Forecast of European procurements for ITER in the long term

Henrik Bindslev
Hot Cell and Radwaste buildings

- Scope and specification being refined by IO by March 2015 (?)

- F4E will place the contract on the basis of **frozen** technical and nuclear safety specifications

- Hot cell facility and Radwaste buildings required only after the 1st Plasma before the start of the nuclear phase
Building procurement beyond 2016

Hot Cell and Radwaste buildings key figures
floors surface

• Hot cell : 10,900 m²
• Radwaste : 1,600 m²
• Personal Access : 150 m²

❖ Call for tender for Personal Access in 2016 (TB12)
❖ Call for tender for Hot cell and Radwaste expected after 2017
Neutral Beam and Current Drive procurements beyond 2016

**EC RF SOURCES (GYROTRONS)**

- Development of 1 MW gyrotron on-going till end of 2016
  => If successful, then the following procurement will be launched by F4E:

<table>
<thead>
<tr>
<th>Component</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1 Series production of Gyrotron tubes: (expected procedure: negotiated)</td>
<td>Q2 2016</td>
<td>Q4 2017</td>
<td></td>
</tr>
<tr>
<td>2 Series production of gyrotron superconducting magnets (cryogen-free or zero-He consumption)</td>
<td>Q3 2017</td>
<td>Q2 2018</td>
<td></td>
</tr>
<tr>
<td>3 Auxiliaries for the RF Sources (cooling manifold, supporting structures, etc.)</td>
<td>2017</td>
<td>2018</td>
<td></td>
</tr>
</tbody>
</table>
The ITER Heating Neutral Beam (HNB) System

HNB injector full scope of procurement shared with Japan

EU to procure:
- 2 NB Injectors
- Power Supplies

European procurement for ITER, H BINDSLEV, SOFT2014-Industry day, 30 Sept 2014
## List of main NB contracts for ITER to be launched by F4E

<table>
<thead>
<tr>
<th>Component</th>
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<tbody>
<tr>
<td>Beam Line Components (Neutralizer, Calorimeter, RID)</td>
<td>Q2 2019</td>
<td>Q1 2020</td>
<td></td>
</tr>
<tr>
<td>4 lots: Vessel (Beam Line + Beam Source), Drift Duct, Exit Scraper, Fast Shutter - All except Exit Scraper are SIC-1 (RCC-MR code)</td>
<td>Q2 2017</td>
<td>Q2 2018</td>
<td></td>
</tr>
<tr>
<td>Absolute Valve - SIC-1 (RCC-MR code)</td>
<td>Q4 2017</td>
<td>Q4 2018</td>
<td></td>
</tr>
<tr>
<td>ACC-Coils</td>
<td>Q2 2017</td>
<td>Q2 2018</td>
<td></td>
</tr>
<tr>
<td>Passive Magnetic Shielding</td>
<td>Q2 2017</td>
<td>Q2 2018</td>
<td></td>
</tr>
<tr>
<td>Beam Sources</td>
<td>Q4 2018</td>
<td>Q4 2019</td>
<td></td>
</tr>
<tr>
<td>Assembly of HNB1 &amp; HNB2</td>
<td>Q1 2018</td>
<td>Q2 2022</td>
<td></td>
</tr>
</tbody>
</table>
Main components and sub-systems:

- Port plug structure (single and double walled)
- Removal transmission line
- Vacuum tight ceramic windows
- Shimming mechanism to move internal components
- Faraday Screen (plasma facing)
- Actively cooled internal shields
- RF contacts
- Radiating elements
- Tooling for partly hand-on maintenance

Sensors and instrumentation (in and ex vessel)

**Function** → Input 20 MW power to the plasma.

**Concept** → port-plug base system for final power transmission, radiating elements and plasma facing components to protect from high heat flux.
Indicative long term schedule

Design, R&D and prototyping activities:
The design will be approved through two FDRs (RF vacuum windows and antenna), both in 2018.

Procurement of components and integration:
The antenna procurement will be staged:
The first CfT is planned for 2018, the last for 2023.

The antenna will be delivered in 2026.
Electron Cyclotron in-vessel & ex-vessel : Component description

**In-vessel (Launcher)**
- Launcher body
- In-vessel waveguides
- Steering mechanisms
- Mirrors
- BSM and First Wall
- Neutron shields
- Services (coolant, gas)
- Diagnostics & I&C

**Ex-vessel (First confinement barrier)**
- Ex-vessel waveguides
- Diamond windows
- Isolation valves
- Back-end assembly
- PHTS in-vessel cooling connections
- CCWS component cooling services
Indicative long term schedule

Design, R&D and prototyping activities:
The design will be approved through several FDRs, starting with the first in 2016 (diamond window) and the last one in 2018 (integrated launcher).

Procurement of components and integration:
Procurement will be staggered, with the first CfT (for diamond window) in 2017 and the last CfT (integration of the antenna) in 2019.

The first launcher will be delivered in 2023, the last (n4) in 2024.
Blanket procurements beyond 2016

• **Blanket/First Wall (FW):**
  Contract for the supply of the pre-series and series of the Normal Heat Flux FW panels (~230) following successful pre-qualification with full-scale prototypes.

  **Launch of Call for Tender in Q2 2017.**
  **Contract signature in Q1 2018.**

• **Blanket Cooling Manifolds (BCM):**
  Scope of contract for the procurement of the Blanket Cooling Manifold for first Assembly Phase divided into 5 Lots.

  **Launch of first Call for Tender in Q4 2016** (Lots 1 & 2) for the inboard and outboard pipe bundles respectively.

  **Contract signature in Q4 2017.**
• **Divertor Cassette Assembly:**

Contract for installation of Plasma Facing Components, diagnostics and instrumentation onto the Cassette Bodies

**Launch of Call for Tender in Q1 2016.**
**Contract signature in Q1 2017.**

• **Divertor Inner Vertical Target:**

Contract for the series production of the divertor inner vertical target.

**Launch of Call for Tender in Q2 2018.**
**Contract signature in Q1 2019.**
Main calls for tender for the procurement of:
• Vacuum pumping equipment (cryopumps, leak detection and localization),
• Water detritiation system and isotope separation system,
• Radiological and environmental monitoring systems,
• Radwaste management,
will be launched between 2017 and 2019.

ITER neutral beam cryopump
• For evacuation of beam line vessel
• Very low pressure (10^{-7} \text{ Pa}).

Water Detritiation System
• LPCE column
• Electrolyzer units
• Tanks.
## Fuel Cycle, Radwaste and Rems procurements beyond 2016

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<tbody>
<tr>
<td>1 Radwaste management</td>
<td></td>
<td>Q1 2017</td>
<td>Q4 2017</td>
</tr>
<tr>
<td>2 Cryostat leak detection and localization system</td>
<td></td>
<td>Q1 2017</td>
<td>Q4 2017</td>
</tr>
<tr>
<td>3 Preliminary design for Isotope Separation System</td>
<td></td>
<td>Q2 2017</td>
<td>Q1 2018</td>
</tr>
<tr>
<td>4 Torus and cryostat cryopumps</td>
<td></td>
<td>Q4 2017</td>
<td>Q3 2018</td>
</tr>
<tr>
<td>5 Water detritiation system</td>
<td></td>
<td>Q4 2017</td>
<td>Q3 2018</td>
</tr>
<tr>
<td>6 Radiological and Environmental Monitoring Systems</td>
<td></td>
<td>Q1 2018</td>
<td>Q1 2019</td>
</tr>
<tr>
<td>7 Isotope separation system</td>
<td></td>
<td>Q4 2019</td>
<td>Q4 2020</td>
</tr>
<tr>
<td>8 Neutral beam cryopumps</td>
<td></td>
<td>Q4 2019</td>
<td>Q4 2020</td>
</tr>
</tbody>
</table>
• Procurement of Ancillary Systems (Final Design + Fabrication):
  – 2 Helium Cooling Systems (8 MPa, 50-500°C, 2.2 kg/s)
  – 2 Helium Purification Systems (8 MPa, 75 Nm³/h)
  – 2 Tritium Extraction Systems (0.6 MPa, 25-450°C, 250 Nl/h)
  – 1 PbLi loop (<1 MPa, 0.2–1 kg/s) + Ancillary Equipment Unit (Structure integrating in Port Cell the PbLi loop + some components of Helium Cooling and Tritium Systems)
  – Data Acquisition and Control System
List of main TBM Systems contracts to be launched by F4E: Ancillary Systems

<table>
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<tr>
<th>Component</th>
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<th>Final CfT</th>
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<tbody>
<tr>
<td>1 Final design &amp; Procurement of 2 pressurized Helium Cooling Systems and 2 Helium Purification System (Open procedure; unique contract covering both Final Design and Fabrication; Final Design: 2018-20; Fabrication: 2020-22)</td>
<td>Q1 2018</td>
<td>Q3 2018</td>
<td></td>
</tr>
<tr>
<td>2 Final design &amp; Procurement of 2 Tritium Extraction Systems (Open procedure; unique contract covering both Final Design and Fabrication; Final Design: 2018-20; Fabrication: 2020-22)</td>
<td>Q1 2018</td>
<td>Q3 2018</td>
<td></td>
</tr>
<tr>
<td>3 Final design &amp; Procurement of 1 PbLi loop (Open procedure; unique contract covering both Final Design and Fabrication; Final Design: 2018-20; Fabrication: 2020-22)</td>
<td>Q1 2018</td>
<td>Q3 2018</td>
<td></td>
</tr>
<tr>
<td>4 Final design &amp; Procurement of an Ancillary Equipment Unit (i.e. removable structure integrating in Port Cell the PbLi loop and few components of Helium Cooling and Tritium System) (Open procedure; unique contract covering both Final Design and Fabrication; Final Design: 2018-20; Fabrication: 2020-22)</td>
<td>Q1 2018</td>
<td>Q3 2018</td>
<td></td>
</tr>
<tr>
<td>5 Procurement of DACS (Open procedure; unique contract for all 7 ancillary systems)</td>
<td>Q2 2018</td>
<td>Q4 2018</td>
<td></td>
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</table>
• Procurement of 2 **Test Blanket Modules** and their Radiation Shield for testing in ITER, including:

  - Procurement of **EUROFER-97 structural material**: based on section A3.19AS of RCC-MRx - Competence required: ‘Clean steels’ production under nuclear C&S
  - Procurement of **2 TBM Boxes and 2 Radiation Shields** fabricated according to qualified Welding Procedure Specification to be provided by F4E – Competence required: Fusion and diffusion-bonding welding processes implemented under high-QA class
  - Procurement of **Ceramic pebbles** (Li$_2$TiO$_3$, ∅ 0.6-1.2 mm, 150 kg), **Beryllium pebbles** (∅ 1.0 mm, 250 kg), **eutectic Pb-16-Li** (~10 t)
  - Procurement and installation of **sensors** (thermal, EM, stress, flow, etc.) – Competence required: radiation resistant sensors
## List of main TBM Systems contracts to be launched by F4E: Test Blanket Modules

<table>
<thead>
<tr>
<th>Component</th>
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<tbody>
<tr>
<td>1</td>
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<td>3</td>
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<td>4</td>
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<table>
<thead>
<tr>
<th></th>
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<th>Contract Signature</th>
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<tbody>
<tr>
<td>1</td>
<td>Q4 2019</td>
<td>Q2 2020</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Q4 2020</td>
<td>Q3 2021</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Q1 2020</td>
<td>Q3 2020</td>
<td></td>
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<tr>
<td>4</td>
<td>Q2 2020</td>
<td>Q4 2020</td>
<td></td>
</tr>
</tbody>
</table>
Diagnostics procurements beyond 2016

5 ‘port-plug based’ diagnostic systems:

- Core-plasma charge-exchange recombination spectroscopy (CXRS)
- Radial neutron camera (RNC)
- Equatorial visible/IR wide angle viewing system (WAVS)
- Core-plasma Thomson scattering (CPTS)
- Collective Thomson scattering (port plug components) (CTS)

and:

- Port structures (radiation shielding modules, port interspace and port cell support structures)
- Port plug assembly and testing
Diagnostics procurements beyond 2016

4 vessel based diagnostic systems:
- Magnetics diagnostics
- Plasma position reflectometer
- Bolometers
- Pressure gauges

and:
- Diagnostic cables, conduits, feedthroughs and connectors

Thin films resistors on thin film ceramic or Mica substrates

Vessel-mounted bolometer camera

Low temperature co-fired Magnetics coils

200-way RH-compatible in-vessel connectors

Cable looms
### Examples of main Diagnostic contracts

<table>
<thead>
<tr>
<th>Component</th>
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<th>Final CfT</th>
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</tr>
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<tbody>
<tr>
<td>1 Radian Neutron Camera (port-plug components)</td>
<td>Q3 2019</td>
<td>Q2 2020</td>
<td>Q4 2020</td>
</tr>
<tr>
<td>2 Core-plasma Thomson Scattering (design &amp; manufacture)</td>
<td>N/A</td>
<td>Q4 2017</td>
<td>Q3 2018</td>
</tr>
<tr>
<td>3 Bolometers</td>
<td>N/A</td>
<td>Q1-Q2 2020</td>
<td>Q4 2020</td>
</tr>
<tr>
<td>4 Plasma Position Reflectometer</td>
<td>Q3 2019</td>
<td>Q4 2019</td>
<td>Q3 2020</td>
</tr>
<tr>
<td>5 Diagnostic Pressure Gauges</td>
<td>Q4 2020</td>
<td>Q2 2021</td>
<td>Q1 2022</td>
</tr>
<tr>
<td>6 Collective Thomson Scattering (port plug components)</td>
<td>N/A</td>
<td>Q4 2018</td>
<td>Q2 2019</td>
</tr>
<tr>
<td>7 Core-plasma Charge Exchange Recombination Spectrometer (port plug components)</td>
<td>Q1 2020</td>
<td>Q3 2020</td>
<td></td>
</tr>
<tr>
<td>8 Visible/IR Wide-Angle Viewing System (port plug components)</td>
<td>Q4 2017</td>
<td>Q2 2018</td>
<td>Q4 2018</td>
</tr>
<tr>
<td>9 Port Plug Shielding Modules</td>
<td>Q3 2020</td>
<td>Q4 2021</td>
<td>Q2 2022</td>
</tr>
<tr>
<td>10 Port Plug Assembly</td>
<td>Q3 2020</td>
<td>Q1 2022</td>
<td>Q3 2022</td>
</tr>
<tr>
<td>11 Cable looms and conduits</td>
<td></td>
<td>Q2 2017</td>
<td>Q4 2017</td>
</tr>
<tr>
<td>12 Divertor RH connectors</td>
<td>Q3 2018</td>
<td>Q2 2019</td>
<td></td>
</tr>
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