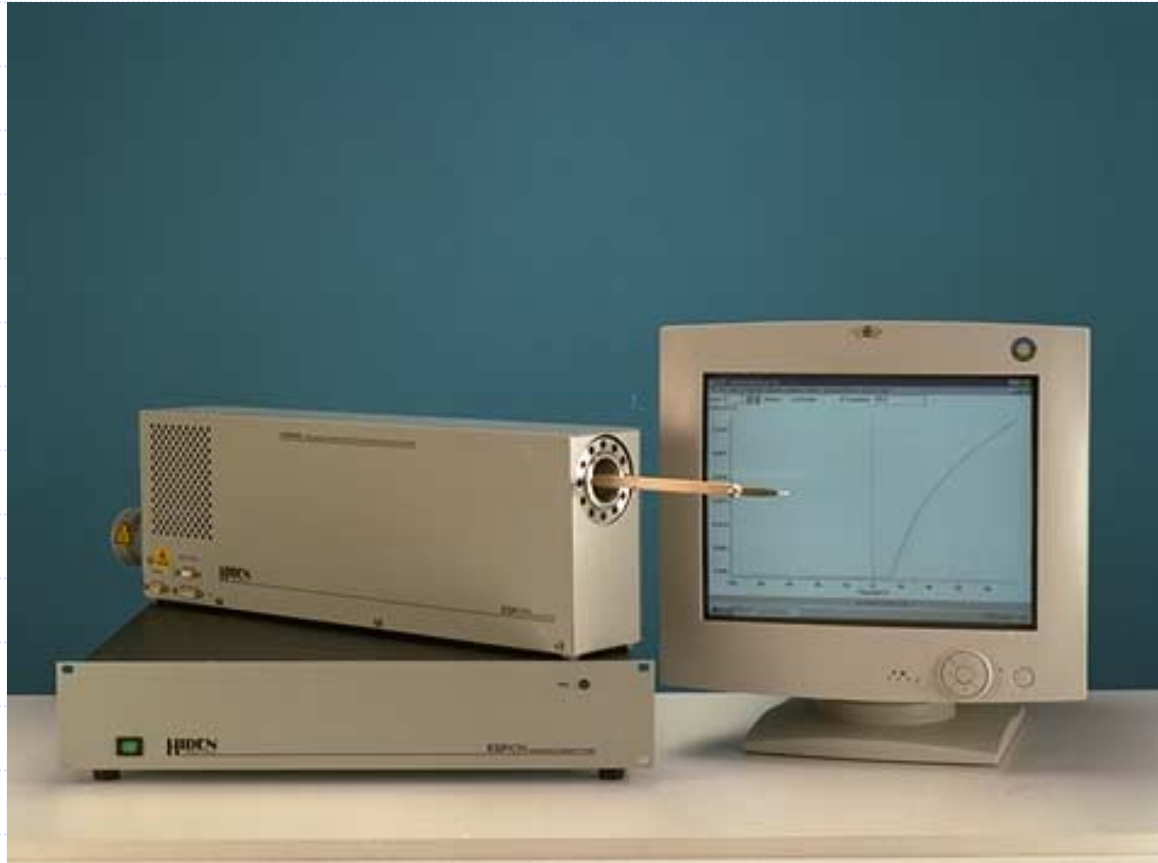


ESPION advanced Langmuir probe



- ◆ etching
- ◆ depositing
- ◆ cleaning
- ◆ pulsed

- ◆ Ne
- ◆ Ni
- ◆ Te
- ◆ EEDF

presentation overview

◆ description of the Langmuir probe technique

- the technique
- interpretation of the I-V characteristic
- operation in different types of plasmas

◆ ESPION advanced Langmuir probe

- the probe
- the hardware
- the software interface

◆ why choose Hiden Analytical ?

- company profile
- people
- installations

ESPION overview

◆ probe

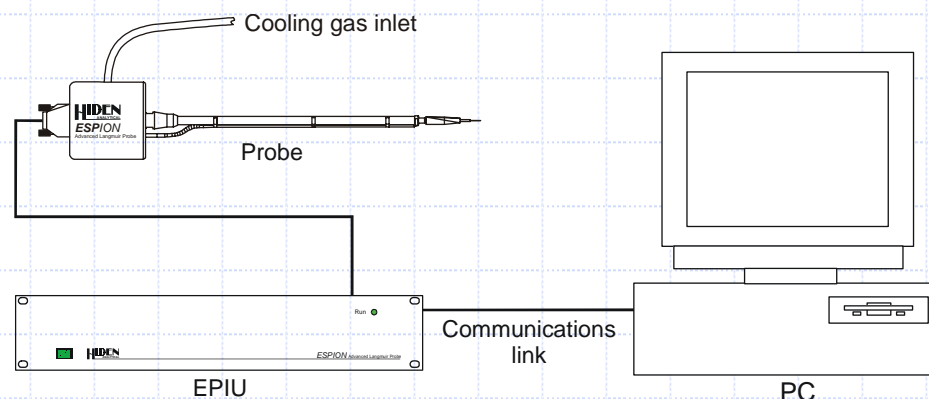
- rf compensation
- low frequency compensation
- auto linear drives

◆ hardware

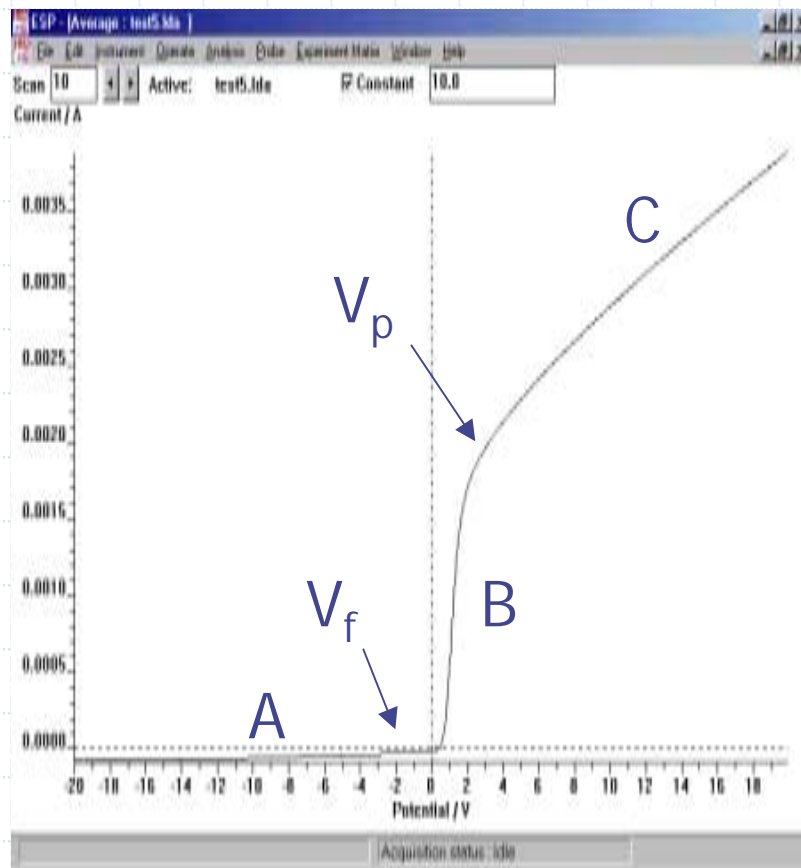
- acquisition speed
- timing circuitry

◆ software

- doe interface
- automatic, semi-automatic, manual analyses
- other features



the I-V characteristic

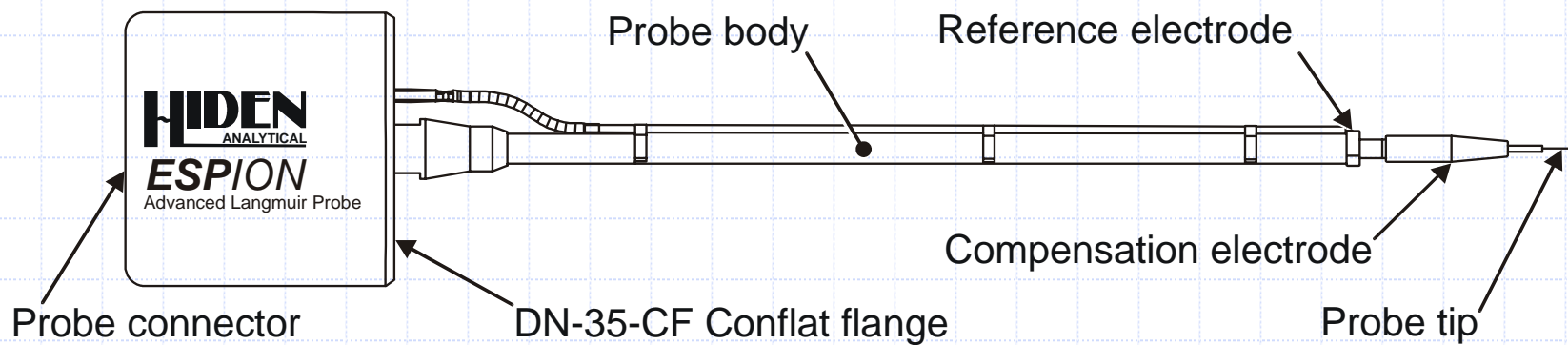


A. ion collection
(yields Ni & Γ i)

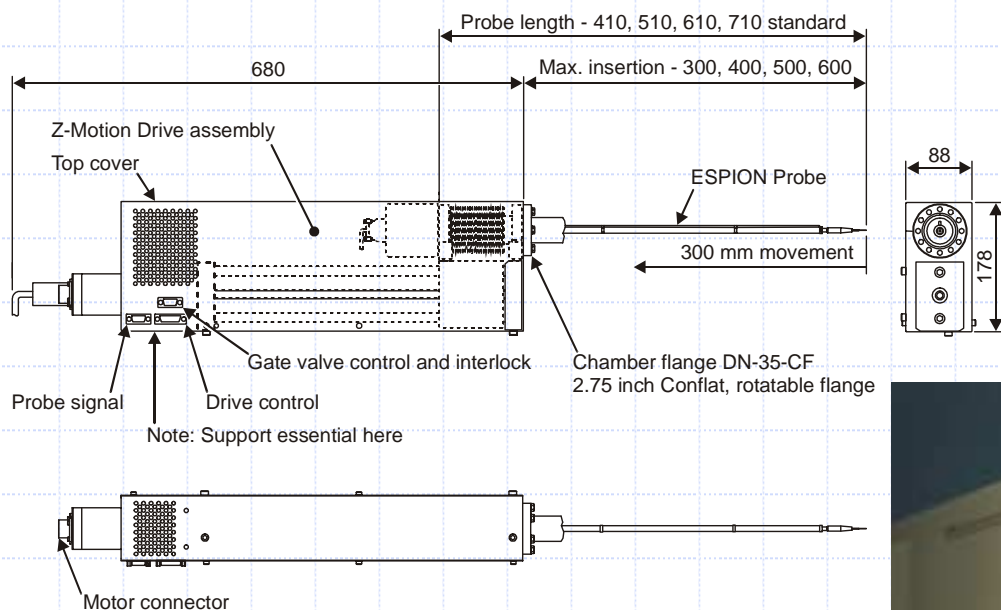
B. electron retardation
(yields Te & EEDF)

C. electron collection
(yields Ne)

probe overview



automatic linear drives

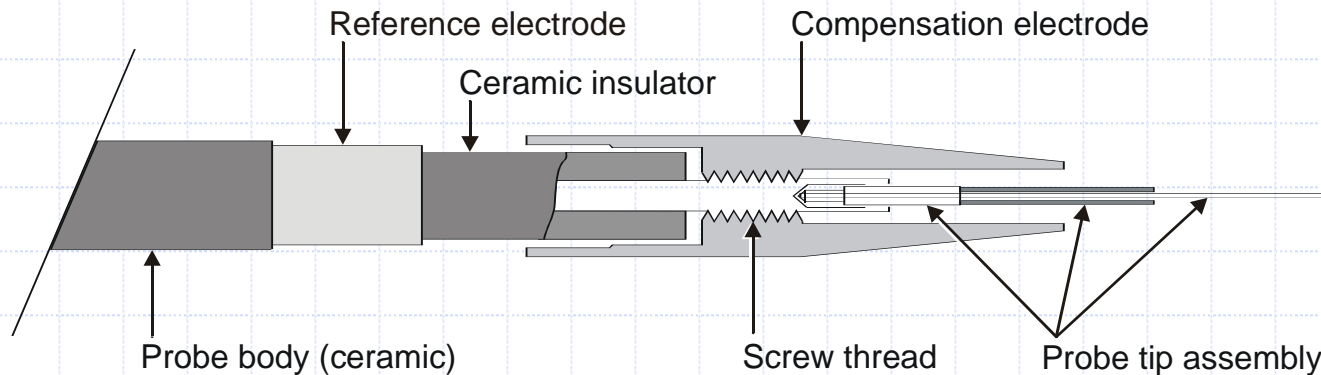


stroke 300-900 mm

speed 12.7-25.0 mms⁻¹



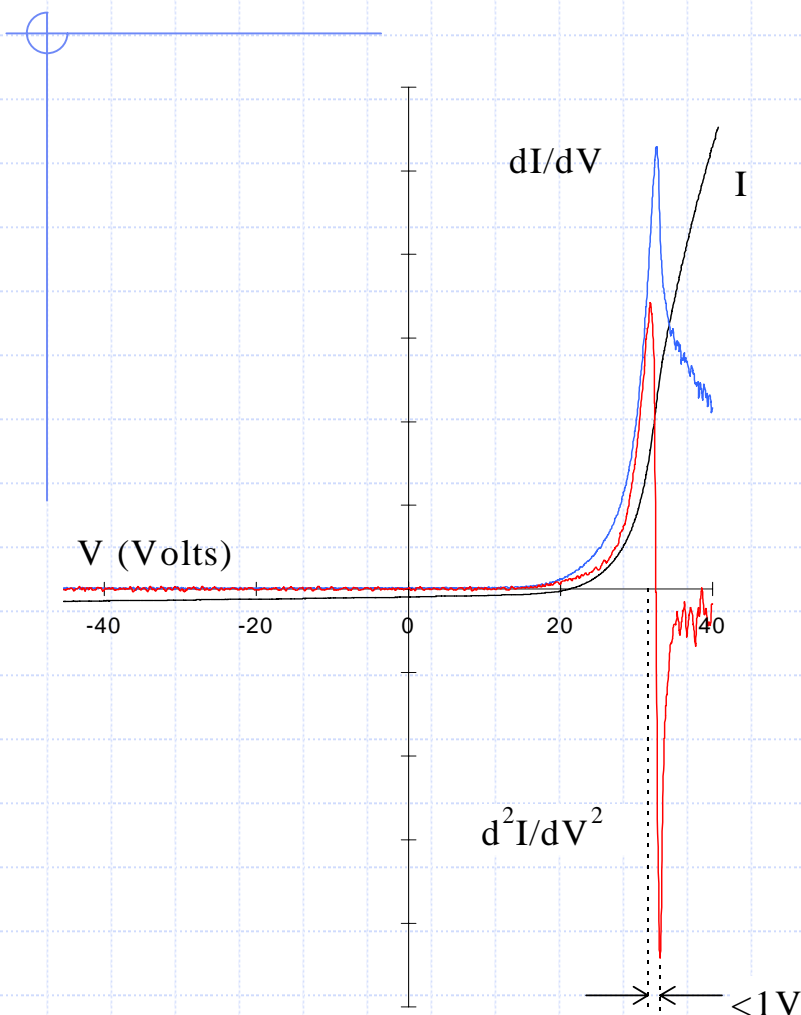
rf compensation



- ◆ component of the rf driving voltage arises between plasma and probe tip distorting probe measurements
- ◆ removed by AC de-coupling the probe from the DC current measuring circuit and letting tip follow rf fluctuations
- ◆ Hiden Analytical were the first to introduce passive compensation and ESPION has the highest blocking impedance of any commercially available Langmuir probe ($4.25 \text{ M}\Omega$ at 13.56 MHz cf. nearest competitors $100\text{k}\Omega$)

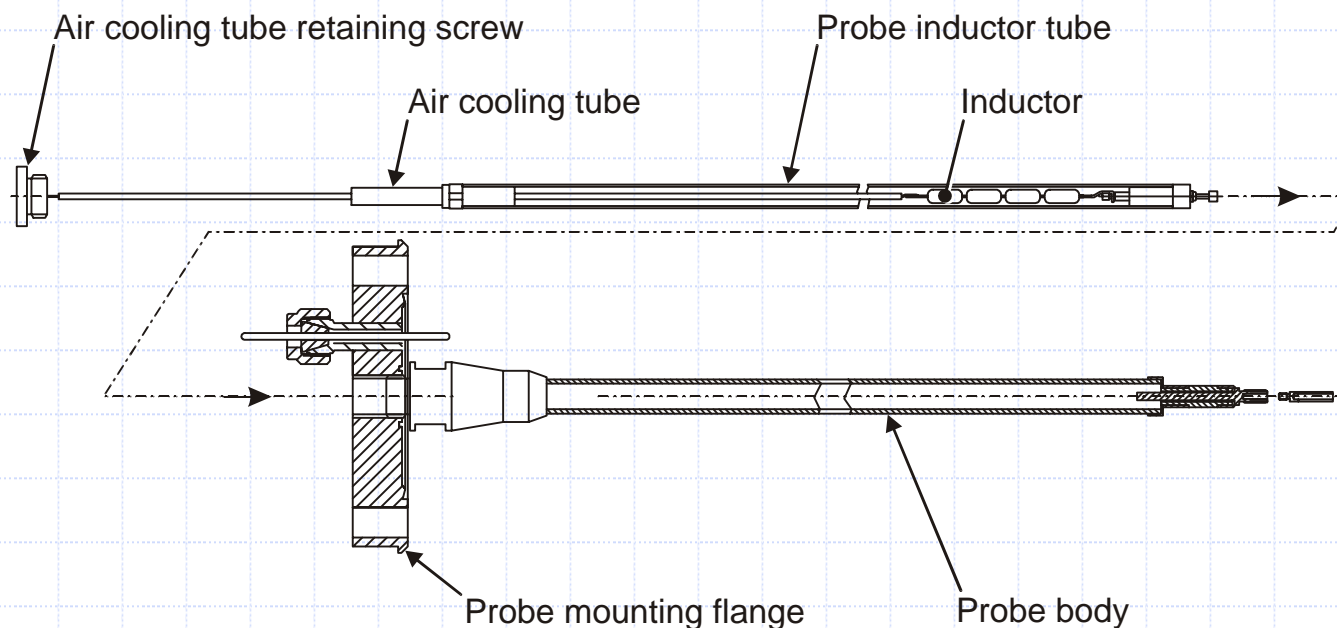
ref. Chatterton, Rees and Al-Assadi, *Vacuum* **42** (1991) 489

rf compensation



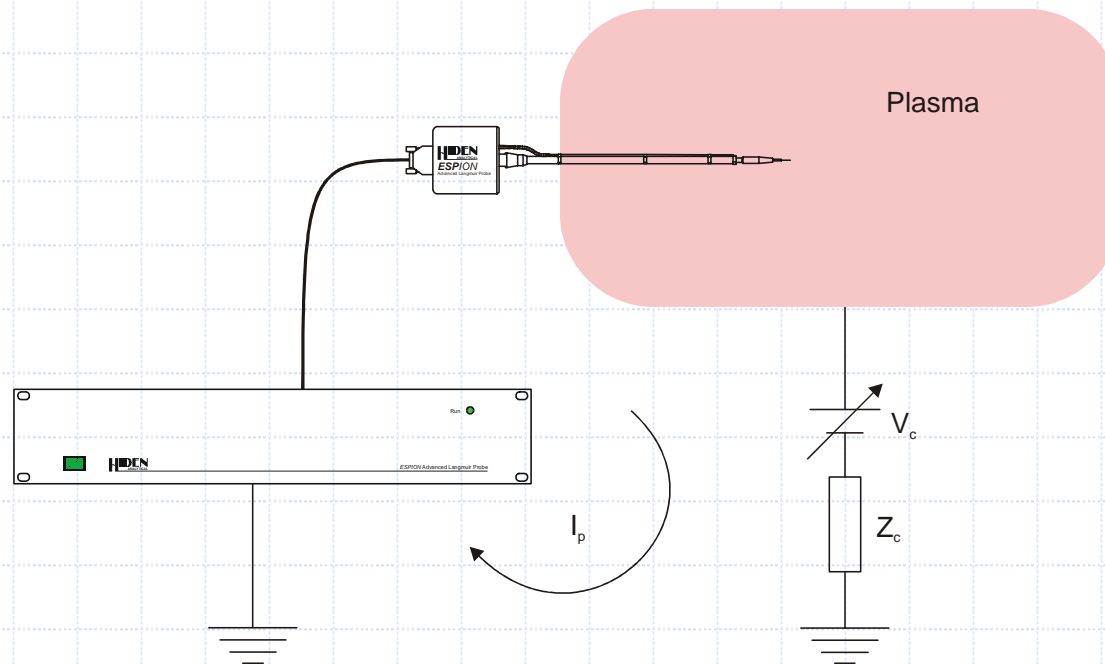
- quality of rf compensation given by the peak separation of the second derivative of the I-V characteristic
- Ideal case (perfect compensation) shows no displacement between the positive and negative peaks (both occurring at V_p)
- As a practical limit, a difference below 1 Volt is considered excellent

user replaceable inductors



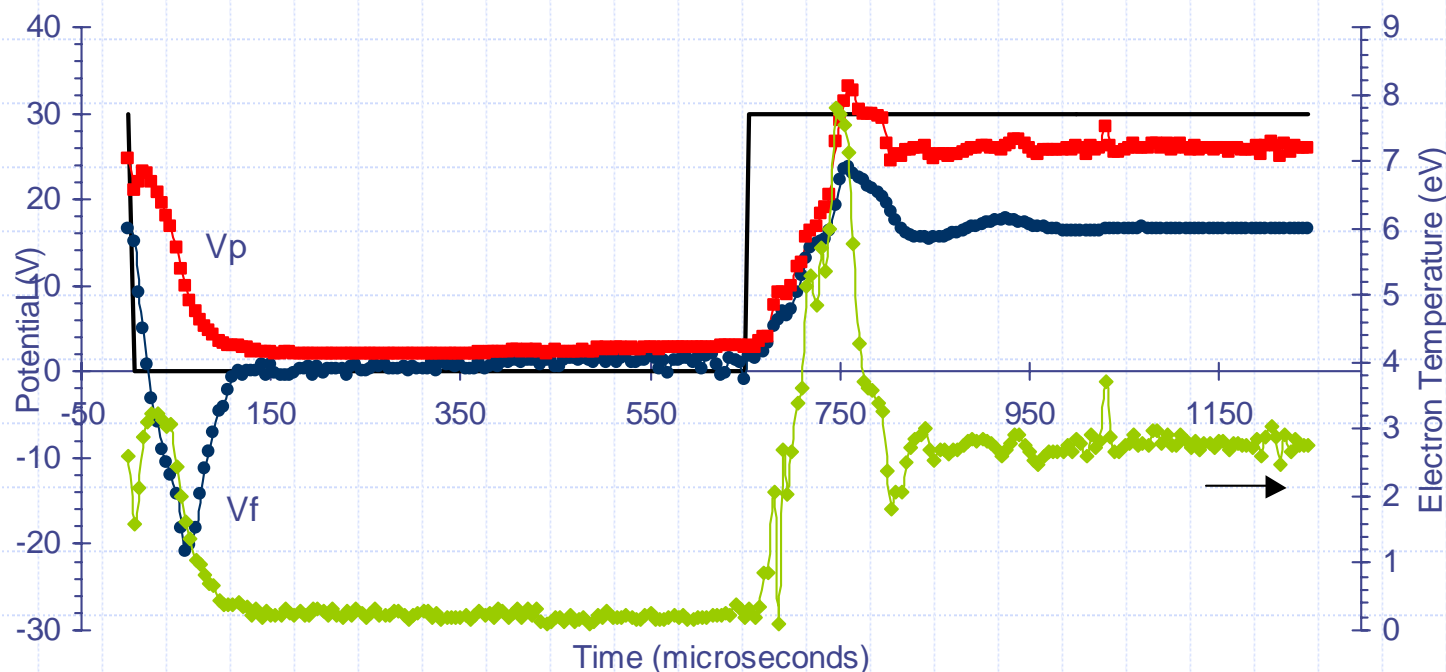
- ◆ unique gas cooled multi-inductor chain is user replaceable for tuning to other rf frequencies without return to factory

low frequency reference probe



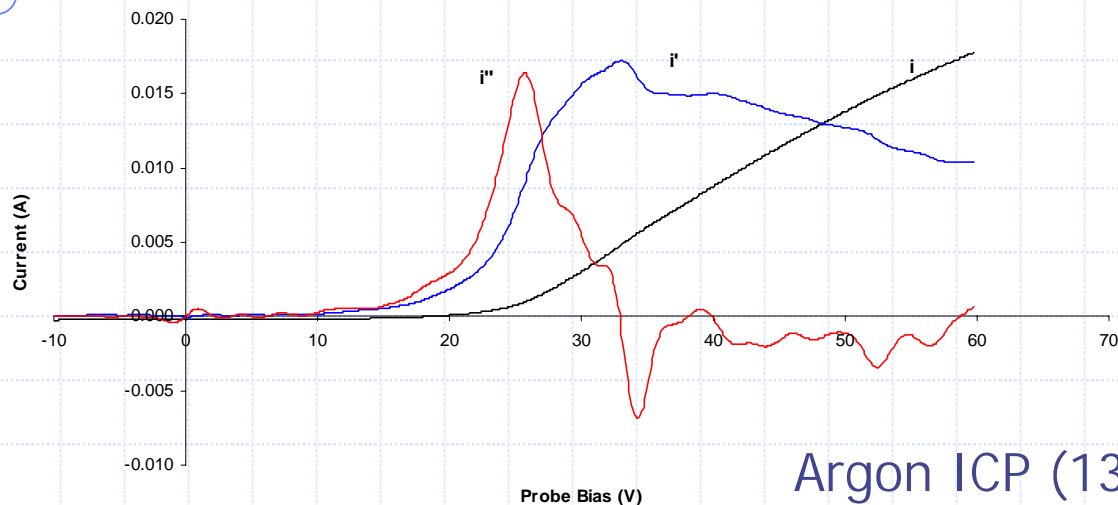
- ◆ reference probe compensates for low frequency effects
 - shift in the plasma potential (e.g. anodised chamber walls)
 - noise (e.g. power supply)

application data – pulsed plasma



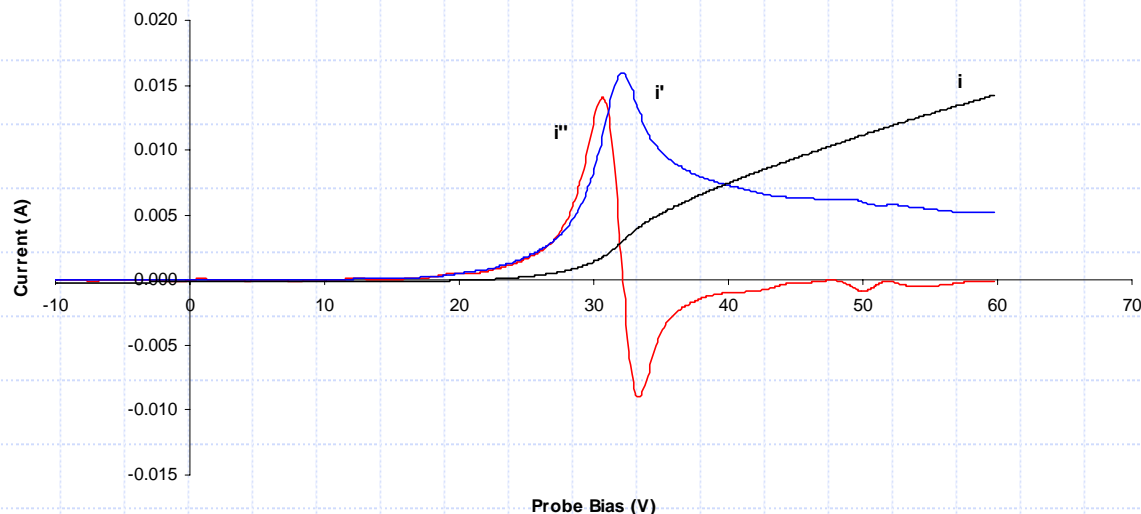
- ◆ time resolved plasma parameters in an Argon ICP discharge, 500 Hz modulation

application data – rf compensation



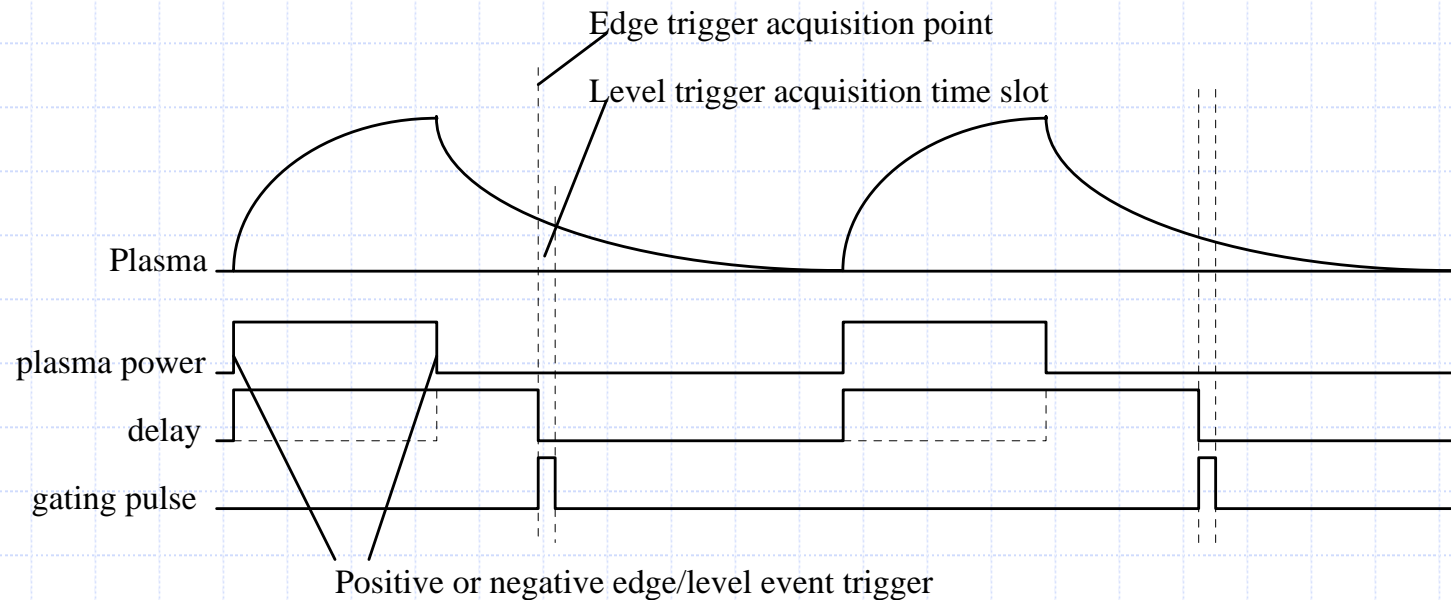
no rf
compensation

Argon ICP (13.56MHz), 30 mTorr, 50 W



with rf
compensation

operation in pulsed plasmas



- I-V curve is constructed over many periods
- by incrementing the delay, time resolved plasma parameters are obtained

operation in pulsed plasmas

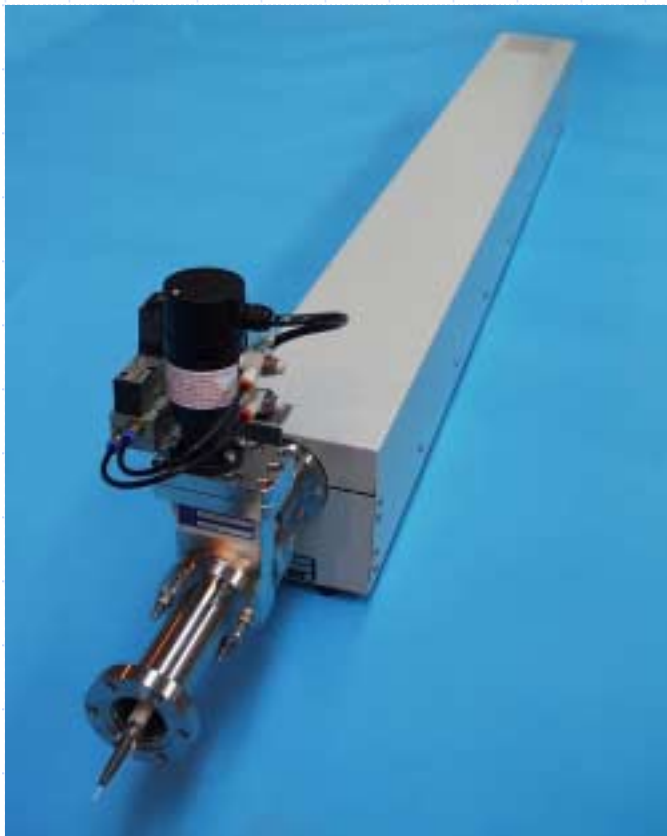
The screenshot shows the 'Acquisition Parameters' dialog box with the following settings:

- Potential Ramp:** Start: -100.00 V, Stop: 100.00 V, Resolution: 0.025 V, Number of Steps: 8001, Reference Probe: ☒
- Range:** Gain range mA: 10.0
- Timing:** Scan Average: 1, Min. Cycle Period: 1000.0 ms
- Probe Information:** Probe Impedance: 0.00 R
- Cleaning & Probe Maintenance:** Pre-Scan Clean: 0.0 ms, Cleaning Potential: 0.00 V, OFF: ☐, 25ms clean / 5ms data acq.: ☒, 100ms clean / 5ms data acq.: ☐, Idle Park Potential: 0.00 V
- Gate Timing:** ☐ Disable, ☒ Enable, Gate Delay: 0.00, Gate Increment: 0.00
- Trigger Mode:** Rising Edge, Falling Edge, Level - high, Level - low

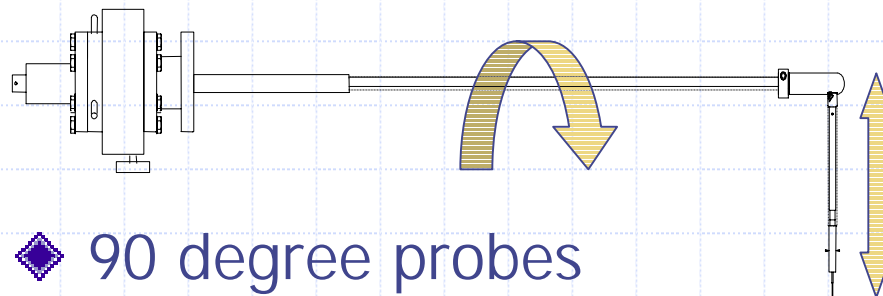
Buttons at the bottom: Ok, Apply now, Cancel

- ESPION has the fastest pulsed plasma specifications of any commercially available Langmuir probe
- ESPsoft contains all necessary gating circuitry as standard

custom solutions



- ◆ 900 mm Auto Linear Drive
- ◆ fully interlocked pneumatic isolation valve



- ◆ 90 degree probes
- ◆ combined linear – rotary drives

collaborating institutes



UCLA

◆ Prof. Francis F Chen



◆ Dr. N St. J Braithwaite
& Dr. Alec Goodyear

why choose Hiden Analytical?

company profile

Hiden Analytical was founded in 1981 and is presently situated in a 23,000 sq. ft. manufacturing plant in Warrington, England with a staff of 65 persons.

Hiden Analytical Inc, a wholly-owned subsidiary of Hiden Analytical Ltd, was formed in New Hampshire on January 1st 1996 to establish a domestic USA sales/service centre.



why choose Hiden Analytical?

people

- ◆ 65 staff providing...
- ◆ sales & service on 4 continents with ...
- ◆ 20 years manufacturing experience and...
- ◆ over 100 staff publications in peer reviewed journals
- ◆ over 200 user publications in peer reviewed journals

why choose Hiden Analytical?

Installations the following sites use Hiden plasma diagnostics

USA

Applied Materials
Axelis
CVC/Veeco
DuPont
IBM Research
LAM Research
Lawrence Livermore
Motorola
NIST
Semetech

UK/Europe

Bosch
IMEC
Motorola
Nortel Networks
Oxford Plasma Technology
Philips
Rolls Royce
SGS Thomson
Siemens
Surface Technology Systems

Asia Pacific

Canon
Hitachi Fundamental Res.
Hyundai
LG Electronics
NEC
Samsung
Sony Corporation
TDK
Tokyo Electron
Toshiba