Magnet Yoke/Carriage Interface

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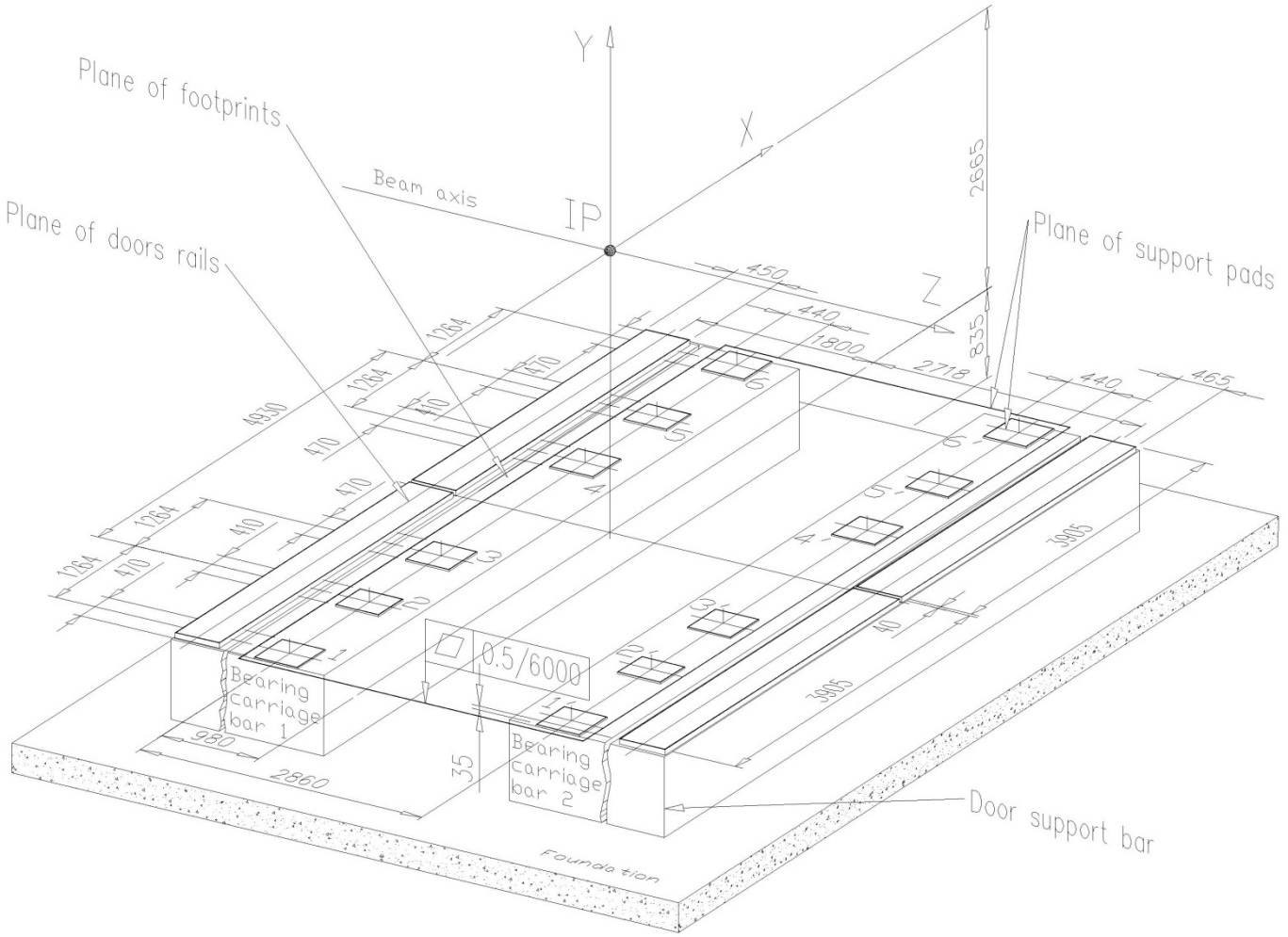
The Goals and Objectives of Yoke/Carriage and Yoke/Cryostat Interfaces

- Geometrical coupling of the carriage/yoke and yoke/ cryostat
- Specification of the transport carriage stiffness under magnet weight load
- Definition of permissible carriage beam to beam mutual inclinations in XY plane
- Definition of space deviations of the cryostat fixation points in the yoke aperture

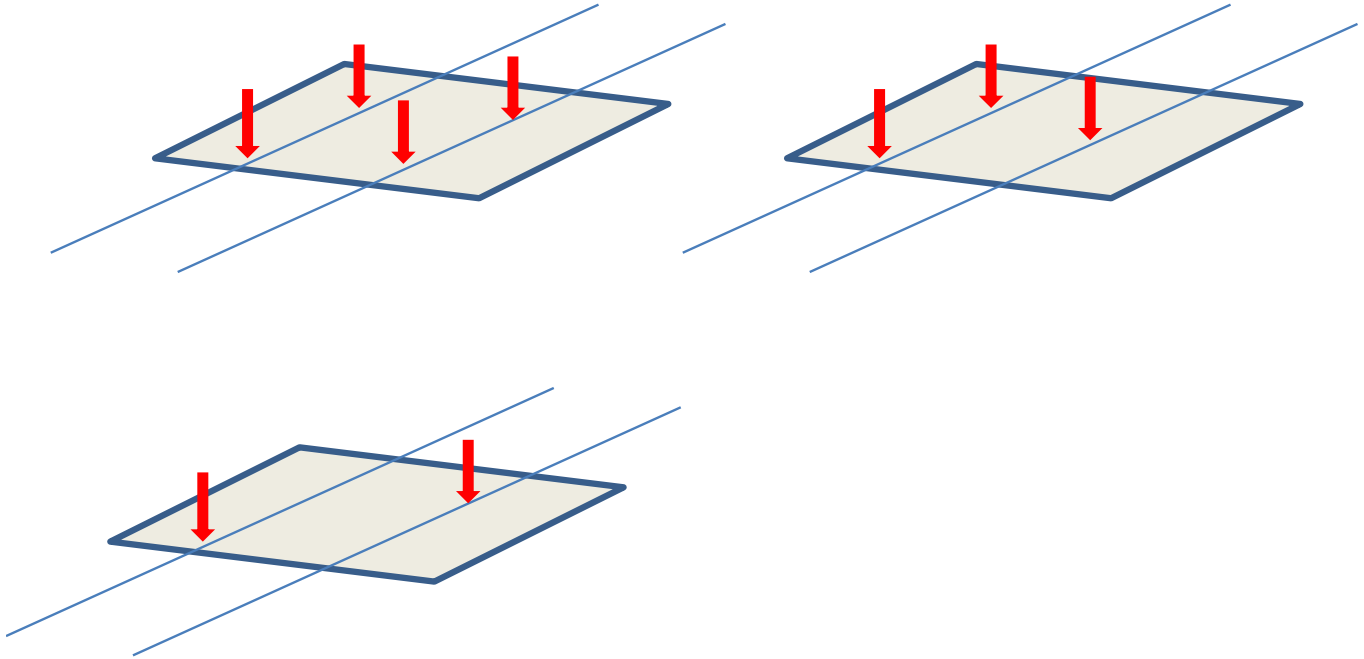
Geometrical Yoke/Carriage Interface



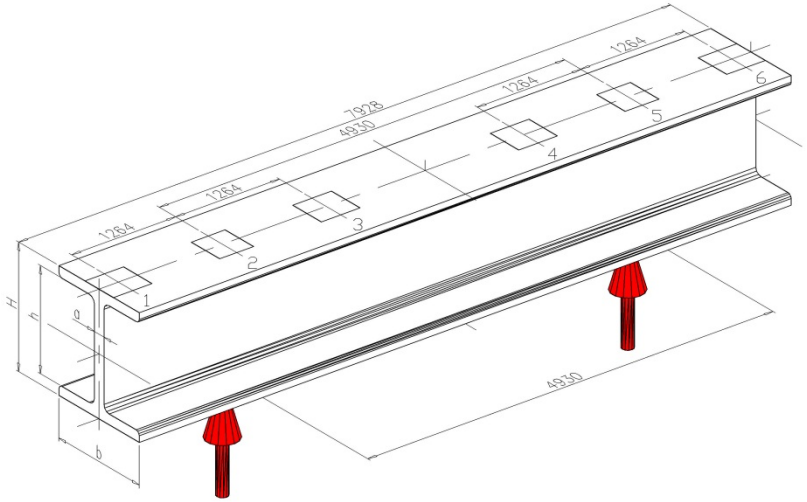
Yoke/Carriage Interface Main Requirements

1. The momentum of inertia supporting beams deposited below yoke banding collars must be ≥2.85 10^6 cm^4,
2. The cross section of the vertical wall (walls) of the beams must be ≥810 cm^2 (overall height of the beam 790 mm).
3. The centrums of side supports of the carriage (wheels or rollers or cushions) must be at the distance ≤4930 mm (this distance corresponds to the distance between yoke frame vertical uprights).
4. During magnet relocation beam to beam inclination (in plane XY) is to be $\alpha \leq 0.2$ mrad.

Possible Options of the Magnet Support



Support Beam Examples



$$Jy := \left(a \cdot \frac{h^3}{12} \right) + \left(\frac{b}{12} \right) \cdot \left(Hx^3 - h^3 \right)$$

$$S := a \cdot h$$

	N 1	N 2
H, m	0.79	1.0
h, m	0.63	0.84
a, m	0.15	0.1
b, m	1.24	0.68
Jy, cm^4	2.8 $x10^6$	2.8 $x10^6$
S, cm^2	945	840
m, ton	18	12

Weight loads distribution in the support points

1. The weight load 360 ton is distributed between 12 support pads on the carriage top.
2. The load distribution depends on the rigidity of the base and on the positions of carriage points of rest.
3. Deviations from the values obtained for the magnet assembly on an absolutely rigid base are indicated in the table (in superscripts and subscripts).
4. In normal operation conditions 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 remain within confidence intervals.

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}

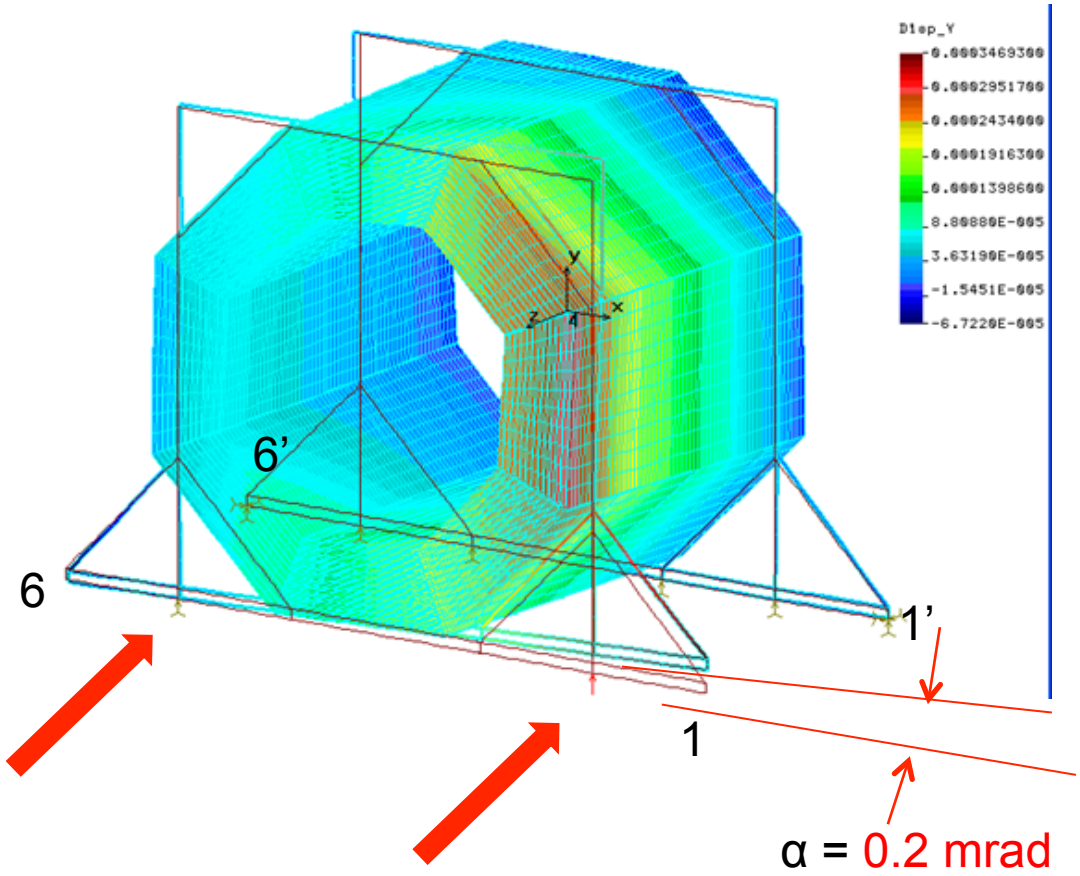
Influence of Different Types of Yoke Fixation on the Beam Surface

Point #	Vertical loads in the support points, kN	
	Rigid fixation	Without friction
1 & 1’	143	161
2 & 2’	428	424
3 & 3’	317	300
4 & 4’	317	300
5 & 5’	428	424
6 & 6’	143	161

Contact conditions don’t influence much on support reactions and vertical deformations

Yoke Deformation under Torsion

Point #	Vertical loads in the support points, kN	
	α = 0	α = 0.2 mrad
1 & 1’	**270**	**370**
2 & 2’	**410**	**579**
3 & 3’	**220**	**250**
4 & 4’	**220**	**196**
5 & 5’	**410**	**247**
6 & 6’	**270**	**156**

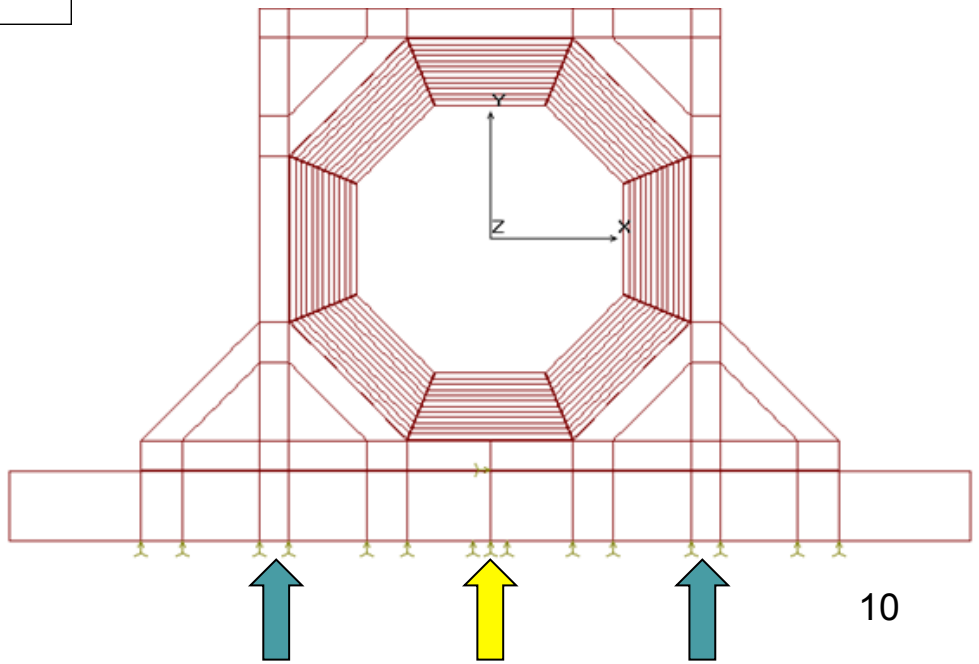


ΔY= + 0 mm
ΔF = - 33 ton

ΔY= + 1 mm
ΔF = + 33 ton

Deformation of the Yoke Opening

	Deformation of the Yoke Opening			
	h, mm	Δh, mm	b, mm	Δb, mm
After yoke assembly and cryostat mounting	-1.11	0.0	1.94	0.0
Door hanging	-1.13	-0.02	1.90	-0.04
Central reaction point	-2.42	-1.31	2.78	0.84
Reaction points below the vertical uprights	-1.32	-0.21	1.92	-0.02



Yoke/cryostat interface

1. Maximal deviations of the yoke inner contour accepted to be in vertical direction $\Delta Y = -1.5$ mm, in horizontal direction $\Delta X = +1.5$ mm for possible deviations of a rail flatness in the process of magnet transportation.
2. Torsion of the yoke barrel 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 rails in the process of magnet movement have to provide maximal torsion of the yoke barrel $\alpha \leq 0.2$ mrad

Yoke Doors/rails Interface

1. The rails will be loaded by the door weights in assembly and beam positions only. During magnet transportation the door wheels will not interfere with the rails.
2. Maximal allowable vertical deformations of the door rail supports under action of the concentrated load of 25 ton must be ≤0.2 mm.

The problems which are solved by rigid carriage beams

The rigid carriage beams provide general stability of the yoke and space deviations of the yoke aperture contour $\Delta h<1.5$ mm and $\Delta b<1.5$ mm

- for any symmetrical carrige supports,
- for any nonsymmetrical supports and rail nonflatness better than 0.5/5000 and rails nonparallelism better than 0.5/5000 ,

THANK YOU
FOR YOUR ATTENTION!

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