WPS PROTOTYPE FOR AN AUTOMATIC 2D SMOOTHING OF A STORAGE RING

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ABSTRACT

In 1993 the ESRF applied the principle of altimetric measurements based on hydrostatic levelling. The high level of precision enabled the realignment of all magnetic elements of the storage ring, with beam on, in record time and to a precision of within a few microns in a few minutes using the HLS.

In 1994 a study was launched to attempt to achieve a similar performance in the realignment of the radial component of the magnetic elements. This study concerned the use of wire alignment techniques which are widely used for the installation of accelerator complexes (alignment with ruler and nylon wire). This technique was reviewed and adapted to the principle of continuous measurements and led to the development of a mono axial captor, the so-called WPS, presented during the 4th International Workshop, held in Tsukuba, Japan in 1995.

More recently, the ECARBONE_X measuring instrument was developed. This instrument enables the measurement of multiple points along a taut carbon wire. This instrument uses the PLUG IN method in 30mm diameter universal CERN standard reference and enables a practically instantaneous continuous measurement set up.

The results presented here use this instrument and demonstrate the complementarity of the WPS and HLS systems for continuous alignment of accelerators in this decade. Both systems pave the way for realignment by smoothing of an accelerator in both the fundamental dimensions, radial and vertical, and the abandon of traditional topographic standards by the adoption of a captor type technology.

1 MEASUREMENT PRINCIPLES OF THE WPS CAPTOR

This sensor can satisfy rapid industrial installation requirements. The measurement range, which is adaptable, was set at 2500 microns for standardization with the ESRF HLS. The definition of the horizontal measurement range of 4mm in which the dR measurement is independent of the vertical position of the wire and thus the tension of the wire (tolerance of up to 2kg) enabled us to envisage a wire tensor with a ratchet wheel permitting a tension accuracy range of 100-200g using a simple dynamometer key. The three strand carbon wire are composed of 500 filaments which brings the breaking load to 21 kg. Thus we are able to work with a tension of between 8 and 10 kg which is not penalised by the deflection of the wire (between .3mm and .4mm in our SR experiment).

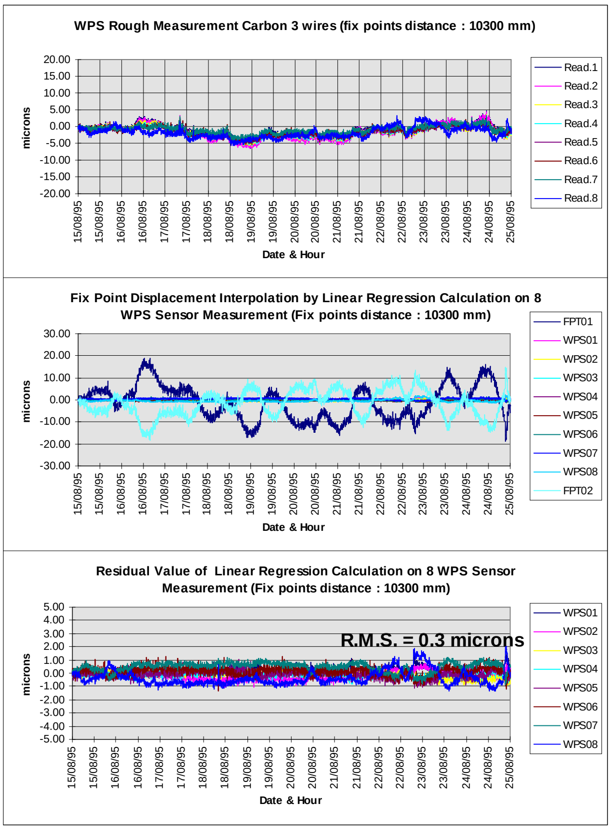

Figure 1: Determination of the resolution and the stability of the captor in the laboratory

The following curves correspond to a tension between two points equidistant at 10.3 m over a 10 day period. The first curve shows the rough measurements on the eight sensors which evolve in function of the position of the so called fixed points. Their motion is correlated with the variations in the air conditionning. The second curve illustrates the residues after linearisation on the right passing through the eight sensors, which are considered as fixed as they are installed on the same rigid support. The third curve is a zoom of the residues on the 8 WPS sensors.

The resolution of the system is better than 0.3 microns r.m.s.

2 THE ECARBONE_X MEASURING INSTRUMENT

Figure 2:General view of the system on the bench

This instrument was developed for a rapid use by insertion into 30mm diameter standard reference with which many accelerators are equipped. The general view and detailed view show both fixed points equipped with dynamometric ratchet wheel which determines the straight line of reference. The height of the wire was chosen for its compatibility with the traditional nylon ruler, but can be varied and adapted to the specific constraints of a given project.

The verticalisation apparatus enables both the verticalisation of the captor (level above the apparatus) and the parallelism of the wire with the measuring electrodes, thus permitting an optimum use of the 4mm linearity range of the captor (four lateral positioning pins). These pins also allow for a rapid control of the position of the wire in altitude (first order saggita control). A "V" shaped support completes the installation tool and supports the captor during adjustment operations.

Figure 3: The ratchet tensor adapted to the standard reference

The fixed points are equipped with collimators which facilitate the orientation of the alignment groove, which can be adjusted to guarantee a centered position on the standard reference. By a double return to 1/10th of a mm in absolute and to 1/100th of a mm in relative (a rotation of one degree is acceptable without modifying the alignment of the wire).

Figure 4: WPS captor adapted to standard reference with verticalizing tool.

3 INSTALLATION ON ESRF STORAGE RING

Figure 5: General view of ECARBONE_X in the tunnel

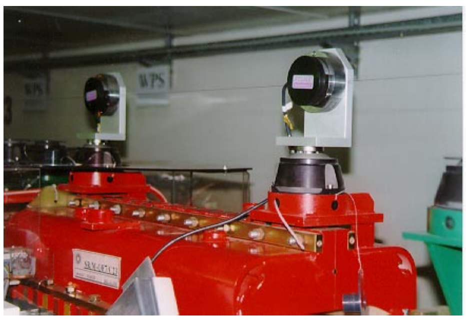

Figure 6: General view of a captor on a quadrupole

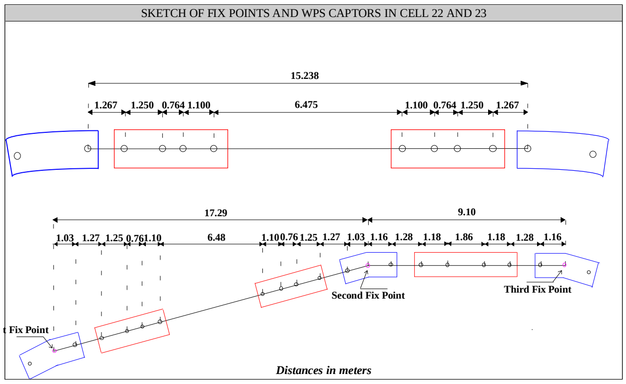

Figure 7a: Installation set up of the prototype, b: Installation set up with the double fixed point

The general and detailed photos illustrate the facility to implement this system in the tunnel and the installation diagram 7a shows the distances concerned during this in situ alignment test. Fixed points were installed on the dipoles and on four captors on girders G30 and G10. This enabled a certain redundancy (two points per girder)

Figure 8 shows the stability of wire during one full day in three modes air conditioning only (1.5µm/day), USM 1/3 filling mode (2.8µm/day) and USM single mode (1.6µm/day).

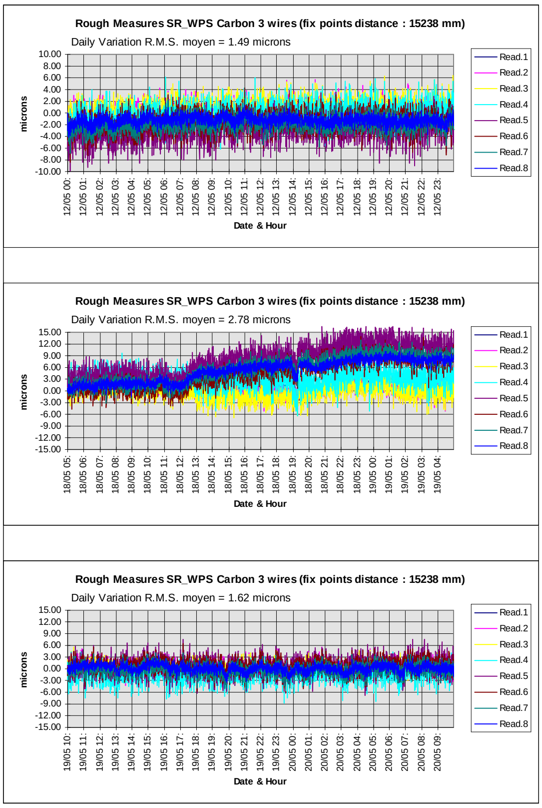

Figure 8: Determination of the stability in the tunnel under air conditioning.

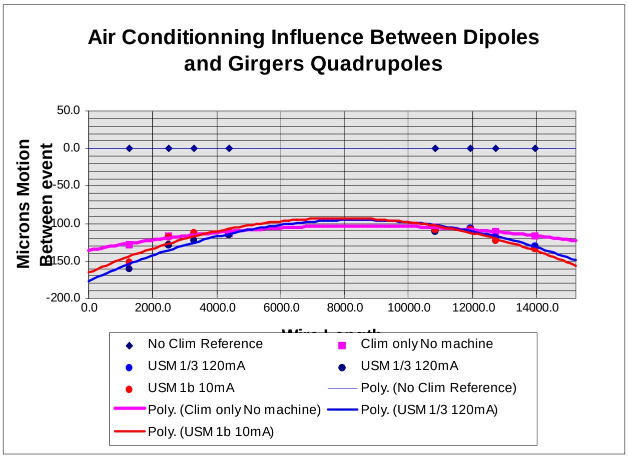

Figure 9: Effect of the different operating modes of the machine on the curve of the wire.

That shows than with air conditioning the sagitta of the wire is about 80 microns, if the machine is running it increase until 150 microns but an extraordinary stability of the sagitta in the 10 microns range during a run.

4 CONCLUSION

The conclusion of these first measurements in situ is we have obtained a stability of the wire better than 3 microns/day before mathematic calculation, and better than 1 microns/day after mathematic calculation (Polynomial 2nd degree).

The ESRF project consists of a succession of 64 modules of two different sorts (32 short and 32 long modules), the articulation points of which are the centre of the 64 dipoles. The dipoles are not motorized and are realigned manually once a year.

We propose to equip 64 double fixed point on dipoles which are considered as fixed between two realignments (basic solution), or variable at angles (preferred solution) by adding two passive WPS sensors on the dipole (no adjustment possibilities).

These sensors will be either passive (solution 1) or active (solution 2) in the calculation of residual displacements of the girders. Each cell would be equipped with 13 sensors (3 on each G10, G20, G30) enabling a repeated control by calculation, and two on each dipole at the exit/entry to enable monitoring of angular variations. The project calls for a total of 416 WPS sensors and 64 double fixed points. The motorization consists of replacing the 192 manual micrometers on the 96 girders G10, G20, G30 with 192 motors.

Even if the major difficulty encountered at the ESRF is the installation of this new system on an existing machine, the design of new accelerators should make provision for this as the servo controlled smoothing technique in both the vertical and radial plane enable considerable time savings for future Users.