LINXON

RGA THEORY AND OPERATION

Module 300:
RGA Hardware and How It Works

PURPOSE

- Develop and demonstrate expertise with myRGA
- Understand how RGAs function as a step toward learning how RGA’s can be used to meet customer needs

OBJECTIVES

Upon completion of this module, you will be able to:

- List the two major items of an **RGA System** and describe their function
- List the two major items of an **RGA** and describe their function
- List the four major sections of a typical RGA sensor and describe their function
- Describe the functions of the items on the rear panel of a myRGA electronics box

OUTLINE

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1. RGA System Overview: RGA and Computer
2. RGA Hardware Overview
3. RGA Sensor
4. RGA Electronics Box

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1

RGA SYSTEM OVERVIEW: RGA AND COMPUTER

GENERAL SCHEMATIC OF RGA SYSTEM

myRGA

Control Computer

- Ethernet connection

FUNCTIONING RGA SYSTEM

2. Detect or measure the gases present in a chamber

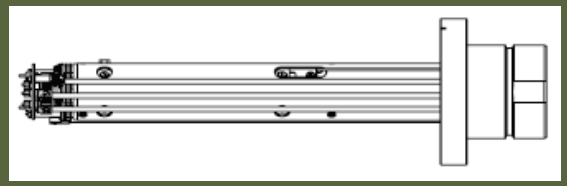
1. Control operation of RGA

3. Analyze, display and store results

2 RGA HARDWARE OVERVIEW

myRGA

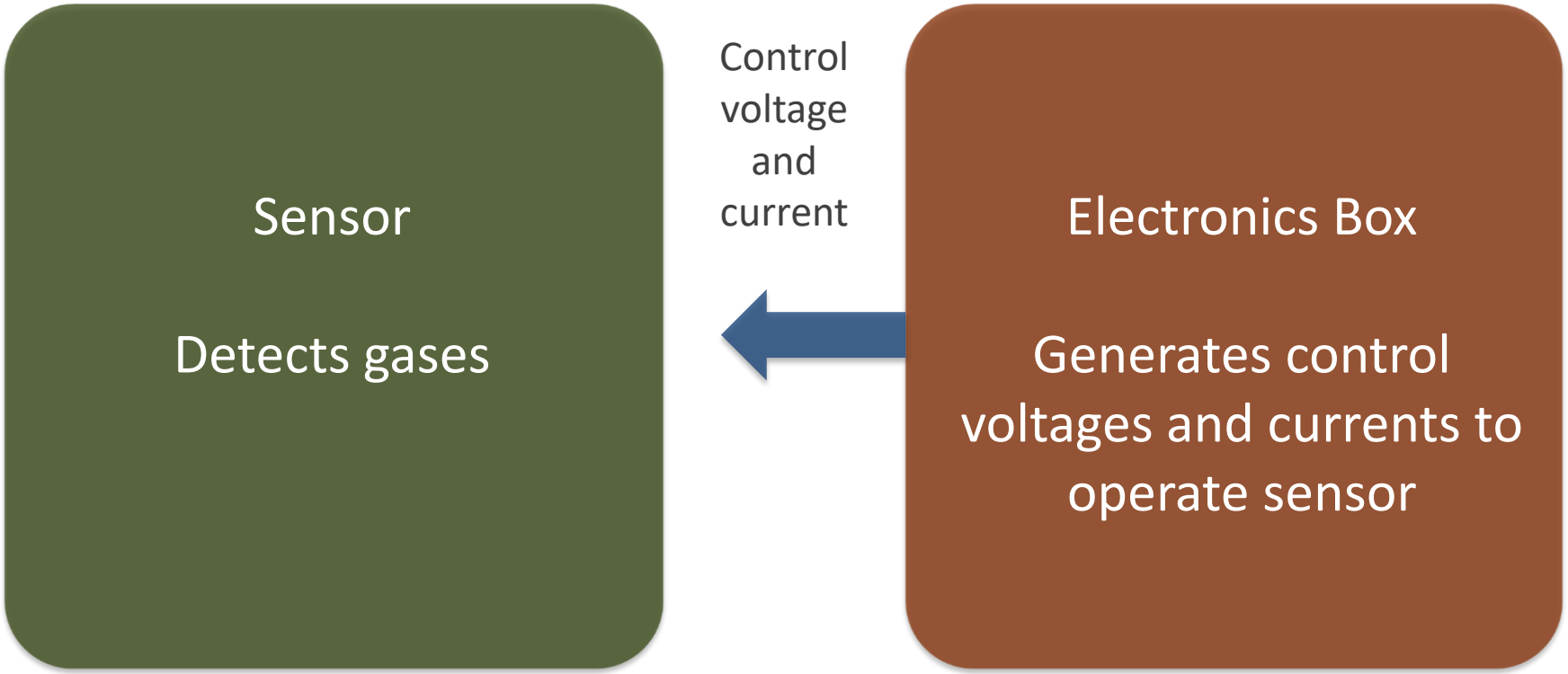
myRGA



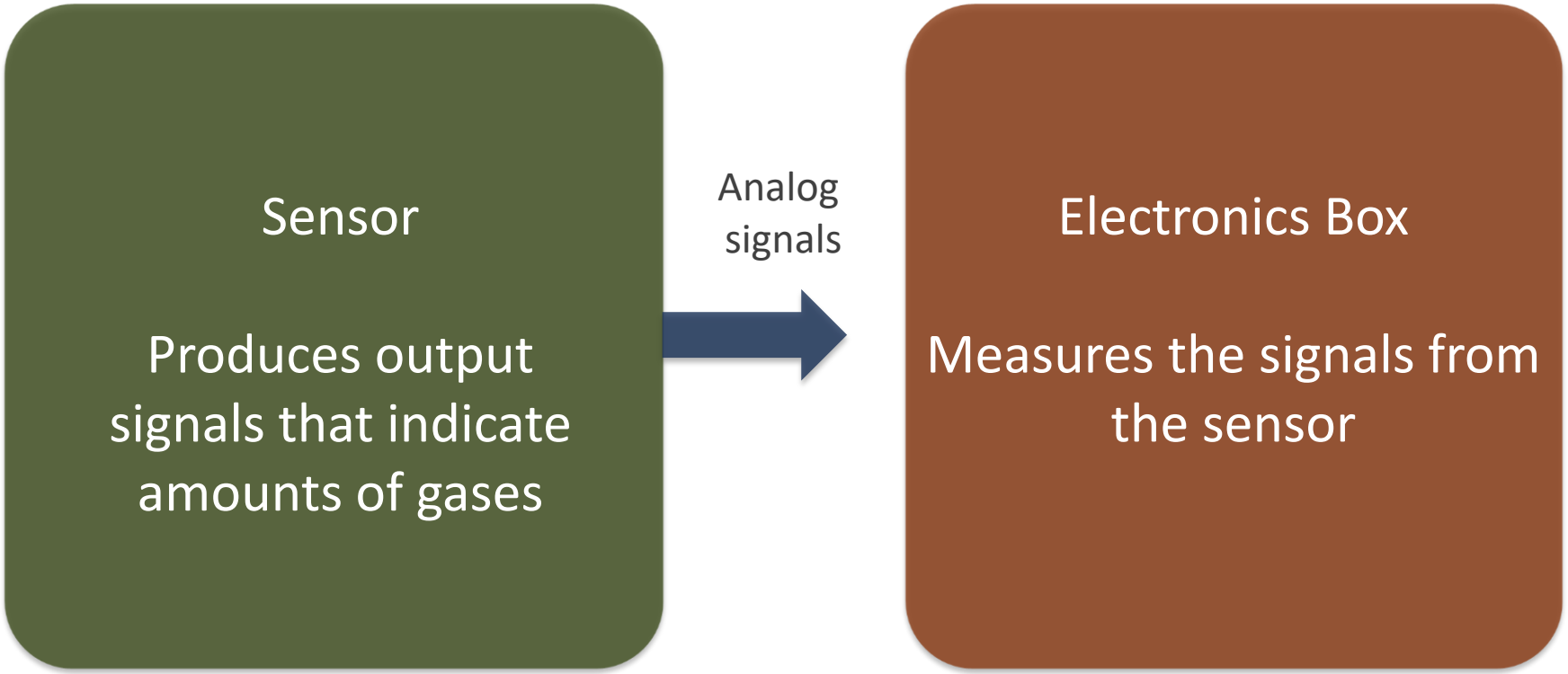
Sensor

Electronics Box

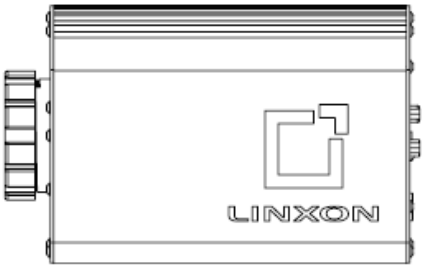
ELECTRONICS BOX TO SENSOR



SENSOR TO ELECTRONICS BOX



ELECTRONICS BOX TO COMPUTER



Sensor

Electronics Box

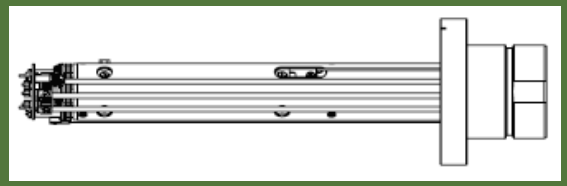
Measured values are converted to digital format

Control Computer

Receive data, then analyze, display and store results

3 RGA SENSOR

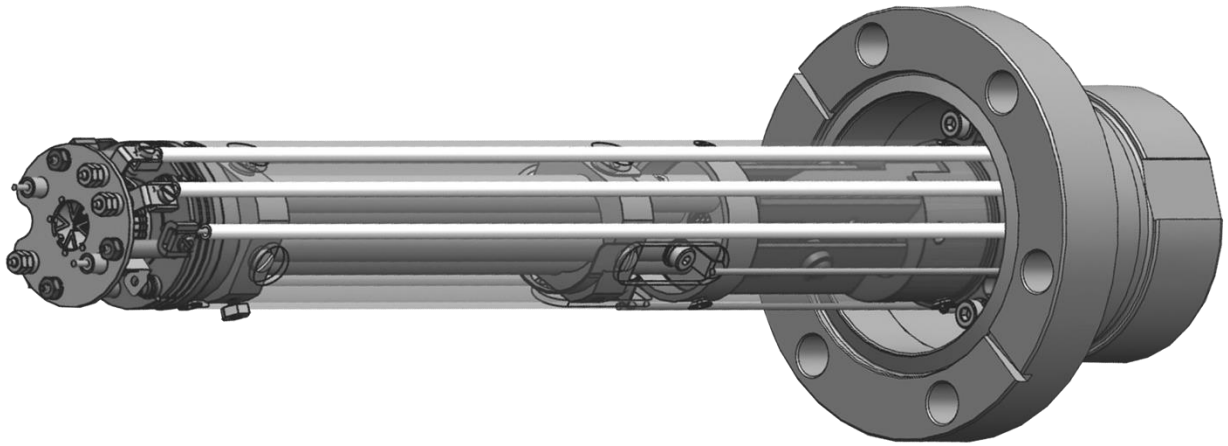
SENSOR



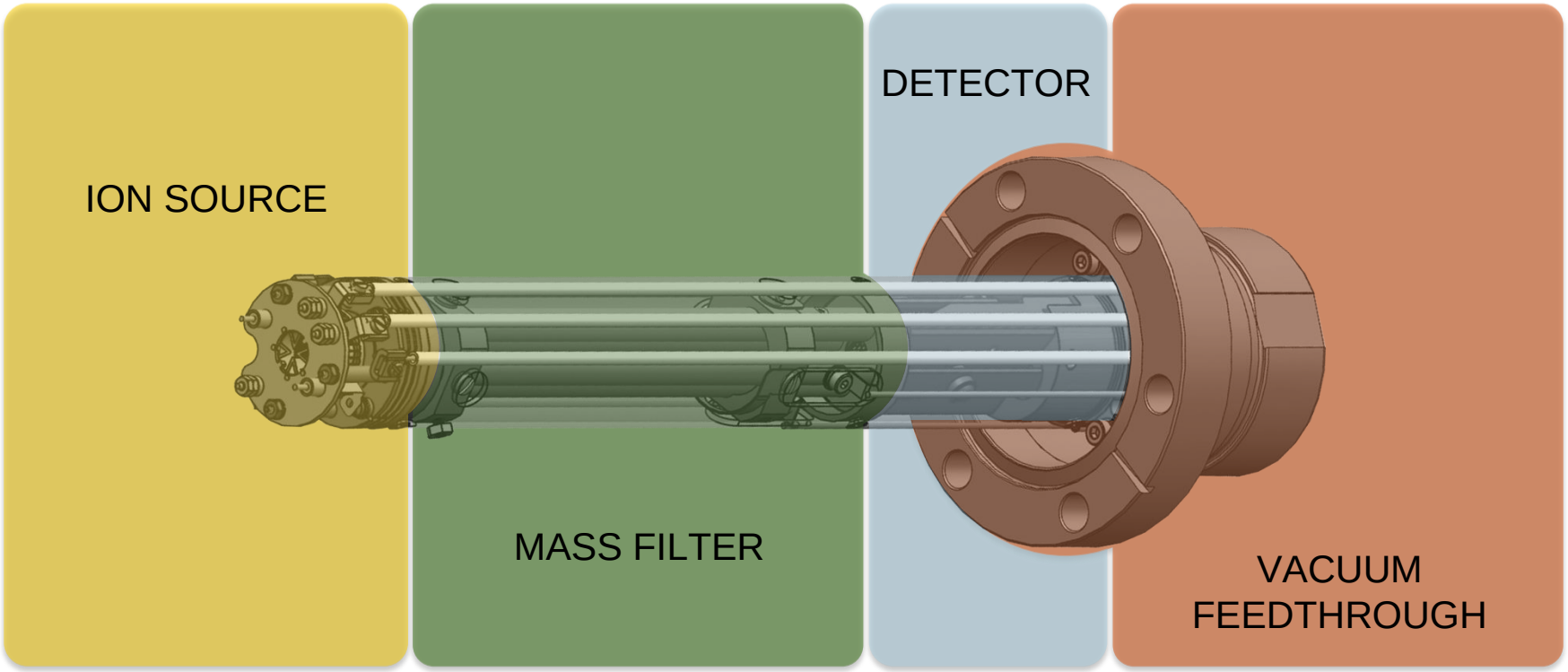
myRGA
Sensor

myRGA
Electronics Box

SENSOR

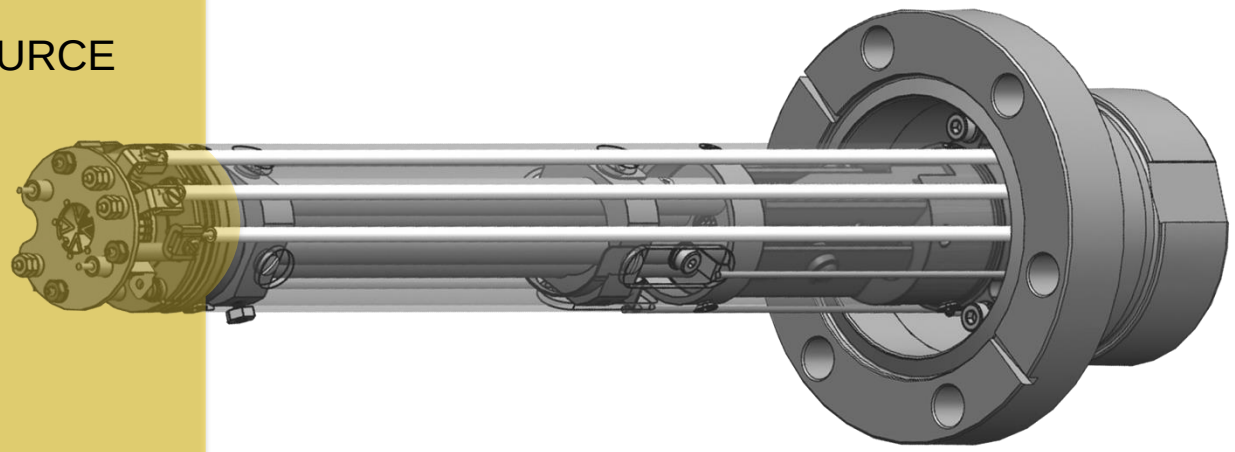


SENSOR



ION SOURCE

ION SOURCE



OPEN ION SOURCE (OIS)

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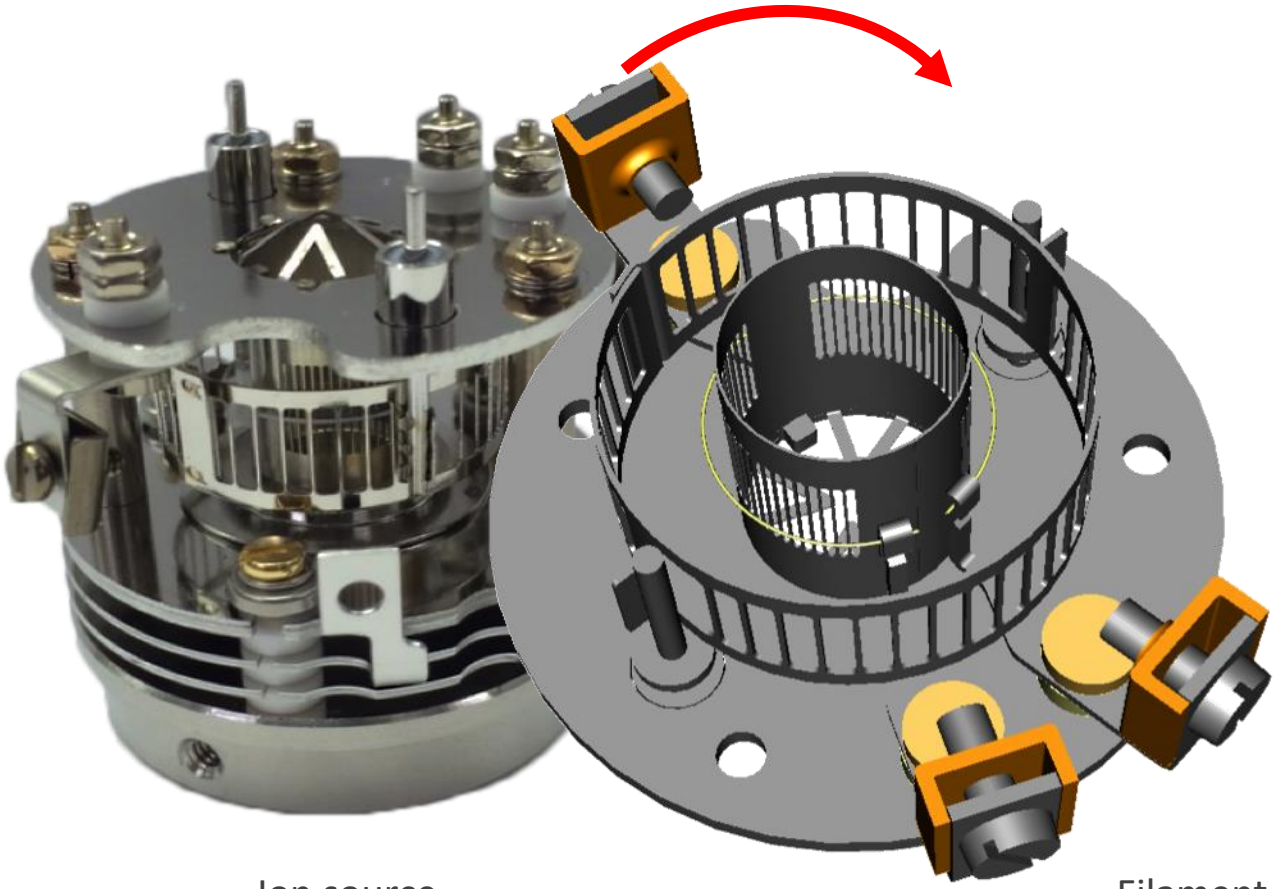
OPEN ION SOURCE STRUCTURE

- Open structure
- Gas can enter easily

OPEN ION SOURCE – FILAMENT ASSEMBLY

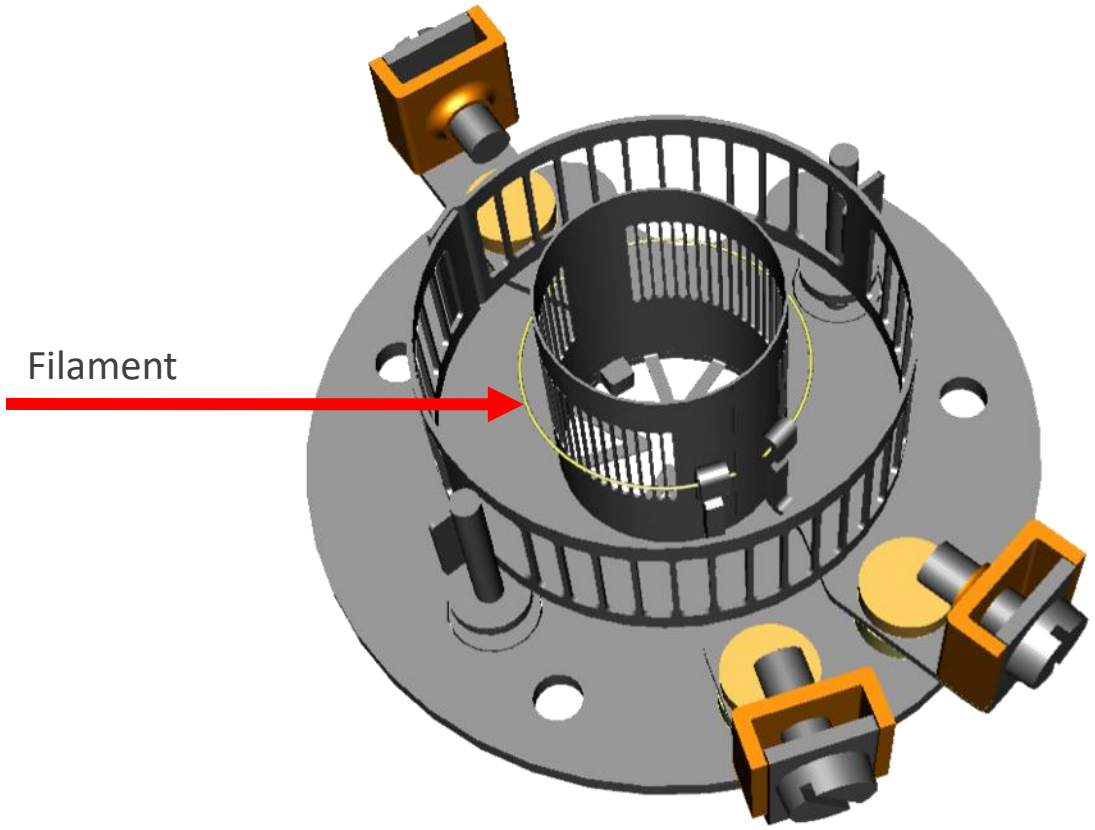


Ion source

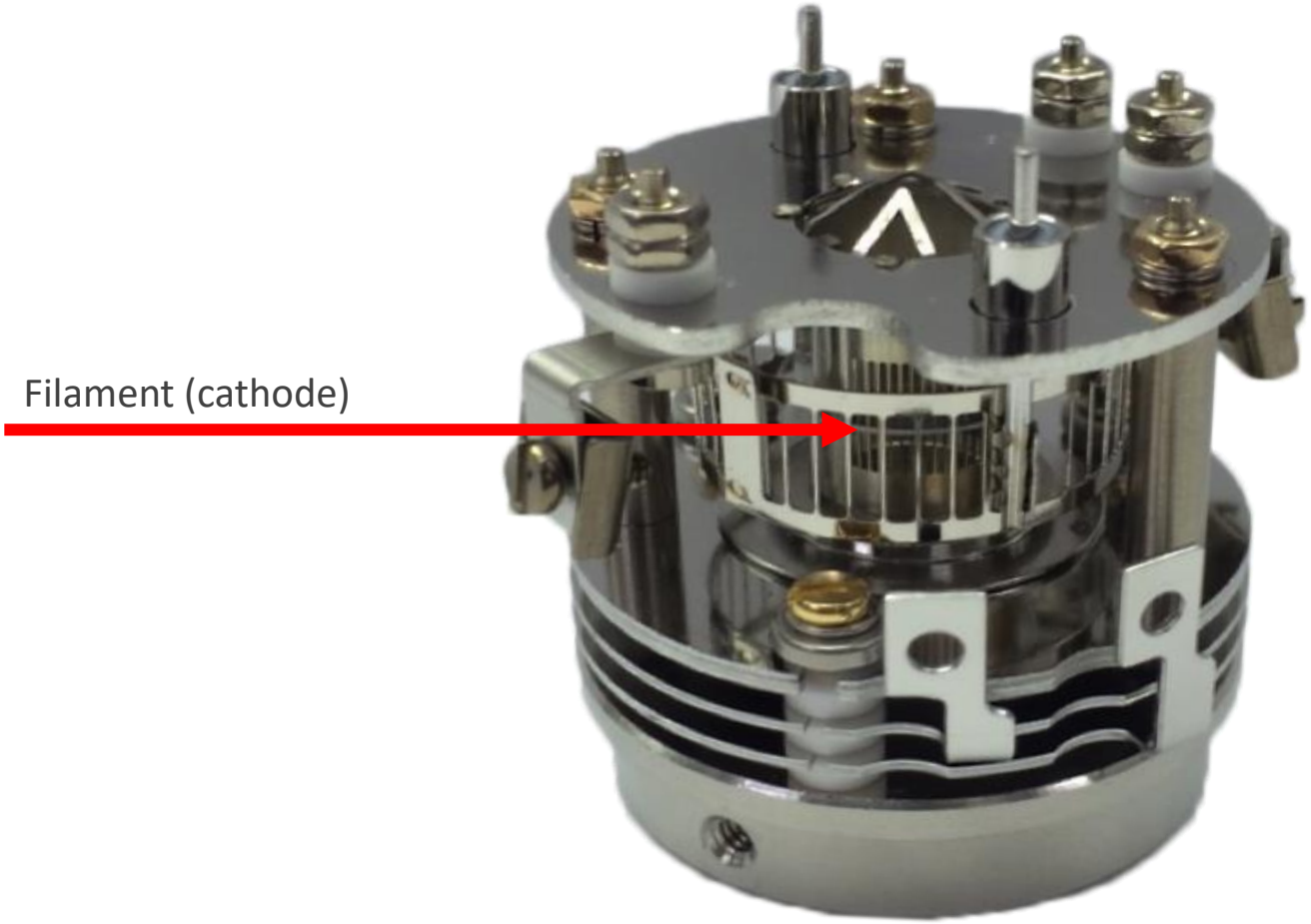
Filament assembly

FILAMENT ASSEMBLY – TWO FILAMENTS

- Two semi-circle filaments
- Made of either:
  - ⇒ Yttria-coated iridium, or
  - ⇒ Tungsten
- Operate one at a time

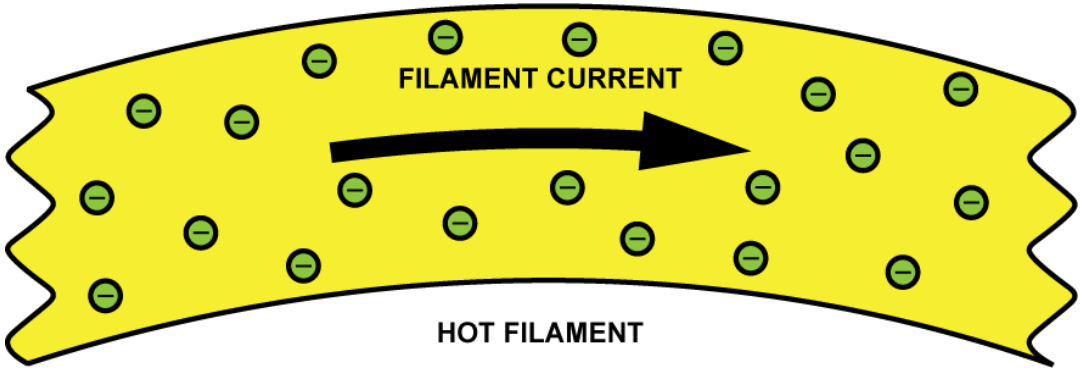


FILAMENT IN THE IONSOURCE



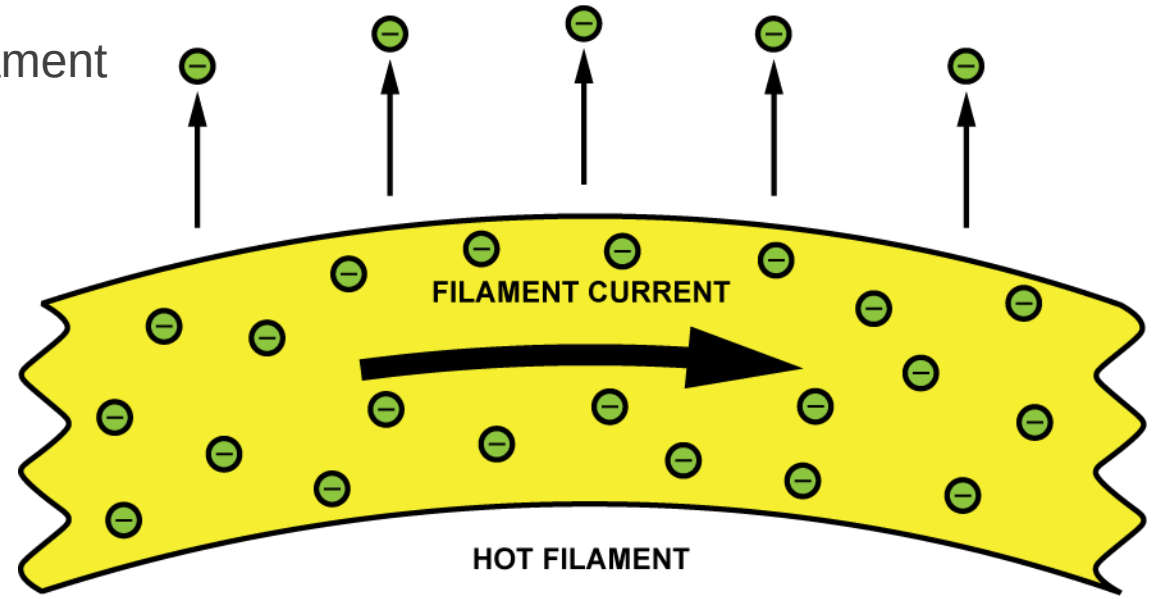
FILAMENT CURRENT

- Electric current in filament
- Filament becomes extremely hot



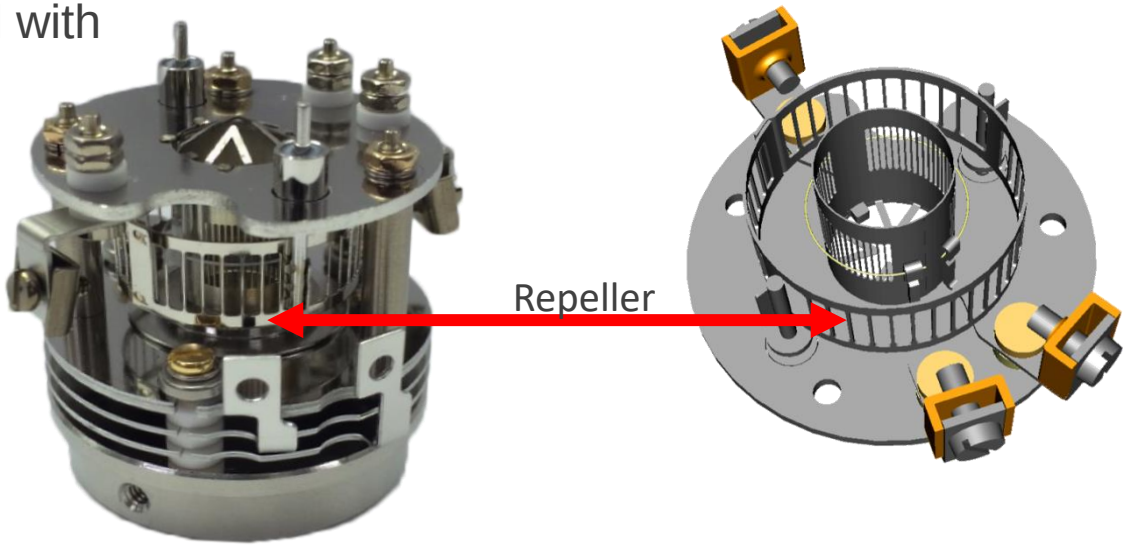
EMISSION CURRENT

- Electrons emitted from filament
- Flow of emitted electrons
- Emission current



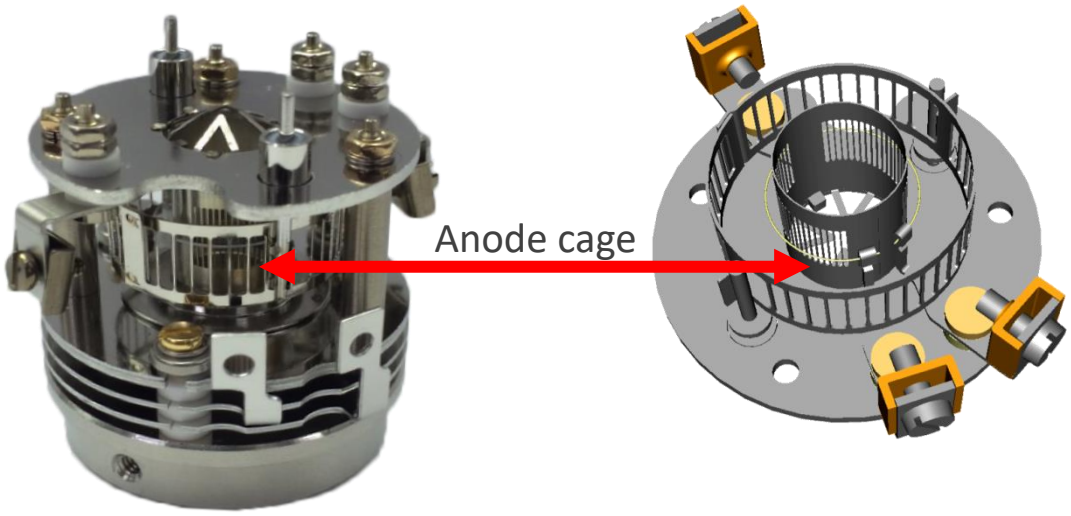
REPELLER

- Outer cage
- Negative electrical potential with respect to filament
- Repels electrons



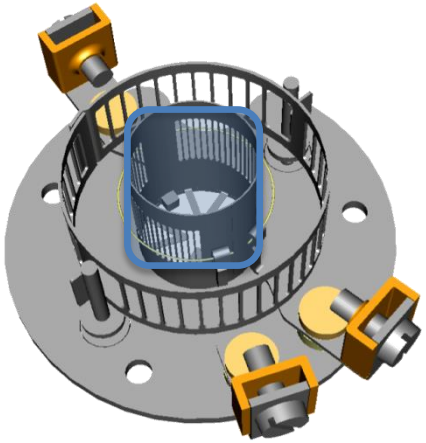
ANODE CAGE (ION CAGE)

- Inner cage
- Positive electrical potential difference to filament
- Attracts electrons

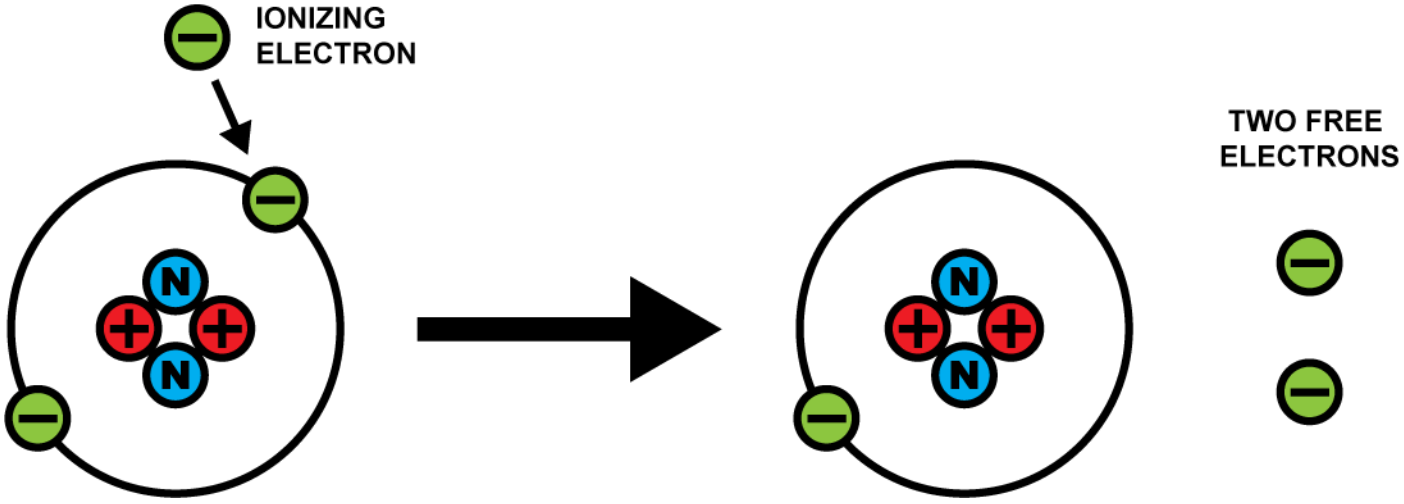


IONIZATION REGION

- Inside the anode cage
- Region where ions are formed
- Electron impact ionization of gas molecules



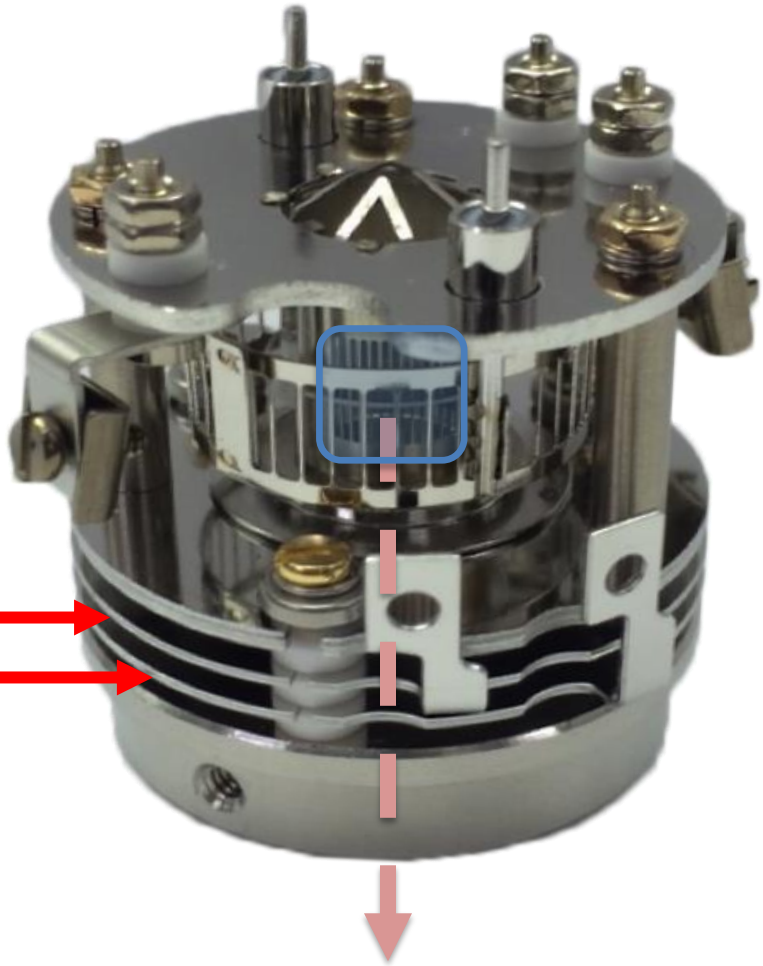
ELECTRON IMPACT IONIZATION



Atom (He)

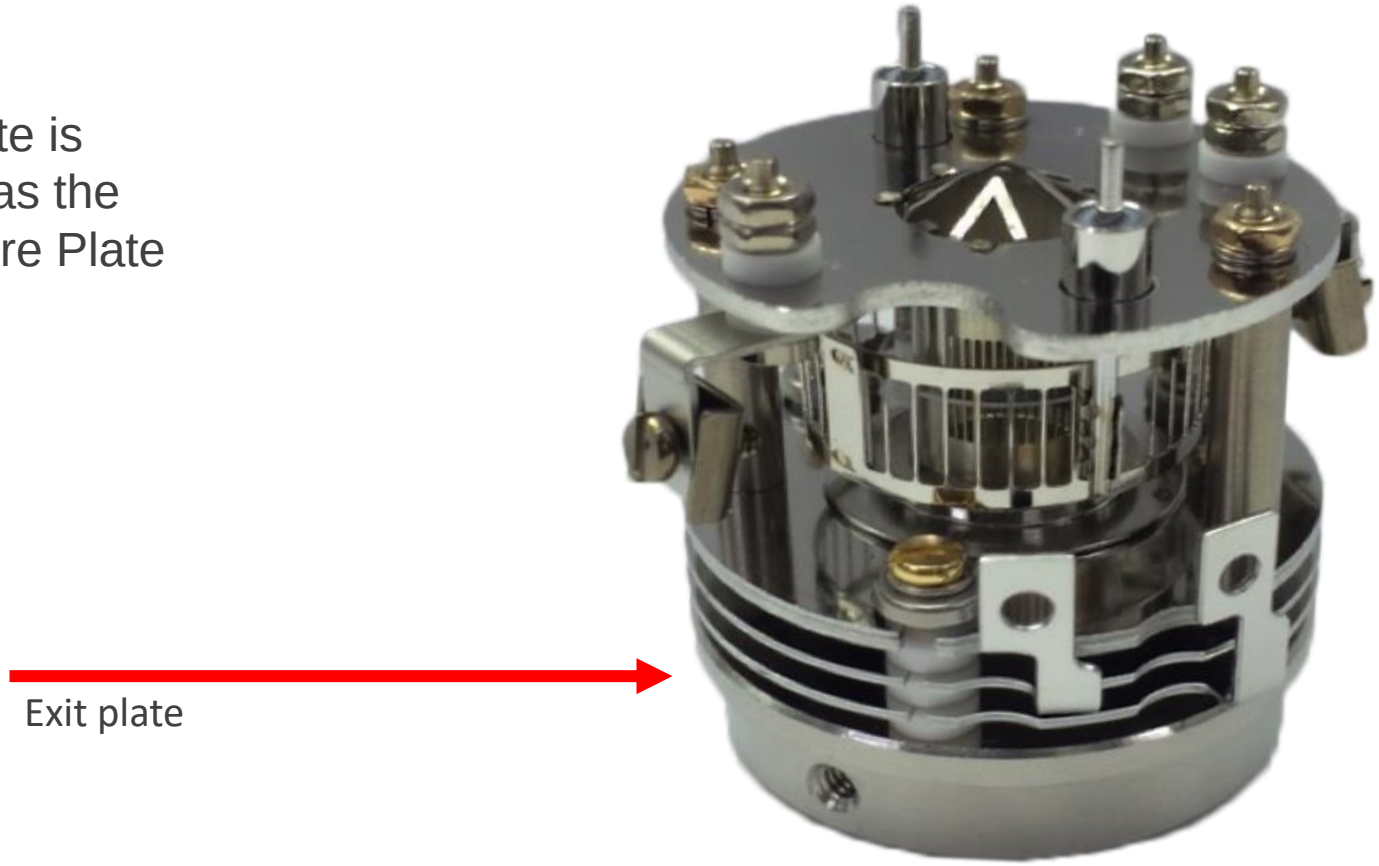
Positive Ion (He^+)

ION OPTICS

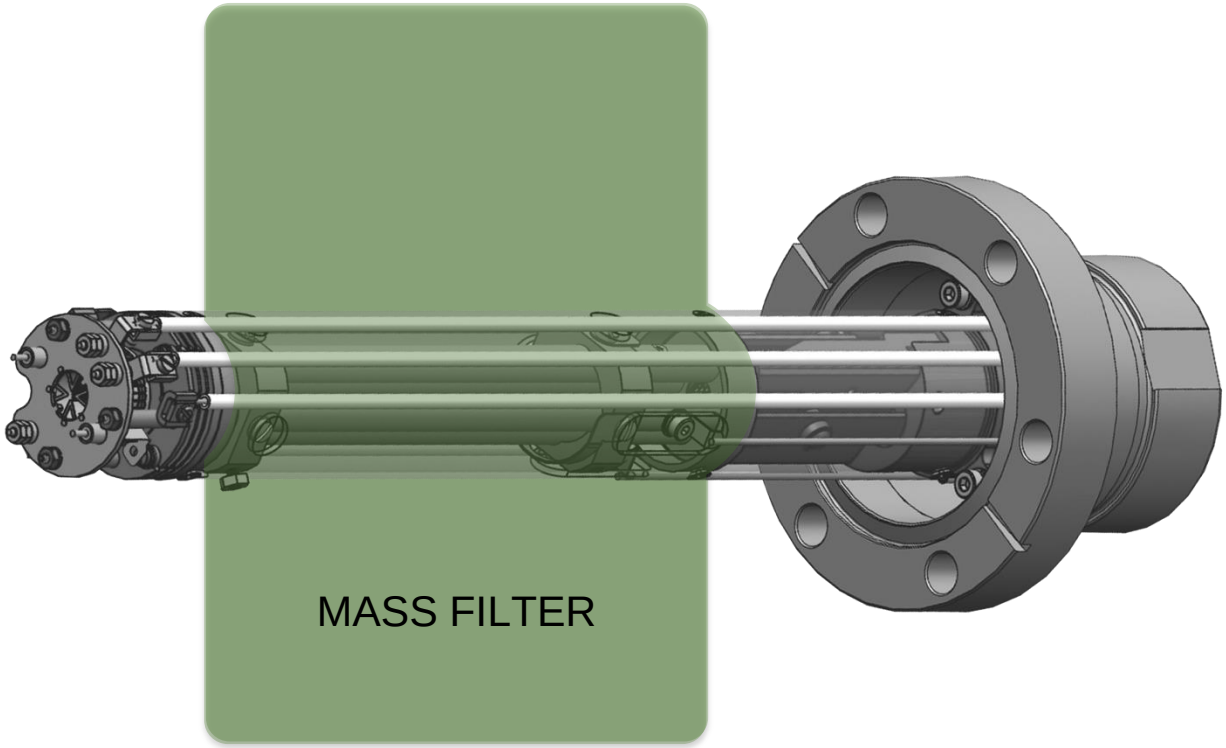


TOTAL PRESSURE PLATE

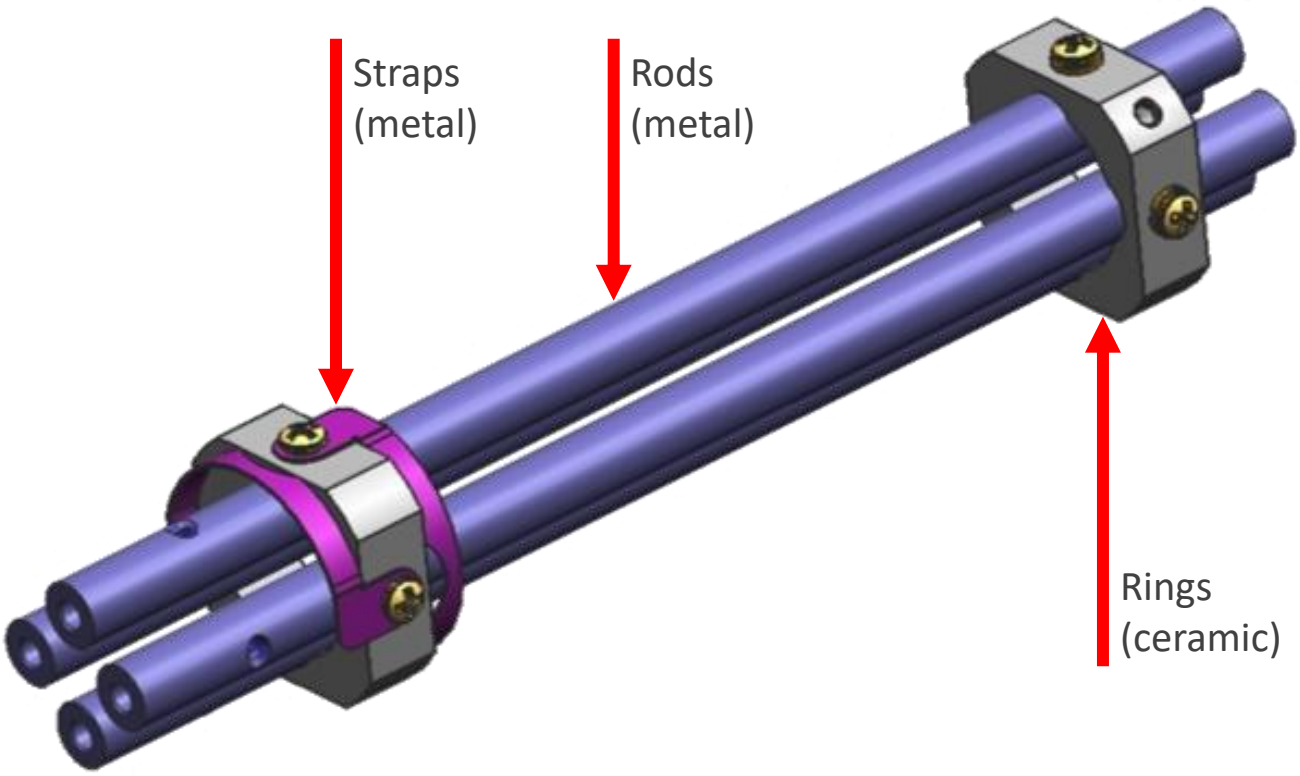
The Exit Plate is
also known as the
Total Pressure Plate



MASS FILTER

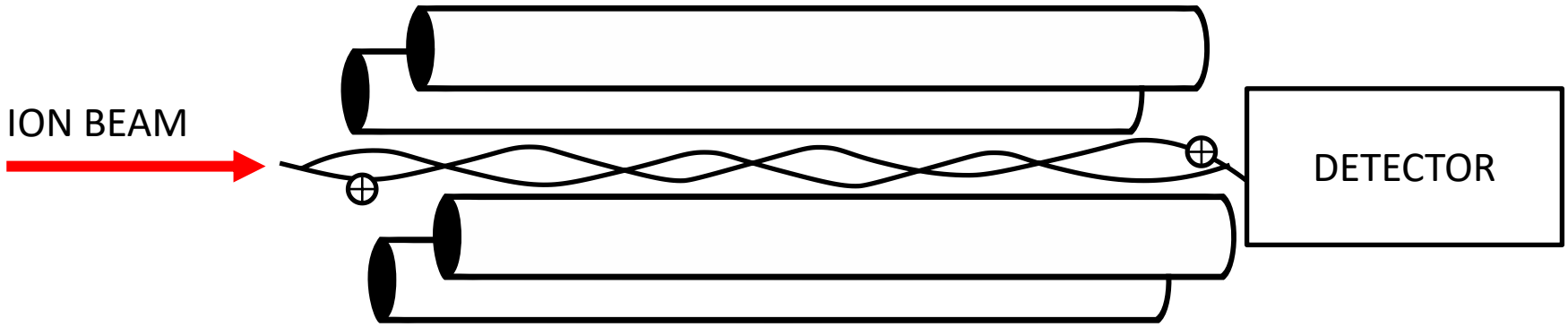


MASS FILTER (QUADRUPOLE)

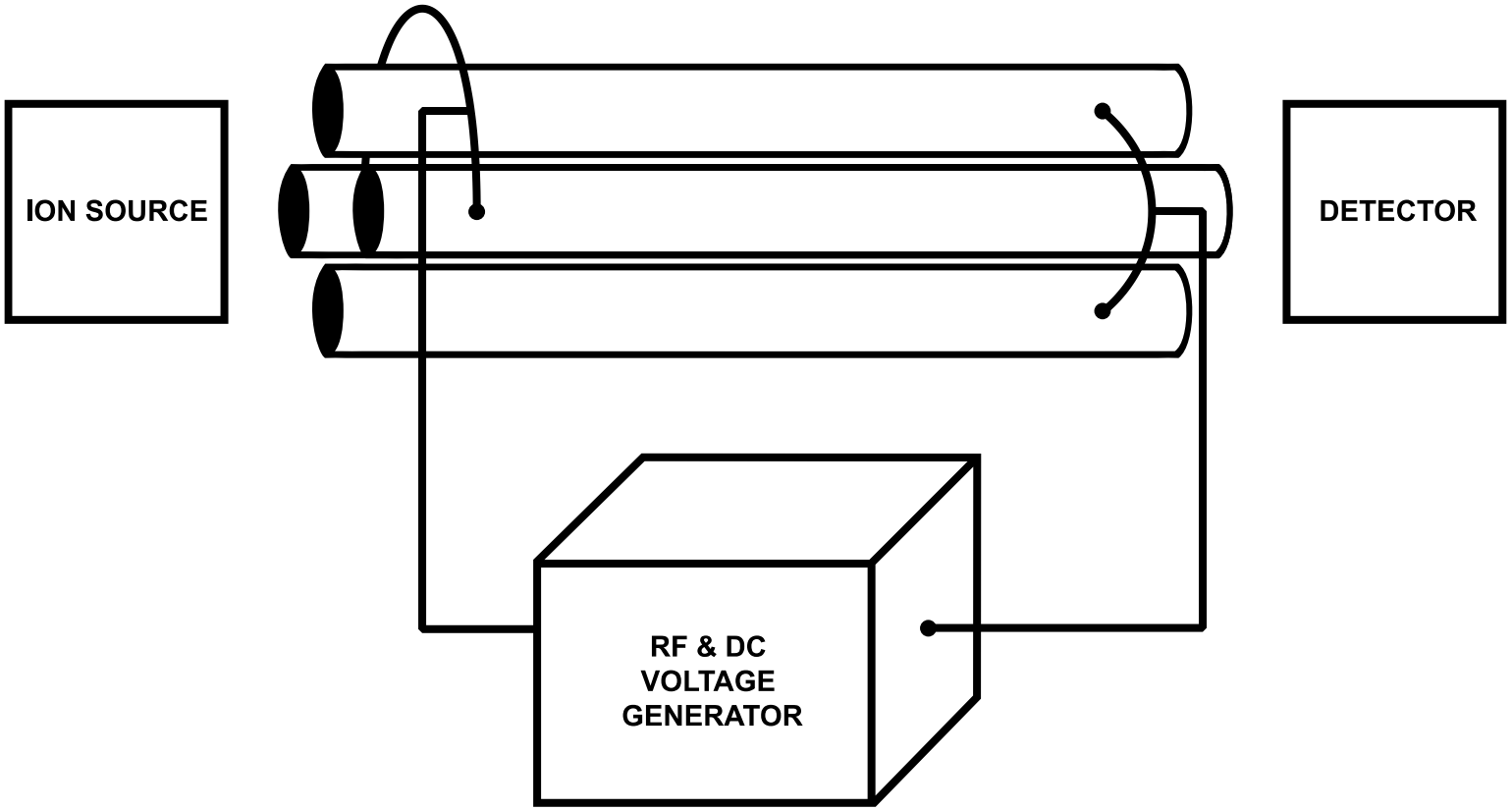


MASS FILTER – ION PATH

- A controlled band of ion masses will reach the detector
- This filters the ions for measuring one gas at a time
- Higher and lower mass ions will strike a rod instead



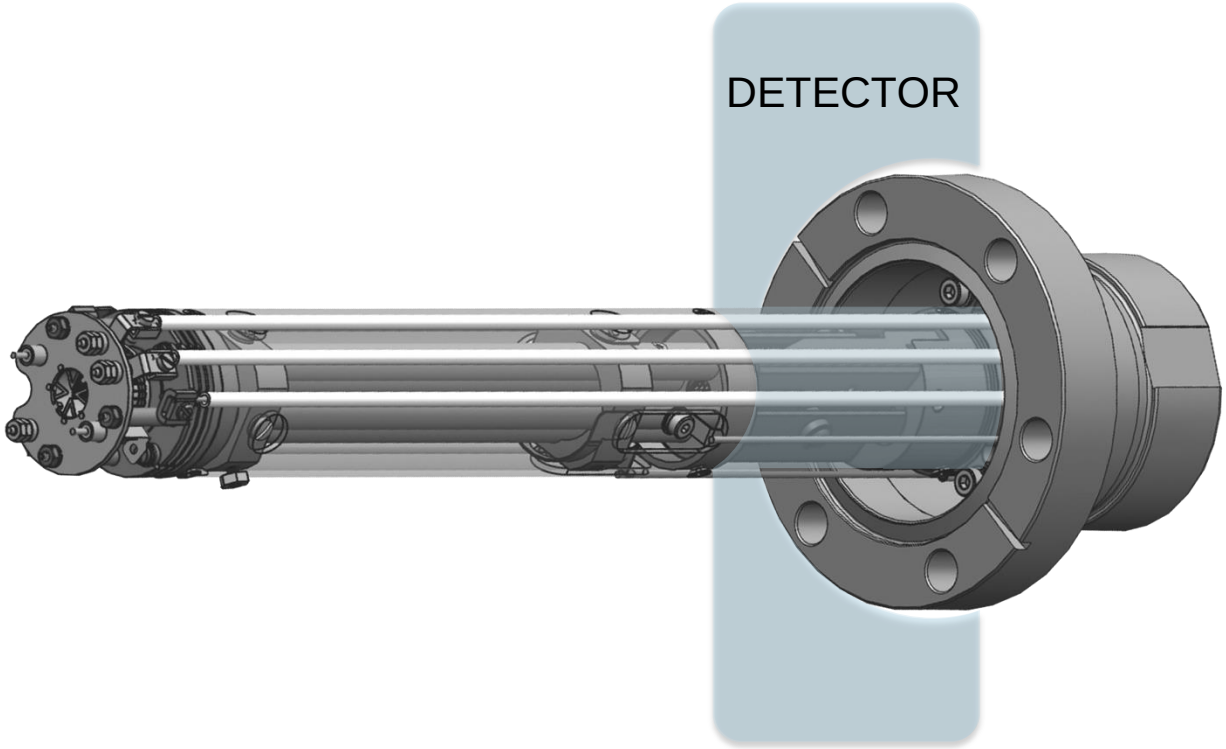
MASS FILTER – ELECTRICAL CONFIGURATION



QUADRUPOLE ASSEMBLY

- Surface uniformity is essential
- Manufactured with precision
- Cleaned and manufactured in clean room

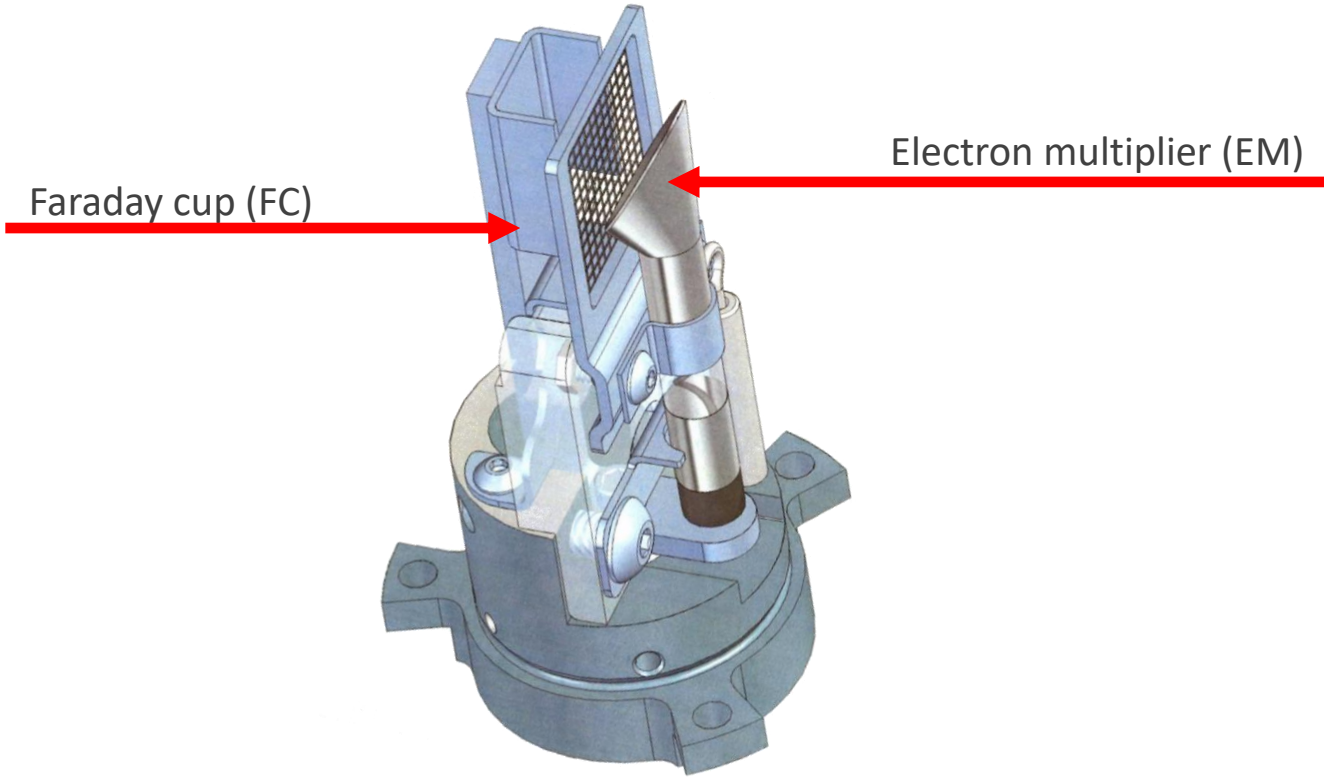
DETECTOR



DETECTOR TYPES

RGA can have:

- FC only, or
- FC and EM



FARADAY CUP (FC)

- Simple metal electrode
- Positive ions strike surface
- Produces electrical output current

ELECTRON MULTIPLIER (EM)

Made of glass doped with specific impurities to form a semiconducting surface

ELECTRON MULTIPLIER (EM)

- Bias voltage attracts ions
- Boosts signal by large gain factor

GAIN OF ELECTRON MULTIPLIER

$$\text{EM Gain} = \frac{\text{EM Current}}{\text{FC Current}}$$

$$\text{EM Current} = \text{FC Current} \times \text{EM Gain}$$

GAIN OF ELECTRON MULTIPLIER

- Gain can range from 10 to 10 million
- Depends on bias voltage applied
- Depends on condition of EM

CHANGES TO ELECTRON MULTIPLIER GAIN

Gain can **decrease** due to:

- Surface degradation
- Contamination
- Usage (dosing)

Gain can be **increased** by increasing the bias voltage.

Increasing the voltage allows the user to recover for gain losses. This allows the user to maintain constant sensitivity over time.

EM IMPACT ON RGA PERFORMANCE

- Improves sensitivity
- Improves signal-to-noise ratio
- Improves minimum detectable partial pressure

APPLIED EM PERFORMANCE

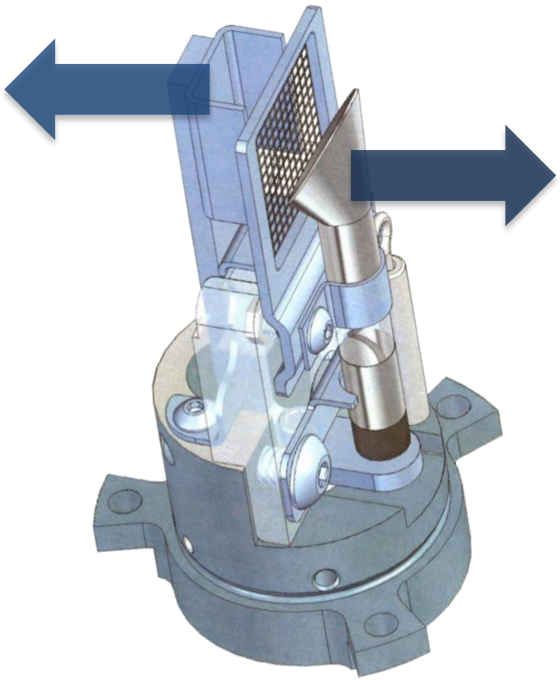
The EM can be used to improve:

- Detection of small leaks
- Detection of trace contaminants
- Measurement speed

WHEN TO OPERATE FC OR EM

FC:

- Does not boost the signal
- Use when gases are present at high levels



EM:

- Boosts the signal
- Use to detect small leaks, trace background gases or contaminants

myRGA EM OPERATING LIMITS

myRGA EM Specifications

- 150°C maximum operating temperature
- 1 x 10^{-6} Amperes maximum output current

Exceeding these limits will:

- Damage the EM
- Degrade RGA performance
- Shorten the useful lifetime of the EM

Target Output Current for EM Protection

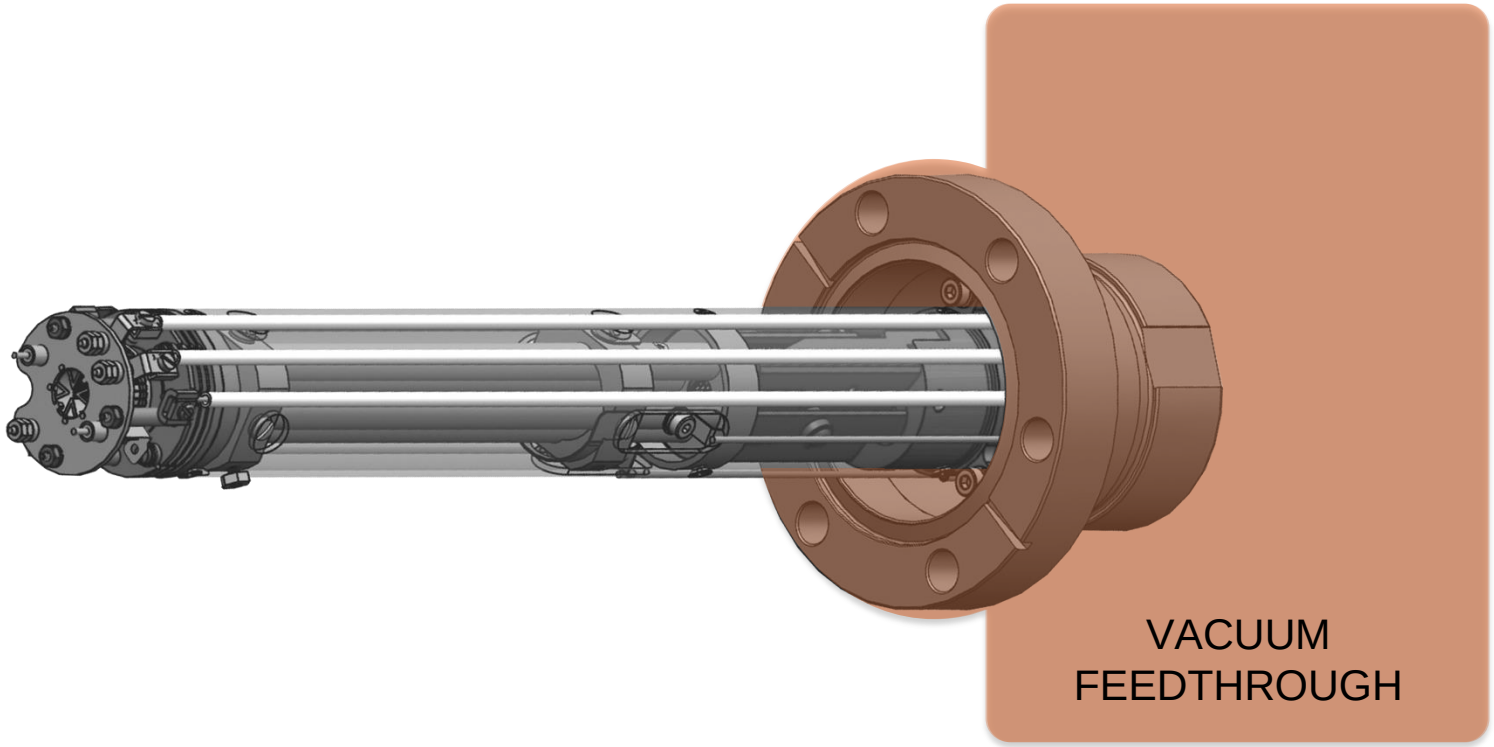
- 2 x 10^{-7} Amperes

LIMITING EM CURRENT

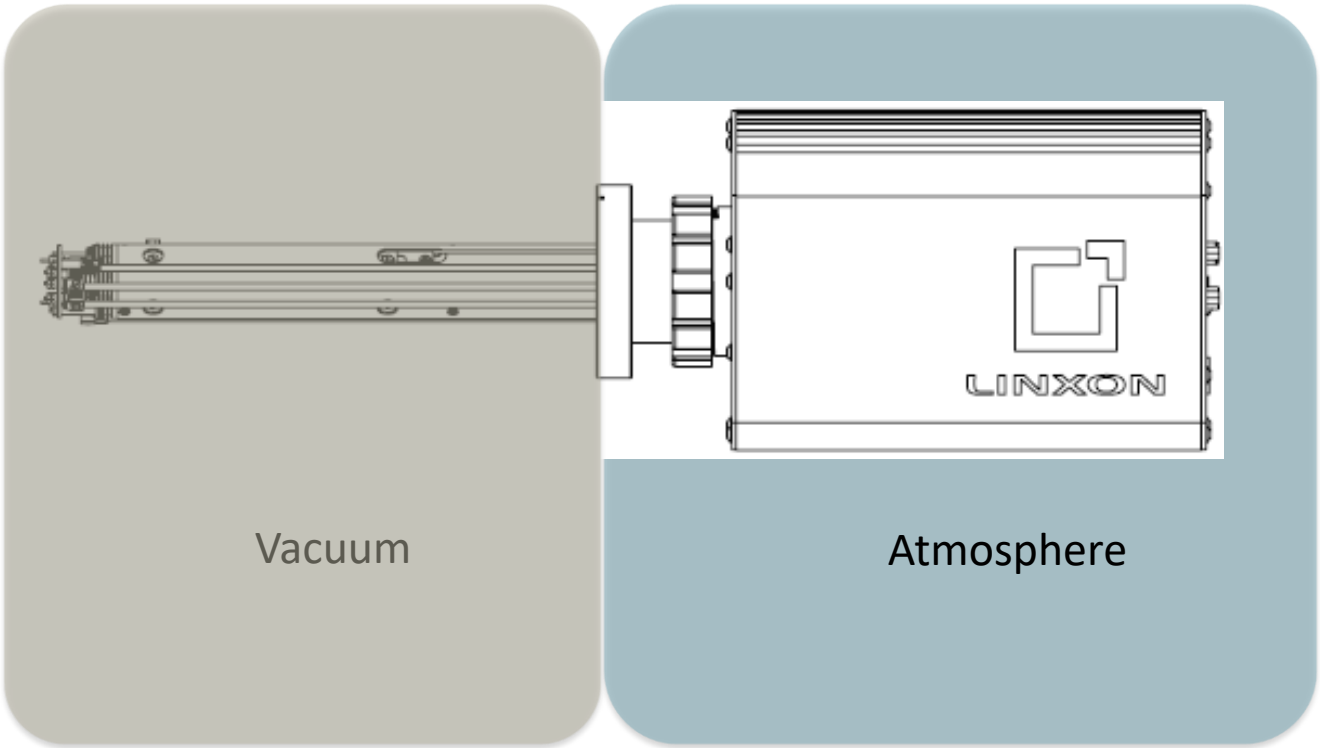
If the EM output current exceeds the specified limit, then either:

- Decrease the EM voltage
- Decrease the gas pressure
- Turn off the EM

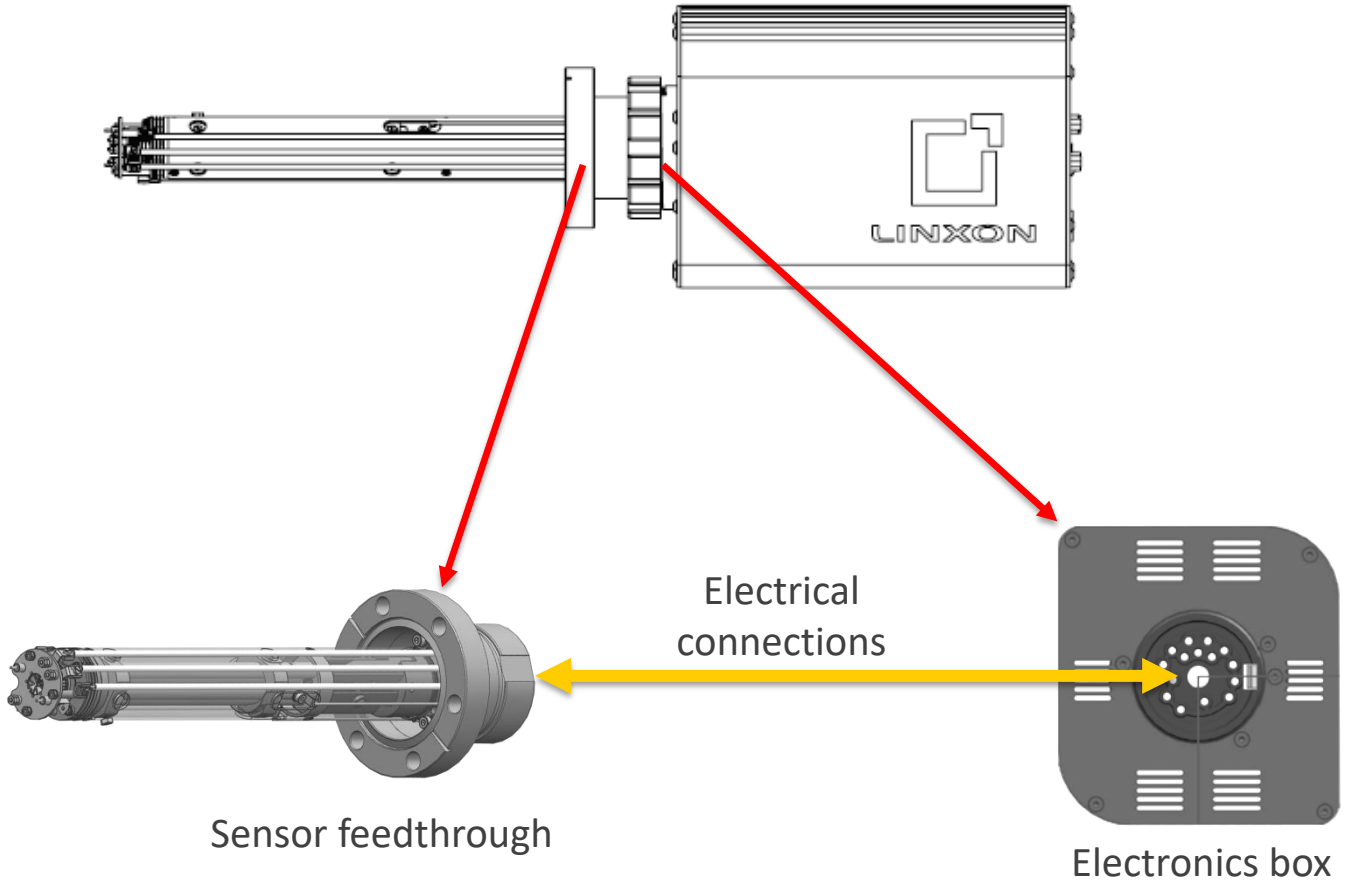
VACCUM FEEDTHROUGH



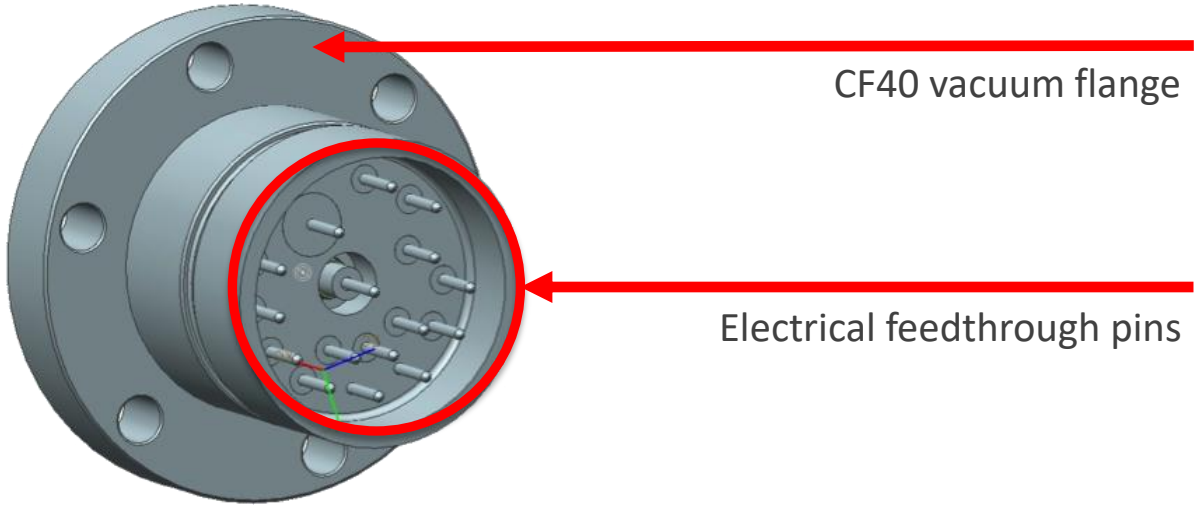
FEEDTHROUGH AS VACUUM SEAL



FEEDTHROUGH AS ELECTRICAL INTERFACE



VACUUM FEEDTHROUGH



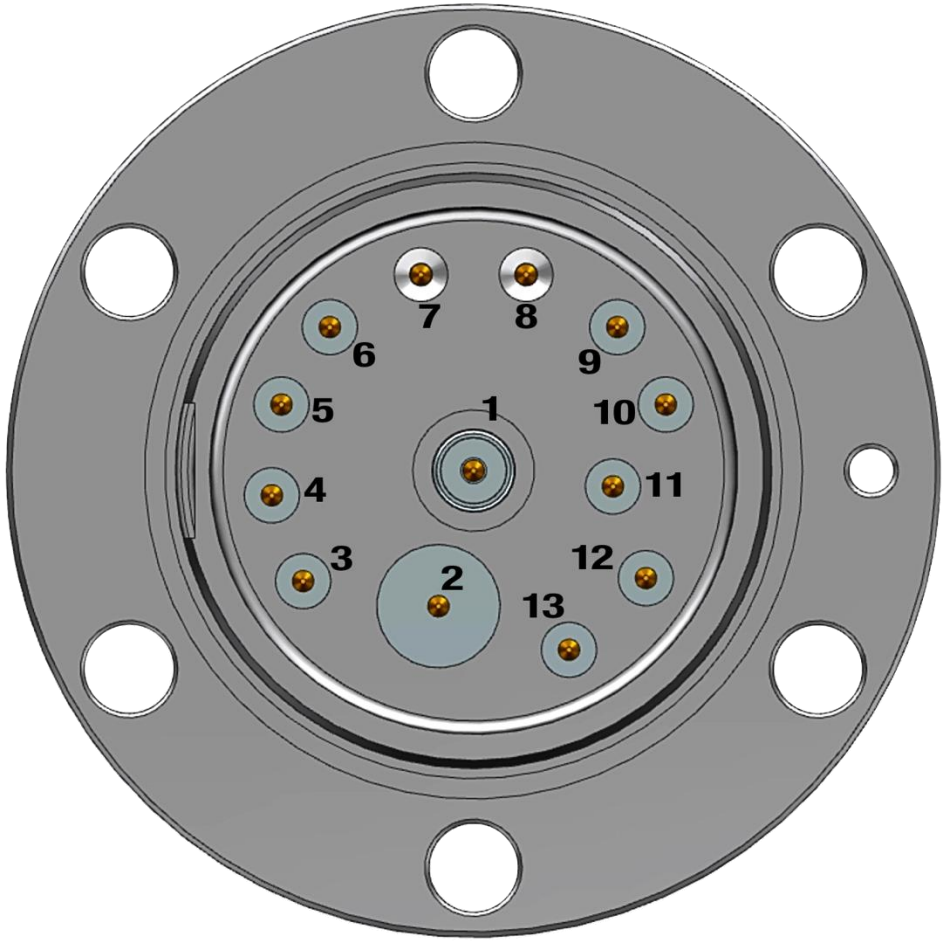
FEEDTHROUGH PINS

Pin 1:

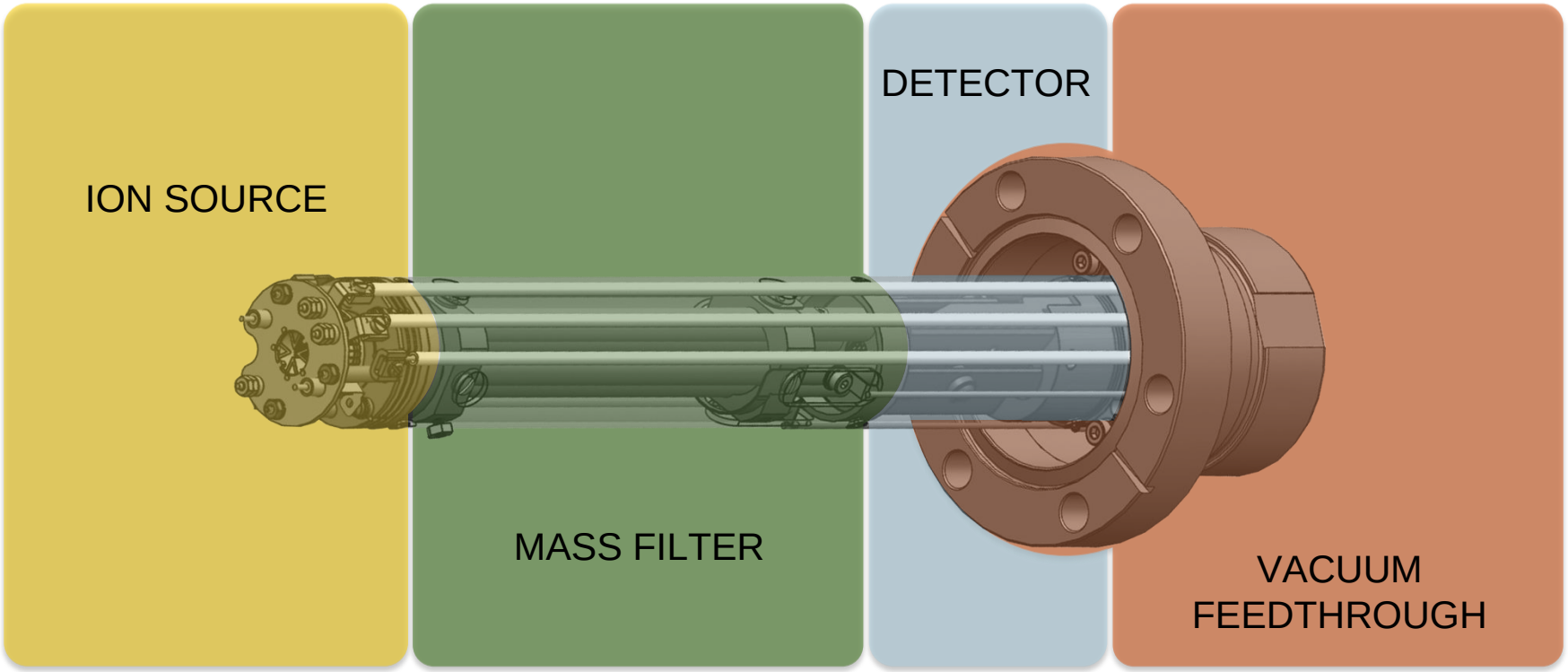
- Center Pin
- Sensor output signal

Pins 2 – 13:

- Control currents and voltages from electronics box to sensor

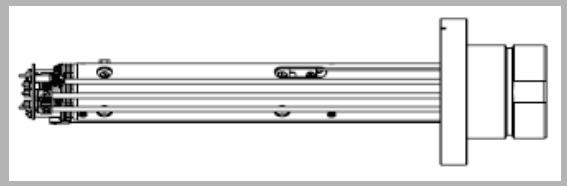


PUTTING IT ALL TOGETHER



4 RGA ELECTRONICS BOX

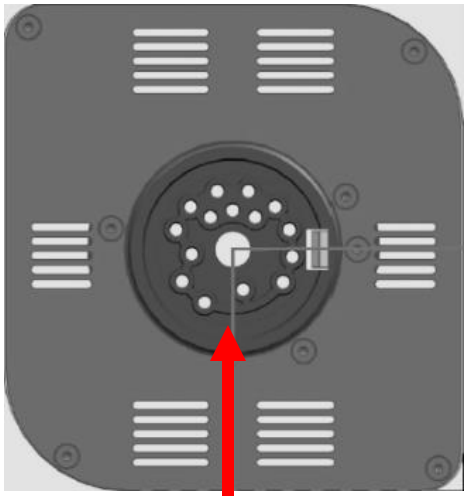
ELECTRONICS BOX



myRGA
Sensor

myRGA
Electronics Box

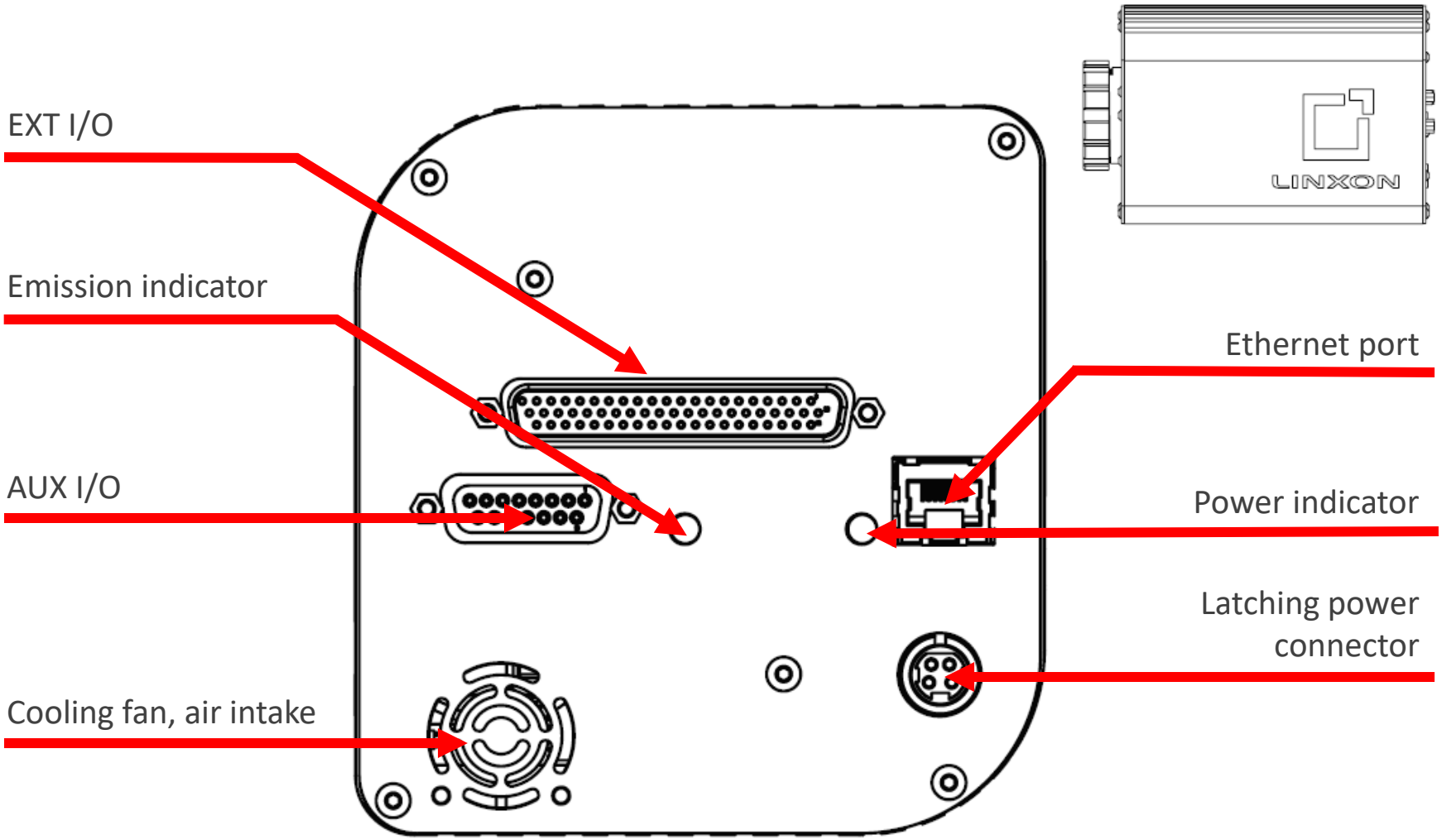
FRONT PANEL



Connector
to mate with
sensor pins

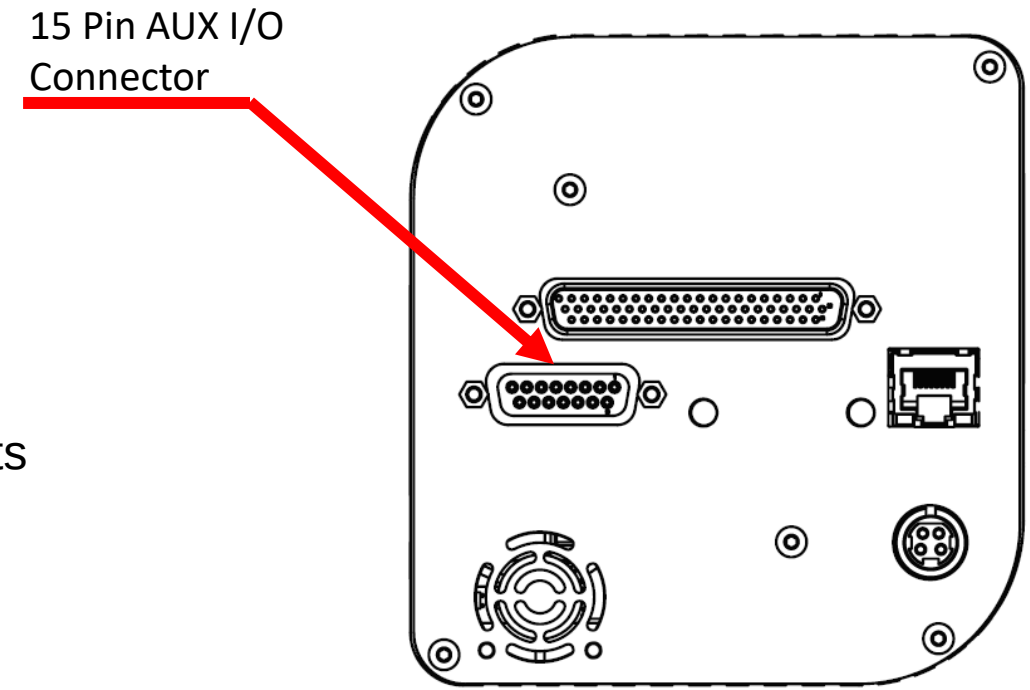
Locking nut to secure
the sensor to the electronics box

BACK PANEL WITH CONNECTORS



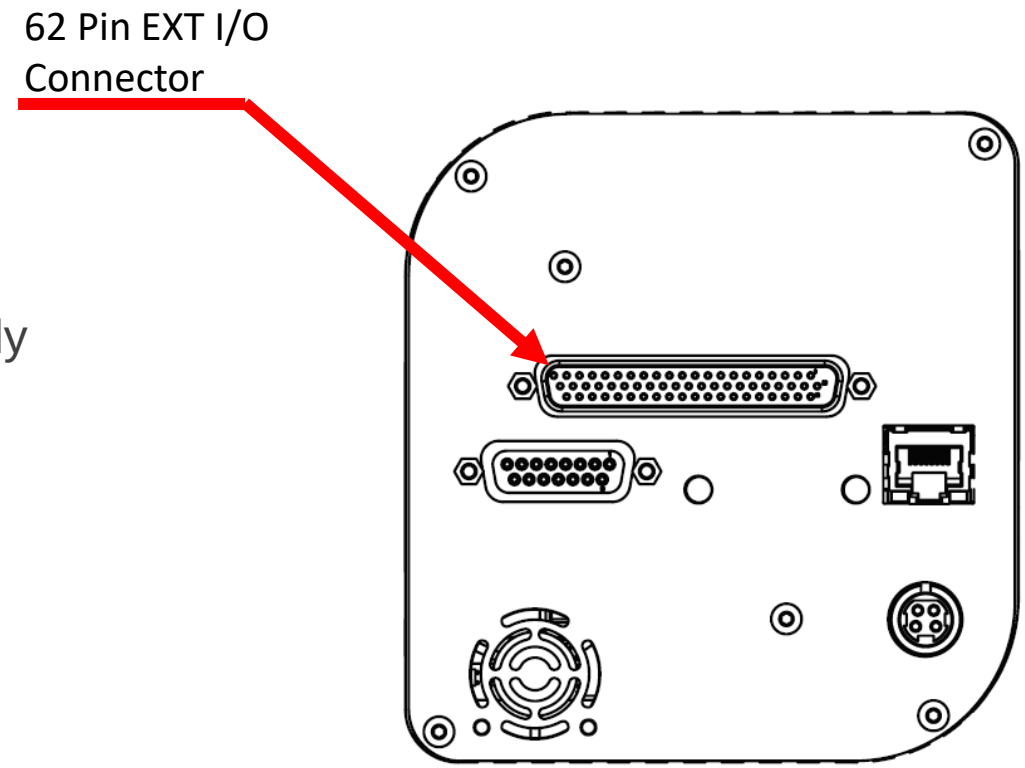
STANDARD I/O CAPACITY

- One analog input for pressure gauge support (interlock kit)
- One 24 volt supply (valve supply)
- One relay (emission status, or valve control)
- One pair of digital remote inputs (emission on/off control)

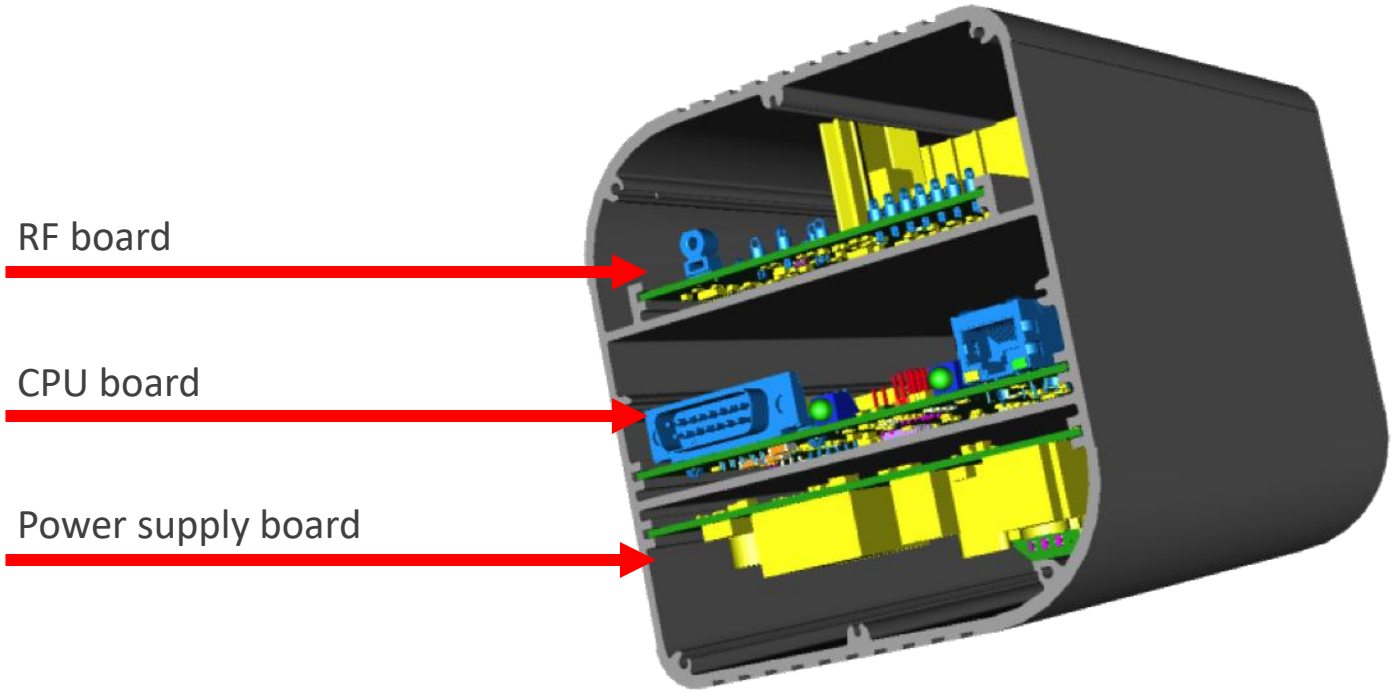


OPTIONAL EXTENDED I/O CAPABILITY

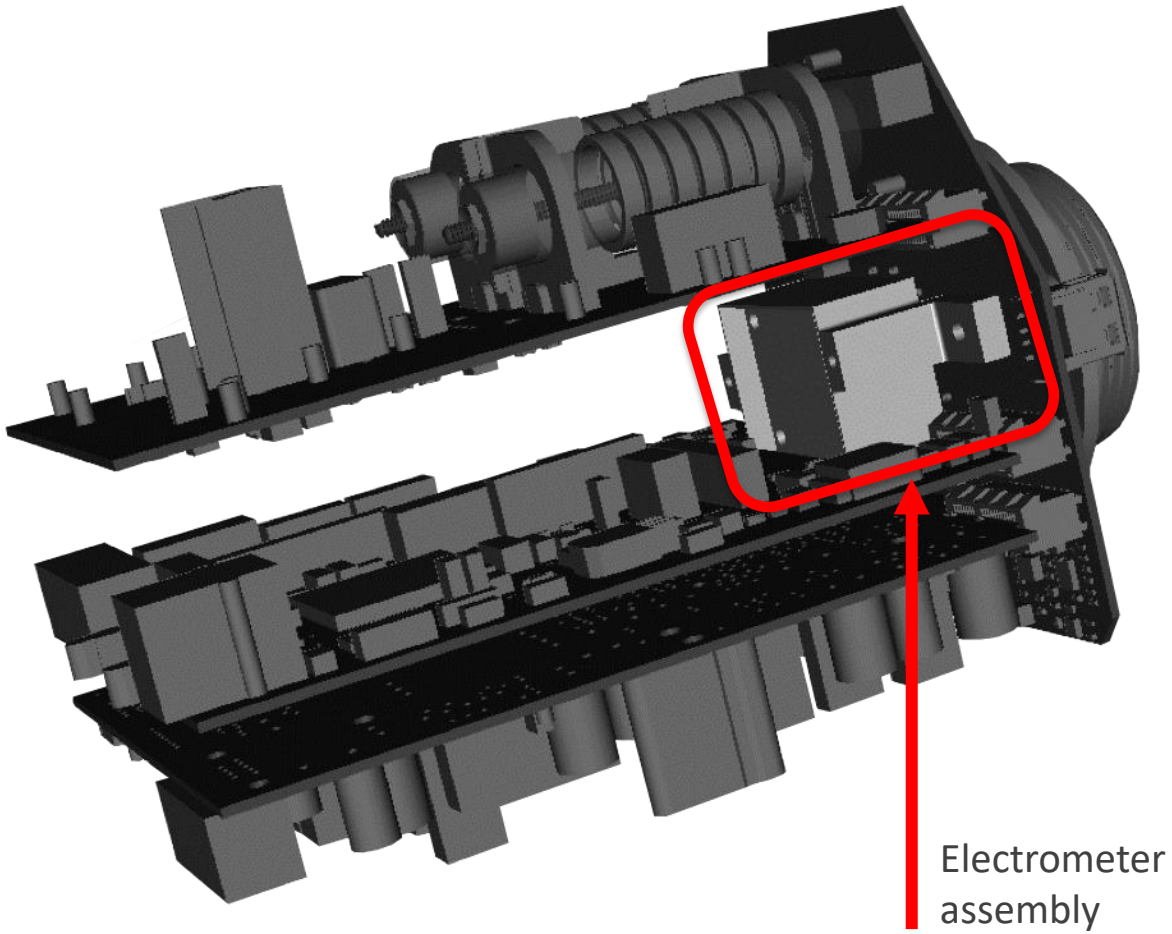
- 4 Analog Inputs
- 4 Analog Outputs
- 4 Relays
- 12 Digital Inputs/Outputs
- 1 Gauge Support 24 Volt Supply



ELECTRONICS BOARD



ELECTROMETER ASSEMBLY



SUMMARY

In this module, you have learned:

- The two major items of an RGA System, and their function
- The two major items of an RGA, and their function
- The four major sections of an RGA sensor, and their function
- The overview design of the myRGA electronics box
- The rear panel functionality of the myRGA electronics box

THANK YOU!

You have completed the

RGA Hardware and How an RGA Works module!

You may come back and review

the content of this module at any time.