LINXON

LINXON myRGA

THEORY AND OPERATION

Module 500:
RGA Analysis Basics

PURPOSE

- Develop and demonstrate expertise with LINXON myRGA
- Understand how RGA measurements are acquired, analyzed and displayed

OBJECTIVES

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

- Describe and configure an analog scan
- Describe and configure selected masses mode (bins)
- Describe the different methods of baseline subtraction
- Describe scan time and how to change it
- Describe the process of spectrum identification
- Describe data scaling options
- Describe different units of measure for display of RGA results
- Describe implications of tuning and calibration on analysis

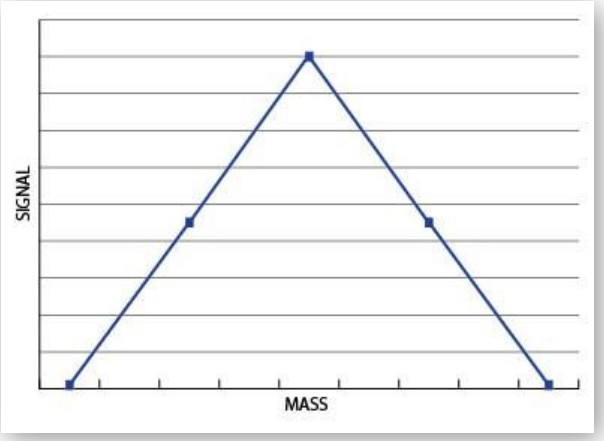
OUTLINE

1. Analog Scans
2. Selected Masses Mode (bins)
3. Baseline Subtraction
4. Scan Time
5. Spectrum Identification
6. Ways to Report Data
7. Tuning and Calibration Effects on Analysis

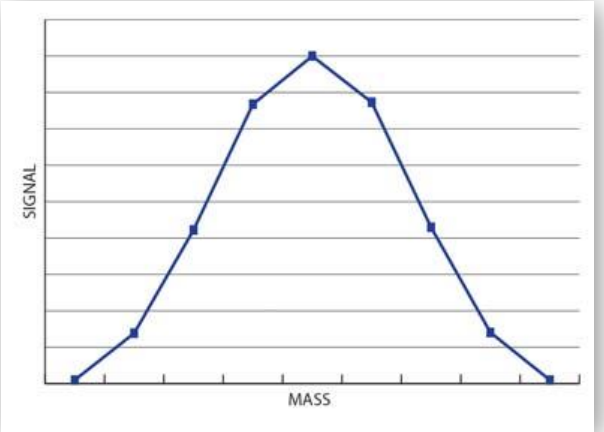
1 ANALOG SCANS

SCAN RESOLUTION

- The number of points acquired for each 1 amu of mass range
- Often labeled as points per amu (ppamu)
- Peak shape is affected by scan resolution



5 ppamu

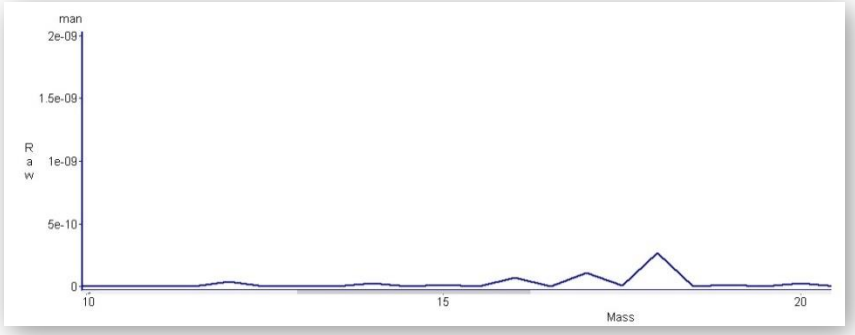


10 ppamu

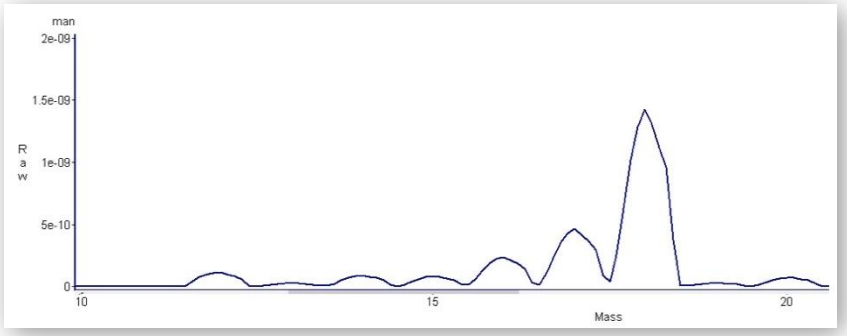
POINTS PER AMU

Increasing ppamu yields

- Smoother peaks (less angular)
- Better visualization of adjacent peaks
- Longer scan time



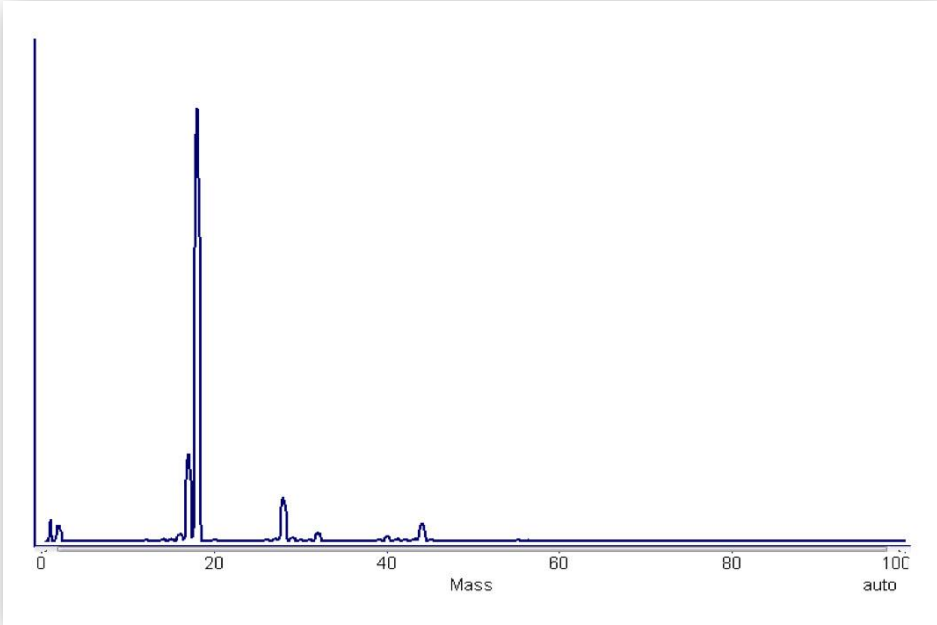
5 ppamu



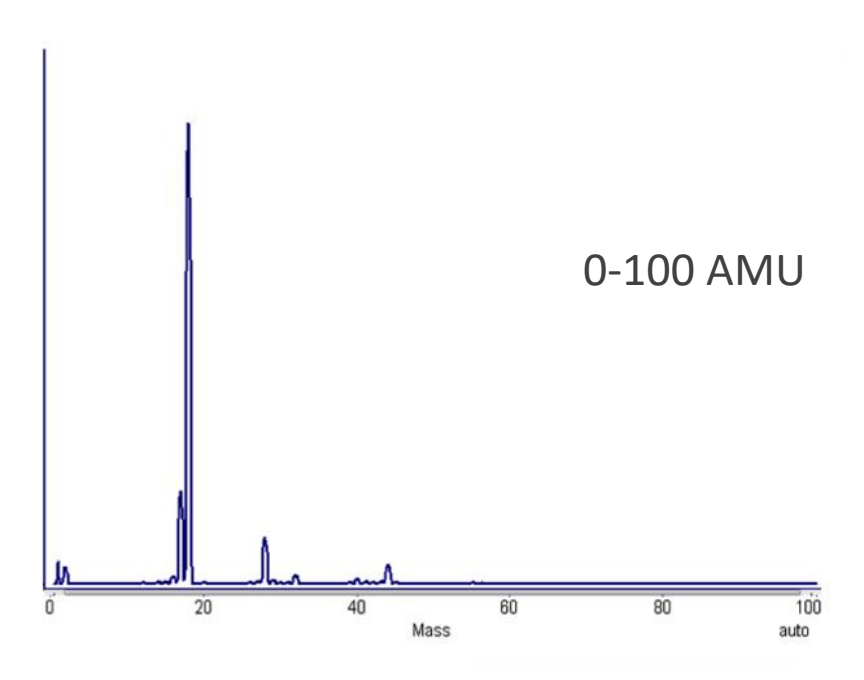
10 ppamu

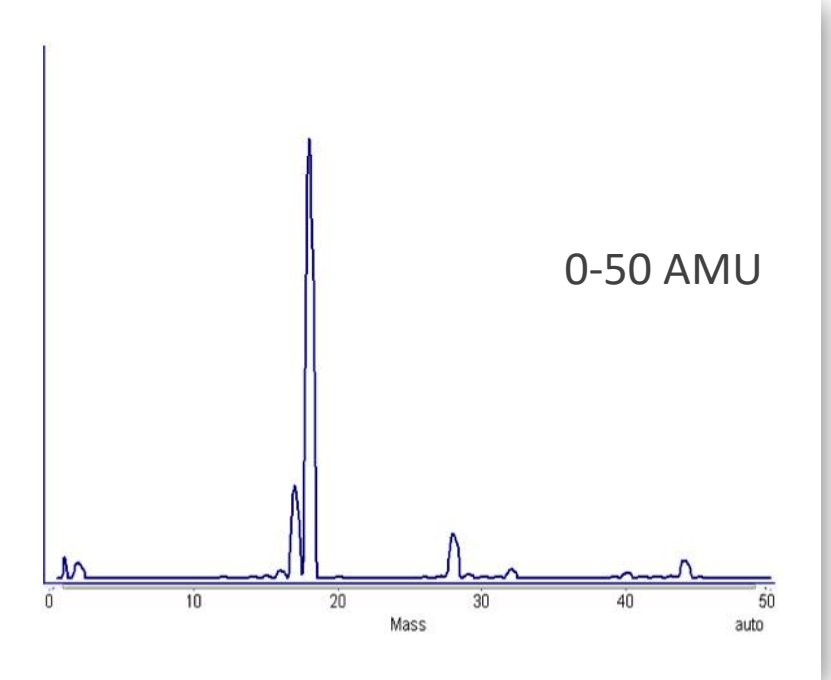
ANALOG SCAN

- Continuous scan with resolution greater than
  1 ppamu
- Visualize spectrum
- Used for tuning
- Can be slow if scanning over large mass range
- Important components include:
  - Mass range (amu)
  - Scan resolution (ppamu)
  - Dwell time (ms)



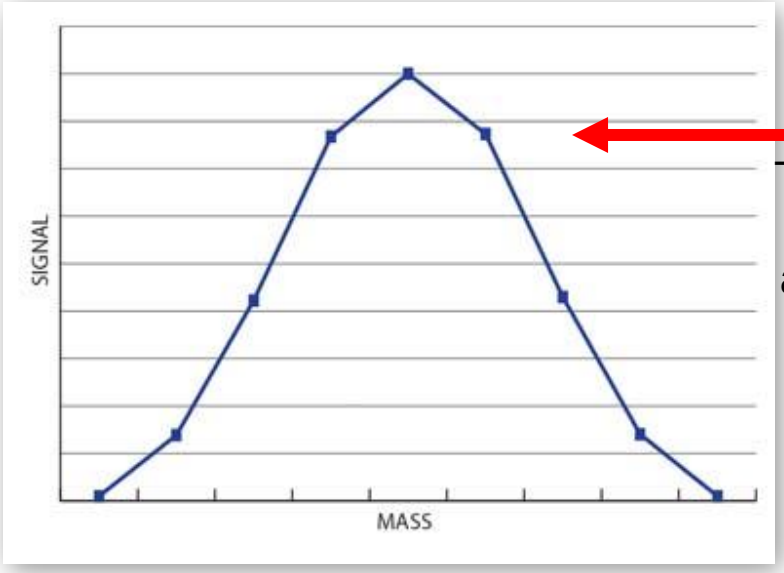
ANALOG SCANS – MASS RANGE





ANALOG SCANS – DWELL TIME

- Dwell time is the amount of time spent acquiring each data point

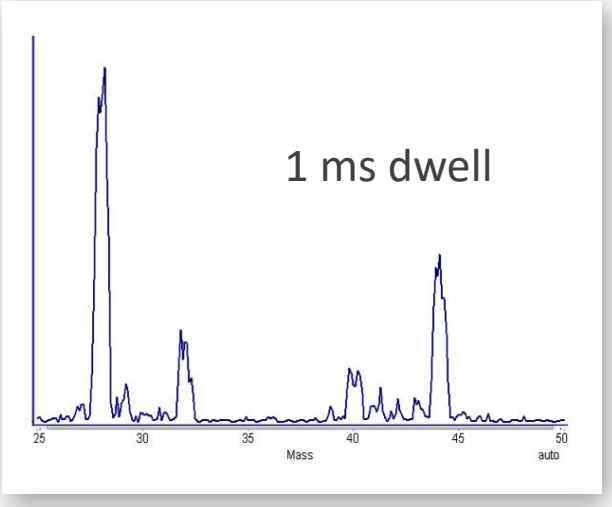


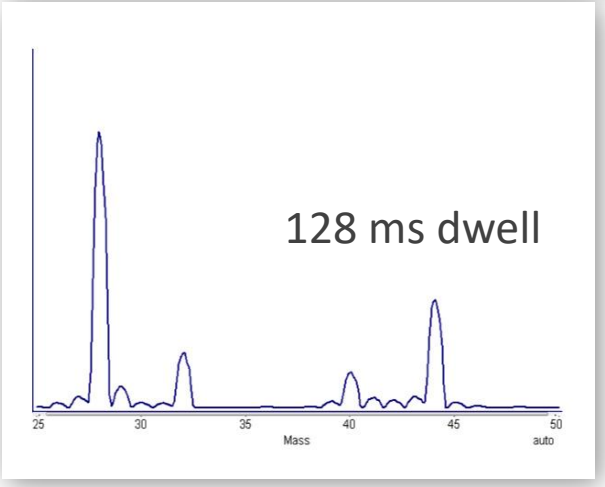
Time spent collecting data
at a single data point

ANALOG SCANS – DWELL TIME

Increasing dwell time yields:

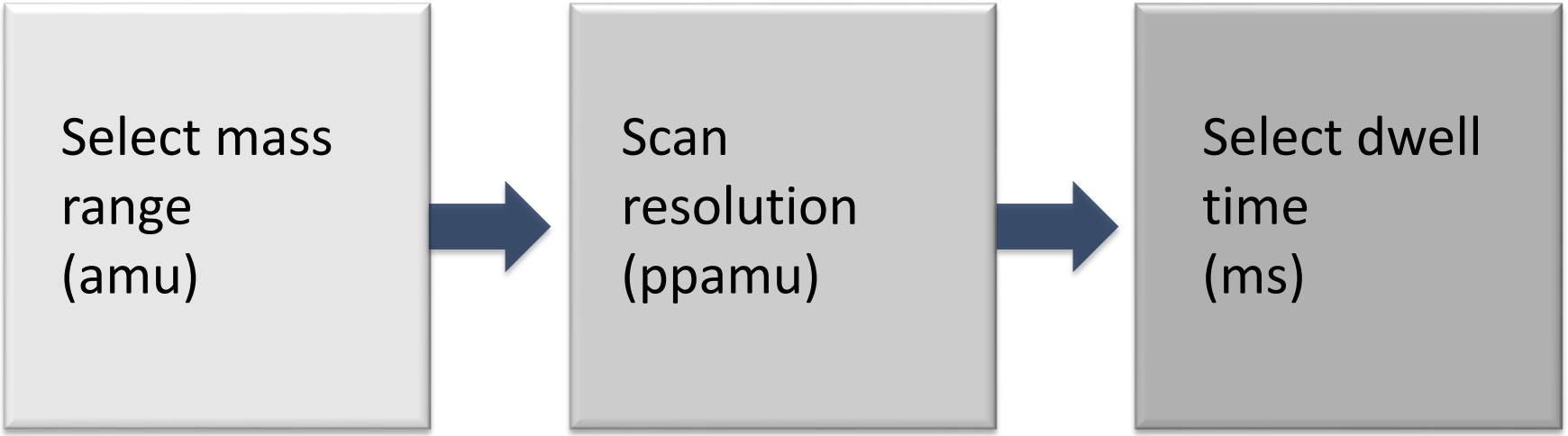
- Smoother peaks
- Reduced noise
- Improved detection limit and MDPP
- Increased scan time





ANALOG SCANS

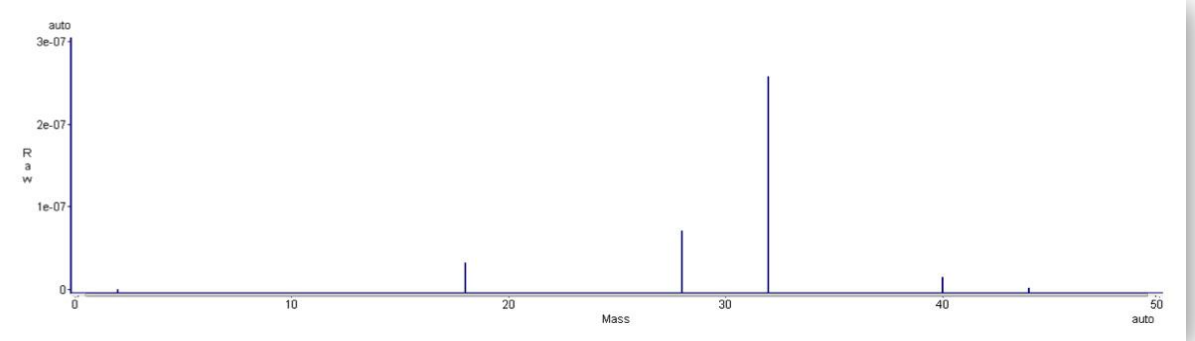
How do I set up an analog scan?



2 SELECTED MASSES MODE (BIN MODE)

SELECTED MASSES MODE (BIN MODE)

- For measuring a specific set of masses
- Measure selected peaks
  - Not necessarily a continuous range
  - Not necessarily at adjacent peaks
- Faster than analog scans
- Scan resolution is 1 ppamu



SELECTED MASSES MODE (BINS)

How do I set up selected masses mode?

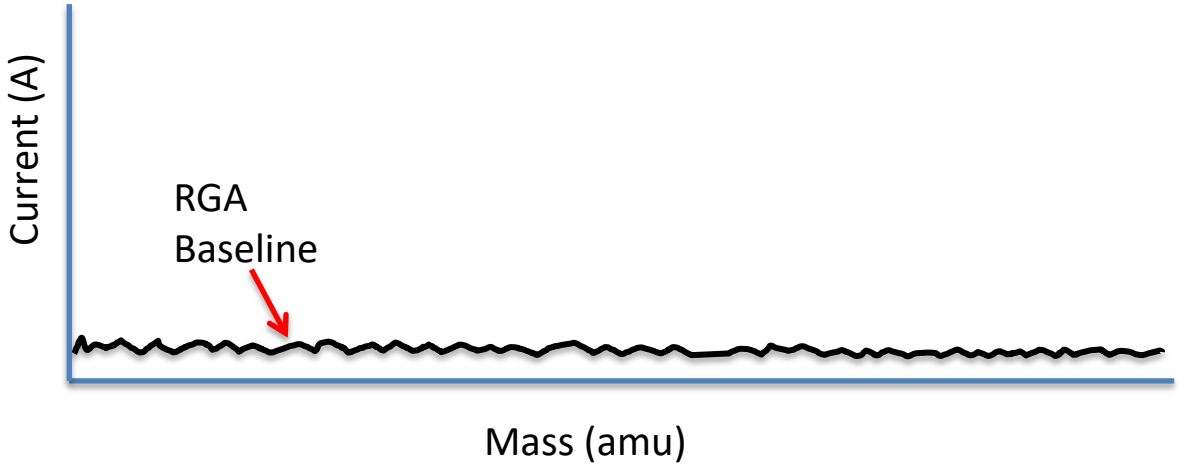
Select specific bins or masses to measure

Select dwell times for each bin

3 BASELINE SUBTRACTION

BASELINE

- Measured at masses where no gas is present
- Relatively small signal
- Subtracted from gas measurements to improve their accuracy



BASELINE SUBTRACTION

Three different types of baseline subtraction:

- Mono baseline subtraction (Monobase)
- Multi baseline subtraction (Multibase)
- Spectra baseline subtraction (Spectrabase)

MONO BASELINE SUBTRACTION

- Mono baseline subtraction is the default mode of data collection
- One baseline value measured after every scan
- Measured while RGA set for no ion current to reach the detector
- Subtracted uniformly across the spectrum

MULTI BASELINESUBTRACTION

- Multi baseline subtraction is only available in bins mode
- Each selected mass has its own baseline value
- Measured while RGA set for no ion current to reach the detector
- Mass filter set to maximum DC voltage
- Mass filter set to RF voltage for the selected mass
- Baselines measured by round robin method
  - After each scan, a baseline is measured for one of the selected masses
  - Successive scans step through the list of selected masses

SPECTRA BASELINE SUBTRACTION

- Also known as SpectraBase
- Baseline is measured at a specific set of mass values
- For example: 9, 23, 37 and 47 amu
- Between these masses, baseline values are interpolated
- Above and below these masses, baseline values are extrapolated

4 SCAN TIME

SCAN TIME

- Important aspect of setting up data acquisition recipe
- Determines sampling period of each scan
- Amount of time per scan
- RGA time resolution for measuring the process
- Speed for detecting a process change, such as a leak

MINIMUM SCAN TIME

- Minimum scan time is automatically calculated when a recipe is being configured
- Time between scans (ms)
- User controlled parameters that can affect time between scans:
  - Dwell time
  - ppAMU
  - Number of masses collected
- Trade-off for decreased scan time can include worse detection limits, poor peak shape in analog mode, increased noise

POINTS PER AMU EFFECTS ON MINIMUM SCAN TIME

- Analog Scan 0-50 AMU
- 32 millisecond dwell time

ppAMU	Scan Time (ms)
5	8880
10	17680

DWELL TIME EFFECTS ON MINIMUM SCAN TIME

- Analog Scan 0-50 AMU
- 5 ppAMU

Dwell Time (ms)	Scan Time (ms)
32	8880
64	16944

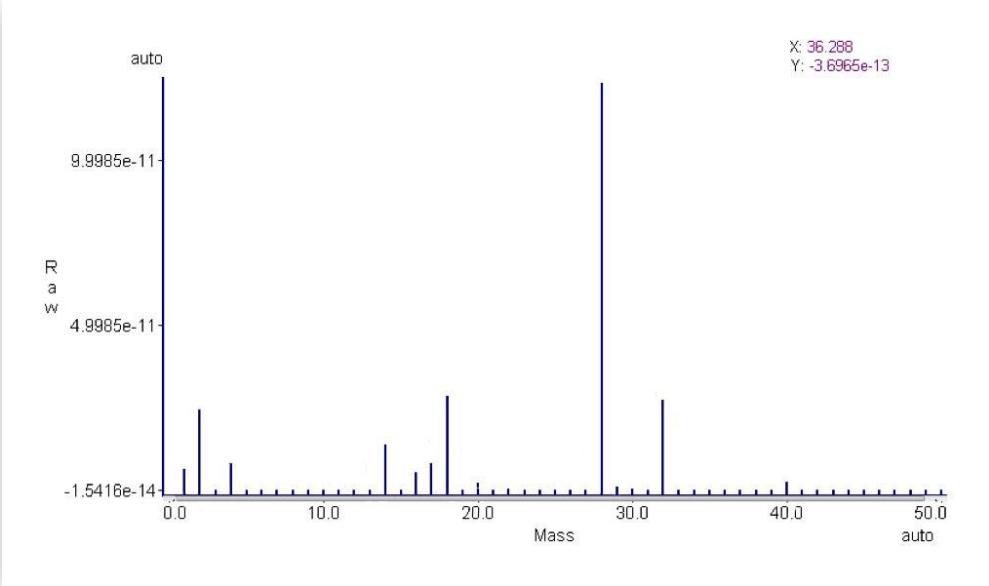
5 SPECTRUM IDENTIFICATION

SPECTRUM IDENTIFICATION

- Common application of RGA
- What gases are in the vacuum system?
- Vacuum diagnostics
- Process diagnostics

AQUIRE THE SPECTRUM

- Collect a mass spectrum for the vacuum system or process
- Determine the masses of the peaks with the highest intensities
- In this example: 1, 2, 4, 14, 16, 17, 18, 28, 32 and 40



SPECTRUM GUIDE

- Masses of interest
  - 1, 2, 4, 14, 16, 17, 18, 28, 32, 40
- Use the spectrum guide document as a starting point
- Use knowledge of vacuum system to identify possible constituents

AMU	Formula	Compound Name
1	H	Hydrogen, Water
2	H_2	Hydrogen
4	He	Helium
14	N	Nitrogen
16	O	Oxygen, Carbon Dioxide, Carbon Monoxide, Water
17	OH	Water
18	H_2O	Water
28	N_2	Nitrogen, Air
32	O_2	Oxygen
40	Ar	Argon

SPECTRUM GUIDE – NIST WEBSITE

NIST Website is a great reference: http://webbook.nist.gov/chemistry/

- The NIST website can give you an idea of what a spectrum should look like for a given compound
- Limited subset of compounds also available in the LINXON Spectra Library document

ADVICE FOR SPECTRUM IDENTIFICATION

- Ensure RGA is properly tuned
- Acquire spectrum in analog mode
  - Collect a complete spectrum across a mass range
  - Distinguish peaks from baseline
- Linear scale clearly identifies largest peaks
- Log scale can help to identify smaller peaks

6 WAYS TO REPORT DATA

LOGARITHMIC VS. LINEAR GRAPH SCALING

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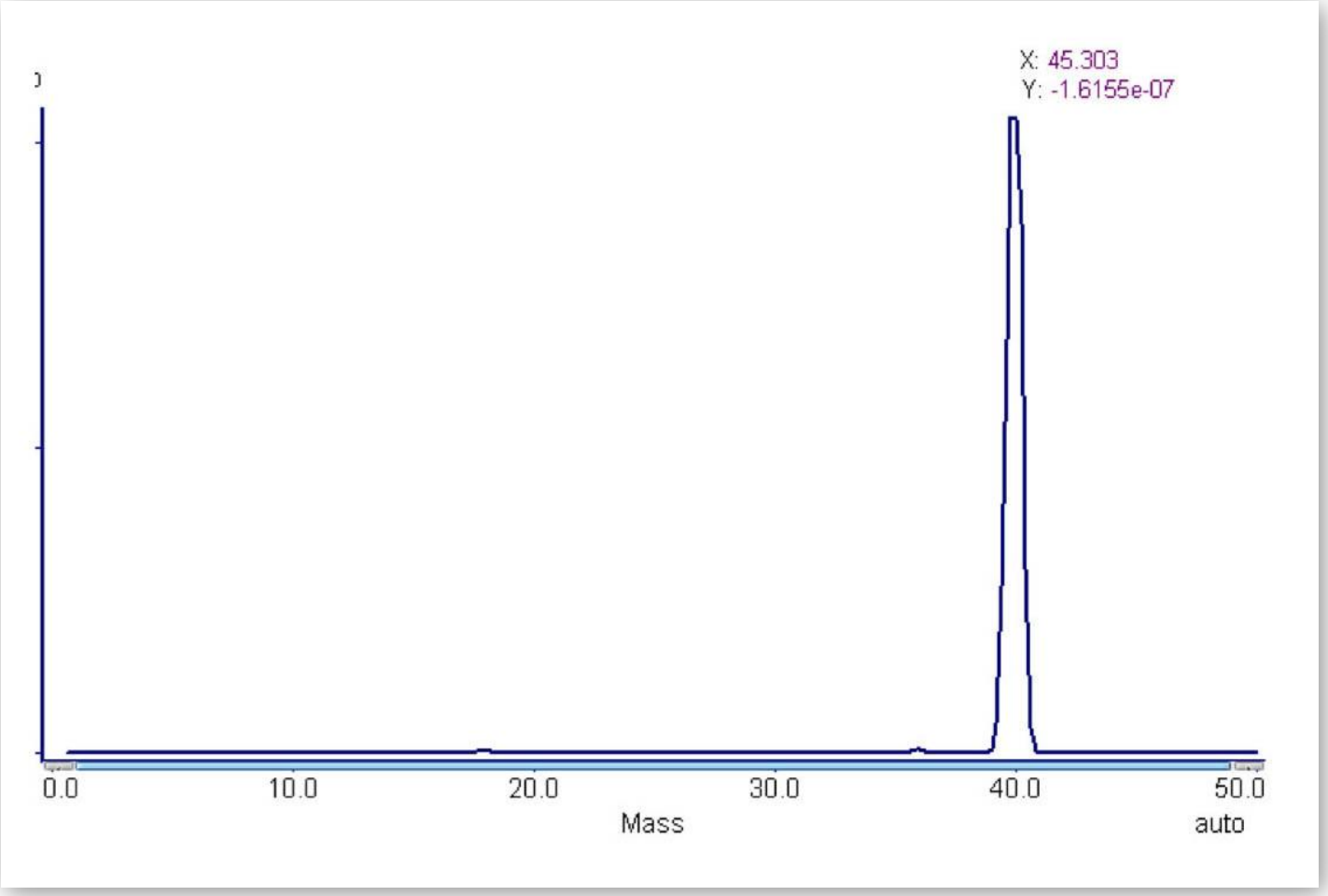
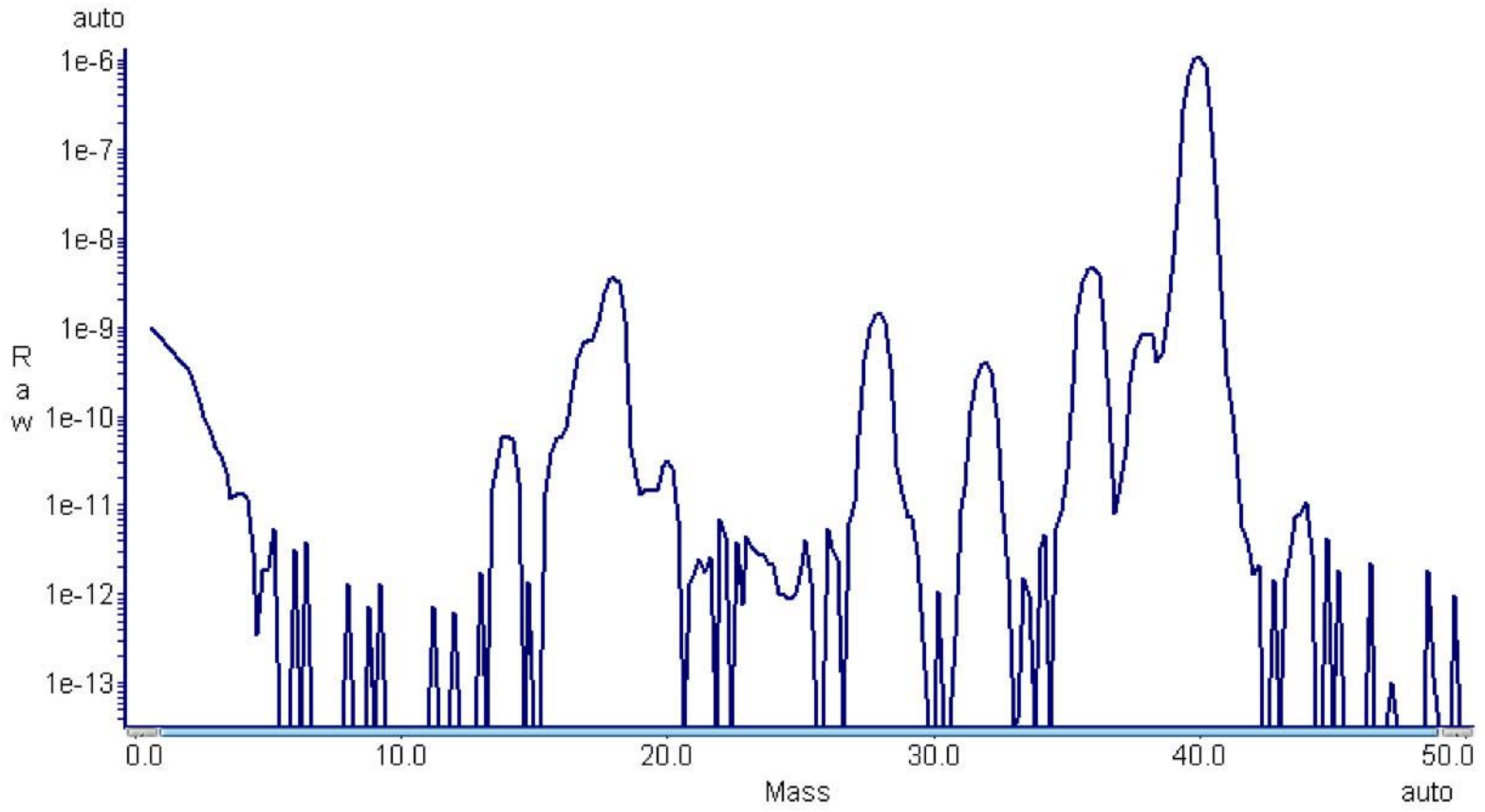
- RGA data display options
- Linear scaled y-axis
  - Linear scale from minimum to maximum axis values
  - Primarily displays the larger peaks
- Logarithmic scaled y-axis
  - Each major scale division represents a factor of 10
  - Displays both the larger and the smaller peaks
- If large concentration of one gas, then display with logarithmic y-axis if you want to display both the large and small peaks.

Y-AXIS LINEAR



Y-AXIS LOGARITHMIC

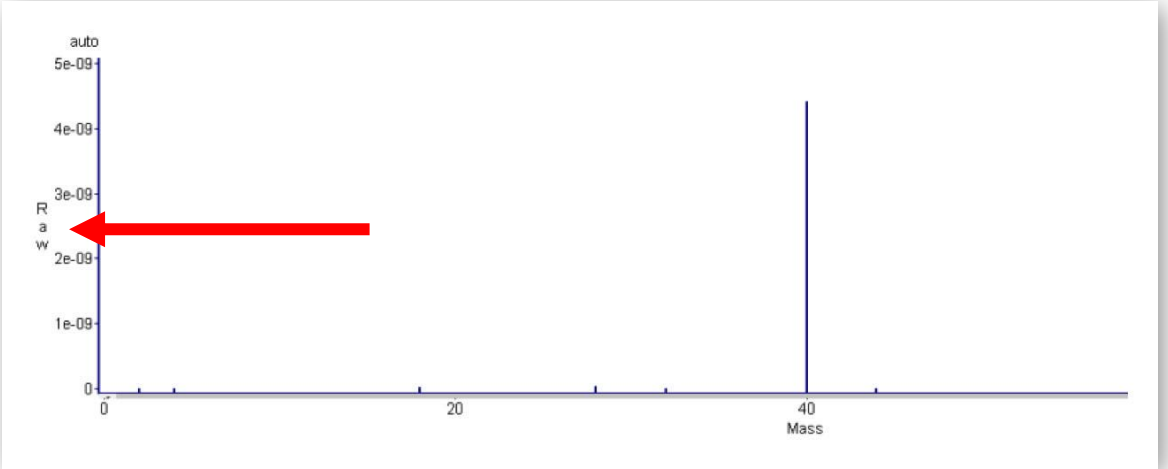


WAYS TO REPORT DATA

- Raw current (A)
- Partial pressure (Torr, mbar, Pa)
- Partial pressure, N_2 equivalent (Torr, mbar, Pa)
- PPM (ratio)

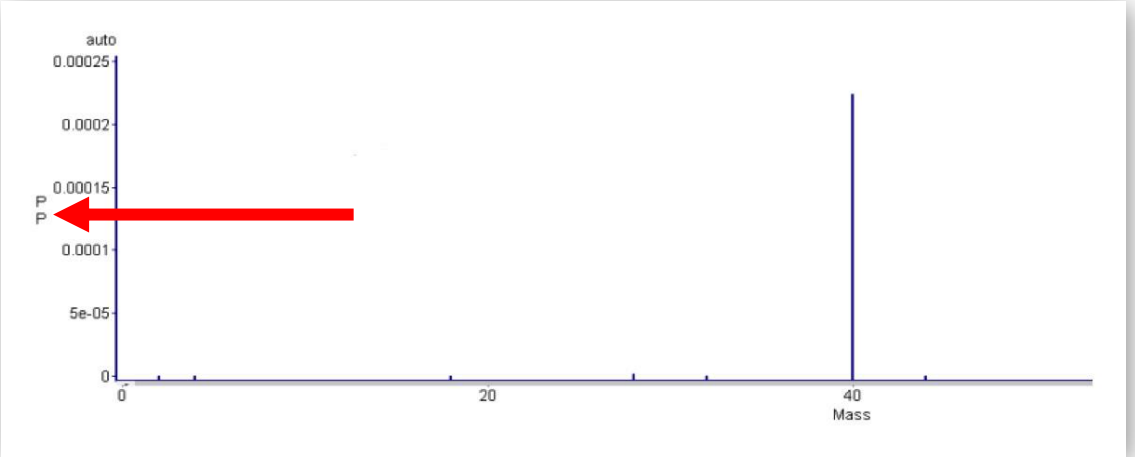
DATA DISPLAY FORMAT – RAW SIGNAL

- Sensor output current (A)
- Labelled “raw”
- No data manipulation, other than baseline subtraction



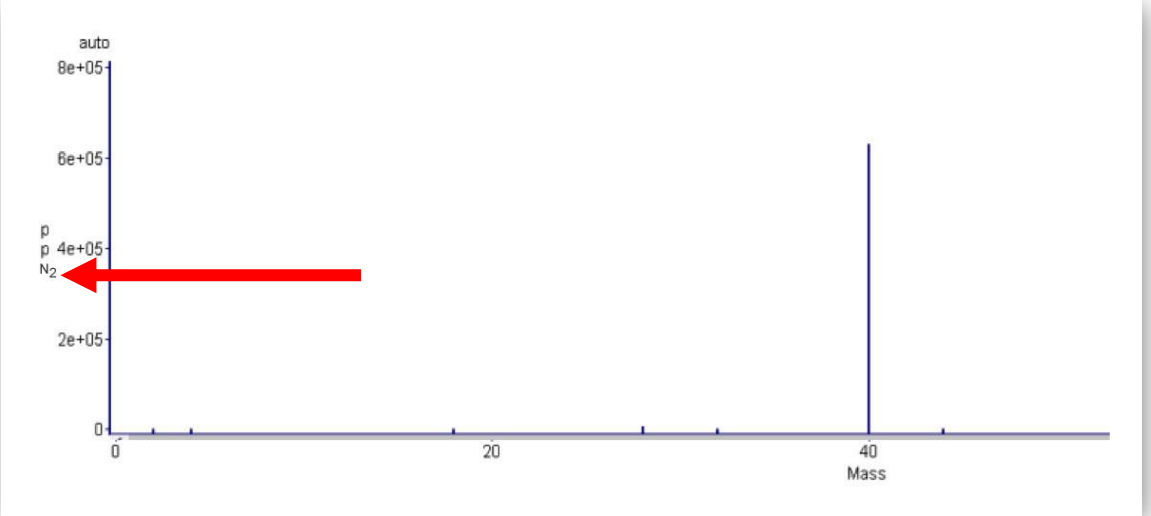
DATA DISPLAY FORMAT – PARTIAL PRESSURE (PP)

- Can approximate as raw current divided by RGA sensitivity
- Algorithm in onboard web server converts current to partial pressure
- Conversion based on several factors:
  - Gas-specific material factors
  - RGA calibration parameters



DATA DISPLAY FORMAT – PARTIAL PRESSURE (N_2 EQUIVALENT)

- The calculation for Partial Pressure N_2 Equivalent is the same as the previous slide, except each mass is treated as N_2

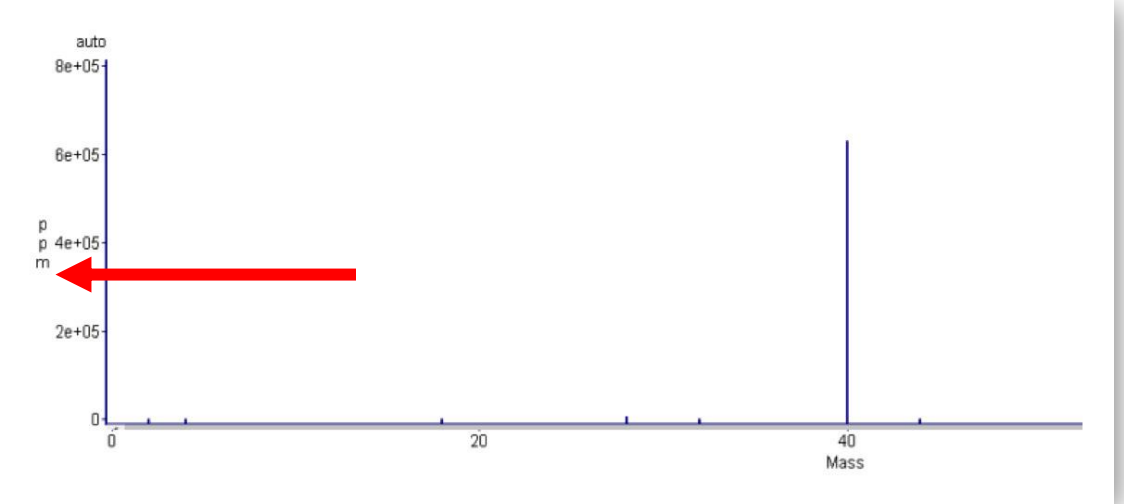


DATA DISPLAY FORMAT – PARTS PER MILLION (PPM)

- Concentration of a specific gas within a mixture of gases
- Gas purity, for example: 10 ppm of water in argon
- Defined as:

*Concentration = (Partial Pressure / Total Pressure) * 1,000,000*

In units of ppm

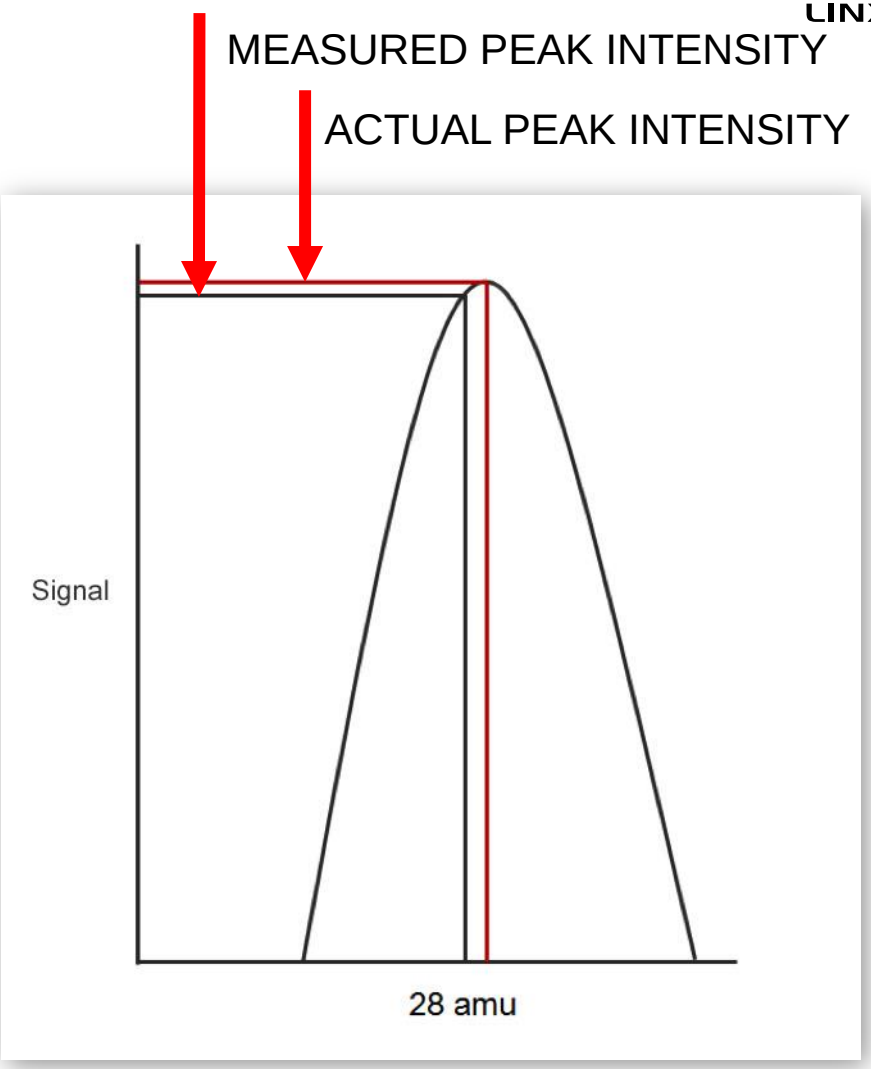


6

TUNING AND CALIBRATION EFFECTS ON ANALYSIS

TUNE QUALITY

- Tune quality affects measurement accuracy
- Peak location not aligned with the integer mass value
- Results in a measurement inaccuracy
- Remedy is tuning the RGA



RGA CALIBRATIONS

- FC sensitivity calibration
  - Monitor
  - Calibrate periodically
  - Service sensor when necessary
- EM gain calibration
  - Monitor
  - Calibrate periodically
  - Service sensor when necessary
- Total pressure calibration
  - Calibrate periodically

SUMMARY

In this module, you have now learned how to:

- Describe and configure an analog scan
- Describe and configure selected masses mode (bins)
- Describe the different methods of baseline subtraction
- Describe scan time and how it can be changed
- Describe the process of spectrum identification
- Describe data scaling options
- Describe different units of measure for display of RGA results
- Describe implications of tuning and calibration on analysis

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.