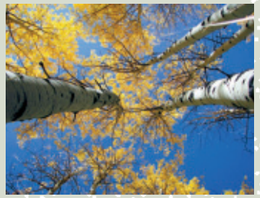
## About Square One

We are a multi-disciplinary engineering company that specializes in the design and development of innovative automated workcells, robots, and precision positioning devices. Nestled in Jackson Hole, Wyoming, Square One maintains state-of-the-art laboratory and manufacturing facilities staffed by engineers, physicists and skilled technicians. Our vision is to assemble the best minds in the business in an idyllic location, equip them with the latest design tools, and then turn them loose on the most challenging automation projects. We believe our unconventional setting fosters original thinking and we know our collaborators always enjoy their visits.



Square One received the 2006 National Tibbetts Award in recognition of the consistent excellence of our SBIR-sponsored research, the success of our commercialization efforts and the positive economic impact our company has had on our region.

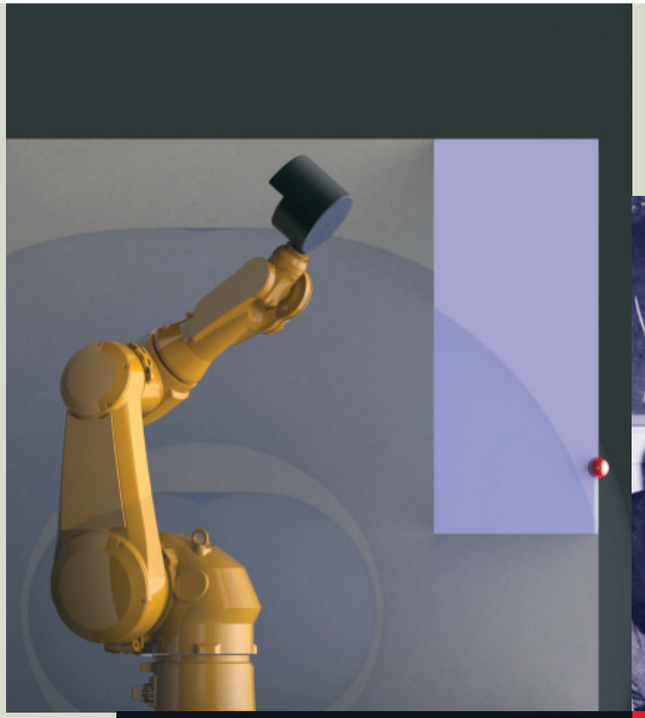
## Collaborations

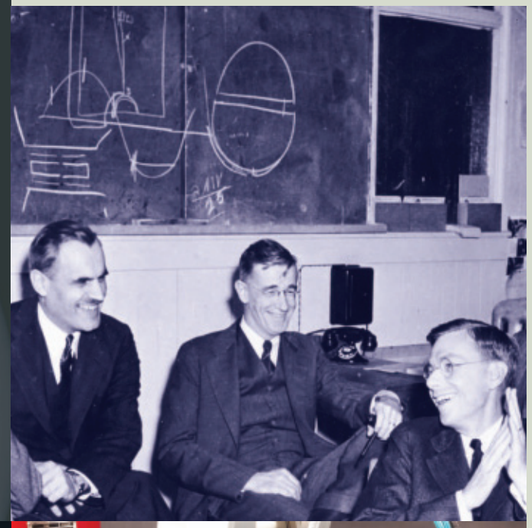
Square One collaborates closely with universities, national labs, and private industry across the nation in support of our research. Current partners include:

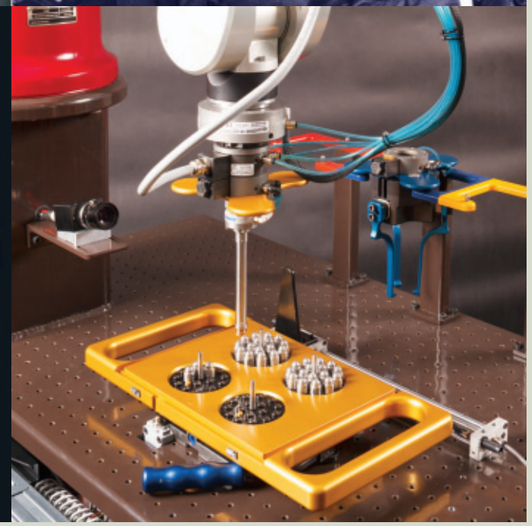
Stanford University
National Instruments
Johns Hopkins Applied Physics Laboratory
The Scripps Research Institute
Stäubli Robotics
Oak Ridge National Laboratory
Boeing PhantomWorks
SLAC National Accelerator Laboratory
The Lawrence Berkeley National Laboratory
Brookhaven National Laboratory

SQUARE ONE
Systems Design

P.O. Box 10520, Jackson, WY 83002
TEL 307 734-0211, EMAIL info@sqr-1.com
WEB www.sqr-1.com







# SYNCHROTRON ROBOTICS

Innovative solutions for automated sample exchange, sample alignment and detector positioning.

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# SAMPLE EXCHANGE ROBOT

Current generation synchrotron light sources provide X-ray beams of unprecedented brightness, allowing experimental data sets to be gathered in a matter of minutes. However, fresh samples are still generally loaded manually; a time-consuming process that compromises the productivity of valuable X-ray resources. Square One's fully-automated Sample Exchange Workcell provides a fast, reliable solution.

**The ability to continually load fresh samples without the need to enter the experimental hutch.**

Samples are typically first mated with an appropriate holder and then enter the hutch in high-capacity magazines. Upon command, the workcell's 6-axis robot pulls a selected sample from the magazine, reads its barcode, correctly orients it and transfers it to the experiment.

The robot is fitted with a fail-safe gripper that matches the geometry of a family of sample types. An integrated gripper exchange system endows the workcell with the ability to automatically re-configure itself for different sample geometries.

Magazines carrying radioactive or other sensitive samples can be safely segregated within portable enclosures. Beamline productivity can be further enhanced by linking the workcell with a magazine feed-through allowing fresh samples to be continually fed to the robot without the need for anyone to enter the experimental hutch.

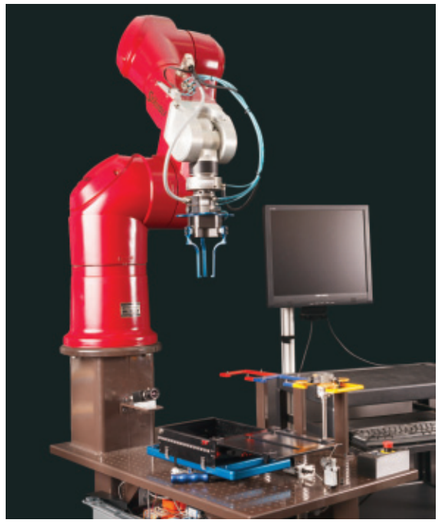
For some applications, the robot can also be used to accurately align a sample relative to the incident X-ray beam and then rotate it through inverse phase space during data collection. This capability eliminates the need for secondary goniometers and translation stages.

## Operational Advantages

- Maximizes beamline productivity
- Automates data tracking
- Isolates sensitive samples from the environment
- Supports remote operation
- Enables real time sample alignment and orientation relative to the beam (virtual goniometer)

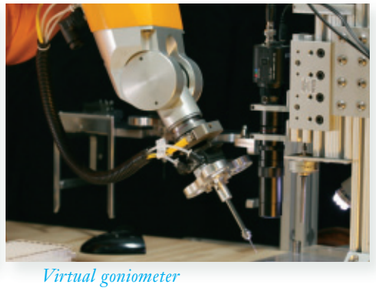
## Features

- Fast, precise and reliable
- Fail-safe gripping
- Automated gripper exchange accommodates multiple sample geometries
- Custom sample magazines, enclosures and hutch feed-throughs protect samples
- Integrated machine vision
- EPICS compatible



*High capacity magazines*

*Vision inspection*



*Virtual goniometer*



## Operational Advantages

- Provides enhanced detection volumes (including back-scattering data)
- A tunable center of rotation accommodates multiple sample locations
- Supports rapid detector repositioning
- Optimizes use of space within the hutch

## Features

- Accurate, repeatable and stable over time
- High payload capacity compatible with large, heavy detectors
- Can be mounted to the hutch floor or overhead
- Pre-programmed detection routines
- EPICS compatible

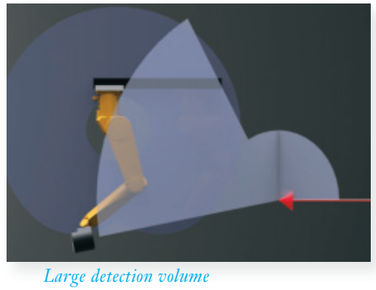
# DETECTOR POSITIONING ROBOT

Advanced 6-axis robots offer a powerful new approach for positioning detectors. Under robot control, a detector can be rapidly repositioned throughout an exceptionally large detection volume. Square One's innovative systems deliver accuracies and repeatabilities equal to that of hard-tooled detector positioning mechanisms. However, unlike these mechanisms, the robot's center of rotation can be instantly re-defined when a sample's location changes. This results in systems that provide maximum operational flexibility.

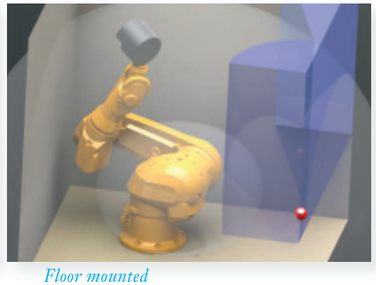
**Detectors can be rapidly repositioned throughout an exceptionally large detection volume.**

Robotic Detector Positioners are available in a range of sizes and payload capacities. At the high end, our systems can accommodate detectors weighing 100 kg and cover detection volumes over 5 meters across. When necessary, detection volumes can be further expanded by mounting the robot atop a linear track. Robots can be either anchored to the hutch floor or mounted overhead. For typical beamlines that are densely populated with experimental hardware, overhead-mounting optimizes the use of valuable real estate.

Independent tests conducted by SLAC's metrology team conclusively demonstrated that robot-based detector positioning delivers positional accuracy, repeatability and stability equal to that of conventional goniometers. Results showed that a detector could be reliably positioned to an accuracy of better than 20 µm and a repeatability of better than ±15 µm in all three translational degrees-of-freedom. Tests also confirmed that the robot can stably maintain the detector's location: less than 6 µm of drift over a 30 minute period.



*Large detection volume*



*Floor mounted*

*Gantry mounted*