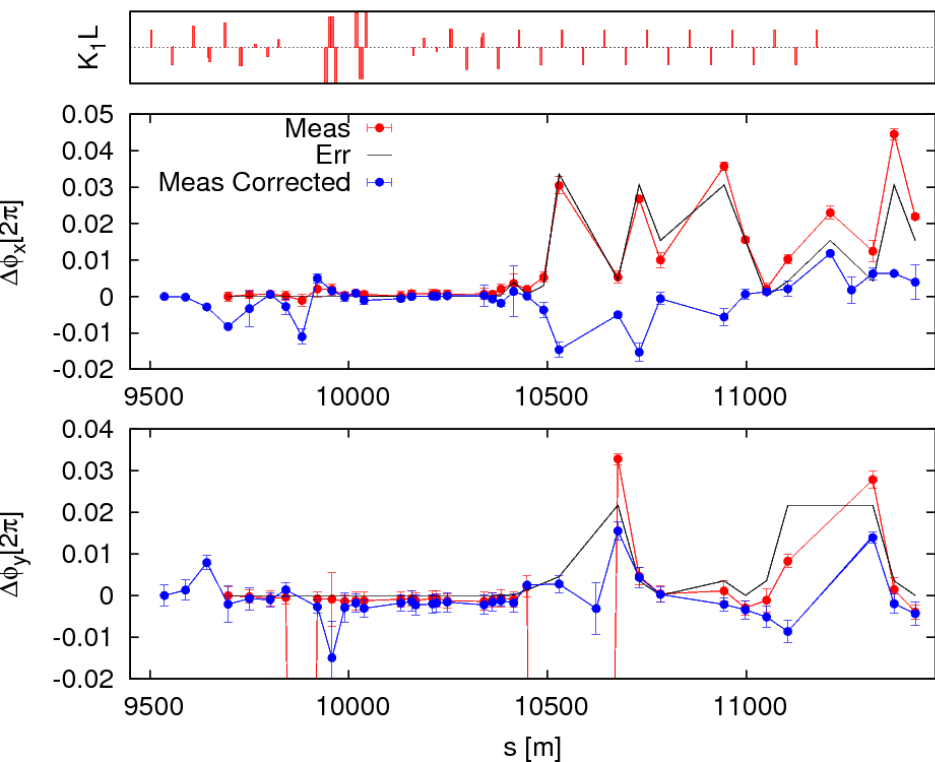


ATS $\beta^* = 20\text{cm}$ S-b-S IP5

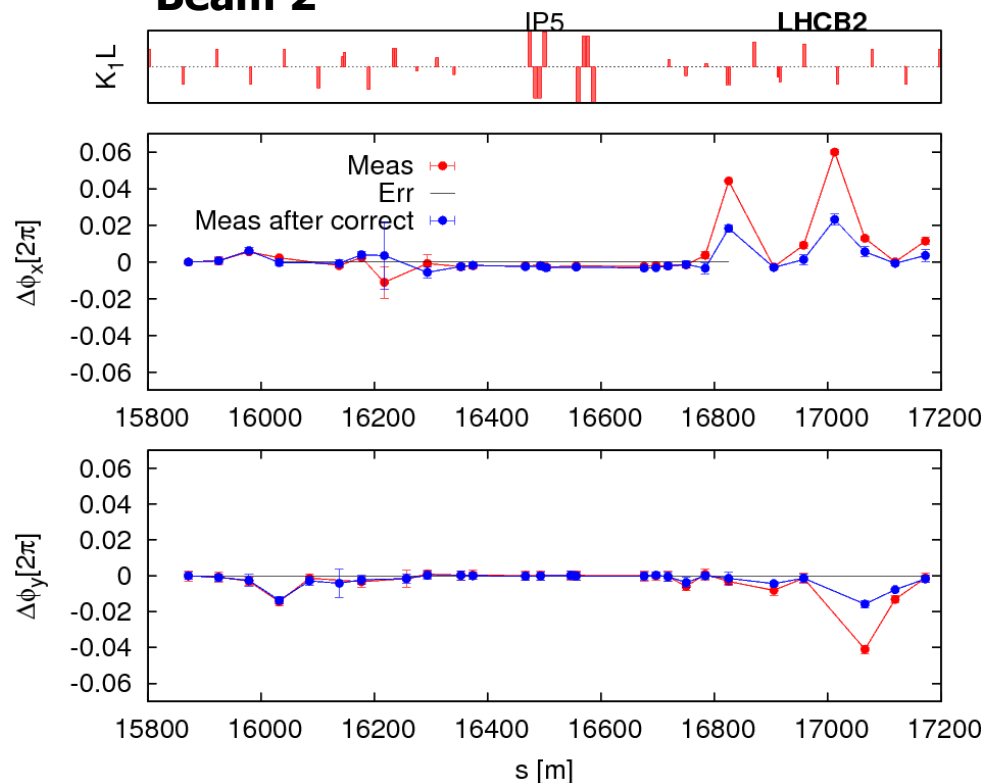


- ◆ Corrections were done at 20cm did not work as expected
 - Definitely needs more attention to understand the problem
 - One of the possible errors is in initial Twiss parameters
 - ◆ ATS has more systematic errors in the measurement
 - Sign errors?

Beam 1

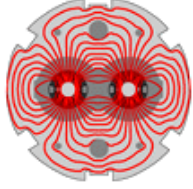


Beam 2

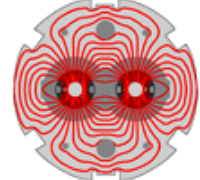




Backup

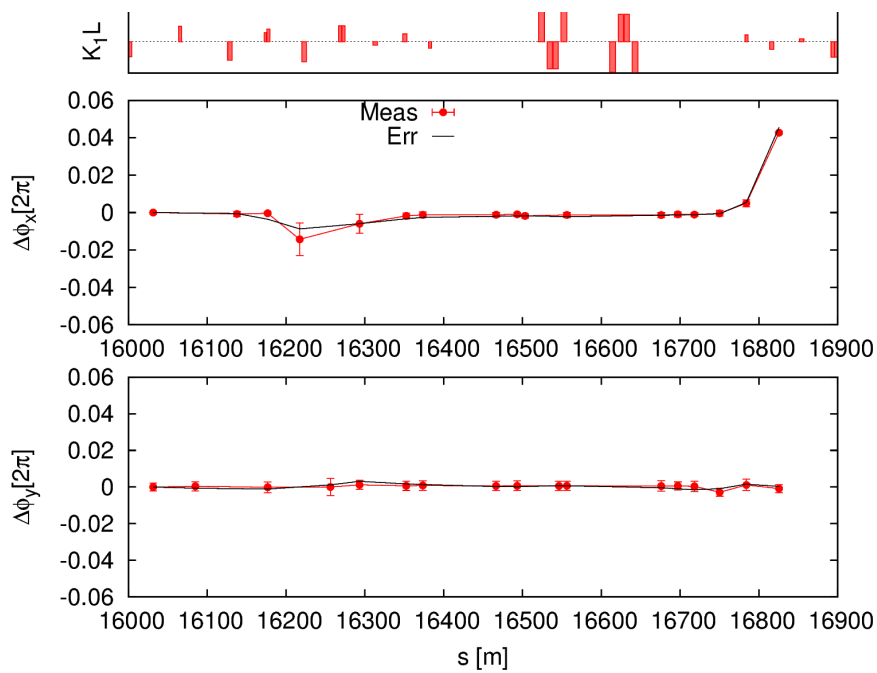
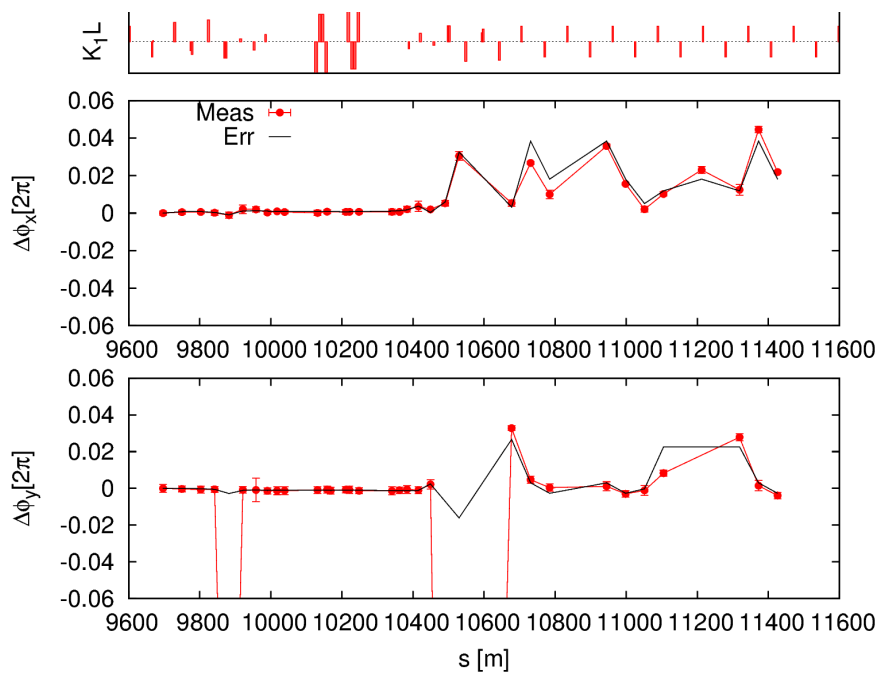


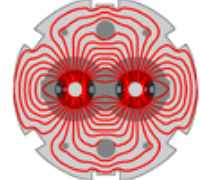
◆ Backup slides



- ◆ For vast majority of the cases a satisfactory result is found within 120 matching iterations
 - Matching takes around 90 seconds

ATS 20cm IP2





◆ Corrections were done at 20cm did not work as expected

