Assembling and Installation of the ESRF-EBS

D. Einfeld
Contents

1.) Introduction and time schedule
2.) Layout of storage ring
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4.) Layout and location of buildings
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7.) Handling and logistics
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10.) Installation
32 straight sections
DBA lattice
42 Beamlines
12 on dipoles
30 on insertion devices
72 insertion devices:
55 in-air undulators, 6 wigglers,
11 in-vacuum undulators, including 2
cryogenic

32 straight sections, 42 Beamlines, 12 on dipoles, 30 on ID's
Hor. Emittance [nm] 0.135
Vert. Emittance [pm] 5
Energy spread [%] 5.0
$\beta_x [m]/\beta_z [m]$ 6.9/2.6

Source performances will improve by a factor 50 to 100

31 magnets per cell instead of 17 currently
The design started already in 2012, when Pantaleo Raimondi became the ASD-Director. Hence the overall time took 7 to 8 years.
TIME SCHEDULE FOR DISMANTLING AND INSTALLATION
THE LAYOUT OF GIRDER 1

![Girder Layout Diagram]

- **Girder 1**
  - Chamber 1
  - Chamber 2
  - Chamber 3
  - BPM1
  - BPM2
  - BPM3
  - Bellow CH2-CH3
  - Valve fixed to girder

- **Components**
  - Valve
  - Pre-Pump
  - ABS
  - Bellow 2-3
  - Crotch
  - CH 1
  - IP75
  - GP 200
  - RGA, Pen 1, Pir 1
  - RGA, Pen 2

- **Weight Specifications**
  - 60 kg
  - 100 kg
  - 350 kg
  - 800 kg
  - 900 kg
  - 420 kg

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THE LAYOUT OF GIRDER 2

Pre-Pump.  CH 5  ABS  Pre-Pump.
GP 200  ABS  IP75
GP 100  CH 6
IP75  GP 200  Pen 3

Bellow
420 kg
300 kg
100 kg  100 kg  100 kg

Chamber 5
Support
CH5&Ch6
BPM4
Girder 2

Chamber 6
Support
BPM03

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Overall there are 13 absorbers per achromat.
### ALL COMPONENTS PER CELL

<table>
<thead>
<tr>
<th>Girder 1</th>
<th>Girder 2</th>
<th>Girder 3</th>
<th>Girder 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Magnets:</strong> 10</td>
<td><strong>Magnets:</strong> 6</td>
<td><strong>Magnets:</strong> 6</td>
<td><strong>Magnets:</strong> 10</td>
</tr>
<tr>
<td>Supports for DL1</td>
<td>Supports for DL2</td>
<td>Supports for DL2</td>
<td>Supports for DL1</td>
</tr>
<tr>
<td>Quadrupoles: QF1</td>
<td>Quadrupoles: QD5</td>
<td>Quadrupoles: QD5</td>
<td>Quadrupoles: QF1</td>
</tr>
<tr>
<td>Quadrupoles: QD2, QF4, QF4</td>
<td>Quadrupoles: QF6</td>
<td>Quadrupoles: QF6</td>
<td>Quadrupoles: QD2, QF4, QF4</td>
</tr>
<tr>
<td>Quadrupoles: QD3</td>
<td>Quadrupoles: QF8</td>
<td>Quadrupoles: QF8</td>
<td>Quadrupoles: QD3</td>
</tr>
<tr>
<td>Sextupoles: SH1</td>
<td>Sextupoles: SD1</td>
<td>Sextupoles: SD1</td>
<td>Sextupoles: SH1</td>
</tr>
<tr>
<td>Sextupoles: SF2</td>
<td>Sextupoles: SD1</td>
<td>Sextupoles: SD1</td>
<td>Sextupoles: SF2</td>
</tr>
<tr>
<td>Octupoles: OF1</td>
<td></td>
<td></td>
<td>Octupoles: OF1</td>
</tr>
<tr>
<td><strong>Vacuum chambers:</strong> 4</td>
<td><strong>Vacuum chambers:</strong> 2</td>
<td><strong>Vacuum chambers:</strong> 2</td>
<td><strong>Vacuum chambers:</strong> 5</td>
</tr>
<tr>
<td>Chamber 1 &amp; BPM 1</td>
<td>Chamber 5</td>
<td>Chamber 8 &amp; BPM 7</td>
<td>Chamber 11 &amp; BPM 8, BPM 9</td>
</tr>
<tr>
<td>Chamber 2</td>
<td>Chamber 6 &amp; BPM 4</td>
<td>Chamber 9</td>
<td>Chamber 12</td>
</tr>
<tr>
<td>Chamber 3 &amp; BPM 2, BPM 3</td>
<td></td>
<td></td>
<td>Chamber 13</td>
</tr>
<tr>
<td>Extension for Ch 1</td>
<td></td>
<td></td>
<td>Chamber 14 &amp; BPM 10</td>
</tr>
<tr>
<td>Bellow</td>
<td></td>
<td></td>
<td>Extension for Ch 14</td>
</tr>
<tr>
<td><strong>Vacuum instrumentation:</strong> 16</td>
<td><strong>Vacuum instrumentation:</strong> 9</td>
<td><strong>Vacuum instrumentation:</strong> 10</td>
<td><strong>Vacuum instrumentation:</strong> 16</td>
</tr>
<tr>
<td>Valve CF63</td>
<td>Valve CF63 (2X)</td>
<td>Valve CF63</td>
<td>Valve CF63 (2X)</td>
</tr>
<tr>
<td>SIP 75 l/s, (3x)</td>
<td>SIP 55 l/s, SIP 150 l/s</td>
<td>SIP 150 l/s</td>
<td>SIP 55 l/s</td>
</tr>
<tr>
<td>RGA (2x)</td>
<td>NEG 200 l/s (3x)</td>
<td>NEG 200 l/s (3x)</td>
<td>SIP 75 l/s (2x)</td>
</tr>
<tr>
<td>Pirani</td>
<td>Absorber 5-1-1</td>
<td>Absorber 8-1-2</td>
<td>Absorber 13-1-1</td>
</tr>
<tr>
<td>NEG 200 l/s (4x)</td>
<td>Absorber 6-1-1</td>
<td>Absorber 8-2-2</td>
<td>Absorber 14-1-1</td>
</tr>
<tr>
<td>Absorber 2-1-1</td>
<td></td>
<td>Absorber 9-1-2 (Crotch 02)</td>
<td></td>
</tr>
<tr>
<td>Absorber 3-1-1 (Crotch 01)</td>
<td></td>
<td>Absorber 9-2-2</td>
<td></td>
</tr>
<tr>
<td>Absorber 4-1-1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Overall there are 96 components which have to be installed on the 4 girders in one cell.
1 cell of the storage ring ESRF-EBS

Overall we have 32 cells with 4 girders per ring

The task of the girder assembly is to bring together all the different components of one girder to one unit.

The goal is to assembly 1 cell per week
Everything should be finished within one year
Mock-up: an ARC fully assembled

The “Mock-up” was proposed by the MAC. With the Mock-up we learnt a lot
## Magnet Assembly

<table>
<thead>
<tr>
<th>Step</th>
<th>Hours</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movement of 4 girders from B2 to B1 (unloading area)</td>
<td>2</td>
<td>0.25</td>
</tr>
<tr>
<td>Movement of 4 girders from unloading area to assembly line</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Installation and fixation of 8 gauges on the girders</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Movement and fixation of 6 magnets supports on the girders</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Movement of 4 DL-magnets with supports on the girders</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Movement of 1 magnet on the girder (≈ 6 min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Movement of 28 magnets on the girders</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Rough alignment of the 32 magnets (+/- 0.5 mm, with gauges)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Removal of gauges</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Opening of 1 magnet (≈ 10 minutes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening of 28 magnets</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>Closing on magnet (≈ 10 minutes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closing 28 magnets</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>Moving 4 girders from the assembly line to outside B1</td>
<td>2</td>
<td>0.25</td>
</tr>
</tbody>
</table>

**SUM** = 22.5

Number of Hours = 22.5

Number of Days = 2.75
Vacuum Assembling (girder 1)

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation for vacuum installation</td>
<td>3</td>
</tr>
<tr>
<td>Installation of supports and pot welding heaters</td>
<td>5</td>
</tr>
<tr>
<td>Installation of vacuum chambers and bellow</td>
<td>3</td>
</tr>
<tr>
<td>Installation of pumping port, diagnostics, absorbers and prepumping</td>
<td>5.5</td>
</tr>
<tr>
<td>Pumping and preparation for bake out</td>
<td>15</td>
</tr>
<tr>
<td>Baking over the weekend</td>
<td></td>
</tr>
<tr>
<td>Stop baking, leak detection, pressure plots, filling with dry N2</td>
<td>4</td>
</tr>
<tr>
<td>Remove pre-pumping, connect BPM cable, move into the magnets (1h)</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Sum (without bake out) = 40

The movement of the vacuum components for the next assembling can be done.
**Tuesday**
- Preparation meeting (all areas) 30 min
- Clean area from previous installation (1h)
- Control of stocks (screws, gaskets, aluminium, etc) (1h)
- Moving palettes with components to be assembled from storage area (1h)
- Moving vacuum chambers to the storage area
- Tables need to be loaded at chambers storage area and moved to B1 (MTBD.016/MTBD.0.17 could be a suitable location)
- Chamber storage area requires crane to remove chambers from supplier box to transport table.
- Spot weld baking elements (Due to delivery, only half of the chambers are available before assembly) (1 day)

**Wednesday**
- Install girder support (1h)
- Install sector valves (1h)
- Install Chambers (hexagonal head screws proposed for better access) (2h)
- Fasten chamber flanges (1h)
- Install components (pumps, gauges, absorbers, etc) (3h)
- Every assembled item needs to be identified on a log book (at least paper)
- Proposal: PSD to be installed only in then tunnel (ok from Berkvens)
- Pneumatic valves to be forced into open position
- Pumps and instrumentation cabled to each area control units
- Start pump down (2 tms, 1 acp)
- Leak test. Test gauges and pumps
- Repairs as needed

**Thursday**
- Install Kapton / Aluminium foils
- Install Aluminium foils (IP, pumping ports, dipole chambers)
- Install baking collars and heating jackets
- Install thermocouples (metal sheated 1.5 m long) 2 per chamber (Ch 6, 7 & 8 may need up to 6)
- All heating elements should be long enough (roughly 3 m) to be cabled to heating bay

**Friday**
- Start bakeout no later than Friday mid day
- Survey bake out for issues
- Weekend bake out (PLC pressure temperature record, possible remote by wifi
- If damage is found after this point there will be no time for repairs. Parts to be identified and repaired after installation in the SR tunnel
- IP and NEG pump under bake out. NEGs baked at 200 C but not activated

**Monday**
- Stop baking Monday morning
- Validation based on pressure plots. RGA's not available on all girders
- Disconnect all cabling
- *It may be required to stop bake out previous evening.*
- Store under N2 (0.5h)
- RE-install stiffeners on bellows. Some baking materials may need to be removed (0.5H)
- Install BPM's cable (2h, installation and cable testing, diag. group)
- Dismount all TNPs & protect pre-pumping valves with cover (0.5h)
- Secure all cabling (bakeout related items) (1h)
- Move assembled table to magnets loading area (1h) (by handling group)
- Install chambers on girders (by handling group +VG)
### STEPS FOR THE ASSEMBLING

#### Sequence for the assembling

1. Movement of girders and components, alignment of girders
2. Installation and opening of girders
3. Alignment of BPM-supports, installation of vacuum chambers
4. Closing and alignment of magnets, moving out of assembled girders

<table>
<thead>
<tr>
<th></th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
<th>Week 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Row A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.......</td>
</tr>
<tr>
<td>Row B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.......</td>
</tr>
<tr>
<td>Row C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.......</td>
</tr>
</tbody>
</table>

The goal is to finish 1 cell with 4 girders in one week. Perhaps we have to work in two shifts.

Parallel to point 1.) and 2.) the assembling of the vacuum chambers have to be done.
ALIGNMENT: ARRANGEMENT OF LASER TRACKERS
For opening the magnets space is required for the storage of the upper parts. As shown in this figure the upper, available parts will be at each end of the girder. The arrows in the above figure show the storage location of the different magnets. A space of roughly 1 m is needed at each end of the girders for the storage of the upper parts of the magnets. The position of the 2 laser trackers is also shown.
AREAS FOR ASSEMBLING

Layout of the assembling building B1

Vacuum preparation area

Emergency corridor

Crane area for the assembling line A

Crane area for the assembling line B

Crane area for the assembling line C

Unloading area mag. (24 m²)
AREAS FOR ASSEMBLING (B1)


Movement of components during assembling.

4. Movement of 4 girders "out".
5. Movement of 4 girders "in".

Vacuum preparation area.

Moving of magnets on the girders.
Available in ESRF 2 is a length of 622 m. For the magnets we need a space of 300 m. This means roughly 300 m are available for the storage of other components. The supports for the vacuum chambers need a length of roughly 130 m, they should also stored in ESRF 2. The vacuum components like pumps, RGA’s, etc need a length of 58 m, they could also be stored in ESRF 2.

In order to see the overall required space, such a plot has to be made for all components.
AREAS FOR STORAGE (B2)

Overall we have a shelf length of:
\[3 \times [14 \times (4 \times 2.78 + 2 \times 1.85)] = 622.4 \text{ m.}
\]
The depth of the shelves are 1.1 m.
New Buildings for Assembly

ESRF 2B  ESRF 2A  ESRF 1

front view

side view
AREAS FOR ASSEMBLING AND STORAGE

<table>
<thead>
<tr>
<th>ESRF Building</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESRF 01</td>
<td>1250</td>
</tr>
<tr>
<td>ESRF 02</td>
<td>1000</td>
</tr>
<tr>
<td>ESRF 10</td>
<td>200</td>
</tr>
<tr>
<td>ESRF 11</td>
<td>500</td>
</tr>
<tr>
<td>ESRF 12</td>
<td>300</td>
</tr>
<tr>
<td>ESRF 13</td>
<td>700</td>
</tr>
<tr>
<td>ESRF 14</td>
<td>400</td>
</tr>
<tr>
<td>ESRF 15</td>
<td>800</td>
</tr>
<tr>
<td>RF-Test Stand</td>
<td>360</td>
</tr>
<tr>
<td>Outside ESRF</td>
<td>1000</td>
</tr>
<tr>
<td>TOTAL</td>
<td>8340</td>
</tr>
</tbody>
</table>
The movement of the assembled vacuum system from assembly table to the assembly line will be done with a “strong back.”

All the strong backs are designed and ordered. The delivery is in 2 to 3 month.
THE MAGNETS ON GIRDER 1 TO 4

Sequence of assembly

Girder 1
QF1, QD2, DL1, QD3, SD1, QF4, SF2, QF4, OF1, SD1, QD5, DL2, QF6, DQ1, QF8

Girder 2

Girder 3
QF8, DQ1, QF6, QD6, SD1, QF1, QF4, SF2, SD1, QD3, DL2

Girder 4
QD2, QF1, DL1

Sequence of assembly

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Positioning of Magnets on the Girders

Positioning gauge

Positioning gauge

Mechanical stop on theoretical position
Pre alignment should be better than 0.5mm in
Cross-Section of the Assembly-building ESRF 1

- 3 assembly lines
- Vacuum assembly area
- 3 * 1.5 t crane
Space for the Assembly in ESRF 1

Area covered by the crane = 3 m
Area required for the assembling with a width of 4.0 m

3 * 1.5 t crane

Position of laser tracker

0.9 m wide corridor
UNLOADING AREAS (7.8*12.5=97.5M^2) IN ESRF 1
This space should be available in ESRF 2. The idea of the movement of the vacuum chambers is the following: 1.) The chambers will be delivered in boxes to the labs of the vacuum group for the FAT and testing. 2.) The boxes with the chambers will be stored in the labs of the vacuum group. 3.) For the assembly the boxes with chambers will be moved to the building ESRF 2. 4.) For the assembly the chambers will be moved on special tables from ESRF2 to ESRF 1, this will happen each week.
STORAGE OF VACUUM BOXES IN ESRF 2

This is the required space for the storage of the boxes with the chambers.

Overall we have a shelf length of:

\[ 3 \times [4 \times (4 \times 2.78 + 2 \times 1.85)] = 622.4 \text{ m}. \]

The depth of the shelves are 1.1 m.
For the movement of the vacuum chambers from ESRF 2 to ESRF 1 we need 4 moveable tables with dimensions of 2.8m*0.8 to 1.3m.
The vacuum components should be stored in ESRF 2 and moved to ERSF1 on moveable tables. The dimensions of the tables should be 0.8*1.2=0.96 m^2
Required space in ESRF 1 for putting the moveable tables with the chambers and components
HANDLING AND ASSEMBLY

- **Companies**
- **Delivery of components**
- **Acceptance of components**

**Preparation of components for assembly**

**Movement of components to the storage place**

**Preparation for movement to B1**

**Movement to airlock entrance of ESRF1**

**Movement to unloading area of ESRF 1**

**Assembly in ESRF 1**

**Movement to airlock entrance of ESRF1**

**Movement to outside of ESRF 1**

**Movement to final storage place**

**Assembly**

**Handling**

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# Movements of Components During Assembly

## Task Movement from A to B

<table>
<thead>
<tr>
<th>Task</th>
<th>Movement</th>
<th>from</th>
<th>to</th>
<th>day</th>
<th>time (h)</th>
<th>Handling tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 / A</td>
<td>4 girders</td>
<td>Truck</td>
<td>Outside B1/B2</td>
<td>Mo. - Th.</td>
<td>2</td>
<td>Forklift</td>
</tr>
<tr>
<td>2 / B</td>
<td>4 girders</td>
<td>Outside B1/B2</td>
<td>B2</td>
<td>Mo. - Th.</td>
<td>2</td>
<td>Transport Module</td>
</tr>
<tr>
<td>3 / C</td>
<td>4 girders</td>
<td>B2</td>
<td>B1</td>
<td>Friday afternoon</td>
<td>2</td>
<td>Transport Module</td>
</tr>
<tr>
<td>4 / D</td>
<td>4 assembled girders</td>
<td>B1</td>
<td>Outside B1/B2</td>
<td>Friday morning</td>
<td>2</td>
<td>Transport Module</td>
</tr>
<tr>
<td>5 / E</td>
<td>4 assembled girders</td>
<td>outside B1</td>
<td>Chartreuse</td>
<td>Friday afternoon</td>
<td>4</td>
<td>Trolley/ transp. mod.</td>
</tr>
<tr>
<td>6 / F</td>
<td>4 vacuum systems</td>
<td>B1-Vacuum area</td>
<td>B1-Unloading area</td>
<td>Monday morning</td>
<td>2</td>
<td>Moveable table</td>
</tr>
<tr>
<td>7 / G</td>
<td>4 vacuum systems</td>
<td>B1-Unloading area</td>
<td>B1-Assembly line</td>
<td>Tuesday morning</td>
<td>2</td>
<td>Strongback</td>
</tr>
<tr>
<td>8 / H</td>
<td>4 DL - bendings + supports</td>
<td>Chartreuse</td>
<td>B1-Unloading area</td>
<td>Mo. &amp; We.-Th.</td>
<td>4</td>
<td>Special trolley with truck</td>
</tr>
<tr>
<td>9 / I</td>
<td>6 magnets supports (QF6,QF8,DQ1)</td>
<td>Chartreuse</td>
<td>B1-Unloading area</td>
<td>Mo. &amp; We.-Th.</td>
<td>2</td>
<td>Special trolley with truck</td>
</tr>
<tr>
<td>10 / J</td>
<td>17 pallets with magnet boxes (full)</td>
<td>B2</td>
<td>B1-Unloading area</td>
<td>Wednesday</td>
<td>4</td>
<td>Forklift</td>
</tr>
<tr>
<td>11 / K</td>
<td>28 magnets</td>
<td>B1-Unloading area</td>
<td>B1-Assembly line</td>
<td>Monday</td>
<td>5</td>
<td>Crane</td>
</tr>
<tr>
<td>12 / L</td>
<td>17 pallets with empty boxes</td>
<td>B1-Unloading area</td>
<td>Disposal area</td>
<td>Mo. &amp; We.-Th.</td>
<td>5</td>
<td>Forklift</td>
</tr>
<tr>
<td>13 / M</td>
<td>6 long vacuum chambers</td>
<td>Vacuum labs</td>
<td>B1</td>
<td>Mo. &amp; We.-Th.</td>
<td>2</td>
<td>Special trolley</td>
</tr>
<tr>
<td>14 / N</td>
<td>5 short vacuum chambers</td>
<td>B2</td>
<td>B1</td>
<td>Mo. &amp; We.-Th.</td>
<td>2</td>
<td>Special trolley</td>
</tr>
<tr>
<td>15 / O</td>
<td>4 tables vacuum components</td>
<td>B2</td>
<td>B1</td>
<td>Mo. &amp; We.-Th.</td>
<td>2</td>
<td>Special trolley</td>
</tr>
<tr>
<td>16 / P</td>
<td>1 table front end chambers</td>
<td>B2</td>
<td>B1</td>
<td>Mo. &amp; We.-Th.</td>
<td>1</td>
<td>Special trolley</td>
</tr>
<tr>
<td>17 / Q</td>
<td>4 pallet with supports for vac.-syst.</td>
<td>B2</td>
<td>B1</td>
<td>Mo. &amp; We.-Th.</td>
<td>1</td>
<td>Special trolley</td>
</tr>
<tr>
<td>18 / R</td>
<td>1 pallet with absorbers</td>
<td>B2</td>
<td>B1</td>
<td>Mo. &amp; We.-Th.</td>
<td>1</td>
<td>Special trolley</td>
</tr>
</tbody>
</table>

The preparation and handling tools have to be discussed.
Overall there are 18 different movements per week
<table>
<thead>
<tr>
<th>Task</th>
<th>Friday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2/B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6/F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/G</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/J</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12/L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13/M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14/N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15/O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16/P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17/Q</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Friday is blocked with the movement of girders.
Unloading Area

Area covered by the crane (3m)
- 2*QF1
- 2*QF2
- 2*QD3
- 2*QD5
- 2*QF4
- 1*QF4
- 1*QF4E
- 2*SD1
- 2*SD1
- 2*SF2
- QF6
- QF6
- QF8
- QF8
- 1*DQ1
- 1*DQ1
- 2*DQ1 supp.
- 2*QF6 supp.
- 2*QF8 supp.
- 8*Corr
- 4*Octup
- Path for transportation (2m width)
MOVING THE MAGNET PALLETS IN AND OUT

1st week of assembly
- Assembly line C
- Assembly line B
- Assembly line A

Stored magnets, moving to the assembly line at Monday
Moving the pallets with magnets in at Tuesday to Friday in week 0
Moving out the empty boxes at Monday / Tuesday

2nd week of assembly
- Assembly line C
- Assembly line B
- Assembly line A

Stored magnets, to the assembling line at Monday week 2
Moving the pallets with magnets in at Tuesday to Friday of week 1
Moving out the empty boxes at Monday / Tuesday of week 2

3rd week of assembly
- Assembly line C
- Assembly line B
- Assembly line A

Stored magnets, moving in at Monday of week 3
Moving out the empty boxes at Monday / Tuesday of week 3
Moving the pallets with magnets in at Tuesday to Friday of week 2

ESRF-EBS Assembling: Presentation at DESY, 05/08/2020
MOVEMENT OF COMPONENTS DURING ASSEMBLY

All this movements will happen at Friday afternoon.
All this movements will happen at Friday afternoon. 2 transport modules will be used. Moving the 4 girders from ESRF 2 to ESRF 1 takes roughly 2 hours or less. 2 persons are required for the movement.

The same process will be done for moving the assembled girders out of ESRF 1
TASKS FOR VACUUM ASSEMBLY AND ALIGNMENT

1st: Movement of the strongback under the crane and lifting it up

2nd: Movement of the moveable table under the lifted strongback and hook it up

3rd: Moving the strongback to the magnets in the assembly line

1st: Strongback

3rd: Strongback

2nd: Strongback
Strongback and DL-magnets can be parked during the movement in the airlock entrance area too.
During the week there are the following “in and out” movements

1.) : Friday morning, moving out the 4 assembled girders
2.) : Friday afternoon, moving in the 4 girders
3.) : Wednesday or Thursday, moving in the 4 DL-magnets
4.) : Monday evening: Movement of the 4 vacuum systems
5.) : Tuesday morning: Movement of vacuum chambers and components
### Magnet Assembly

<table>
<thead>
<tr>
<th>Step Description</th>
<th>Hours</th>
<th>Hours</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.) Movement of 4 girders from B2 to B1 (unloading area)</td>
<td>2</td>
<td>2</td>
<td>0.25</td>
</tr>
<tr>
<td>2.) Movement of 4 girders from unloading area to assembly line</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3.) Installation and fixation of 8 gauges on the girders</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.) Movement and fixation of 6 magnets supports on the girders</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.) Movement of 4 DL-magnets with supports on the girders</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6a.) Movement of 1 magnet on the girder (≈ 6 min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6b.) Movement of 28 magnets on the girders</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.) Rough alignment of the 32 magnets (+/- 0.5 mm, with gauges)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.) Removal of gauges</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9a.) Opening of 1 magnet (≈ 10 minutes)</td>
<td>5</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>9b.) Opening of 28 magnets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10a.) Closing on magnet (≈ 10 minutes)</td>
<td>5</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>10b.) Closing 28 magnets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.) Moving 4 girders from the assembly line to outside B1</td>
<td>2</td>
<td>2</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>SUM</strong></td>
<td>22.5</td>
<td>22.5</td>
<td>2.75</td>
</tr>
</tbody>
</table>
# Tasks for Vacuum Assembly and Alignment

<table>
<thead>
<tr>
<th>Task</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing for vacuum installation</td>
<td>3</td>
</tr>
<tr>
<td>Installation of supports and pot welding heaters</td>
<td>5</td>
</tr>
<tr>
<td>Installation of vacuum chambers and bellows</td>
<td>3</td>
</tr>
<tr>
<td>Installation of pumping port, diagnostics, absorbers and prepumping</td>
<td>5.5</td>
</tr>
<tr>
<td>Pumping and preparation for bake out</td>
<td>15</td>
</tr>
<tr>
<td>Baking over the weekend</td>
<td></td>
</tr>
<tr>
<td>Stop baking, leak detection, pressure plots, filling with dry N2</td>
<td>4</td>
</tr>
<tr>
<td>Remove pre-pumping, connect BPM cable, move into the magnets (1h)</td>
<td>4.5</td>
</tr>
<tr>
<td>Sum (without bake out)</td>
<td>40</td>
</tr>
</tbody>
</table>

## Alignment

<table>
<thead>
<tr>
<th>Task</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment of the girderes on the ground plates</td>
<td>4</td>
</tr>
<tr>
<td>1 hour per girder</td>
<td></td>
</tr>
<tr>
<td>Alignment of the magnets on the girder</td>
<td>24</td>
</tr>
<tr>
<td>6 hours per girder</td>
<td></td>
</tr>
<tr>
<td>Alignment of the vacuum supports on the girder</td>
<td>16</td>
</tr>
<tr>
<td>4 hours per girder</td>
<td></td>
</tr>
<tr>
<td>Verification of the alignment of the magnets</td>
<td>8</td>
</tr>
<tr>
<td>2 hours per girder</td>
<td></td>
</tr>
<tr>
<td>Sum =</td>
<td>52</td>
</tr>
<tr>
<td>Group</td>
<td>Girder assembling</td>
</tr>
<tr>
<td>-------</td>
<td>------------------</td>
</tr>
<tr>
<td>1.</td>
<td>Movement of 4 girders from B2 to B1-unloading area</td>
</tr>
<tr>
<td>2.</td>
<td>Movement of 4 girders from B1-unloading area to assembly line</td>
</tr>
<tr>
<td>3.</td>
<td>Alignment of the girders on the groundplate</td>
</tr>
<tr>
<td>4.</td>
<td>Fixation of 8 gauges / templates on the girders</td>
</tr>
<tr>
<td>5.</td>
<td>Movement of 6 magn. Supp. (QF6, QF8 &amp; DQ1) to the girders + fixation</td>
</tr>
<tr>
<td>6.</td>
<td>Movement of 4 DL-magnets plus supports to the girders + fixation</td>
</tr>
<tr>
<td>7.a</td>
<td>Movement of 1 magnet on the girder (≈10 minutes)</td>
</tr>
<tr>
<td>7.b</td>
<td>Movement of 26 magnets on the girders</td>
</tr>
<tr>
<td>8.</td>
<td>Rough alignment of 32 magnets (+/-0.5 mm, with templates)</td>
</tr>
<tr>
<td>9.</td>
<td>Removal of gauges / templates from the girders</td>
</tr>
<tr>
<td>10.</td>
<td>Alignment of magnets on the girders (6h per girder)</td>
</tr>
<tr>
<td>11.a</td>
<td>Opening the of the magnets (≈ 15 minutes)</td>
</tr>
<tr>
<td>11.b</td>
<td>Opening of 26 magnets</td>
</tr>
<tr>
<td>12.</td>
<td>Moving the vac. Syst. into the magents &amp; final electr. conn.</td>
</tr>
<tr>
<td>13.</td>
<td>Alignment of the vacuum chamber string (4h per girder)</td>
</tr>
<tr>
<td>14.a</td>
<td>Closing 1 magnet (≈ 10 minutes)</td>
</tr>
<tr>
<td>14.b</td>
<td>Closing 26 magnets</td>
</tr>
<tr>
<td>15.</td>
<td>Mounting of coolingpipes for the absorbers</td>
</tr>
<tr>
<td>16.</td>
<td>Verification of alignment</td>
</tr>
<tr>
<td>17.</td>
<td>Movement of 4 assembled girders out ESRF</td>
</tr>
</tbody>
</table>

Sum = 98.5 74.5 14
Girder Assembling Tasks of the mechanic team

Days: Su Sa Mo Tu We Th Fr
1.) Mo.: Afternoon
2.) Tu.: Full day
3.) We.: Morning
4.)
5.)
6.)
7.)
8.)
9.)
10.) Su Sa Mo Tu We Th Fr

Tasks of the mechanic team

1st week
From Wednesday afternoon to Friday, the mechanic team can participate in the handling

Days: Su Sa Mo Tu We Th Fr
10.) Mo.: Afternoon
11.) Tu.: Full day
12.) Fr.: Morning
13.)
14.)

2nd week

Days: Su Sa Mo Tu We Th Fr
14.)
15.)
16.)
17.)

3rd week

Mo.: Full day
Tu.: Morning
Fr.: Morning

A1

A2

A3
### Time schedule for the girder assembly

<table>
<thead>
<tr>
<th></th>
<th>Week 0</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
<th>Week 8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Row A</strong></td>
<td>A1</td>
<td>A2</td>
<td>A3</td>
<td>A1</td>
<td>A2</td>
<td>A3</td>
<td>A1</td>
<td>A2</td>
<td></td>
</tr>
<tr>
<td><strong>Row B</strong></td>
<td></td>
<td></td>
<td>A1</td>
<td>A2</td>
<td>A3</td>
<td>A1</td>
<td>A2</td>
<td>A3</td>
<td>A1</td>
</tr>
<tr>
<td><strong>Row C</strong></td>
<td></td>
<td></td>
<td></td>
<td>A1</td>
<td>A2</td>
<td>A3</td>
<td>A1</td>
<td>A2</td>
<td>A3</td>
</tr>
</tbody>
</table>

The goal is to finish 1 cell with 4 girders in 1 week:

- A1 task 1 to 9
- A2 task 9 to 12
- A3 task 12 to 14
ASSEMBLING OF THE 4 GIRDERS
Time schedule for Assembly

8 weeks are free for repairing, etc. Which means a contingency of 25 %
Organization Chart for Assembly

Storage Ring
Assembly Team Management Organisation Chart
October 2017 to December 2018
2016-07-27

Organization Chart:
- Assembly Leader
- Mechanical Assembly on Girder
- Fluids Connections
- Alignment
- Handling

- Vacuum Assembly
  - Vacuum Leader
    - Zone Girder 1 Vacuum 2
    - Zone Girder 3 Vacuum 2
    - Zone Girder 4 Vacuum 2

- Mechanical Assembly on Girder
  - Girders 1-4 Line A Mech 2
  - OR
    - Girders 1-4 Line B Mech 2

- Lead Mechanical Technician
- Alignment Supervisor
- Handling Leader
  - Handling Leader
    - Storeman / Forklift Driver / Crane Driver 2

- Team 1 Survey 2 Mech 1
- Team 2 Survey 2 Mech 1
- Team 3 Survey 2 Mech 1

4 Leader 8 Technicians
1 Leader 6 Technicians
6 persons
4 Technicians
**Human Resources for ESRF-EBS**

For the different areas the following EXTRA human resources are required:

**Team in ESRF 1 for the assembling of the girders (2 Engineer and 16 technicians):**

<table>
<thead>
<tr>
<th>Team</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanic team</td>
<td>1 leader (1 Engineer)</td>
</tr>
<tr>
<td>Vacuum team</td>
<td>1 leader (1 Engineer)</td>
</tr>
<tr>
<td>Mechanic team</td>
<td>2 teams of 2 persons plus crane driver (6 people)</td>
</tr>
<tr>
<td>Vacuum team</td>
<td>4 teams with 2 people and 1 leader (12 people)</td>
</tr>
<tr>
<td>Alignment team</td>
<td>3 teams with 2 persons each</td>
</tr>
</tbody>
</table>

The vacuum team will be supervised by personal from the vacuum group.

**Handling teams for movement of components to ESRF 1 (4 technicians)**

- **Team 1:** 1 forklift driver plus 1 person for the movement of magnets and girders.
- **Team 2:** 1 forklift driver plus 1 person for the movement of vacuum chambers and components.
Human Resources for ESRF-EBS

Mechanic team:
  Mechanical technicians with handling license for the crane

Vacuum team:
  Mechanical technicians with basic knowledge in vacuum assembly.
  A training in the vacuum group will be done.

Alignment team:
  Trained/experienced in the survey-field technicians are needed.
  We also foresee additional period of training in the ALGE, in order to
  become conversant with the ALGE techniques, software and
  instrumentation.

Handling team:
  Technicians
Human Resources from BINP for Assembly

TECHNICAL SPECIFICATIONS

RFQ 2485
Girder Assembly for the ESRF-EBS Project

The duration of assembly is planned from beginning of October 2017 to the end of October 2018 (13 month). These dates depend upon the delivery and availability of the components. It could be that these dates have to be shifted by some months because of delays.

The numbers given for the different teams are preliminary ones, the exact numbers will be given after having the experiences by building the mock up in spring 2017.

Mechanics team (6 technicians plus 1 team leader)
Team leader: mechanical engineer with experience in assembly procedures.
Mechanical technicians with handling license for the cranes and appropriate electrical certification (6 technicians). All the technicians have to be up to date with safety trainings (mechanical, handling, electrical, etc.)

Vacuum team (8 technicians plus 1 team leader):
Team leader: Mechanical engineer with experience in vacuum and vacuum assembly procedures.
Mechanical technicians with basic knowledge in vacuum assembly.
All the technicians have to be up to date with safety trainings (mechanical, handling, electrical, etc.)
Dismantling and Preparation of the SRTU

- Preparation (system shutdown, drainage, etc) [All groups]
- Disconnection services [Disconnect Vacuum, piping, cables. Recover items]
- Open whole cell Roof
- Dismantling Removal of the girders, support feet, IDs, part of front ends *
- Close whole cell roof *
- Remove old services (including some cable recovery) *
- Civil work (Drilling concrete, removing pillars, painting)
- Floor plates setup alignment, fixing and grouting
- Opening Cell roofs over IDs and installation of access stairs
- Timing yet to decide for: Installing emergency telephones, temporary ventilation, power for plugs
- * Storage of all items coming out requires B1/B2 and Technical Gallery to have the required space available
Dismantling

Duration: 33H/cell. 3 cell in parallel
3 teams of 4 people:
Disconnect power cables
Remove
- Low current cables
- Electrical boxes
- Cable trays
- Pipes

Special cells: 32,1,2
Dismantling – 29th January 2018

[Images of workers dismantling equipment in a facility]
Radiation Measurements
SR INSTALLATION – ENTRY POINTS

Layout of the ESRF-Storage -Ring

Entry point Cell 8

Entry point Cell 14

Entry point Cell 24
✓ 1 modules outside the tunnel to carry girder to lifting area
✓ 2 modules inside the tunnel for final installation at ± 1 cm
✓ Gantry will be moved from ID08 to ID14 entrance

<table>
<thead>
<tr>
<th>Activity type</th>
<th>In charge</th>
<th>ESRF staff role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handling</td>
<td>Subcontractor</td>
<td>Supervisor</td>
</tr>
</tbody>
</table>
Installation of Girders
Installation of Girders
Installation of Girders
RF cavities installation:

Cell 05: 5 cavities 08-04-2019
Cell 07: 5 cavities 18-04-2019
Cell 25: 3 cavities 21-05-2019
The last installed Element

- All ceramic chambers have been delivered by Friatec to Polyteknik
- Coating process tuned to obtain required resistance and good connection with RF fingers
- Installation of the four kickers done
MANY THANKS FOR YOUR ATTENTION