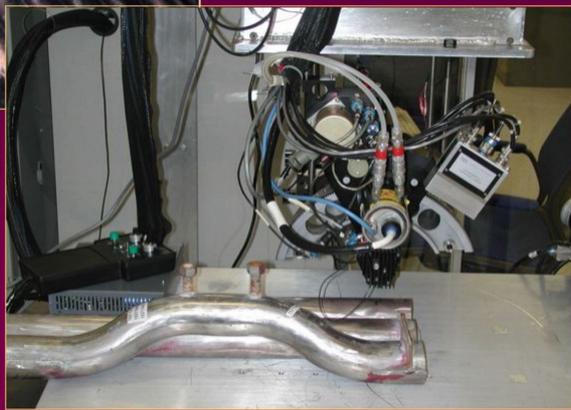


# Large Specimen X-Ray Residual Stress Mapping Facility

## Background

- ❖ X-Ray residual stress measurement for large samples is often done in the field, and a number of portable instruments have been commercially developed.
- ❖ These typically require manually positioning the unit for each strain component and each location of measurement.
- ❖ A dedicated operator is required for hardware and sample manipulation as well as interactive software prompts.



## Upgrade Goals

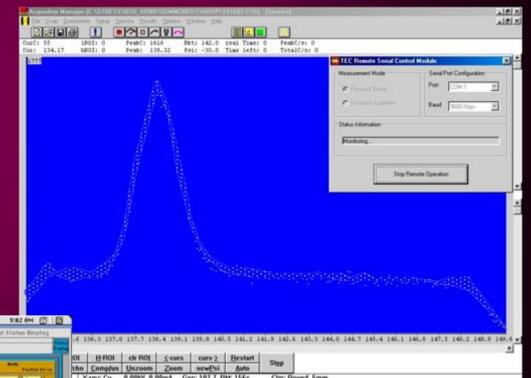
- ❖ Map residual stresses as a function of location under full computer control using an existing X-ray stress analyzer
- ❖ Use expertise and control software already developed for the Neutron Residual Stress Mapping Facility
- ❖ Accept both large specimens and small research samples
- ❖ Develop interchangeable sample mounting methods



Example grid for mapping stresses on an engine block

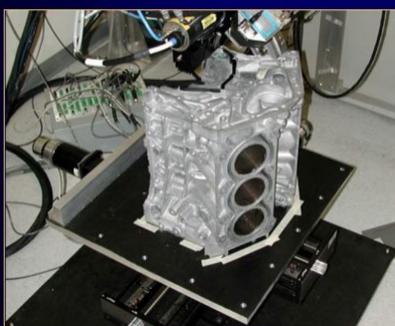
## Automated Mapping Capability Achieved with Three Software Programs

1. "Standard" TEC data collection software
  - Requires user keyboarding for initial data collection set up
2. TEC Remote Control Software Module
  - Special software developed for ORNL
  - Facilitates communication between Labview code and TEC data collection software
  - Allows user commands to be entered by another computer
3. "Run-the-System" LabView VI controls the data collection and motion control computers
  - Adapted neutron diffraction LabView code
  - Graphical user interface for setting up the mapping
  - Annotates filename with location



## X-ray Source and Sample Movement Achieved by Combination of a Gantry System and Two Sample Stages, Respectively

- ❖ Enclosure provides room for large samples
  - Dimensions: 15 x 8.2 x 9.2 ft. (L x W x H)
- ❖ X-ray stress analyzer joined to gantry system
  - Enclosure X-ray source mounted to an overhead on a Z-stage
  - Z stage mounted to an overhead cart with X ( $\pm 4$  ft)-Y ( $\pm 7$  ft) movement
- ❖ Samples mounted to motorized stages
  - Small  $xy\phi$  stages have 200 mm travel, 100 lb. load capacity
  - Large  $XY\Phi$  stages have 400 mm travel, 250 lb. load capacity
  - Huge samples may be placed on floor
- ❖ Safety features
  - W-Cu shutter material
  - ORNL audio alarm indicates x-rays emitted and door opened
  - Gantry walls provide radiation shielding
  - Emergency power shut off switch outside enclosure



## Data Analysis

- ❖ TEC system has package for data analysis but the peak position is based on fitting a parabola to the top 20% of the profile
  - Shown to be inadequate in some cases due to  $\alpha_1$ - $\alpha_2$  splitting, sloping backgrounds, low counting statistics, etc
- ❖ New LabView code was developed to fit the full profile and background and then to provide the  $\sin^2(\psi)$  fit to obtain the stress

## Acknowledgements

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