3FLEX
Surface Characterization

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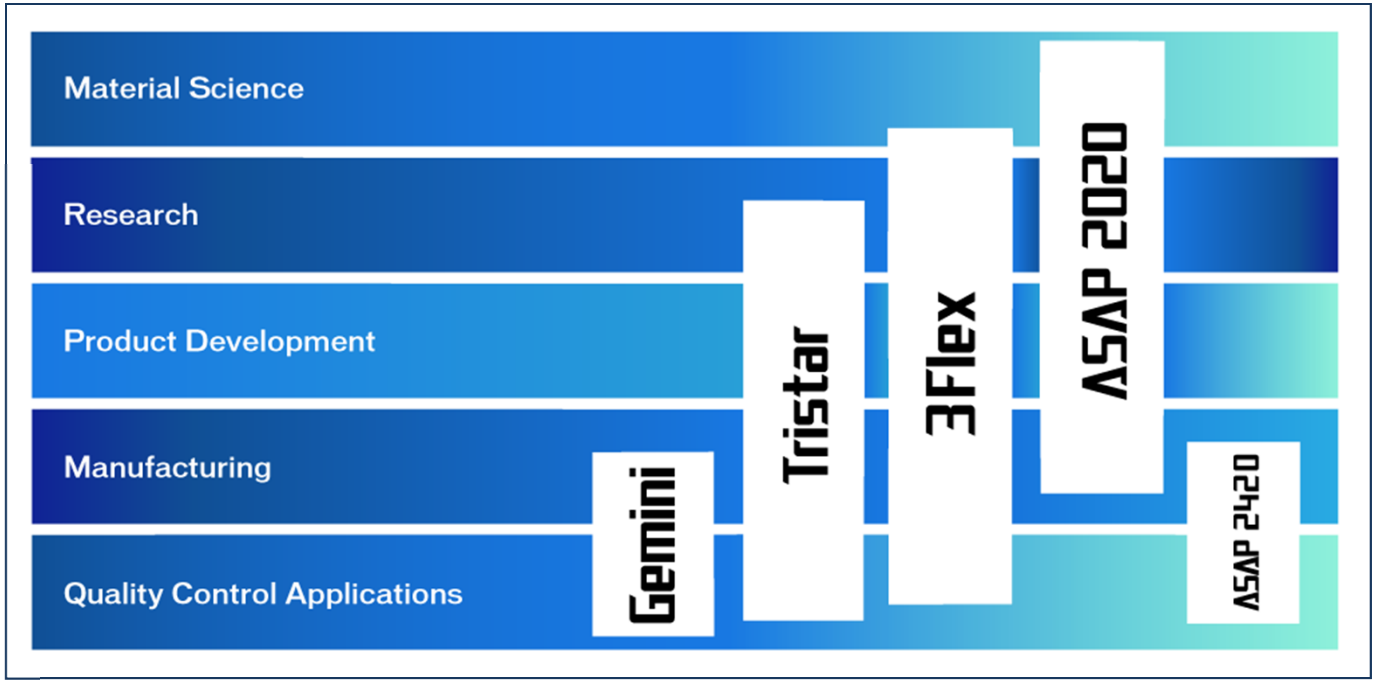
3FLEX Surface Characterization

Quick application view of Micromeritics Gas Adsorption Instruments



3FLEX
Surface Characterization

Profile and Performance Features

Profile for the 3Flex

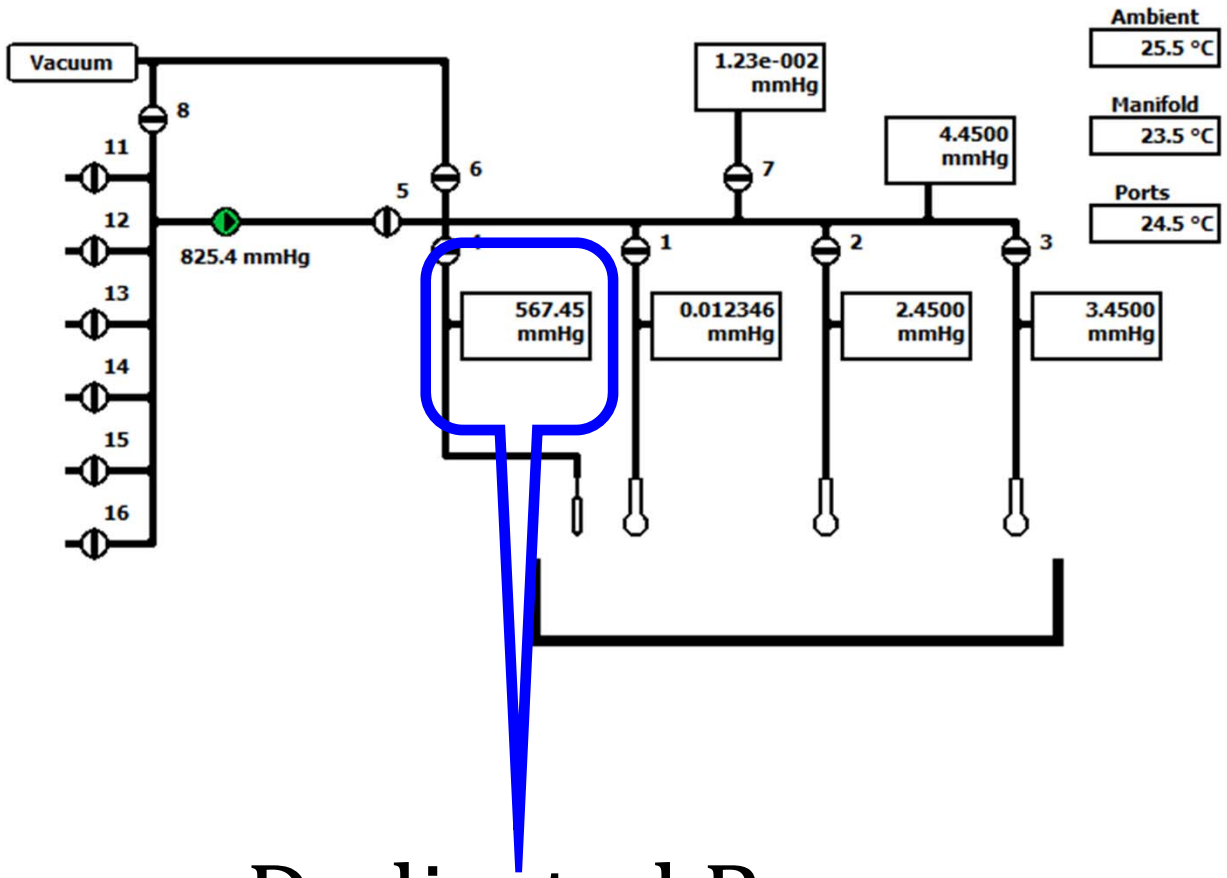
- Three analysis ports with independent transducers
- A P_o port with a dedicated transducer
- Inlet ports for helium and five analysis gases
- 29 bit A/D conversion of pressure transducers
- Stainless steel gas inlet and analysis manifolds
- Hard seal valves
- Minimum >70 hour useable Dewar life (3 sample tubes, isothermal jacket, P_o tubes and heated manifold)
- Data reduction with MicroActive and new user defined report options
- The ability to control up to four instruments from one computer
- Built-in diagnostics for maximum uptime performance

Manifold design

- **Hard seals**
  - Welded components
  - **VCR - component connections**
    - Highest quality available
  - **Metal diaphragm - PCTFE valve seat**
    - Best available technology for use with VCR and welded components

Pressure measurement

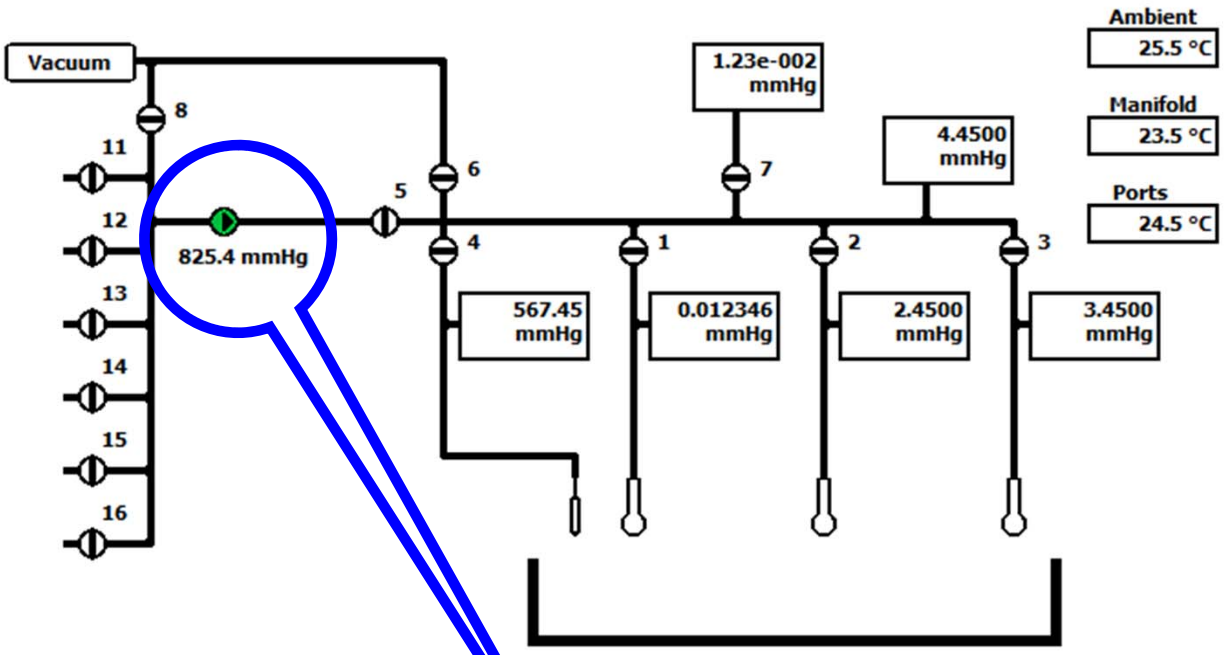
- **Dosing manifold transducers**
  - 1000 torr
  - 10 torr
- **Port (equilibrating) transducers**
  - 1000 torr (3)
  - 10 torr (2 or 3)
  - 0.1 torr (2 or 3)
- **P_{sat} port**
  - 1000 torr
- **Vacuum gauge**
  - Pirani
  - Cold cathode



Dedicated P_o

Vacuum gauges

- **Dual gauge**
  - Pirani
  - Cold cathode
- **Compensated for gas type**
  - Gas specific and updated for each gas used during an analysis
- **Unique Physical location**
  - Comparable to the sample location to provide measurements that are consistent with the sample, not measured at pump inlet as competition



Servo control for
dosing and evacuation provides higher degree of gas management

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Surface Characterization

Review of Performance Results

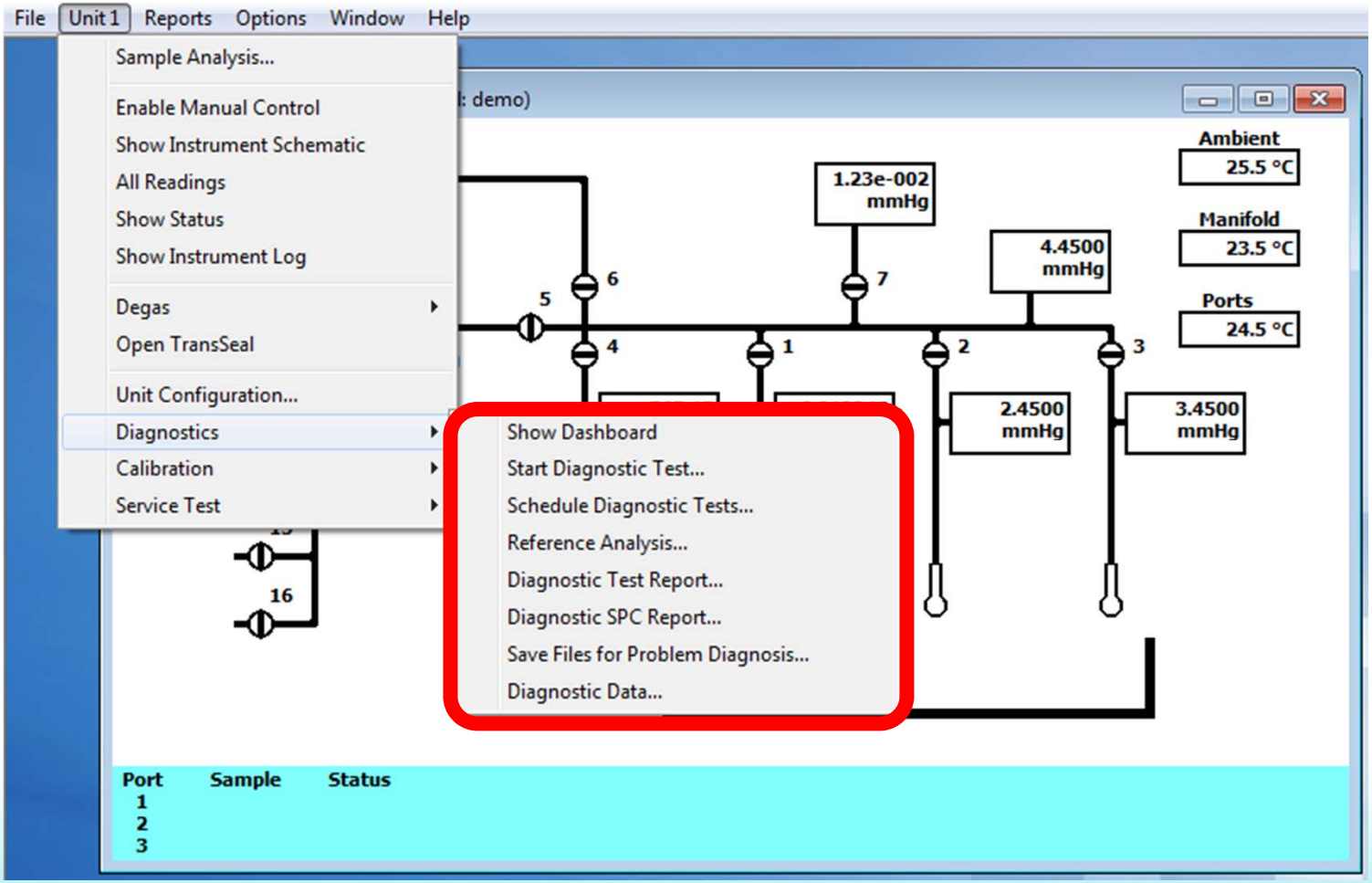
Temperature control

- **Proprietary Micromeritics technology**
  - Developed by Micromeritics
    - Benefit of integrating hardware, software and control
    - 3 strategic RTD locations
  - **Temperature control of +/- 0.05° C**
    - Better control than provided by a temperature controlled transducer

Instrument Hardware Specifications

	Competitor B	Competitor Q	3Flex
Transducers	11	7	12
Transducer (temperature controlled)	2 (manufacturer)	2 (manufacturer)	12 (proprietary Micromeritics)
Vacuum gauge	Dual gauge	Dual gauge	Dual gauge
Manifold (temperature controlled)	40° C	optional	45° C (proprietary Micromeritics)
Data acquisition A/D	24 bit	24 bit	25 bit (29 bit a/d)
Dosing & Evacuation	Needle valves	Needle valves	Servo
Hybrid turbo pump	Elastomer seal	CF (metal seal)	CF (metal seal)
Roughing pump	2 stage diaphragm	2 stage diaphragm	4 stage diaphragm

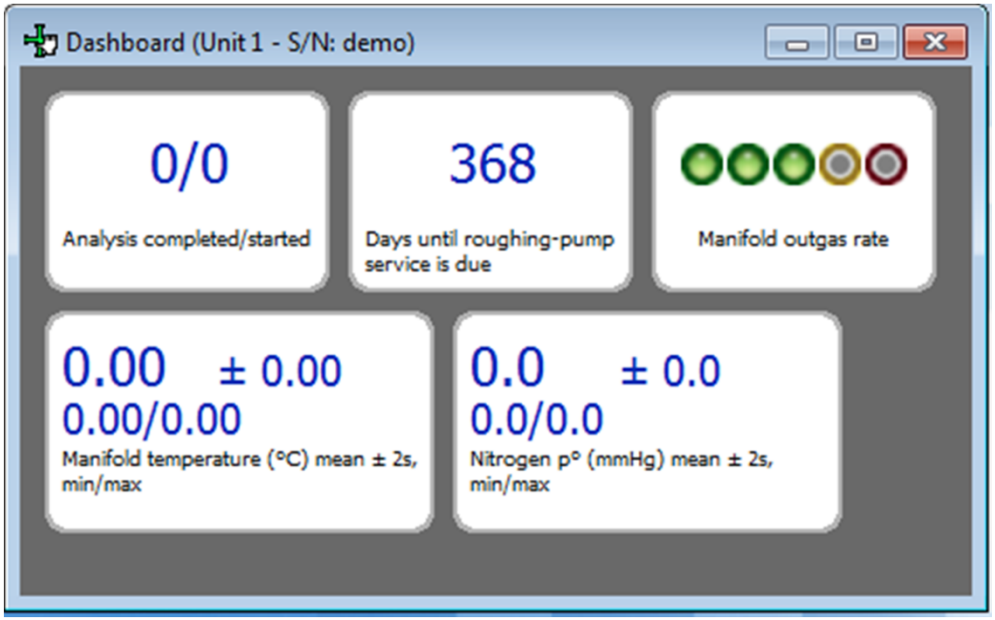
Diagnostics for system monitoring and performance

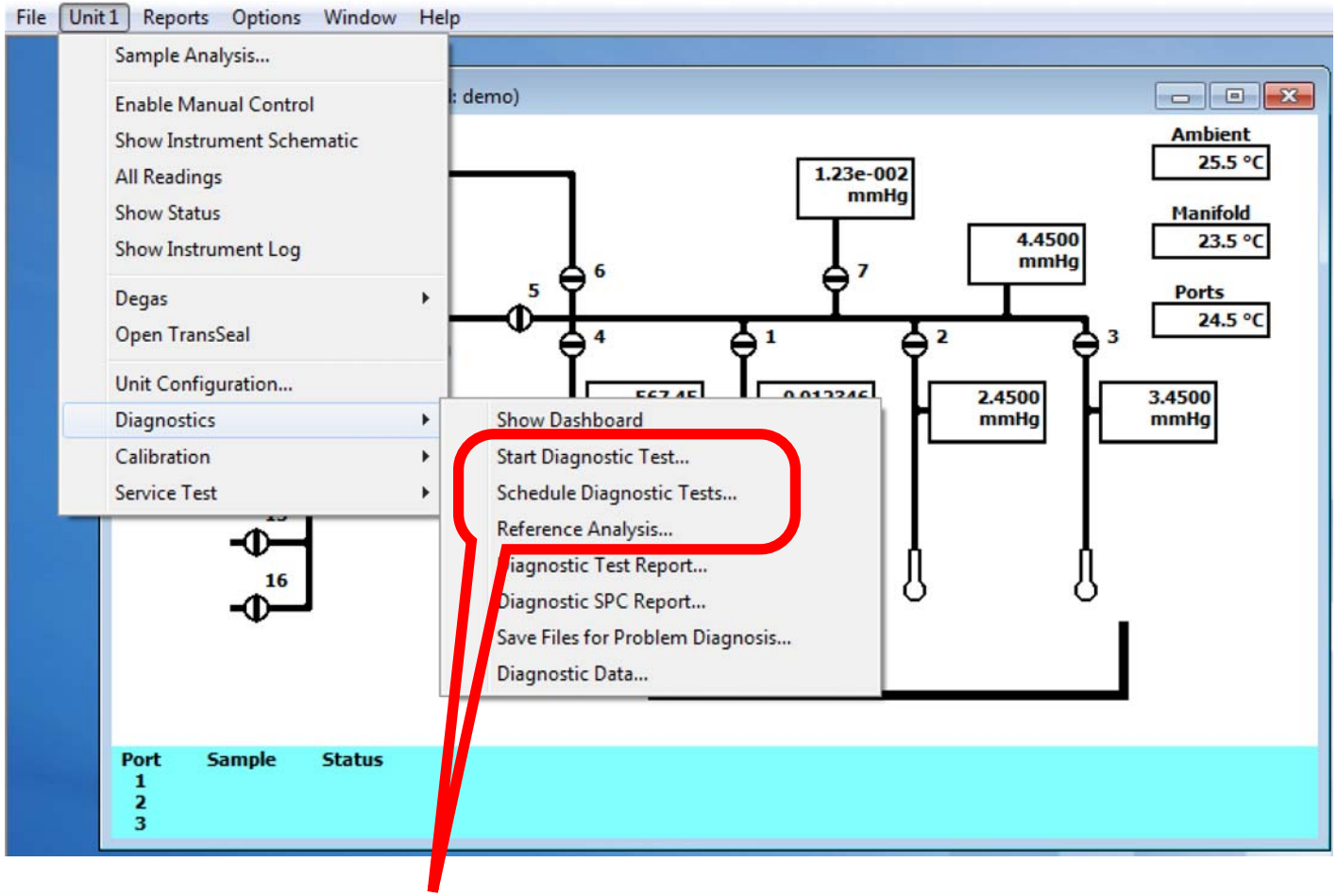


Operational Dashboard

Routine event monitoring

- Number of analyses
- Diaphragm pump life
- Nitrogen P_o
- Manifold outgas rate
- Reference material

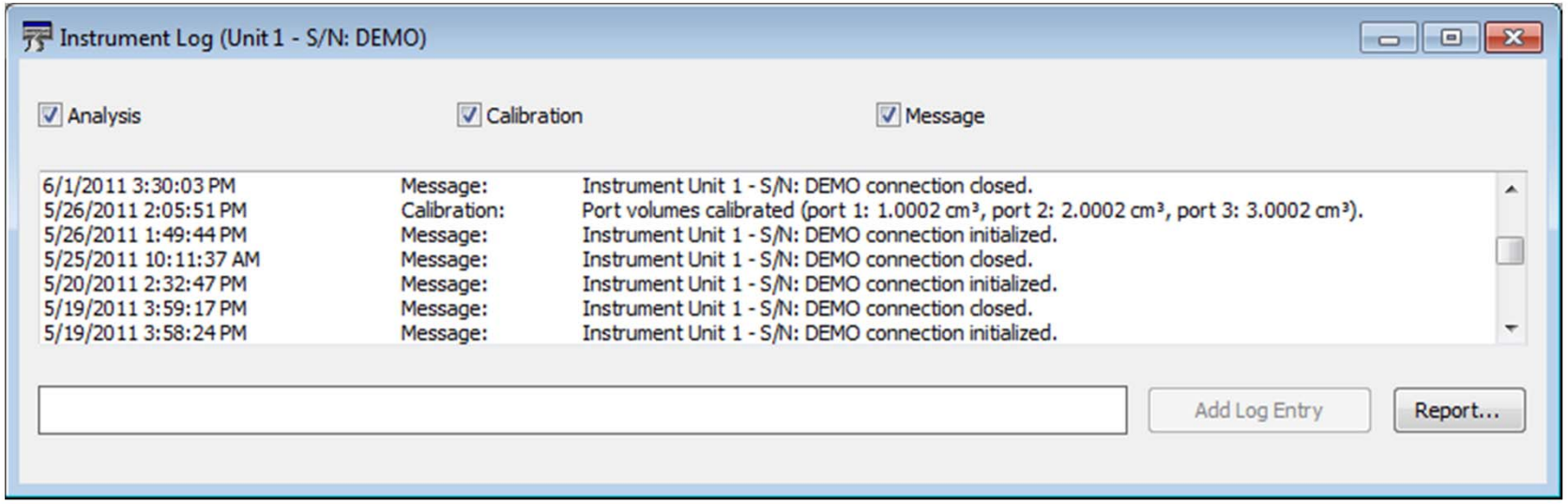




User scheduled diagnostic testing

Background monitoring while the instrument is idle

Diagnostics



Full logging of all system events, calibration and error messages

Adsorptive properties

- **Standard library includes more than 30 fluids**
  - Inorganic gases: nitrogen, oxygen, argon, krypton ...
  - Alkanes: methane, ethane, propane, butane, ...
  - Alkenes: ethylene, propylene, ...
- **The 3Flex is designed with extensive chemical compatibility**
  - The large library allows the user to utilize the full instrument capabilities
- **Reduce the "user effort" to find information**
  - Do more faster

Adsorptive Library

Nitrogen	Methane
Argon	Ethane
Krypton	Propane
Oxygen	n-Butane
Helium	i-Butane
Neon	Pentane
Xenon	Hexane
Hydrogen	Heptane
Deuterium	Octane
Ammonia	Nonane
Sulfur hexafluoride	Decane
Carbon dioxide	Ethylene
Carbon monoxide	Propylene
Nitrous oxide	Methanol
Water	Ethanol
Acetone	

Reports

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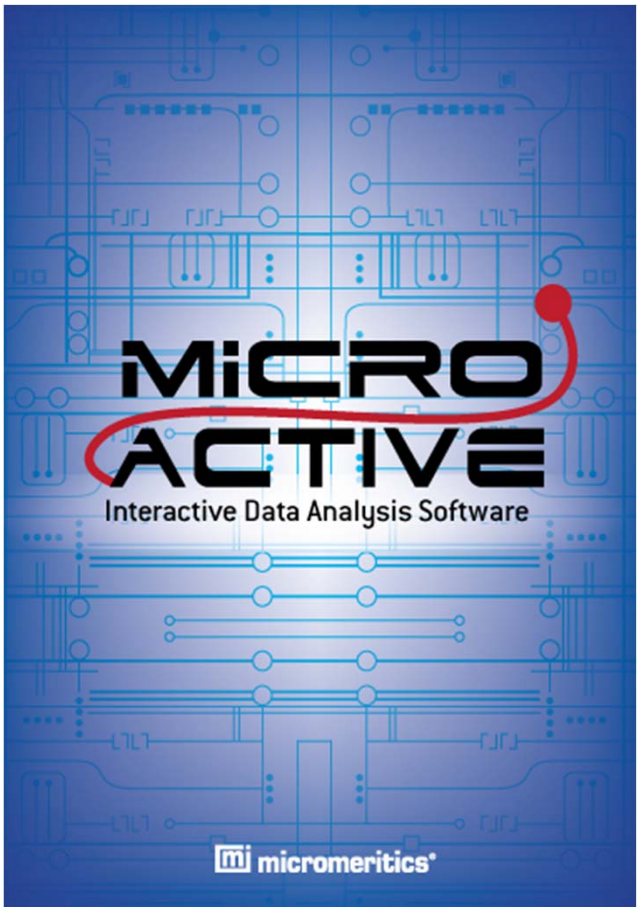
Surface Characterization

Configurable Reports

- Users can specify the reports and the order for presentation
- Overlays (up to 25) to allow more and easier selection

Integration

- **MicroActive**
  - Select a script
  - Manipulate the model using MicroActive controls
- **Report System**
  - Summary
  - Tabular
  - Graphics

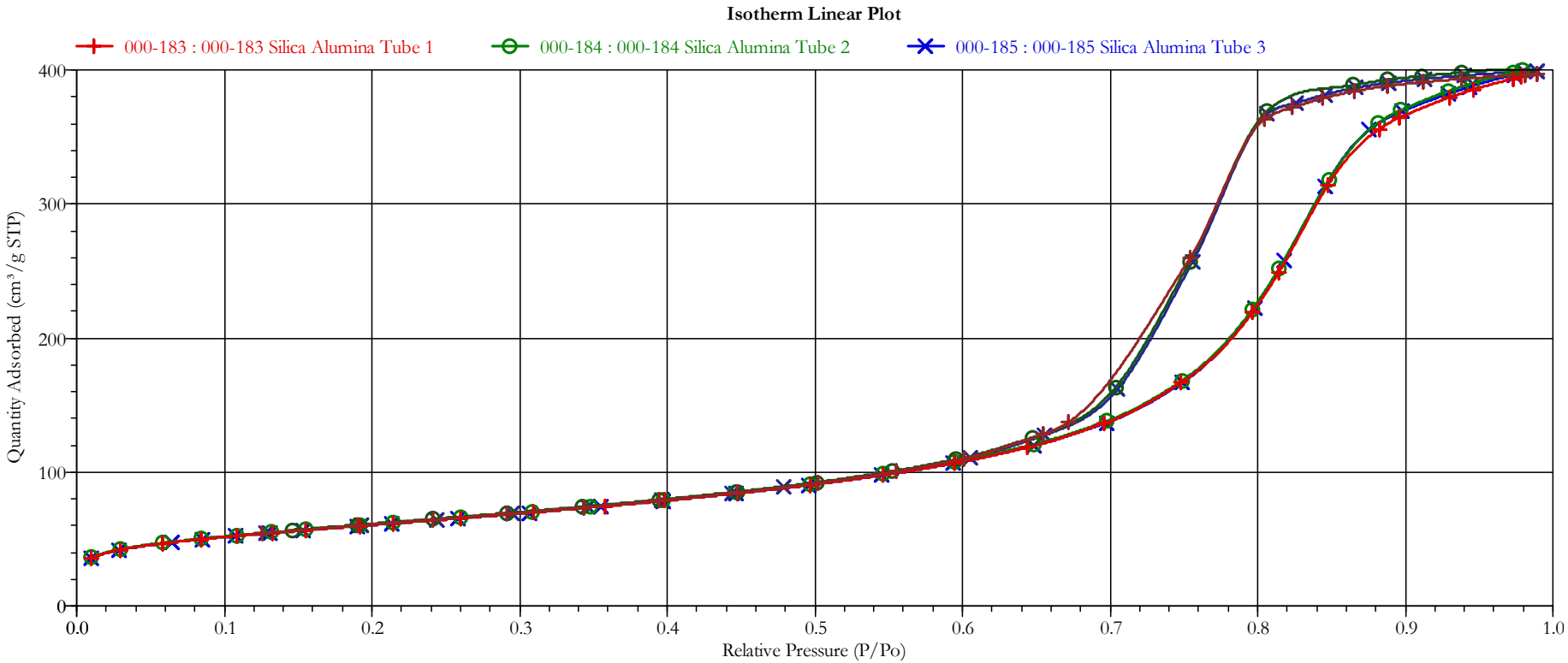


3Flex Sample Analysis Results

Reference Material Analyses

Silica-Alumina Isotherms

- Nitrogen adsorptive at LN2 Temperature



Silica-Alumina BET Surface Area

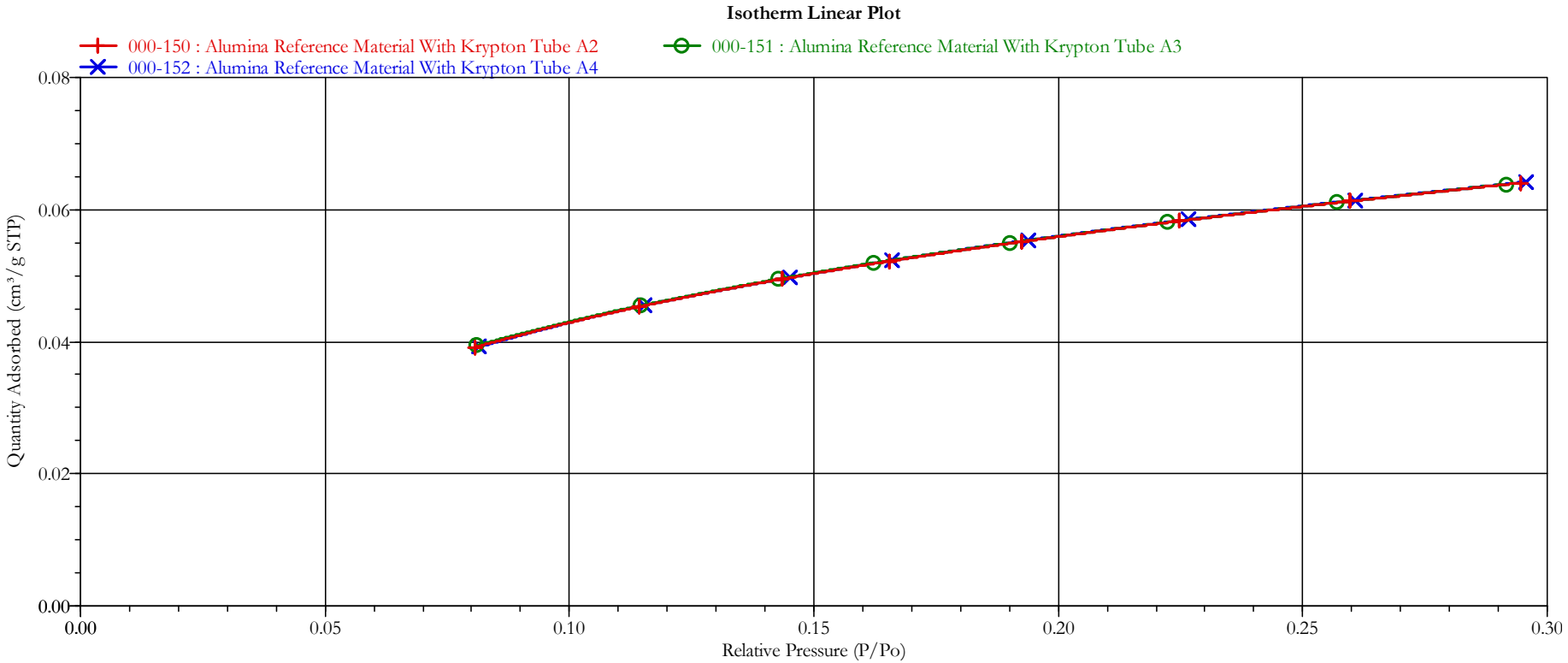
- Silica-Alumina Reference Material 004-16821-00 214 +/- 6 m^2/g

BET Surface Area Report

BET Surface Area: 217.5052 ± 0.2739 m^2/g
Slope: 0.019841 ± 0.000025 g/cm^3 STP
Y-Intercept: 0.000173 ± 0.000004 g/cm^3 STP
C: 115.822081
Qm: 49.9645 cm^3/g STP
Correlation Coefficient: 0.9999960
Molecular Cross-Sectional Area: 0.1620 nm^2

alpha-Alumina Isotherms

- Krypton adsorptive at LN2 Temperature



alpha-Alumina BET Surface Area

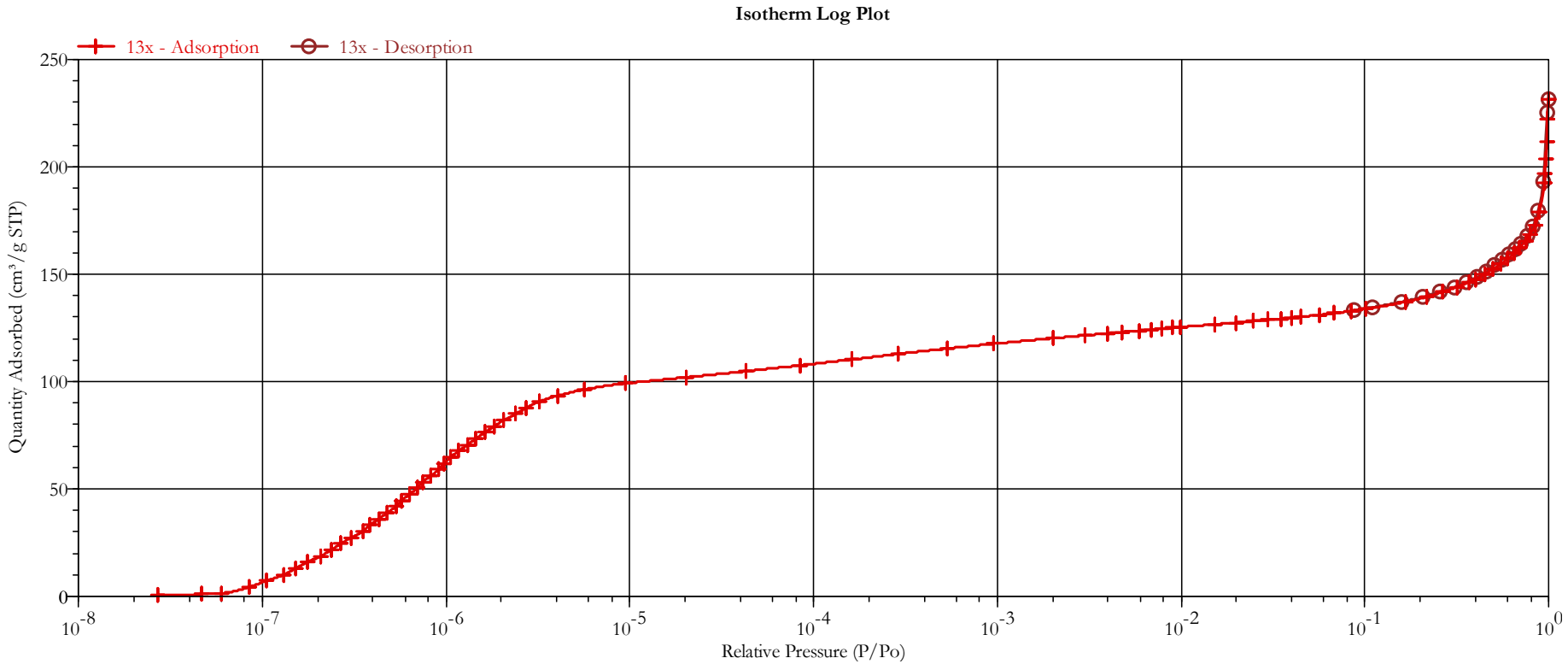
- Alumina Reference Material 004-16816-00 0.28 +/- 0.03 m^2/g

BET Surface Area Report

BET Surface Area: 0.2755 ± 0.0047 m^2/g
Slope: 19.931535 ± 0.346146 g/cm^3 STP
Y-Intercept: 0.552528 ± 0.068085 g/cm^3 STP
C: 37.073343
Qm: 0.0488 cm^3/g STP
Correlation Coefficient: 0.9990964
Molecular Cross-Sectional Area: 0.2100 nm^2

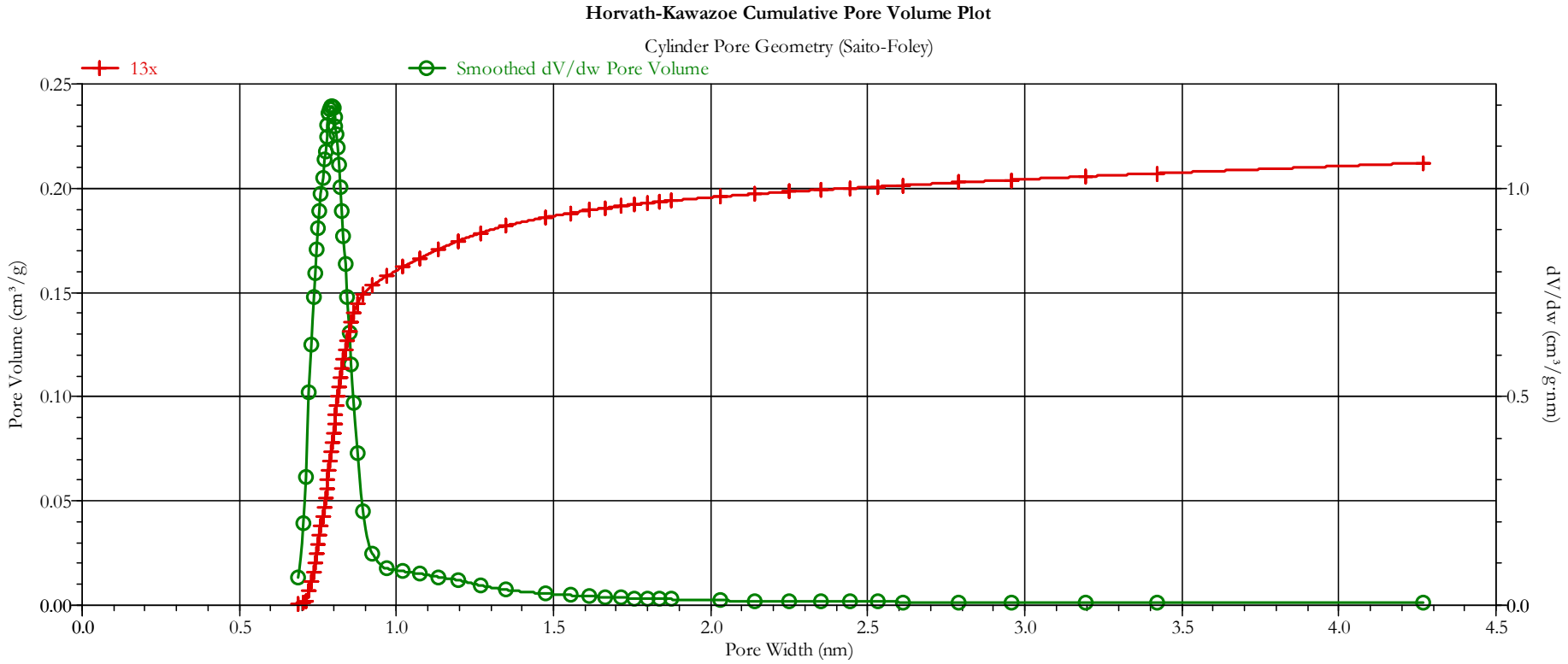
13X Isotherm

- Nitrogen adsorptive at LN2 Temperature



13X Horvath-Kawazoe Pore Width

- Nitrogen adsorptive at LN2 Temperature



13X Horvath-Kawazoe Pore Width

- 004/16843/00 13X Reference Material – 0.80 +/- 0.02 nm

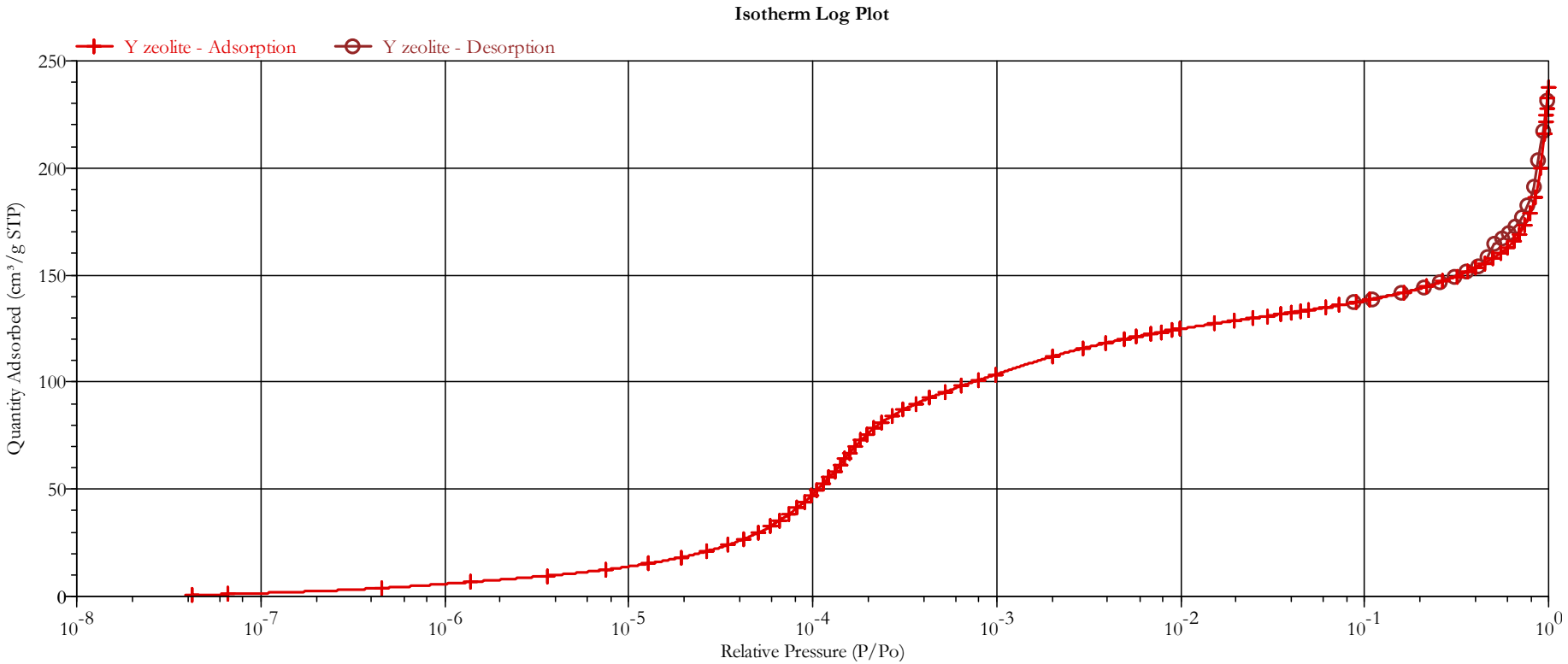
Maximum Pore Volume: 0.212201 cm^3/g
at Relative Pressure: 0.165860101
Median Pore Width: 0.8189 nm
Relative Pressure Range: 2.716e-008 to 1.659e-001

Diameter of Adsorptive Molecule: 0.3000 nm
Adsorptive Density: 6.710e+014 molecules/cm^2
Adsorptive Dispersion Constant: 7.777e-059
Diameter of Sample Atom: 0.3040 nm
Sample Density: 3.750e+015 molecules/cm^2
Sample Dispersion Constant: 7.923e-059

Density Conversion Factor: 0.0015476

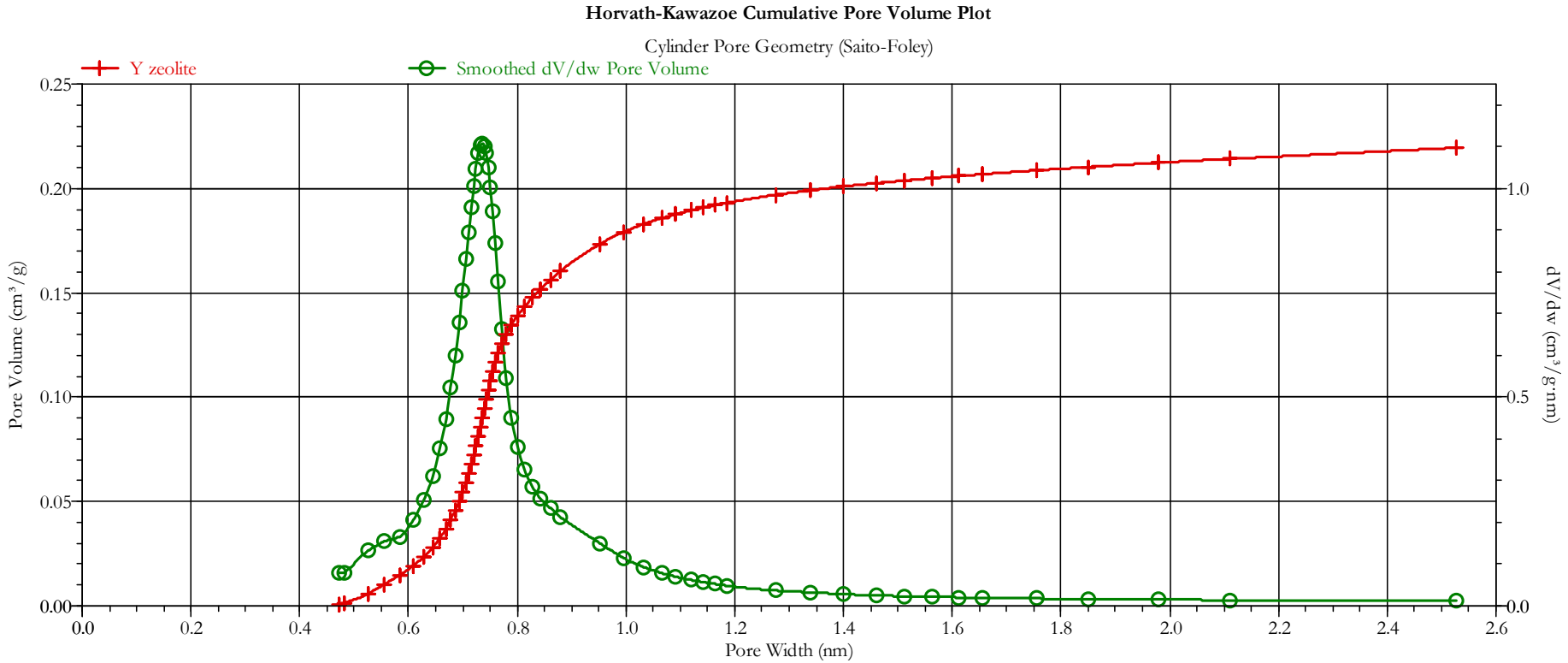
Y Zeolite Isotherm

- Nitrogen adsorptive at LN2 Temperature



Y Zeolite Horvath-Kawazoe Pore Width

- Nitrogen adsorptive at LN2 Temperature



Y Zeolite Horvath-Kawazoe Pore Width

- 004/16844/00 13X Reference Material – 0.74 +/- 0.02 nm

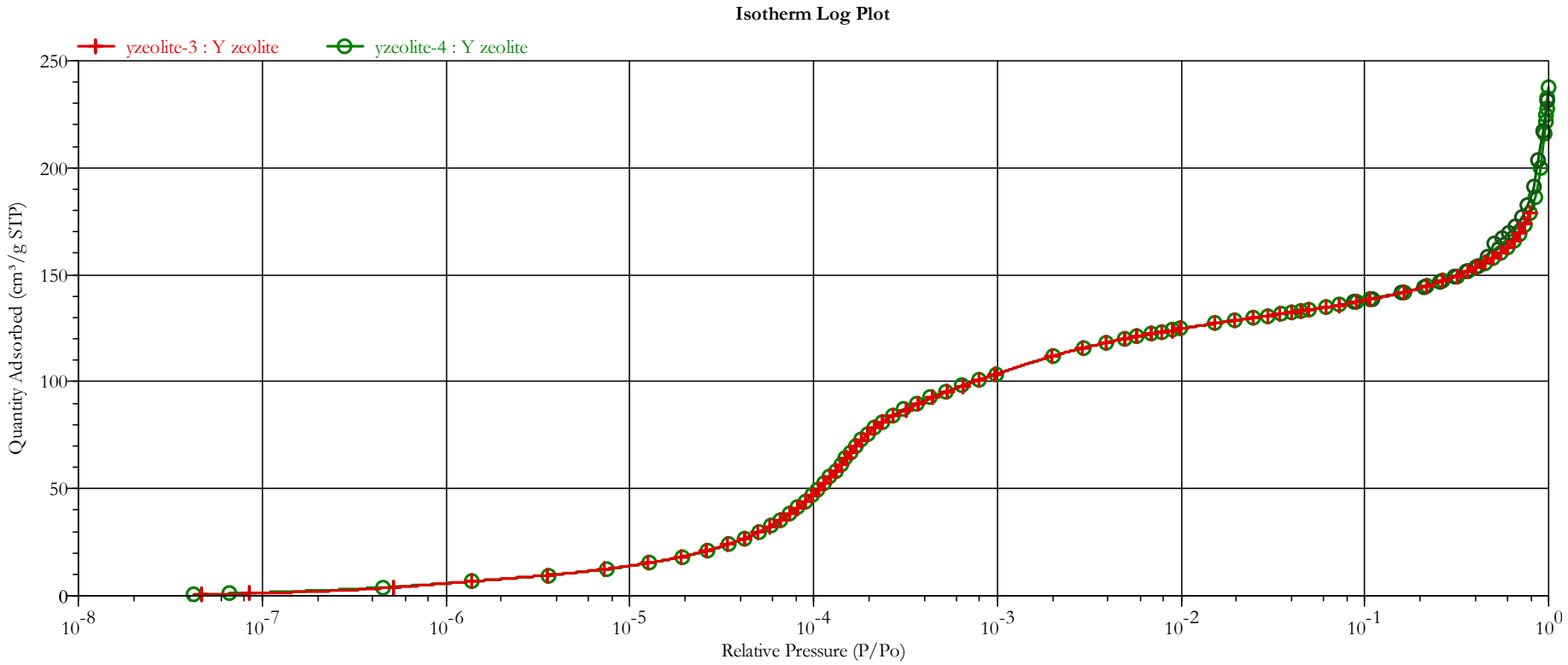
Maximum Pore Volume: 0.219492 cm^3/g
at Relative Pressure: 0.164575388
Median Pore Width: 0.7522 nm
Relative Pressure Range: 4.209e-008 to 1.646e-001

Diameter of Adsorptive Molecule: 0.3000 nm
Adsorptive Density: 6.710e+014 molecules/cm^2
Adsorptive Dispersion Constant: 7.777e-059
Diameter of Sample Atom: 0.2760 nm
Sample Density: 1.310e+015 molecules/cm^2
Sample Dispersion Constant: 8.957e-059

Density Conversion Factor: 0.0015474

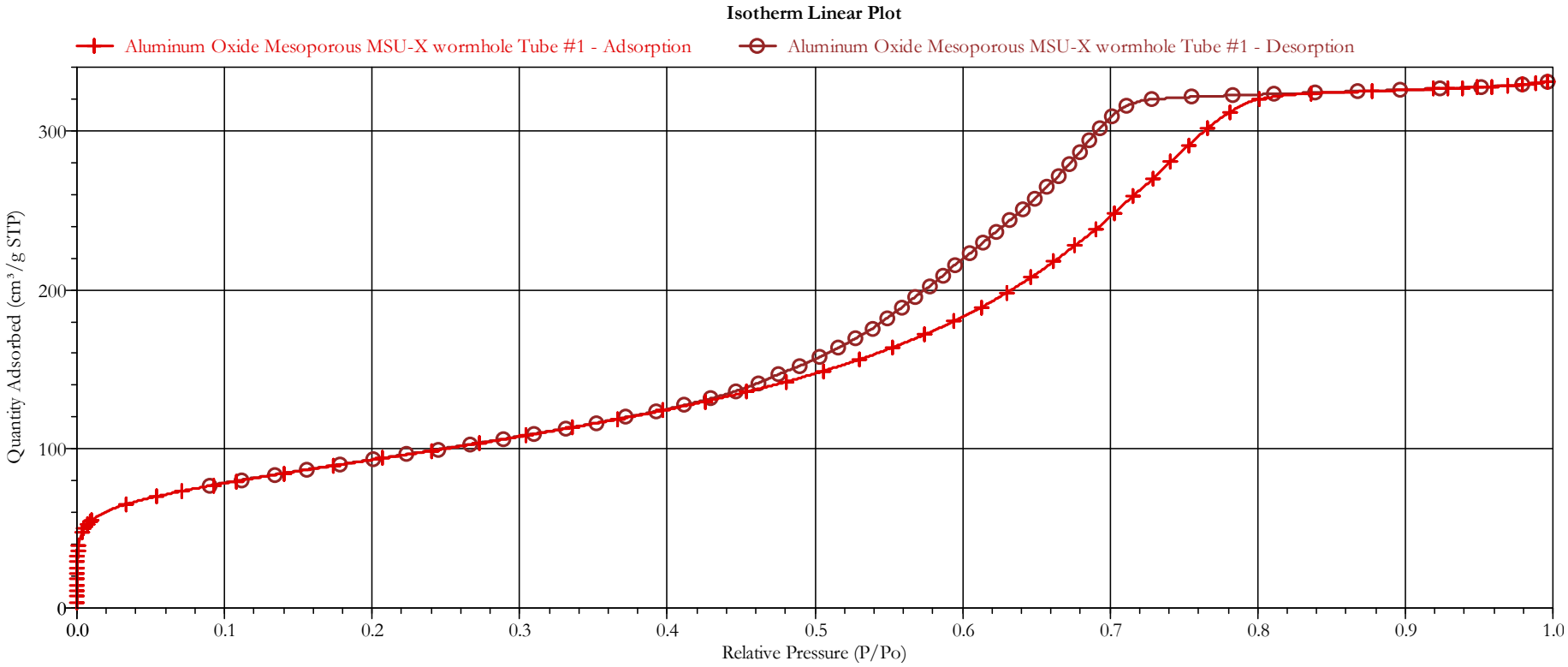
Y Zeolite Isotherm Overlay

- Nitrogen adsorptive at LN2 Temperature



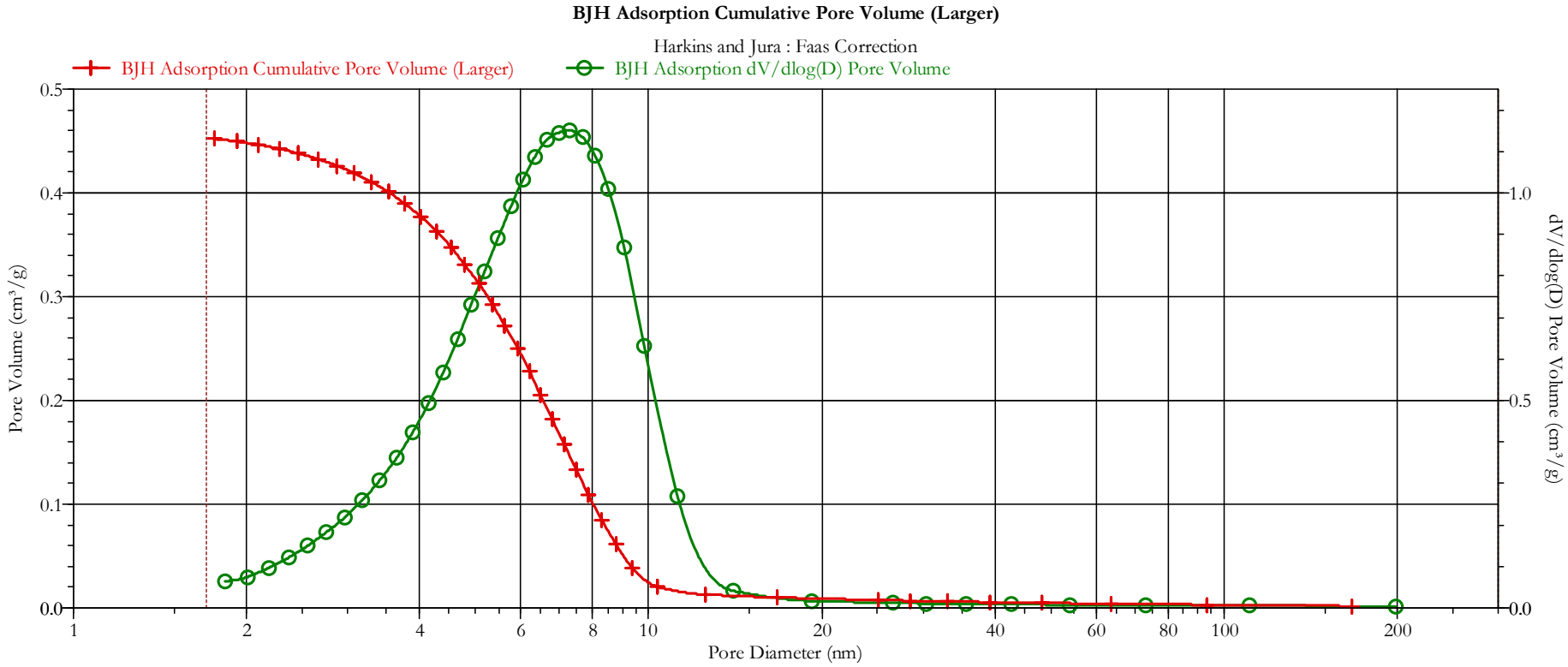
Mesoporous Alumina Isotherm

- Nitrogen adsorptive at LN2 Temperature



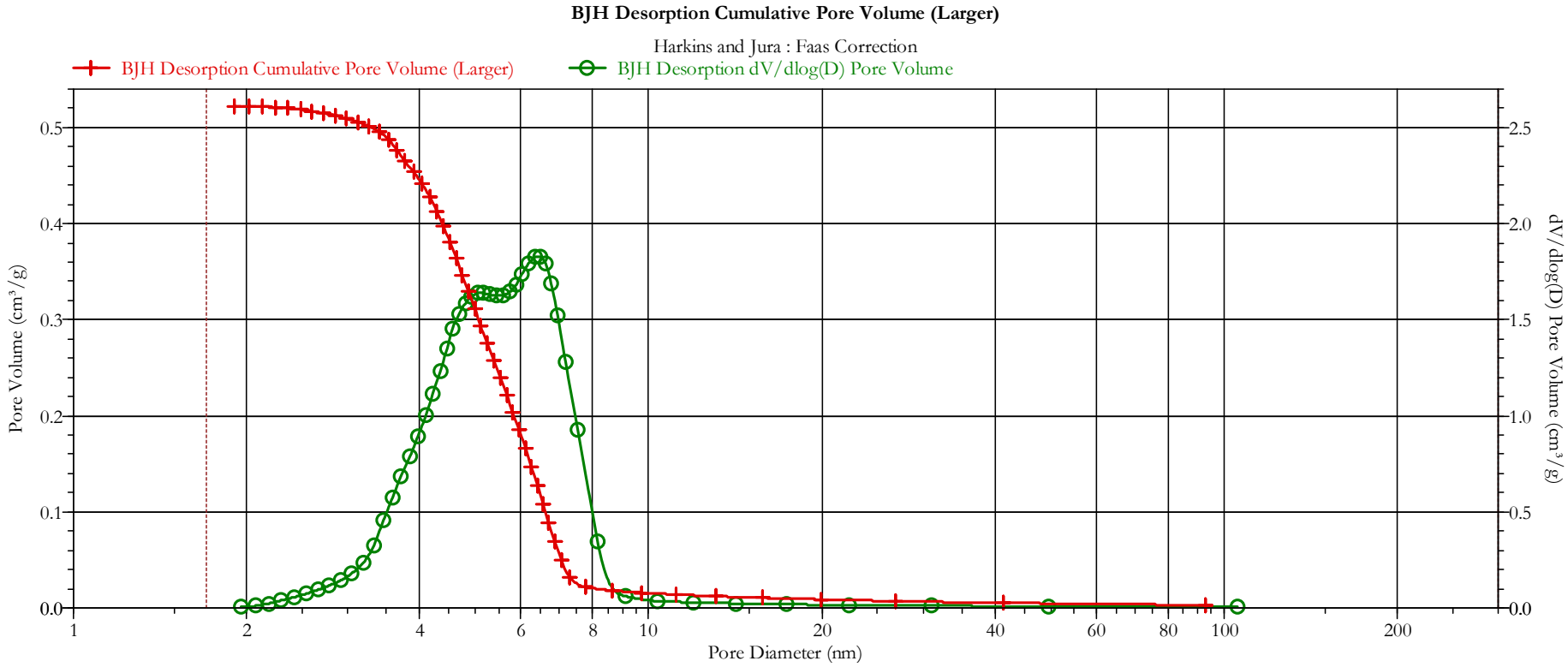
Mesoporous Alumina BJH Adsorption Pore Vol. Dist.

- Nitrogen adsorptive at LN2 Temperature



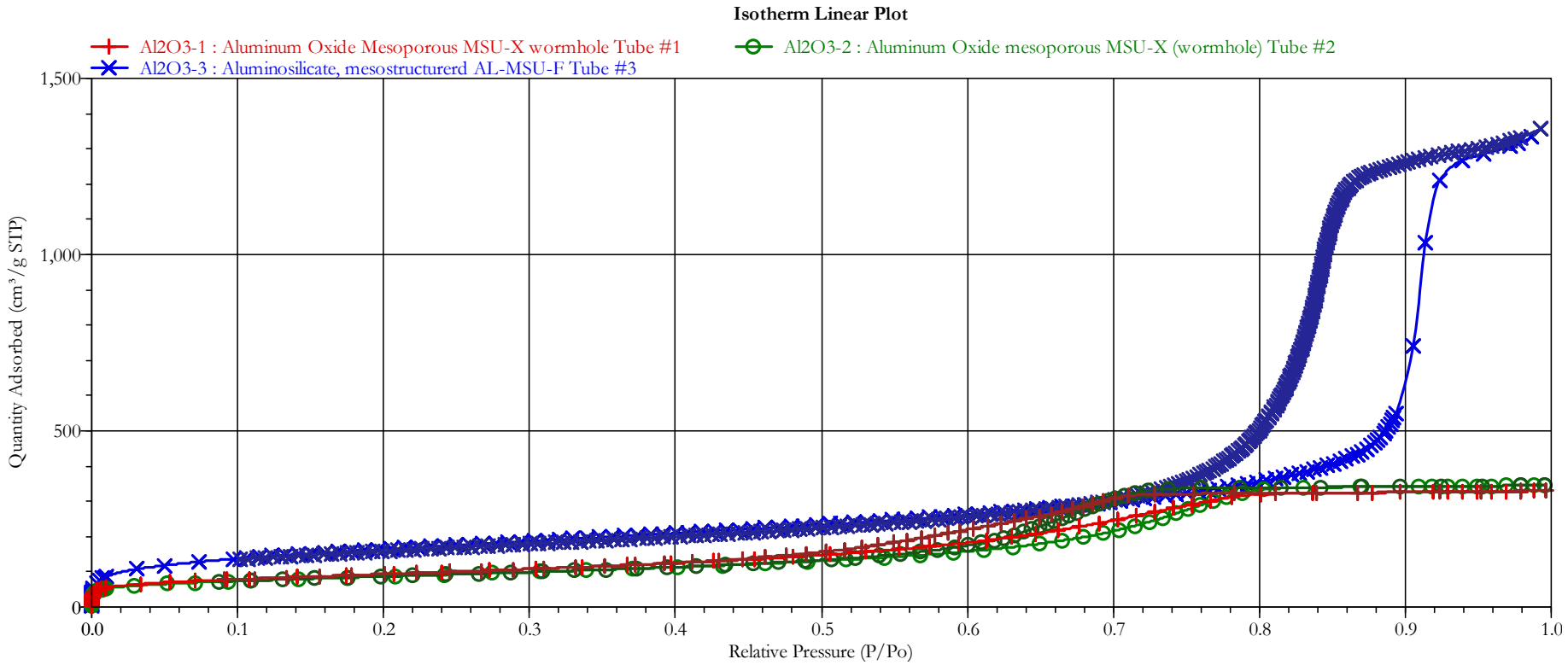
Mesoporous Alumina BJH Desorption Pore Vol. Dist.

- Nitrogen adsorptive at LN2 Temperature



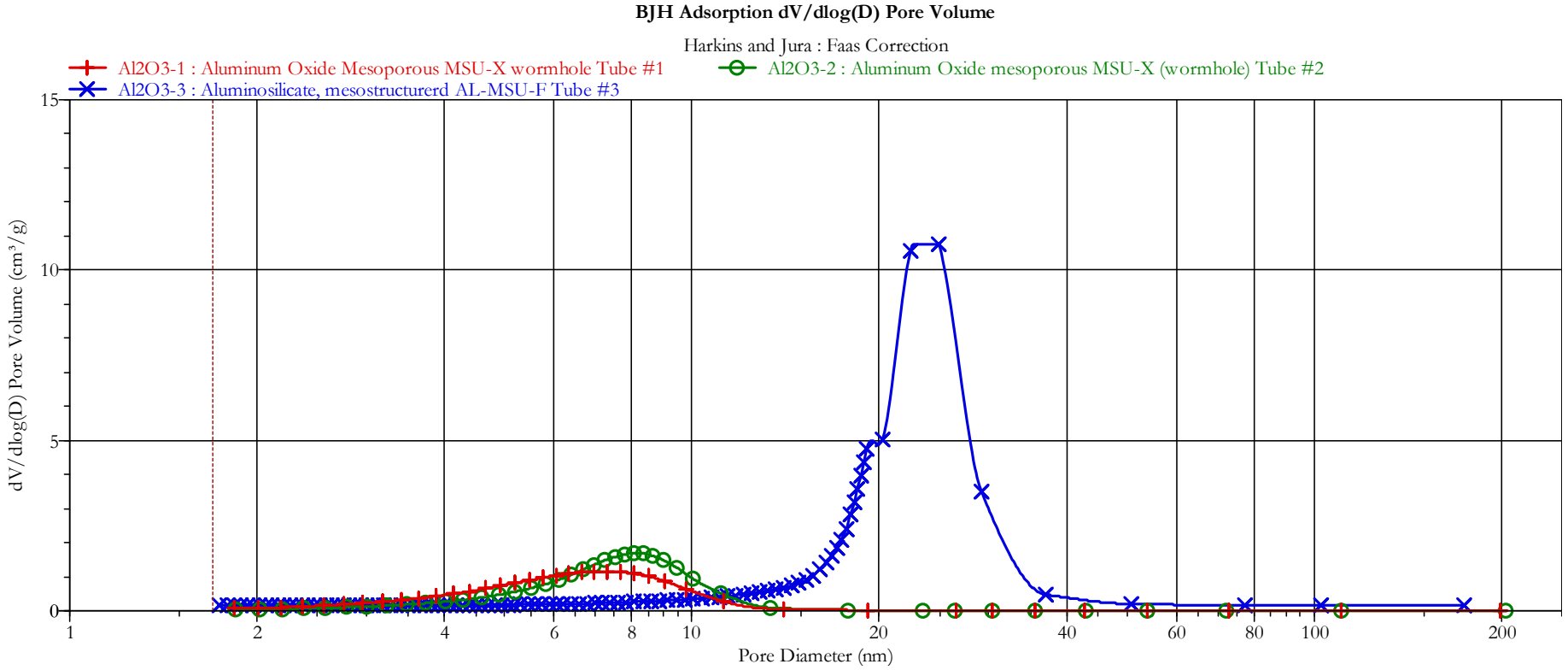
Three Mesoporous Aluminas Isotherm Overlay

- Nitrogen adsorptive at LN2 Temperature



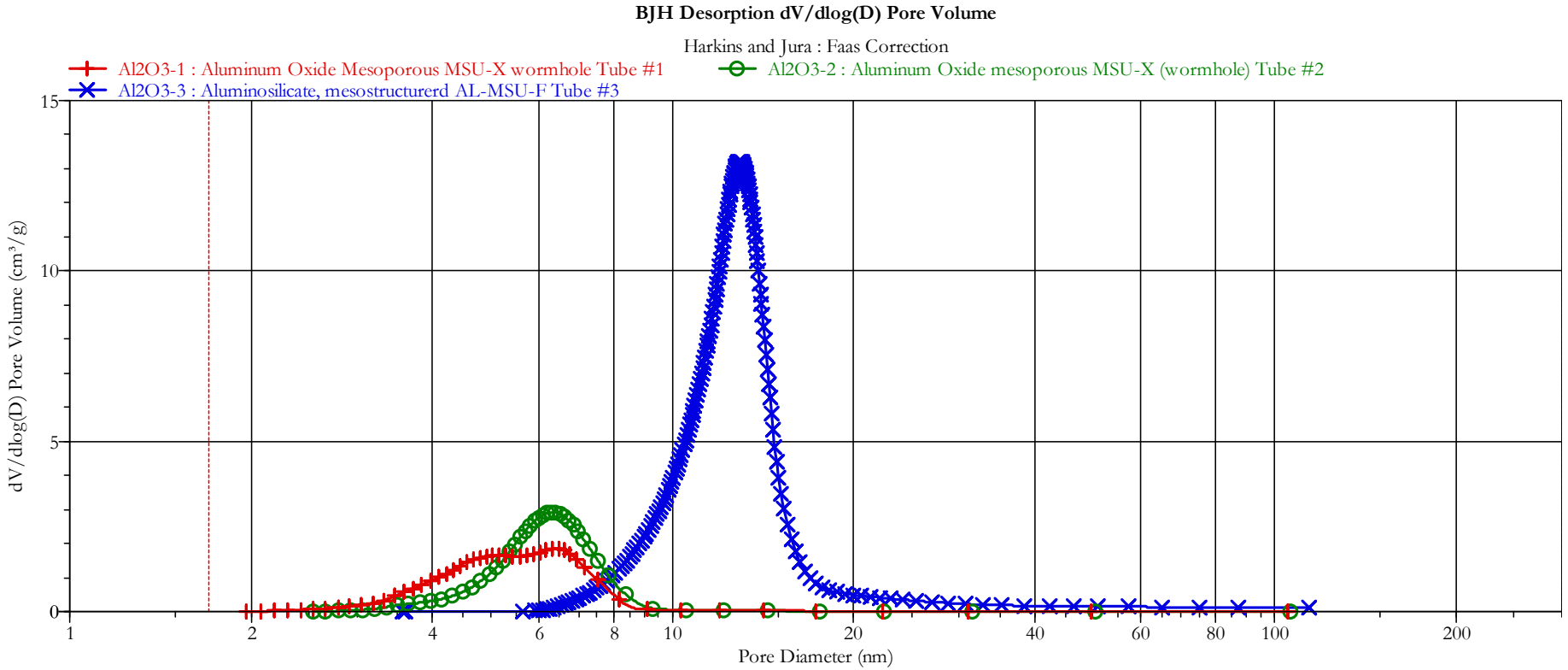
Three Mesoporous Aluminas BJH Adsorption Overlay

- Nitrogen adsorptive at LN2 Temperature



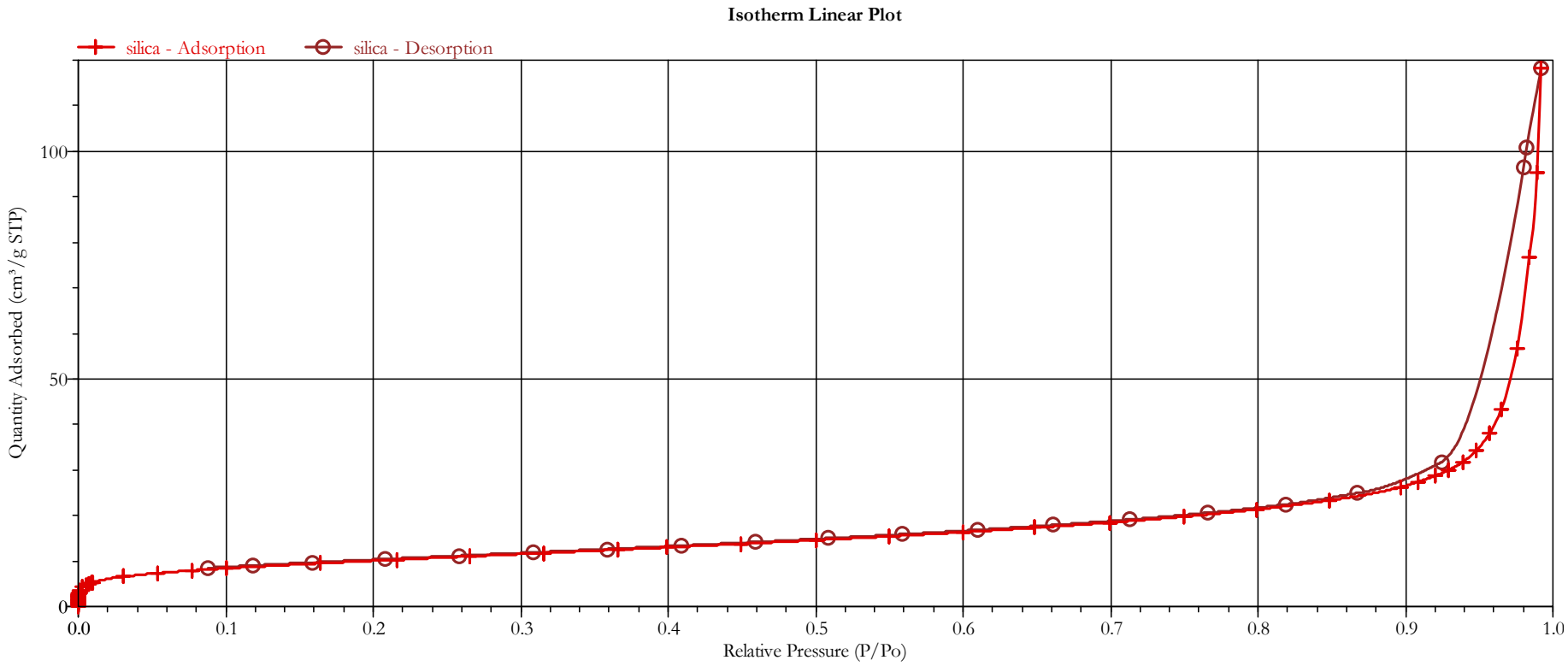
Three Mesoporous Aluminas BJH Desorption Overlay

- Nitrogen adsorptive at LN2 Temperature



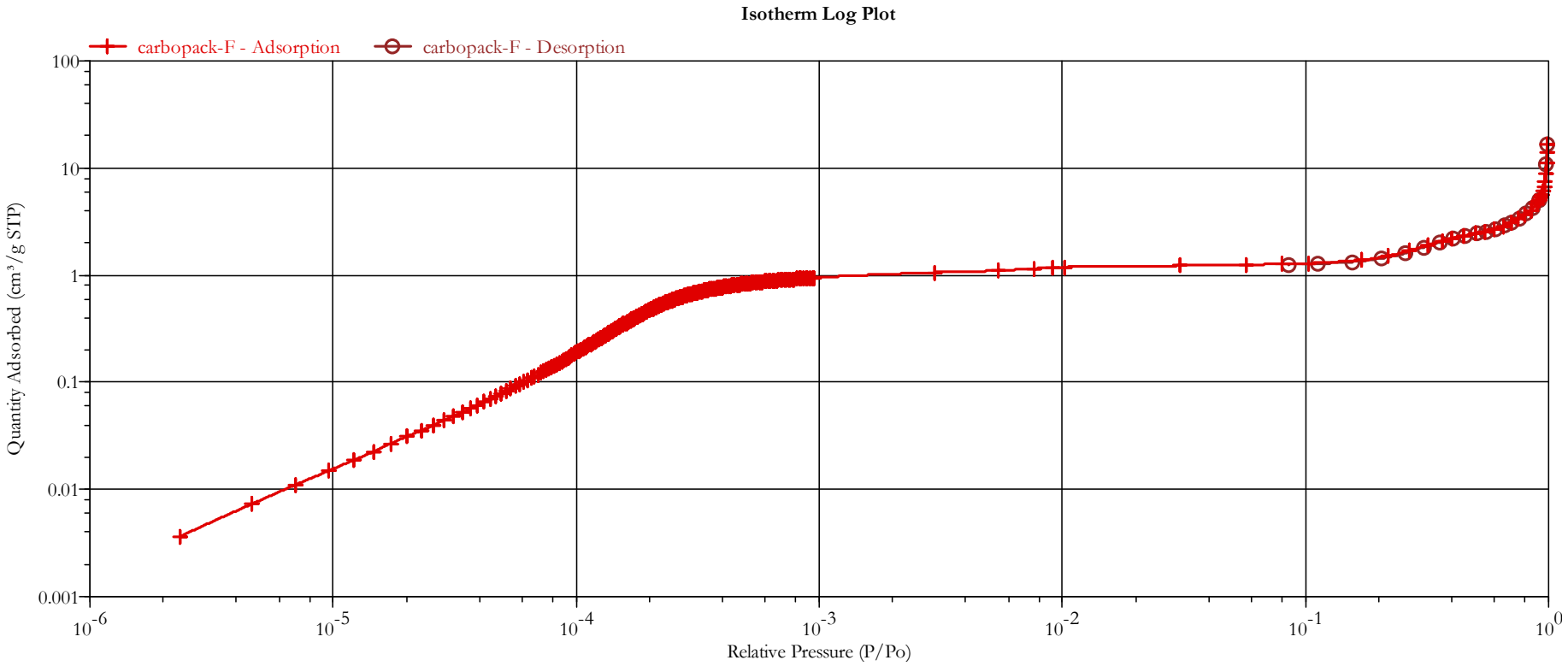
Macroporous Silica Isotherm

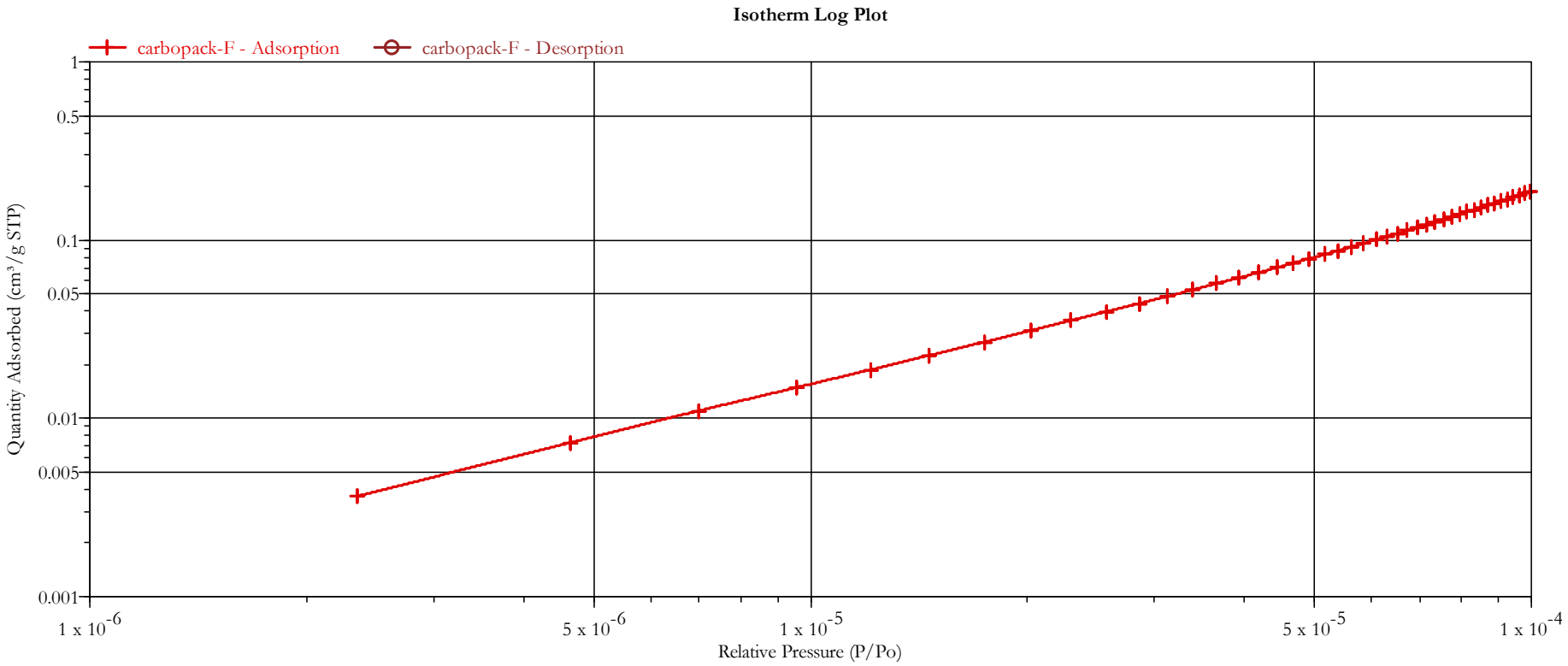
- Nitrogen adsorptive at LN2 Temperature



CarboPack F Isotherm

- Nitrogen adsorptive at LN2 Temperature



CarboPack F Isotherm

- Henry's Law Linearity