European Organization for Nuclear Research
*Organisation européenne pour la recherche nucléaire*

Group Code: TE

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# Price Enquiry

# Technical Specification

# Supply of Bipolar High-Power Impulse Magnetron Sputtering (HiPIMS) units

## Abstract

This technical specification concerns the supply of twenty bipolar HiPIMS units to be used for sputtering targets and/or substrate (bias) powering.

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# 1. INTRODUCTION

The Contract will be performed in accordance with the General Conditions of CERN Contracts (CERN/FC/6674-II). However, this Technical Specification prevails over the General Conditions of CERN Contracts with regard to the particular provisions specified in this document, and this without prejudice to any other provision in the General Conditions of CERN Contracts.

Capitalised terms in the body text are defined either in the General Conditions of CERN Contracts or in the present document.

## 1.1 Introduction to CERN

CERN, the European Organization for Nuclear Research, is an intergovernmental organization with over 30 Member States[1]. Its seat is in Geneva but its premises are located on both sides of the French-Swiss border (https://maps.web.cern.ch/). CERN's mission is to enable international collaboration in the field of high-energy particle physics research and to this end it designs, builds and operates particle accelerators and the associated experimental areas. At present, more than 10 000 scientific users from research institutes all over the world are using CERN's installations for their experiments. Further information is available on the CERN website: http://cern.ch.

The accelerator complex at CERN is a succession of machines with increasingly higher energies. Each machine injects the beam into the next one, which takes over to bring the beam to an even higher energy, and so on. The flagship of this complex is the Large Hadron Collider (LHC) (see Figure 1).

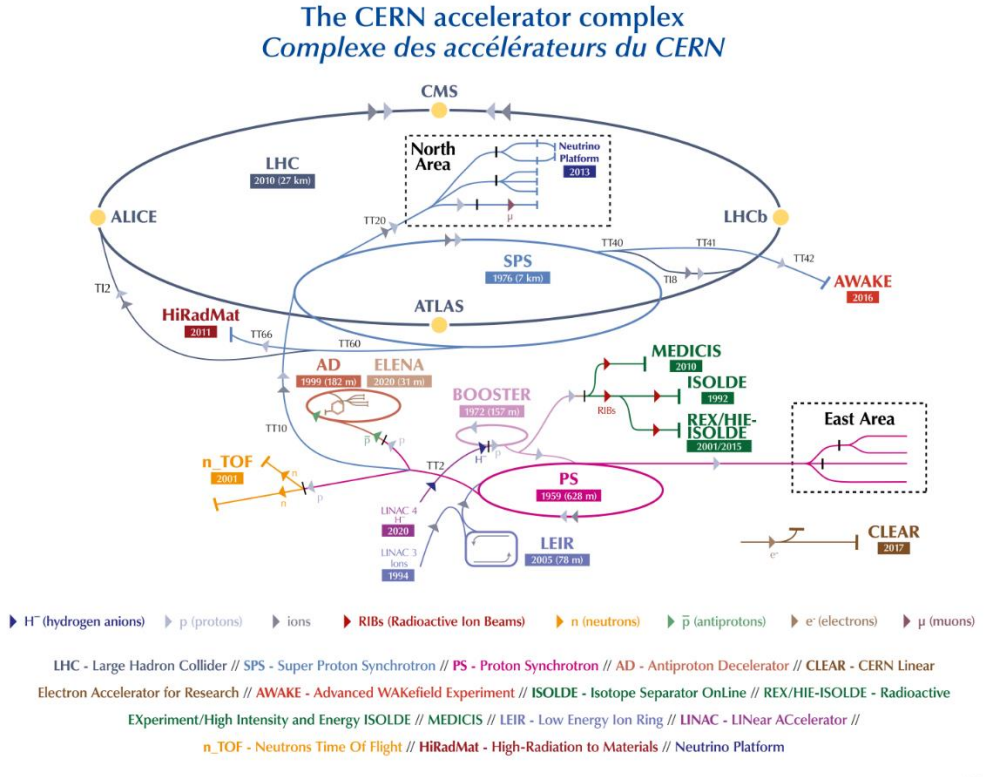


Figure 1: CERN Accelerator Complex

[1] http://home.web.cern.ch/about/member-states

## 1.2 Introduction to the Project

The Large Hadron Collider (LHC) is the most recent accelerator constructed on the CERN site. The LHC machine accelerates and collides proton beams but also heavier ions up to lead. It is installed in a 27 km circumference tunnel, about 100 m underground. The LHC design is based on superconducting twin-aperture cryo-magnets which operate in a superfluid helium bath at 1.9 K.

High Luminosity LHC (HL-LHC) is a project aiming to upgrade the LHC collider after 2020–2025 in order to maintain scientific progress and exploit its full capacity. By increasing its peak luminosity by a factor five over nominal value it will be able to reach a higher level of integrated luminosity, nearly ten times the initial LHC design target. To this aim, HL-LHC is exploring new beam configurations and new advanced technologies in the domain of superconductivity, cryogenics, rad-hard materials, electronics and remote handling.

To gurantee a proper operation of the HL-LHC machine it is crucial to adress the heat load problematic induced by the formation of electron clouds in the beam vacuum chamber. This phenomenon leads to a significant heat dissipation and overcomes the cooling capacity of the cryogenic infrastructures.

An in-situ coating system of amourphous carbon is under development and aims at coating the vacuum chambers with a thin amorphous carbon layer to reduce the surface secondary electron yield below the multipacting threshold value. This coating will be performed using High Power Impulse Magnetron Sputtering (HiPIMS).

## 1.3 Introduction to Unit

### *1.3.1 Technology (TE) Department*

The Technology Department is responsible for technologies which are specific to existing particle accelerators, facilities and future projects and to guarantee permanence of expertise, follow the state-of-the-art and to develop knowledge in the particle accelerator technology fields.

The main domains of activities cover magnets (superconducting, normal conducting, fast pulsed magnets, electrostatic and magnetic septa), their machine integration and protection, power converters, cryogenics, high and ultra-high vacuum systems, coatings and wet surface treatments.

### *1.3.2 Thin Film Coating activities*

The Surface Coatings and Chemistry section is responsible, among other duties, to provide Physical Vapor Deposition support for various applications across the accelerators' infrastructures. The three most important activities are related to the coating of amorphous carbon for Secondary Electron Yield mitigation, non-evaporable getters for distributed pumping and superconducting materials for radiofrequency application. In general, the focus is put on metallic thin films elaborated by diode sputtering, magnetron sputtering and High Power Impulse Magnetron sputtering.

## 2. SCOPE OF THE SUPPLY

The successful bidder (hereinafter referred to as the "contractor") shall deliver the required bipolar HiPIMS units (hereinafter referred to, in whole or in part, as the "units") as defined in this technical specification.

## 2.1 General Description

The price enquiry concerns the supply of twenty bipolar HiPIMS units to be used in a sputter coating apparatus, and the related operational and technical documents (in English or French). All relevant circuitry for dealing with the highly non-linear plasma loads specific to glow discharge plasma and for arc management related to sputter coating stability are an essential feature of these units.

## 2.2 Content of the Supply

The supply shall include:

- 20 bipolar HiPIMS units (including the required DC power supplies) to be delivered upon Factory Acceptance Test (FAT)
- Packing
- Shipping, if so requested
- Control software
- Firmware (if applicable)

- *Documentation* as specified in § 5:
  - A full set of drawings (overall drawing, schematics of the external connections)
  - The documents explaining the operation and the maintenance of the equipment
  - These documents shall be provided with the first unit's delivery in pdf format.

# 3. SPECIFICATION OF THE TECHNICAL DELIVERABLES

The Supply shall include the technical deliverables as specified in the present section.

### *3.1.1 Description and purpose of the Power Supplies*

The power supplies are electronic devices intended to maintain a plasma magnetron discharge in High Power Impulse Magnetron Sputtering mode to proceed to surface thin film coatings.

### *3.1.2 Characteristics and Performances*

The power supplies shall comply with the following characteristics and performance requirements:

- Reverse (positive) pulse feature, with pulse delay, duration and amplitude controls.
- Nominal negative pulse power: 500 W time averaged power.
- Stable operation down to 5 W or 1% of nominal time average power.
- Main pulse output peak voltage: 0 to -1000 V minimum. Adjustable by 1V increments.
- Main pulse output peak current: 150 A minimum.
- Positive pulse output voltage: from 0 V to +500 V. Adjustable by 1V increments.
- Positive pulse output power: up to 250 W
- Pulse frequency adjustable from 1 Hz to 2 kHz.
- Main Pulse width adjustable from 2 μs to 1000 μs by increments of 1μs.
- Positive Pulse width adjustable from 1 μs to 500μs by increments of 1μs
- Positive pulse delay with respect to main pulse: Adjustable from 1μs to 500 μs by increments of 1μs.
- Current, voltage and power regulation modes.

- Forced-air cooling.
- Full arc management circuitry, including arc detection and suppression adapted for sputter sources, with programmable thresholds and counter.
- The twenty units must be able to work together:
    - Synchronously (target and substrate powering, or two targets powering);
    - Independently (two targets from two different systems), without external synchronization of the arc detection circuitry.
- The units should have a control port to be connected to a computer for remote control.
- The units shall be supplied with a windows compatible control software.
- The units shall be equipped with voltage and current monitoring connectors (BNC type). The monitoring voltage and current probes shall be directly integrated in the power supplies.
- Output synchronisation connector for external devices/plasma diagnostics.
- Input: 1 x 240 V, 50 Hz depending on the power rating.
- Interlocking: the units should be equipped with an interlock system to prevent the units from pulsing in case the interlock is either open or closed.
- Line regulation: ± 0.1 % for ± 10 % line voltage change.
- The DC power supplies used to provide both the negative and positive pulses shall be integrated in the same case as the pulsing unit.

### *3.1.3 Operational and Environmental Conditions*

The Power supplies will be located indoors and shall be capable of operating in the following ambient conditions without degrading the performance ratings stated in this Technical Specification:

- At an altitude of approximately 400 meters above sea level;
- In ambient air temperature that varies between 10°C and + 30 °C;
- In relative humidity < 90 %;

### *3.1.4 Dimensions and Interface Requirements*

The Power Supplies shall comply with the following requirements on dimensions and interface:

- 19” rack mounting frame
- Height: 3U
- Length: (400mm +/- 50mm)
- Weight: 18 kg +/- 3 kg

### *3.1.5 Specific Safety Requirements*

In addition to the provisions of § 6, the Power Supplies shall comply with the following requirements:

The equipment shall comply with the CERN Electrical Safety Code C1 and all CERN Safety Instructions. The code is derived from IEC-standards as well as French and Swiss national standards and is available at the URL:

http://edms.cern.ch/file/335725/LAST_RELEASED/C1_E.pdf

The power supplies shall be CE certified.

#### *3.1.6 Identification, Markings and Labelling*

The power supplies shall all be individually identified with their respective serial numbers.

## 4. SPECIFICATION OF THE ACTIVITIES

The Supply shall include the activities listed in the present section. These activities shall comply with the requirements specified below.

#### *4.1.1 Packing and Shipping*

The Contractor shall be responsible for the packing and, if requested by CERN, for the transport to CERN. In this case, the Contractor shall take up a dedicated all-risk transport insurance for the Supply concerned in accordance with the provisions of DAP Incoterms 2020 conditions, Prévessin (FR).

In all cases, the Contractor shall comply with the packing and shipping instructions available under: https://procurement.web.cern.ch/system/files/document/packing-and-shipping-instructions_0.pdf and, in particular, ensure that the Supply is packed in a way that guarantees the absence of any contamination and that no damage or any possible deterioration in performance due to transport conditions can occur.

## 5. SPECIFICATION OF THE DOCUMENTATION

The Supply shall include the documentation related to the Supply (§ 5.1) and the documentation related to the performance of the Contract (§ 5.2). This documentation shall comply with the requirements specified below.

### 5.1 Documentation Related to the Supply

The documentation related to the Supply shall include:

- Detailed Design File (DDF) (see § 5.1.1);
- Technical Documentation (see § 5.1.2);
- User Manual

#### *5.1.1 Detailed Design File*

The Contractor shall submit a DDF including:

- Generator main block diagram
- Generator’s dimensions
- General power distribution diagrams

#### *5.1.2 Factory Acceptance Test report*

The Contractor shall submit a FAT report in accordance with the schedule defined in § 7.1, including:

- All tests performed;
- All test results;
- All non-conformities;

- All modifications performed;
- Anything else of interest for CERN.

### *5.1.3 Technical Documentation*

The Contractor shall submit technical documentation including:

- Drawings, schematics;
- As-built documentation;
- Safety documentation;
- EC/EU declaration of conformity;

## 6. APPLICABLE RULES, NORMS AND STANDARDS

The Supply shall comply with Laws. For the purpose of the Contract, Laws shall include all relevant rules, norms and standards and, and in particular:

### 6.1 Rules

- CERN Safety rules, available under: http://cern.ch/safety-rules;
- European and French rules;
- CERN Computing rules, available under: https://cern.ch/computing-rules;

## 7. PERFORMANCE OF THE CONTRACT

### 7.1 Schedule

The Contractor shall deliver the Supply in accordance with the following schedule, starting from the date of notification of award of the Contract to the Contractor:

Table 2: Schedule

| | **Milestones** | **Indicative Date** |
|---|---|---|
| $T_0$ | Notification of award of the Contract to the Contractor | May 2025 |
| | Delivery of first 4 units | September 2025 |
| | Delivery of 4 units | December 2025 |
| | Delivery of 6 units | March 2026 |
| | Delivery of last 6 units | June 2026 |

## 7.2 Contractor's Personnel

The Contractor shall assign an appropriate number of qualified personnel for the performance of the Contract. The personnel assigned by the Contractor shall at all times remain under the sole direction and responsibility of the Contractor.

## 7.3 Contract Follow-Up and Progress Monitoring

The Contractor shall assign a person in charge of the technical execution of the Contract and its follow-up, as well as a person in charge of the commercial follow-up, during the whole duration of the Contract. These persons shall be able to communicate in at least one of the official languages of CERN (English or French).

The Contractor shall send to CERN a written progress report (as specified in § 5.2.3) every 3 months until the end of the Contract. All communications and documents shall be in English or French.

## 7.4 Acceptance of the Supply by CERN

### *7.4.1 Acceptance of the Supply*

The Contractor shall deliver to CERN for acceptance the Supply according to the schedule defined in § 7.1.

CERN will, within eight weeks, verify the conformity of the Supply in accordance with clause 22 of the General Conditions of CERN Contracts.

## 7.5 Warranty

The warranty period shall be of 2 years from the date of acceptance (see § 7.4).

# 8. CERN REPRESENTATIVES

All commercial and technical correspondence concerning the Invitation to Tender shall be communicated to the CERN Procurement Officer and in copy to the Technical Officer. Any communication by or to any other person than the CERN Procurement Service shall not be valid and have no effect.

| **Procurement officer** | **Tel** | **Email** |
|---|---|---|
| Mr. Andrea Musso | Tel: +41 22 767 0762 | Andrea.Musso@cern.ch |
| In case of absence: | | |
| Ms. Julia Bentchikou | Tel: +41 22 766 7471 | Julia.Ranya.Bentchikou@cern.ch |
| **Technical officer** | **Tel** | **Email** |
| Guillaume Rosaz | Tel: +41 22 766 2956 | Guillaume.Rosaz@cern.ch |
| In case of absence: | | |
| Valentine Petit | Tel: +41 22 766 5899 | Valentine.Petit@cern.ch |