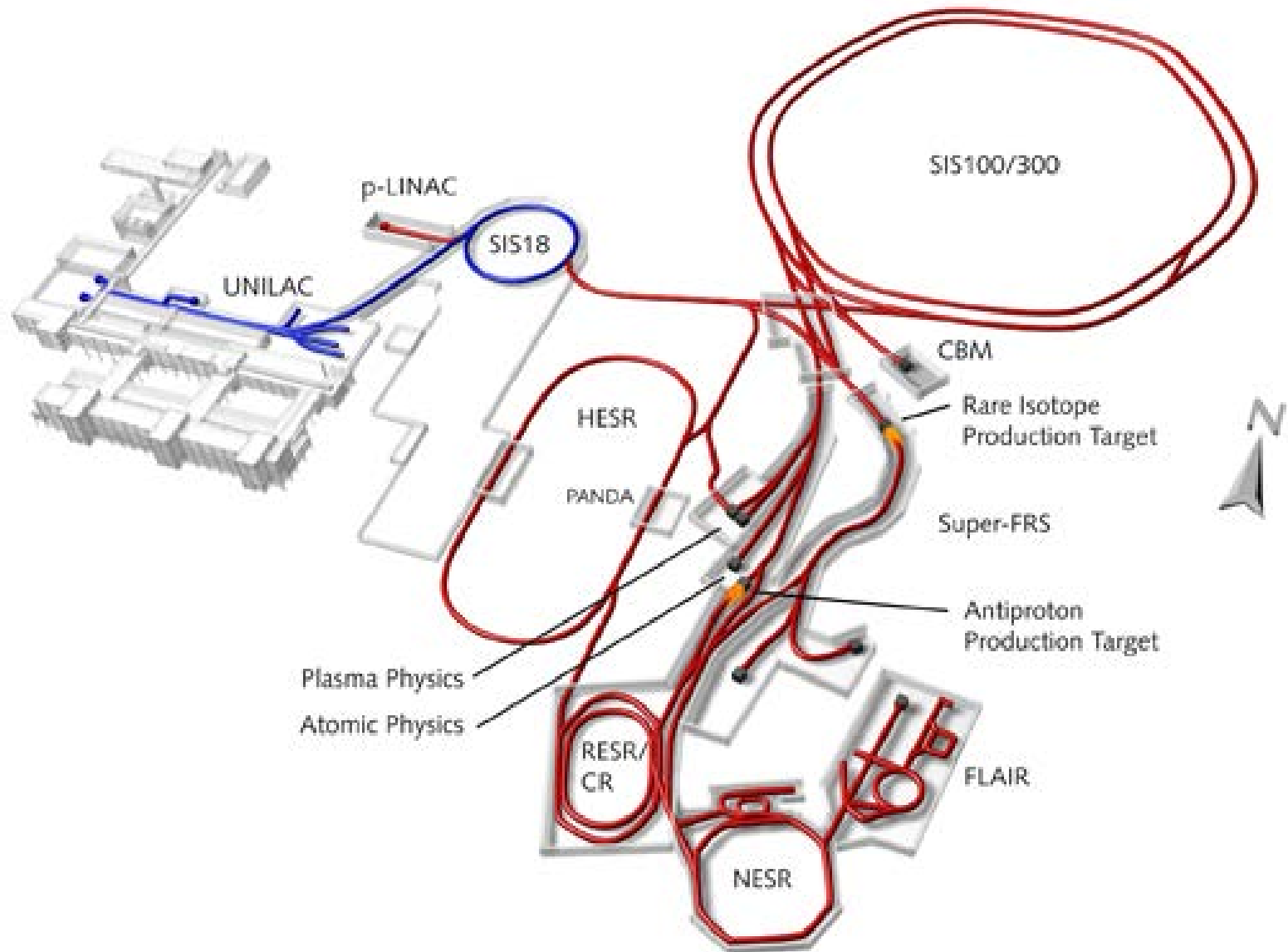


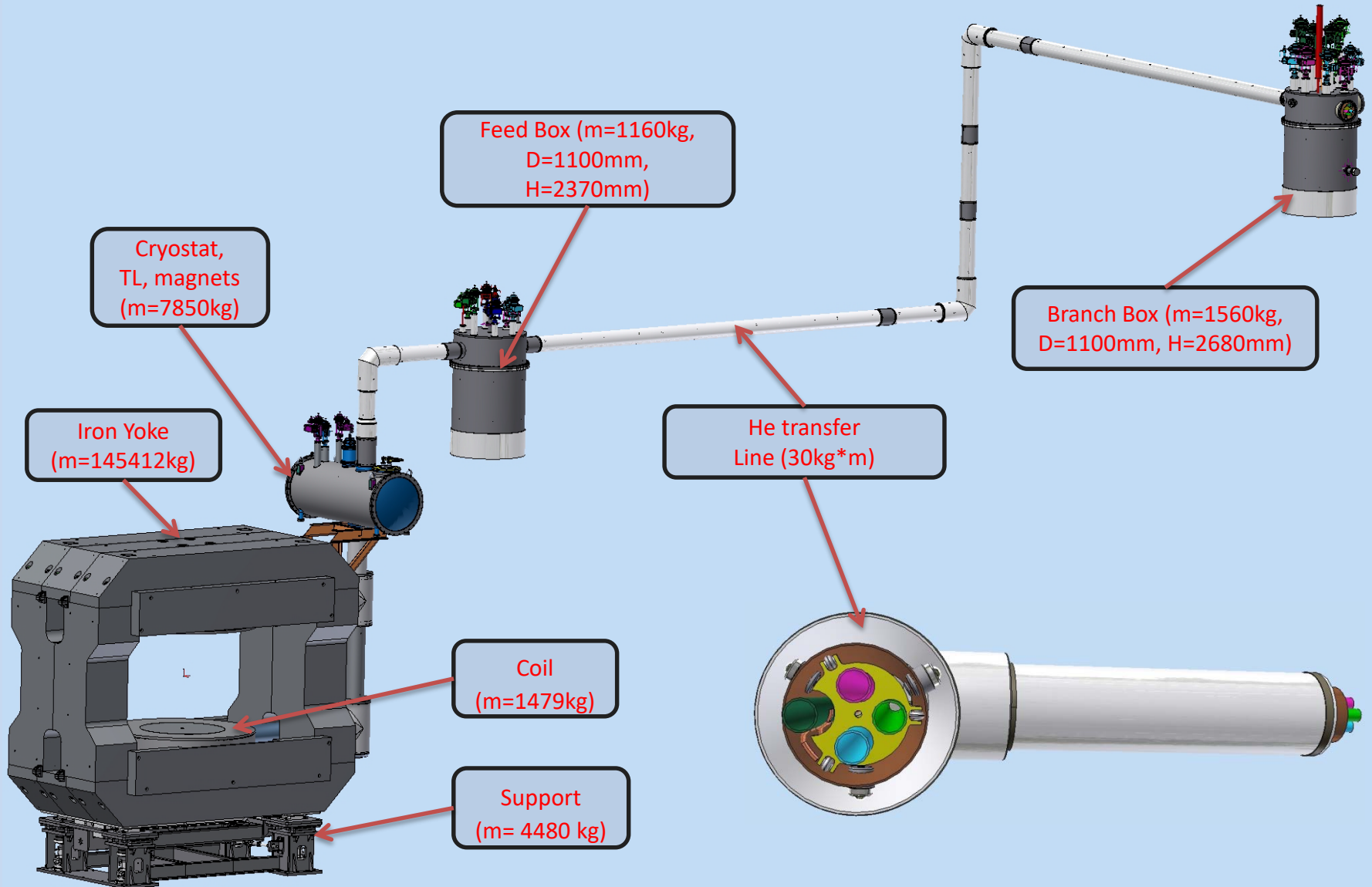
CBM Iron yoke and support design

11 2019, BINP, M.Kholopov, A.Bragin, S. Pivovarov.

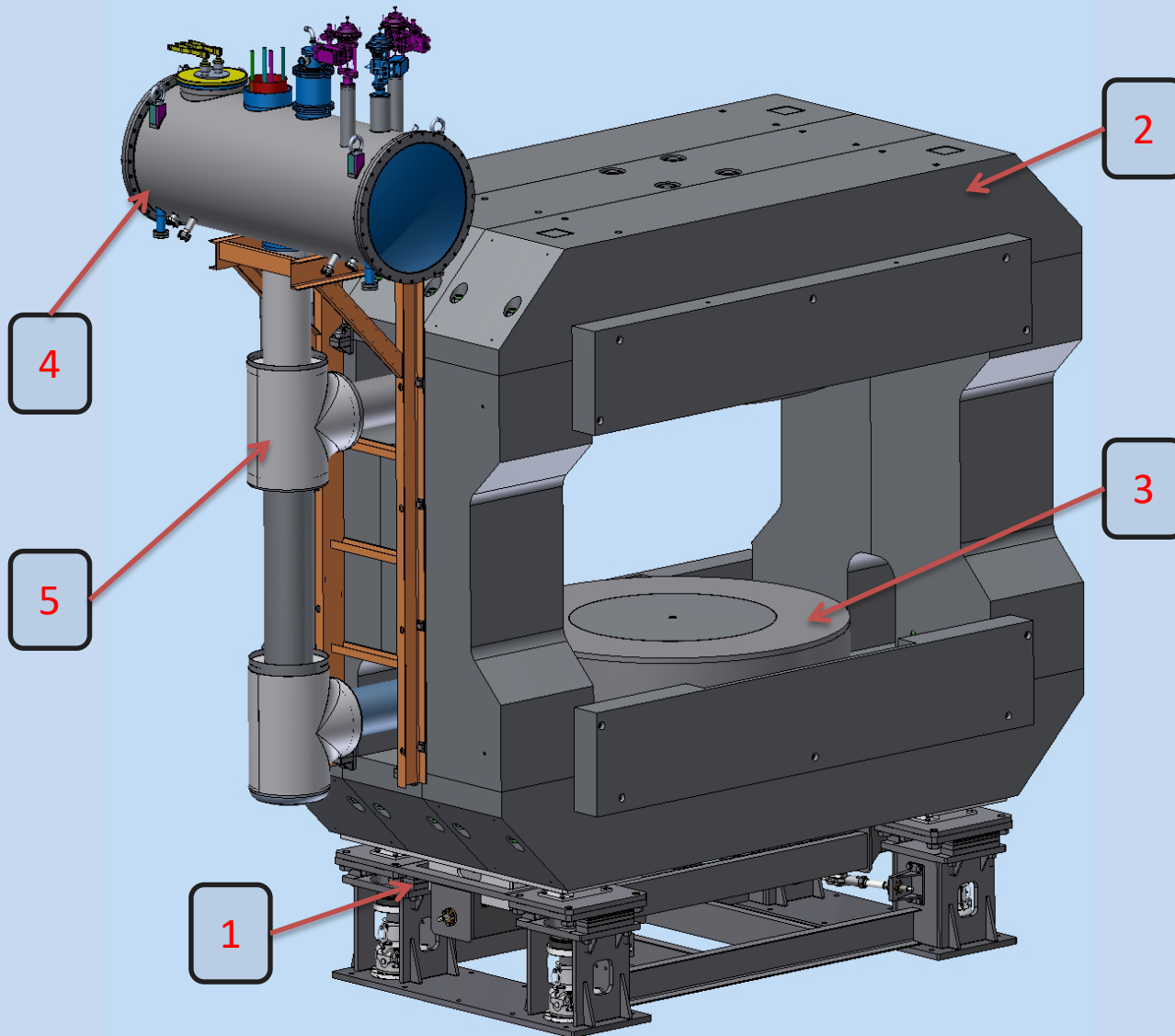
FAIR



3D Model of CBM Magnet and cryosystem



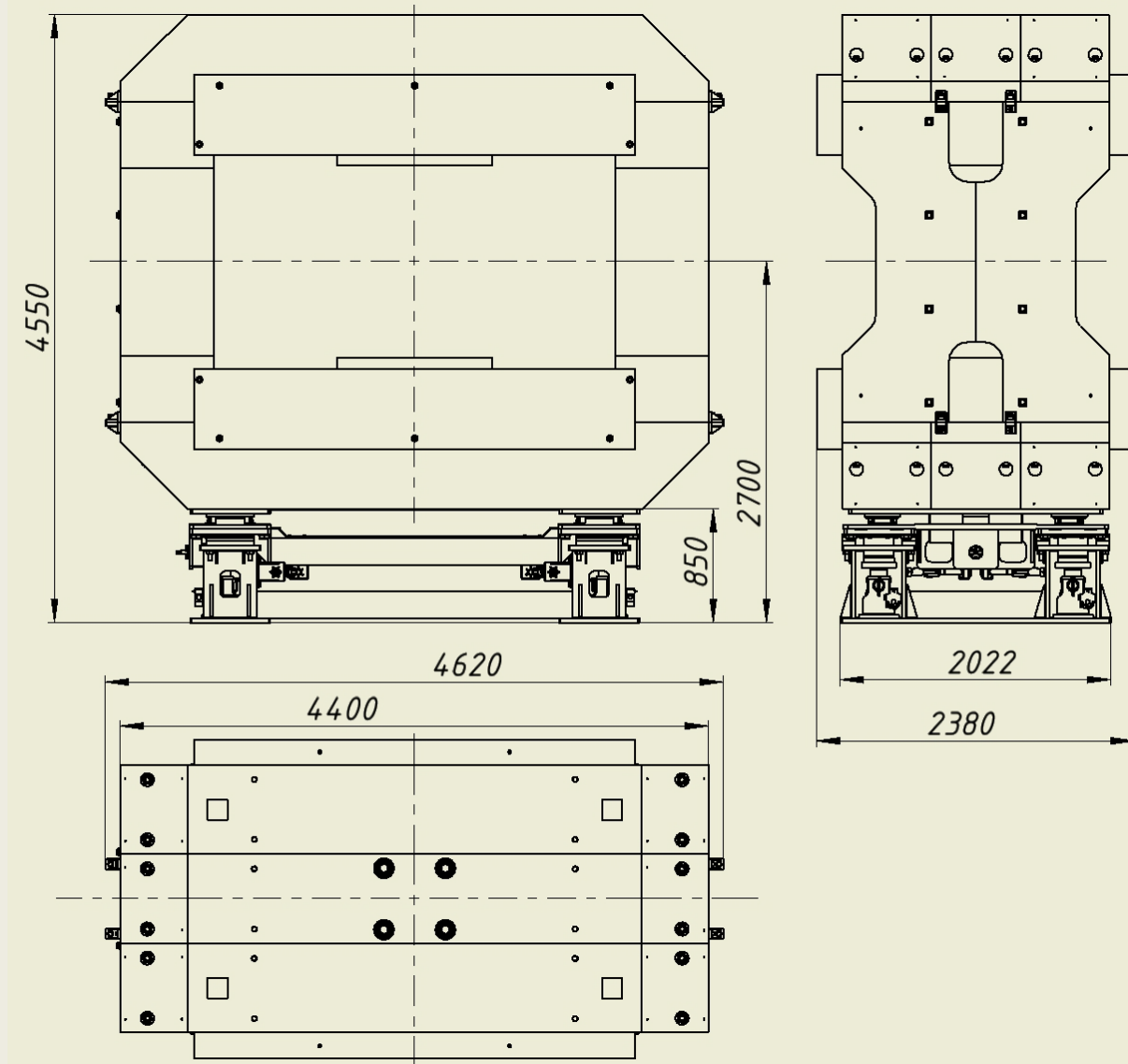
3D Model of CBM Magnet (new design)



- 1. Support $m= 4480 \text{ kg}$
- 2. Iron Yoke $m=145412\text{kg}$
- 3. Coils $m=3100\text{kg}$
- 4. Cryostat $m=940\text{kg}$
- 5. Cryostats TL $m=710\text{kg}$

The support's load – 154 tons

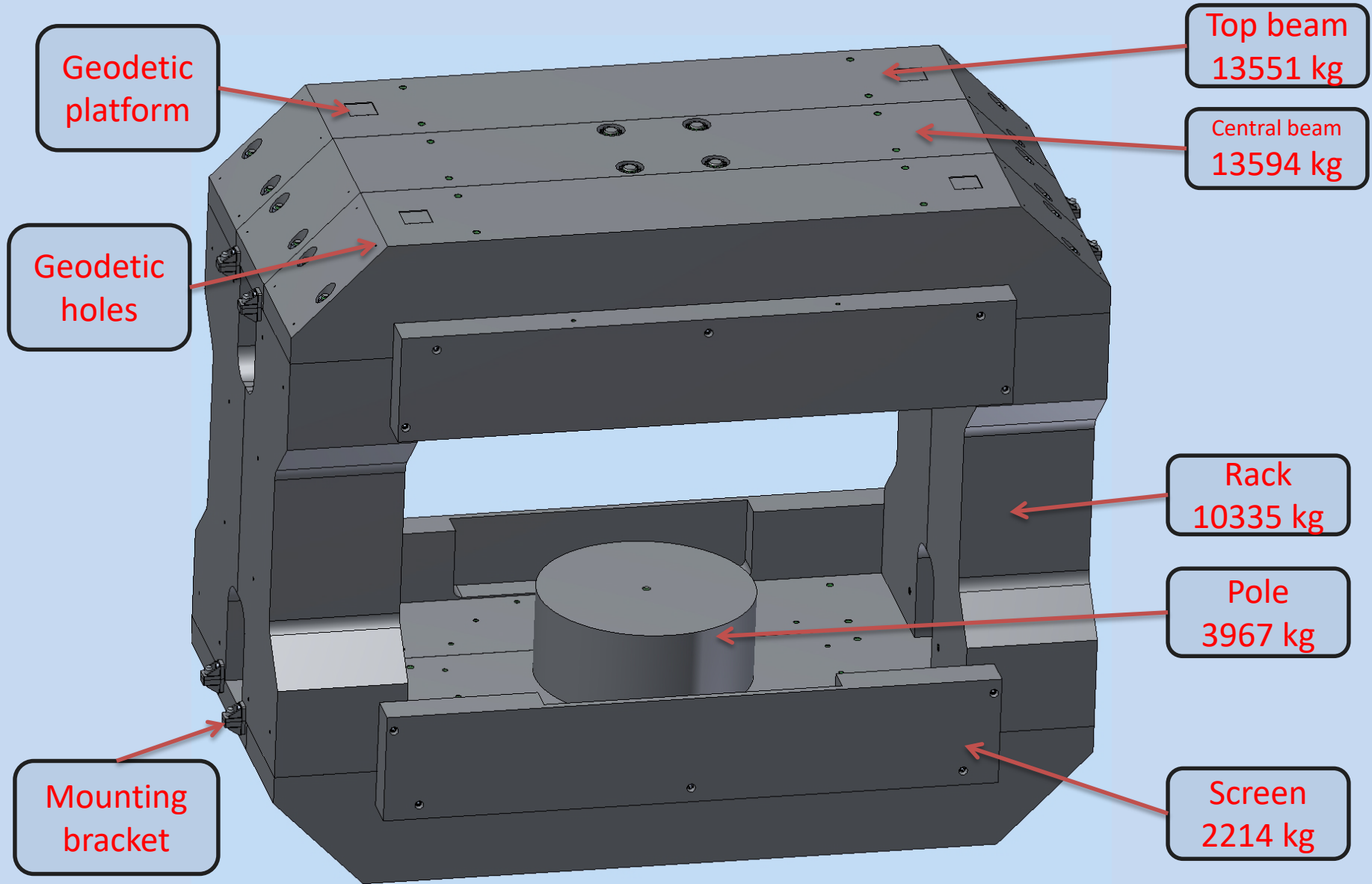
Iron Yoke and supports drawing



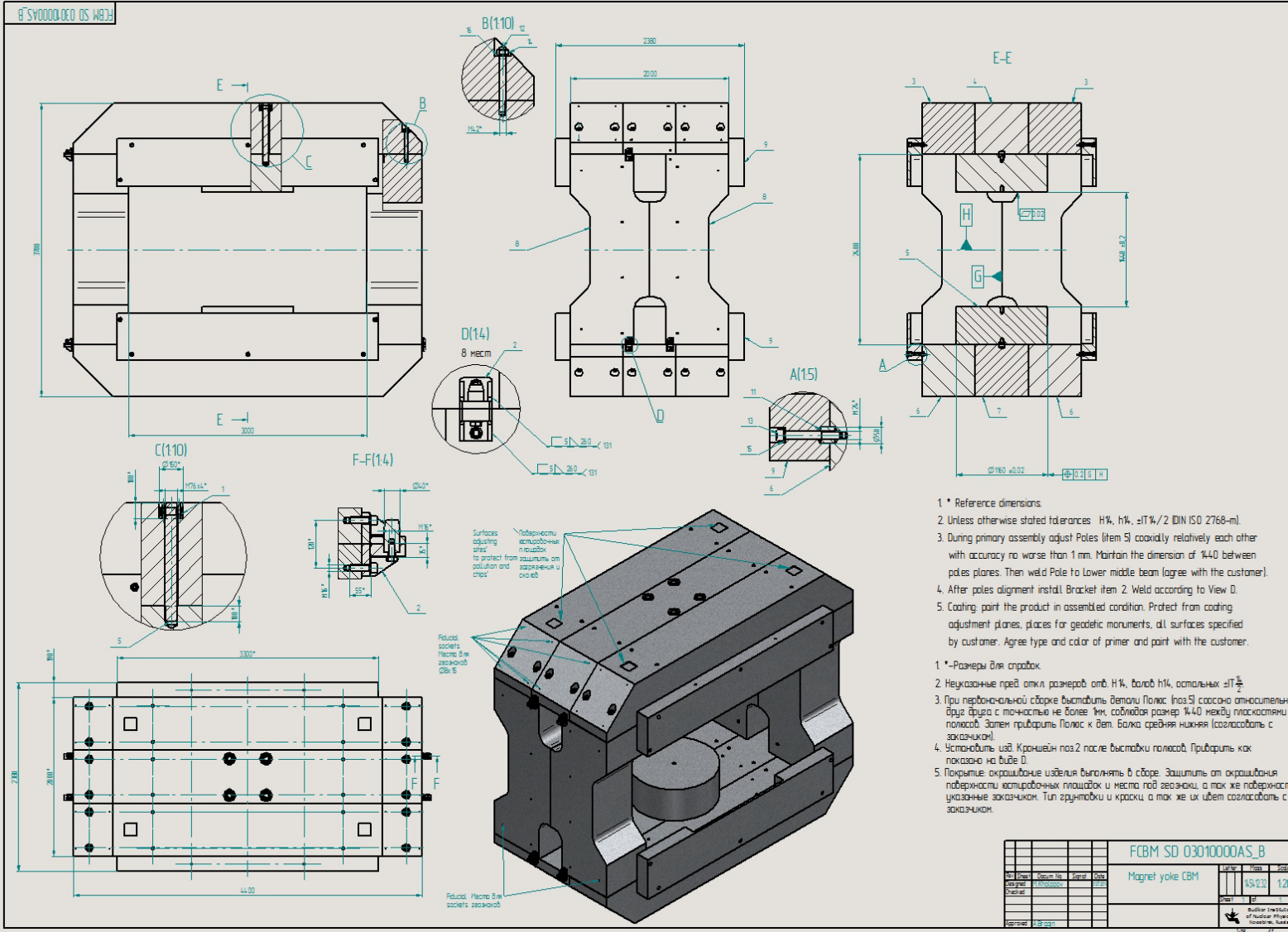
Weight and size

- $m = 150000$ kg
- $L = 4620$ mm
- $W = 2380$ mm
- $H = 4550$ mm

Iron Yoke 3D Model



Iron Yoke and supports drawing



Weight and size

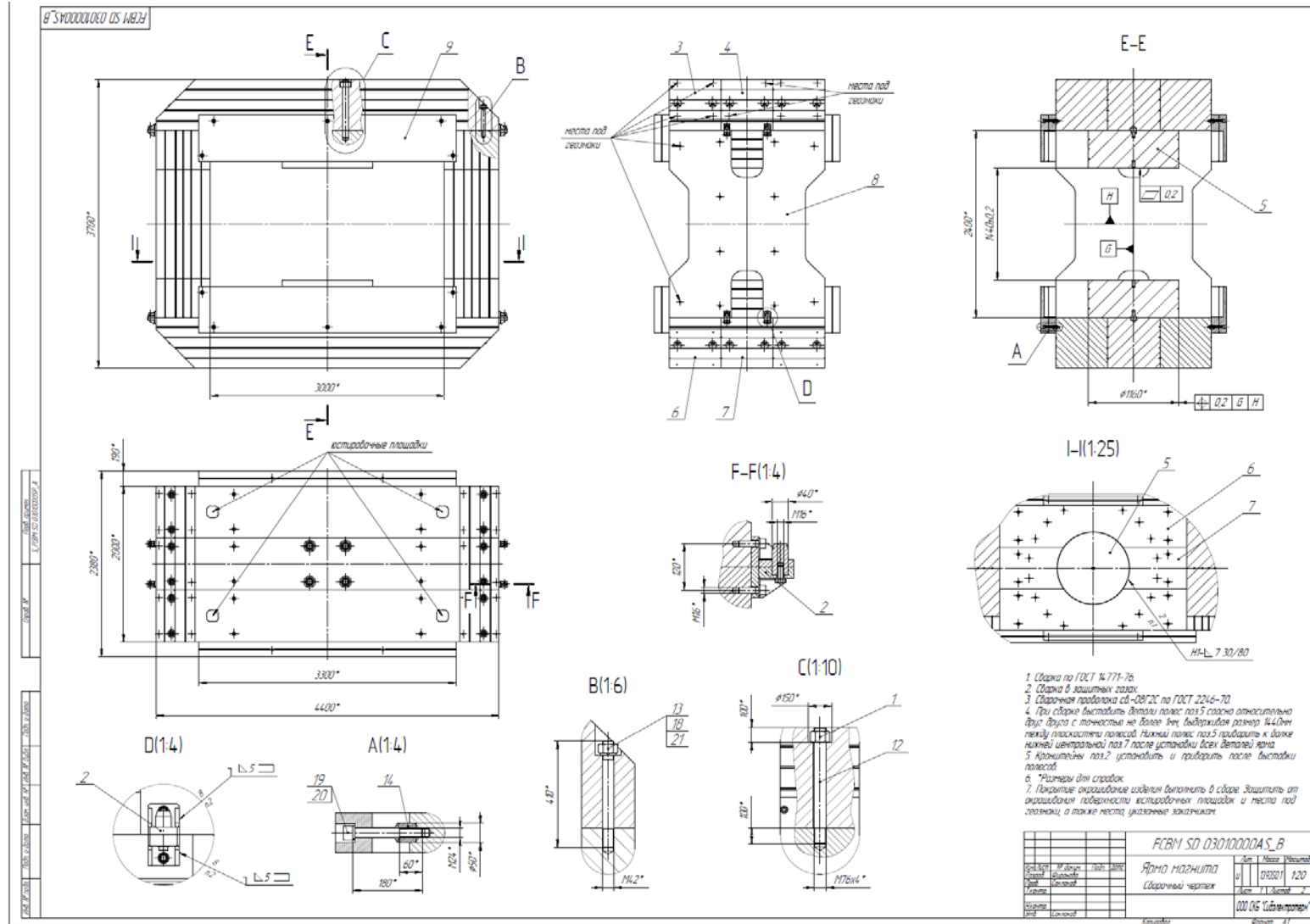
- m= 145412 kg
- L=4440mm
- W=2380mm
- H=3700mm

- 1 * Reference dimensions.
- 2 Unless otherwise stated tolerances: H4, h4, ±IT4/2 (DIN ISO 2768-m).
- 3 During primary assembly adjust Poles (item 5) coaxially relatively each other with accuracy no worse than 1 mm. Maintain the dimension of 1440 between poles planes. Then weld Pole to Lower middle beam (agree with the customer).
- 4 After poles alignment install Bracket item 2. Weld according to View D.
- 5 Coating paint the product in assembled condition. Protect from coating adjustment planes, places for geodetic monuments, all surfaces specified by customer. Agree type and color of primer and paint with the customer.

- 1 * -Размеры для справок.
- 2 Неуказанные пред. откл. размеров отн. H4, h4, остальных ±IT₄/2.
- 3 При первоначальной сборке выставить детали Полюс (поз.5) согласно относительно друг друга с точностью не более 1мм, сохраняя размер 1440 между плоскостями полюсов. Затем приварить Полюс к вет. Балка средняя нижняя (согласовать с заказчиком).
- 4 Установить изв. Крайней поз.2 после выставки полюсов. Приварить как показано на Виде D.
- 5 По окончании окрасочные изделия выполнять в сборе. Защитить от окрасочной поверхности установочных площадок и места под датчики, а так же поверхности указанные заказчиком. Тип грунтовок и красок, а так же их цвет согласовать с заказчиком.

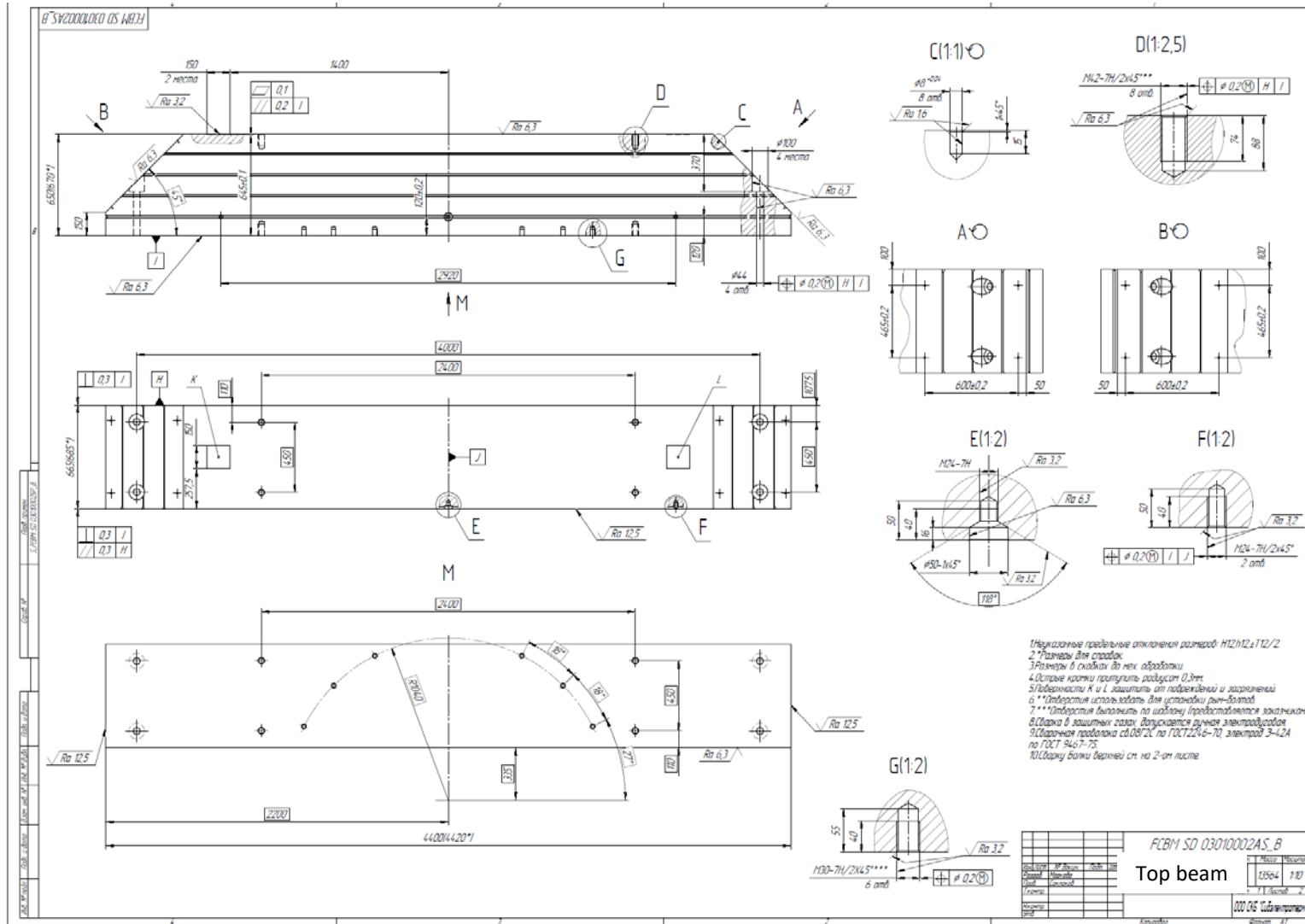
FCBM SD 03010000AS_B				Magnet yoke CBM	
№ Изм.	Содерж. Изм.	Дата	Исполн.	№ Изм.	Дата
01				01	
FCBM SD 03010000AS_B				№ Изм.	Дата
Magnet yoke CBM				01	12.01.2019
FCBM SD 03010000AS_B				FCBM SD 03010000AS_B	
Magnet yoke CBM				Magnet yoke CBM	
FCBM SD 03010000AS_B				FCBM SD 03010000AS_B	
Magnet yoke CBM				Magnet yoke CBM	

Iron Yoke production drawing



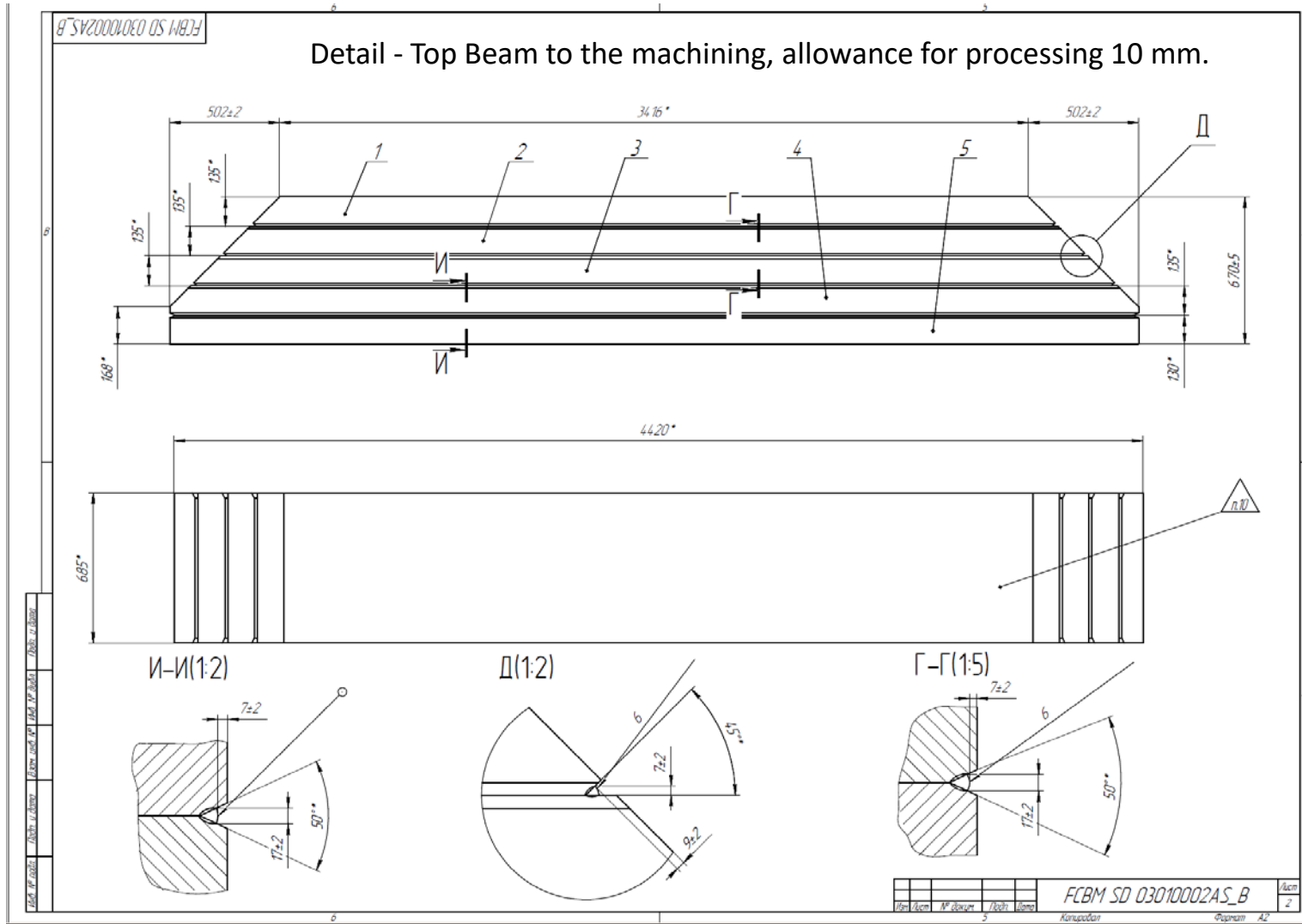
Drawings are processed in technologists and prepared for translation.

Iron Yoke production drawing



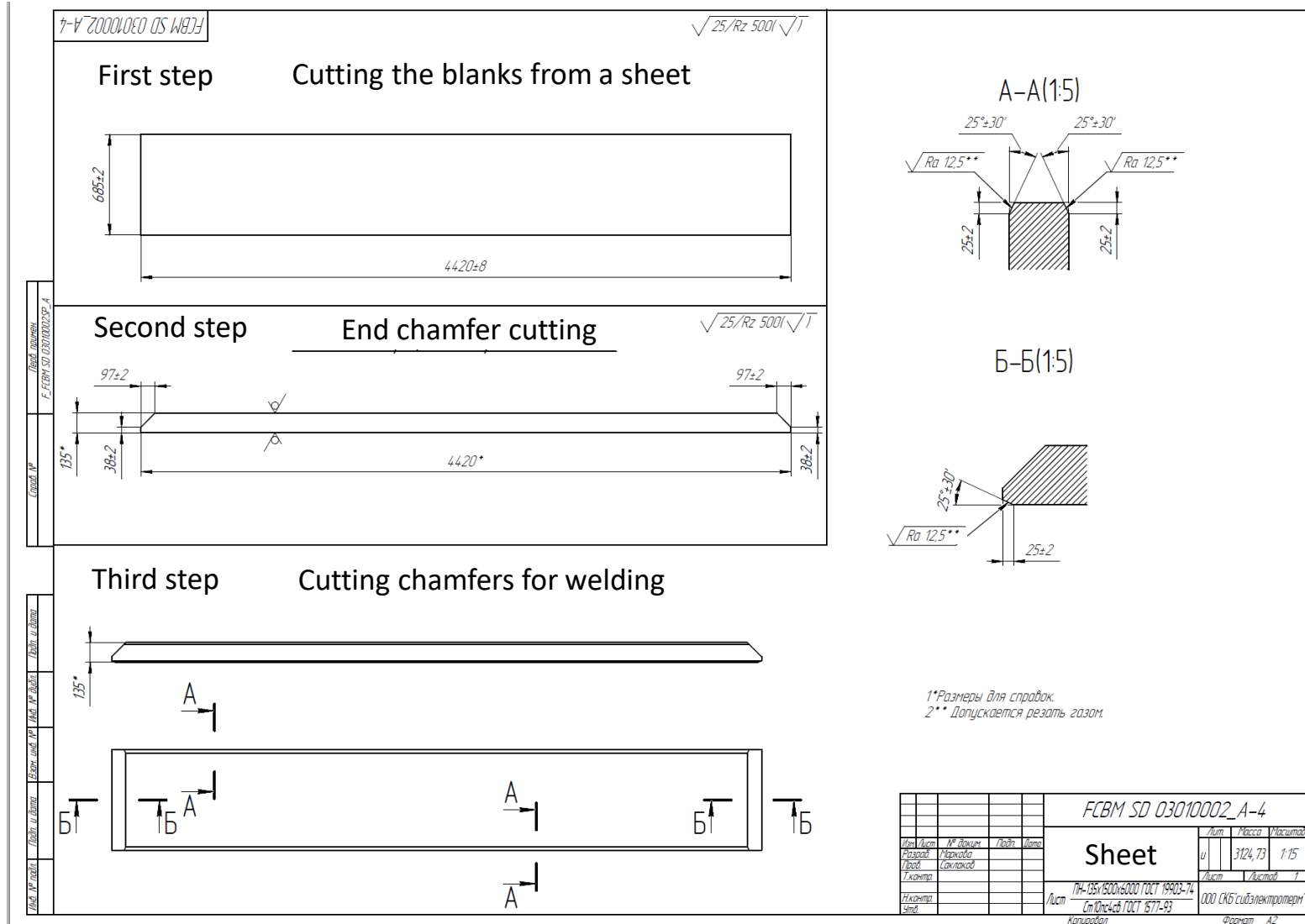
An example of the implementation of the yoke of sheet material.

Iron Yoke production drawing



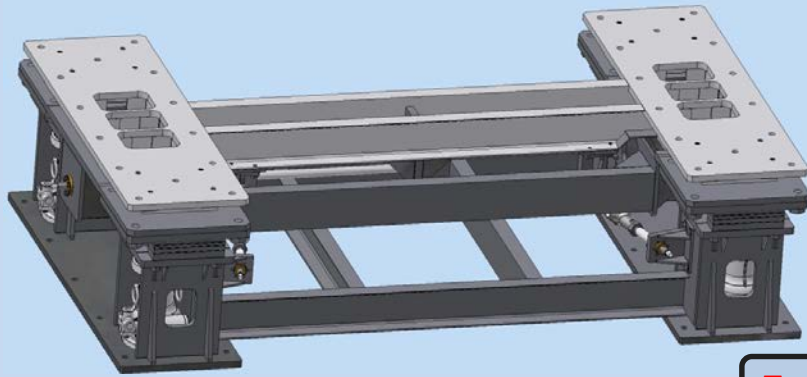
An example of the implementation of the yoke of sheet material.

Iron Yoke production drawing



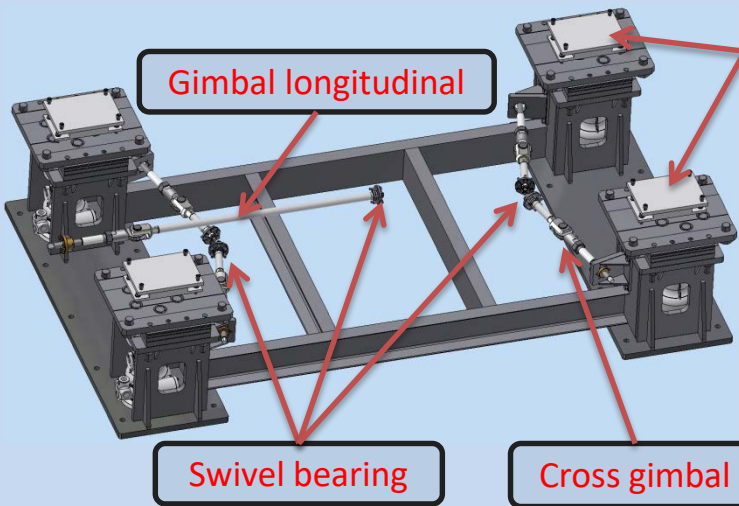
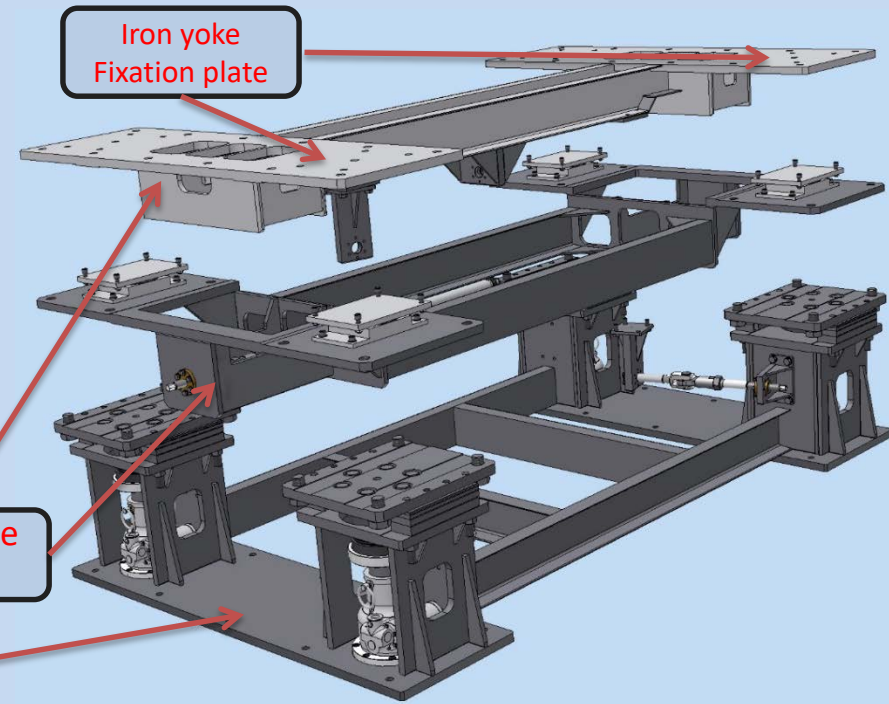
An example of the implementation of the yoke of sheet material.

CBM Magnet support

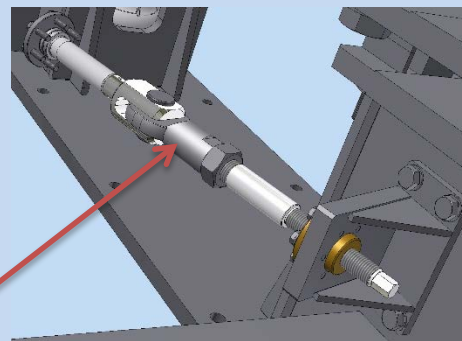


Magnet supports alignment tools

- Position accuracy: ± 0.5 mm (meeting in December 2018)
- Orientation accuracy (roll): ± 0.5 mrad
- Also, this design allows rotation around vertical axis $\pm 0.5^\circ$
- The gimbals has a fixation and alignment tool



Sliding support



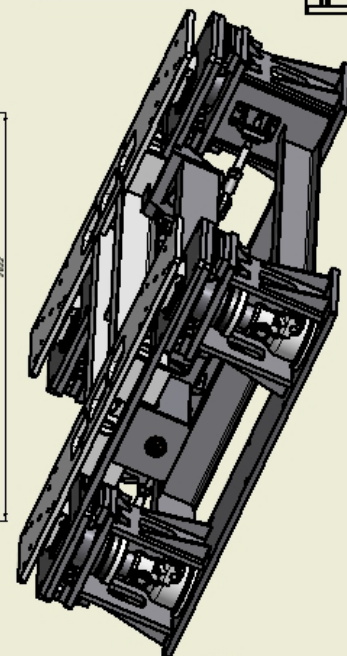
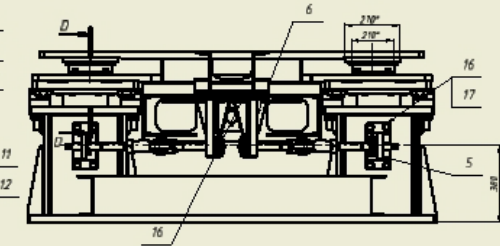
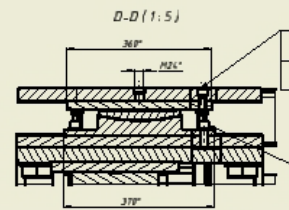
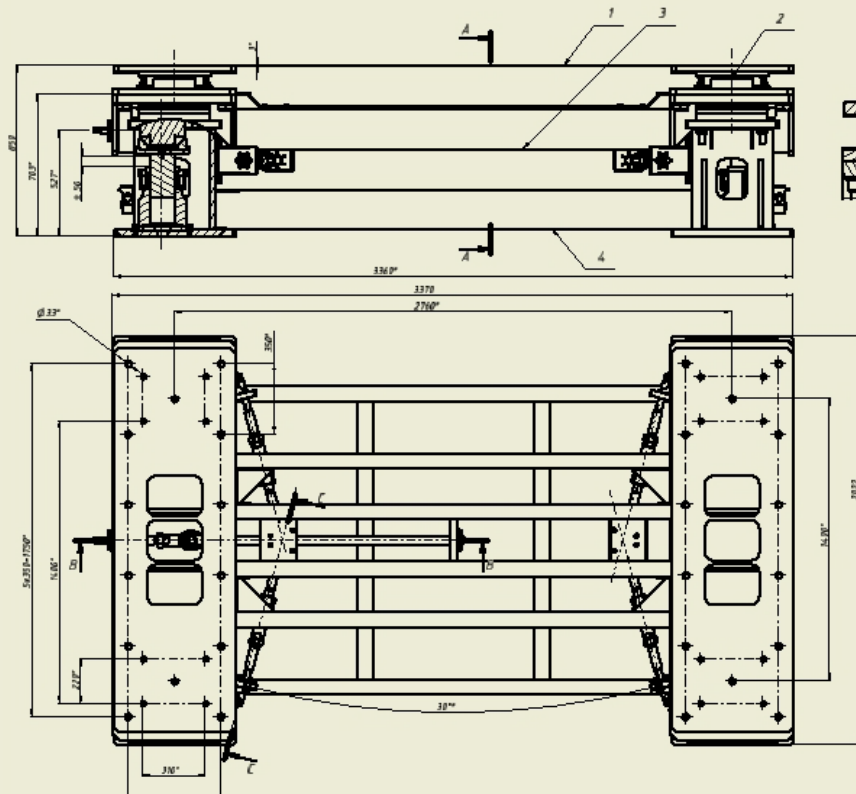
Weight and size

- $m = 4480$ kg
- 2022x3470x850mm
- move in 3D ± 40 mm
- Rotation top frame $\pm 4^\circ$
- Loading capacity 200000 kg
- strength class of fasteners - 8.8

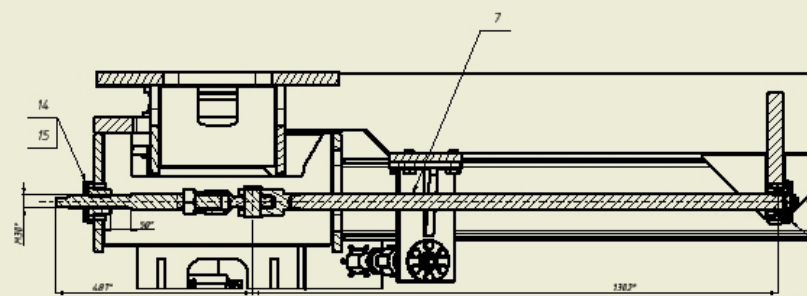
Magnet supports drawing

3-5V00007060 05 A02J4

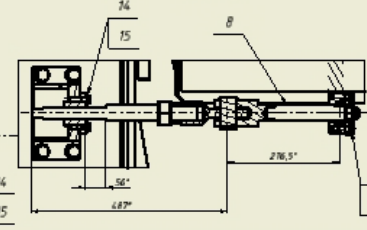
A-A (1:10)



B-B (1:5)



C-C (1:5)



- * Reference dimensions.
 - Check dimensions after fabrication are 40 ± 0.1, ± 0.15.
 - Start supporting assembly with a thin layer of grease.
 - Keep clean during assembly and between operations.
The product must be clean inside and outside.
- * По размеру для справок.
 - Проверить размеры после изготовления: 40 ± 0,1, ± 0,15, и после сборки.
 - Начать сборку с тонким слоем смазки.
 - Сохранять чистоту сборки и чистоту деталей между операциями.
Продукт должен быть чистым внутри и снаружи.

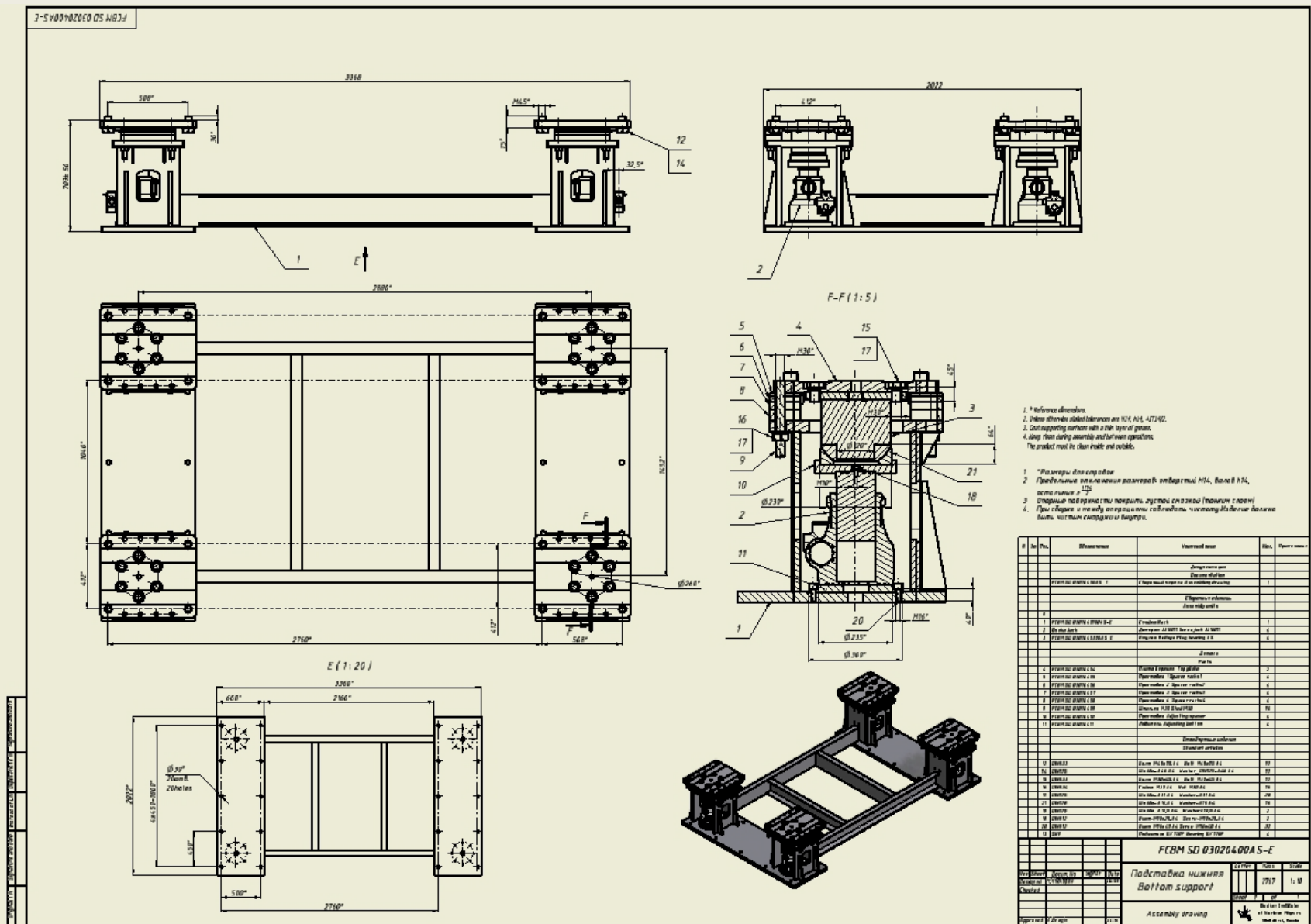
№	Кол.	Обозначение	Материал	Вид	Примечание
					Заготовка из
					Из материала
					Продукт из материала
					Из материала
1		FCBM SD 03020000S-E	FCBM SD 03020000S-E	1	
2		FCBM SD 03020000S-E	FCBM SD 03020000S-E	1	
3		FCBM SD 03020000S-E	FCBM SD 03020000S-E	1	
4		FCBM SD 03020000S-E	FCBM SD 03020000S-E	1	
5		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
6		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
7		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
8		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
					Из материала
					Из материала
9		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
10		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
					Из материала
					Из материала
11		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
12		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
13		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
14		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
15		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
16		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	
17		FCBM SD 03020000S-E	FCBM SD 03020000S-E	2	

FCBM SD 03020000S-E

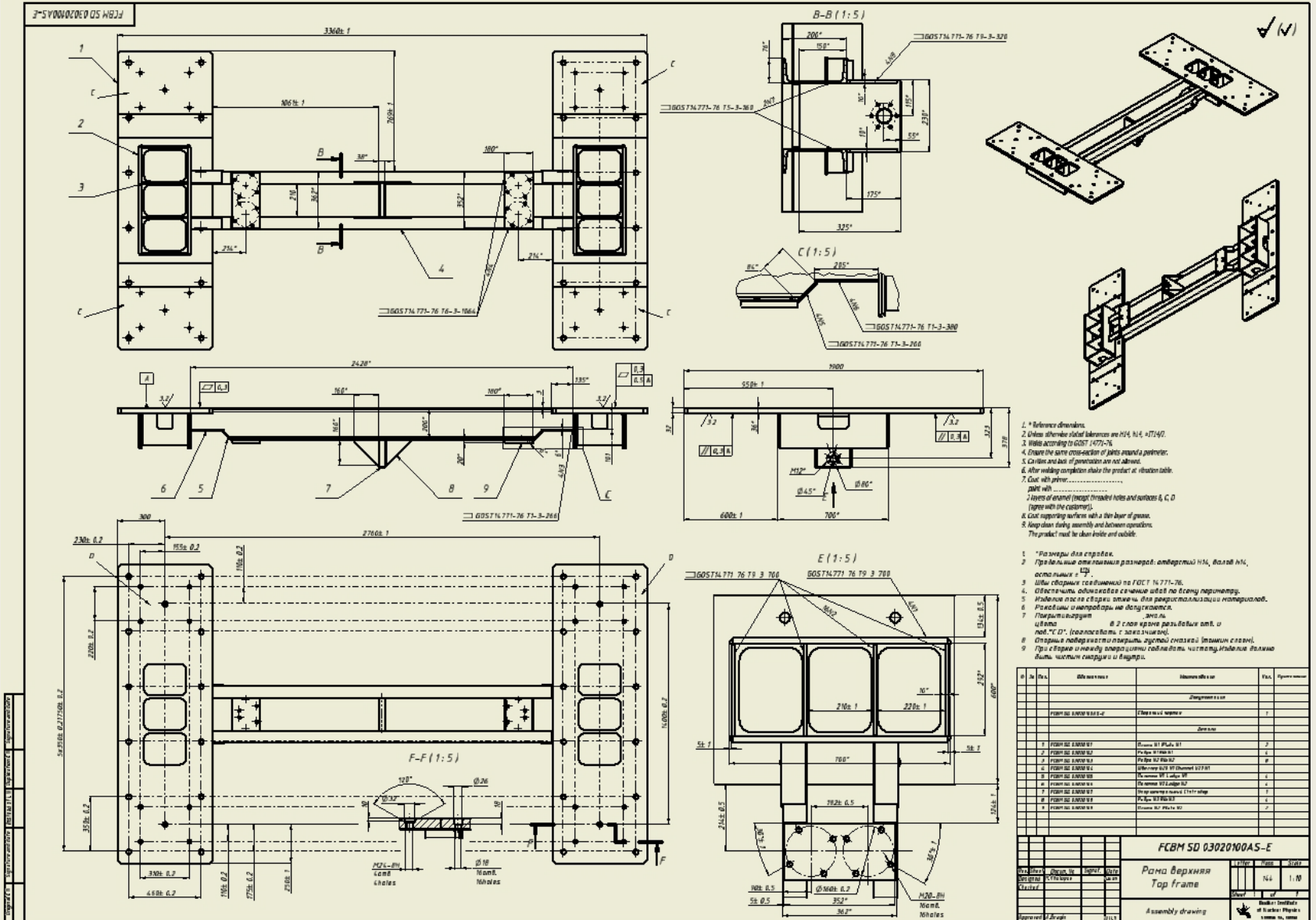
Подставка магнита
Magnet support

Assembly drawing

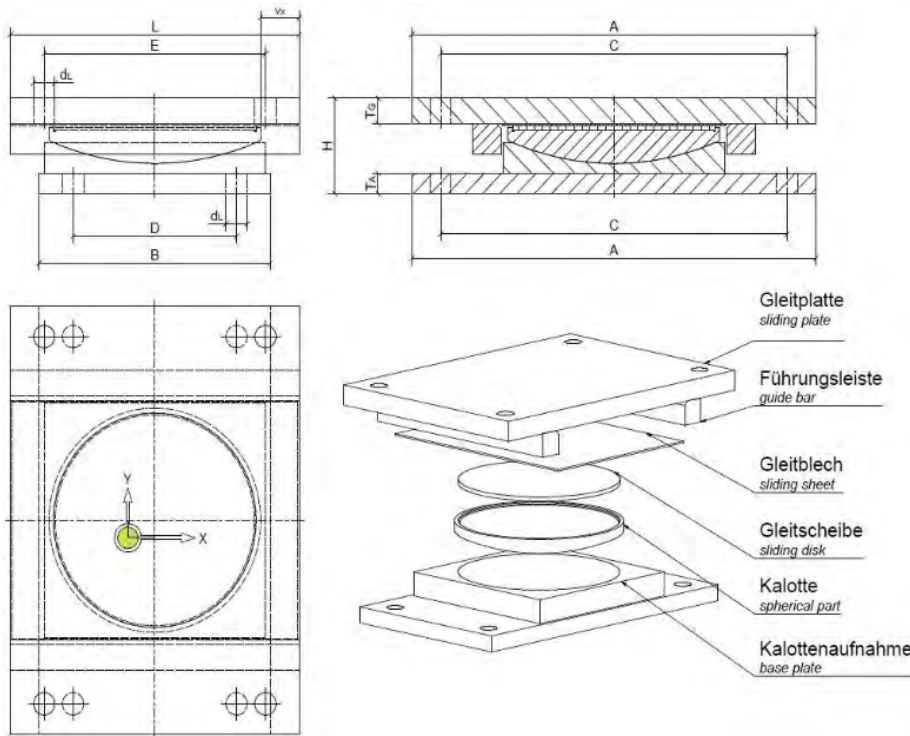
Bottom supports drawing



Top frame drawing



PGslide® Kalotten- Gleitlager mit 1 PTFE- Gleitelement, geführt PGslide® spherical slide bearing with 1 PTFE pad, guided



Typ / type	Lasten / loads		Abmessungen / dimensions													
	max. NS, s [kN]	Vy, sd	A	B	C	D	T _A	T _G	H	d _L	L ± 20	L ± 40	L ± 80	E ± 20	E ± 40	E ± 80
K 11sb	100	20	200	100	160	60	10	10	55	14	120	160	240	80	120	200
K 11sb	250	50	250	140	210	100	10	15	65	14	160	200	280	120	160	240
K 11sb	500	100	330	180	280	120	15	20	77	18	200	240	320	150	190	270
K 11sb	750	150	370	210	320	150	15	20	85	18	230	270	350	180	220	300
K 11sb	1.000	200	420	240	360	170	20	25	95	22	260	300	380	190	230	310
K 11sb	1.500	300	520	290	440	200	20	25	100	26	310	350	430	230	270	350
K 11sb	2.000	400	620	330	520	230	30	30	117	32	350	390	470	250	290	370
K 11sb	2.500	500	670	370	570	270	30	40	133	32	390	430	510	290	330	410
K 11sb	3.000	600	700	400	600	300	30	40	133	32	420	460	540	320	360	440
K 11sb	3.500	700	760	430	660	330	30	50	150	32	450	490	570	350	390	470
K 11sb	4.000	800	810	450	690	330	35	55	158	38	470	510	590	350	390	470
K 11sb	4.500	900	870	480	750	360	35	55	165	38	500	540	620	380	420	500
K 11sb	5.000	1.000	890	500	770	380	35	55	164	38	520	560	640	400	440	520

PTFE plate can be replaced with radiation resistant material. For example bronze with lubrication.

PTFE bearings are maintenance-free, this also applies to lubricated PTFE bearings;

Very Low Friction Constant

For the sake of simplicity, the following friction constants may be assumed under optimum installation conditions:

PTFE bearing, not lubricated about max. $\mu = 0.1$

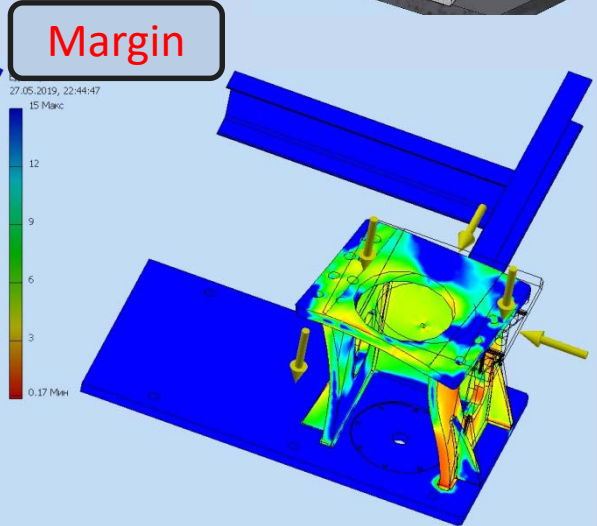
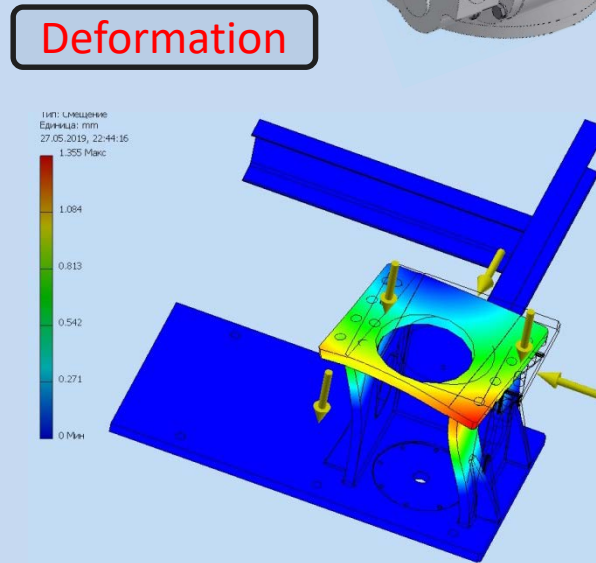
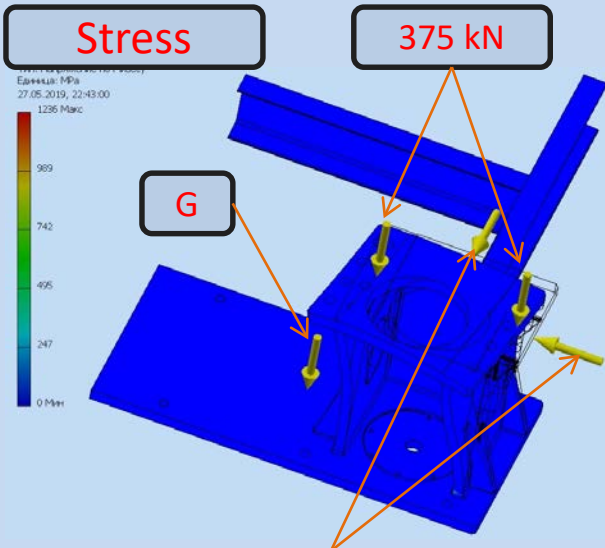
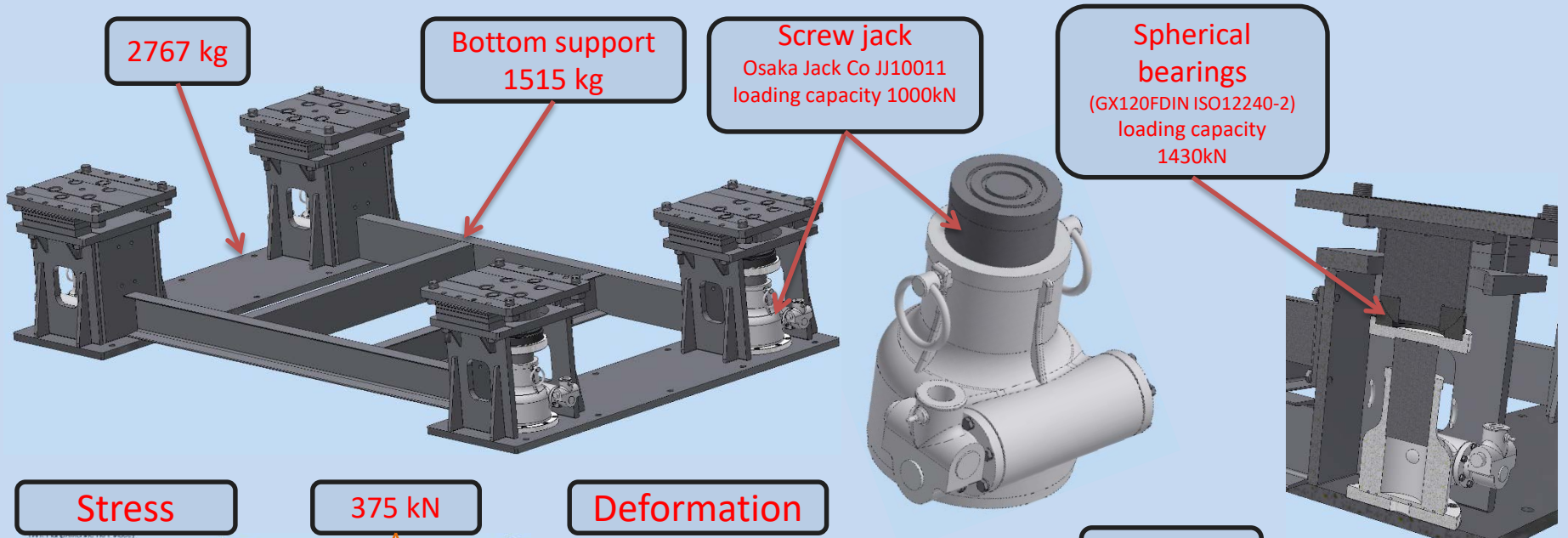
PTFE bearing, lubricated about max. $\mu = 0.04$

The PTFE slidingplates are absolutely corrosion resistant, re-sistant against chemicals and aging. The steel parts of the bearings are by standard sandblasted and provided with a zinc phosphate coating. Upon request, all usual corrosion protection processes are of-fered, including hot galvanizing. Versions made of special steel alloys or stainless steel on request

Fastener strength tablet

class of fasteners			ST-4.6		ST-8.8		A2-70		A4-80	
Thread	d2, мм	Площадь по d2, mm ²	MAX load, N	Work load, kg	MAX load, N	Work load, kg	MAX load, N	Work load, kg	MAX load, N	Work load, kg
M 1	0,8	0,5	121	0	322	10	126	0	151	0
M 2	1,7	2,27	544	20	1 452	70	567	20	681	30
M 3	2,6	5,31	1 274	60	3 396	160	1 327	60	1 592	70
M 4	3,5	9,62	2 308	110	6 154	300	2 404	120	2 885	140
M 5	4,4	15,2	3 647	180	9 726	480	3 799	180	4 559	220
M 6	5,3	22,05	5 292	260	14 112	700	5 513	270	6 615	330
M 8	7,1	39,57	9 497	470	25 326	1 260	9 893	490	11 872	590
M10	8,9	62,18	14 923	740	39 795	1 980	15 545	770	18 654	930
M12	10,7	89,87	21 570	1 070	57 520	2 870	22 469	1 120	26 962	1 340
M14	12,6	124,63	29 910	1 490	79 761	3 980	31 157	1 550	37 388	1 860
M16	14,6	167,33	40 159	2 000	107 092	5 350	41 833	2 090	50 199	2 500
M20	18,3	262,89	63 093	3 150	168 249	8 410	65 722	3 280	78 867	3 940
M24	21,9	376,49	90 359	4 510	240 956	12 040	94 123	4 700	112 948	5 640
M27	24,9	486,71	116 810	5 840	311 493	15 570	121 677	6 080	146 012	7 300
M30	27,6	597,98	143 516	7 170	382 708	19 130	149 495	7 470	179 394	8 960

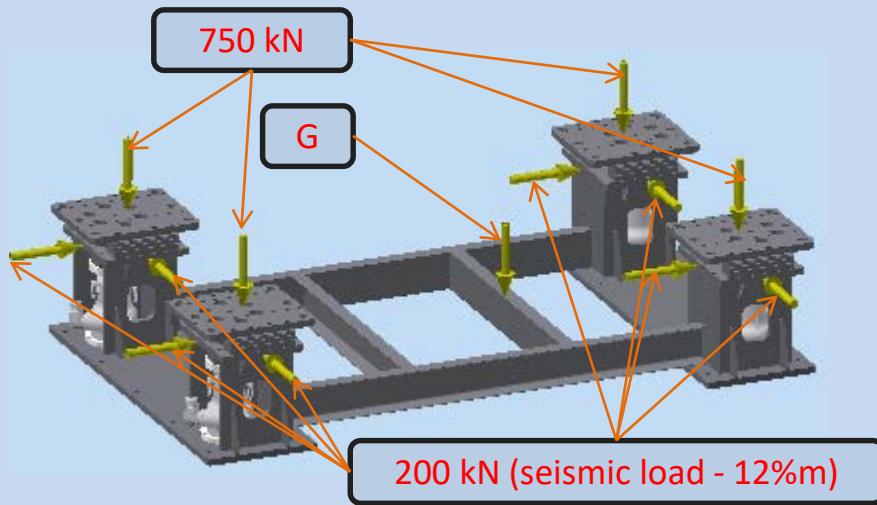
Screw jack Rack : design and calculation



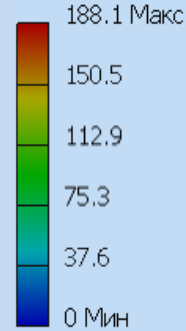
200 kN (seismic load - 12% m)

The bottom support is designed for a load of 200 tons and additionally added seismic hazard (20 tons)

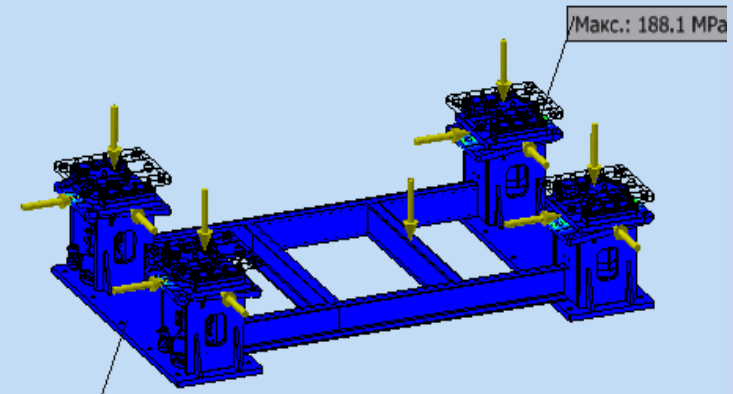
Screw jack Rack : design and calculation



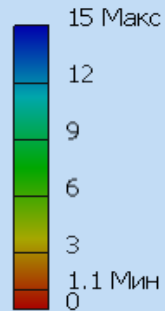
Единица: МПа
15.11.2019, 11:07:18



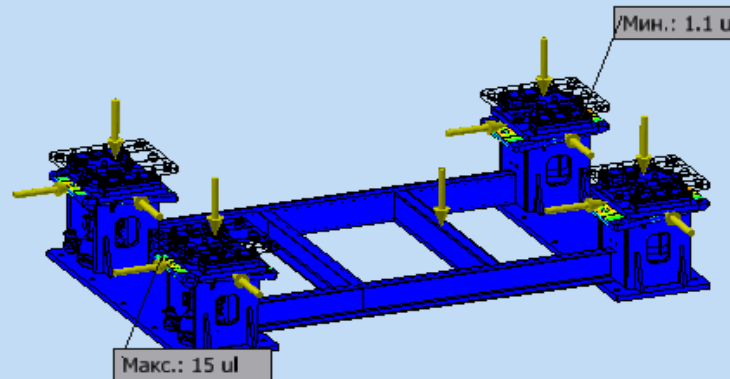
Stress



Единица: ul
15.11.2019, 11:07:35



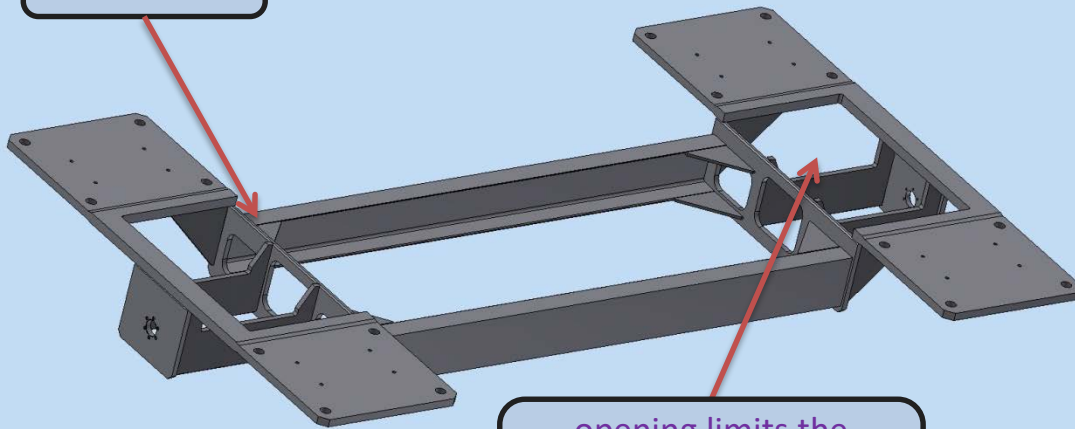
Margin



The bottom support is designed for a load of 200 tons and additionally added seismic hazard (20 tons)

Intermediate frame : design and calculation

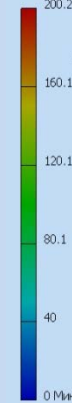
644 kg



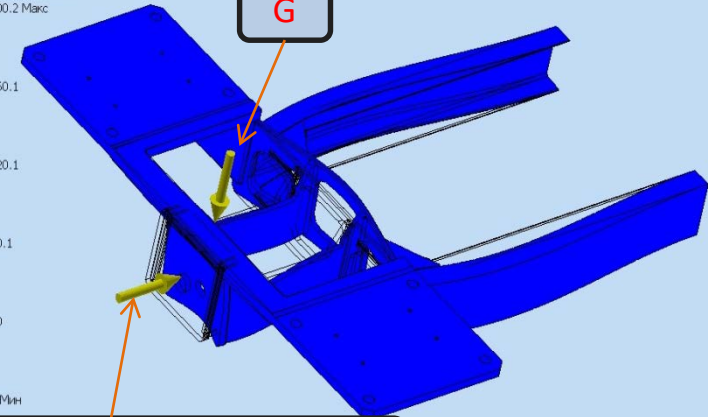
opening limits the movement of the Top frame

Stress

Единица: МПа
27.05.2019, 23:12:51
200.2 Макс



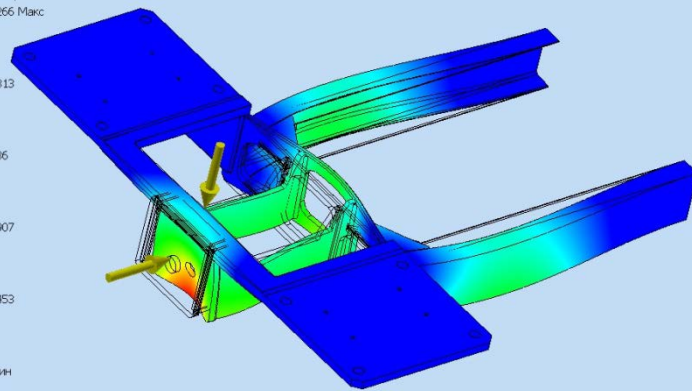
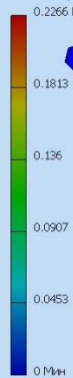
G



200 kN (seismic load - 12%*m*)

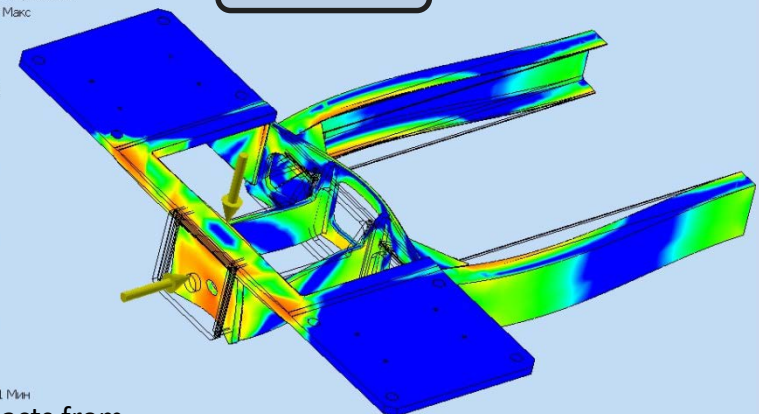
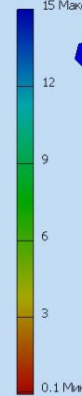
Deformation

Единица: мм
27.05.2019, 23:13:30
0.2266 Макс



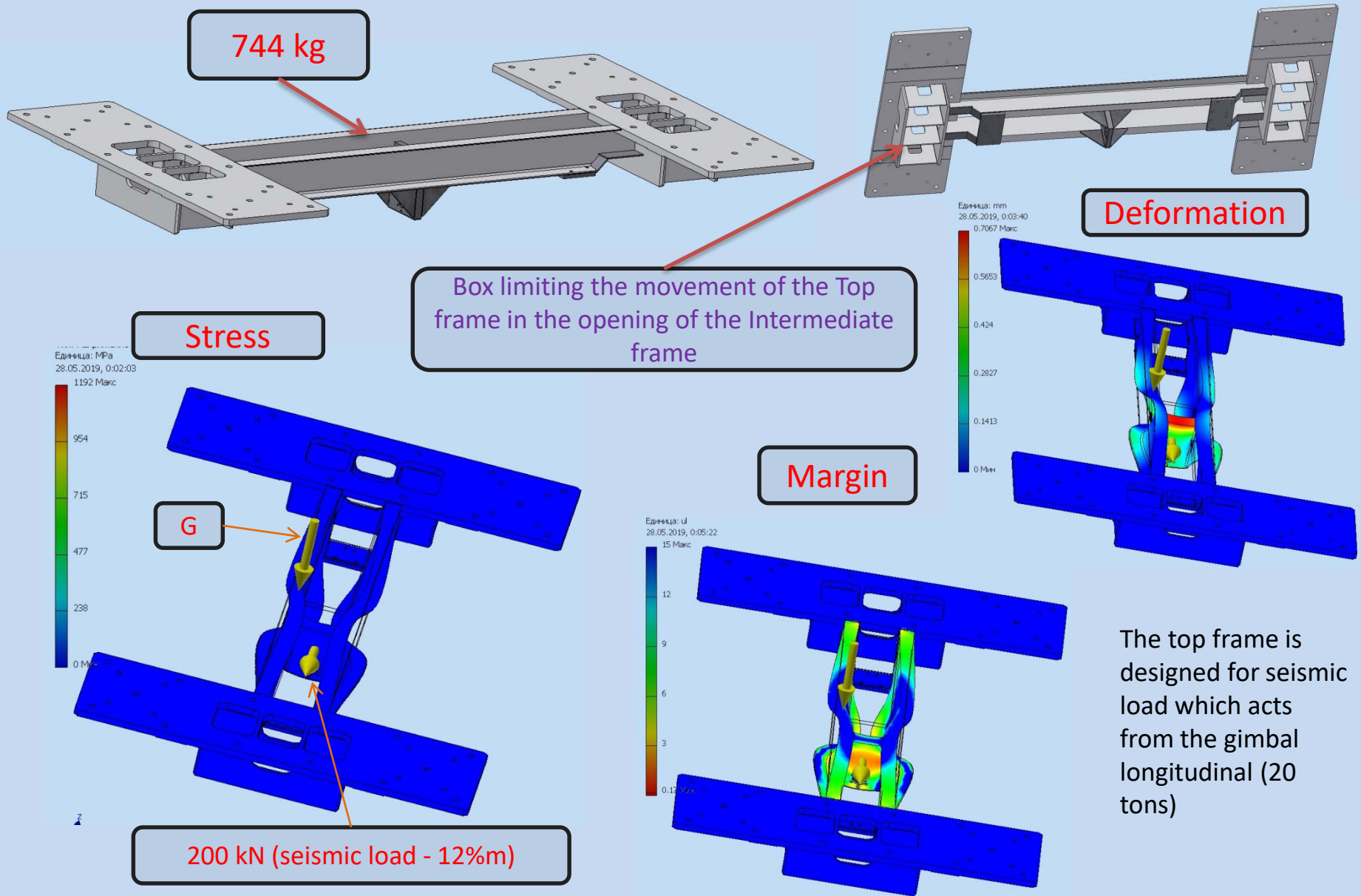
Margin

Единица: коэффициент
15 Макс

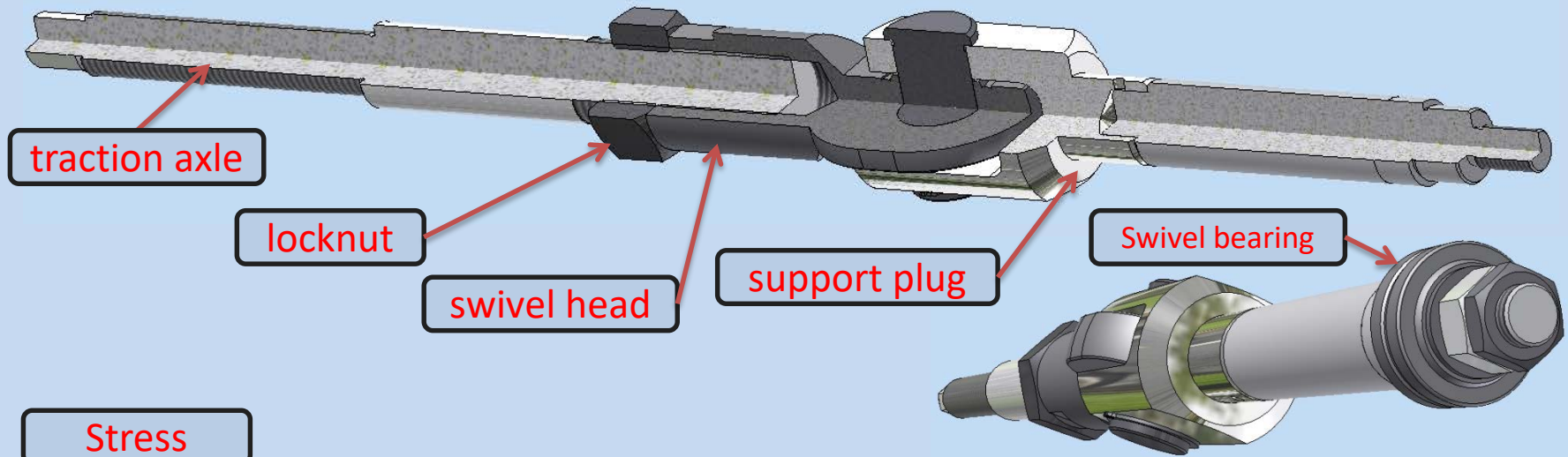


The intermediate frame is designed for seismic load which acts from the gimbal longitudinal (20 tons)

Top frame : design and calculation



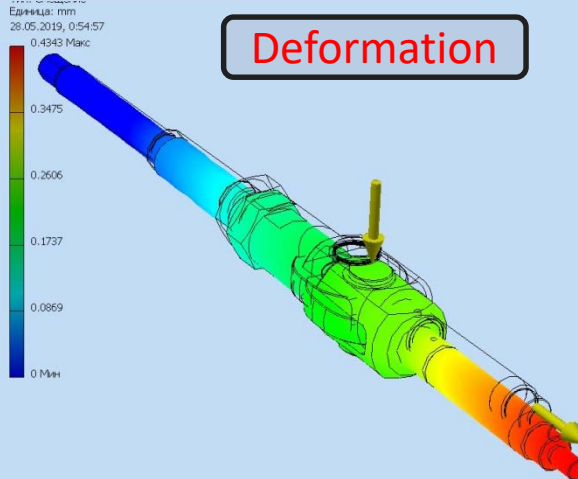
Gimbals : design and calculation



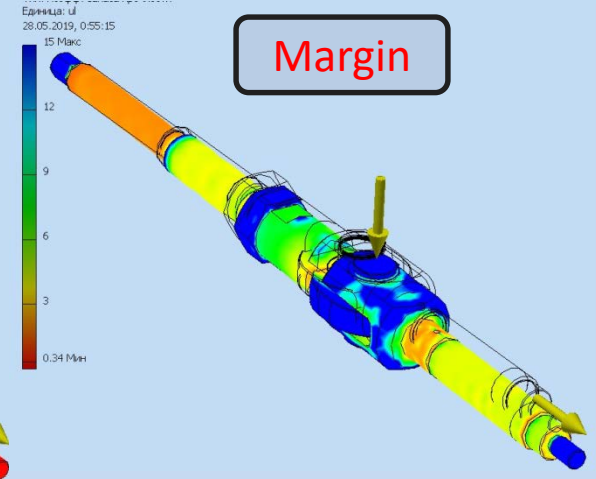
Stress



Deformation



Margin

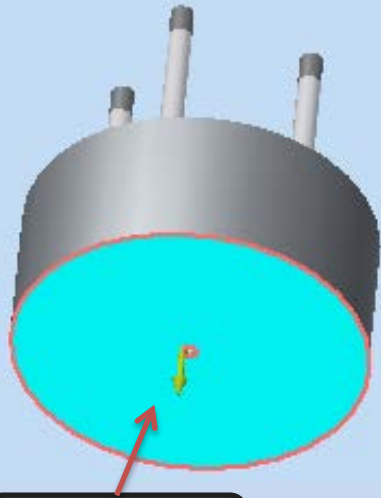


200 kN (seismic load - 12% m)

- workload : 50kN
- design load: 200kN

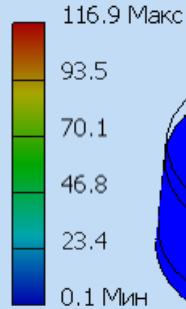
Calculation of studs for Pole CBM magnet

Stress



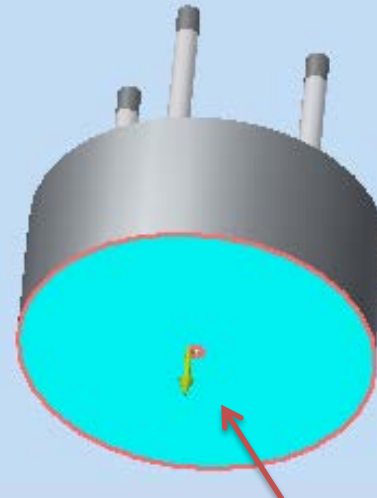
1500000N

Единица: МПа
23.04.2018, 19:27:48



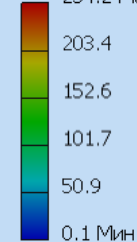
Мин.: 0.1 МПа
Макс.: 116.9 МПа

Stress



3000000N

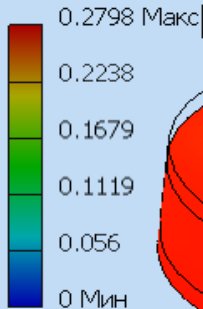
Единица: МПа
02.03.2018, 15:23:02



Мин.: 0.1 МПа

Deformation

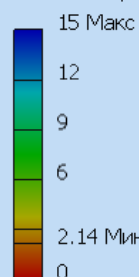
Единица: mm
23.04.2018, 19:27:51



Мин.: 0 mm

Margin

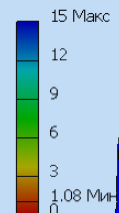
Единица: ul
23.04.2018, 19:27:51



Макс.: 15 ul
Мин.: 2.14 ul

Margin

Тип: Коэфф. запаса прочности
Единица: ul
02.03.2018, 15:23:04

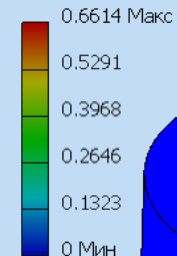


Мин.: 1.08 ul

Макс.: 15 ul

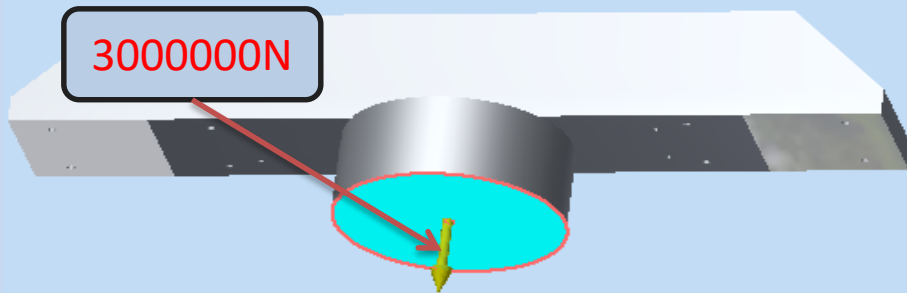
Deformation

Единица: mm
02.03.2018, 15:23:05

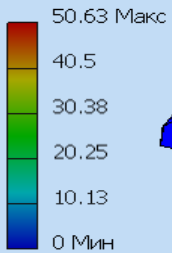


Макс.: 0.6614 mm

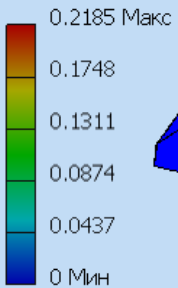
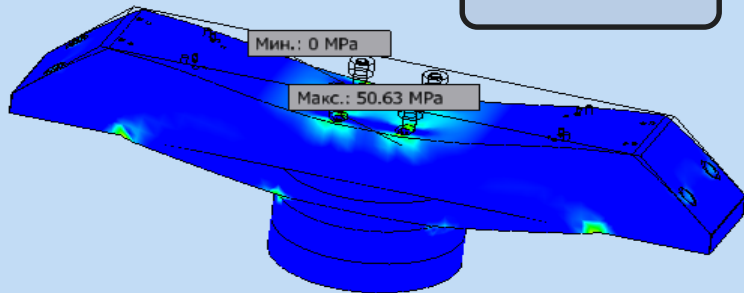
Calculation of Pole & crossbar CBM magnet



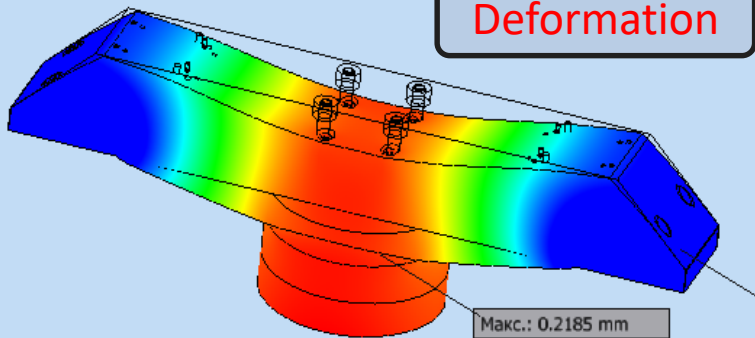
17.04.2018, 16:39:06



Stress

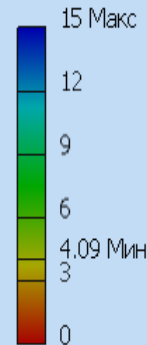


Deformation

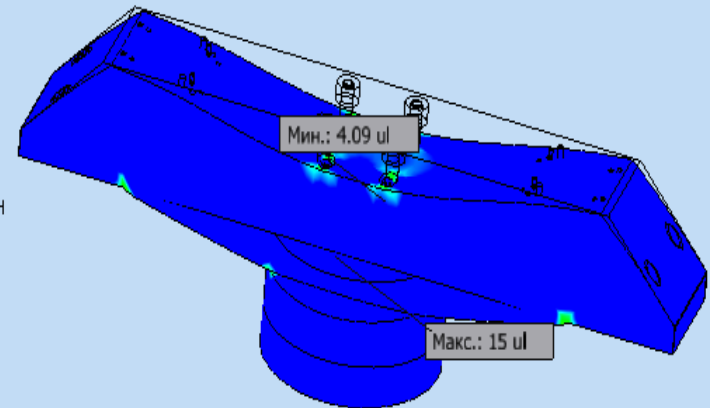


Имя	Low carbon steel	
General	Mass density	7.86 г/см ³
	Yield strength	207 МПа
	Ultimate tensile strength	345 МПа
stress	young modulus	220 ГПа
	poisson ratio	0.275 бр
	Shear modulus of elasticity	86.2745 ГПа

Единица: ul
17.04.2018, 16:40:41



Margin





Thank you for your
attention!