technische universität dortmund

DELTA

The XXV European Synchrotron Light Sources Workshop

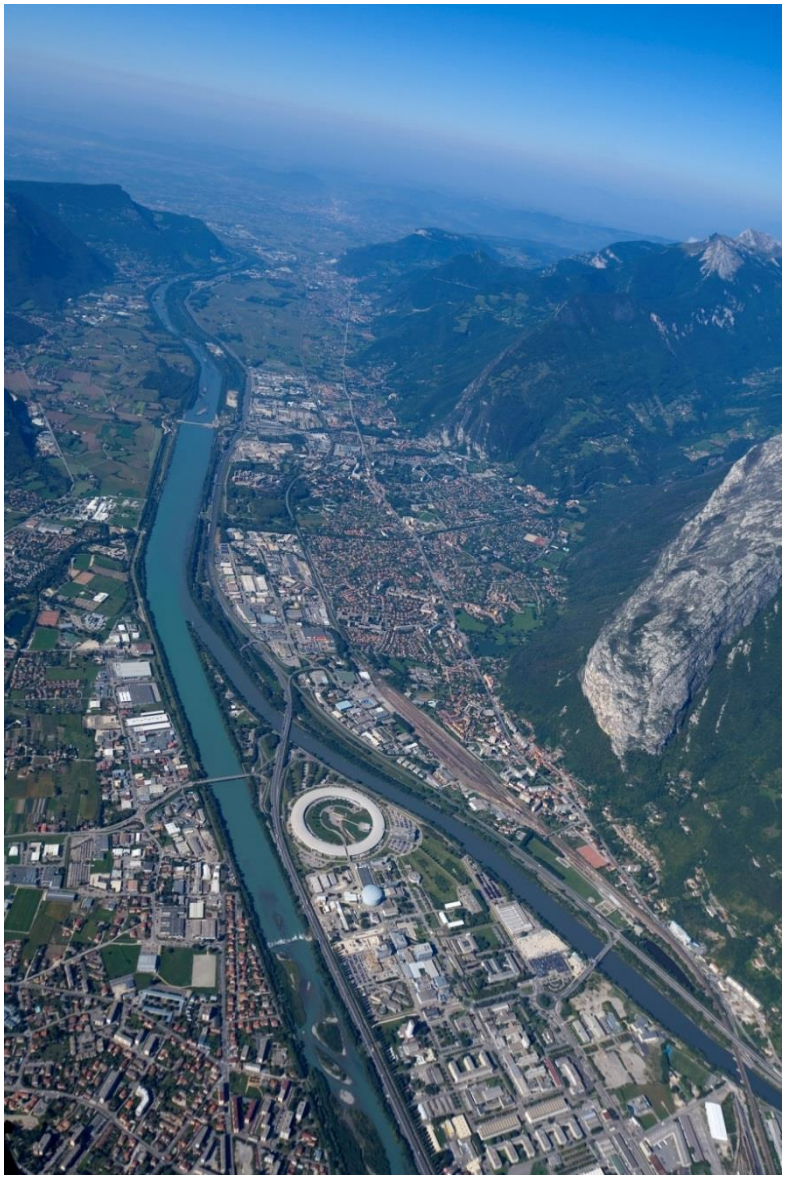
ESRF: Operation and Upgrade Status

Jean-Luc Revol

20-22 November 2017

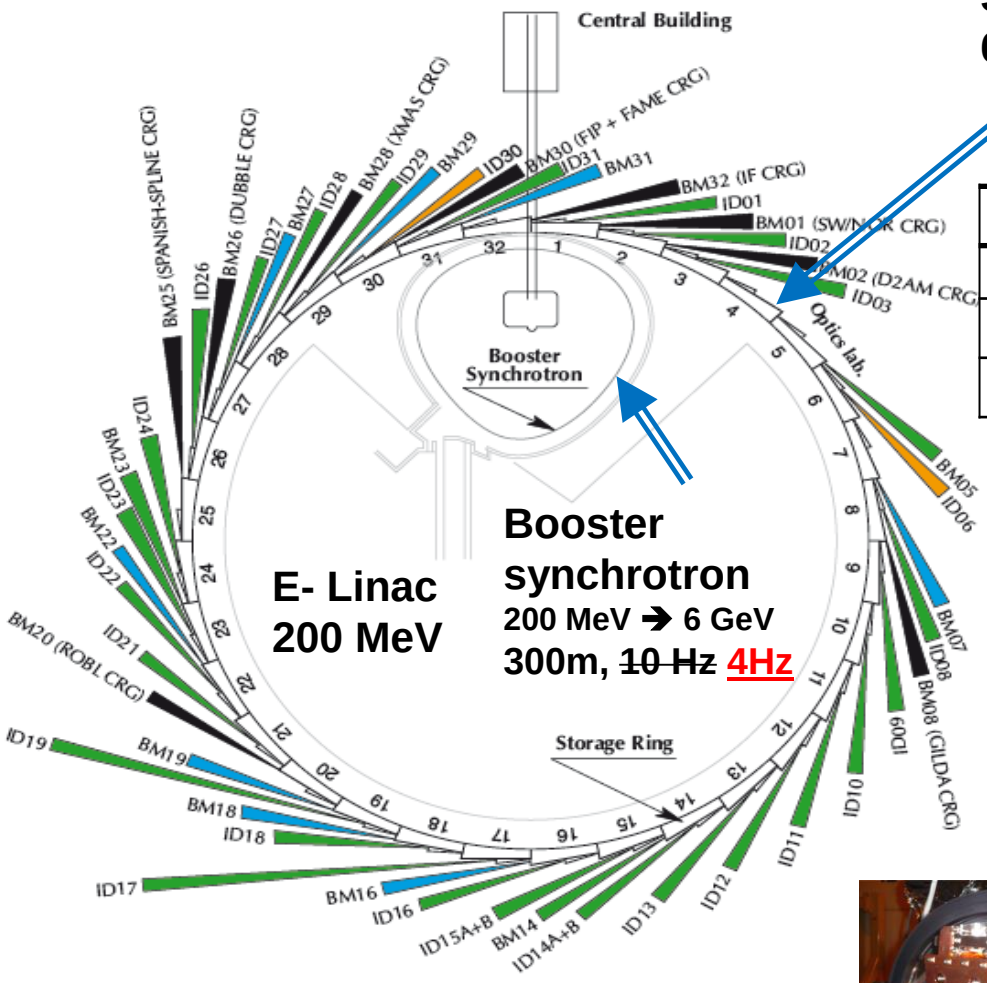
ESRF | The European Synchrotron

OUTLINE



- The ESRF in brief
- Operation performance
- Top-up operation
- ERSF/EBS project overview
- Schedule 2015-2020
- Project design & procurement status
- Assembly & Installation Phase

ESRF TODAY



Storage ring
6GeV, 844 m

Energy	GeV	6.04
Multibunch Current	mA	200
Horizontal emittance	nm	4
Vertical emittance	pm	4

32 straight sections

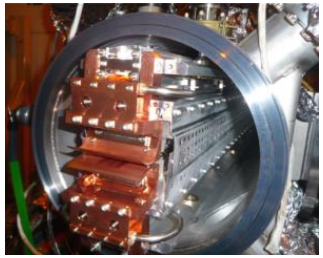
DBA lattice

42 Beamlines

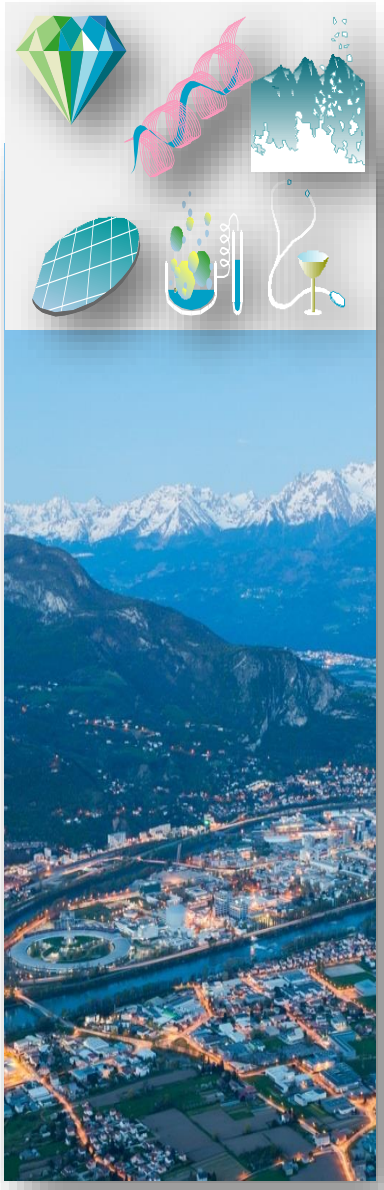
12 on dipoles

30 on insertion devices

72 insertion devices:
55 in-air undulators, 6 wigglers,
10 in-vacuum undulators,
including 3 cryogenic



OPERATION : MACHINE STATISTICS FOR 2014-2017



Throughout 2016, the ESRF delivered 5485 hours of beamtime to its users, out of the 5537 planned

	2014	2015	2016	2017 *(until Nov.)*
Availability (%)	99.11	98.53	99.06	**98.05**
Mean Time Between Failures (hrs)	105.5	93.6	93.8	**58.4**
Mean duration of a failure (hrs)	0.94	1.37	0.88	**1.14**

2014: 52 Failures / 2015: 59 Failures / 2016: 59 Failures / 2017: 61 Failures until now.

MAIN LONG FAILURES

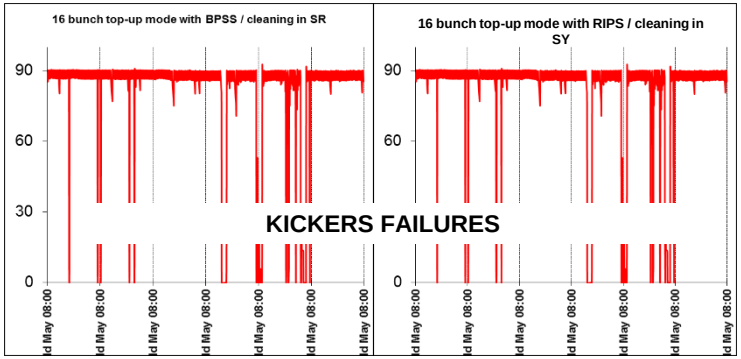
RUN2017-02

11 failures k6, 9 due to kicker3.

The thyratron was suspected and replaced.

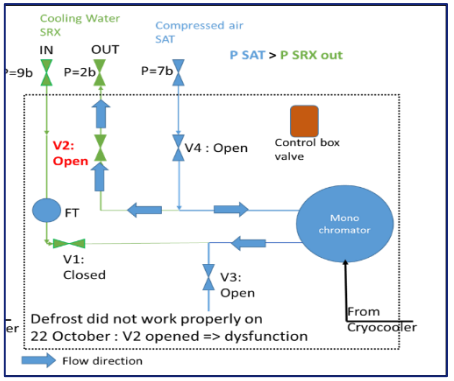
RUN2017-04

13 failures due to bad synchronization of the 4 kickers @ 4 Hz.



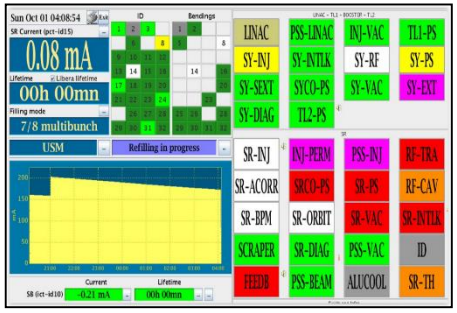
RUN2017-05

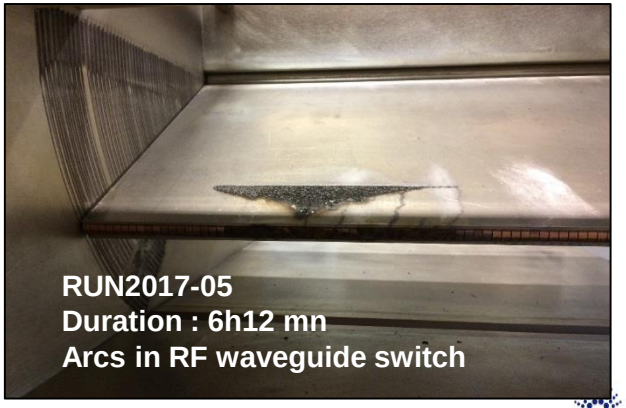
Duration front end closed : 12h30
Compressed air in the water beamline water cooling network.



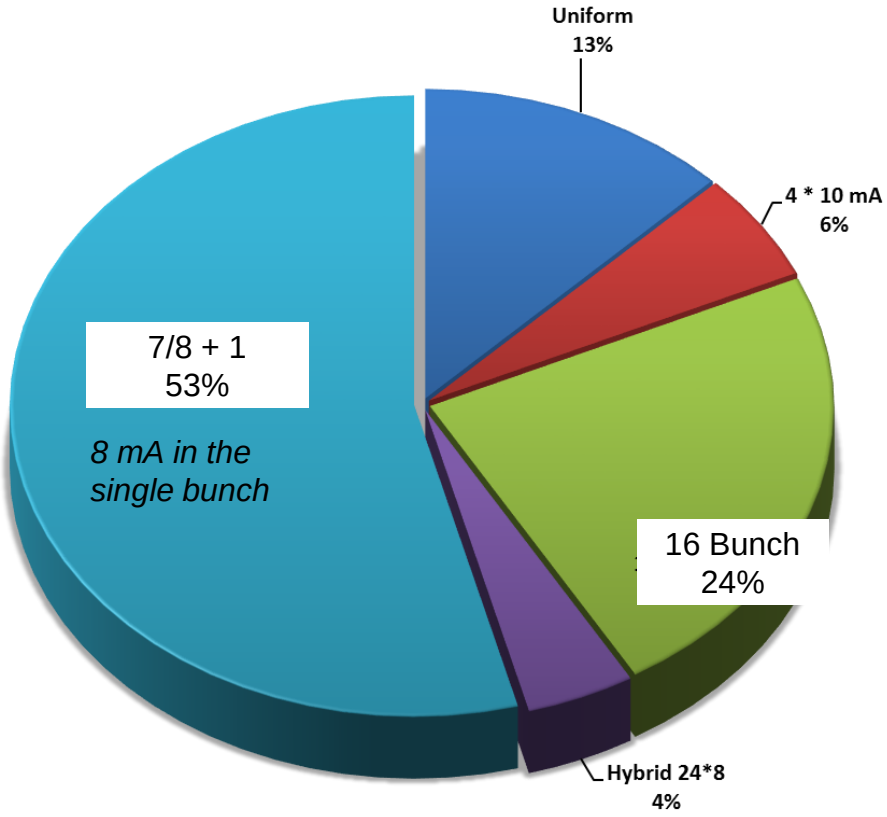
RUN2017-04
Duration : 238 mn
Storm and lightning <u>on ESRF site</u> with electrical drop.

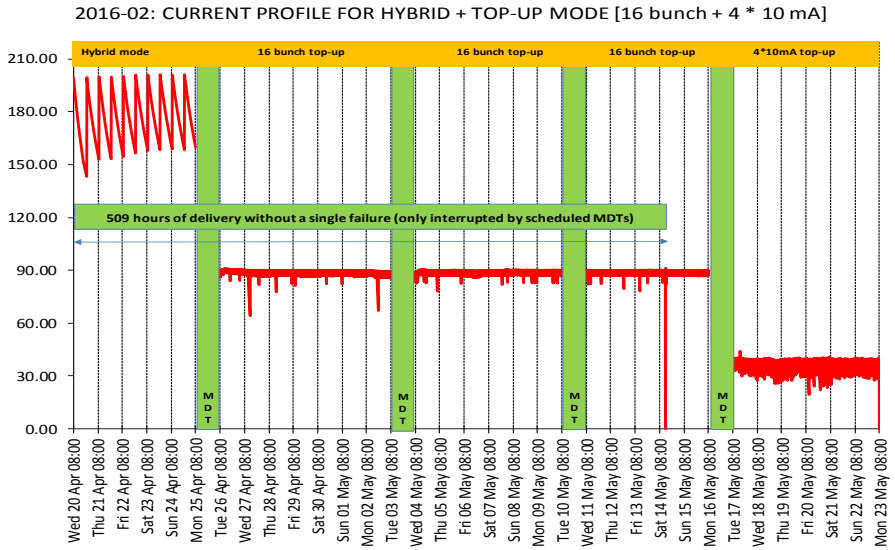
RUN2017-04
Duration : 343 mn
A circuit breaker triggered, due to a air damaged (aging)





OPERATION: FILLING MODES IN 2017





16 Bunch in top-up since 26 April 2016
<u>High brightness</u>

I max = 90 mA,
Refill every 20 mins, delta I = 5 mA,
Vertical emittance < 10 pm

PREREQUISITE FOR TOP-UP OPERATION

1) Suppress the vertical blow-up during cleaning (*suppress the impurity*) In time structure mode

Was 1nm.rad vertically during 20 sec ➔ now ZERO

➔ *Cleaning performed in the booster prior to injection*

➔ *A few shifts during MDT with the specialized beamline ID18*

➔ *Routinely performed in 16 bunch and 4 bunch*

2) Define the injection frequency

Was 6 and 4 hours with a vertical blow-up of the vertical emittance to increase the lifetime

➔ *A few shifts with users during MDT to test different injection frequencies*

➔ *now 20 mn in 16 bunch and 4 bunch with standard low vertical emittance*

3) Automatize the injection process

Was manual actions from the operators lasting a few minutes

➔ *now automatic sequencing of the various equipment, including error management*

➔ *Routinely used in 16 bunch and 4 bunch*

4) Minimize the orbit perturbation of the stored beam during injection

Was more than 1mm horizontally and a few hundred µm vertical

➔ *now 100 µm peak H and 10 µm peak V, routinely achieved in all modes*

➔ *A few MDT shift with users to determine their sensitivity.*

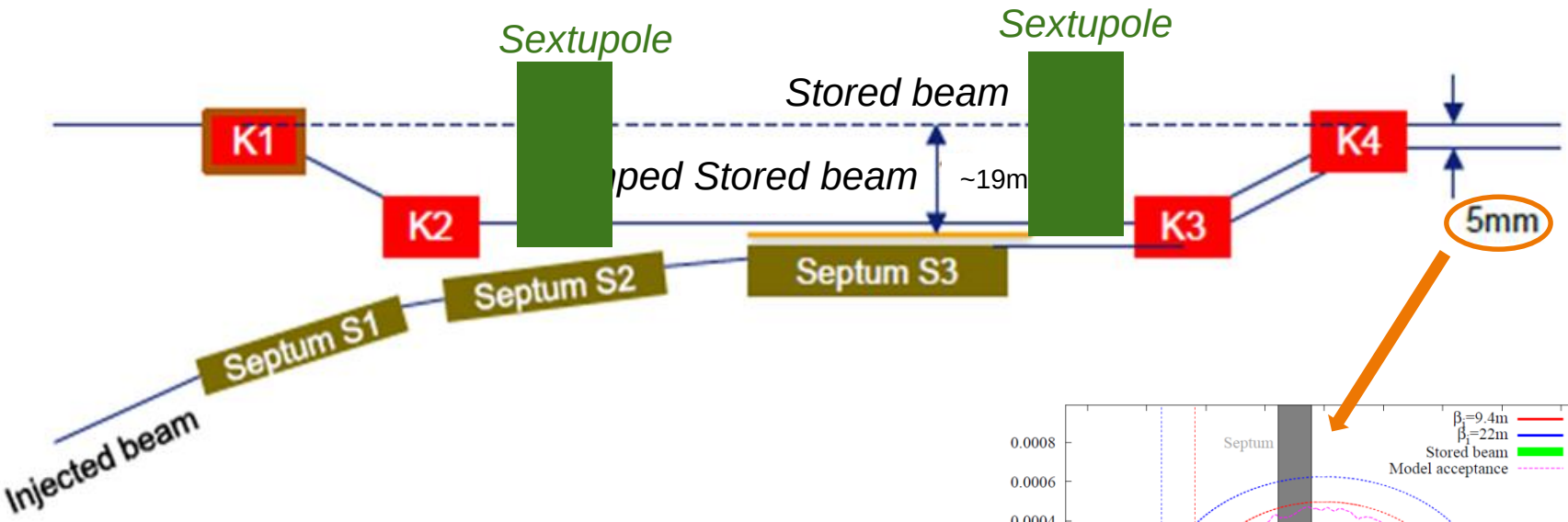
Most of them are not sensitive or could do normalization

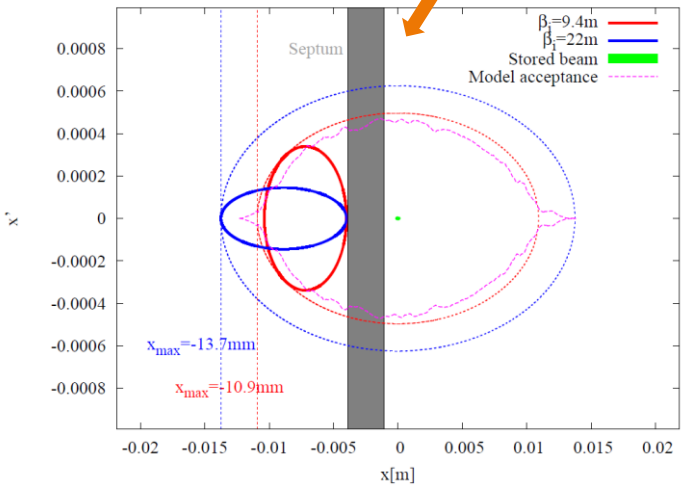
One beamline very very sensitive to horizontal motion with ms resolution

➔ *See all perturbations with high resolution! … could use gating*

➔ *Sensitivity of beamlines using coherence still to be fully assessed*

INJECTION INTO THE STORAGE RING

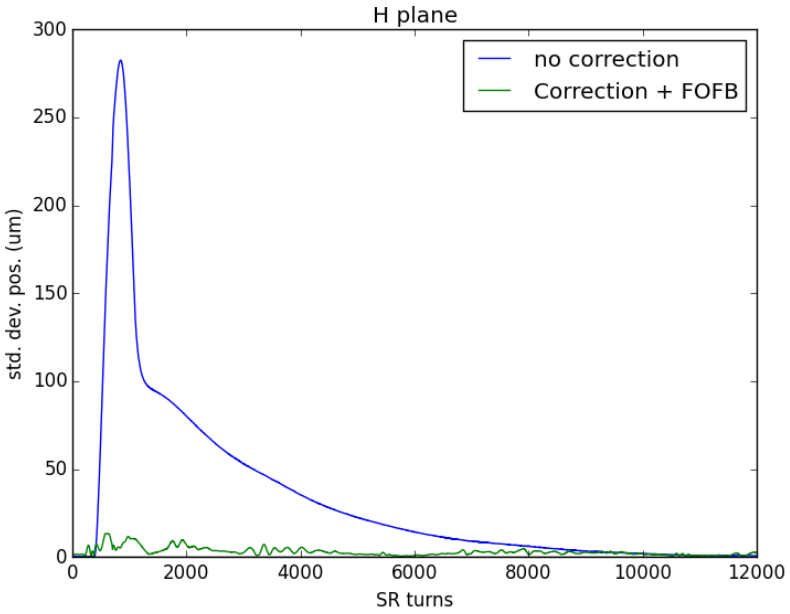


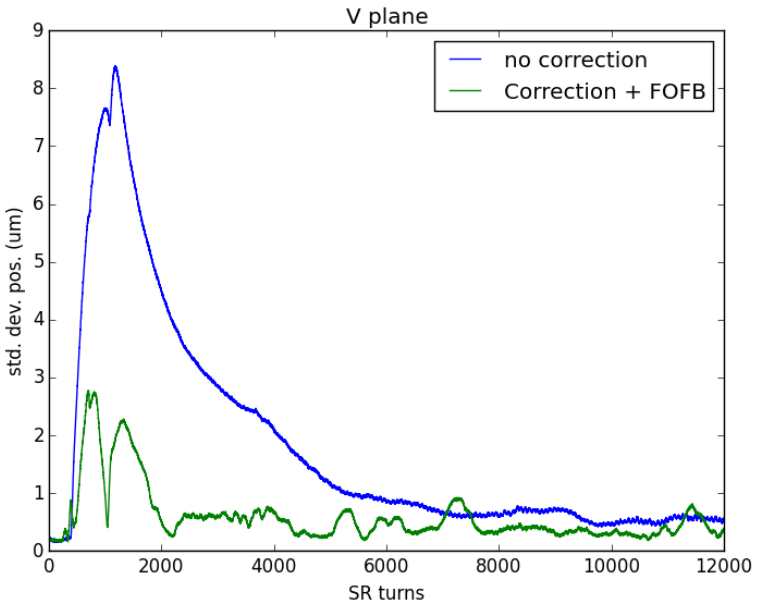


- **Injection magnets at the end of the transfer line from the booster**
  - **2 active septa S1 and S2 – 2 ms pulsed**
  - **1 in-vacuum septum S3 – 66 μs pulsed**
- **Injection magnets on the stored beam trajectory**
  - **4 active kickers K1,K2,K3 and K4 – 1 μs pulsed**
  - **2 sextupoles located within the injection bump producing non linear effects**

SEPTA PERTURBATIONS

- **Septa:** fringe fields, depends on field strength and distance to the stored beam





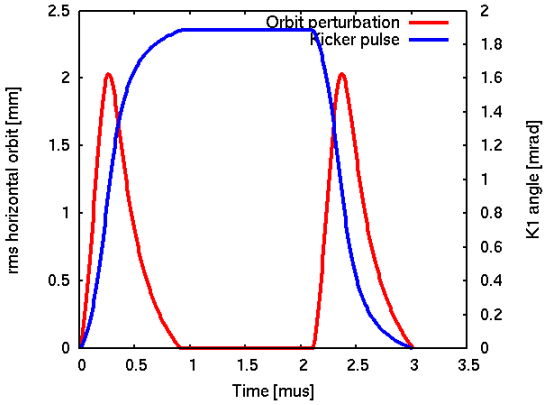
- **The perturbation is reproducible and now corrected by the Fast Orbit Feedback (FOFB) system**

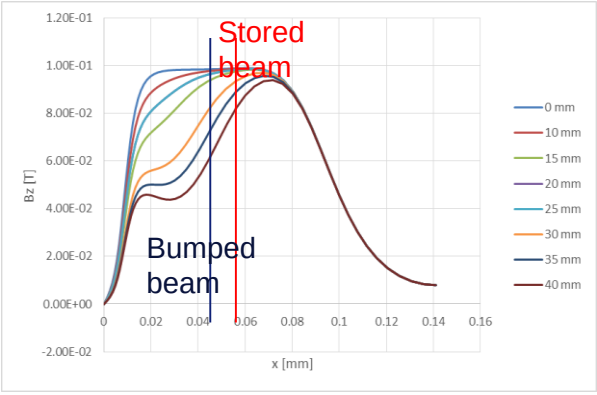
➔ Perturbation reduced to a few microns in both planes

KICKERS PERTURBATIONS

- **Bump non-closure**, 4 identical kickers pulse shape required (timing, pulse shape,…) ➔ Need precise tuning and reproducibility
- **Sextupoles located inside the injection bump (dominating effect):**
  - $B_y(x)$ evolves quadratically
  - Amplitude (time) dependent orbit distortion
  - Amplitude (time) dependent β-beat

→ **Both resulting in apparent emittance increase**





➔ **Now largely corrected by adding copper shims inside the kickers ferrite gap to generate a non-linear field**

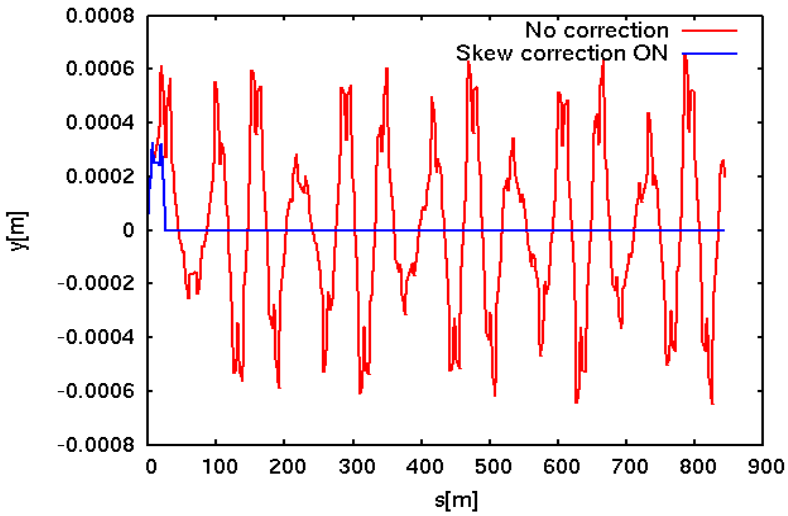
➔ **In parallel an active feed-forward system is in operation using a vertical and horizontal shaker**

VERTICAL PERTURBATIONS

- Vertical perturbations also observed from : coupling, misaligned elements...

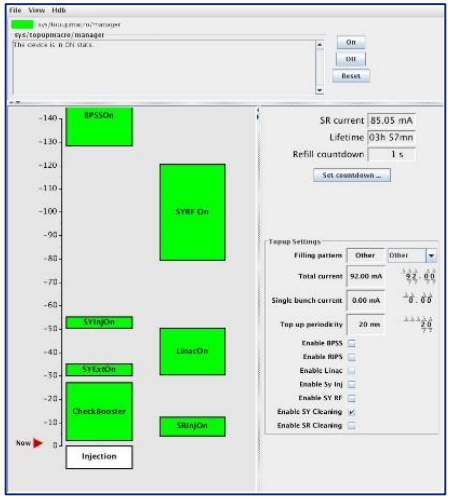
- **Vertical perturbation dominated by non-linear kicker, vertical offsets and roll angles:**

- **Use a pair of skew quadrupoles to locally correct the vertical perturbations**

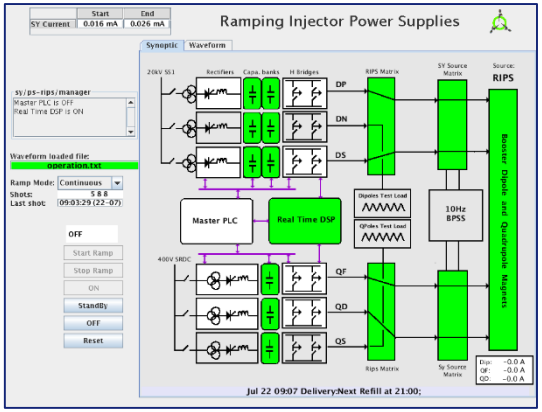


TOP-UP IN USER MODE

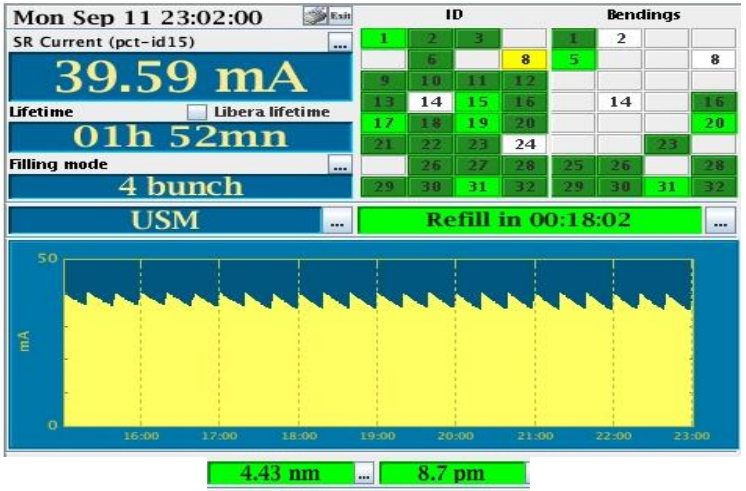
- **Top-up operation in 16x6 and 4x10 bunch modes since April 2016:**
  - **Refill every 20 minutes in 16 bunch and in 4 bunch**

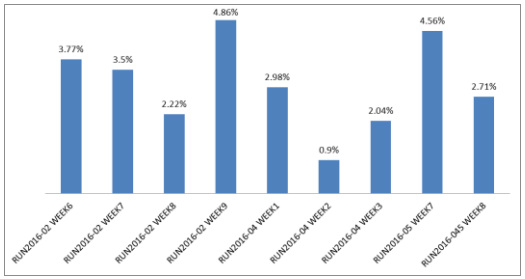


Injection sequencer in operation



A new booster Ramped Injection Power Supply (RIPS) is in operation





- **3.0% skipped injections on average over year 2016-2017:**

SHORT AND MEDIUM TERM PERSPECTIVES

1) Use cleaning in the injector in 7/8+1.

➔ *Envisaged this run*

2) Implement top-up in 7/8+1

➔ *Envisaged in 2018*

➔ *Depending on the results of the last tests with users, further improvement could still be envisaged to reduce perturbations*

3) Supress sextupoles in the bump

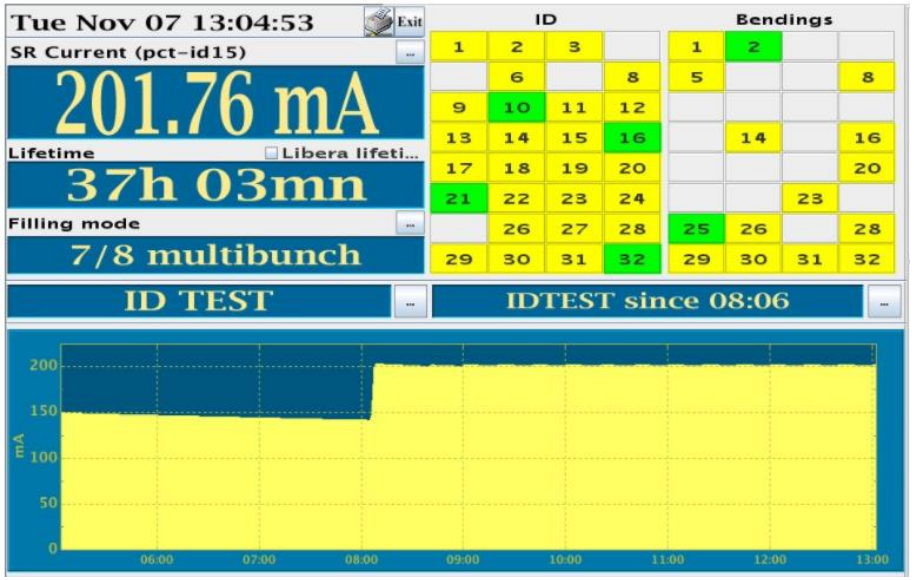
➔ *Done for the new machine*

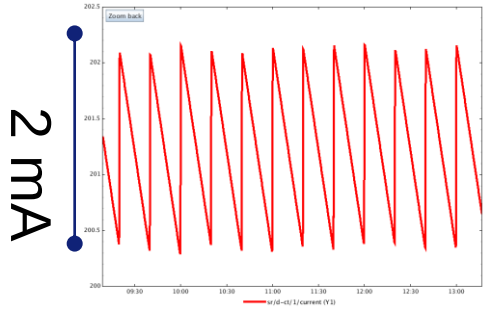
4) Improve Septum leakage field effects

➔ *New septa for the new machine*

5) Improve Septum and kickers power supply stability

➔ *Will be implemented for the new machine*





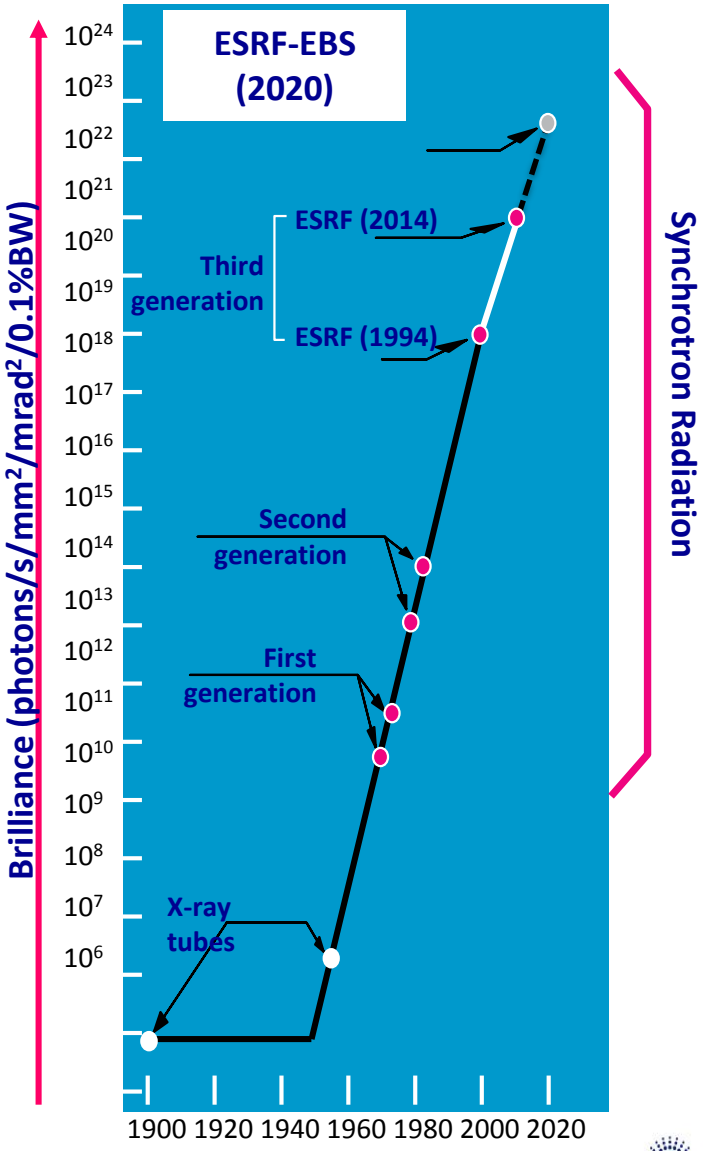
20 mn between refill

ESRF-EBS: AN AMBITIOUS NEW STANDARD FOR SYNCHROTRON STORAGE RINGS

ESRF Extremely Brilliant Source
ESRF-EBS – 150 M€ (2015-2022)

ESRF-EBS
Extremely Brilliant Source

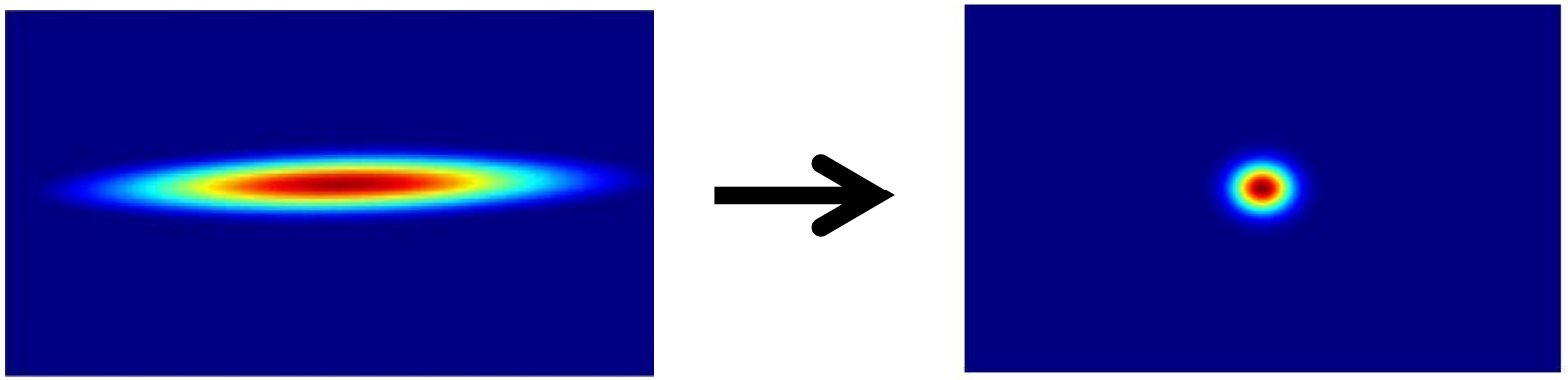
- ~100 times more brilliant and coherent X-rays
- Programme to exploit the qualities of this new and unique extremely brilliant X-ray source:
  - Creation of new beamlines
  - Innovative detector programme
  - « Data as a Service » strategy



Budget for the source only: 104 M€

ESRF-EBS: AN AMBITIOUS NEW STANDARD FOR SYNCHROTRON STORAGE RINGS

Reduce the **horizontal** emittance from **4nm** to **0.14nm**



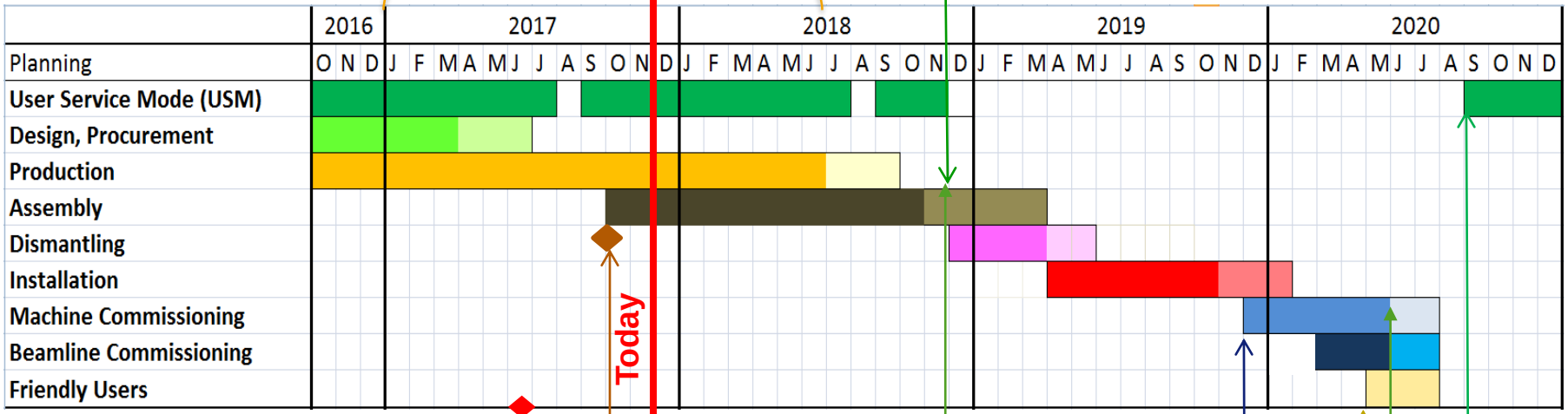
Beam-line experiments can benefit from :

an increase in brilliance
an increase of coherence
(the coherent fraction, in hor. plane)

OPERATION AND EBS PROJECT PLAN (2015-2020)

January 2017-June 2018 – Delivery of components

10/12/2018 – Start of shutdown



Milestone: Decision on shutdown date

11 Nov 2019 – Start of machine commissioning

Oct 2017 - Start of assembly phase

May-July 2020 – Friendly Users

25/08/2020 – Start of USM

1.5 year of User Service Mode interruption

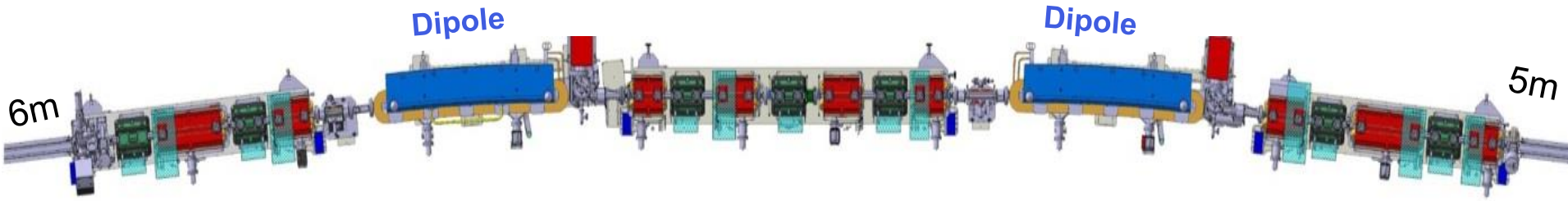
2018 is a normal year for Operation

October	2017	Start of the girder assembly (estimated duration 1 year)
10 December	2018	Start of the long shutdown, dismantling starts
December	2019	Accelerator commissioning
March	2020	Beamline commissioning starts
25 August	2020	Back to USM

NEW LATTICE VS PRESENT ESRF LATTICE

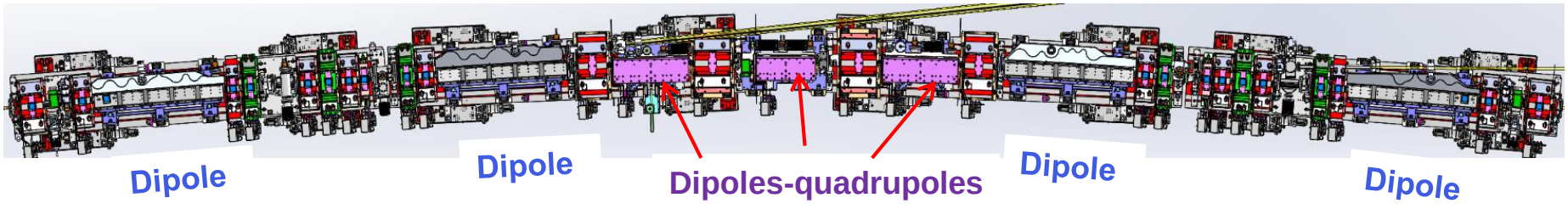
- **Present ESRF lattice**

32 cells, Double Bend Achromat = (2 dipoles + 15 quad. sext.) per cell
ID length = 5 m (standard) / 6m / 7m



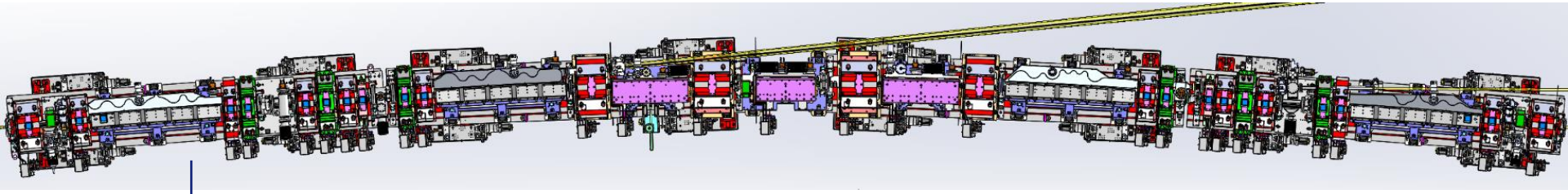
- **ESRF EBS lattice**

Hybrid 7 Bend Achromat = (4 dipoles + 3 dipoles-quad + 24 quad., sext., oct.) per cell
32 identical arcs 21.2 m long, ID length = 5 m



31 magnets per cell instead of 17 currently
Free space between magnets (total for one cell): **3.4m** instead of **8m** today !!

GIRDERS



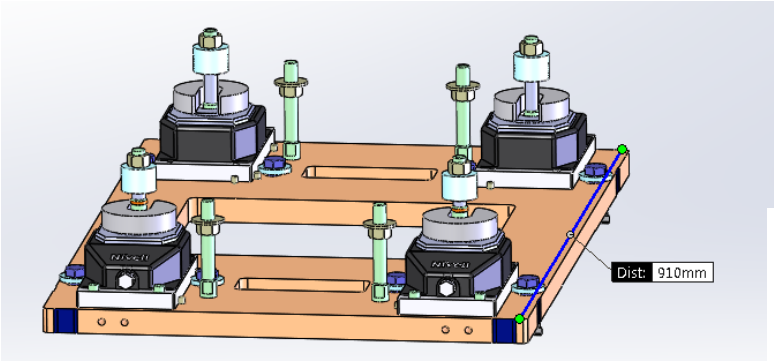
Four girders per cell to install:

- Magnet supports
- Magnets
- Vacuum equipment
- Diagnostics

Bare girder weight: ~6t
Fully equipped girder: ~12-13t
129 girders in total

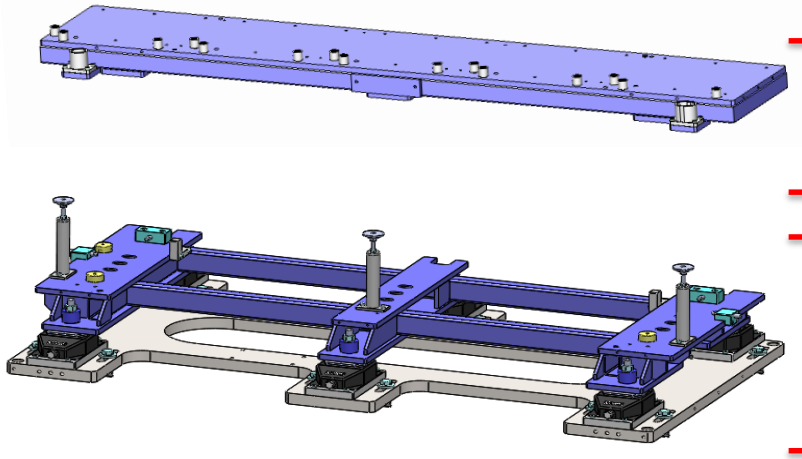
More than 70% of the girders produced
About 30 girders at ESRF, the remaining ones stored at the factories

`MAGNET SUPPORTS



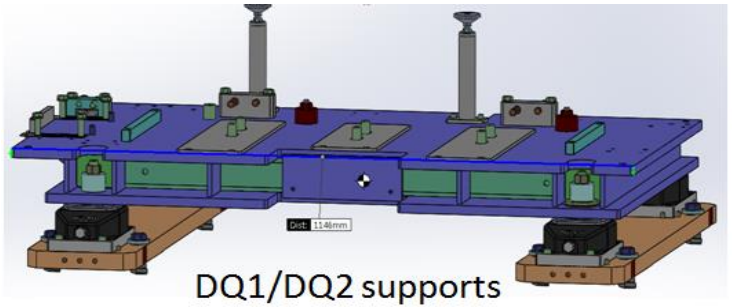
QF6/QF8 supports

Dipole support assembly



Top Frame

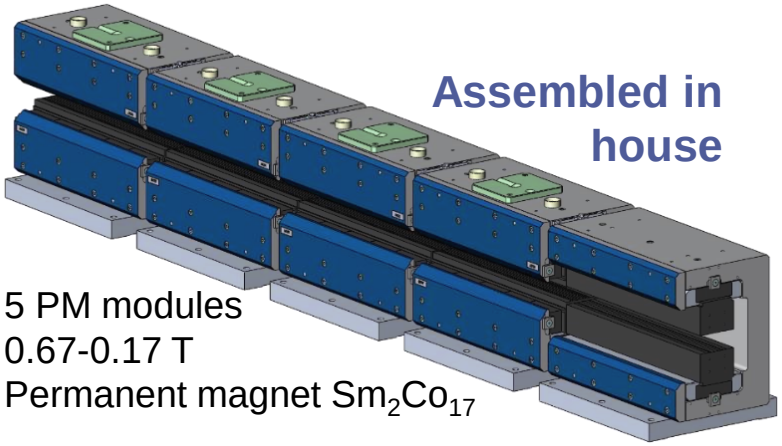
Base support



200mm

About 70% of the supports delivered

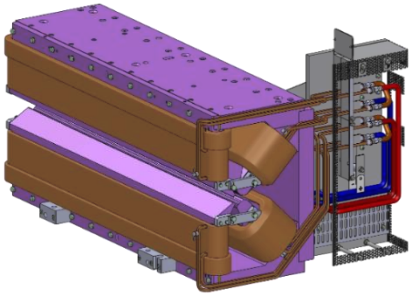
MAGNETS: MORE THAN 1000 MAGNETS TO PRODUCE



Assembled in house

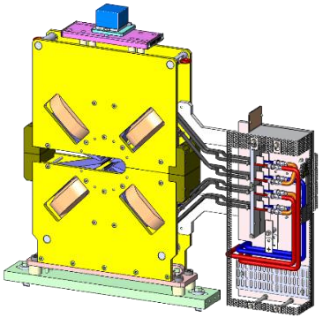
- 5 PM modules
- 0.67-0.17 T
- Permanent magnet Sm_2Co_{17}

132 Dipoles



- Nominal dipole 0.55 – 0.39 T
- Nominal gradient 36-39 T/m
- Poles longitudinally curved

100 Dipole-quadrupoles

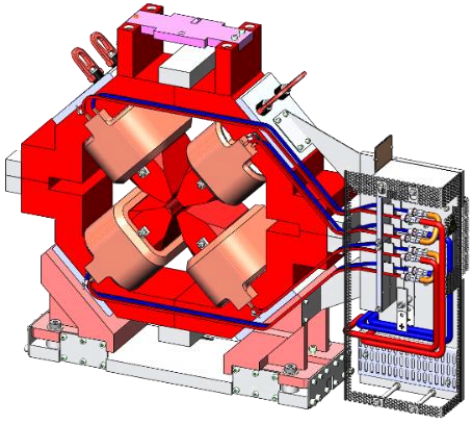


- 36900 T/m3
- Stay clear for SR

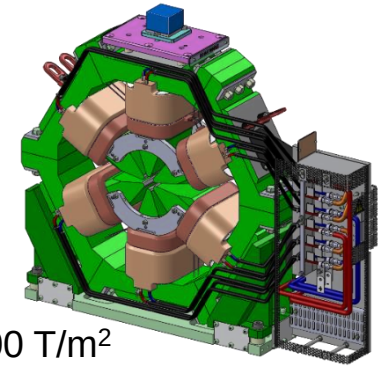
66 Octupoles

High Gradient
- 89 & 87 T/m

Moderate
- Up to 54 T/m

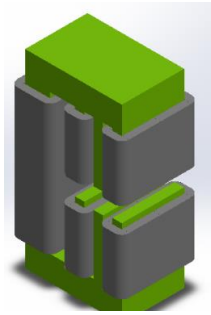


524 Quadrupoles (132 HG, 392 MG)



- 1700 T/m^2
- Including correction coils

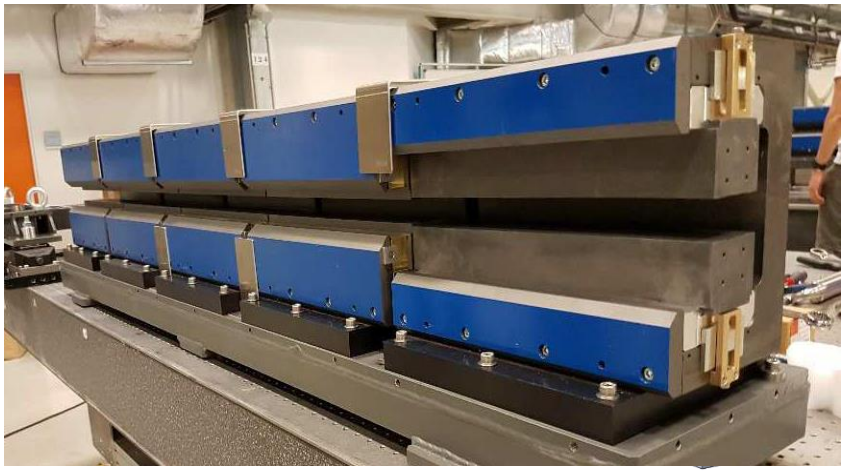
196 Sextupoles



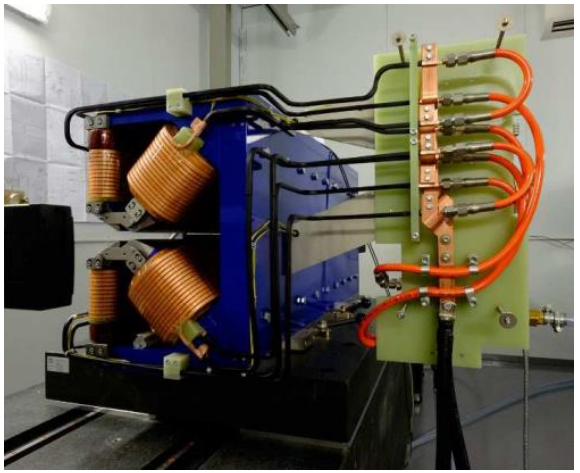
- Horizontal: 0.1 T.mm
- Vertical 0.1 T.mm
- Skew quad: 0.12 T

98 Correctors

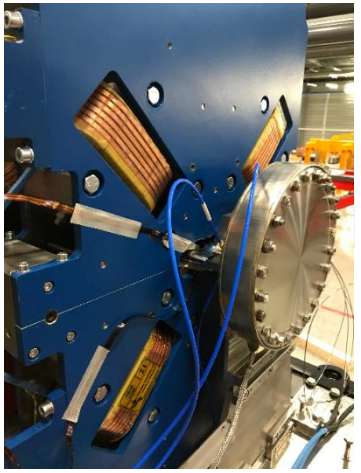
MAGNETS: MORE THAN 1000 MAGNETS TO PRODUCE



132 Dipoles

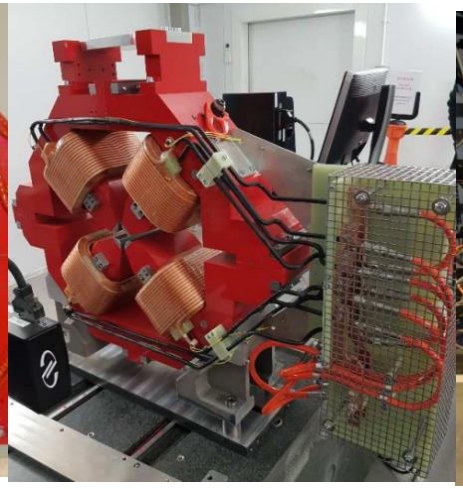


100 Dipole-quadrupoles

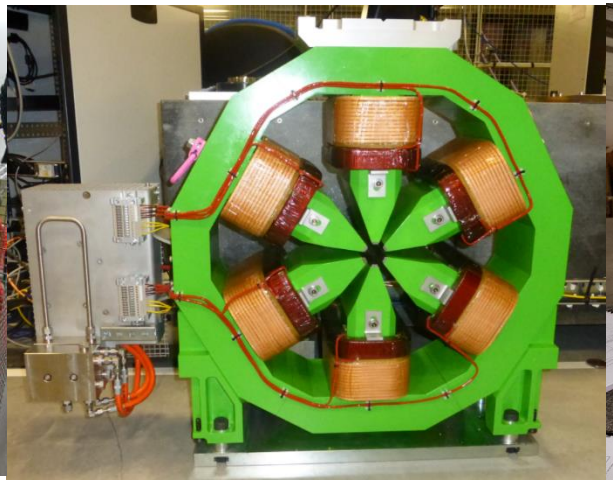


66 Octupoles

About 60% of the magnets produced, 40% delivered



524 Quadrupoles (132 HG, 392 MG)



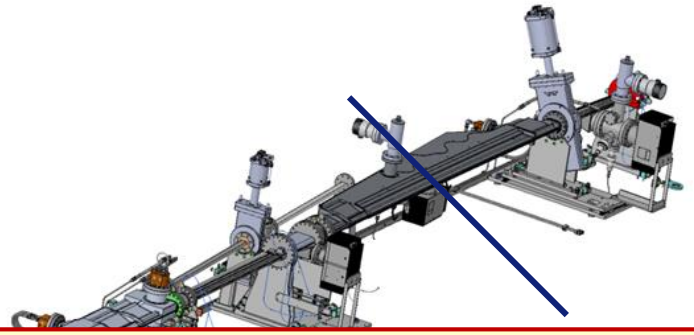
196 Sextupoles

98 Correctors

VACUUM CHAMBERS

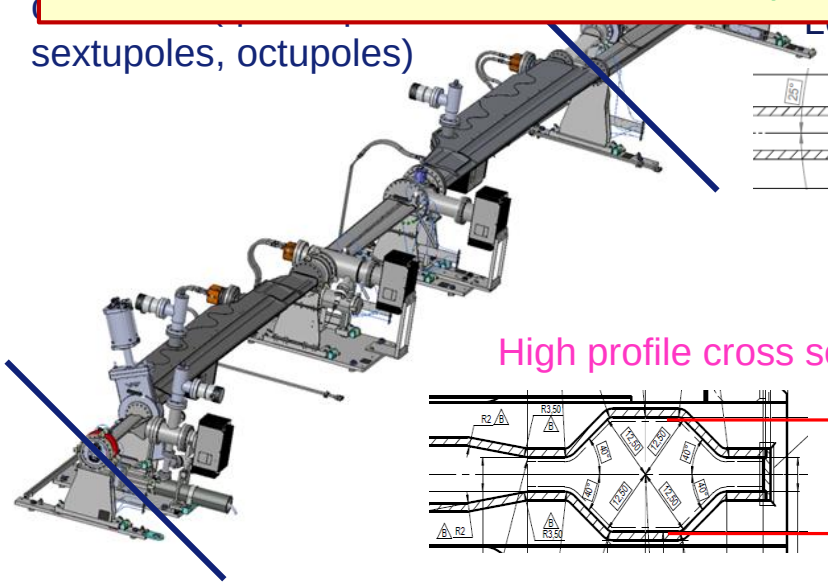
✓ Three main families of chambers:

Low profile stainless steel chambers (inside combined dipole-quadrupoles & HG

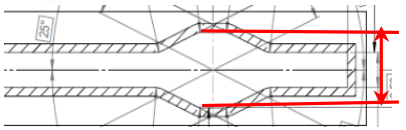


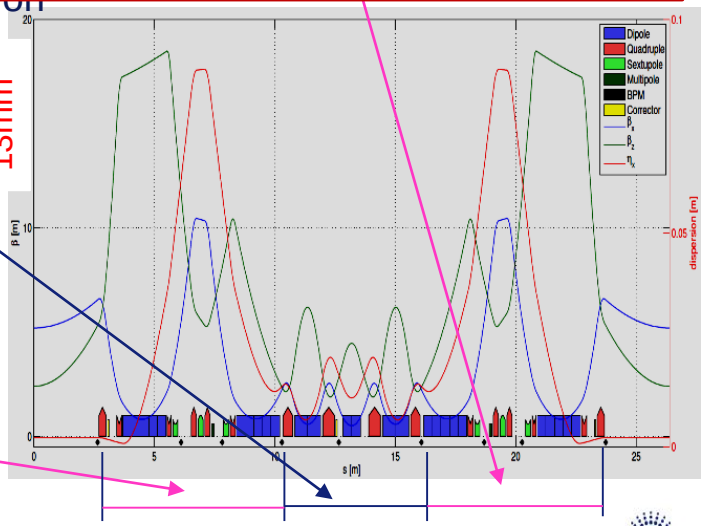
About 25% of the aluminum chambers delivered
About 10% of the Stainless Steel chambers delivered
Production in line with the assembly process
Several batches of Valves, Pumps, Bellows etc have been deliverd

sextupoles, octupoles)



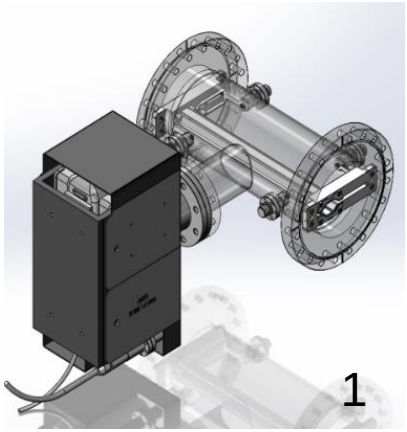
Low profile cross section



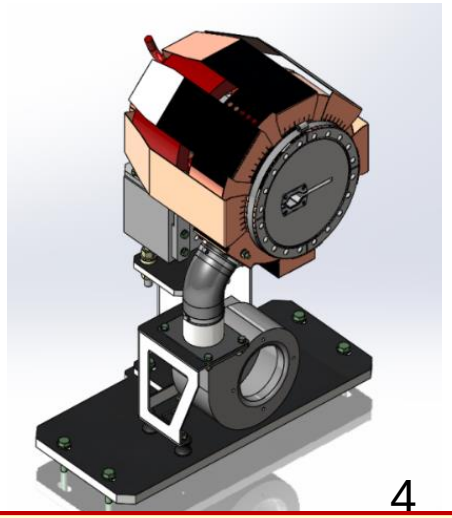


High profile cross section

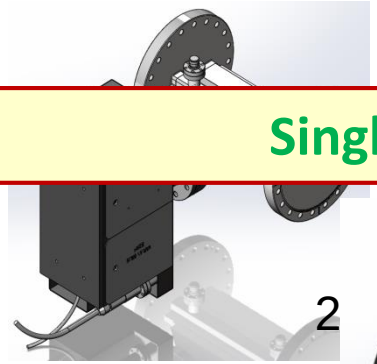
VACUUM CHAMBERS – CH12 DIAGNOSTICS

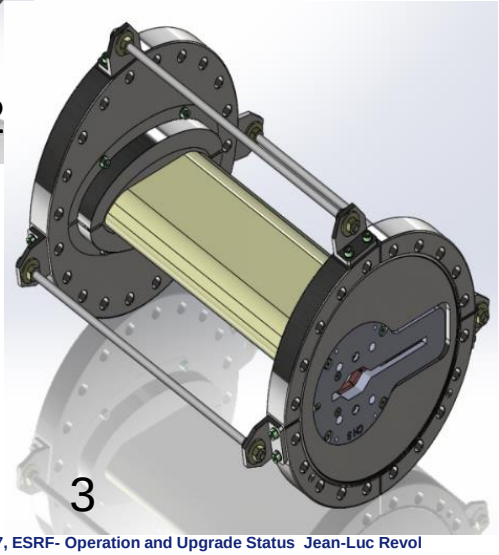


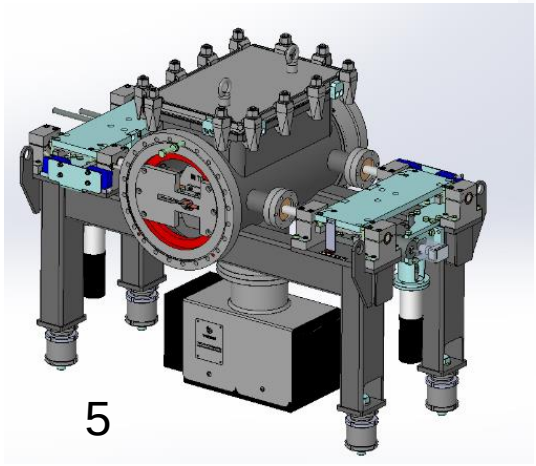
1. H stripline
2. V stripline
3. Shaker
4. Current transformer
5. Beam losses collimator

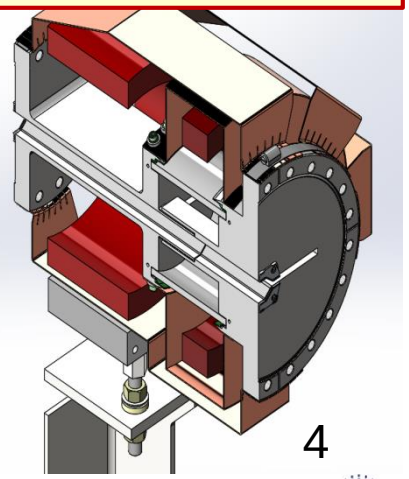


Single pieces components fabrication in progress



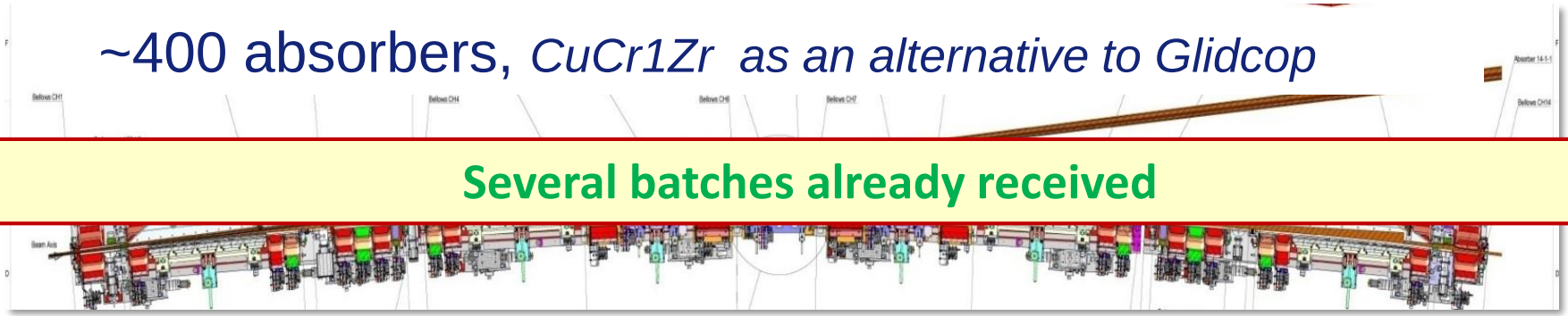






ABSORBERS DESIGN : TWO FAMILIES

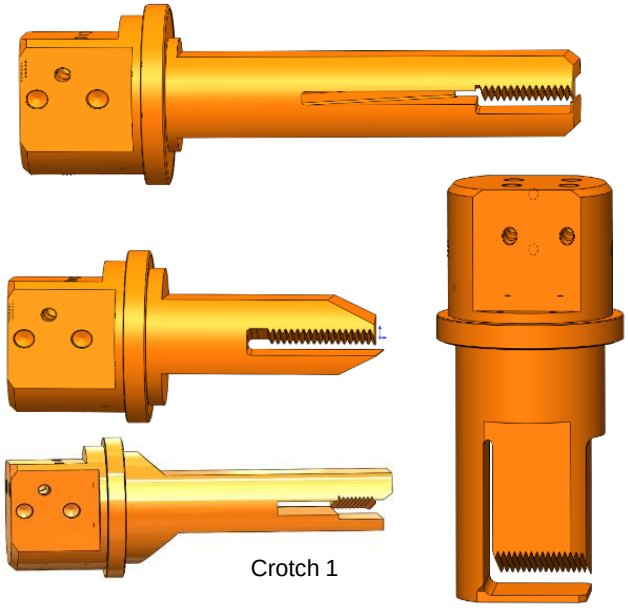
~400 absorbers, *CuCr1Zr as an alternative to Glidcop*



Several batches already received

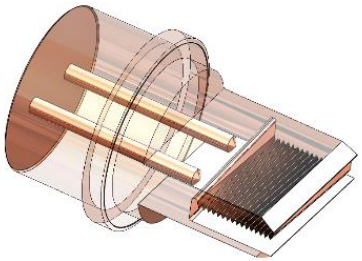
Family Toothed (up to 110 W/mm^2)

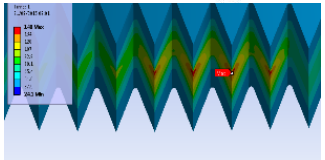
Toothed geometry optimized to reduce thermal stresses over large area



Crotch 1

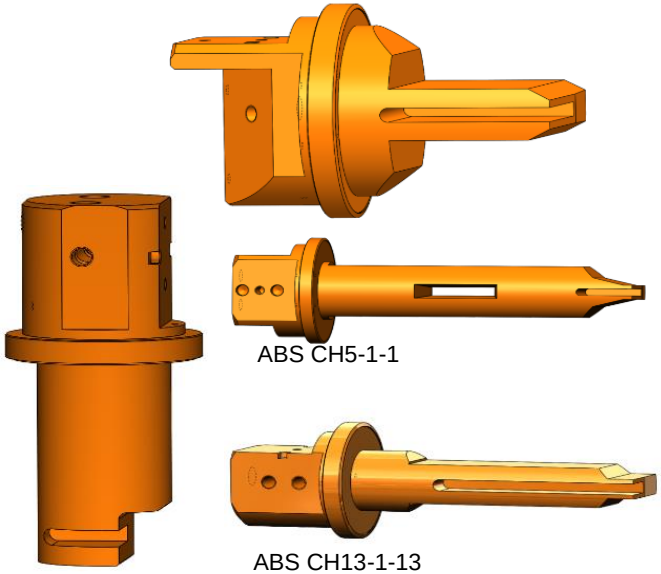
ABS CH9-1-29





Temperature photon
Toothed absorber

Family Frontal (up to 50 W/mm^2)



ABS CH5-1-1

ABS CH13-1-13

ABS CH4-1-1

No weld, no braze

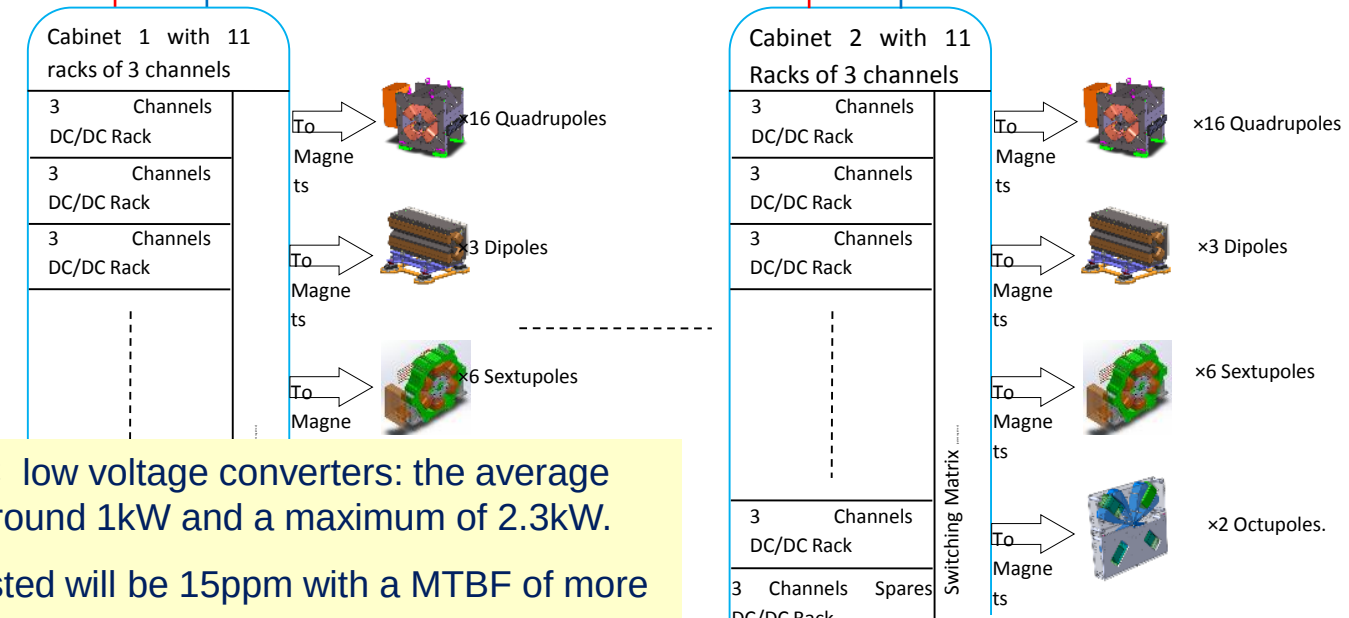
POWER SUPPLIES

400V | 12Pulses common

360 V dc distribution network

Prototype received

Existing AC/DC PS to be modified



About 1000 DC-DC low voltage converters: the average channel power is around 1kW and a maximum of 2.3kW.

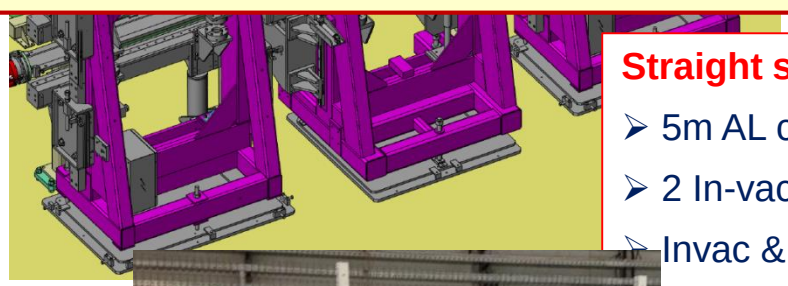
The stability requested will be 15ppm with a MTBF of more than 400 000 hours.

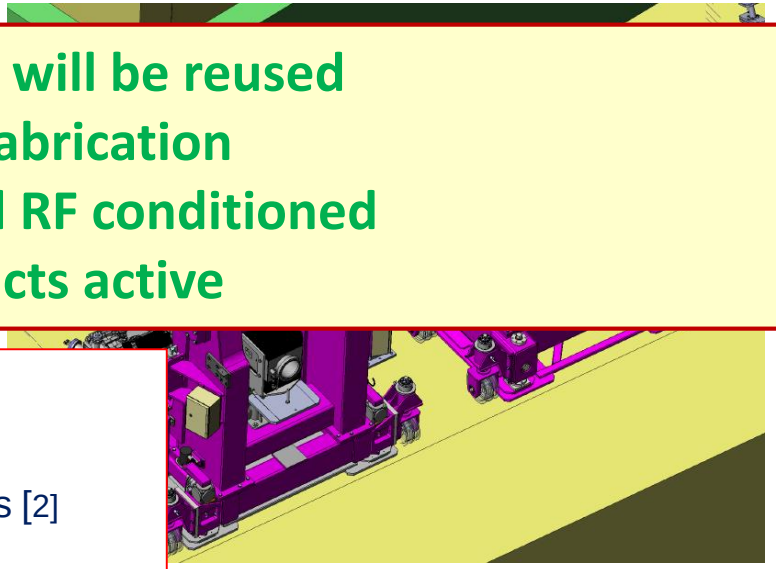
The integration in 32 cabinets will be designed with the Computer Services for redundancy and HOT-Swappability

Individual magnet power supply

STRAIGHT SECTIONS: IDS AND RF

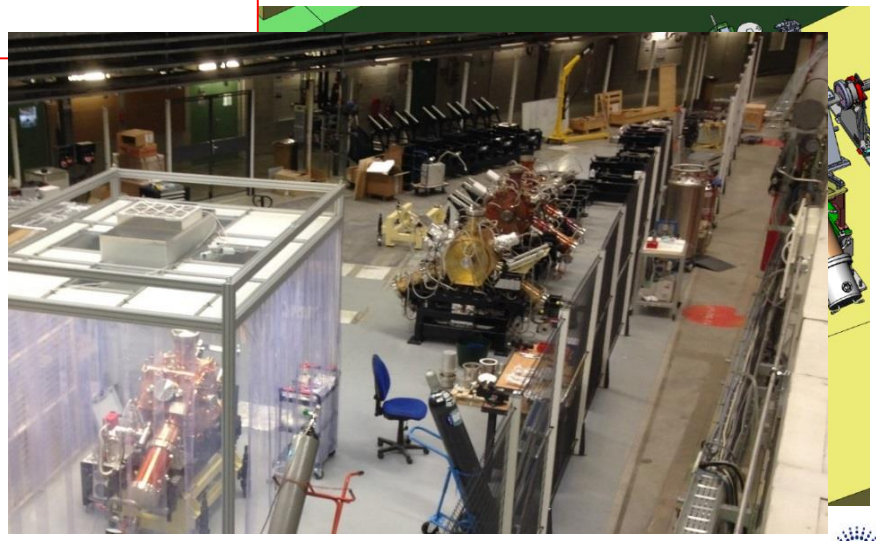
Present Insertion Devices will be reused
New BM devices in fabrication
All RF cavities received and RF conditioned
All RF-related contracts active



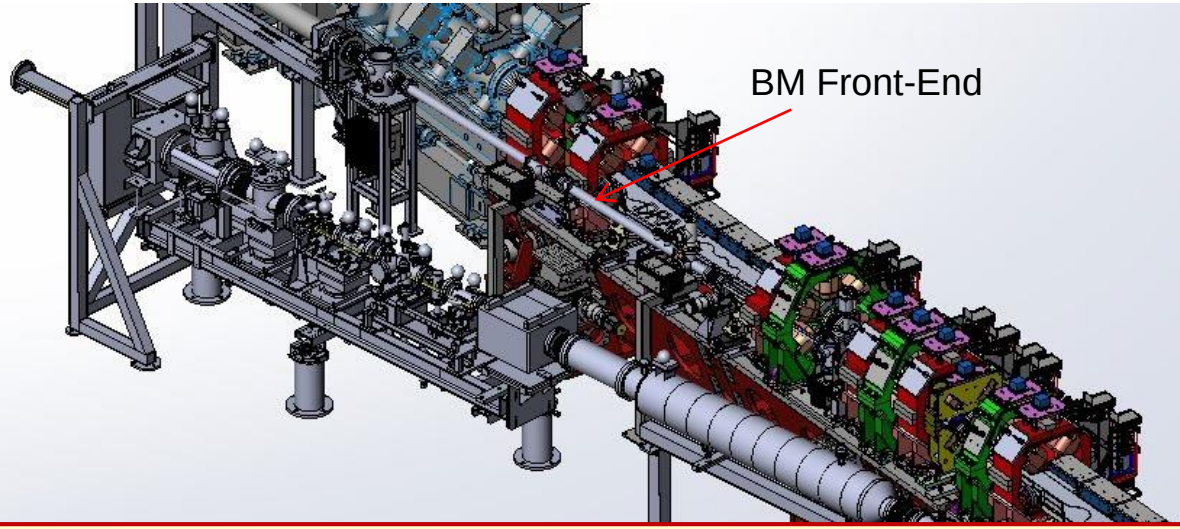


Straight sections

- 5m AL chamber [1]
- 2 In-vacuum undulators [2]
- Invac & Al chamber [3]
- RF cavities [4]



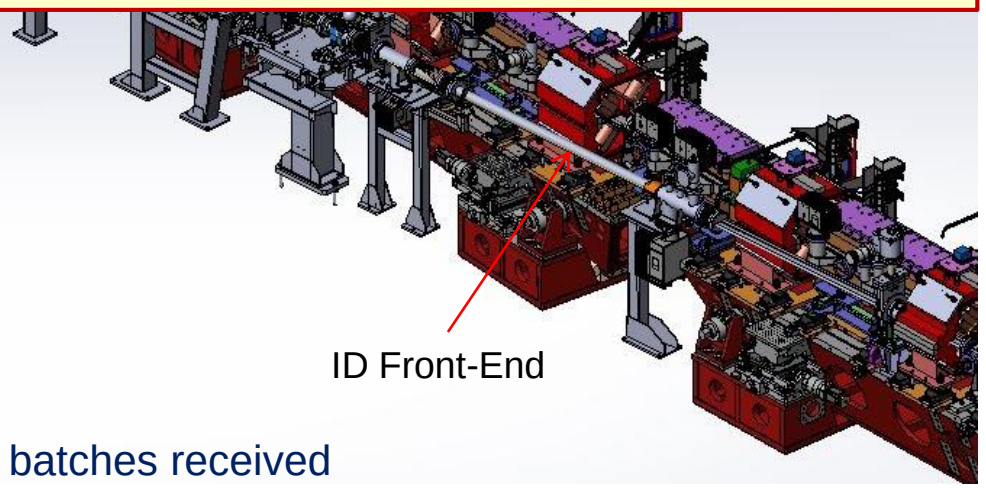
FRONT-ENDS



42 Front-Ends

- 28 ID FE's
- 14 BM FE's

All FE components in production, several batches received



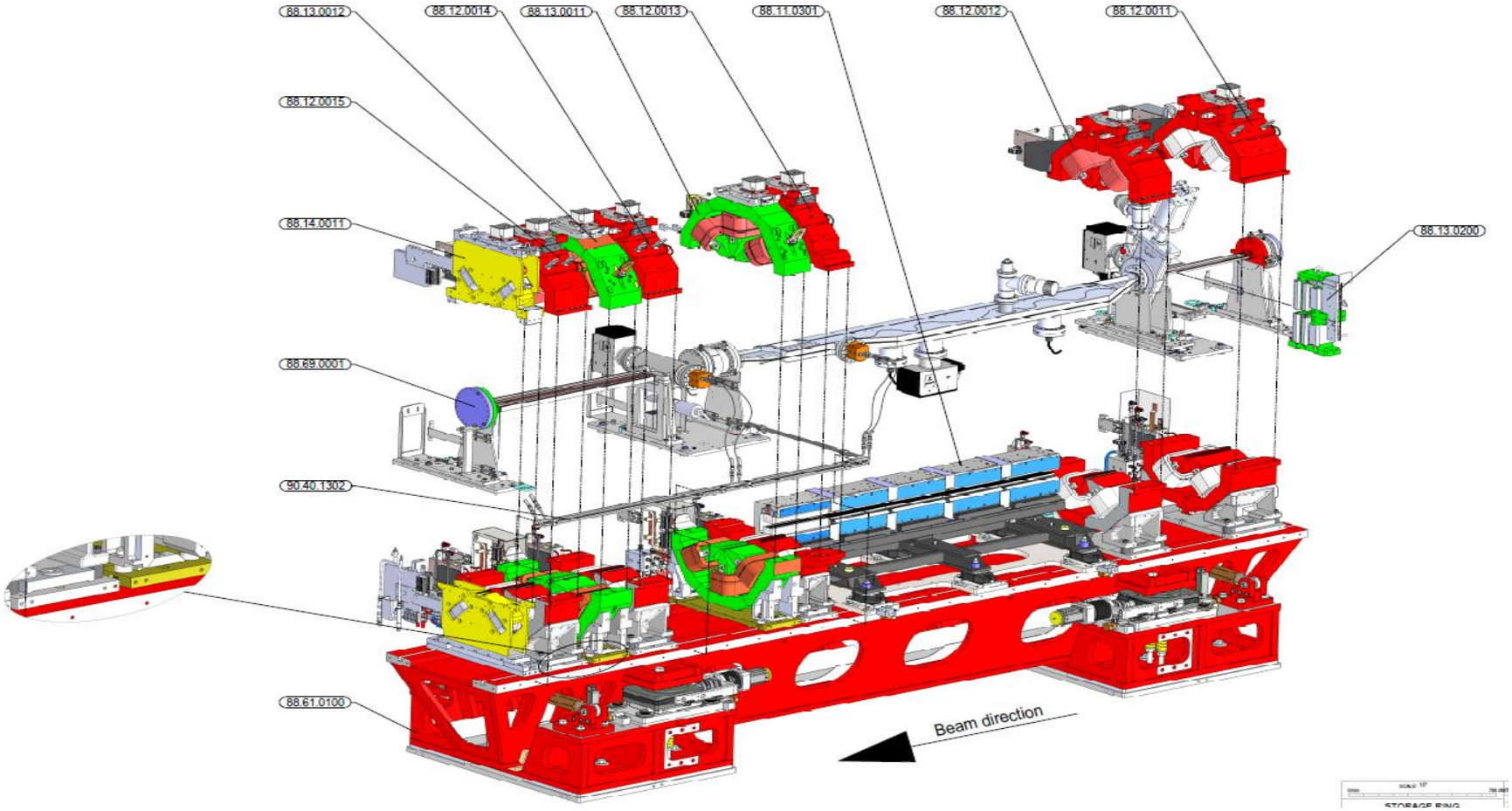
New Front-End design completed for :

- SR junction chambers
- BM and ID FE module1

All FE components in production, several batches received

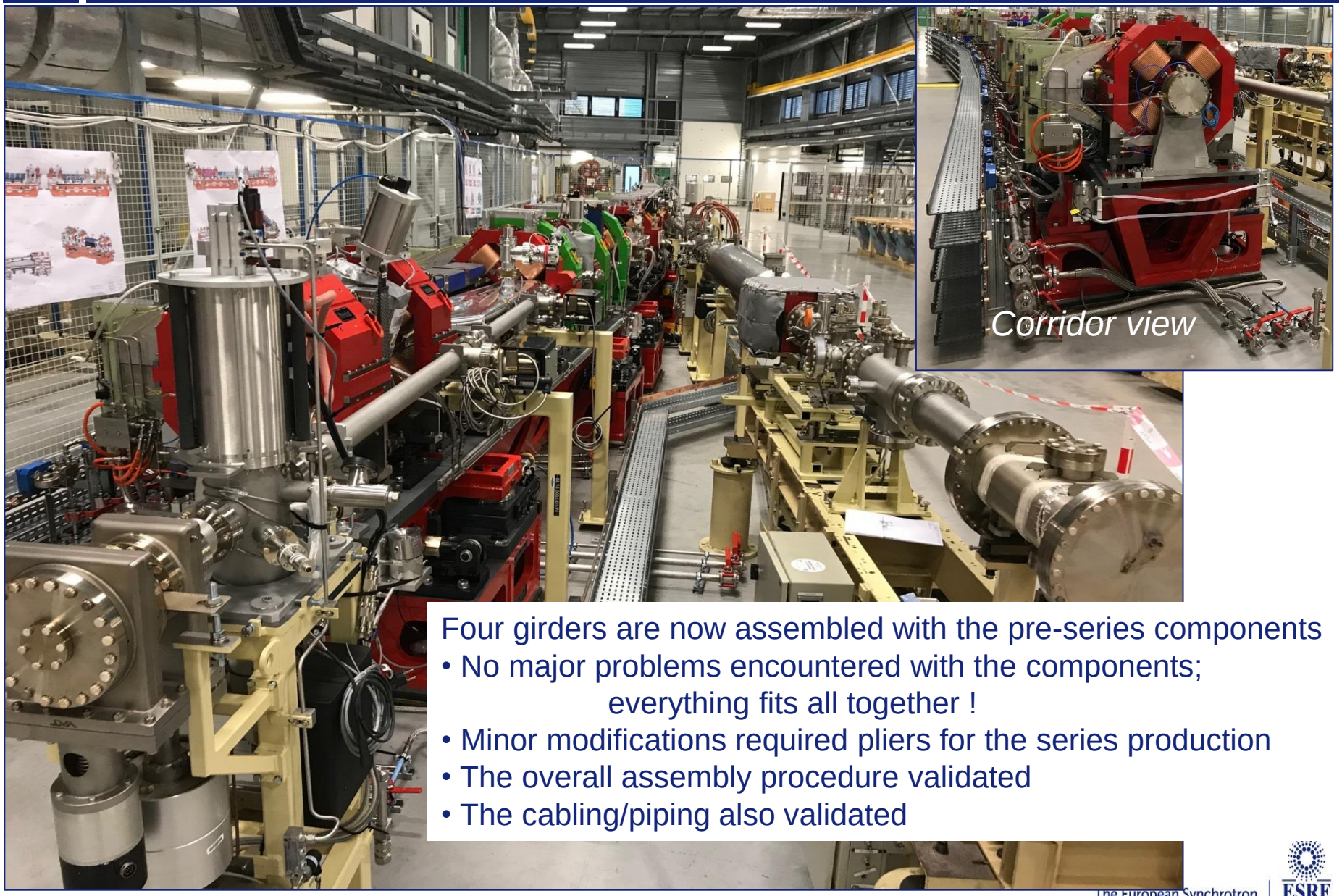
FROM ASSEMBLY TO INSTALLATION

COMPLETE GIRDER DISASSEMBLED VIEW



FULL CELL MOCKUP

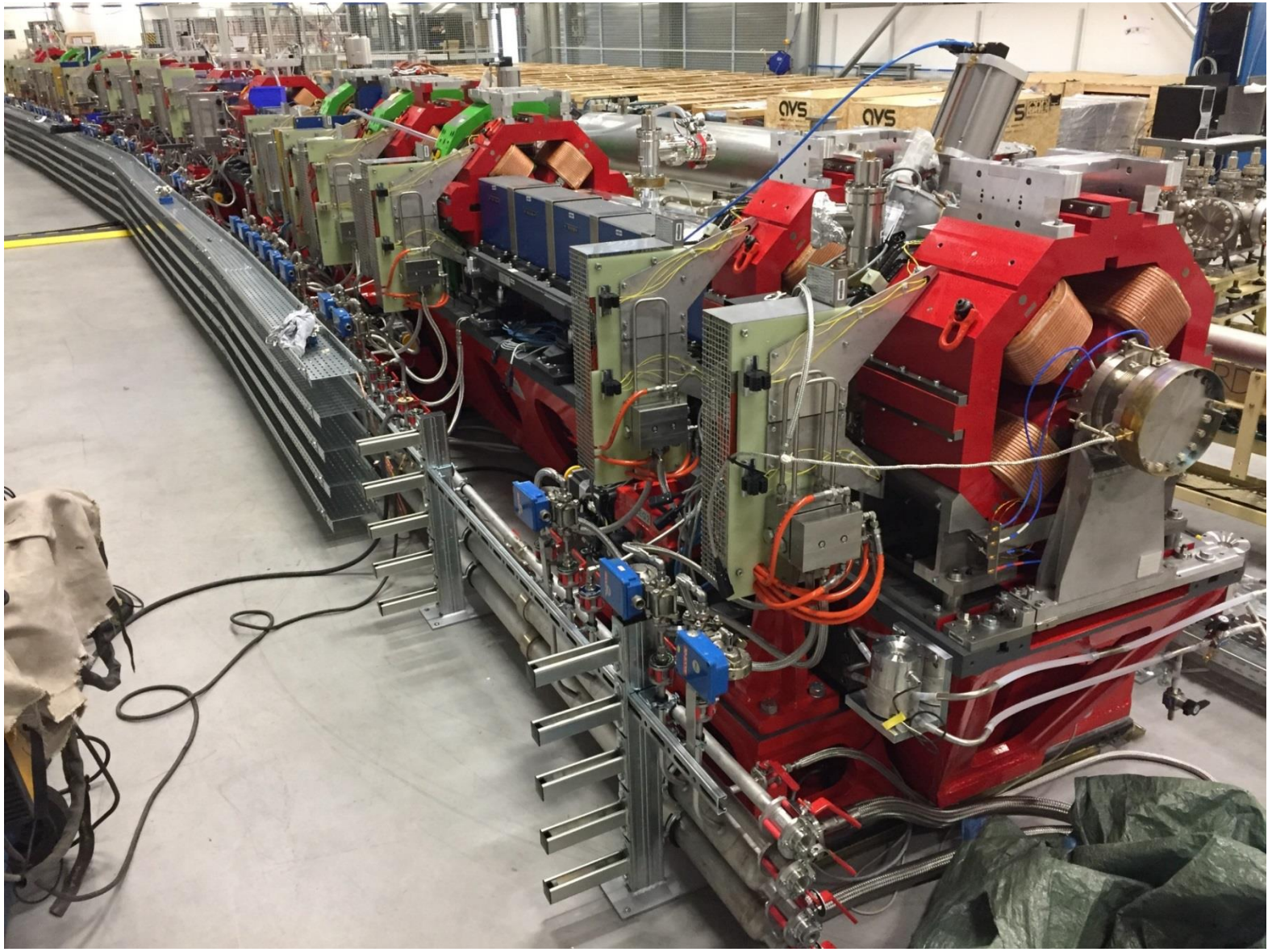
FULL CELL MOCKUP



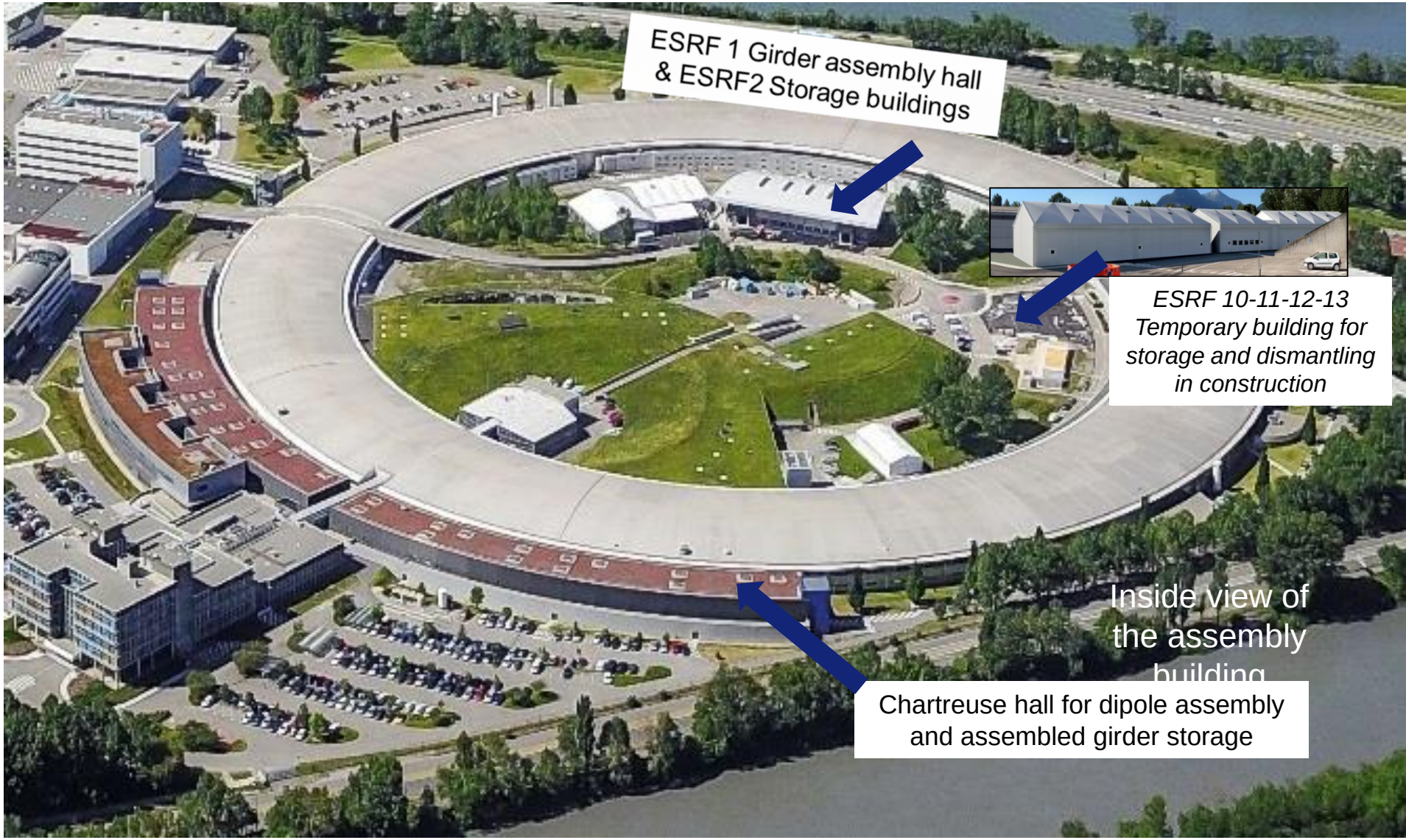
Four girders are now assembled with the pre-series components

- No major problems encountered with the components; everything fits all together !
- Minor modifications required pliers for the series production
- The overall assembly procedure validated
- The cabling/piping also validated

MOCK-UP: TUNNEL CORRIDOR VIEW



EBS BUILDINGS FOR THE ASSEMBLY AND INSTALLATION PHASE



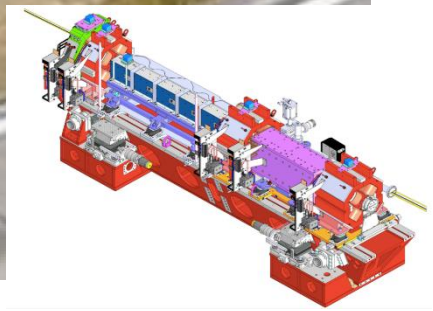
ESRF01 – STORAGE AND ASSEMBLY BUILDING

Storage building

Assembly building

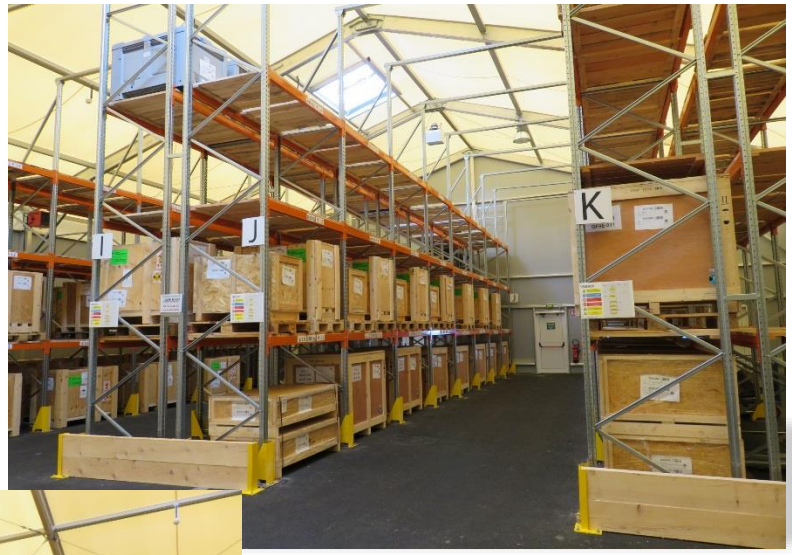
Aim of the Assembly Phase:

Produce 129 fully equipped girders, ready to be installed in the SRTU

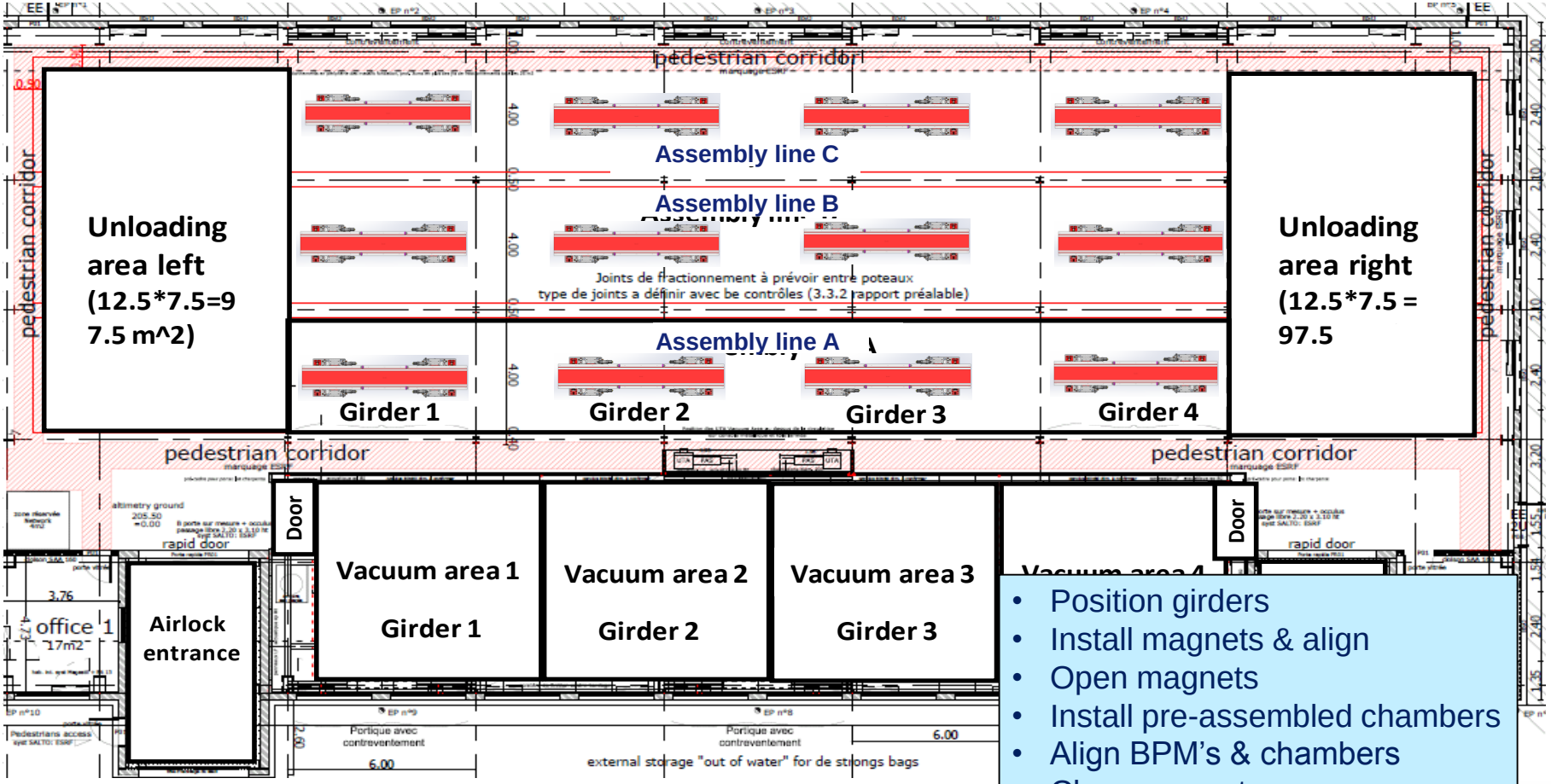


The Assembly phase takes place during the Operation of the facility!

ESRF02A/B – STORAGE BUILDINGS



ASSEMBLY PLANNING – ESRF01 LAYOUT

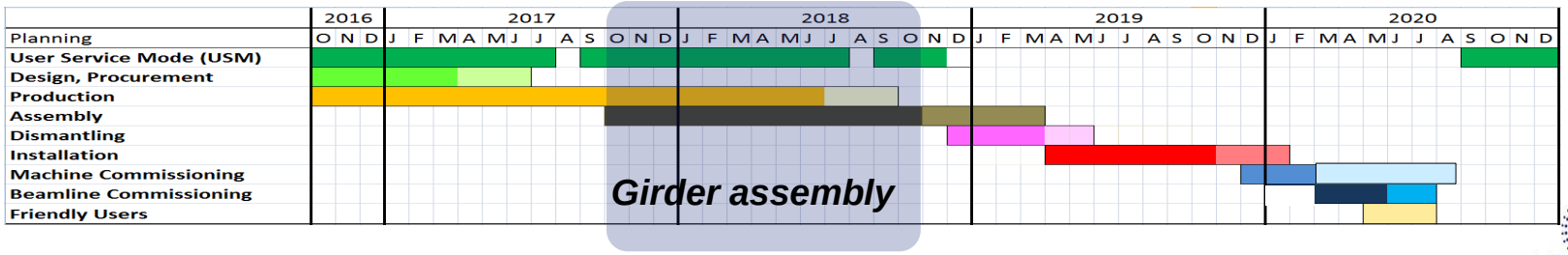


ESRF1-Assembly building

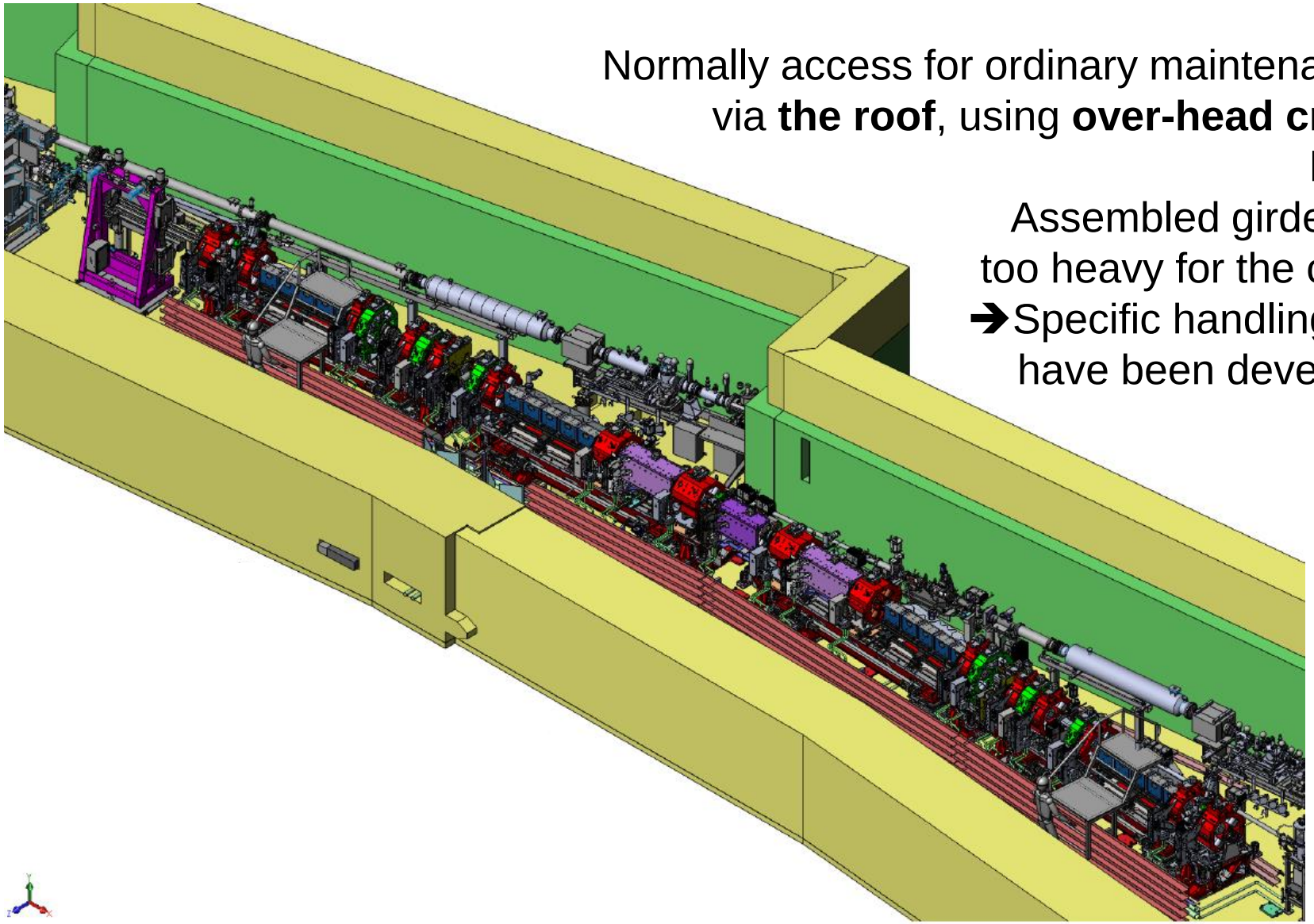
- Position girders
- Install magnets & align
- Open magnets
- Install pre-assembled chambers
- Align BPM's & chambers
- Close magnets
- Final alignment check

ASSEMBLY STARTING DATE: GIRDERS ROLL IN ON OCTOBER 20, 2017

ASSEMBLY IN FULL SWING: MAGNETS & VACUUM



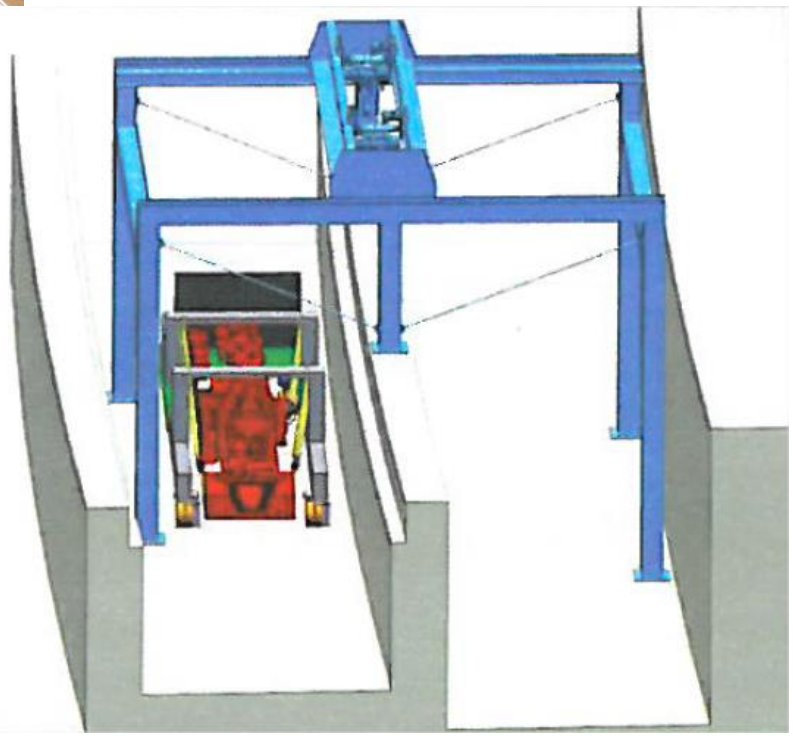
INSTALLATION



Normally access for ordinary maintenance is via **the roof**, using **over-head cranes,** but ….
Assembled girders are too heavy for the cranes
➔Specific handling tools have been developed.

INSTALLATION

- Dedicated transport module has been developed
- Dedicated gantry will be installed to pass over the tunnel wall



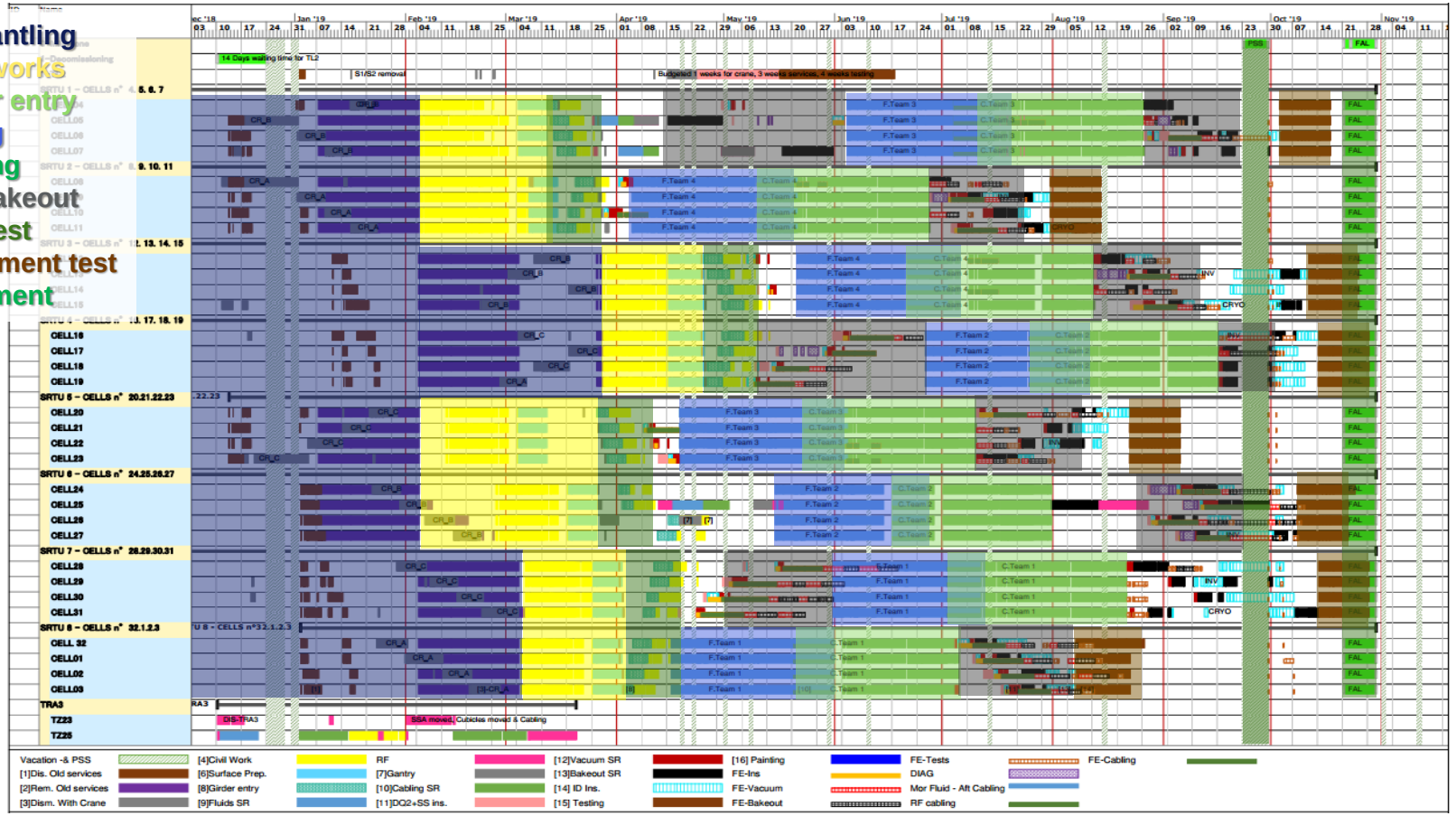
✓ The first girder transport module has been delivered to ESRF

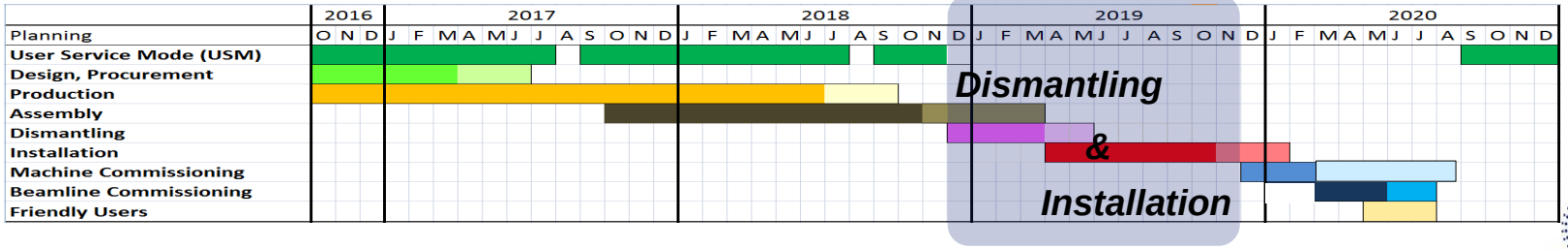
✓ There will be four girder transport

✓ The girder transport modules will be used inside our buildings

DISMANTLING + INSTALLATION PLANNING

Dismantling
Civil works
Girder entry
Piping
Cabling
FE+Bakeout
PSS test
Equipment test
Alignment





The European Synchrotron | ESRF

STORAGE RING COMMISSIONING

System tests completed by 1 December 2019

2 weeks per cell (power supplies, low-level RF, vacuum front-ends, IDs)

1 week for Personal Safety System,

1 week Machine interlock, RF

Allocated time for electron beam commissioning: 3 months

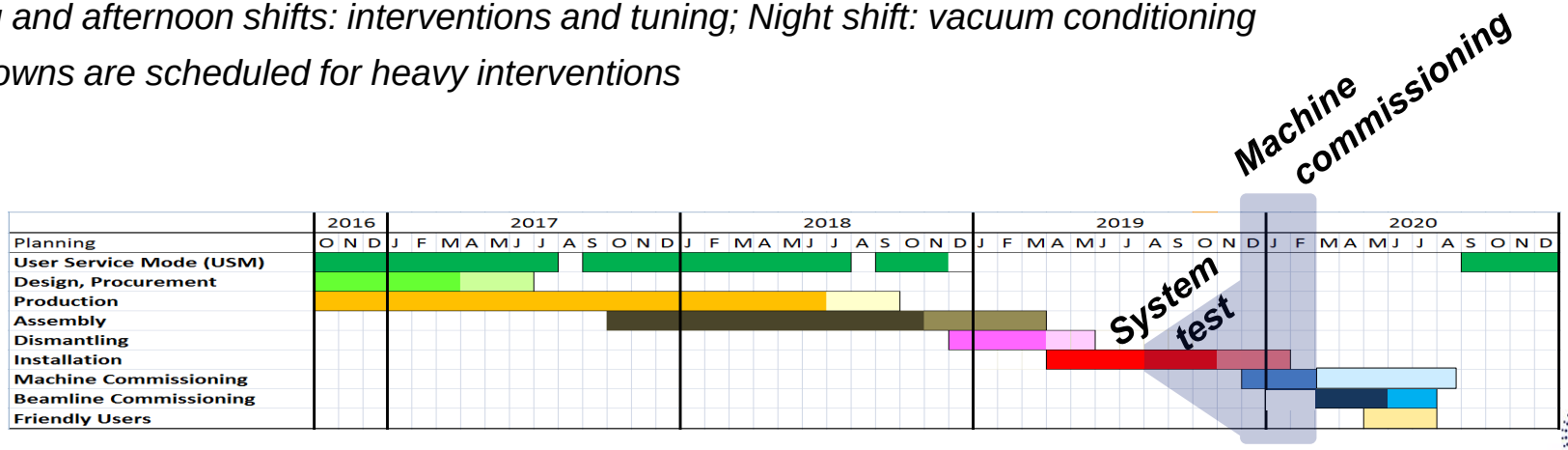
Start: Monday December 2nd, 2019 ➔ End: Sunday March 1st, 2020

Best case scenario: (risk mitigation and alternative scenarios not available now).

- Month 1: debugging of equipment and software, 1st turn, initial tuning at low current
- Month 2: Current ramping, finer optics tuning
- Month 3: Contingency, stabilisation of the beam delivery

Morning and afternoon shifts: interventions and tuning; Night shift: vacuum conditioning

2 shutdowns are scheduled for heavy interventions



DRAFT OPERATION SCHEDULE 2020

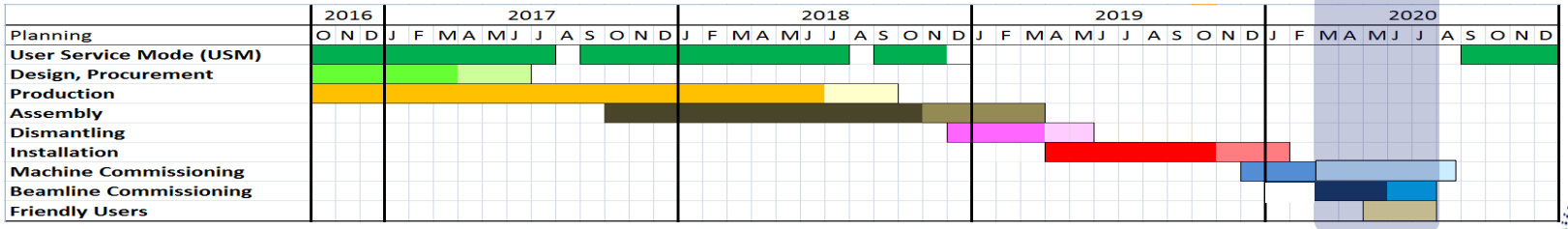
Dec 2019				Jan 2020				Feb 2020				Mar 2020				Apr 2020				May 2020				Jun 2020				Jul 2020				Aug 2020				Sep 2020				Oct 2020				Nov 2020				Dec 2020			
Sun 01	s	s	s	Wed 01	s	s	s	Sat 01	M	M	C	Sun 01	M	M	C	Wed 01	B	M	C	Fri 01	B	B	C	Mon 01	s	s	s	Wed 01	B	M	C	Sat 01	B	B	C	Tue 01	M	M	M	Thu 01	.	.	.	Sun 01	.	.	.	Tue 01	M	M	M
Mon 02	F	F	C	Thu 02	s	s	s	Sun 02	M	M	C	Mon 02	M	B	C	Thu 02	B	B	C	Sat 02	B	B	C	Tue 02	s	s	s	Thu 02	B	B	C	Sun 02	B	B	C	Wed 02	.	.	.	Fri 02	.	.	.	Mon 02	.	.	.	Wed 02	.	.	.
Tue 03	F	F	C	Fri 03	s	s	s	Mon 03	M	M	C	Tue 03	B	M	C	Fri 03	B	B	C	Sun 03	B	B	C	Wed 03	s	M	M	Fri 03	B	B	C	Mon 03	s	s	s	Thu 03	.	.	.	Sat 03	.	.	.	Tue 03	M	M	M	Thu 03	.	.	.
Wed 04	F	F	C	Sat 04	s	s	s	Tue 04	M	M	C	Wed 04	B	M	C	Sat 04	B	B	C	Mon 04	B	M	C	Thu 04	M	M	M	Sat 04	B	B	C	Tue 04	s	s	s	Fri 04	.	.	.	Sun 04	.	.	.	Wed 04	.	.	.	Fri 04	.	.	.
Thu 05	F	F	C	Sun 05	s	s	s	Wed 05	M	M	C	Thu 05	B	B	C	Sun 05	B	B	C	Tue 05	M	B	C	Fri 05	M	M	M	Sun 05	B	B	C	Wed 05	s	s	s	Sat 05	.	.	.	Mon 05	.	.	.	Thu 05	.	.	.	Sat 05	.	.	.
Fri 06	F	F	C	Mon 06	s	s	s	Thu 06	M	M	C	Fri 06	B	M	C	Mon 06	B	M	C	Wed 06	B	M	C	Sat 06	M	M	M	Mon 06	B	M	C	Thu 06	s	s	s	Sun 06	.	.	.	Tue 06	M	M	M	Fri 06	.	.	.	Sun 06	.	.	.
Sat 07	F	F	C	Tue 07	s	s	s	Fri 07	M	M	C	Sat 07	B	B	C	Tue 07	M	B	C	Thu 07	B	M	C	Sun 07	M	M	M	Tue 07	M	B	C	Fri 07	s	s	s	Mon 07	.	.	.	Wed 07	.	.	.	Sat 07	.	.	.	Mon 07	.	.	.
Sun 08	F	F	C	Wed 08	s	s	s	Sat 08	M	M	C	Sun 08	B	B	C	Wed 08	B	M	C	Fri 08	B	B	C	Mon 08	M	B	C	Wed 08	B	M	C	Sat 08	s	s	s	Tue 08	M	M	M	Thu 08	.	.	.	Sun 08	.	.	.	Tue 08	M	M	M
Mon 09	F	F	C	Thu 09	s	M	C	Sun 09	M	M	C	Mon 09	B	M	C	Thu 09	B	B	C	Sat 09	B	B	C	Tue 09	B	M	C	Thu 09	B	B	C	Sun 09	s	s	s	Wed 09	.	.	.	Fri 09	.	.	.	Mon 09	.	.	.	Wed 09	.	.	.
Tue 10	F	F	C	Fri 10	M	M	C	Mon 10	s	s	s	Tue 10	M	B	C	Fri 10	B	B	C	Sun 10	B	B	C	Wed 10	B	M	C	Fri 10	B	B	C	Mon 10	s	s	s	Thu 10	.	.	.	Sat 10	.	.	.	Tue 10	M	M	M	Thu 10	.	.	.
Wed 11	F	F	C	Sat 11	M	M	C	Tue 11	s	s	s	Wed 11	B	M	C	Sat 11	B	B	C	Mon 11	B	M	C	Thu 11	B	B	C	Sat 11	B	B	C	Tue 11	s	s	s	Fri 11	.	.	.	Sun 11	.	.	.	Wed 11	.	.	.	Fri 11	.	.	.
Thu 12	F	F	C	Sun 12	M	M	C	Wed 12	s	s	s	Thu 12	B	B	C	Sun 12	B	B	C	Tue 12	M	B	C	Fri 12	B	B	C	Sun 12	B	B	C	Wed 12	s	s	s	Sat 12	.	.	.	Mon 12	.	.	.	Thu 12	.	.	.	Sat 12	.	.	.
Fri 13	F	F	C	Mon 13	M	M	C	Thu 13	s	s	s	Fri 13	B	B	C	Mon 13	B	B	C	Wed 13	B	M	C	Sat 13	B	B	C	Mon 13	B	M	C	Thu 13	s	s	s	Sun 13	.	.	.	Tue 13	.	.	.	Fri 13	.	.	.	Sun 13	.	.	.
Sat 14	F	F	C	Tue 14	M	M	C	Fri 14	s	s	s	Sat 14	B	B	C	Tue 14	B	B	C	Thu 14	B	B	C	Sun 14	B	B	C	Tue 14	M	B	C	Fri 14	s	s	s	Mon 14	.	.	.	Wed 14	s	s	s	Sat 14	.	.	.	Mon 14	.	.	.
Sun 15	F	F	C	Wed 15	M	M	C	Sat 15	s	s	s	Sun 15	B	B	C	Wed 15	s	s	s	Fri 15	B	B	C	Mon 15	B	M	C	Wed 15	B	M	C	Sat 15	s	s	s	Tue 15	M	M	M	Thu 15	s	s	s	Sun 15	.	.	.	Tue 15	M	M	M
Mon 16	F	F	C	Thu 16	M	M	C	Sun 16	s	s	s	Mon 16	B	M	C	Thu 16	s	s	s	Sat 16	B	B	C	Tue 16	M	B	C	Thu 16	B	B	C	Sun 16	s	s	s	Wed 16	R	.	.	Fri 16	s	s	s	Mon 16	.	.	.	Wed 16	.	.	.
Tue 17	F	F	C	Fri 17	M	M	C	Mon 17	s	s	s	Tue 17	M	B	C	Fri 17	s	s	s	Sun 17	B	B	C	Wed 17	B	M	C	Fri 17	B	B	C	Mon 17	s	s	s	Thu 17	.	.	.	Sat 17	s	s	s	Tue 17	M	M	M	Thu 17	.	.	.
Wed 18	F	F	C	Sat 18	M	M	C	Tue 18	s	M	C	Wed 18	R	M	C	Sat 18	s	s	s	Mon 18	B	M	C	Thu 18	B	B	C	Sat 18	B	B	C	Tue 18	s	s	s	Fri 18	.	.	.	Sun 18	s	s	s	Wed 18	.	.	.	Fri 18	.	.	.
Thu 19	s	s	s	Sun 19	M	M	C	Wed 19	M	M	C	Thu 19	B	B	C	Sun 19	s	s	s	Tue 19	M	B	C	Fri 19	B	B	C	Sun 19	B	B	C	Wed 19	s	s	s	Sat 19	.	.	.	Mon 19	s	s	s	Thu 19	.	.	.	Sat 19	.	.	.
Fri 20	s	s	s	Mon 20	M	M	C	Thu 20	M	M	C	Fri 20	B	B	C	Mon 20	s	s	s	Wed 20	B	M	C	Sat 20	B	B	C	Mon 20	B	M	C	Thu 20	s	M	M	Sun 20	.	.	.	Tue 20	s	s	s	Fri 20	.	.	.	Sun 20	.	.	.
Sat 21	s	s	s	Tue 21	M	M	C	Fri 21	M	M	C	Sat 21	B	B	C	Tue 21	s	s	s	Thu 21	B	B	C	Sun 21	B	B	C	Tue 21	M	B	C	Fri 21	M	M	M	Mon 21	.	.	.	Wed 21	s	s	s	Sat 21	.	.	.	Mon 21	s	s	s
Sun 22	s	s	s	Wed 22	M	M	C	Sat 22	M	M	C	Sun 22	B	B	C	Wed 22	s	s	s	Fri 22	B	B	C	Mon 22	B	M	C	Wed 22	B	M	C	Sat 22	M	M	M	Tue 22	M	M	M	Thu 22	s	s	s	Sun 22	.	.	.	Tue 22	s	s	s
Mon 23	s	s	s	Thu 23	M	M	C	Sun 23	M	M	C	Mon 23	B	M	C	Thu 23	s	M	M	Sat 23	B	B	C	Tue 23	M	B	C	Thu 23	B	B	C	Sun 23	M	M	M	Wed 23	.	.	.	Fri 23	M	M	M	Mon 23	.	.	.	Wed 23	s	s	s
Tue 24	s	s	s	Fri 24	M	M	C	Mon 24	M	M	C	Tue 24	M	B	C	Fri 24	M	M	M	Sun 24	B	B	C	Wed 24	B	M	C	Fri 24	B	B	C	Mon 24	M	M	M	Thu 24	.	.	.	Sat 24	M	M	M	Tue 24	M	M	M	Thu 24	s	s	s
Wed 25	s	s	s	Sat 25	M	M	C	Tue 25	M	M	C	Wed 25	B	M	C	Sat 25	M	M	M	Mon 25	s	s	s	Thu 25	B	B	C	Sat 25	B	B	C	Tue 25	.	.	.	Fri 25	.	.	.	Sun 25	M	M	M	Wed 25	.	.	.	Fri 25	s	s	s
Thu 26	s	s	s	Sun 26	M	M	C	Wed 26	M	M	C	Thu 26	B	B	C	Sun 26	M	M	M	Tue 26	s	s	s	Fri 26	B	B	C	Sun 26	B	B	C	Wed 26	.	.	.	Sat 26	.	.	.	Mon 26	M	M	M	Thu 26	.	.	.	Sat 26	s	s	s
Fri 27	s	s	s	Mon 27	M	M	C	Thu 27	M	M	C	Fri 27	B	B	C	Mon 27	M	B	C	Wed 27	s	s	s	Sat 27	B	B	C	Mon 27	B	M	C	Thu 27	.	.	.	Sun 27	.	.	.	Tue 27	.	.	.	Fri 27	.	.	.	Sun 27	s	s	s
Sat 28	s	s	s	Tue 28	M	M	C	Fri 28	M	M	C	Sat 28	B	B	C	Tue 28	B	M	C	Thu 28	s	s	s	Sun 28	B	B	C	Tue 28	M	B	C	Fri 28	.	.	.	Mon 28	.	.	.	Wed 28	.	.	.	Sat 28	.	.	.	Mon 28	s	s	s
Sun 29	s	s	s	Wed 29	M	M	C	Sat 29	M	M	C	Sun 29	B	B	C	Wed 29	B	M	C	Fri 29	s	s	s	Mon 29	B	M	C	Wed 29	B	M	C	Sat 29	.	.	.	Tue 29	M	M	M	Thu 29	.	.	.	Sun 29	.	.	.	Tue 29	s	s	s
Mon 30	s	s	s	Thu 30	M	M	C					Mon 30	B	M	C	Thu 30	B	B	C	Sat 30	s	s	s	Tue 30	M	B	C	Thu 30	B	B	C	Sun 30	.	.	.	Wed 30	.	.	.	Fri 30	.	.	.	Mon 30	.	.	.	Wed 30	s	s	s
Tue 31	s	s	s	Fri 31	M	M	C					Tue 31	M	B	C					Sun 31	s	s	s					Fri 31	B	B	C	Mon 31	.	.	.					Sat 31	.	.	.					Thu 31	s	s	s

From 1 January 2020 to 31 december 2020:

1720	hours	215	shifts	s	Shutdown *(249 shifts in 2017)*
0	hours	0	shifts	F	Debugging+ First beam
1856	hours	232	shifts	M	Intervention and Machine tuning
1608	hours	201	shifts	B	Beamline commissioning
1384	hours	173	shifts	C	Vacuum conditionning
2200	hours	275	shifts	.	USM
16	hours	2	shifts	R	rad / PSS
8784	hours	*1098*	shifts		

Shutdown activities:

Winter 19-20:	
February	one single pole and one 2 poles
April	All 2 poles installed
May	All single pole installed
Summer	
October	
Winter 20-21	



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CONCLUSION

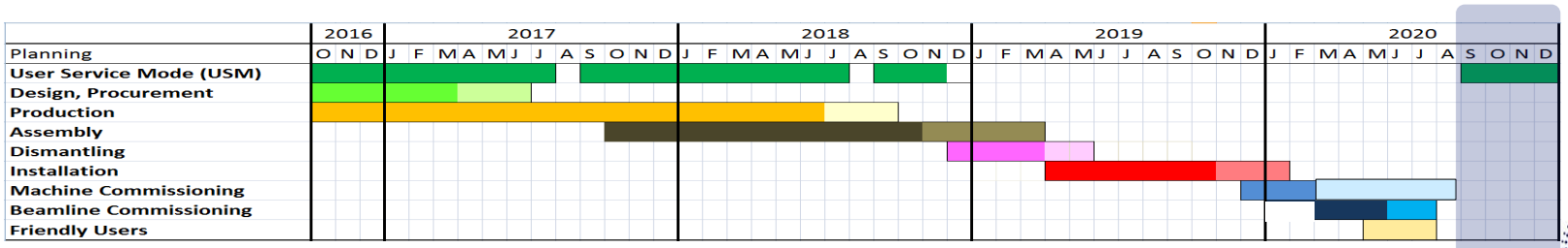
EBS project running in parallel with ESRF operation

- No impact on user operation
- Continuation of the development (injector, top-up, cryo undulators,…)

EBS project execution progression:

- Engineering Design completed
- Production of the ESRF-EBS components is in full swing
- The first cell (out of 32) called “MockUp” has been built
- Serial components contracts will be exhausted over the next 10 months
- Assembly has started on October 20th, 2017 and will last about 1 year
- Dismantling/Installation planning and organisation charts are finalised
- Storage Ring and Beamlines Commissioning phase is being finalised

At this stage, no major show stopper identified.



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MANY THANKS FOR YOUR ATTENTION

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