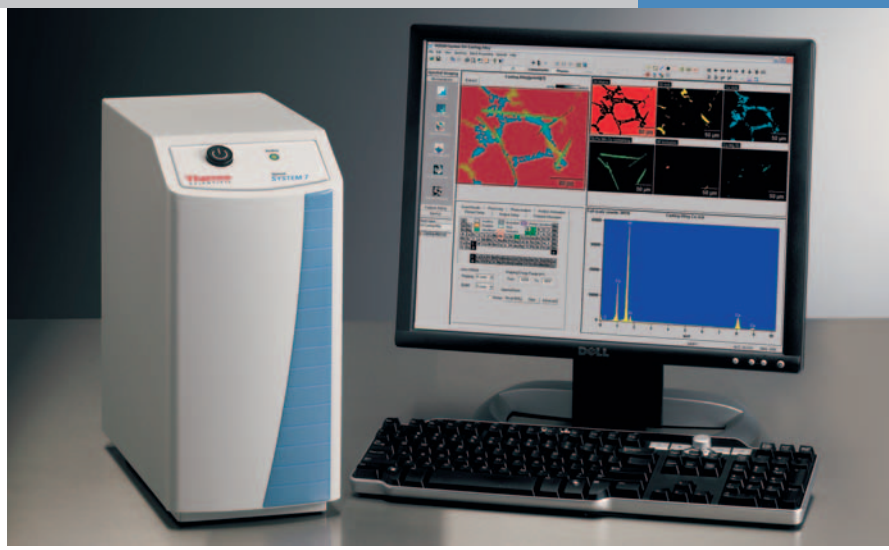
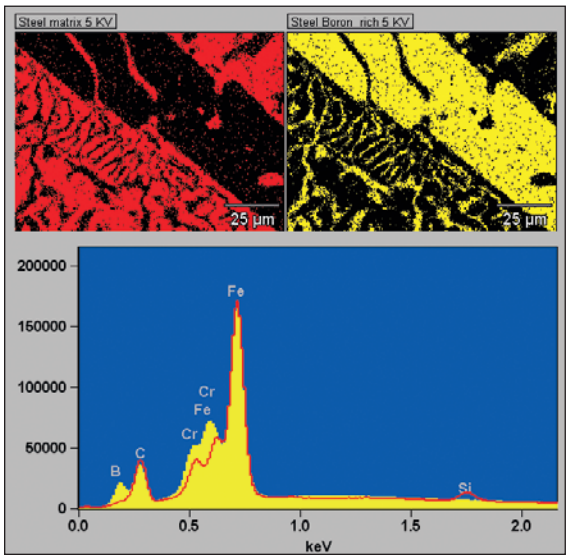
Product Specifications

The Thermo Scientific NORAN System 7 provides the ultimate in microanalysis capabilities for the modern electron microscopy lab; X-ray detectors with the highest sensitivity, pulse processors and digital imaging with the highest throughput and the most sophisticated software suite available.

NORAN System 7

X-ray Microanalysis





The NORAN System 7 is an all new X-ray microanalysis system that builds on over 40 years of experience and a heritage of analytical innovation. New to the NORAN System 7 is the ability to collect more than 1,000,000 X-ray counts per second in each digital pulse processor. When attached to two detectors, a combined acquisition rate of more than 2,000,000 counts can be achieved, speeding the journey to results from spectrum acquisition to complete compound analysis from Spectral Images in just seconds. NORAN System 7 utilizes a distributed processing architecture to maximize data throughput and application performance. The hardware for the NORAN System 7 resides in the analyzer chassis which includes a dedicated computer running a real time operating system and a combination of digital pulse processors and a digital imaging board all connected to the host Microsoft® Windows® PC via Ethernet. This distributed architecture allows the host PC to perform high level applications such as peak identification and the unique Direct-To-Phase (DTP) while the analyzer chassis takes care of the acquisitions.

NORAN System 7 Pulse Processor

Beyond the unparalleled ability to process more than 1,000,000 counts per second, the NORAN System 7 pulse processor has new features that eliminate virtually all artifacts seen in other processor designs.

Sum peaks are extremely small and can be corrected in the NORAN System 7 host application with a single click or can be removed automatically during the acquisition.

Integral peak linearity is better than 1 channel (10eV) for all energies greater than 500eV. This ensures that peaks are in expected positions, even for low energy elements.

Protection of the detector is a priority in NORAN System 7. The leakage rate of the detector's FET is monitored and bias voltages are automatically shut off when conditions exist that could cause damage, such as low vacuum or lack of cooling in the detector cryostat.

The NORAN System 7 pulse processor is not only compatible with the previous and current generations of high performance detectors but is ready for the next generation as well.

NORAN System 7 Pulse Processor

Number of pulse processors	1 or 2
Maximum input count rate	> 1,000,000 cps[1]
Maximum storage count rate	> 300,000 cps[1,3]
Acquisition range	40keV for SEM, 80keV for (S)TEM
Channel width	10 eV
Peak shift	< 10 eV on MnKα 60% dead time[2]
Integral linearity	< 10 eV for peaks greater than 500eV[2]
Spectral resolution degradation	< 3% up to 60% dead time[2]
Sum peaks	< 1.2% of parent up to 50,000 CPS store[1,2]
Base line restoration	Moving window (U.S. Patent #5307299)
FET protection	Automatic
Thermal Protection	Automatic
Bias voltage	0~1000V

NORAN System 7 Digital Imaging

"A picture is worth a thousand words."[4] We pay special attention to the quality of the image that the NORAN System 7 collects. From matching the aspect ratio of the electron microscope to automatic brightness and contrast, NORAN System 7 ensures that the image is always of the highest quality. The imaging board utilizes a continuous scan in the X direction, the same method that all modern electron microscopes employ. This continuous scan allows for improved signal averaging providing the ultimate in clear imaging. Programmable over-scan and retrace-timing minimize distortion. Combined with the NORAN System 7 digital pulse processor, high speed spectral imaging is a reality with complete dead time corrected spectra collected at each pixel of the image.

NORAN System 7 Digital Imaging

Image digitization	16 bit
Number of inputs	2
Minimum acquisition size	64 x 64 pixels
Maximum acquisition size	4096 x 4096 pixels
Maximum scan speed	1 µSecond per pixel (1 second for 1024 x 1024 image)

1. Requires that a new UltraDry detector be included with the system.
2. Only valid for analyzers delivered with a new Thermo Scientific detector.
3. Maximum storage rate valid for one pulse processor
4. Fredrick Barnard, Printers Ink, 1921

Spectral Imaging

Spectral imaging replaces the X-ray mapping of older systems. Both the digital imaging board and pulse processor work together to create a data cube with a spectrum at every pixel of the image. On the surface you see an electron image, but underneath are the spectra needed to perform X-ray map display, area analysis, line scans or more complex and powerful operations such as Quantitative Maps, Compass or Direct-To-Phase.

To speed the access to the data the spectral imaging file is compressed automatically during the acquisition. The proprietary compression algorithm is completely lossless and allows for dynamic additions to the file allowing you to spend more time on the analysis than on the data file management.

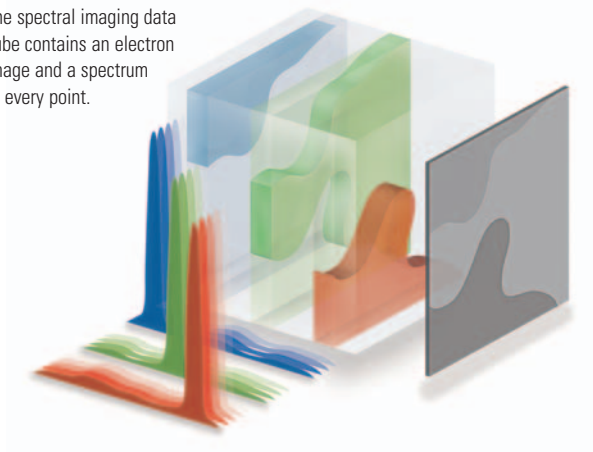
Spectral images can be collected in as little as one frame or to reduce beam damage to the sample, multiple frames can be collected. Statistics are important when collecting analytical data, NORAN System 7 allows you to set termination criteria based on: a) counts either in an elemental map, or b) the average number of counts in each spectrum. It is no longer necessary to guess how long to collect data, the NORAN System 7 will determine this for you and dynamically update the remaining time on the screen.

Elemental maps can be displayed during the acquisition either manually by user-selection from the dynamic periodic table or automatically by the peak identification of the cumulative spectrum. The operator can also choose to select only a subset of the image with any of the shape tools to ignore unimportant regions of the sample, like an epoxy mount.

Spectral Imaging

Minimum acquisition size	64 x 64 pixels
Maximum acquisition size	1024 x 1024 pixels
Maximum acquisition speed	50 µSeconds per pixel (3.3 seconds for 256 x 256 spectral-image frame)
Acquisition types	Single- or multi-frame
Termination Criteria	Time, Average counts per pixel spectrum, elemental map full scale
Dead time correction	Automatic
Maximum number of elemental maps	> 50
Individual map annotations	Intensity range, micron bar
Acquisition length	No limit, spectral imaging file dynamically resizes as data increases

The spectral imaging data cube contains an electron image and a spectrum at every point.



Line Scans

Line scans allow the acquisition of spectra along a line overlaid on the electron image. Direction, length, time, number of scans and number of spectra are all variables available. Up to 4096 discrete points may be collected. Results include raw elemental counts or quantitative analysis of each spectrum.

In addition if stage automation is included in the system, the beam can be held at the center of the image and the stage scanned in X, Y and Z directions. This is most useful when covering large areas or when performing combined EDS/WDS analysis.

Line Scans

Maximum number of points	4096 for beam scanning, unlimited for stage scanning
Results Display	Raw counts or quantitative analysis
Acquisition type	Single- or multi-pass
Geometric flexibility	Any angular orientation

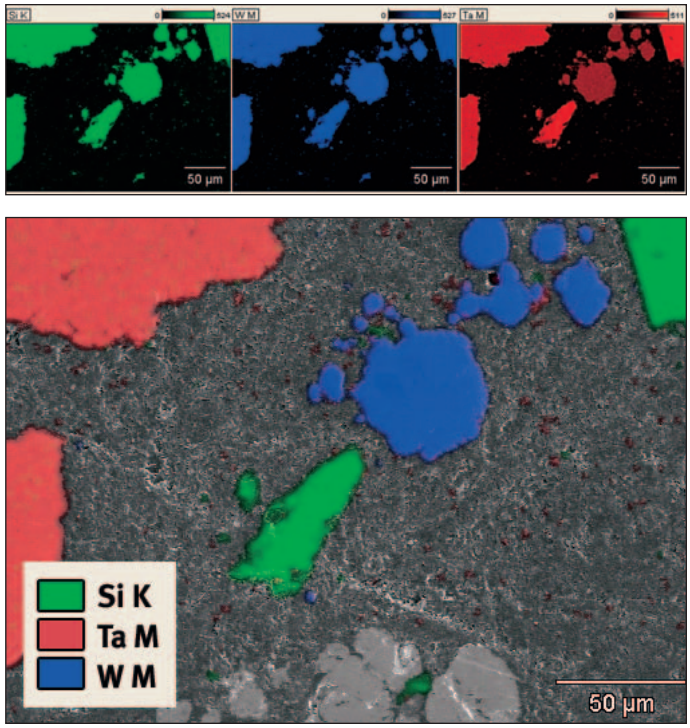
Spectral Imaging Extractions

SI spectral extractions: point/rectangular, circular, user-drawn, intensity flood-fill (magic wand), cumulative and maximal channel (Dale Newbury) spectrum displays are available. Linescan extractions are also available, options to vary the extraction width and number of analysis points permits tailoring the investigation to both the spatial dimensions and quantity of data available for the analysis. All display and calculation options available for traditional line scans are also available for SI extracted line scans.

SI map extractions: The optimum line family is automatically chosen for map display from the beam energy (no manual selection is necessary, increasing both the efficiency and quality of the map display). Additional selections include (1) a less-efficient line family, (2) maps for both line families, and (3) the sum of both line families, Simple single-click elemental overlay on electron image, Powerful single-click for ALL elemental overlays on electron image. Automatic independent brightness and contrast for each elemental map along with individual manual override, coordinated cursor which displays a legend of the current value for all displayed maps, number of displayed maps limited only by the number of elemental line families in the periodic table!

Quantitative Maps

Quantitative maps extracted from the spectral image data cube allow accurate representation of the sample composition. The calculation only takes seconds and eliminates confusing overlaps of elements and improves the map contrast by removing the background. Quantitative maps are calculated using the digital filter for background removal and least squares fitting for the calculation of peak intensities. Peak intensity values are corrected for matrix effects using Phi Rho Z, ZAF or Cliff-Lorimer routines. To ensure accurate results, automatic pixel binning is used to provide sufficient statistics for the fitting algorithms.



Conventional mapping shows an overlap of Si, W and Ta maps, while quantitative maps clearly show the separation of the three elements

Reports

Generating a report requires only a single button click. Report choices include direct to printer, Microsoft Word and Microsoft PowerPoint®. Both US and metric paper sizes are supported along with customization of the company logo, project and operator information.

Reports

Header	User name, Company name, Title, Logo, pagination
Page layout	Margins, font, orientation, PowerPoint background image, resolution
Color management	Printer friendly, Screen colors, Black and White

User Interface

The user interface on the NORAN System 7 reflects more than 40 years of analyzer design. Central to the operation is the concept of a data project. It appears as a folder that the operator selects on the PC, but contains a wealth of information. Foremost, the data from all analyses are stored there. Settings used to interpret the data. There is no need to validate all of the acquisition and analysis settings every time that the user opens a project because they are exactly as they were when the project was left. Efficiency of operator time and effort is vital in this design.

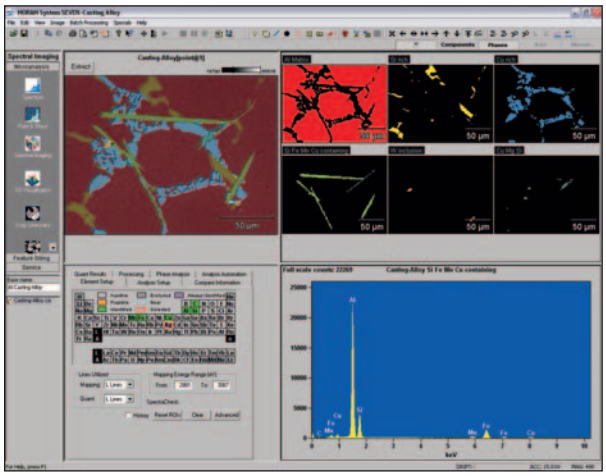
The interface focuses on showing the operator the information needed for the specific analysis. All data, whether it is spectral, electron images, maps, components, phases or linescans is displayed in a single window. Toolbars change for each display mode and their location can be modified by each operator; the location of each is automatically saved in the operator profile which is linked to the MS Windows login name. The layout of the screen, including font size, color and sub-window positions, is stored per operator as well.

Parameters for the acquisition are easily seen in the status bar at the bottom of the screen. Changing modes is as easy as clicking an icon. All data files for a particular mode are in a displayed list; opening a data file requires a single click on the file name.

Integrity of the system for laboratory administrators is an advantage in multi-user facilities. NORAN System 7 has built-in security measures to lock regular operators from modifying system critical functions such as calibrations and detector settings.

Unique to the system is the method of storing data during the acquisition. Every spectrum, image, map or linescan is automatically stored. If no action is taken upon shutdown or project change the data is kept in the project, giving the user peace of mind that data is always safely stored.

Service Security Administrator privileges to secure the service pages from prying eyes.



NORAN System 7 provides a familiar windows design. Each data area of the screen may be resized or colored.

User Interface

Spectrum manipulation	Mouse drag motions or toolbar buttons
Element identification	Possible elements highlighted in the periodic table by cursor position
Element search	Arrow buttons or toolbar buttons
Spectrum overlaps	Unlimited number of overlaps with normalization by time, element, region or factor
Qualitative analysis	Automatic peak identification using peak shapes, rules and least squares fitting to determine most probable element(s)
Spectrum simulation	SpectraCheck: simulates and normalizes spectra to unknown based on periodic table element selections. Includes both Chi-Squared value and visual indication of simulated spectrum, background and residual
Quantitative analysis	Background by digital filter, peak intensities by least squares fit from either stored peak shapes or generated Gaussian peaks. Matrix correction by PROZA $\Phi(\rho Z)$, ZAF or Cliff-Lorimer.
Quantitative element line selection	Rules based on over voltage factor.
Quantitative standards	Factory supplied or operator collected
Elements by Stoichiometry	Borides, Carbides, Nitrides and Oxides
Quantitative results display	24 values
Point & Shoot modes	Point, rectangle, circle, polygon, free form drawing, linked to grey level
Line scan features	Coordinated cursor on image and linescan, spectrum stored at each position, overlays of data on image, recalculation of elemental values, error bars on results.

NORAN System 7 General Specifications

Operating system	Microsoft Windows XP
Mode selection	Single click for Spectrum, Point & Shoot, Spectral Imaging, 3D Visualization, Linescans, Electron Imaging, Feature Sizing and Chemical Typing
Analysis options	Tabbed selection of Element setup, Analysis setup, Compare spectrum, Quantitative results, Spectrum processing, Point & Shoot selections, Analysis Automation, Phase Analysis, Spectrum attributes, Notes, Detector status, Quantitative standards, Match results and Region tool
Data storage	Project based using MS Windows directory structure
Analytical setup	Templates for analysis may be saved and applied to storage any project. Child projects automatically inherit parameters from the parent project
Tool bars	Data storage, Acquisition, Qualitative, Quantitative, Match, Spectrum manipulation, KLM markers, Compass, Xphase and Direct-To-Phase
Popup help	Tool tips pop up when the mouse is positioned over a button
Help system	Context sensitive help for all functions
Supported languages	English, German and Japanese

Optional Application Software

Direct To Phase

Combines the capability of Compass, Xphase and Spectrum Match to provide automatic analysis of Spectral Imaging data sets during the acquisition (Patent Pending). Results are shown as a named phase image and a spectrum that is associated with the area of the image. The phase images are overlaid on the electron image giving the analyst instant information on the composition of the sample at regular intervals during the acquisition.

Spectrum Match

Based on technology first introduced in 1975, Spectrum Match uses a Chi-Squared analysis of the current spectrum to all of the spectra in a spectral database to identify the best fit. The system is supplied with an alloy database of 350 compounds. Analysts can create or collect additional spectra and save them in the master database. Ability to create sub-databases is also provided.

Xphase

Xphase software allows automatic or manual analysis of all types of images and maps to find correlations among them. The results are a phase image and, for spectral imaging derived maps, an associated spectrum. Input data can be electron images, X-ray maps, quantitative maps or Compass components.

Compass

Available since 1999, it is the automatic analysis of Spectral Imaging data sets using multi-variant statistical analysis (MSA) to determine where chemically unique areas and spectrum exist within the spectral image data set. Both quick and powerful, Compass allows all operators to obtain the same results. No prior information is required other than the spectral image. Compass also ensures that only the statistically significant spectra are analyzed preventing inaccurate results.[4]

Drift Compensation

The Drift compensation feature provides automatic correction of the image's movement caused by charging samples or stage drift. A set and forget feature, Drift continuously corrects the image position. Drift compensation time can occur at either fixed time intervals or can occur only as required based on acquisition metrics.

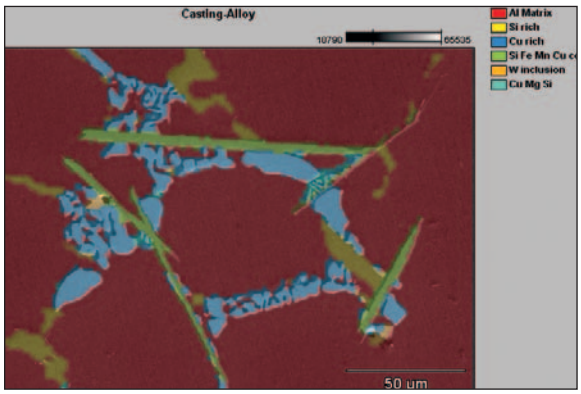
Feature Sizing and Chemical Typing

Providing both morphology and compound identification, Feature Sizing is used for a wide variety of applications including: Steel, air particulates, coal, mining, forensics. Ability to measure a multitude of particle features and image frame features. Exclusive electron intensity tracking feature is very advantageous in situations where the electron beam intensity may vary during the extended analysis. This application is most useful when used in combination with Analysis Automation.

Analysis Automation

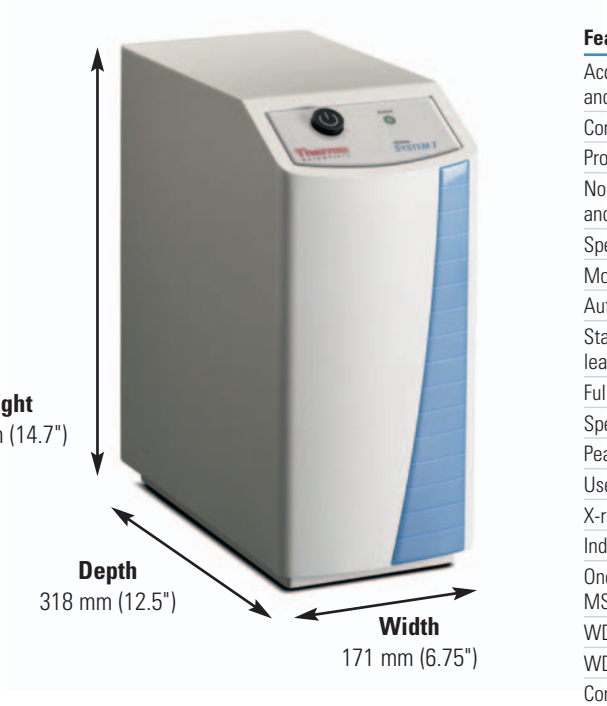
The Analysis Automation feature automatically moves the microscope stage for repetitive analysis at multiple locations on the sample. Compatible with all hands free operations for analysis of multiple areas or samples.

4. Licensed from Sandia National Labs covered by patents 1 & 2.



Direct to Phase provides clear results with a distinct color defined for each identified compound or phase

NORAN System 7



Dimensions

- Width – 171 mm, 6.75"
- Depth – 318 mm, 12.5"
- Height – 380 mm, 14.7"
- Weight – 10.6 kg, 23 lbs

Patents

1. 6,584,413
2. 6,675,106

Features	312 System	212 System	112 System
Acquisition electronics, greater than 1,000,000 input and 300 kcps storage rate	•	•	•
Compatible with up to 2 EDS detectors	•	•	•
Project based data storage	•	•	•
No-compromise spectral acquisitions, intelligent and accurate analysis during the acquisition	•	•	•
Spectral terminations based on time or statistics	•	•	•
Mouse based spectral navigation	•	•	•
Automatic peak identification	•	•	•
Standardless quantitative analysis using filtered least squares fit	•	•	•
Full-standards quantitative analysis	•	•	•
Spectra Check	•	•	•
Peak reference subtract	•	•	•
User-defined elemental references	•	•	•
X-ray line energy adjust	•	•	•
Industry-standard data formats	•	•	•
One click reports to printer, MS Word, and (optionally) MS PowerPoint	•	•	•
WDS quantitative, qualitative spectral analyses (optional)	•	•	•
WDS input for linescan and mapping (optional)	•	•	
Compatibility with EBSD (optional)	•	•	•
Remote EDS acquisition via 3rd Party Techniques (optional)	•	•	•
Optional Spectral match	•	•	•
Optional column automation	•	•	•
Optional analysis automation software	•	•	•
Digital image acquisitions from 64 to 4096 pixels	•	•	
Spectral Imaging acquisitions of full deadtime corrected spectra at every point	•	•	
Dynamic display of elemental maps	•	•	
Spectral Imaging termination criteria based on time or statistics	•	•	
Spectral Imaging Maps from 64 to 256 pixels	•	•	
Expansive Spectral Imaging Maps up to 1024 pixels	•		
Selected area mapping	•	•	
Quantitative map extraction	•	•	
Spectral Extractions using Summed or Maximal display selection	•	•	
Spectral Extractions using point, rectangle, circle, Magic Wand, and polygonal shapes	•	•	
Qualitative or quantitative Maps with unlimited image overlap	•	•	
Qualitative or quantitative Linescan Extractions with elemental image	•	•	
Linescan plot overlays on electron image	•	•	
Point and Shoot spectral acquisitions with shapes that include point, rectangle, circle, Magic Wand, and polygon	•	•	
Linescan acquisitions up to 4096 points, either qualitative or quantitative	•	•	
Linescan overlays with flexible line direction, width and point selection	•	•	
Optional COMPASS Component Extraction software	•	•	
Optional XPhase Compound Identification software	•	•	
Optional Drift Compensation Software	•	•	
Optional Direct To Phase acquisition software	•		
Optional Feature Sizing and Chemical Typing	•	•	

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