Semester & Year: **Fall 2014**  
Date: **October 31, 2014**  
$85,075.00

Submitted by **Reuben Collins**  
Email Address: **rtcollin@mines.edu**  
Ext: **3851**

**Title of Proposal:** User friendly, bench top, electron microscopy for hands-on nanoscience and nanotechnology

**Department/Organization:** Physics

### Budget Information

<table>
<thead>
<tr>
<th>Item</th>
<th>Tech Fee Request</th>
<th>Direct Match* (Cash)</th>
<th>Total $ To Be Expended</th>
<th>Other Contributions (in kind, disc, etc)</th>
<th>Total Project Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>81,175.00</td>
<td></td>
<td>81,175.00</td>
<td></td>
<td>81,175.00</td>
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<tr>
<td>Software</td>
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<td>3,900.00</td>
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<td>3,900.00</td>
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<td>Maintenance</td>
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<tr>
<td>Operating &amp; Supplies</td>
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<td></td>
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<tr>
<td>Student Help</td>
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<td></td>
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<tr>
<td>Other (attach detail)</td>
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<td></td>
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<td>0.00</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$85,075.00</strong></td>
<td><strong>$0.00</strong></td>
<td><strong>$85,075.00</strong></td>
<td><strong>$0.00</strong></td>
<td><strong>$85,075.00</strong></td>
</tr>
</tbody>
</table>

*Notes:* Direct. Match must be actual funds that are or will become available to be applied to direct expenditures. General department/organization technology operating or support costs are not appropriate. Work-study funds cannot be identified as matching funds. Use the “Other Contributions” column if applicable for faculty/staff/student time, vendor discounting beyond normal academic discounts, previous investments or purchases, and other in-kind contributions. Documentation of matching fee expenditures must be provided to Technology Fee Account Manager as expenditures are made if a proposal is funded. The same matching funds cannot be used in more than one proposal (ie. If all proposals from a dept/organization are funded then the sum of all matching funds must be committed.)

### Proposal Executive Summary

Nanoscience, nano-materials, and nanoengineering are among the most significant economic drivers of the 21st century. The campus has made a major investment in nanotechnology through the faculty it has hired, research directions it has taken, and in its curriculum and course offerings. Hands on undergraduate experience with nanotechnology has been hard, however, to achieve. As a cornerstone of the nanoscience revolution, electron microscopy can be a doorway into this world, while also offering unique lessons in the science behind nanosystems. Unfortunately, electron microscopes on campus are too expensive, fragile, in demand, and challenging to operate as a broadly accessible educational tool.

The recent development of robust, "relatively" inexpensive, turn-key, bench top electron microscopes has changed this scenario. This proposal seeks to purchase such a system which will be integrated across the physics curriculum providing hands on experience for each major during the summer field session, opportunities for new nanoscience laboratory experiences in upper division courses, and access to nanocharacterization within the senior design sequence which all Physics majors complete. The impact of the tool will extend beyond the Physics program through demos in the introductory and modern physics sequence. Ultimately, being able to include electron microscopy as a tool in curriculum, lab, and demonstration development will provide a more fundamental integration of nanoscience and technology into student's education while at the same time giving them a very marketable skill-set in an emergent high tech industry.
<table>
<thead>
<tr>
<th>This section must be fully completed for your proposal to be considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is this request part of a continuing project for which you have received previous technology fee awards?  □ Yes  ☒ No</td>
</tr>
<tr>
<td>If yes, how many awards and how much funding have you received for this project during the past 3 years?</td>
</tr>
<tr>
<td>What is the proposed project lifetime or life expectancy of resources to be acquired?  10 years</td>
</tr>
<tr>
<td>Where will the resources acquired be located?  Meyer Hall 425 or the GRL annex until the new CoorsTek Center for Applied Science and Engineering building is complete, and then in shared use space within the new building</td>
</tr>
<tr>
<td>Does this change the use of the existing space?  □ Yes  ☒ No</td>
</tr>
<tr>
<td>If Yes, how is the space used now?</td>
</tr>
</tbody>
</table>
| What impact will acquiring these resources have on cooling, power, and other building infrastructure?  
  If there is any impact, the requirements must be discussed with Capital Planning and Facilities Management |
| None |
| Will this project require additional network wiring or ports, have other impacts on the campus network, or involve the provision of wireless networking services in any way?  □ Yes  ☒ No |
| If yes, you must coordinate those activities with the CCIT networking staff  
  All wireless projects are subject to the campus wireless network infrastructure policy at  
| If yes, explain: |
| Who will manage the resources?  Departmental Electronics Technician - Steve Hill |
| Will other resources be retired or replaced if you receive this award?  □ Yes  ☒ No |
| If yes, what do you propose to do with the old resources? |
| Explain the impact on both departmental and central support staff as a result of acquiring these resources. Include in your discussion the consequences of reusing the old resources as well as the impact of acquiring new resources:  
  Installation will be done by department faculty working in conjunction with Steve Hill. As a turn key system it will be straightforward. There are no old resources to remove. |
| What will the primary use of the requested resources be?  
  Class demonstrations in lower division physics courses, electron microscopy theory and operation training in field session, lab sequences in upper division physics courses, nanoscience and characterization in senior design |
| How many students per semester will use the requested resources?  >100 |
| How many hours per week will the requested resources be committed to scheduled, supervised lab or classroom use?  
  20 per week both during the academic year and field session. |
| How many hours per week will the requested resources be available in an open use / open lab environment?  
  20 per week |
| Who will be permitted to use the resources (which students, in what classes or options, under what restrictions, etc)?  
  Students who have taken the Physics field session and been tested on the instrument will be allowed to use it in classes, and outside of a formal class with approval. |
TECHNICAL/STRATEGIC BASIS FOR THE REQUEST:

It is widely believed that nanoscience and nanotechnology will be fundamental economic drivers of the 21st century. In many of its departments, CSM has embraced this revolution. The CSM physics department in particular has introduced nanoscience into its curriculum through: the inclusion of background skills required for making nanomaterials in its summer field session, its emphasis on quantum mechanical phenomena in Modern Physics I (taken by many students on campus) and Modern Physics II, the creation of a graduate level course in Nanoscale Physics, and exposure of undergraduate and graduate students to cutting edge research at the nanoscale in senior design projects and thesis research. At the same time, the department would like to significantly expand student experience with nanoscience into introductory physics, bioscience and engineering, the summer field session and junior physics lab sequence, and through its senior design experience.

There is a core set of techniques, which the faculty believe every physics student (and which would seem useful for many other disciplines on campus) should understand at a fundamental level and with which they should have a level of practical experience. Laser science and optics, vacuum technology, electronics, simulation and computation are all examples that the Physics department has integrated across the curriculum. Electron microscopy is the cornerstone of nanoscale analysis and characterization and has now moved to the level of one of these core techniques. The campus has an excellent electron microscopy facility with high-resolution tools that are essential to our research mission. Unfortunately, these systems are not designed for broad undergraduate access. By taking the semester long electron microscopy course offered in Metallurgical and Materials Engineering, or becoming involved in a research project that requires electron microscopy, undergraduates can be trained and use some of these tools, but becoming proficient requires significant time commitment on the student’s part and access to the tools which are heavily subscribed and susceptible to user related damage. Being able to commit one of these tools to, as an example, a two week junior lab experiment that all students in a department take, just isn’t feasible.

In the past few years, a new class of very user-friendly “bench top” scanning electron microscopes has appeared on the market. Unlike their research-oriented cousins, sample exchange in these systems is rapid and fool proof. There is almost no possibility of making a mistake and introducing atmosphere to the electron beam column. Tuning the beam for optimal imaging is done automatically. They are designed so sample charging is minimized. These are really tools that an undergraduate can learn to run in a short period of time, and use to obtain excellent, high-resolution images, in the first sitting. While not capable of the performance of the top end research systems on campus, these bench top systems are not toys. The one being spec’d has a 17nm resolution limit, and an integrated high resolution optical microscope that is aligned par focal to allow optical and electron microscope imaging of exactly the same region and therefore easy alignment of the electron beam on a specific sample region. This optical microscope/electron microscope combination along with a very high spatial resolution is one of the reasons this particular bench top system was chosen. At ~100lbs, and with a robust physical design, the tool can be moved to allow its use in multiple laboratory or classroom settings. The software that will be purchased with the system allow remote operation over the internet for either classroom or outreach activities. There is really no system like this on campus.
The instrument will ultimately be housed in the new CoorsTek Center for Applied Science and Engineering, in a shared use lab that has key card control and is easily (and routinely) accessed by undergraduate and graduate students across campus. For spring 2015, it will be in shared space in the GRL annex that physics will occupy while the new building is under construction. The instrument, however, is transportable and can be moved to other locations like the junior-level Physics labs or Field session rooms. It requires just a few hours to pump down again and become operational. In other laboratories, people have put this system in a car and used it in an outreach demonstration at an elementary school. The remote operation software that will be purchased with it, will make it even easier to use from any classroom across campus or remote location. The chosen system is designed to be low maintenance. Likely expenses are filament changes and these will be handled by Physics department operational funds. Technical support will be provided by the Physics electronics technician or through the Renewable Energy Materials Research Science and Engineering Center. If funded, the instrument will be purchased during spring or summer 2015 depending upon when funds become accessible. Options are available to extend the capabilities of the selected tool. For example, an x-ray detector can be added to enable energy dispersive spectroscopy for elemental detection and analysis. Our plan is to request this addition in a future technology fee proposal since it will open up a whole new set of learning experiences that identify such phenomena as phase segregation and impurity incorporation at the nanoscale.

**EDUCATIONAL AND OTHER BENEFITS THAT WILL ACCRUE:**

If funded, the bench top system will be integrated throughout the physics curriculum. In Physics 200, which covers concepts in electromagnetism, the electron microscope will allow demos that image electronic elements (e.g. semiconductor lasers or chips) and which motivate a discussion of “electromagnetic lenses” and focusing. In Modern Physics discussions of wave particle duality and of the smaller wavelength of electrons compared to light will naturally evolve out of using the instrument to image nanostructures (e.g. nanowires). The presence of both a high-resolution optical microscope and electron microscope in the same tool will facilitate this discussion. A fixed module of the Physics Field Session will be devoted to learning to use the tool for metrology of biological, solid state, and optical materials and structures. This will be the training that allows students to routinely use the instrument in subsequent courses. Experimental modules in Solid State Physics based on the microscope will be added to the junior laboratory course (~60 students each term). The system will be used to image nano-optical components like gratings and plasmonic nanostructures in optics courses (~20 students a term), biological samples in Biophysics (~10 students), and it will be in regular use in the Nanophysics class (~15 students). The microscope will become the capstone tool in the capstone physics Senior Design class. Over half of the projects the seniors are involved in need electron microscopy to detect and characterize thin films, nano-materials, photonic structures, bio-specimen, and to explore nano-material synthesis techniques. This has been a routine bottleneck which has limited the scope of the projects that students could pursue, placed a burden on the campus microscopy center and, ultimately, influenced the level of understanding possible in this critical, open ended problem solving course.

The Physics department recognizes the cost of the system is relatively large on the scale of Technology Fee proposals. The department also feels, quite strongly, that the tool will have an effect, each year, on each of the ~260 majors that are in the program. While the primary use will be in Physics classes, it will also impact introductory physics, which is taken by
nearly all students on campus, and modern physics, which had 87 major and 32 non majors in the 2013-2014 academic year. It will have a cross disciplinary effect on curricula from biophysics and materials physics to applied optics and subatomic physics. It will not only be an experimental tool, but also a learning device helping students better understand wave matter interactions, electronic structure, and nanoscience. It is likely this initial implementation by the Physics program will lead other departments with strong efforts in bio and nanotechnology to introduce bench top electron microscopy into their curriculum as well and Physics will assist with this by allowing other professors access to their curriculum and demos and access to the system.

BUDGET DETAILS AND NARRATIVE:

The Scanning Electron Microscope that will be purchased is a nanoScience Instruments Phenom Pro desktop SEM. A brochure and a quote are included as an attachment. This request includes the base system which operates stand-alone, and a special sample holder to allow non conductive samples to be studied. After educational discount the cost is $81,175.00. It also includes a software package costing $3,900.00. In addition to facilitating metrology, the package allows remote operation of the system. If a professor arranges for a local colleague to insert a sample, the tool can be operated fully and the sample imaged from any location. The average time to maintenance of this tool is 6 years and this typically involves replacing the source. The department will save a small amount of funding each year to build up a fund to cover this cost. Other tools that are needed like simple metal sputtering for nonconductive samples exist within the Physics department.
Reuben Collins  
Colorado School of Mines  
1523 Illinois Street  
Meyer Hall 466  
Golden, CO 80401  

<table>
<thead>
<tr>
<th>Qty</th>
<th>Part #</th>
<th>Description</th>
<th>Unit Price</th>
<th>Ext. Price</th>
</tr>
</thead>
</table>
| 1   | PW-100-016 | Phenom Pro desktop SEM  
Phenom Pro SEM, motorized stage, navigation optical camera, standard sample holder, sample preparation starter kit. Upgradable with EDS and ProSuite.  
Features:  
- Magnification Range: 80X - 100,000X  
- x/y Motorized Stage  
- Long Life, high brightness CeB6 Electron Source  
- 20 - 120x Zoom Color Video Camera: The integrated navigation camera (nav cam) has the same point of view as the detector.  
- Never-Lost Navigation: Interactive Relation Between Optical and Electron Image  
- 19” mointor/mouse/keybord (touchscreen is optional for an additional charge)  
- Backing Pump for Turbomolecular Pump  
- Mini Sample Kit  
- Sample Cup, Pin Stub Mount  
- Service Flight Case  
Note: Pro is compatible with Pro Suite, Fibermetric, Particlemetric and 3D Roughness Reconstruction software  
Includes 1 year Warranty | $89,900.00 | $89,900.00 |
| 1   | PW-220-001 | Phenom Pro Suite  
Includes monitor, keyboard, mouse, Small PC, pre-installed ProSuite software, standard applications software: Automated Image Mapping and Remote UI.  
Compatible with all Phenom SEMs. The Pure model requires the Phenom Pure completion pack for Pro Suite. | $3,900.00 | $3,900.00 |
| 1   | PW-600-002 | Charge Reduction Sample Holder  
Charge reduction holder for 3.5mm pin stubs. | $1,275.00 | $1,275.00 |
|     |           | **SubTotal** |           | **$95,075.00** |
| 1   | PW-DISC   | Academic Discount on Phenom  
- $10,000.00 |           | **$85,075.00** |
|     |           | **Total** |           | **$85,075.00** |

**Applications Software Options:**

<table>
<thead>
<tr>
<th>Qty</th>
<th>Part #</th>
<th>Description</th>
<th>Unit Price</th>
<th>Ext. Price</th>
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</thead>
</table>
| 1   | PW-210-002 | 3D Roughness Reconstruction application software  
Pro Suite not included | $6,900.00 | $6,900.00 |
| 1   | PW-210-003 | PPI Phenom Programming Interface  
Pro Suite not included | $5,500.00 | $5,500.00 |
| 1   | PW-210-001 | Fibermetric application software  
Pro Suite not included | $14,750.00 | $14,750.00 |
| 1   | PW-210-004 | ParticleMetric application software  
ParticleMetric software for analysis of particles. ProSuite not included.  
Particle disperser Nebula I (PW-700-002) is optional | $14,900.00 | $14,900.00 |
<table>
<thead>
<tr>
<th>Qty</th>
<th>Part #</th>
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<th>Ext. Price</th>
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<td>PW-610-001</td>
<td><strong>Metallurgical Sample Holder</strong></td>
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<td>$990.00</td>
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<td>1</td>
<td>PW-610-002</td>
<td><strong>Metallurgical Charge Reduction Sample Holder</strong></td>
<td>$1,275.00</td>
<td>$1,275.00</td>
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<tr>
<td>1</td>
<td>PW-630-001</td>
<td><strong>Micro Tool &amp; Tilt-Rotation Sample Holder</strong></td>
<td>$3,980.00</td>
<td>$3,980.00</td>
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<td>1</td>
<td>PW-630-003</td>
<td><strong>Motorized Tilt &amp; Rotation Sample Holder</strong></td>
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<td>$12,990.00</td>
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<td>1</td>
<td>PW-630-002</td>
<td><strong>Temperature Controlled Sample Holder (Peltier stage)</strong></td>
<td>$14,900.00</td>
<td>$14,900.00</td>
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<tr>
<td>1</td>
<td>TR300</td>
<td><strong>On-site SEM Training - 1 day</strong></td>
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<td>1</td>
<td>PW-920-002</td>
<td><strong>Phenom Standard Service Maintenance Agreement - one year</strong></td>
<td>$6,500.00</td>
<td>$6,500.00</td>
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</tbody>
</table>

**Hardware Options:**

- **Metallurgical Sample Holder**
- **Metallurgical Charge Reduction Sample Holder**
- **Micro Tool & Tilt-Rotation Sample Holder**
- **Motorized Tilt & Rotation Sample Holder**
- **Temperature Controlled Sample Holder (Peltier stage)**

**Training & Service Maintenance:**

- **On-site SEM Training - 1 day**
- **Phenom Standard Service Maintenance Agreement - one year**

**Included:**
- Inspection of Source during Scheduled Maintenance and replacement if necessary
- Inspection and cleaning of objective lens and final aperture and pole piece
- Turbo Molecular Pump maintenance
- Pre Vacuum Pump maintenance
- Hardware lubrication
- Replacement of fan filters
- Inspection & cleaning of back scatter detector
- Inspection & cleaning of O-rings and replacement if necessary
- Inspection and cleaning of sample cup
- Software upgrade to the most current version
- Adjustments and alignments to original factory specification or better
- 20% discount on labor and parts purchases for non-covered repairs
- Additional individual phone and web based training at no charge
- Unlimited phone, email and remote web-based support

* This SMA does not include shipping costs.

The SMA package is attractively priced; only slightly more than the cost of a single preventative maintenance and source change.

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**TERMS AND CONDITIONS**

- **Currency:** US$
- **Delivery:** 6 - 8 Weeks ARO
- **FOB:** Dest, PP&Add
- **Terms:** Net 30 OAC

Customer is responsible for all taxes & shipping costs.
Phenom-Pro

Most Professional Desktop SEM Imaging

- **PHENOM PRO**
  High-end desktop SEM with superb imaging power

- **MAGNIFICATION**
  Magnification range up to 100,000x

- **ACCELERATION VOLTAGES**
  5 kV and 10 kV acceleration voltages for the best resolution on a large variety of samples

- **NEVER LOST NAVIGATION**
  Swift navigation to any region of interest with zoom and full color functionality

Phenom-World products are high quality, fast, compact and easy to use. The Phenom Pro™ is the high-end desktop SEM with superb imaging power for all markets and applications.
The Phenom Pro is Phenom-World’s high-end imaging desktop SEM. In combination with a large range of sample-holders and automated system software, it can be tailored to suit a multitude of applications.

**PHENOM PRO**

Phenom-World is focused on enabling its customers to keep pace with continuously shrinking feature sizes and to increase productivity while bringing down the costs of analysis. The Phenom Pro is the most effective and fastest imaging oriented desktop SEM on the market. Its unique design makes it suitable for use in a wide variety of applications and markets.

With custom-made detection hardware, a high brightness source and a state-of-the-art color navigation camera, it is an extremely powerful desktop SEM. The zoom functionality of the color navigation camera narrows the gap between optical and SEM imaging.

The combination of a touch screen and the option of working with an optical mouse allow even faster and more accurate navigation. The Phenom Pro is the platform that offers automated and mechanized accessories such as Pro Suite and active sample holders.

The Phenom Pro can be upgraded to Phenom ProX with EDS or equipped with the Phenom Pro Suite at one of the Phenom-World service hubs.

**IMAGING SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Imaging Modes</th>
<th>Magnification: 20 - 120x</th>
<th>Magnification range: 80 - 100,000x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light optical</td>
<td>Digital zoom: max. 12x</td>
<td></td>
</tr>
<tr>
<td>Electron optical</td>
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</table>

<table>
<thead>
<tr>
<th>Illumination</th>
<th>Bright field / dark field modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light optical</td>
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</table>

<table>
<thead>
<tr>
<th>Acceleration Voltage</th>
<th>5 kV, 10 kV</th>
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</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>≤ 17 nm</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Digital Image Detection</th>
<th>Color navigation camera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light optical</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>High-sensitivity backscattered electron detector (compositional and topographical modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electron optical</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image Formats</th>
<th>JPEG, TIFF, BMP</th>
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</table>

<table>
<thead>
<tr>
<th>Image Resolution Options</th>
<th>456 x 456, 684 x 684, 1024 x 1024 and 2048 x 2048 pixels</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Data Storage</th>
<th>USB flash drive</th>
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<tbody>
<tr>
<td>Network</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Sample Stage</th>
<th>Computer-controlled motorized X and Y</th>
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</table>

<table>
<thead>
<tr>
<th>Sample Size</th>
<th>32 mm (Ø); 100 mm (h)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Sample Loading Time</th>
<th>Light Optical &lt; 5 s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Electron Optical &lt; 30 s</td>
</tr>
</tbody>
</table>

**SPECIFICATION SHEET**
NEVER LOST NAVIGATION

The color navigation camera in the Phenom Pro provides information that helps the operator to make a link between the optical and electron-optical images. Users are ready to take images after only 10 minutes of basic training. A large variety of sample holders is available for the Phenom Pro to accommodate a large range of samples. Sample loading is fast and easy due to our patented sample vacuum loading technology.

The optical camera, motorized stage and touch-screen user interface work together to help you navigate swiftly to any region of interest. Just touch the position you want to investigate on the optical image and the stage automatically centers the region of interest. Switching to electron imaging mode is fully automated and fast at the touch of just one button. A high resolution image is available within 30 seconds after loading the sample. Saving images is practical and easy on a USB memory stick or network storage location for off-line analysis and distribution.

The Phenom Pro is equipped with two acceleration voltages: 5 kV and 10 kV. This allows the users of the Phenom Pro to make higher resolution images at the same magnification, providing even more details from the sample than before. At the same time, the Phenom Pro can be used with the lower beam current setting. The combination of two different acceleration voltages and two beam current settings offers a high level of flexibility, creating the best results for a large variety of samples.

SYSTEM SPECIFICATIONS

<table>
<thead>
<tr>
<th>System</th>
<th>Imaging module, 19” touch-screen monitor, rotary knob, mouse, diaphragm vacuum pump, power supply, USB flash drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions &amp; Weight</td>
<td></td>
</tr>
<tr>
<td>Imaging module</td>
<td>286(w) x 566(d) x 495(h) mm, 50 kg</td>
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<tr>
<td>Diaphragm vacuum pump</td>
<td>145(w) x 220(d) x 213(h) mm, 4.5 kg</td>
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<tr>
<td>Power supply</td>
<td>156(w) x 300(d) x 74(h) mm, 3 kg</td>
</tr>
<tr>
<td>Monitor</td>
<td>375(w) x 203(d) x 395(h) mm, 7.9 kg</td>
</tr>
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</table>

REQUIREMENTS

<table>
<thead>
<tr>
<th>Ambient Conditions</th>
<th>Temperature 15°C ~ 30°C (59°F ~ 86°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Humidity &lt; 80 % RH</td>
</tr>
<tr>
<td>Power</td>
<td>Single-phase AC 110 - 240 Volt, 50/60 Hz, 300 W (max.)</td>
</tr>
</tbody>
</table>

| Recommended                   | Table size 120 x 75 cm, load rating of 100 kg                                           |
**Upgrade Options**

**Pro Suite**
Pro Suite is an optional application system that has been developed to further enhance the capabilities of the Phenom system. Pro Suite enables maximum information to be extracted from images obtained on the Phenom imaging system. It offers multiple solutions to specific application needs. Pro Suite contains standard applications such as Automated Image Mapping and Remote User Interface. Optional applications are Fibermetric and 3D Roughness Reconstruction. Virtually all the properties of a sample can be revealed using the Phenom Pro in combination with Pro Suite.

**Upgrade to Phenom ProX**
The Phenom ProX is the ultimate all-in-one imaging and X-ray analysis system. With the ProX, sample structures can be physically examined and their elemental composition determined. The optional Elemental Mapping and Line Scan software allow further analysis of the distribution of elements. A dedicated software package is included and installed on the Pro Suite PC to control the fully integrated EDS detector. Analysis has become as easy as imaging, since there is no need to switch between external software packages or computers. The latest Phenom Pro models can be upgraded to Phenom ProX at Phenom-World service hubs. Contact your local sales representative for details.

**Pro Suite Specifications**
- **System**
  - Automated collection of images
  - Real-time remote control
  - Intuitive single-page user interface
  - Standard applications included:
  - Automated Image Mapping
  - & Remote User Interface

- **Optional**
  - **3D Roughness Reconstruction**
    - Based on “shape from shading” technology, no stage tilt required
    - Fast reconstruction

- **Fibermetric**
  - Fast and automated collection of all statistical data
  - Large range of fibers and pores can be measured

**EDS Specifications**
- **Detector Type**
  - Silicon Drift Detector (SDD)
  - Thermoelectrically cooled (LN₂ free)
- **Detector active area**
  - 25 mm²
- **X-ray window**
  - Ultra-thin Silicon Nitride (Si₃N₄) window allowing detection of elements C to Am
  - Mn Kα ≤ 140 eV
- **Energy resolution**
  - Multi-channel analyzer with 2048 channels at 10 eV/μC
- **Max. input count rate**
  - 300,000 cps
- **Hardware integration**
  - Fully embedded

**Software**
- Integrated in Phenom Pro Suite
- Integrated column and stage control
- Auto-peak ID
- Iterative strip peak deconvolution
- Confidence of analysis indicator
- Export functions: CSV, JPG, TIFF, ELID, EMSA

**Report**
- Dock format

**Sold in the USA and Canada by:**

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Phenom-World B.V.

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Phenom™ Pro Suite

The ultimate application software solution

Phenom™ Pro Suite is developed to enable Phenom users to extract maximum information from images made with the Phenom G2 pro desktop scanning electron microscope (SEM). It extends the capabilities of the Phenom G2 pro, a high-resolution imaging tool, providing solutions to specific application needs.

The Phenom Pro Suite software is installed on the Phenom Application System. This monitor-mounted PC is the hardware platform for all Pro Suite software, leaving the Phenom G2 pro system in its original state and guaranteeing maximum system stability and up-time.

The applications included in the standard Pro Suite software package are:

• Automated Image Mapping
  The Automated Image Mapping application enables users to automatically collect multiple images in a regular grid.

• Remote User Interface
  Phenom Pro Suite’s Remote User Interface makes it possible to access the Phenom from a different location.

• measureIT (Olympus SIS)

The Phenom Application System and Pro Suite are available for the Phenom G2 pro desktop SEM. The Phenom Application System can be connected direct, via local network or Internet, enabling network storage and remote system control.

Optional applications:

• 3D Roughness Reconstruction
  With the 3D Roughness Reconstruction application, the Phenom G2 pro is able to generate three-dimensional images and sub-micrometer roughness measurements.

• Fibermetric
  The Fibermetric application produces accurate size information from micro and nano fiber samples.

For more information on these applications, visit our website: www.phenom-world.com
Automated Image Mapping

The Automated Image Mapping application enables users to automatically collect multiple images in a regular grid.

The Automated Image Mapping application enables user-defined collection of images with a large field of view on a high-resolution image map.

After an area has been defined in the overview, Automated Image Mapping scans the area with the desired resolution and number of images.

The images are tiled to one large overview which can be stored and navigated for detailed observation. All images can be stored separately, for image analysis or as a reference database.

The main benefits of Automated Image Mapping are:
- Large field of view (FOV) images  
  (min. magnification 31.8x, max. FOV 8.07 mm)
- Extremely high-resolution complete sample image maps
- Automated procedure for collecting all sample image data
- Intuitive single-page user interface
- Creation of low-magnification overviews
- Automated acquisition for Fibermetric
On the left: Automated Image Mapping can be used to collect an array of images from a fiber sample. The application can take 100 images at 1024 x 1024 pixel within minutes.
On the right: A batch of these images can be loaded into Fibermetric for fiber- and pore-size measurements.

On the left: An overview of a 2.46 x 2.46 mm semiconductor scanned at high resolution, resulting in an 85 Megapixel image.
On the right: A close up of the image map revealing small details on the surface of the chip.
Remote User Interface

Phenom Pro Suite’s Remote User Interface makes it possible to access the Phenom G2 pro from a different location. This application is ideal for customers needing support from Phenom-World Customer Support to optimize the performance of their Phenom G2 pro. Customer Support can log on to the Phenom G2 pro and help to adjust the necessary settings if access is granted from the customer’s location.

The Phenom G2 pro can be controlled with all the common features from the Phenom User Interface. It is also a perfect application for interacting with colleagues based at a different location.

Samples can be imaged and stored on a USB, a network location or local hard drive. This is the ideal solution for showing live results during a presentation or customer demonstration.

The main benefits of Remote User Interface are:
- Real-time remote control
- Direct feedback from service
- Interaction with colleagues at various locations