

FROM RESEARCH TO INDUSTRY

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STATUS OF THE ORBIT CORRECTION SCHEME

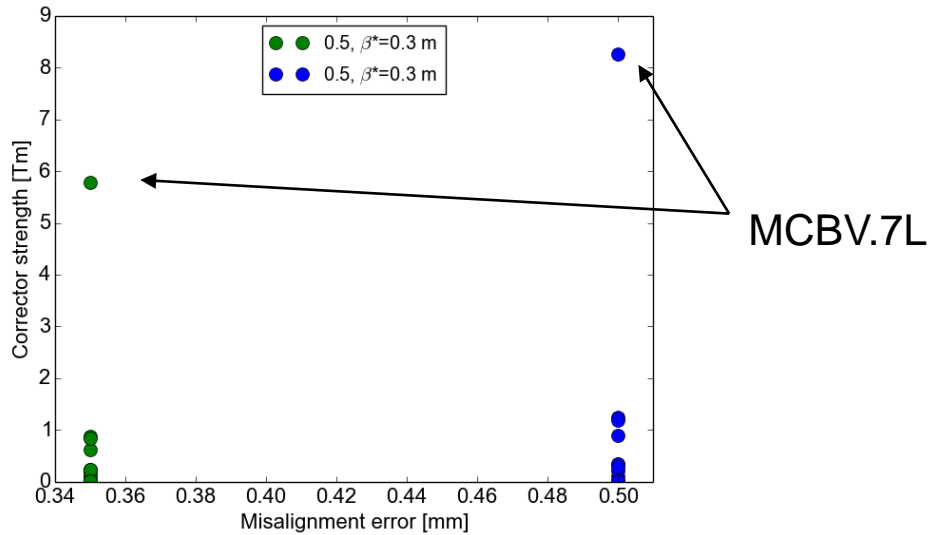
- ❑ Historical and current status
- ❑ Comparison of quadrupole unit 7 configurations
- ❑ Conclusions and perspectives

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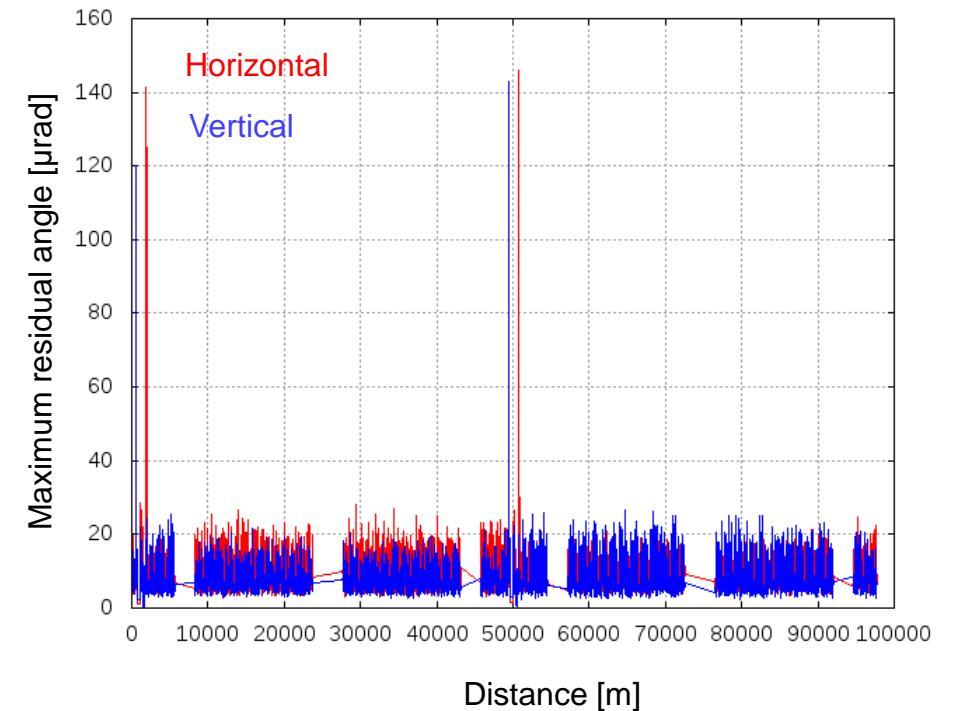
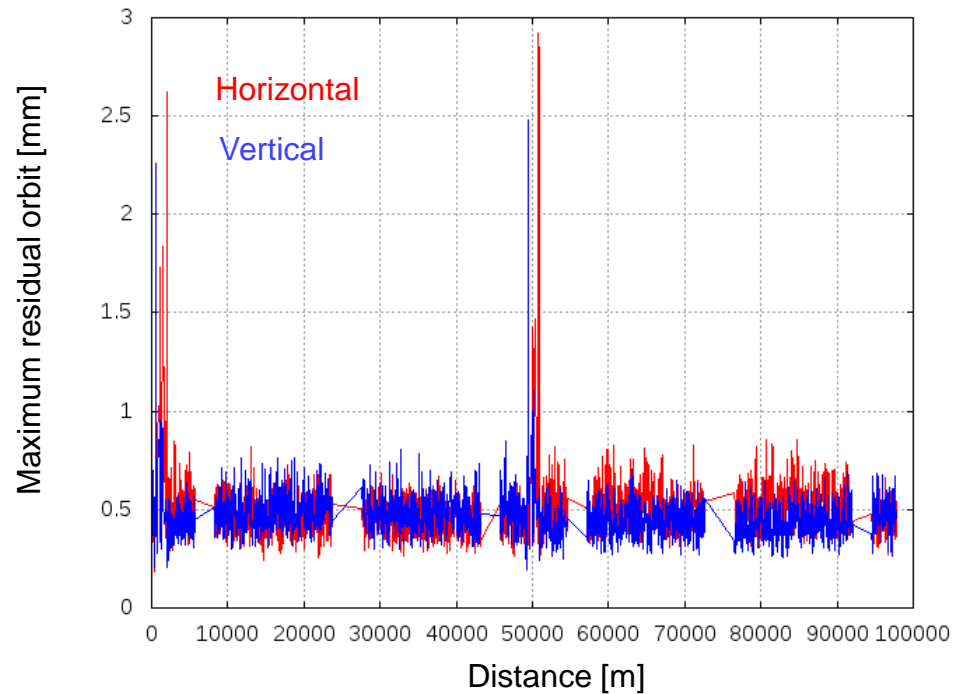
18/12/2018

STATUS AT EUROCIRCOL MEETING 2016 (E. CRUZ)

- Studies of the corrector strength (90-percentile) needed for correction in the non-crossing orbit with misalignment errors in the quadrupoles in the IT and the matching section and tilt errors in the separation dipoles.



- When adding MS errors all correctors have a 90-percentile corrector strength below 1.5 Tm except for corrector next to MQ7 (MCBV.7L).
- Explore a different correction or make this corrector longer.



Residual orbit > 2 mm in IRs
Residual angle > 100 μ rad in IRs

Same orbit and angle in arc sections compared to injection case

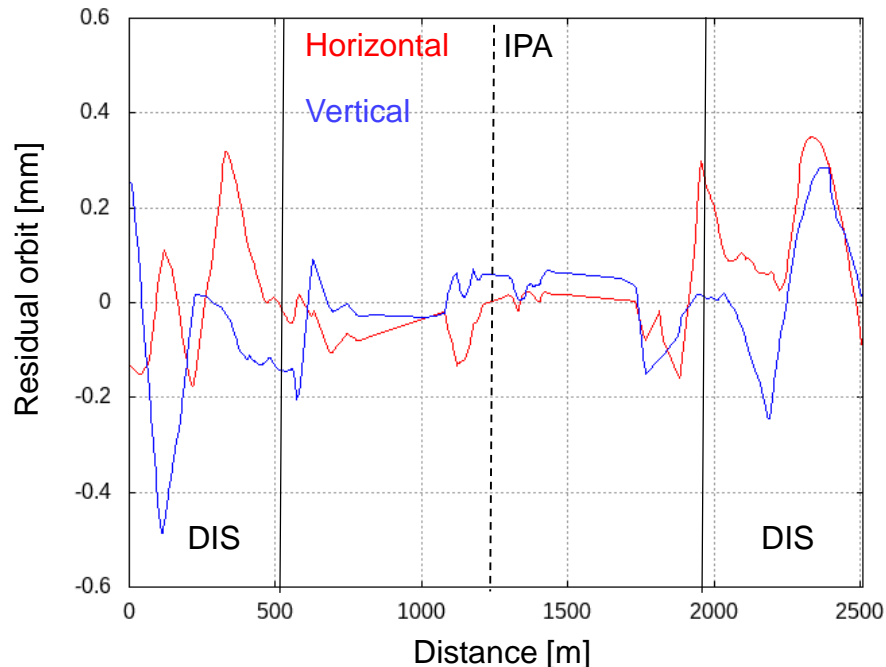
Other variables (beta-beating, dispersion beating, corrector strengths scaled to the same rigidity) are similar to injection

many instabilities of the lattice with MADX => only 20% of the machines are converging

IR correction scheme needs a few modifications => position of BPMs and correctors to match the arcs configuration?

- Correction scheme taken from IR orbit correction (courtesy of E. Cruz)
- Scheme in quadrupole units 7 modified (now as in arcs/DIS)
- Correctors strengths similar to what has been simulated before: unit 7 up to 9.55 Tm, unit 6 up to 5.6 Tm, unit 5 up to 3.5 Tm, unit 4 up to 8.6 Tm, inner correctors below 4 Tm
- Need to evaluate the correct lengths for all outer correctors

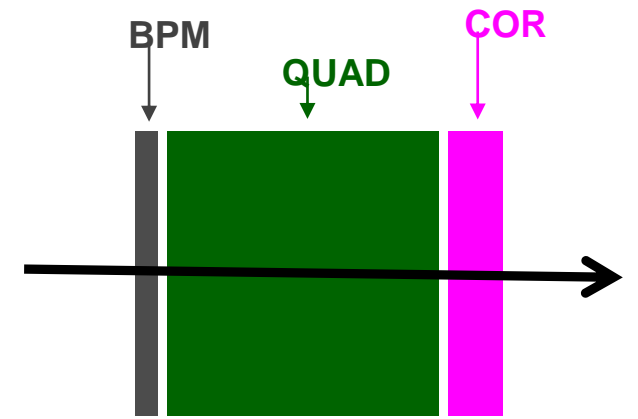
Corrected @ injection



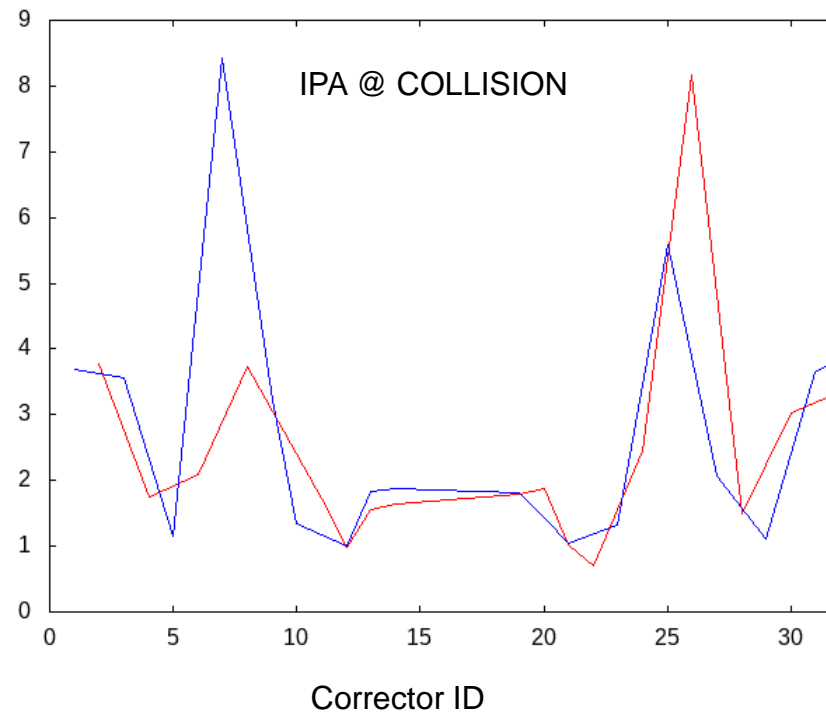
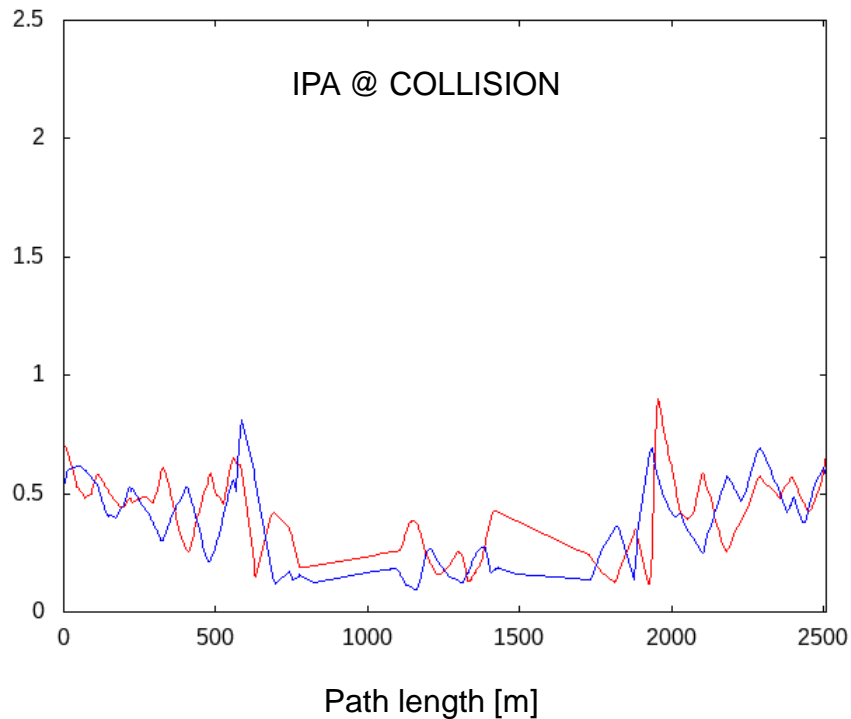
Element	Error	Error desc.	Units	IR triplet	IR other	Comments
Dipole	$\sigma(\psi)$	roll angle	mrad		1	Dipoles D1/D2
	$\sigma(\delta B/B)$	random b1	%		?	
	$\sigma(\delta B/B)$	random b2	10-4 units		0.1/1.8	0.1/1.1 at collision
	$\sigma(\delta B/B)$	random a2	10-4 units		0.1/0.2	
Quad	$\sigma(\delta B/B)$	uncert. a2	10-4 units		?	
	$\sigma(x), \sigma(y)$		mm	0.2	0.5	
	$\sigma(\psi)$	roll angle	mrad	?	?	0.2/0.5 envisaged
BPM	$\sigma(\delta B/B)$	random b2	%	?	?	
	$\sigma(x), \sigma(y)$		mm	0.3	0.3	value relative to quad
	$\sigma(\text{read})$		mm	0.05	0.05	accuracy

CONFIGURATION « ARC SIDE »

- BPM in QP unit 7 on the left of the IP is located on the **left** of the QP
- Orbit corrector in QP unit 7 on the right of the IP is located on the **right** of the QP
- Orbits below 1 mm
- Corrector strengths up to **9.6 Tm**

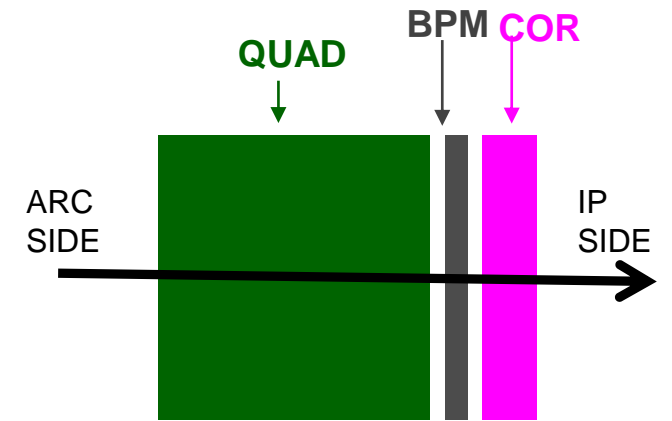


MQM.7L

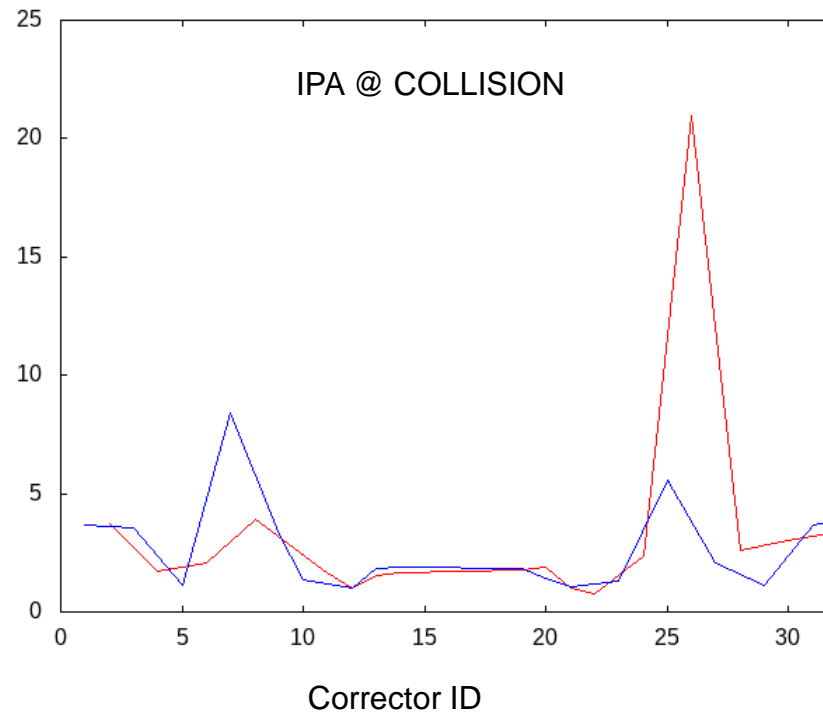
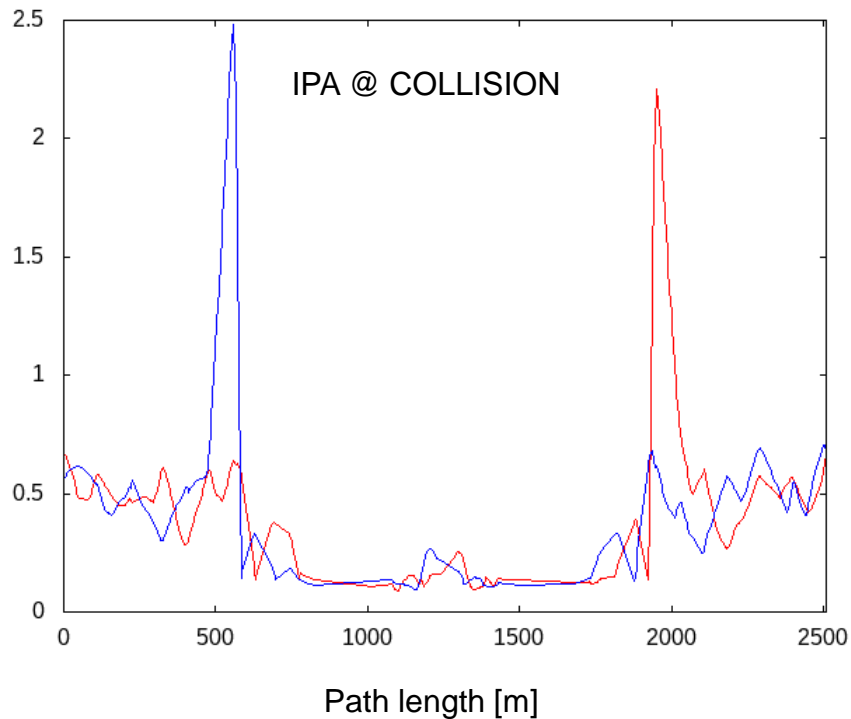


CONFIGURATION « IP SIDE »

- BPM in QP unit 7 on the left of the IP is located on the **right** of the QP
- Orbit corrector in QP unit 7 on the right of the IP is located on the **left** of the QP
- Orbits up to **2.5 mm**
- Corrector strengths up to **20 Tm**



MQM.7L



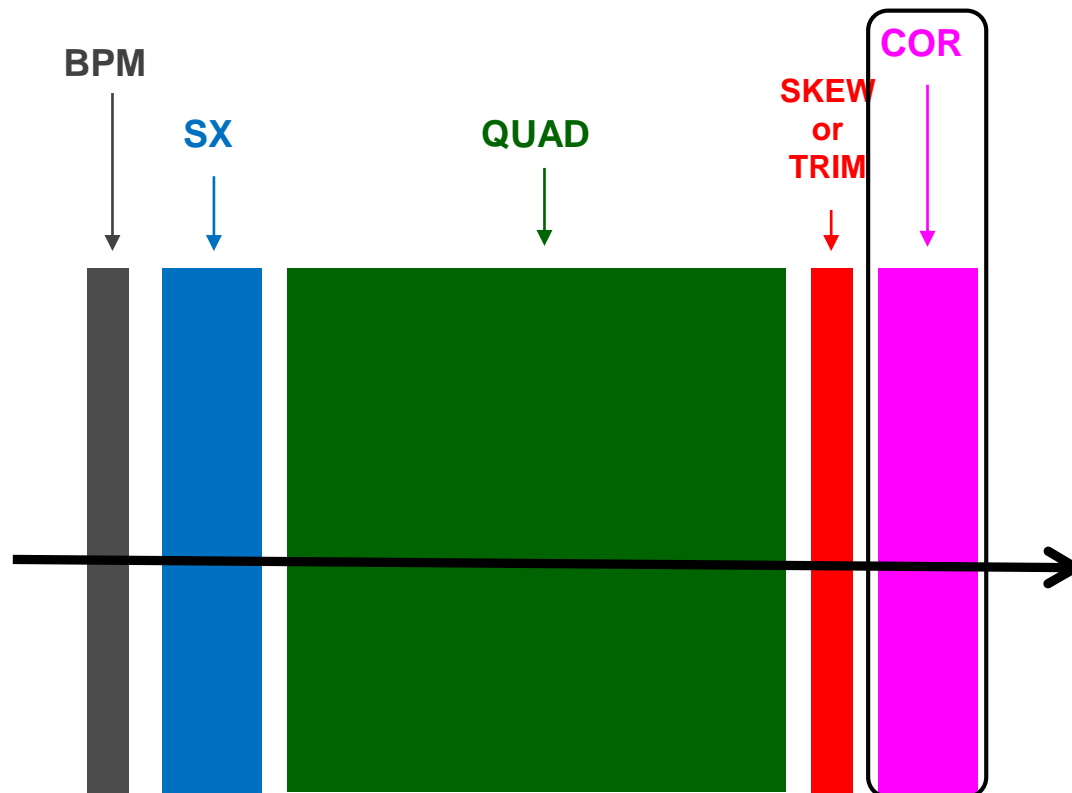
Different strategies are envisaged:

- Adding a corrector in unit 6
- Reducing the tolerance in unit 7 (not feasible?)
- Testing other matching procedures (correcting the IR separately)

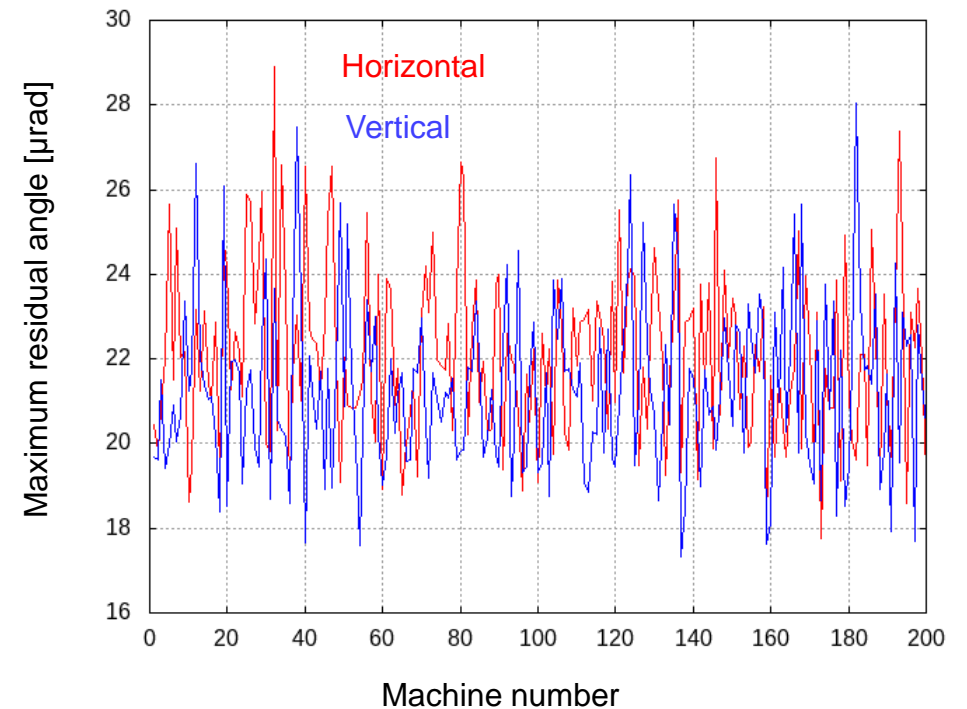
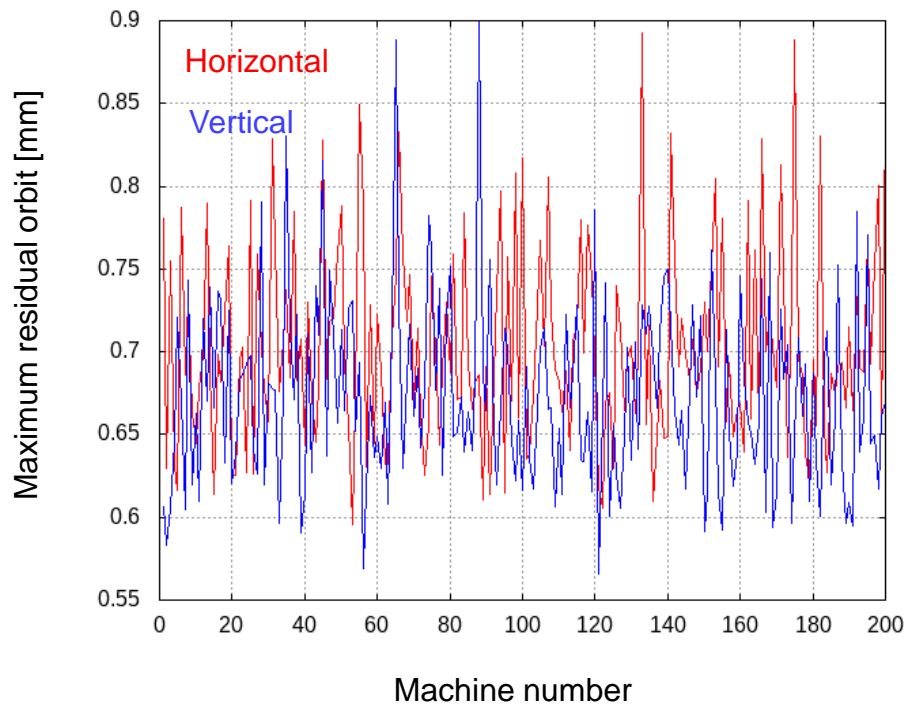
BACKUP

ORBIT CORRECTION

- Performed with dipolar correctors, $L = 1.2$ m, max. integrated strength = 4.8 Tm, Nb-Ti technology
- Global correction of the residual orbit measured by BPMs (horizontal or vertical plane)
- Same number of BPMs (parameters) and orbit correctors (variables), over 400 independent correctors on each plane
- Within the global correction scheme, each orbit corrector is coupled with the BPM located on the 2nd next quadrupole (phase advance of 90°)



RESIDUAL ORBIT AND ANGLE AT INJECTION



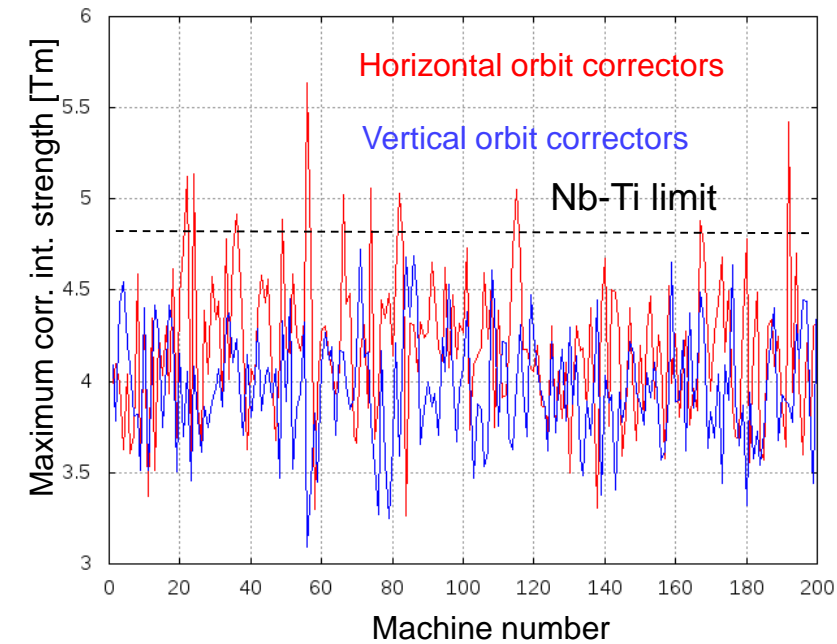
Residual orbit < 1 mm at any point of the arc sections, in accordance with the geometry of the dipole chamber (5 mm aperture)

With an alignment error of 0.5 mm RMS for arcs and IR (non-triplet) quadrupoles, both sections contribute equally to the results

90% values: horizontal orbit 0.79 mm, vertical orbit 0.74 mm, horizontal angle 25 μrad, vertical angle 24 μrad

The combined contributions of the residual orbit of 0.79 mm, a vertical residual angle of 24 μrad and of the emission cone of photons (19 μrad at collision) contribute to a total vertical offset of **+/- 1.3 mm** after a drift of 11 m

CORRECTOR STRENGTHS AT COLLISION



$\sigma(x/y) = 0.5$ mm compatible with Nb-Ti technology for 1.2 m orbit correctors at 90% level

The IR orbit correctors are not included in the analysis

Skew quadrupoles are below 200 T/m

Trim quadrupoles do not exceed 220 T/m, strong values correlated with badly corrected tunes after coupling correction

90% values: horizontal orb corr. 4.6 Tm, vertical orb corr. 4.3 Tm, skew quad. 156 T/m, trim quad. 133 T/m