ANNEX A)

ROUGH DESCRIPTION OF THE REQUIRED INSTRUMENTATION

LOT no. 1

1.1 UHV (Ultra High Vacuum) CHAMBER

Stainless steel ultra high vacuum chamber composed by a cylindrical main body with an internal diameter of 200 mm, height of 300 mm and with 19 CF flanges of which features, shape, inclination and diameter are described in technical tables and drawings provided by the customer. Among the 19 flanges, 3 have to be equipped with UHV re-entrant calcium fluoride windows and one has to be equipped with a "Quick Access Door" and a reducer flange from CF125 to CF100 on which a magnesium fluoride window has to be mounted.

1.2 CRYOSTAT

The cryostat is equipped with a rotatable flange and it has to be positioned vertically at the top of the XYZ-theta manipulator above the UHV chamber (by the differential pumped UHV Quick Access Door CF150). The main features of the cryostat are the following:

- **a)** Second stage minimum temperature (or of the possible *cold tip extension*) lower than 4 K;
- **b)** Second stage cooling power greater than or equal to 1.5 W at 5 K;
- **c)** First stage maximum diameter 95 mm;
- **d)** Steady state Power Consumption lower than 8 kW;
- **e)** Maximum weight of 20 kg.

1.3 SAMPLE-HOLDERS

It has to be possible to mount and disassemble, on the terminal part of the cryostat, three copper sample-holders whose shape and sizes are shown in the drawings provided by the customer.

1.4 CRYOSTAT TRANSLATIONAL (XYZ) AND ROTATIONAL (THETA) MOVEMENT SYSTEM

The movement system of the cryostat has to be composed of:

- **a)** A differentially pumped UHV Quick Access Door to connect the cryostat with the movement system. The Quick Access Door has to be separable into two distinct components (with a removable pin hinge) to allow the vertical lift of the cryostat;

b) XYZ-theta movement UHV system (described below in order from top to bottom). The positioning devices have to be equipped with motorized control on each axis (XYZ-theta) and related independent controllers providing also the ability to act manually (e.g. by means of a clutch) on positioning along the four axes;

c) Z vertical translation with:
- **c_1)** 100 mm excursion;
- **c_2)** Free internal diameter greater than or equal to 140 mm;
- **c_3)** Height not exceeding 110 mm in the maximum compression mode;
- **c_4)** Motorized control system with stepper motor and drivable with TTL signal (programmable number of step and direction);
- **c_5)** Resolution with step motor system better than 30 μm.

d) XY horizontal translation with:
- **d_1)** ±12.5 mm excursion (both in X and Y direction);
- **d_2)** Resolution better than 30 μm;
- **d_3)** Free internal diameter greater than or equal to 140 mm;
- **d_4)** Height not exceeding 180 mm.

e) Z(θ) rotation along Z axis with differential pumping to be mounted directly on the top of the UHV chamber and with:
- **e_1)** 360° excursion;
- **e_2)** Free internal diameter 200 mm;
- **e_3)** Upper flange adapter to CF150 (half-nipple from CF200 to CF150);
- **e_4)** Total height (rotation + half-nipple) not exceeding 115 mm;
- **e_5)** Load capacity at least 300 kg.

Note that the rotating stage has to be mounted directly on the top of the UHV chamber in order to allow the rotation of the entire XYZ translation system plus cryostat.

1.5 PUMPING GROUPS

A pumping group for the UHV chamber has to be composed of:
- **a)** Magnetic levitation turbo molecular pump, that reaches a vacuum of 10^{-9} mbar, with a CF200 flange connection and a nitrogen flow rate greater than or equal to 1400 l/s;
- **b)** Oil free backing pump;
- **c)** System for the pressure measurement.

A pumping group with three entrances for the differential vacuum: for the rotational system along Z axis (θ rotation) and for the quick access doors, it has to be made of:
- **a)** Turbo molecular pump with a nitrogen flow rate at least of 60 l/s;
- **b)** Oil free backing pump;
- **c)** System for the pressure measurement.

1.6 SUPERSONIC HELIUM JET PULSED VALVE

Steel valve with the following features:

a) Gas (Helium) nominal opening time lower than or equal to 200 µs;
b) The valve has to be able to work also in single pulse mode;
c) Maximum input pressure greater than or equal to 3 bar;
d) Nominal operating input pressure greater than or equal to 1 bar;
e) Nozzle diameter 0.5 mm;
f) Maximum dimensions of the valve body: maximum diameter 90 mm, maximum length 60 mm;
g) Stainless steel CF100 flange for the connection;
h) The valve has to be mounted on a CF100 flange through a cylindrical extension of suitable length as shown in the drawings provided by the customer. Connections for gas input and electrical connections between the valve and the CF100 flange have to be included. The support CF100 flange of the valve has to be mounted on a XYZ positioning device. The positioning device will be mounted on the **CF100** flange of the chamber through a CF100 full nipple (tube length 60 mm) that allows to place the nozzle at the centre of the chamber.

1.7 XYZ POSITIONING DEVICE FOR THE PULSED VALVE

The XYZ positioning device has to have the following features:

a) Excursion in X and Y axis (vertical plane) at least +/-10 mm;
b) Maximum excursion along Z axis (horizontal axis) greater than or equal to 100 mm;
c) Resolution better than 30 μm.

The positioning device has to be equipped with motorized control on each axis (XYZ) and related independent controllers providing also the ability to act manually (e.g. by means of a clutch) on positioning along the three axes.

Furthermore, the valve has to be equipped with an adequate power supply so that the valve can produce a supersonic gas pulse with duration of 200 microseconds or less and can be actuated via a TTL pulse.

The company awarded the tender has to:

a) ensure assembly and presence of its own specialised personnel during on-site testing;
b) provide the necessary software and hardware for the control of the movement system;
c) provide an electric cabinet that in addition to a main switch and an emergency STOP button, houses the various readout and control devices of the components present in the system (cryostat temperature controller, vacuum pump ignition button, vacuum chamber pressure sensor controller, positioning devise control system, helium jet valve feeder, and so on...).

LOT no. 2

2.1 IR LASER

Pulsed Nd:YAG LASER with optical parametric oscillator (OPO) tunable in the range 2700-3100 nm with the following features:

- **a)** Spectral linewidth less than 10 cm^{-1};
- **b)** Pulse repetition rate greater than or equal to 10 Hz;
- **c)** Pulse length less than 10 ns;
- **d)** Pulse peak energy greater than 6 mJ over the entire wavelength range;
- **e)** Divergence less than 12 mrad.

Furthermore:

- **a)** The system has to allow access to the fundamental wavelength of the pump laser (1064 nm; full power);
- **b)** The system has to be suitable for the addition of the second and fourth harmonic generator;
- **c)** The system has to be able to work in single pulse mode synchronized with an external trigger signal;
- **d)** The system has to be provided with:
  - **d_1)** Laser power attenuator variable from 0% to 100%, controllable by computer;
  - **d_2)** Visible laser for alignment (aiming beam);
  - **d_3)** Closed loop cooling system with air/water exchanger.

The following accessories for the IR Laser are also required:

- **a)** Optical table adjustable in height;
- **b)** N.2 mirror holders with "beam-steering";
- **c)** N.1 eight-channel delay generator;
- **d)** N.1 set of spare lamps for the pump laser;
- **e)** Power meter equipped with all measuring heads necessary for all wavelengths emitted by OPO laser.

In addition, the company who is awarded the tender will be required to ensure laboratory installation and staff training for the use of the IR Laser.

2.2 UV LASER

Pulsed Nd:YAG LASER 355 nm (third harmonic) with the following features:

- **a)** Spectral linewidth at 355 nm less than 3 cm^{-1};
- **b)** Pulse repetition rate greater than or equal to 10 Hz;
- **c)** Pulse length less than 10 ns;
- **d)** Pulse peak energy at 355 nm greater than or equal to 200 mJ;
- **e)** Divergence at 355 nm less than 2 mrad;
- **f)** The system has to be able to work in single pulse mode synchronized with an external trigger signal.

Furthermore, the Laser has to be equipped with:

- **a)** “autotuning” system of harmonics;
- **b)** Closed loop cooling system with air/water exchanger.

The following accessories for the UV Laser are also required:

- **a)** External laser power attenuator;
- **b)** Optical table adjustable in height;
- **c)** N. 1 mirror holder with "beam-steering";
- **d)** N. 1 set of spare lamps for the pump laser;
- **e)** Power meter equipped with all the measuring heads needed for the main harmonics of the Nd:YAG laser (1064 nm, 533 nm, 355 nm, 266 nm);
- **f)** N. 1 Si photodiode calibrated by NIST in the range from 116 to 254 nm. The photodiode has to have the following features:
  - **f_1)** Size of the active area from 10mm×10mm to 20mm×20mm;
  - **f_2)** Responsiveness greater than 0.06 A/W in the wavelength range between 110 and 250 nm;
  - **f_3)** Response time from 10% to 90% less than 15 µs (15×10^{-6} seconds).

The company who is awarded the tender will be required to ensure laboratory assembly and presence of its own specialised personnel during on-site testing.

LOT no. 3

Orthogonal time of flight mass spectrometer with electrostatic mirror (reflectron). The spectrometer has to be mounted on an adjustable table (already present in the laboratory). The spectrometer has to have sizes compatible with the table slot and mounting holes compatible with the support and handling system flanges described in the technical support tables provided by the customer.

The spectrometer has to have the following features:

- **a)** M/Q range from a value lower than or equal to 10 Th to a value greater than or equal to 2800 Th;
- **b)** Resolving power M/dM = 5000;
- **c)** Highest repetition rate greater than or equal to 28 kHz;
- **d)** Interfaced with the ultra-high vacuum chamber (described in Lot1) via a CF63 flange;
- **e)** Ability to reveal positive ions;
- **f)** Ability to operate in two possible configurations:
  - **f_1)** Plume mode: with the sample to be analyzed placed close to the ion transfer optic (TOF extractor);
  - **f_2)** Jet mode: in this case the spectrometer is interfaced to the vacuum chamber through a special chamber (*cross*) in which the ionization takes place. The additional chamber has to be equipped with a *skimmer* which is designed to carry out a differentiated pumping with respect to the main chamber. In this configuration the gas jet is produced by the jet valve described in Lot1.
- **g)** In both configurations the spectrometer has to be able to operate with two ionization methods: external ionization (via UV Laser, see Lot2) and internal ionization (electronic impact).

Switching from the Jet mode configuration to the Plume mode configuration (and vice versa) has to be possible by removing/inserting the *cross* with the *skimmer* and moving the mass spectrometer along the slot of the table in which it is positioned, using the cart and its mounting flanges.
The *cross* has to be equipped with 6 CF63 flanges.
The two vertical flanges have to be equipped with windows with flat and parallel faces on CF63 flange in Magnesium Fluoride. The two horizontal flanges have to be equipped with CF63 flange caps.
The fifth flange is the one that connects to the CF63 flange of the mass spectrometer.
The sixth flange is the one that connects to the UHV chamber by interposing the flange equipped with a *skimmer*.
The nickel or copper *skimmer* has to have the diameter of the orifice of 2 mm and the thickness of the orifice edge not exceeding 10 micrometers;
To ensure maximum flexibility, the *skimmer* has to be mounted on a special CF63 flange to be mounted between the flange of the vacuum chamber and that of the *cross* (sixth flange).

The system has to be equipped with:

- **a)** Computer with preinstalled software and hardware;

b) Pumps (vacuum and backing pumps) and pressure gauges with controllers;
c) Suppression filters for the masses corresponding to helium and water;
d) Two spare filaments.

The company who is awarded the tender will be required to ensure laboratory assembly and presence of its own specialised personnel during on-site testing.