Impedans
PLASMA MEASUREMENT

Instrument Catalogue

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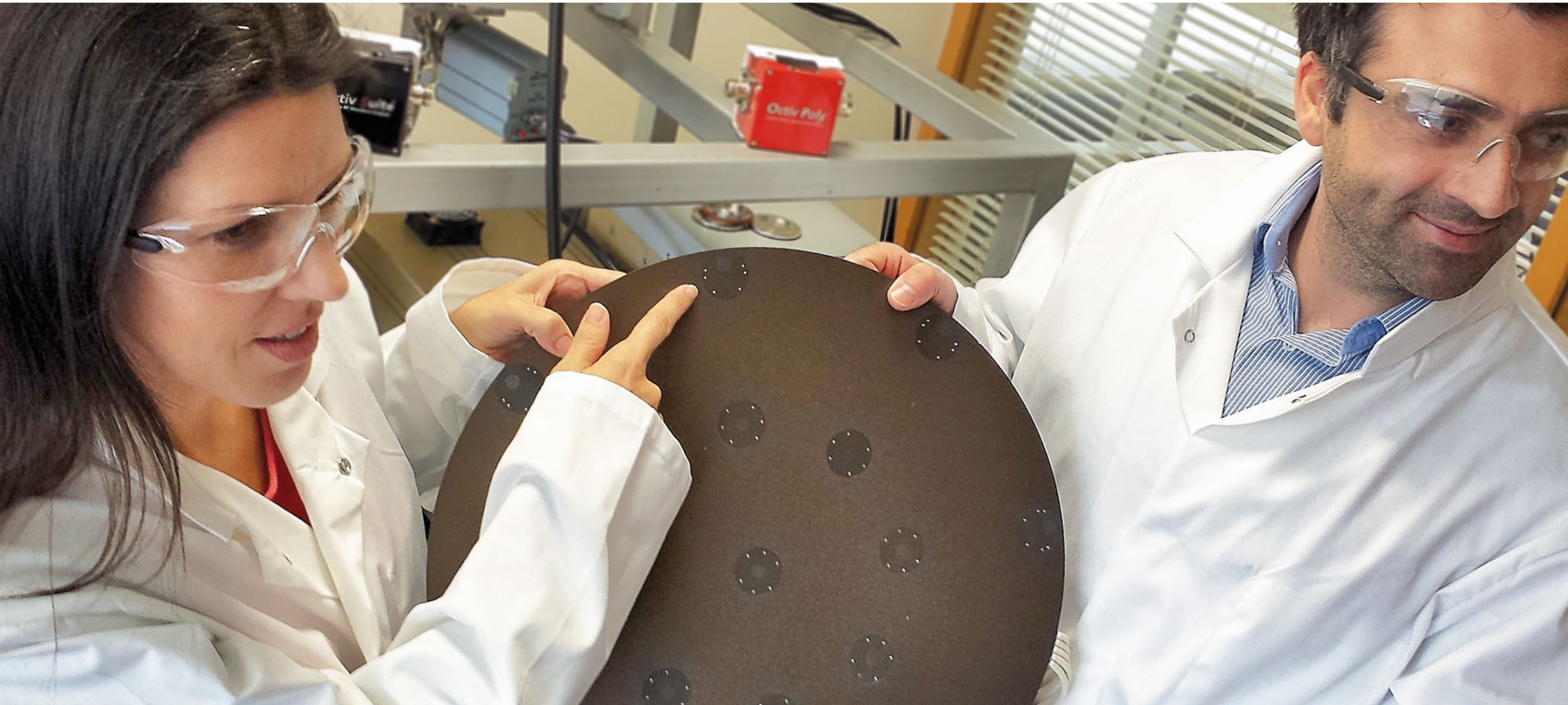
Plasma Measurement to Understand and Control the Future

Impedans focus exclusively on innovative plasma measurement systems incorporating unique expertise built up over many years of experience. We believe the right plasma measurement products and ongoing expertise will enable our customers to better understand and control their processes. The knowledge and understanding gained by our customers help them create value and stay ahead of the competition.

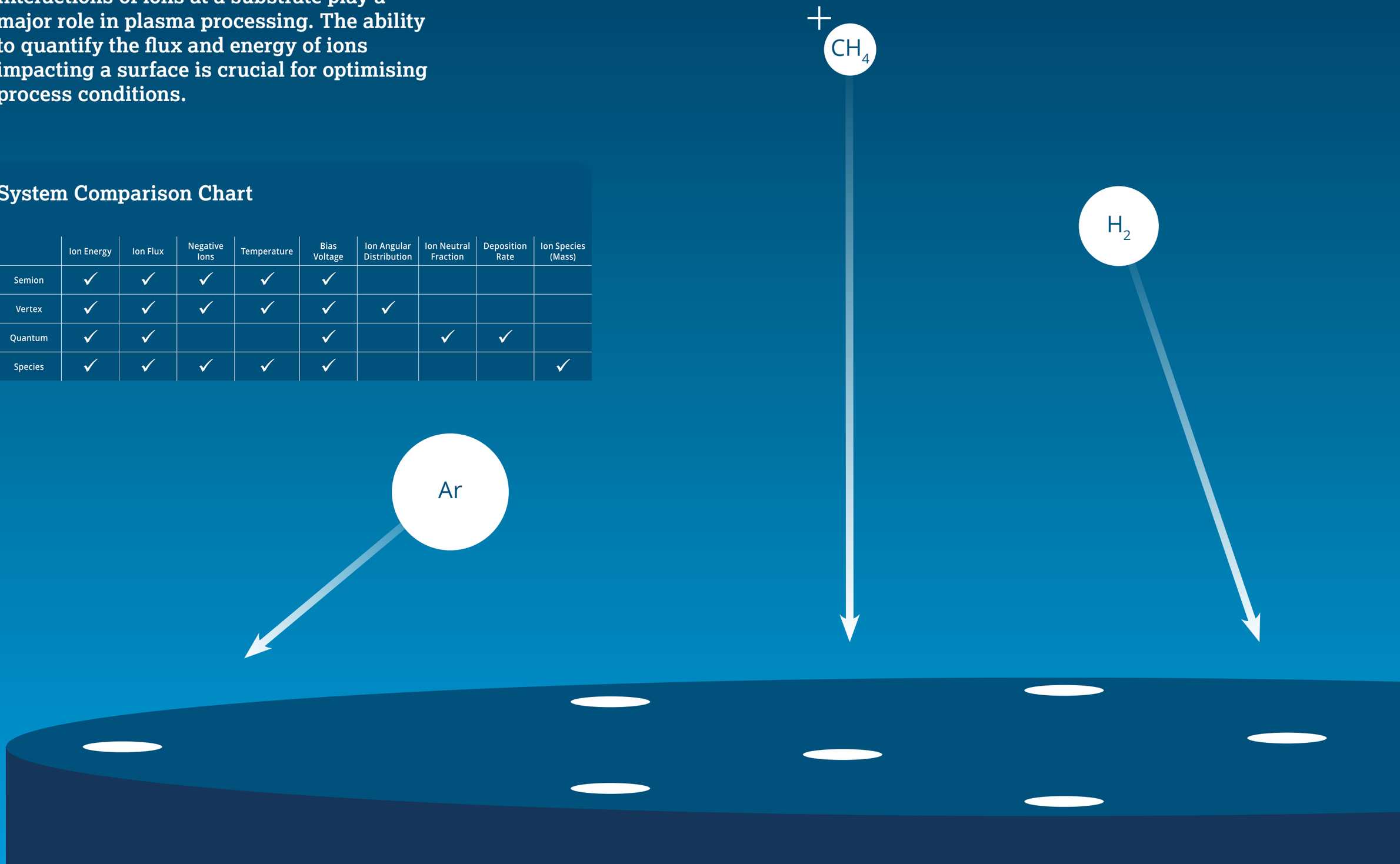


Substrate Ion Interactions

Interactions of ions at a substrate play a major role in plasma processing. The ability to quantify the flux and energy of ions impacting a surface is crucial for optimising process conditions.

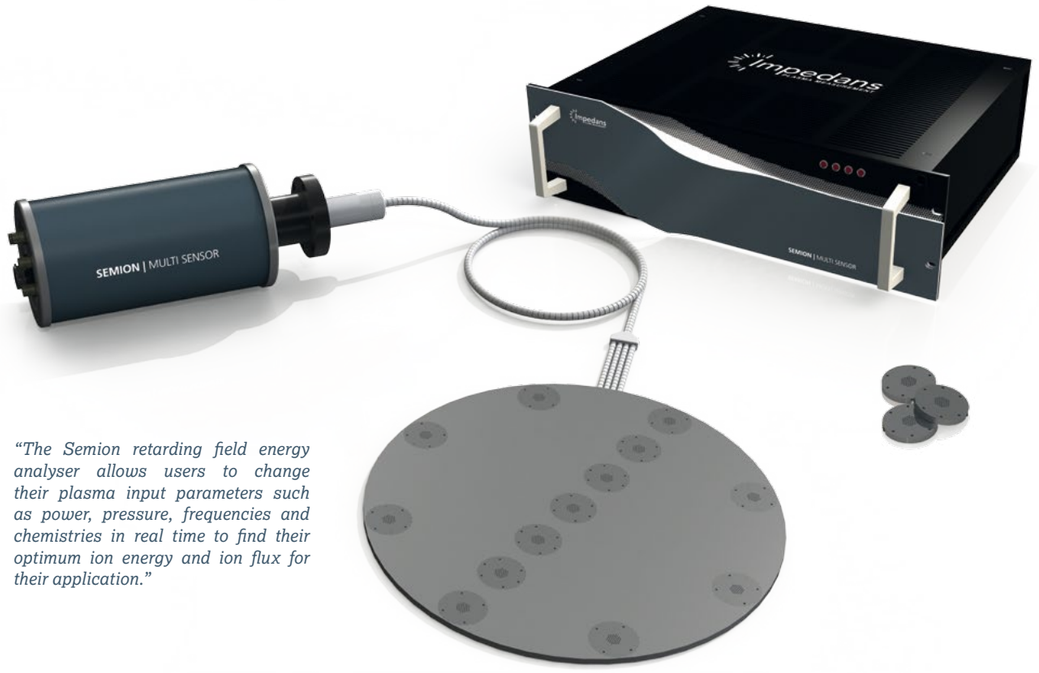
System Comparison Chart

	Ion Energy	Ion Flux	Negative Ions	Temperature	Bias Voltage	Ion Angular Distribution	Ion Neutral Fraction	Deposition Rate	Ion Species (Mass)
Semion	✓	✓	✓	✓	✓				
Vertex	✓	✓	✓	✓	✓	✓			
Quantum	✓	✓			✓		✓	✓	
Species	✓	✓	✓	✓	✓				✓



Semion System

Ion Energy and Ion Flux



"The Semion retarding field energy analyser allows users to change their plasma input parameters such as power, pressure, frequencies and chemistries in real time to find their optimum ion energy and ion flux for their application."

Measures
- Ion energy
- Ion flux
- Negative ions
- Temperature
- Bias voltage

Functionality
- Time averaged
- Time resolved
- Time trend

Features
- Up to 13 measurement points
- Simultaneous measurement
- Replaceable button probe sensors
- Custom sensor holder-plates
- Energy levels up to 2500eV
- User friendly software
- Fully automated system
- Easy to setup and use
- Most advanced ion energy and ion flux measurement system in the world

The Semion Multi Sensor retarding field energy analyser measures the uniformity of ion energies hitting a surface using a number of plasma measurement sensors.

This cutting edge retarding field energy analyser also measures the uniformity of ion flux, negative ions, temperature, and bias voltage at any position inside a plasma chamber.

The Semion Multi Sensor is primarily used for researching wafer uniformity in industrial plasma applications but it also finds applications in research. Users in the semiconductor community are concerned with the uniformity of ion interactions with the substrate and this holds true for coatings, etching, plasma sputtering, PECVD and ion beam applications.

With ever increasing substrate sizes plasma uniformity becomes increasingly critical. The Semion Multi Sensor saves time and confirms plasma uniformity models, which is essential in the development of larger plasma tools.

Measuring Parameters	
Ion Energy Range	0 to 2500eV
Ion Current	2mA DC max
Ion Flux	0.1 - 20mA/cm²
IEDF Resolution	± 1eV nominal

Probe Bias Conditions	
Max RF Bias Voltage	1kV pk-to-pk
Bias Frequency Range (Time Averaged Measurements)	100kHz to 80MHz
Bias Frequency Range (Time Resolved Measurements)	0Hz to 100kHz
Time Resolution	5µs

RFEA Probe	
Number of Sensors	1 - 13
Probe Configuration	4-grid
Button Probe Diameter	33mm
Holder Diameter	50mm, 100mm, 150mm, 200mm, 300mm and custom shapes
Holder Thickness	5mm
Max Operating Temperature	200°C
Mounting	RFEA probe holder mounted on electrode
Probe Enclosure and Holder Material	Aluminium, anodized aluminium, stainless steel and Al2O3
RFEA Probe Cable Length	650mm standard (custom available)

Feed-Through Assembly	
Flange Type	CF40 (custom available)

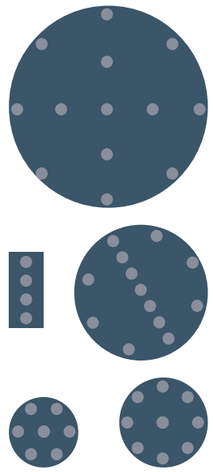
Control Unit Electronics	
Suppression Voltage Range	-1.6kV to 0V
Grid Voltage Range	-1.5kV to +1.5kV
Current Range	100pA to 2.4mA
Connectivity	USB 2.0

Application Software	
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8

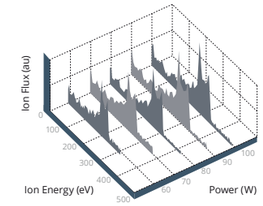
Operating Parameters	
Pressure (Pascal)	0 to 40Pa
Pressure (Torr)	0 to 300mTorr
Density	$10^6 cm^{-3}$ to $10^{14} cm^{-3}$
Gas Reactivity	Inert to highly reactive

Sensor Holders

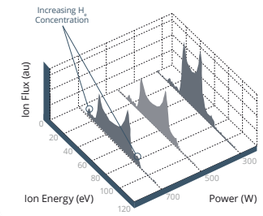
The Semion sensor holder is available in various standard sizes of 50mm, 70mm, 100mm, 150mm, 200mm, 300mm, 450mm with custom shapes also available. It sits on a grounded or biased electrode and is used to hold the replaceable button probe sensors. The holder is available in a number of materials including aluminium, anodised aluminium and stainless steel with custom materials available.



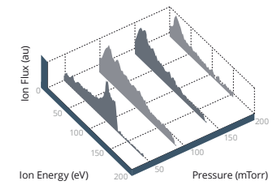
Ion Energy as a Function of Power



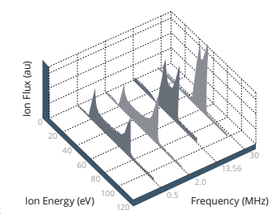
Ion Energy as a Function of Chemistry



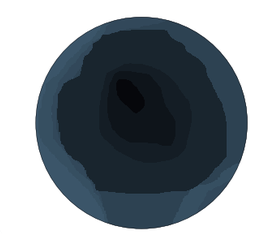
Ion Energy as a Function of Pressure



Ion Energy as a Function of Frequency



Contour Map



Vertex System

Ion Angular Distribution

"By measuring the uniformity of ion angular distribution from different locations the user can identify changes in their process and troubleshoot input parameters affecting it."

Measures

- Ion angle
- Ion energy
- Ion flux
- Negative ions
- Temperature
- Bias voltage

Functionality

- Time averaged
- Time resolved
- Time trend

Features

- Vertex advanced electronics unit
- Analytical software suite
- Range of sensor holder arrays
- Replaceable button probe sensors
- Quick start and advanced user modes

The Vertex Multi Sensor measures the uniformity of ion angular distribution hitting a surface inside a plasma reactor from multiple locations.

The uniformity of ion energy, ion flux, temperature, and bias voltage is also measured from multiple locations. The ion angular distribution is composed of a series of ion energy distributions as a function of elevation angle, where the angle is determined from the ratio of parallel to perpendicular energy of the incoming ions at the surface of the button probe sensor.

The Vertex Multi Sensor is increasingly used in many applications in industry and research where ion angle uniformity is of interest, such as plasma etching for larger substrates, ion beams, and plasma sputtering.

In sputtering applications the sputter rate is determined not just by the ion energy but the angle of the ions hitting the surface. The ion angle will also determine the etch profile.

The Vertex Multi Sensor helps users confirm models, develop new processes and experiments that use plasma. The Vertex Multi Sensor finds applications across a wide range of applications including etching, PECVD, fundamental research, coatings and ion beam.

Measuring Parameters	
Ion Angle Resolution	3°
Ion Energy Range	0 to 2500eV
Ion Current	2mA DC max
Ion Flux	0.1 - 20mA/cm²
IEDF Resolution	± 1eV nominal

Probe Bias Conditions	
Max RF Bias Voltage	1kV pk-to-pk
Bias Frequency Range (Time Averaged Measurements)	100kHz to 80MHz
Bias Frequency Range (Time Resolved Measurements)	0Hz to 100kHz
Time Resolution	5µs

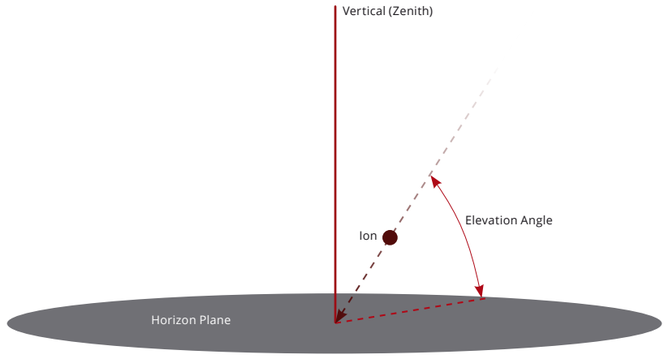
RFEA Probe	
Number of Sensors	Up to 13
Probe Configuration	4-grid
Button Probe Diameter	33mm
Holder Diameter	50mm, 100mm, 150mm, 200mm, 300mm and custom shapes
Holder Thickness	5mm
Max Operating Temperature	200°C
Mounting	RFEA probe holder mounted on electrode
Probe Enclosure and Holder Material	Aluminium, anodized aluminium, stainless steel and Al2O3
RFEA Probe Cable Length	650mm standard (custom available)

Feed-Through Assembly	
Flange Type	CF40 (custom available)

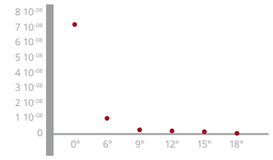
Control Unit Electronics	
Suppression Voltage Range	-1.6kV to 0V
Grid Voltage Range	-1.5kV to +1.5kV
Current Range	100pA to 2.4mA
Connectivity	USB 2.0

Application Software	
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8

Operating Parameters	
Pressure (Pascal)	0 to 40Pa
Pressure (Torr)	0 to 300mTorr
Density	$10^6 cm^{-3}$ to $10^{14} cm^{-3}$
Gas Reactivity	Inert to highly reactive

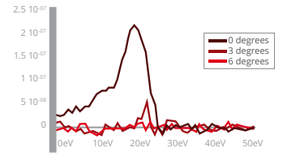


Ion Angle Distribution



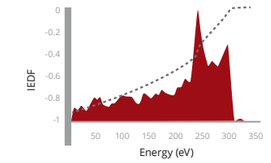
The ion angle of ions arriving at a range of energies can be plotted as a function of elevation angle

Ion Angle and Energy Distribution



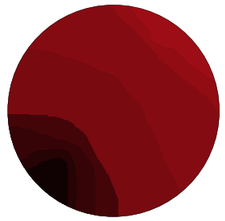
The complete ion energy distribution as a function of elevation angle in a parallel plate discharge

Ion Energy Distribution Function & Total Current



The ion energy distribution function and total current in a single location

Contour Map



Contour map showing parameters as a function of position

Quantum System

Ion Neutral Fraction

"The ion flux fraction at multiple locations is now measurable. This offers our clients a unique view into their plasma process with never before seen detail."

Measures

- Ion neutral fraction
- Deposition rate
- Ion energy
- Ion flux
- Bias voltage

Functionality

- Time averaged
- Time trend

Features

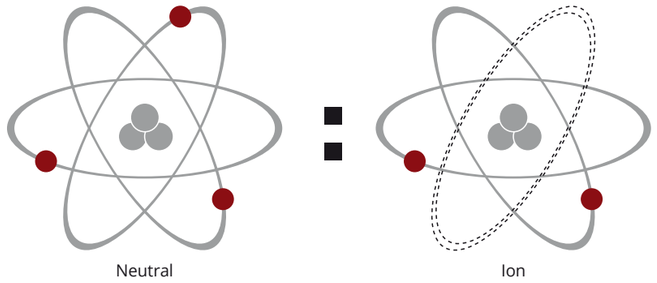
- Quantum electronics unit
- Advanced analytical software suite
- Range of sensor holder arrays
- Replaceable button probe sensors
- Quick start and advanced user modes

The Quantum Multi Sensor is an energy resolving gridded quartz crystal microbalance, used to measure the ion neutral fraction hitting a surface inside a plasma reactor from multiple locations.

This cutting edge instrument also measures the uniformity of deposition rate, ion energy, ion flux and bias voltage.

The Quantum Multi Sensor is used in sectors across industry and research where uniformity is of interest, such as plasma deposition, coatings, plasma sputtering, PECVD, etching and ion beam.

The Quantum System is perfect for users researching plasma recipes, ionization, plasma processes, tool development and fundamental plasma research.



Measuring Parameters

Ion Energy Range	0 to 2500eV
Ion Current	2mA DC max
Ion Flux	0.1 - 20mA/cm²
IEDF Resolution	± 1eV nominal
Crystal Measurement Channels	2

Crystal Monitor

Frequency Range	3.5MHz to 6.1MHz
Frequency Resolution	1 Hz
Mass Resolution (at crystal)	12.3ng/cm²
Mass Resolution (at sensor surface)	372.73ng/cm²
Film Thickness Resolution (Copper)	4Å
Measurement Update Rate	10 measurements / sec minimum

RFEA Probe

Probe Configuration	3-grid and 4-grid options
Button Probe Diameter	32mm
Holder Diameter	70mm, 100mm (4"), 300mm (12") as standard
Holder Thickness	5mm
Max Operating Temperature	200°C
Max RF Bias Voltage	1kV pk-to-pk
RF Bias Frequency Range	400kHz to 80MHz
Mounting	RFEA probe holder mounted on electrode
Probe Enclosure and Holder Material	Aluminium, anodized aluminium, stainless steel and Al2O3
RFEA Probe Cable Length	650mm standard (custom available)

Feed-Through Assembly

Flange Type	CF40 (custom available)

Control Unit Electronics

Suppression Voltage Range	-1.6kV to 0V
Grid Voltage Range	-1.5kV to +1.5kV
Current Range	100pA to 2.4mA
Connectivity	USB 2.0

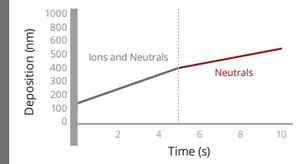
Application Software

Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8

Operating Parameters

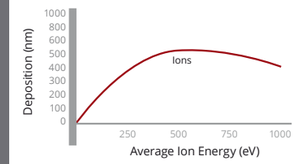
Pressure (Pascal)	0 to 40Pa
Pressure (Torr)	0 to 300mTorr
Density	$10^6 cm^{-3}$ to $10^{14} cm^{-3}$
Gas Reactivity	Inert to highly reactive
Power Frequency	400kHz to 80MHz

Ion Flux Fraction as a Function of Time



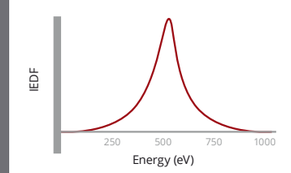
Total deposition rate versus neutral deposition rate in a plasma deposition chamber

Ion Flux Fraction as a Function of Ion Energy



Deposition as a function of increasing average ion energy hitting a substrate in a plasma deposition chamber

Ion Energy



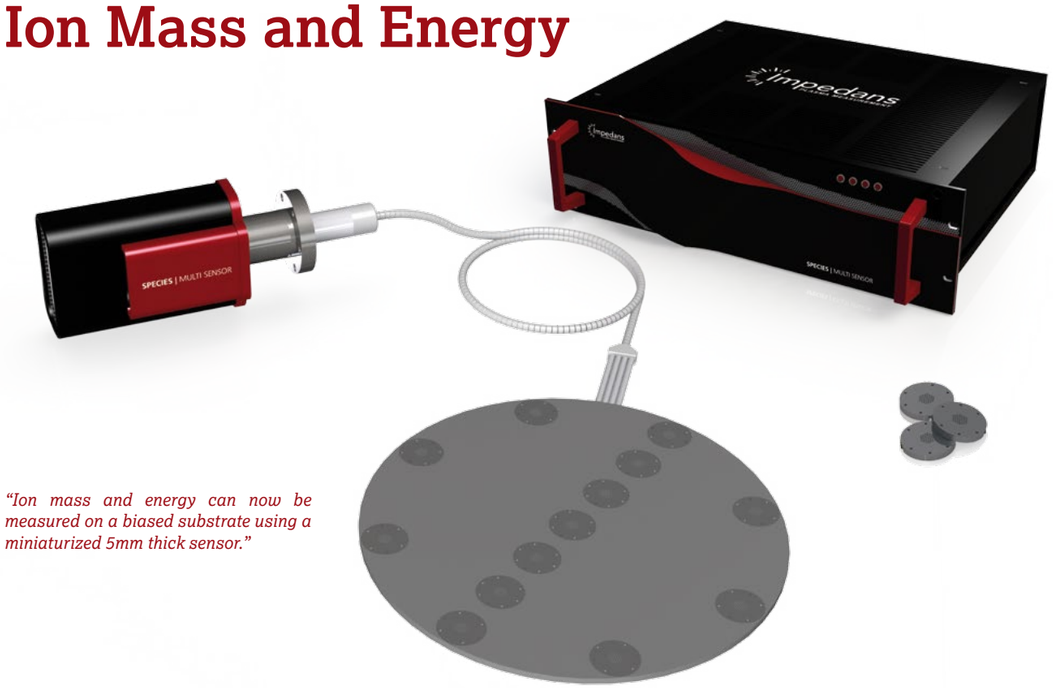
The ion energy distribution function in a single location

Contour Map

Contour map showing parameters as a function of position

Species System

Ion Mass and Energy



"Ion mass and energy can now be measured on a biased substrate using a miniaturized 5mm thick sensor."

Measures

- Ion species (mass)
- Ion energy distribution
- Ion flux
- Negative ion
- Temperature
- Bias voltage

Functionality

- Time averaged
- Time resolved
- Time trend

Features

- Ion mass and energy analyser electronics unit
- Advanced analytical software suite
- Range of sensor holder arrays
- Replaceable button probe sensors
- Quick start and advanced user modes
- Easy installation across a number of different chambers requiring no chamber adjustment

The Species Multi-Sensor mass and energy analyser measures the uniformity of ion species (mass) hitting a surface using an array of miniaturised sensors.

This ground-breaking plasma diagnostic measurement system can also measure the uniformity of ion energy, ion flux, temperature, and bias voltage from any location inside a plasma reactor.

For the first time an energy analyser combined with an integral mass separation capability is available. In many applications the ion of interest in a process may have a unique energy distribution that is not visible from the total ion energy distribution function. The Species system can differentiate the energy distribution of different species with a 5amu separation of mass.

The Species Multi Sensor helps users in plasma manufacturing with chamber to chamber matching, fault detection, fingerprinting, researching new processes and preventative maintenance in an offline environment.

Measuring Parameters

Ion Mass Resolution	5amu
Ion Mass Range	0 to 100amu
Ion Energy Range	0 to 2500eV
Ion Current	2mA DC max
Ion Flux	0.1 - 20mA/cm²
IEDF Resolution	± 1eV nominal

Probe Bias Conditions

Max RF Bias Voltage	1kV pk-to-pk
Bias Frequency Range (Time Averaged Measurements)	100kHz to 80MHz
Bias Frequency Range (Time Resolved Measurements)	0Hz to 100kHz
Time Resolution	5µs

RFEA Probe

Number of Sensors	Up to 13
Probe Configuration	4-grid
Button Probe Diameter	33mm
Holder Diameter	50mm, 100mm, 150mm, 200mm, 300mm and custom shapes
Holder Thickness	5mm
Max Operating Temperature	200°C
Mounting	RFEA probe holder mounted on electrode
Probe Enclosure and Holder Material	Aluminium, anodized aluminium, stainless steel and Al2O3
RFEA Probe Cable Length	650mm standard (custom available)

Feed-Through Assembly

Flange Type	CF40 (custom available)

Control Unit Electronics

Suppression Voltage Range	-1.6kV to 0V
Grid Voltage Range	-1.5kV to +1.5kV
Current Range	100pA to 2.4mA
Connectivity	USB 2.0

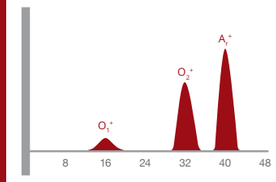
Application Software

Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8

Operating Parameters

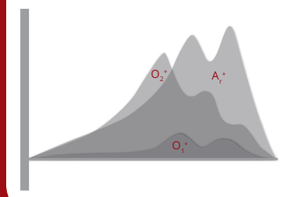
Pressure (Pascal)	0 to 40Pa
Pressure (Torr)	0 to 300mTorr
Density	$10^{6}cm^{-3}$ to $10^{14}cm^{-3}$
Gas Reactivity	Inert to highly reactive
Power Frequency	400kHz to 80MHz

Ion Mass Spectrum



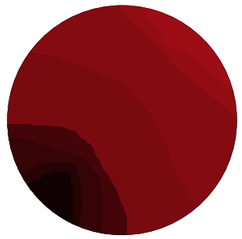
Ion mass spectrum in an Argon Oxygen plasma

Energy Spectrum



Ion energy distribution of several species

Contour Map



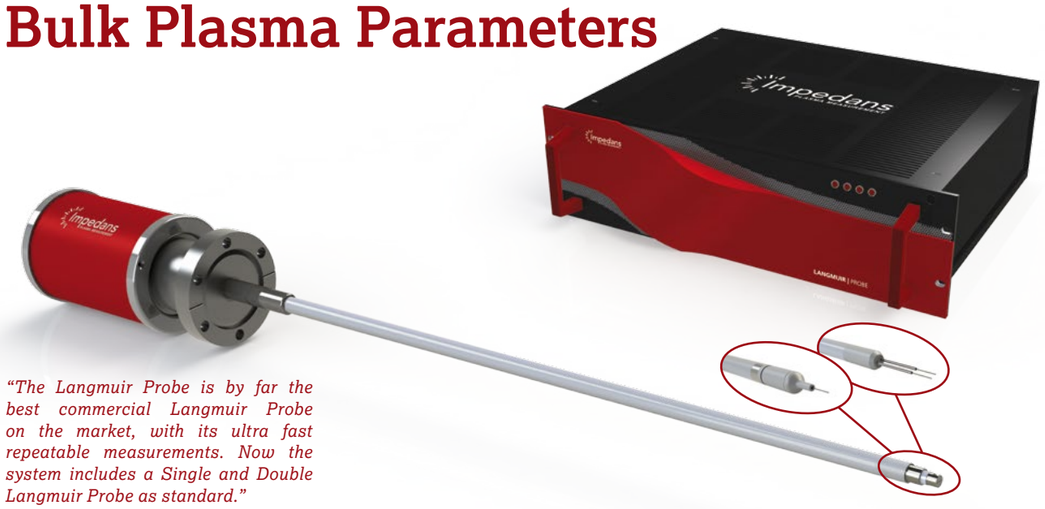
Contour map showing parameters as a function of position

Bulk Plasma Parameters

The parameters that make up the bulk of the plasma such as plasma potential, plasma density, ion density, electron energy and electron temperature can be measured giving greater understanding of the bulk plasma.

Langmuir Probe

Bulk Plasma Parameters



"The Langmuir Probe is by far the best commercial Langmuir Probe on the market, with its ultra fast repeatable measurements. Now the system includes a Single and Double Langmuir Probe as standard."

Measures

- Floating potential
- Plasma potential
- Plasma density
- Ion current density
- Electron energy distribution function

Functionality

- Time averaged
- Time resolved
- Time trend

Features

- Langmuir probe automated electronics unit
- Advanced analytical software suite
- Replaceable probe head
- Quick start and advanced user modes
- External trigger
- DC compensation
- RF compensation

The Langmuir Probe is one of the most common and widely used plasma diagnostics and characterisation instruments to measure parameters in the bulk of the plasma. The Langmuir Probe measures plasma parameters such as floating potential, plasma potential, plasma density, ion current density, electron energy distribution function and electron temperature.

The Langmuir Probe has the most advanced technology on the market and analyses ion and electron trajectories to obtain accurate measurements of the real plasma parameters in a wide range of plasma applications. The Langmuir Probe is the fastest and most reliable Langmuir probe in the world (time resolution 12.5ns). In addition to speed and reliability, the Langmuir Probe provides the most advanced and trusted, fully automated data analysis in real time.

The Impedans Langmuir Probe system comes complete with both a single Langmuir Probe and a Double Langmuir Probe (at no extra cost) which can be used with the same electronics unit. This allows users to conduct experiments across different reactors and allows measurements in reactors which have a poor ground return.

The Langmuir Probe is used to establish plasma process repeatability. It helps the user to understand plasma changes and the impact on surface treatment. The Langmuir Probe is an essential plasma process diagnostic to understand the correlation between plasma inputs and the plasma state. The Langmuir Probe reduces process and tool development time, as well as the time to market for new plasma products. Pulsed plasmas are used to tailor the electron or ion energy and the Langmuir Probe is an integral part of pulsed process development.

Measuring Parameters

Floating Potential	-145V to 145V
Plasma Potential	-100V to 145V
Plasma Density	10^6 to $3x10^{13}cm^{-3}$
Ion Current Density	1μA/cm² to 300mA/cm²
Electron Temperature	0.1 to 15 eV
Electron Energy Distribution Function	0 to 100eV

Langmuir Probe Specifications

Plasma Power Source	DC, RF, microwave, continuous, pulsed plasma
RF Plasma	Broadband Probe 2MHz to 100MHz
Probe Length	300mm to 1400mm (custom available)
Probe Diameter	6.5mm (custom available)
Probe Tip Length	10mm (custom available)
Probe Tip Diameter	0.4mm (custom available)
Probe Tip Material	W, Ta, Ni, Pt. (custom available)
Probe Customisation	90°, 45° bend (custom available)
Maximum Operating Temperature	230°C (custom up to 1200°C)

Linear Drive

Step Resolution	0.025mm
Control Mechanism	Automated through software
Drive Length	300mm, 450mm, 600mm or custom

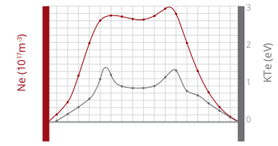
Electronics Control Unit

Probe Voltage Scan Range	-150V to +150V
Current Range	15nA to 150mA or 1.5μA to 1A for high current densities
Communication	USB 2.0
Sampling Rate	80 MSPS (V,I)
Data Acquisition Resolution	4.5mV, 4.5nA
Time Resolved Step Resolution	12.5nS
External Trigger TTL Compatible	10Hz to 1 MHz

Operating Parameters

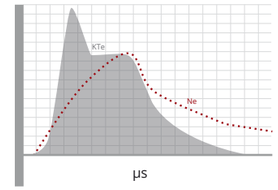
Pressure (Pascal)	0 to 1,000Pa
Pressure (Torr) | Single Probe	0 to 10Torr
Pressure (Torr) | Double Probe	0 to 760Torr
Gas Temperature	20° to 1000°
Density	10^4cm^{-3} to $10^{14}cm^{-3}$
Gas Reactivity	Inert to highly reactive
Power Frequency	DC (0kHz) • pDC (0 to 350kHz) • MF (0 to 1MHz) • RF (1MHz to 100MHz) • Microwave (1GHz to 3 GHz)

Spatial Resolution



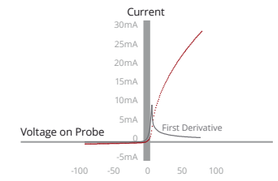
Spatial distribution of electron density and energy in a 150mm chamber

Time Resolution



The electron energy and density in a micro-second pulse

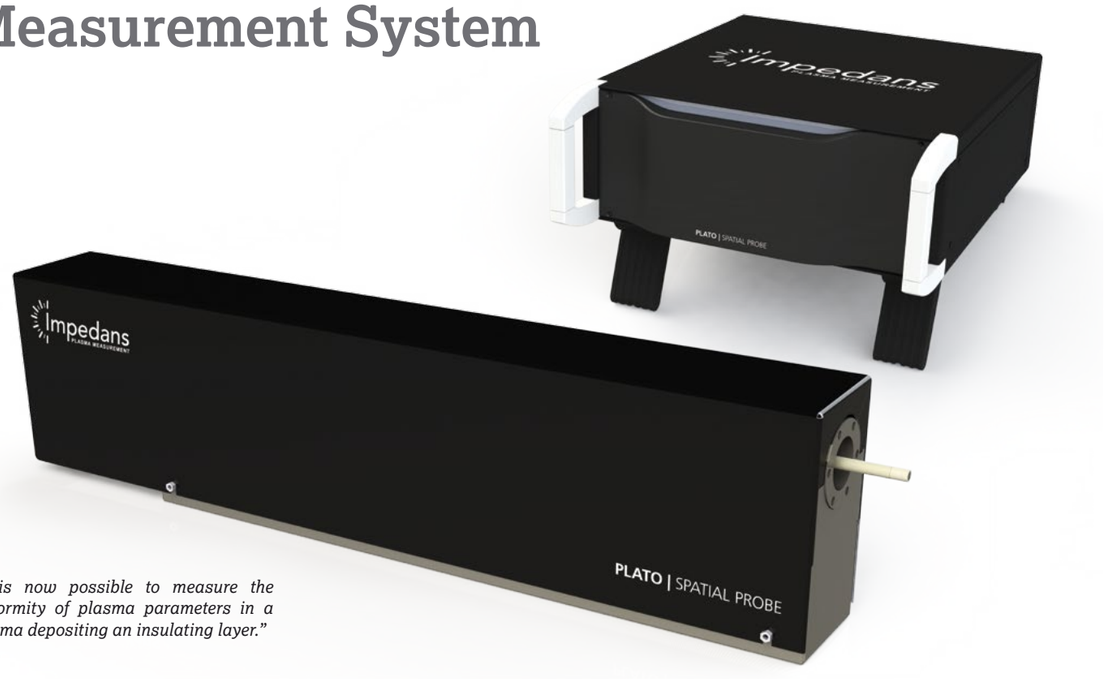
Single Probe Trace



The current as a function of probe voltage in a plasma. The first derivative peaks at the plasma potential. All parameters are calculated automatically.

Plato Probe

Process Compatible Plasma Measurement System



"It is now possible to measure the uniformity of plasma parameters in a plasma depositing an insulating layer."

Measures
- Plasma density
- Ion current density
- Electron temperature

Functionality
- Time averaged
- Time resolved
- Time trend

Features
- Fully automated electronics and software
- Reactive process compatible probe tips
- External trigger
- DC compensation
- RF compensation

The Plato Probe is designed to work in deposition plasmas when an insulating film is deposited on the probe surface. This deposition process compatible probe can remain inside a plasma reactor while highly reactive insulating gasses are in use.

The Plato Probe measures plasma parameters such as plasma density, ion current density and electron temperature in plasmas with high deposition rates, like plasma enhanced chemical vapour deposition (PECVD).

The Plato Probe has the most advanced patented technology on the market using ultra-fast biasing to penetrate the deposited film to obtain accurate measurements of the real plasma parameters in a wide range of plasma applications.

The Plato Probe is used to establish plasma process repeatability, even in reactive gas plasma. It is the perfect instrument to understand plasma changes and the impact on surface treatment. The Plato Probe is an essential plasma process diagnostic to understand the correlation between plasma inputs and the plasma state in environments with a high rate of deposition.

Measuring Parameters	
Plasma Density	$1x10^{6}$ to $3x10^{13}cm^{-3}$
Ion Current Density	$1\mu A/cm^2$ to $300mA/cm^2$
Electron Temperature	0.1 to 15 eV

Plato Probe Specifications	
Plasma Power Source	DC, RF, microwave, continuous, pulsed plasma
RF Plasma	Broadband probe 2MHz to 100MHz
Probe Length	300mm to 1400mm (custom available)
Probe Diameter	9.5mm
Probe Tip Diameter	7mm
Probe Customisation	On request
Maximum Operating Temperature	230°C

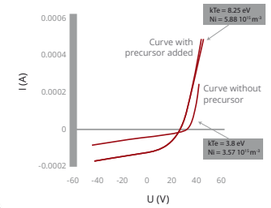
Linear Drive	
Step Resolution	0.025mm
Control Mechanism	Automated through software
Drive Length	300mm, 450mm, 600mm or custom

Electronics Control Unit	
Probe Voltage Scan Range	Floating potential ±30V
Current Range	100nA to 20mA
Communication	USB 2.0
Sampling Rate	80 MSPS (V,I)
Data Acquisition Resolution	4.5mV, 4.5nA
Time Resolved Step Resolution	1µS to 1mS
External Trigger TTL Compatible	TTL compatible 10Hz to 50KHz

Application Software	
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8

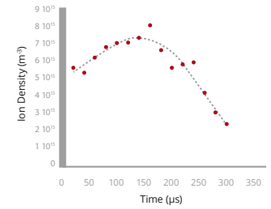
Operating Parameters	
Pressure (Pascal)	0 to 1,000Pa
Pressure (Torr)	0 to 10Torr
Density	$10^{6}cm^{-3}$ to $10^{14}cm^{-3}$
Gas Reactivity	Inert to highly reactive
Power Frequency	DC (0 to 50kHz) • RF (2MHz to 100MHz) • UHF (100MHz to 1GHz) • Microwave (1GHz to 3 GHz)

Plato Probe Measurements



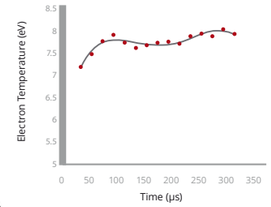
Current and voltage characteristic with and without depositing precursor

Time Resolved Ion Density



Time resolved ion density in a pulsed deposition plasma

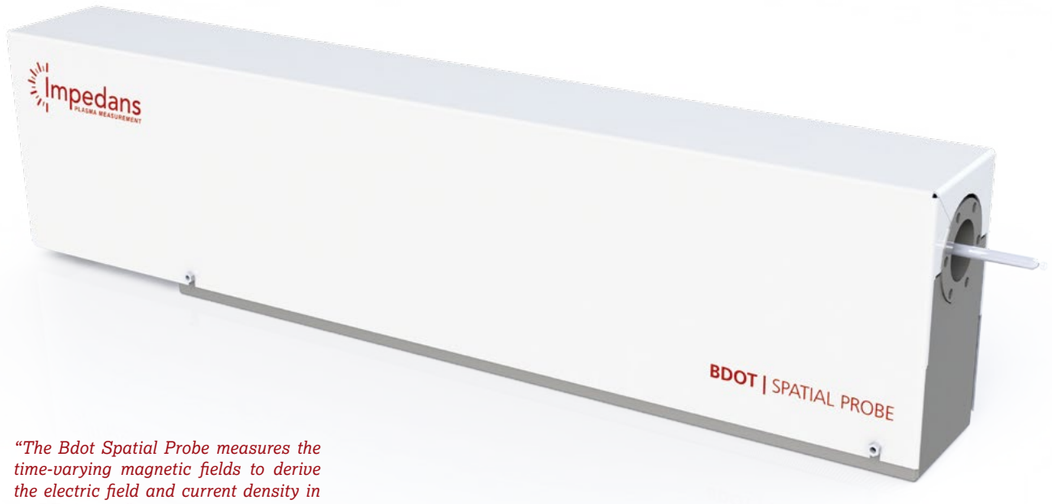
Time Resolved Electron Temperature



Time resolved electron temperature in a pulsed deposition plasma

Bdot Probe

Rate of Change of Magnetic Flux



"The Bdot Spatial Probe measures the time-varying magnetic fields to derive the electric field and current density in an RF plasma."

Measures
- B-dot

Functionality
- Time averaged
- Time resolved
- Time trend

Features
- Bdot linear drive
- Bdot replaceable tips
- Bdot replaceable shaft
- Time-resolved measurements
- Time averaged measurements
- External trigger

The Bdot Spatial Probe is mounted on a linear drive system and measures the rate of change in the magnetic fields while scanning across a plasma reactor. It is inserted through a vacuum port and measures in the bulk of the plasma. Both the probe and the linear movement is controlled via PC.

The Bdot Spatial Probe is used in most sectors using RF plasma across industry and research, such as etching, coatings, sputtering, PECVD and ion beam. The Bdot Spatial Probe is used to confirm models, develop new processes, plasma tool design and plasma research.

Knowing more about the time varying magnetic fields can help provide information about common problems like uniformity. The Bdot Spatial Probe is mainly used on the research side of plasma diagnostics but its robust nature and its ability to take useful measurements allows it to be used in the most harsh of plasma environments.

Measuring Parameters

B-dot	T / s
dB-dot/dz	T / s / m

Bdot Probe Specifications

Plasma Power Source	RF, continuous, pulsed plasma
RF Plasma	Broadband probe 0.4MHz to 100MHz
Probe Length	300mm to 1400mm (custom available)
Probe Diameter	9.5mm (custom available)
Single Probe Loop Radius	2.5mm
Double Probe Loop Radius	2.5mm x2
Probe Tip Material	W, Ta, Ni, Pt (custom available)
Probe Customisation	90°, 45° bend (custom available)
Maximum Operating Temperature	230°C (custom up to 1200°C)

Linear Drive

Step Resolution	0.025mm
Control Mechanism	Automated through software
Drive Length	300mm, 450mm, 600mm or custom

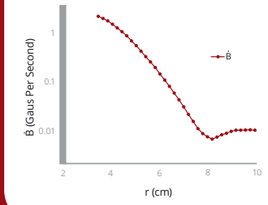
Electronics Control Unit

B-dot Current	1mA to 300mA
Communication	USB 2.0
Sampling Rate	10 samples per second
Data Acquisition Resolution	4.5mV
Time Resolved Step Resolution	1µs
External Trigger TTL Compatible	10Hz to 1MHz

Application Software

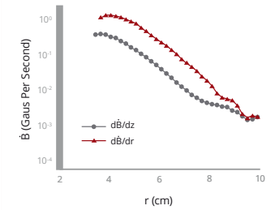
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8

ḃz Magnetic Flux Strength



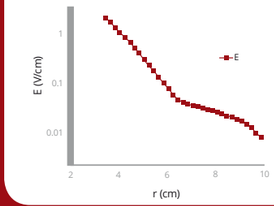
Radial profile of the ḃz magnetic flux strength measured with the single loop

dḂr/dz and dḂz/dr



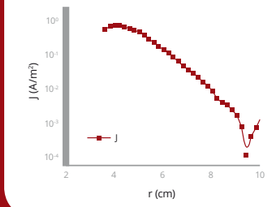
Radial profile of dḃr/dz and dḃz/dr

Calculated Azimuthal Electric Field



Radial profile of the calculated azimuthal electric field

Calculated Azimuthal Current Density



Radial profile of the calculated azimuthal current density

Atmospheric Plasma Parameters

Plasmas used in applications at high pressures have become more prevalent in recent years. The ability to measure and understand the plasma parameters gives great insight into the processes.

Atmospherix Probe

High Pressure Plasma Measurement

"This high temperature atmospheric pressure Langmuir probe is ideal for measuring the plasma parameters of plasma torches and flames."

Measures
- Electron temperature
- Plasma density
- Ion flux
- Ion density
- Debye length

Functionality
- Time averaged
- Time resolved
- Time trend

Features
- Atmospherix probe automated electronics and software
- Automated probe tip cleaning
- Replaceable probe tips
- Replaceable probe shaft
- Spatial profile measurements
- External trigger
- DC compensation
- RF compensation

The Atmospherix Probe is designed to function in high pressure plasma environments including atmospheric pressure plasma. It is mainly used to characterise the plasma parameters of plasma flames, plasma jets or other plasmas that are not contained inside a chamber.

This ground-breaking plasma diagnostic and plasma characterisation system measures electron temperature, plasma density, ion flux, ion density and Debye length.

The Atmospherix Probe is the first instrument enabling scientists to measure the electron density, Ion density, electron temperature and floating potential of plasma at atmospheric pressure and provides plasma parameter measurement in DC, RF, arcs, microwave, continuous and pulsed plasma. The Atmospherix Probe has the most advanced geometry on the market to measure flowing plasma at high pressure.

This unique instrument includes a linear drive system to enable controlled movement through a plasma with minimal disturbance.

Measurement Parameters

Plasma Density	10^9 to 6x10^{16}cm^{-3}
Ion Current Density	1μA/cm² to 300mA/cm²
Electron Temperature	0.1 to 15eV

Atmospherix Probe Specifications

Plasma Power Source	DC, RF, arc, torch, microwave, continuous and pulsed
Probe Length	300mm (custom available)
Probe Tip Diameter	0.4mm
Customisation	On request
Maximum Gas Temperature	5,000°C

Recommended Cooling System (not included)

Method	Re-circulating chiller
Coolant	Distilled water
Coolant Capacity	8 litres
Pump Pressure	4 bar
Water Flow Rate	1 litre per minute
Power Handling Capability	1kW

Linear Drive

Step Resolution	0.025mm
Control Mechanism	Automated through software
Drive Length	150mm

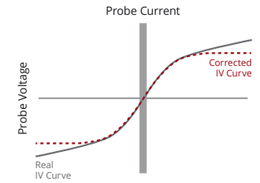
Electronics Control Unit

Probe Voltage Scan Range	±145V
Current Range	100nA to 20mA
Communication	USB 2.0
Sampling Rate	80 MSPS (V,I)
Data Acquisition Resolution	4.5mV, 4.5nA
Time Resolved Step Resolution	12.5nS to 1ms
External Trigger TTL Compatible	10Hz to 50 KHz

Application Software

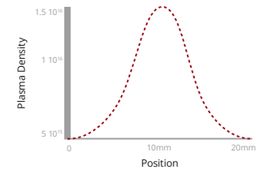
Operating System	Windows 2000 / XP / Vista / Windows 7 / Windows 8

Atmospherix Double Probe Characteristic



Atmospherix Double Probe characteristic showing correction for sheath expansion

Plasma Density Spatial Profile



Spatial profile of plasma density in microwave arc at atmosphere

Power Delivery Plasma Measurement

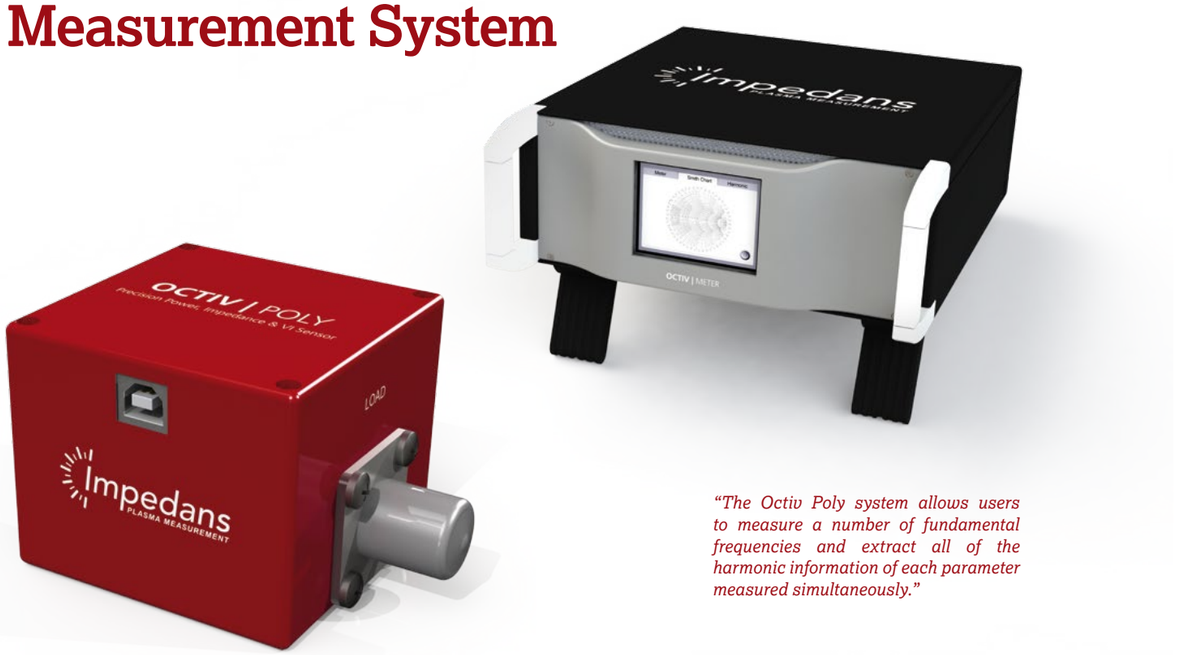
Slight changes in power, as a plasma input parameter, can affect the quality of a substrate. Monitoring the voltage, current, phase and harmonic information can result in better process stability.

Octiv System Comparison Chart

	Real Power	Forward Power	Reflected Power	Impedance	Voltage	Current	Phase Angle	Harmonics	Simultaneous Measurements	Ion Flux	Waveform Reconstruction
Mono	✓	✓	✓	✓							
VI	✓	✓	✓	✓	✓	✓	✓	✓			
Poly	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Suite	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Octiv Poly

Multi Frequency In-Line RF Voltage, Current, Phase, Impedance & Harmonic Measurement System



"The Octiv Poly system allows users to measure a number of fundamental frequencies and extract all of the harmonic information of each parameter measured simultaneously."

Measures
- Voltage
- Current
- Phase
- Harmonics
- Impedance

Functionality
- Time averaged
- Time resolved
- Time trend
- Smith chart

Features
- Optional meter display unit
- Compact probe design
- Frequency agile software
- Application Programming Interface (API) for extending software
- USB 2.0 communications interface as standard with RS-232 and Ethernet available on request

The Octiv Poly is a multi-frequency in-line RF voltage, current and phase measurement system. It can measure multiple fundamental frequencies and their harmonics simultaneously and has an accuracy of 1% with 1µs time resolution.

The Octiv Poly can detect and measure up to 5 fundamental frequencies and all their components (voltage, current, phase angle and harmonics) at the same time. Measurements can be viewed directly on a PC via USB. Some users may require a desktop meter unit for continuous monitoring that can be purchased separately as an optional extra.

Measuring Parameters (Range)	
Voltage Range	Voltage 20 – 3000 Vrms
Current Range	0.1 – 100 Arms
Phase Range	± 180°
Harmonic (Voltage, Current and Phase)	Up to 32 harmonics
Frequency Range	350 kHz - 300 MHz
Fundamental Frequencies	5 simultaneous
Impedance	1 to 500Ω
Power Real, Forward and Reflected (Watt)	200mW to 12KW

Pulsed Parameters (Time)	
Voltage, Current, Phase	1µs
Harmonic (Voltage, Current and Phase)	1µs
Frequency and Impedance	1µs
Power Real, Forward and Reflected (Watt)	1µs

Measuring Parameters (Accuracy)	
Voltage and Current Accuracy	± 1%
Phase Accuracy	± 1°
Harmonic (Voltage, Current and Phase) Accuracy	± 5%
Frequency Accuracy	± 10kHz
Impedance	± 1%
Power Real, Forward and Reflected (Watt)	± 1%

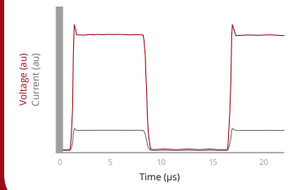
Measuring Parameters (Resolution)	
Voltage Resolution	0.25V
Current Resolution	10mA
Phase Resolution	0.01°
Harmonic (Voltage, Current and Phase) Resolution	As above
Frequency Resolution	1kHz
Impedance Resolution	± 1%
Power Real, Forward and Reflected (Watt) Resolution	± 1%

Sensor	
Number of fundamentals	(F0) Maximum of 5 simultaneously
RF Power	Max 12.5kW (limited by connector)
Uniformity	2% maximum
Connectors	All standard connectors available
Sensor Impedance	50Ω

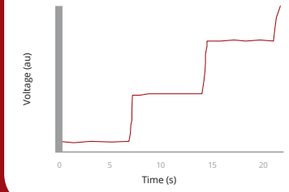
Display Meter	
Dimensions	350 x 200 x 120mm
Display	Touch screen LCD
Weight	1.5Kg
Connections	Analog I/O, Digital I/O, Ethernet, Devicenet

Operating Parameters	
Impedance	0Ω to 5,000Ω
Pulsed Repetition Frequency	10Hz to 100KHz
Voltage	20V to 3,000V
Current	0.1A to 100A
Phase	±90°, ±180°
Power Frequency	MF (350kHz to 1MHz) • RF (1MHz to 100MHz)

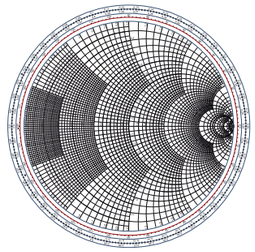
Pulsed Time Resolution



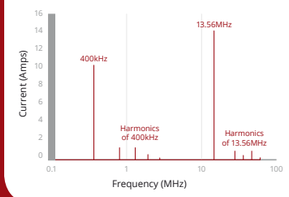
Voltage Step



Smith Chart

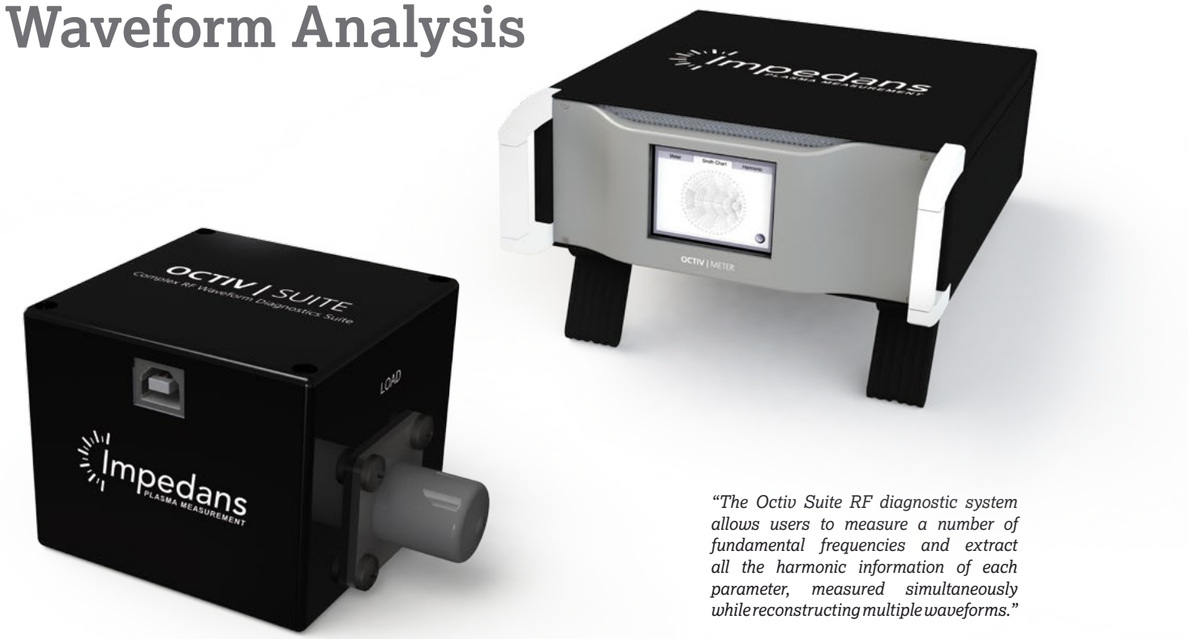


Spectrum of Dual Frequency System



Octiv Suite

Multi-Frequency RF System with Plasma Diagnostic and Complex Waveform Analysis



"The Octiv Suite RF diagnostic system allows users to measure a number of fundamental frequencies and extract all the harmonic information of each parameter, measured simultaneously while reconstructing multiple waveforms."

Measures
- Voltage
- Current
- Phase
- Harmonics
- Impedance
- Ion flux
- Waveform reconstruction

Functionality
- Time averaged
- Time resolved
- Time trend
- Smith chart

Features
- Optional meter display unit
- Compact probe design
- Frequency agile software
- Application Programming Interface (API) for extending software
- USB 2.0 communications interface as standard with RS-232 and Ethernet available on request

The Octiv Suite RF diagnostic is an in-line RF voltage, current, phase, harmonics and plasma diagnostic system. It can measure all the parameters of RF power, break them down to their individual components and reconstruct the waveforms of multiple fundamental frequencies simultaneously.

This cutting edge system can also measure plasma parameters such as ion flux by using the RF electrode as a sensor. The Octiv Suite is truly in a class of its own when it comes to analysing power delivery into a plasma reactor. The Octiv Suite measures voltage, current, phase, impedance and harmonics and the measurements can be viewed from a PC or direct on the optional meter unit.

Measuring Parameters (Range)	
Voltage Range	Voltage 20 – 3000 Vrms
Current Range	0.1 – 100 Arms
Phase Range	± 180°
Harmonic (Voltage, Current and Phase)	Up to 32 harmonics
Frequency Range	350 kHz – 300 MHz
Fundamental Frequencies	5 simultaneous
Impedance	1 to 500Ω
Power Real, Forward and Reflected (Watt)	200mW to 12KW

Measuring Plasma Parameters	
Ion Flux (based on 300mm electrode)	1 A/m² to 100 A/m²
Plasma Resistance	1 to 500Ω
Non Linear Sheath Impedance	.1 to 500Ω

Pulsed Parameters (Time)	
Voltage, Current, Phase	1µs
Harmonic (Voltage, Current and Phase)	1µs
Frequency and Impedance	1µs
Power Real, Forward and Reflected (Watt)	1µs

Measuring Parameters (Accuracy)	
Voltage and Current Accuracy	± 1%
Phase Accuracy	± 1°
Harmonic (Voltage, Current and Phase) Accuracy	± 5%
Frequency Accuracy	± 10kHz
Impedance	± 1%
Power Real, Forward and Reflected (Watt)	± 1%

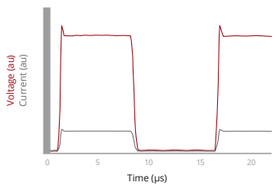
Measuring Parameters (Resolution)	
Voltage Resolution	0.25V
Current Resolution	10mA
Phase Resolution	0.01°
Harmonic (Voltage, Current and Phase) Resolution	As above
Frequency Resolution	1kHz
Impedance Resolution	± 1%
Power Real, Forward and Reflected (Watt) Resolution	± 1%

Sensor	
Number of fundamentals	(F0) Maximum of 5 simultaneously
RF Power	Max 12.5kW (limited by connector)
Uniformity	2% maximum
Connectors	All standard connectors available
Sensor Impedance	50Ω

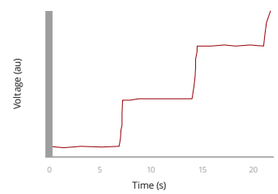
Display Meter	
Dimensions	350 x 200 x 120mm
Display	Touch screen LCD
Weight	1.5Kg
Connections	Analog I/O, Digital I/O, Ethernet, Devicenet

Operating Parameters	
Impedance	0Ω to 5,000Ω
Pulsed Repetition Frequency	10Hz to 100KHz
Voltage	20V to 3,000V
Current	0.1A to 100A
Phase	±90°, ±180°
Power Frequency	MF (350kHz to 1MHz) • RF (1MHz to 100MHz)

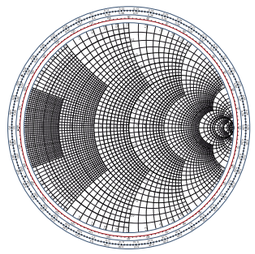
Pulsed Time Resolution



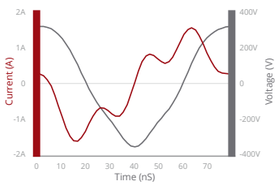
Voltage Step



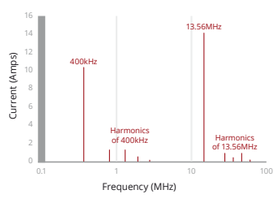
Smith Chart



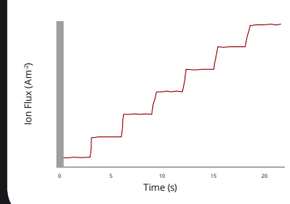
Waveform Reconstruction



Spectrum of Dual Frequency System



Ion Flux Time Trend



Octiv Mono

In-Line RF Power

"The Octiv Mono RF power meter and RF power sensor can measure up to five different fundamental frequencies in a single sensor. This reduces the need for multiple sensors in a laboratory environment."

Measures
- Real power
- Forward power
- Reflected power
- Impedance

Functionality
- Time averaged
- Time resolved
- Time trend
- Smith chart

Features
- Octiv VI meter display unit
- Compact probe design
- Frequency agile software
- Application Programming Interface (API) for extending software
- USB 2.0 communications interface as standard with RS-232 and Ethernet available on request

The Octiv Mono is an in-line RF power meter and RF power sensor measurement system. It measures a single fundamental frequency and has an accuracy rating of 1% and a time resolution of 1µs. Each system has a drop down menu with a choice of 5 fundamental frequencies. It measures real power, forward power, reflected power, impedance and displays through a meter unit.

The Octiv Mono is a precision RF power sensor used in a large number of laboratory applications. The Octiv Mono operates to 1% true accuracy, and is immune to harmonics. It measures true power into any load, including a non-50Ω cable or load, making it the most trusted power sensor for applications such as semiconductor manufacturing.

The Octiv Mono is calibrated to five fundamental frequencies: 2MHz | 13.56MHz | 27.12MHz | 40.68MHz | 60MHz. Each frequency can be selected via a drop down menu and the sensor has a power range from 0 to 12 kW.

The Octiv Mono RF power meter and RF power sensor helps solve issues such as poor production yields, tool matching, fault detection and classification. It helps to define exact process windows and determines the health of power subsystems. The Octiv Mono helps determine 'process run to run' stability. It gives you the confidence to trust the accuracy of the most complex process input, RF power delivery.

Impedans
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