Now the most part of PANDA magnet yoke interfaces have been discussed and listed in the document prepared by Inti Lehmann. But there are some very important interfaces: carriage/iron yoke and iron yoke/cryostat, which have not been considered jet. The need of these interfaces appears in consequence of magnet dividing on three large parts (cryostat&coil, yoke and carriage) which are being elaborated by different groups. Timely coordination (and timely updating) of these interfaces would ensure the independent design work of all groups. Unfortunately these interfaces were not coordinated and it means that now we don't have a basis to unify the different parts of the magnet in the integral construction.

These interfaces have to coordinate:

- geometrical coupling of the carriage/yoke/cryostat and
- bearing capacity of the transport carriage for the weight load of the magnet and bearing capacity of the barrel part of the yoke for the cryostat weight load in normal operation regimes.

Besides that, the interfaces have to ensure the rigidity of the magnet parts in abnormal conditions/regimes. As abnormal conditions we can consider assembly processes of the yoke on the top of the carriage and movement of the magnet along the rail track. The assembly process can originate concentrated loads on the carriage top and distort the footprint plane for further assembly. In the process of magnet transportation a wheel/air cushion of the carriage can move onto an irregularity on the rail surface (abnormal regime of movement). It originates deformations and stresses in the carriage elements which are being transmitted to yoke elements and then to cryostat&coil elements sequentially.

Of course if the design work is being performed by one organization, the designer would prepare a general magnet FE model (including foundation, carriage, yoke and cryostat&coil) and define all critical deformation/stresses in the magnet elements in the assembly process and according to values of irregularities on the rails in the process of magnet transportation. Since the work is being performed by several groups which are not able to coordinate and prepare a general FE model of the magnet, the boundary conditions have to be defined for every part of the magnet separately. It is natural that the interface requirements are very majorant for such approach to a problem because they are defined on the base of simplified FE models.

Eventually ANSYS calculation and further optimization of the magnet parts and their bracing can be addressed to the firm which will assume a liability for the whole magnet design.

To complete the set of yoke mechanical interfaces we have to consider yoke/cryostat interface. Practically the cryostat doesn't influence much on the yoke strength. Quite the contrary the presence of the cryostat fixated on the inner surface of the yoke improves the general stability of the yoke because the cryostat supports functions as additional braced framing of the yoke. For the purpose of Interface document simplification we have to consider maximal space position deviations of the cryostat fixating points without taking into consideration the cryostat support ties.

Yoke/carriage interface

1. The magnet weight load 360 ton (yoke barrel part, doors, cryostat and detectors) is distributed between twelve (2 x 6) support pads on the carriage top (see fig.1). These loads depend on the rigidity of the assembly base and on the positions of carriage points of rest. The range of all possible weight loads on the support pads is specified in Table 1. The possible deviations of the weight loads in the support points from the values obtained for the magnet assembly on an absolutely rigid base are indicated in superscripts and subscripts (these deviations correspond to the carriage support beam rigidity specified in item 6). In the normal operation conditions all loads are symmetric with respect to YZ-plane and approximately symmetric relative XY-plane. In abnormal regimes the symmetry can be lost but all loads are within confidence intervals specified in the Table 1.

2.

Table 1. Weight loads distribution in the support points

Support points #	Weight loads, kN
1 and 1’	270_{-130}
2 and 2’	410^{+110}
3 and 3’	220^{+100}_{-160}
4 and 4’	220^{+100}_{-160}
5 and 5’	410^{+110}
6 and 6’	270_{-130}

3. To provide further magnet vertical adjustment in the beam position, the plane of the support pads (fig.1) have to be lowered down to 5 mm from the horizontal plane Y = -2660 mm.
4. The preliminary non-flatness of the support pads plane must be secured within 0.5 mm before the yoke assembly. Additional leveling of the support surfaces will be done by means of metal shims in the process of assembly.
5. The dimensions of the support pads, the distances of them from beam axis and Interaction point are indicated in the fig.1.
6. The momentum of inertia of each of the two supporting beams deposited below two yoke banding collars must be ≥2.85 10^6 cm^4, the cross section of the vertical wall (walls) of the beams must be ≥810 cm^2 for the overall height of the beam 790 mm.
7. The centrums of side supports of the carriage (wheels or rollers or cushions) for the given lower limit of the momentum of inertia must be at the distance ≤4930 mm (this distance corresponds to the distance between yoke frame vertical uprights).
8. The dimensions of the pads for door rails are shown on the fig 1. The rails will be loaded by the door weights in the process of magnet assembly/further detectors revision in the assembly and beam positions only. During magnet transportation the door wheels will not interfere with the rails.
9. Maximal allowable vertical deformations of the door rail supports under action of the concentrated load of 25 ton must be ≤0.2 mm.

Yoke/cryostat interface

1. Maximal deviation of the yoke inner contour in vertical direction ΔY = -1.5 mm, in horizontal direction ΔX = +1.5 mm for all possible deviations of the rail flatness in the process of magnet transportation.

2. Torsion of the yoke barrel part in consequence of mutual rotating of the carriage beams in vertical plane in the process of movement doesn’t change the shape of the inner contour of the yoke.

3. The estimated maximal value of torsion of the yoke barrel part in the process of magnet movement is $\alpha \leq 2 \times 10^{-4}$ rad.

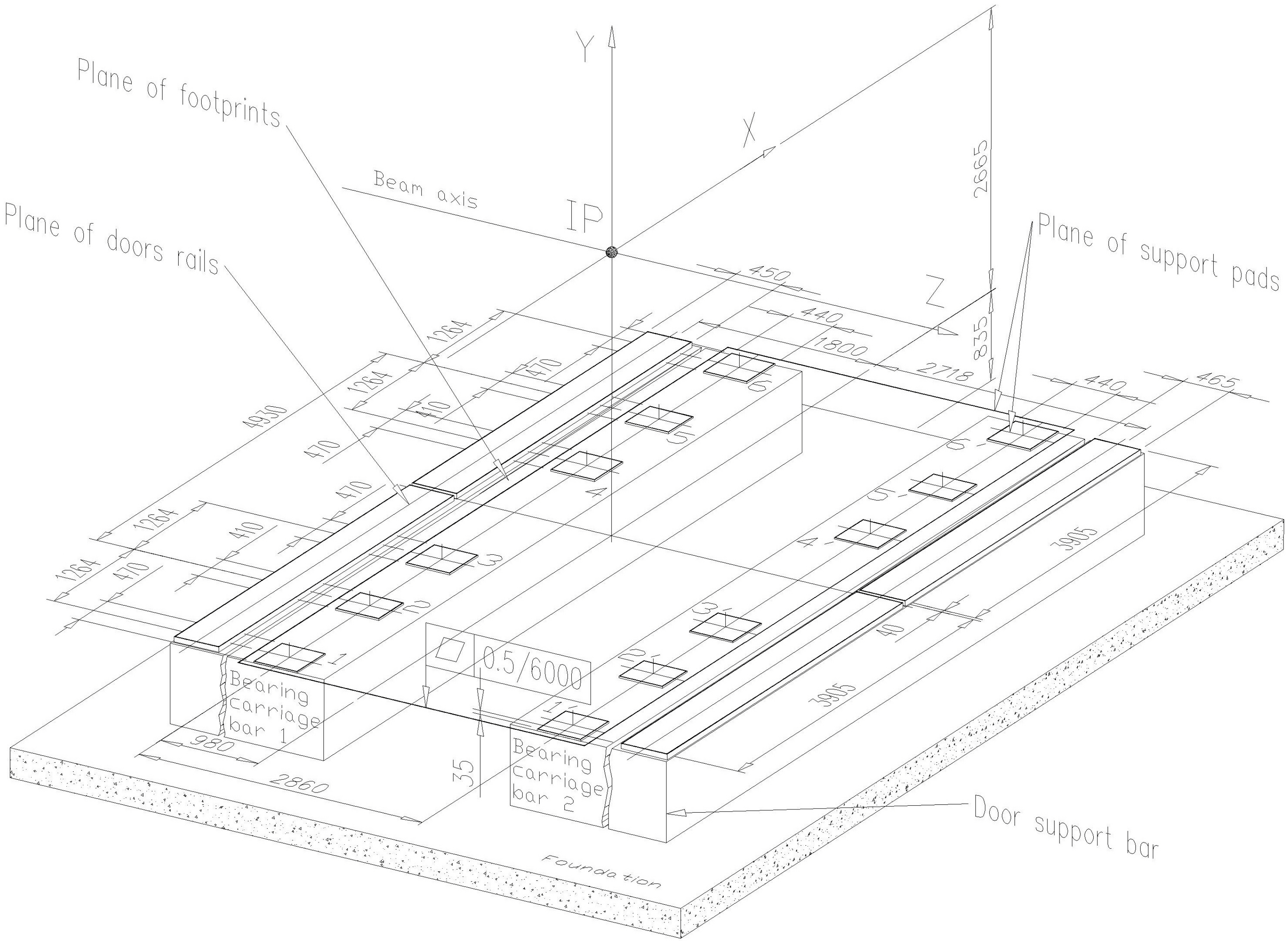

Fig. 1. Geometrical interface of the yoke and the transport carriage