

Lessons learned from the ESRF magnets and vacuum chamber assembling

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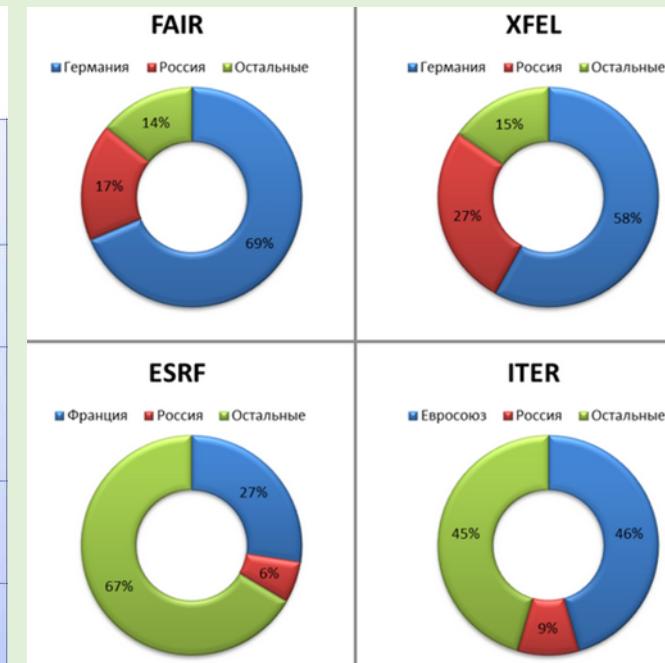


Russia makes a significant contribution to European mega-installations.

Russia's contribution to the development of Mega-Science research infrastructure in Europe

Mega-Science research infrastructure	Russian Federation Funding
The European X-ray Free Electron Laser (XFEL)	306 000 000 EURO
European Organization for Nuclear Research (CERN)	110 000 000 EURO
Facility for Antiproton and Ion Research (FAIR)	178 000 000 EURO
International Thermonuclear Experimental Reactor (ITER)	1 000 000 000 EURO

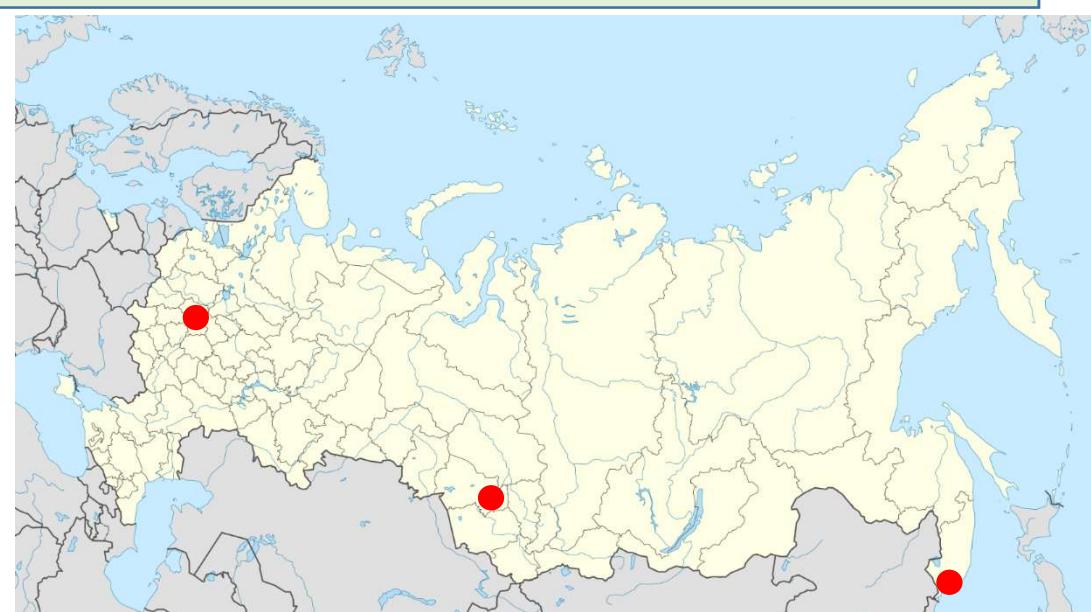
Report «Mega-Science research infrastructure», 2-4 April 2014 by S. Salikhov



Red shares are Russian contribution.

Russian national strategy for light sources:

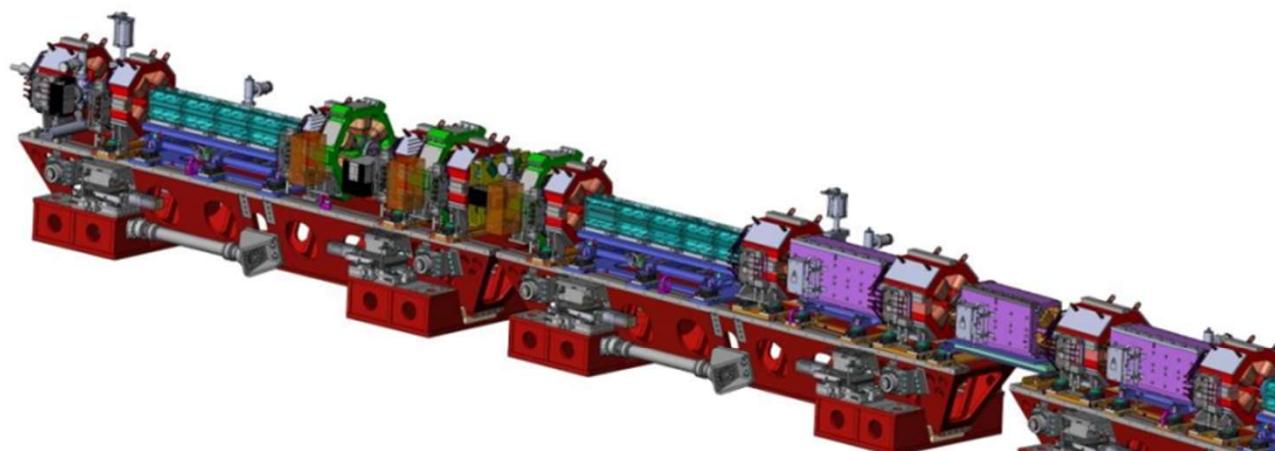
1. Moscow, 6 GeV, 1.3 ÷ 1.5 km.
2. Novosibirsk, 3 GeV, 480 m.
3. Vladivostok



ESRF-EBS

Energy	6 GeV
Beam current	200 mA
Natural emittance	132 pmrad

Circumference	844 m
Number of cells	32
Number of girders	128



Dipole DL	4
Dipole DQ	3
Quadrupole	16
Sextupole	6
Octupole	2
<u>Correctors</u>	3
Total	34

EBS lattice - Hybrid 7 Bend Achromat

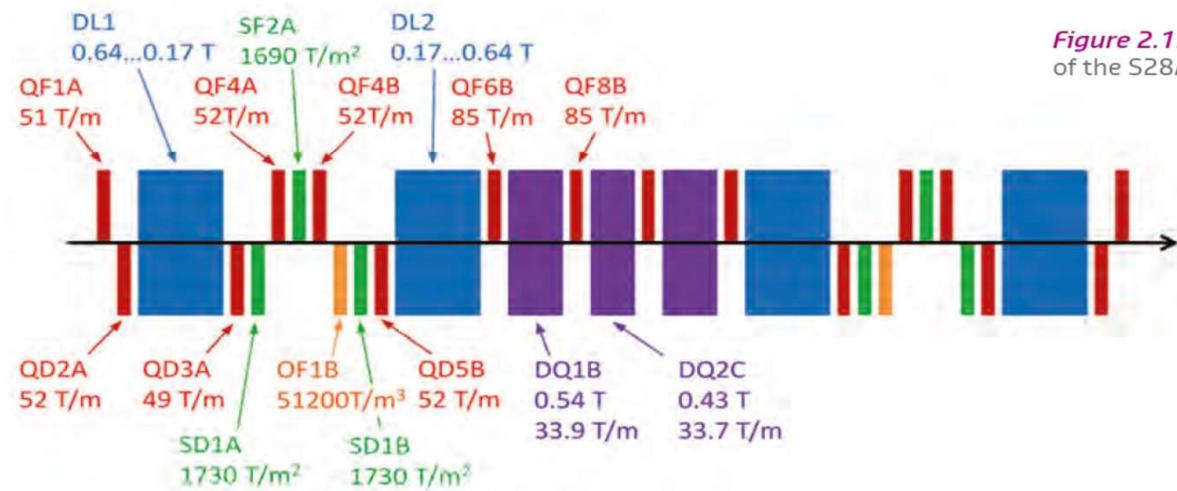
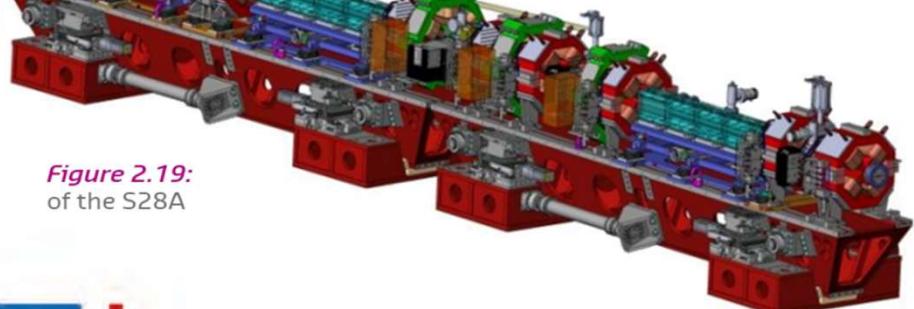


Figure 2.19:
of the S28A





In order to decrease the emittance there is a longitudinal gradient introduced in the bending magnets and to reduce the electricity consumption permanent magnet will be used. The ESRF-EBS is the first light source using a longitudinal gradients for the bending magnets and build it up with permanent magnets.



Girder assembly G4

The girders are all identical with a length about 5 meters.

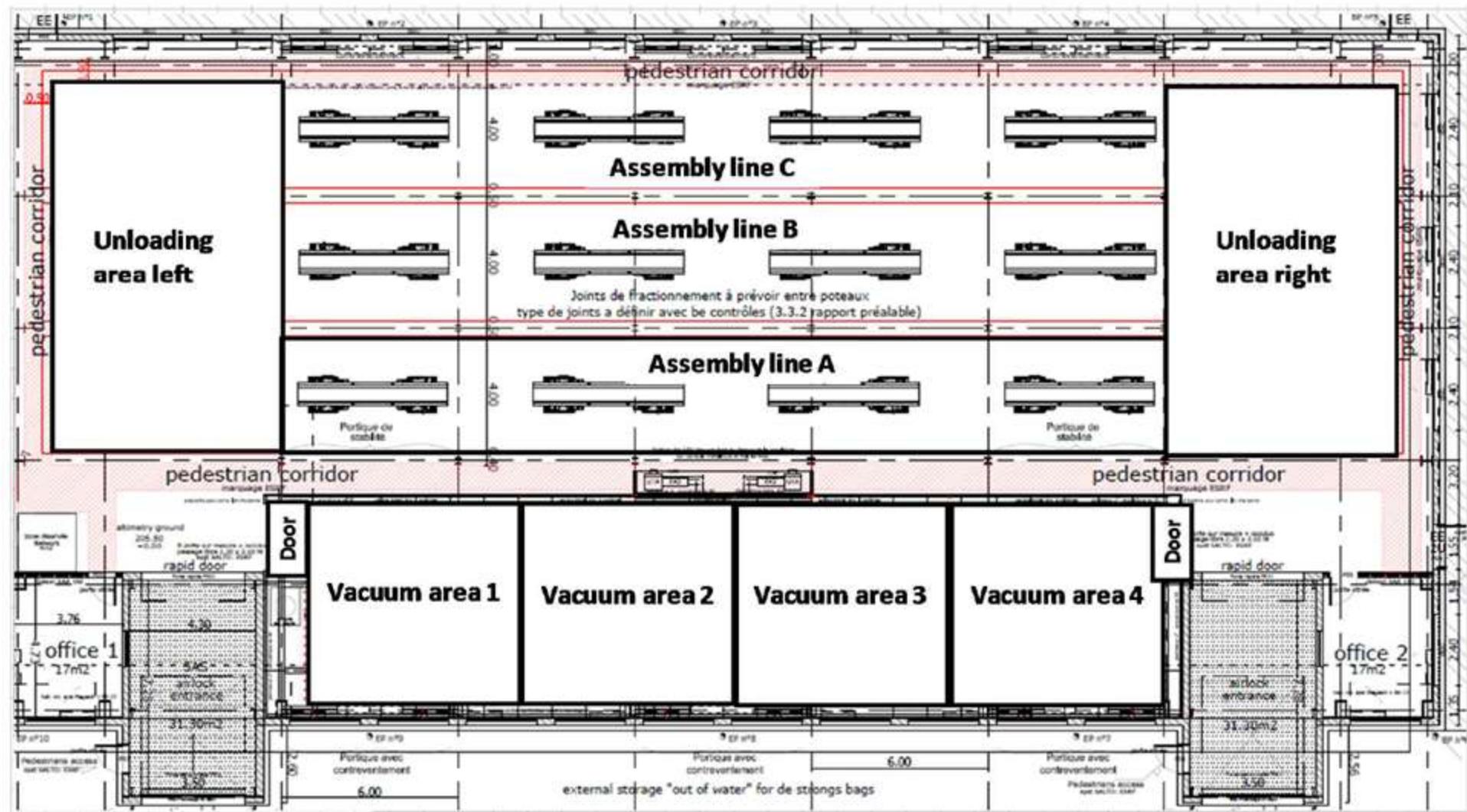
The installation of magnets is more dense.
The distance between the yoke of the magnets
is about 70 mm.
Between coils is about 10 mm.





Typical list of components for one girder assembling was around 80 items.
Calculations of required storage places should take into account risk that some of tens
producers can delay supply.
It took > 4000 m² only for assemble and total 6000 m² together with dismantling.

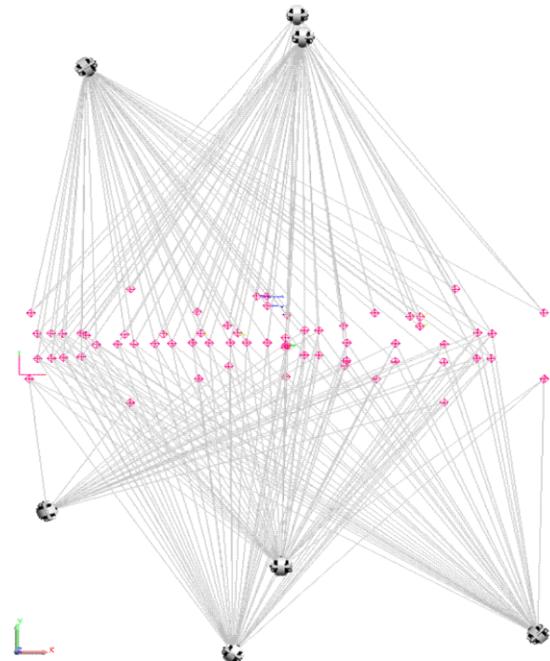
Assembling area



Conveyer schedule

Week	Vacuum area	Line 1	Line 2	Line 3
N-1		Logistic		
N	Chamber assembling for Line 1,	Girder alignment, Magnet Installation, Alignment of magnets Survey of magnets Magnet opening	Assembling of commutation and accessories, QA Tests, Packing Logistic	Chamber installation Chamber alignment Magnet closing Survey of assembled girder
N+1	Chamber assembling for Line 2,	Chamber installation Chamber alignment Magnet closing Survey of assembled girder	Girder alignment, Magnet Installation, Alignment of magnets Survey of magnets Magnet opening	Assembling of commutation and accessories, QA Tests, Packing Logistic
N+2	Chamber assembling for Line 3,	Assembling of commutation and accessories, QA Tests, Packing Logistic	Chamber installation Chamber alignment Magnet closing Survey of assembled girder	Girder alignment, Magnet Installation, Alignment of magnets Survey of magnets Magnet opening

With increasing accuracy, more measurements and checks are required.



For 4 girders per week it is necessary have at least 4 geodesic teams. 1 surveyor engineer and 1 technician in each. Plus one team for magnetic measurements.

Discussion of all tolerances and uncertainties can be found in the presentation of David Martin, “Alignment of the ESRF Extremely Brilliant Source (EBS)”, International Workshops on Accelerator Alignment, IWAA2018

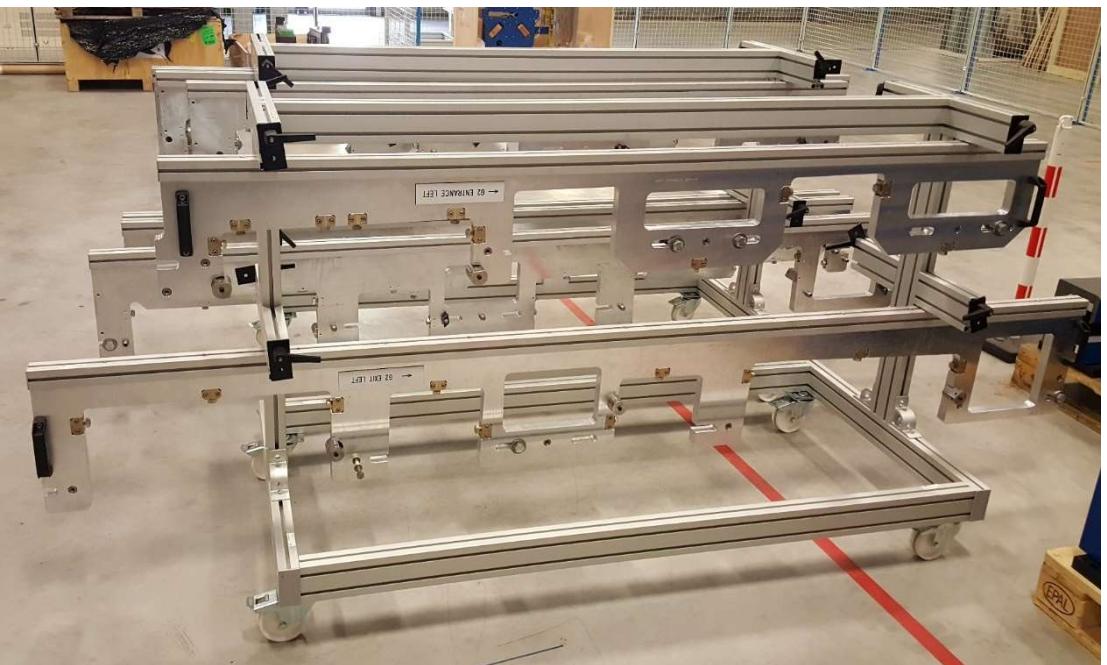
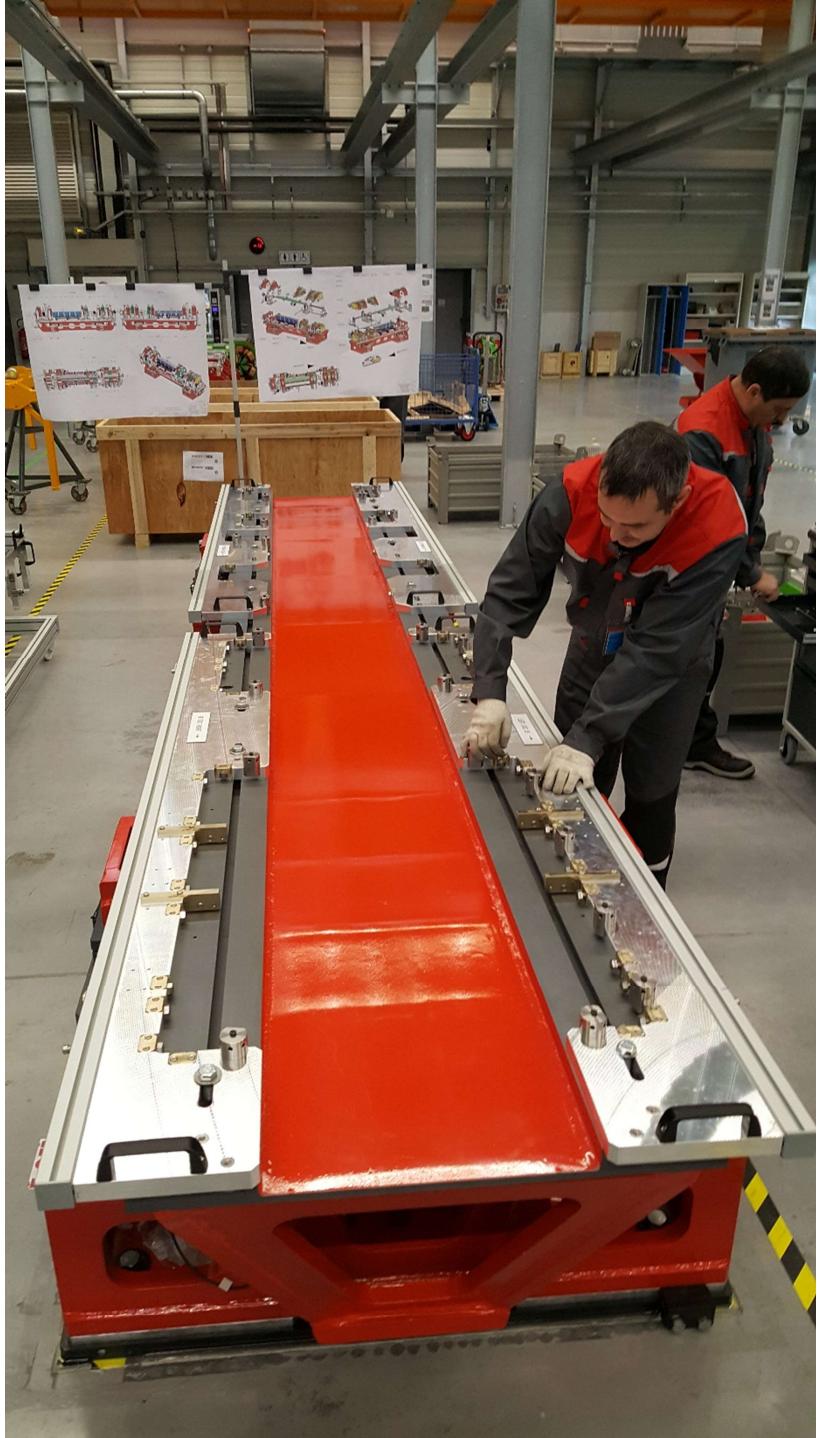


It is desirable to make geodesic sites on all magnets at the same height.

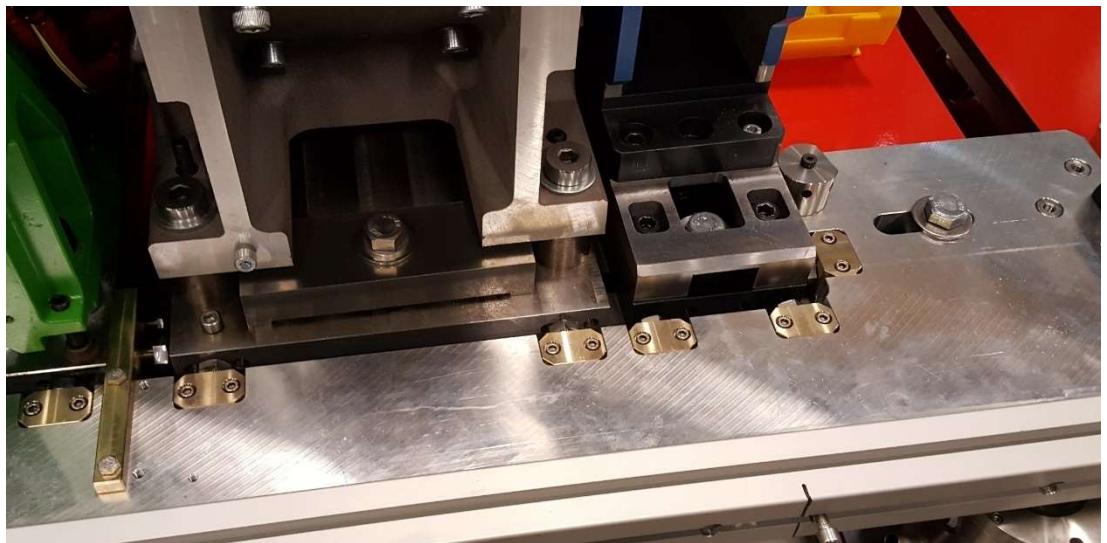
Every Friday, packaged assemblies were shipped out and new girders, magnets, vacuum chambers, supports and other components were delivered. During the weekend, girders, magnets and the room become thermostabilized.







Templates allow to preinstall all magnets with accuracy 0,5 mm.



Well designed templates can save a lot of time.



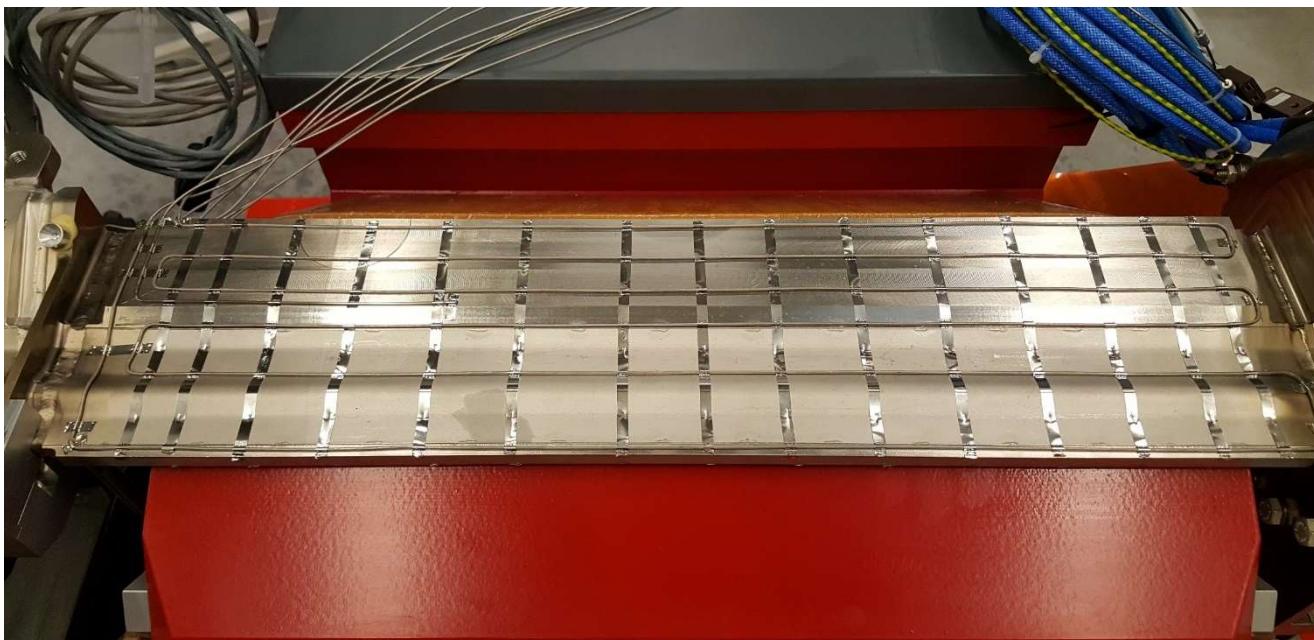
Templates with fine thread bolts were used to align magnets better than 0,050 mm.

After the alignment of magnets, the girder with magnets were surveyed.

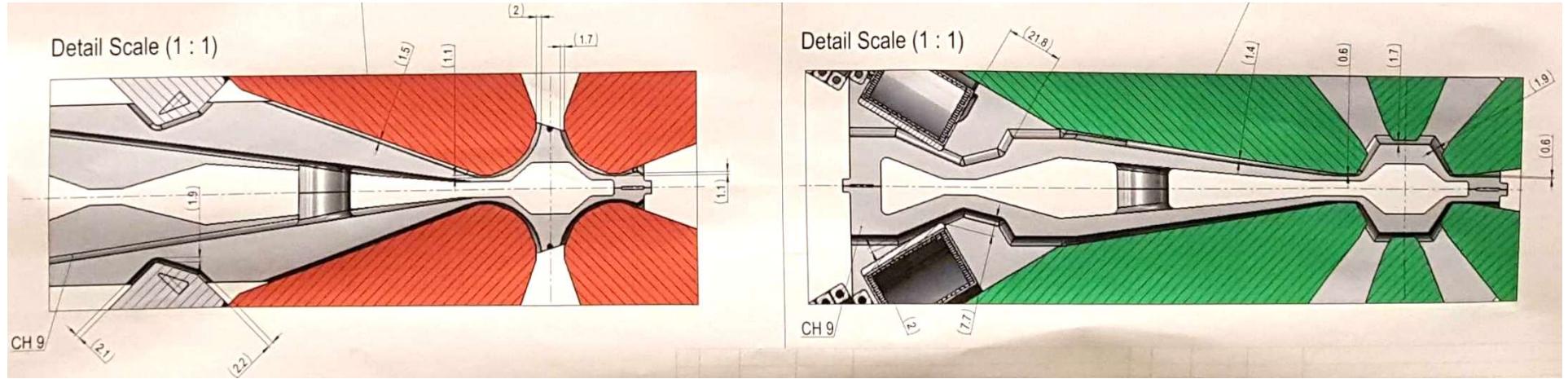
Then the templates were removed, the magnets split, and the dipoles moved out



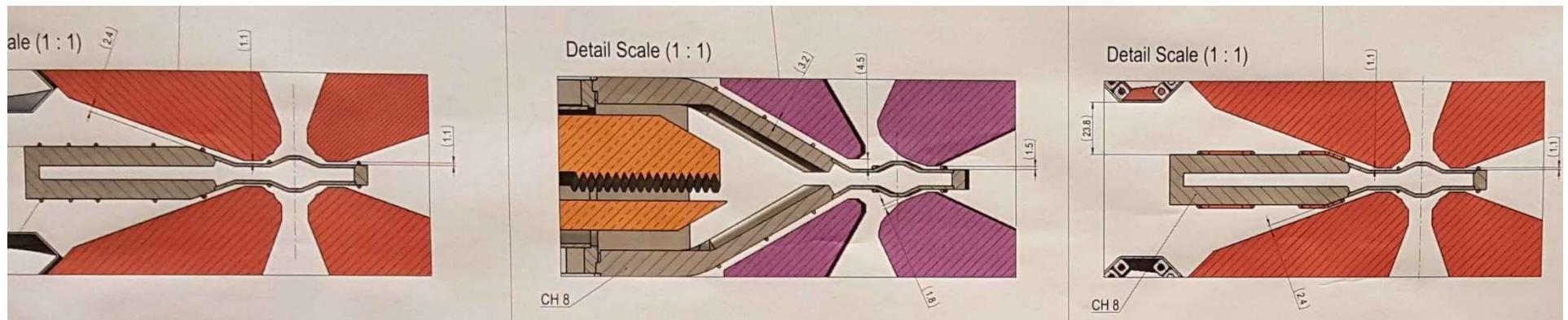
The chambers connecting the insertion device vacuum chambers in the straight section to the rest of the cell were NEG coated in order to reduce the pressure bump over this section.



Aluminum vacuum chambers were made with grooves for installation of heating wires.



Aluminum vacuum chambers usually were installed without any issues.



During installing stainless steel vacuum chambers, we had to periodically look for solutions.

The distance between the chambers and the poles of the magnets was checked by strips of 0.1 mm polyimide film.





In the vacuum area it is possible to assemble 4 chambers per week.

Assemblage of vacuum chambers also requires participation of surveyor team. Half day per chamber.

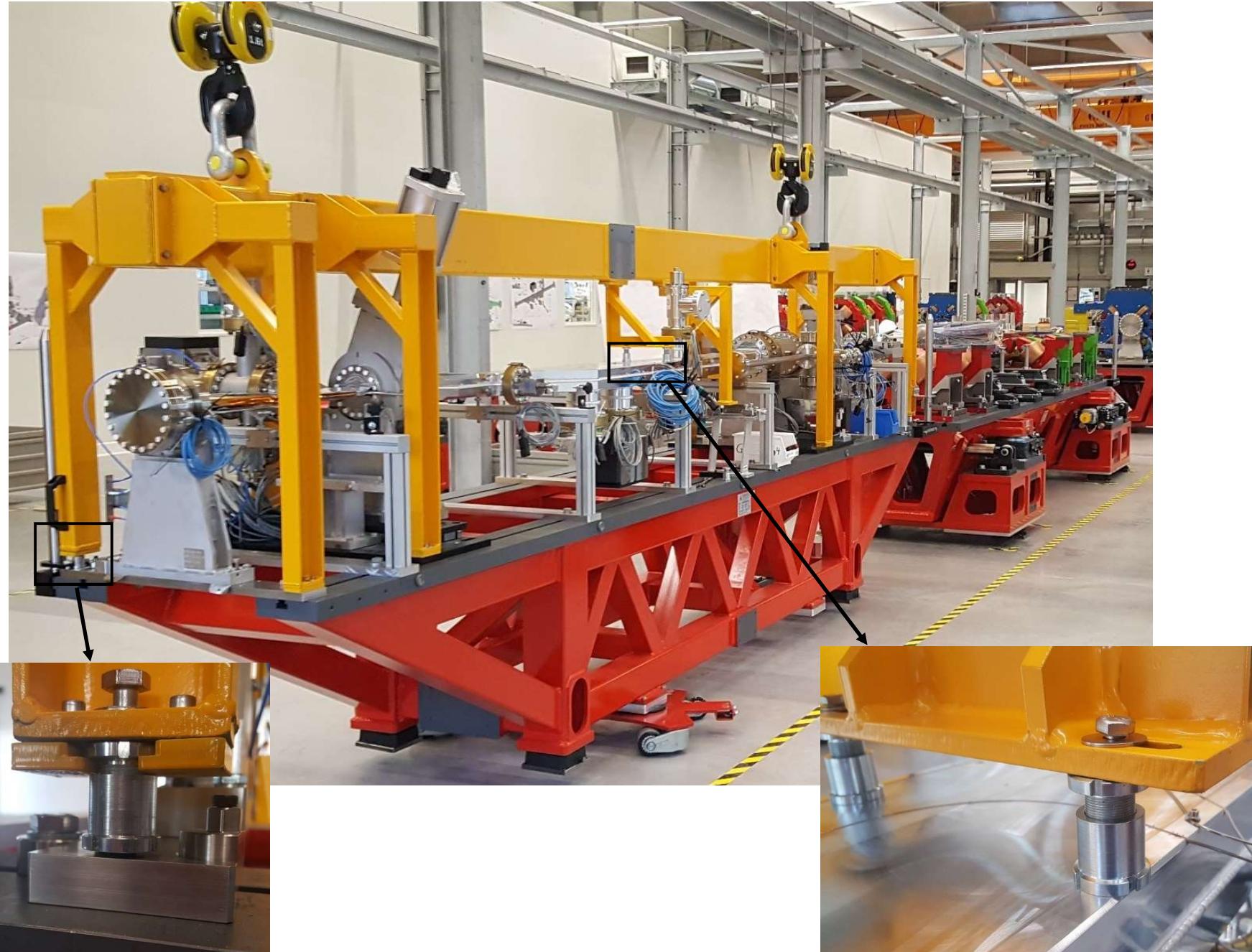
Assembled vacuum chambers are back out during two days and cool down during the weekend.



Every Monday morning, the vacuum team did test of chambers, filled them with nitrogen and gave the cameras for installation in magnets.



Yellow frame legs should allow height adjustment.

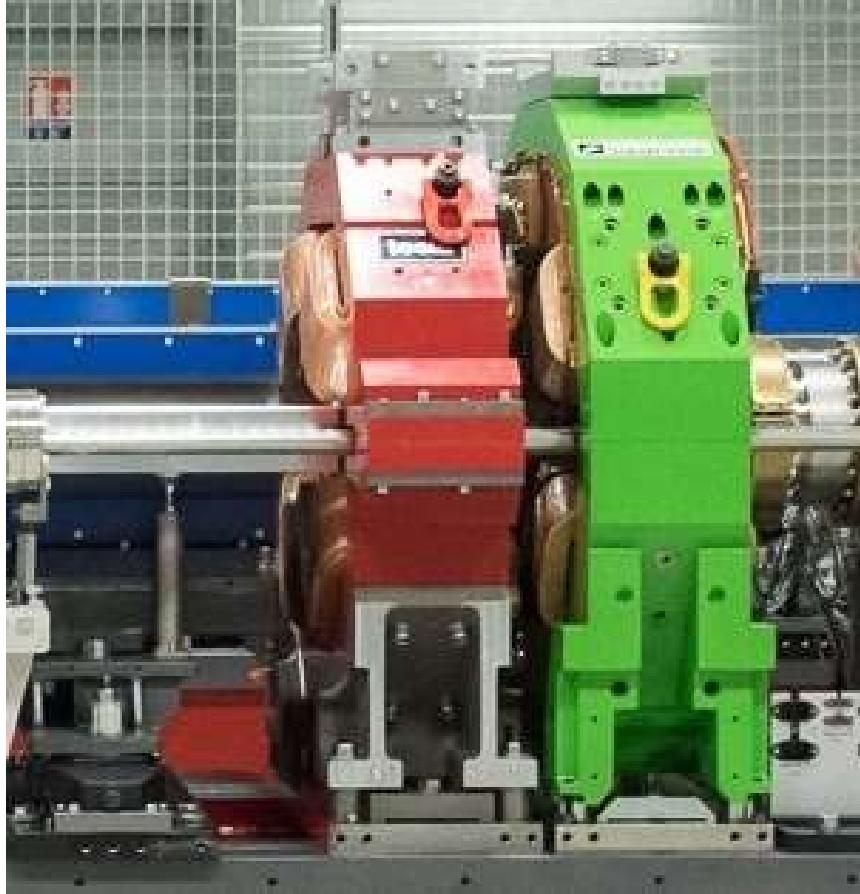


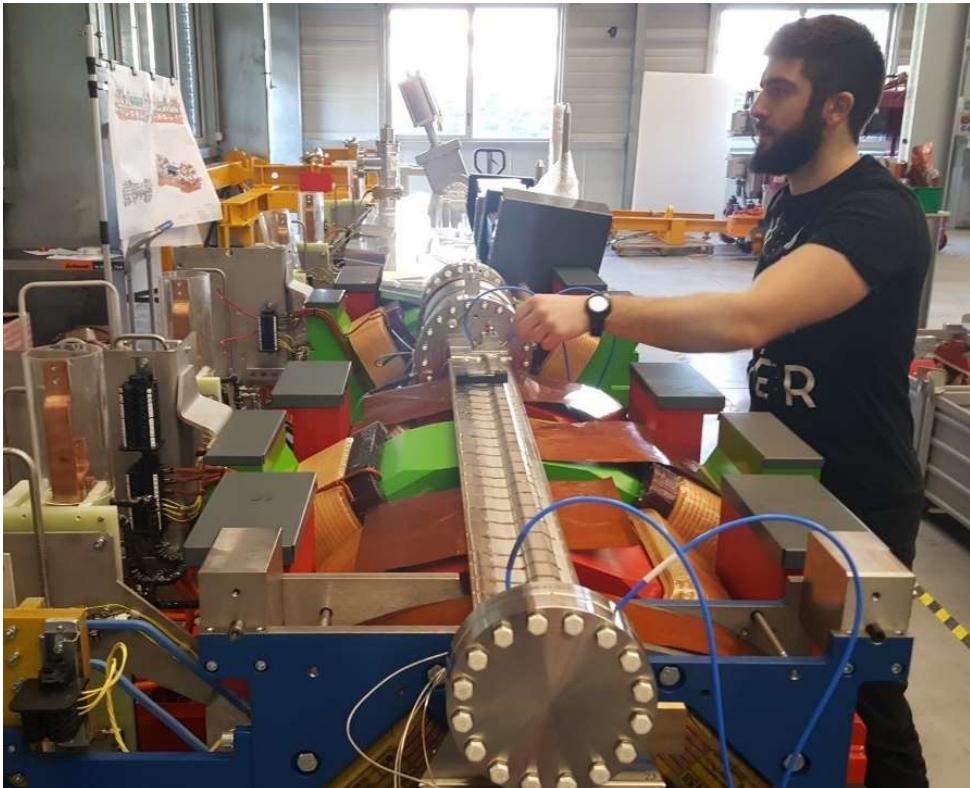


Laying vacuum chamber requires special care and attention.
For safety it is desirable to have 6 persons.



Do not forget to design permanent magnet dipoles with protective plastic covers.



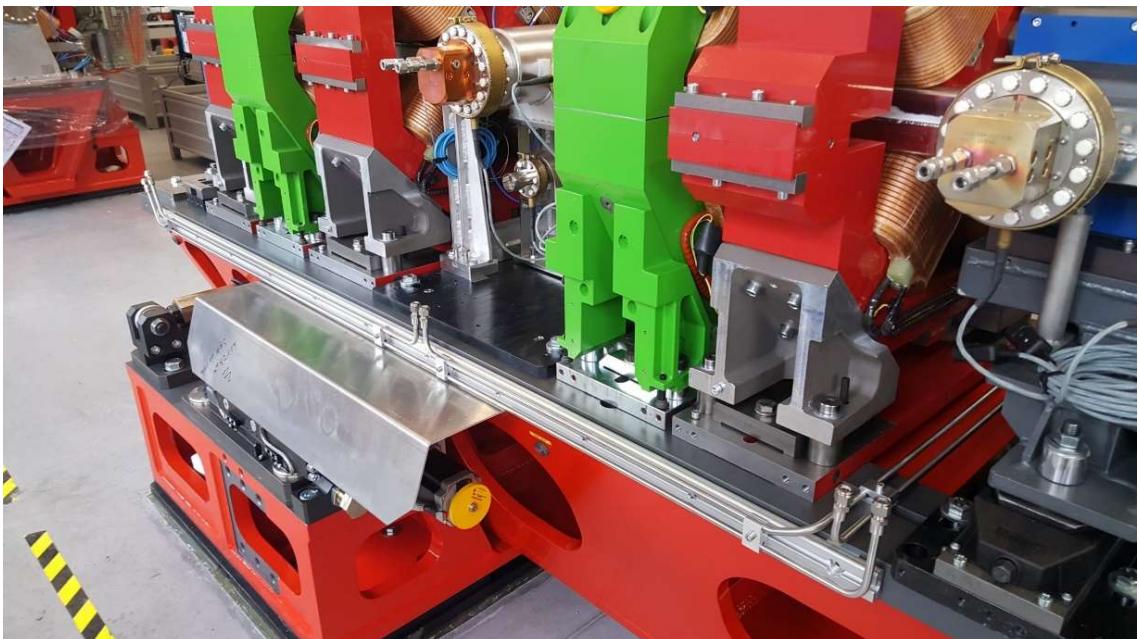


Week 3: Assembling of commutation
and accessories,
QA Tests,
Packing

The vacuum chambers are aligned.
BPMs are aligned with accuracy 0,1 mm.

On vacuum string are placed the
polyamide band. Magnets are closed.
Polyamide bands are removed.

The final alignment survey is made.

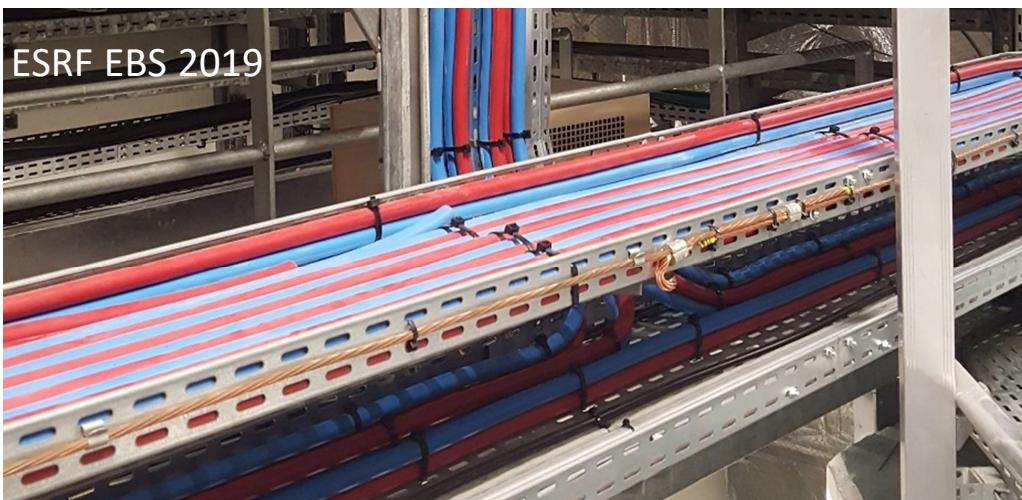
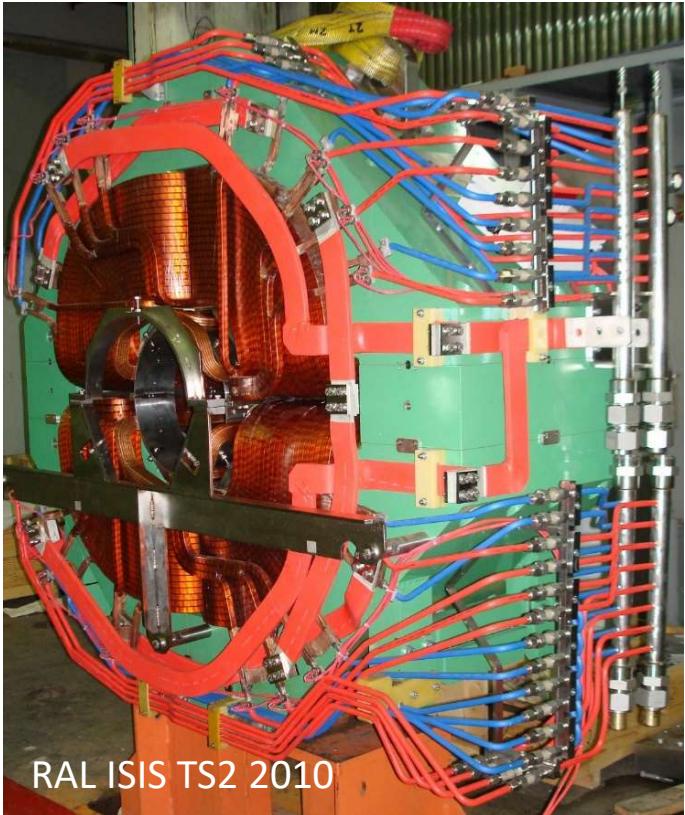


Unification



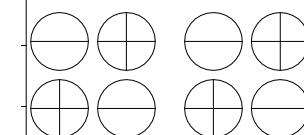
It is advisable to purchase components (thermoswitches, electrical terminal blocks, hoses) for all magnets at once or at least define its in technical specifications. This will reduce the zoo of spare parts.

Good design can reduce the number of errors with the wrong connection.

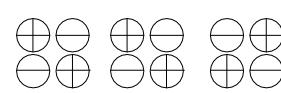


Dipoles

$BR-BD$ $BR-BF$



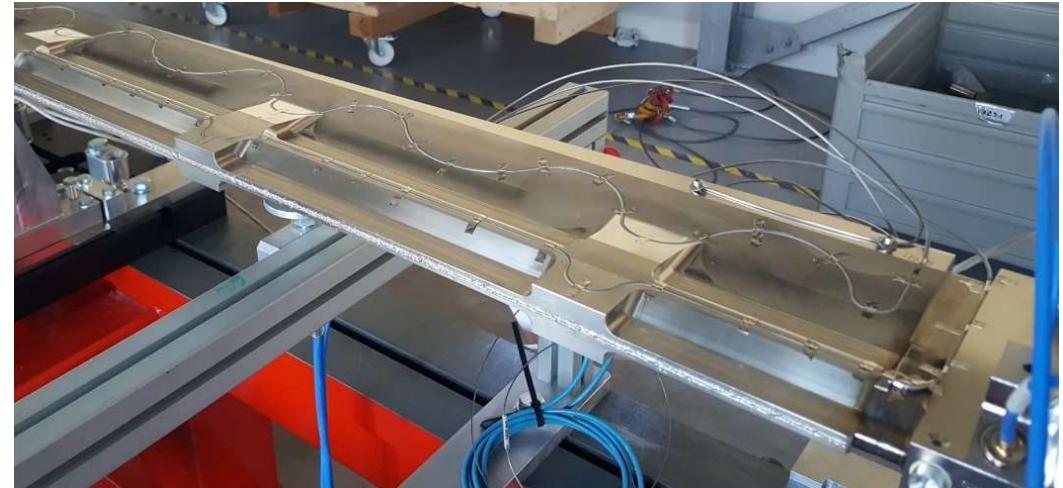
Quadrupoles



EBS Schedule

	2016	2017												2018												2019																					
Planning	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D								
User Service Mode (USM)																																															
Design, Procurement																																															
Production																																															
Assembly																																															
Dismantling																																															
Installation																																															
Machine Commissioning																																															
Beamline Commissioning																																															
Friendly Users																																															

The last girder (injection type) have to assembled this week



Thank you for your attention!

