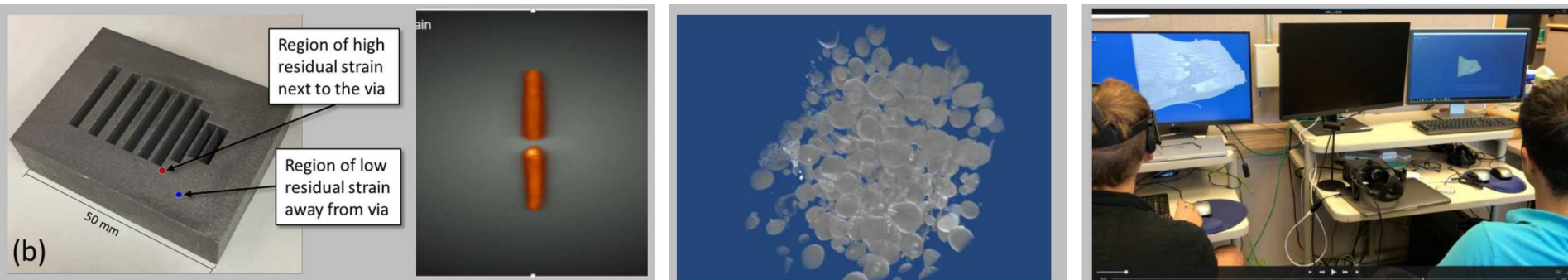


*Exceptional service in the national interest*



## SV3D: From 3D Interrogation to 3D Collaboration

**Mark A. Rodriguez, Jonathan Madison, Tod Amon, Aaron Comen, Timothy Dropps, Thomas Ivanoff, and John J. Jones**

# Our Enhanced Surveillance Project Goal

Develop an **Intuitive and Immersive Diagnostic** for  $\mu$ -CT and other 3D datasets to improve the speed and efficiency by which these massive files are explored and evaluated.

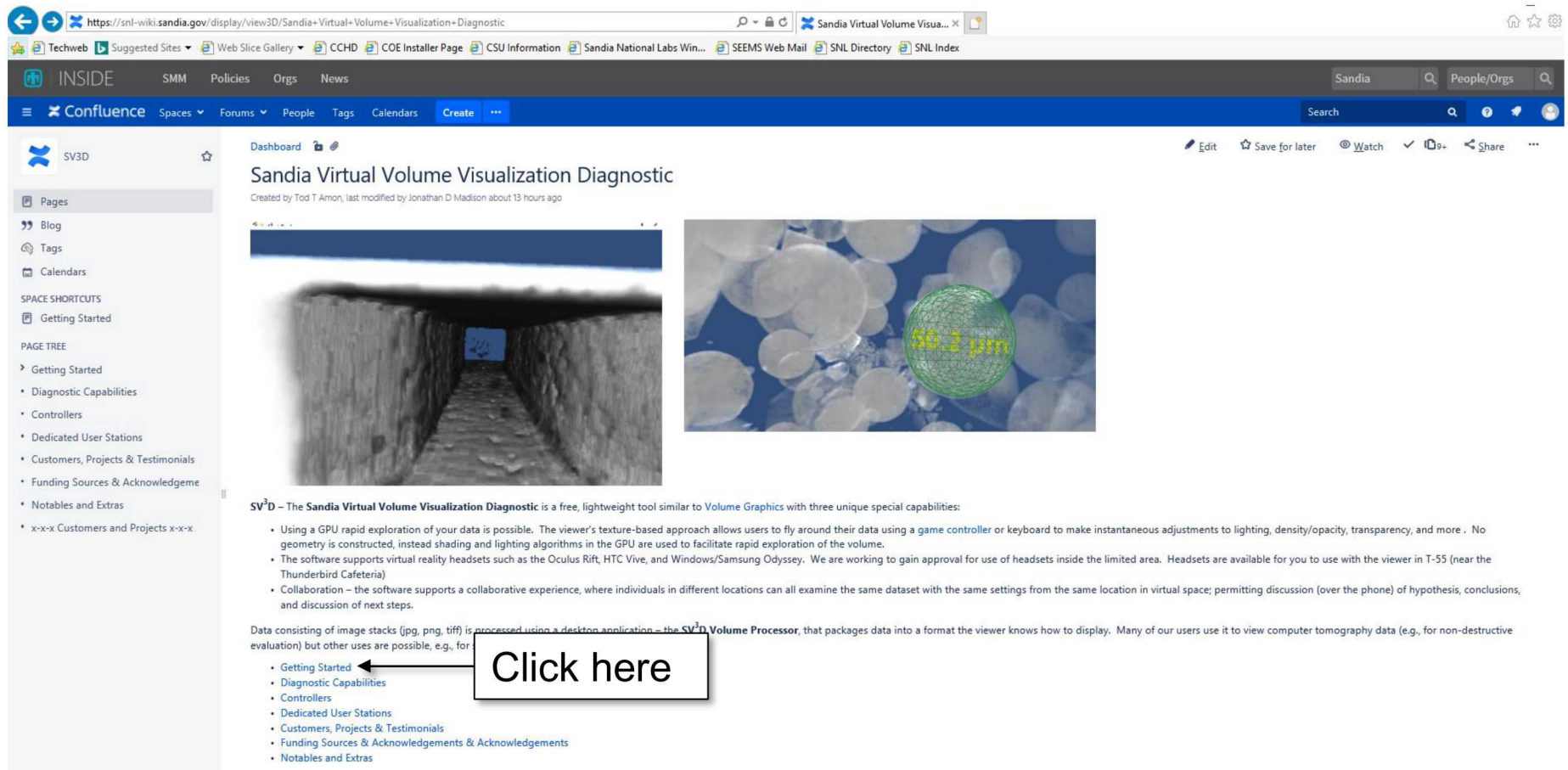
We employ a **Virtual Reality** environment and powerful **GPUs** to realize this goal

**It's Free!**

It is currently available to Sandians via our Wiki site on the SRN!

# We have a Wiki link to our site

<https://snl-wiki.sandia.gov/display/view3D/Sandia+Virtual+Volume+Visualization+Diagnostic>



The screenshot shows a web browser displaying a Confluence page titled "Sandia Virtual Volume Visualization Diagnostic". The page is part of a Confluence site with a sidebar on the left containing navigation links like "Pages", "Blog", "Tags", "Calendars", "SPACE SHORTCUTS", "Getting Started", "PAGE TREE", and a list of topics including "Getting Started", "Diagnostic Capabilities", "Controllers", "Dedicated User Stations", "Customers, Projects & Testimonials", "Funding Sources & Acknowledgements", "Notables and Extras", and "x-x-x Customers and Projects x-x-x".

The main content area of the page features two images: a 3D visualization of a tunnel-like structure on the left and a 3D visualization of a sphere with a green wireframe overlay on the right. Below the images, the text reads: "SV<sup>3</sup>D – The Sandia Virtual Volume Visualization Diagnostic is a free, lightweight tool similar to Volume Graphics with three unique special capabilities:".

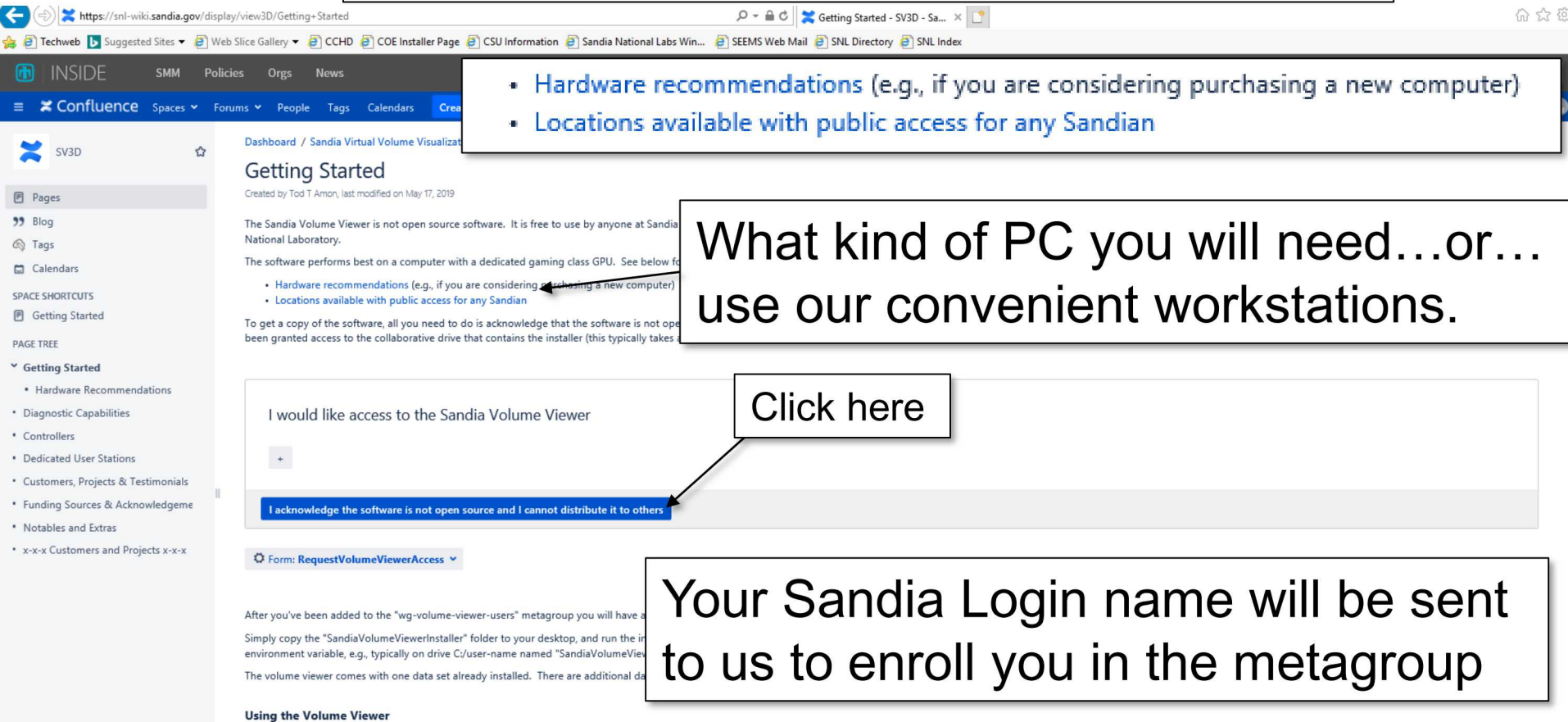
- Using a GPU rapid exploration of your data is possible. The viewer's texture-based approach allows users to fly around their data using a game controller or keyboard to make instantaneous adjustments to lighting, density/opacity, transparency, and more. No geometry is constructed, instead shading and lighting algorithms in the GPU are used to facilitate rapid exploration of the volume.
- The software supports virtual reality headsets such as the Oculus Rift, HTC Vive, and Windows/Samsung Odyssey. We are working to gain approval for use of headsets inside the limited area. Headsets are available for you to use with the viewer in T-55 (near the Thunderbird Cafeteria)
- Collaboration – the software supports a collaborative experience, where individuals in different locations can all examine the same dataset with the same settings from the same location in virtual space; permitting discussion (over the phone) of hypothesis, conclusions, and discussion of next steps.

Below the list, a paragraph states: "Data consisting of image stacks (jpg, png, tiff) is processed using a desktop application – the SV<sup>3</sup>D Volume Processor, that packages data into a format the viewer knows how to display. Many of our users use it to view computer tomography data (e.g., for non-destructive evaluation) but other uses are possible, e.g., for..."

At the bottom of the page, there is a list of links: "Getting Started", "Diagnostic Capabilities", "Controllers", "Dedicated User Stations", "Customers, Projects & Testimonials", "Funding Sources & Acknowledgements & Acknowledgements", and "Notables and Extras". A callout box with the text "Click here" and an arrow points to the "Getting Started" link.

# How would I get started?

<https://snl-wiki.sandia.gov/display/view3D/Getting+Started>



The screenshot shows the Sandia National Laboratories wiki page for 'Getting Started'. The page is titled 'Getting Started' and is part of the 'Sandia Virtual Volume Visualization' section. It includes a list of hardware recommendations and locations available with public access for any Sandian. A callout box points to the 'Hardware recommendations' link, stating: 'What kind of PC you will need...or... use our convenient workstations.' Another callout box points to the 'I acknowledge the software is not open source and I cannot distribute it to others' checkbox, stating: 'Click here'. A third callout box points to the 'Form: RequestVolumeViewerAccess' link, stating: 'Your Sandia Login name will be sent to us to enroll you in the metagroup'. A fourth callout box points to the 'Using the Volume Viewer' section, stating: 'We can provide you with a game controller too!'. The page also includes a sidebar with navigation links and a footer with contact information.

- Hardware recommendations (e.g., if you are considering purchasing a new computer)
- Locations available with public access for any Sandian

What kind of PC you will need...or... use our convenient workstations.

Click here

Your Sandia Login name will be sent to us to enroll you in the metagroup

We can provide you with a game controller too!

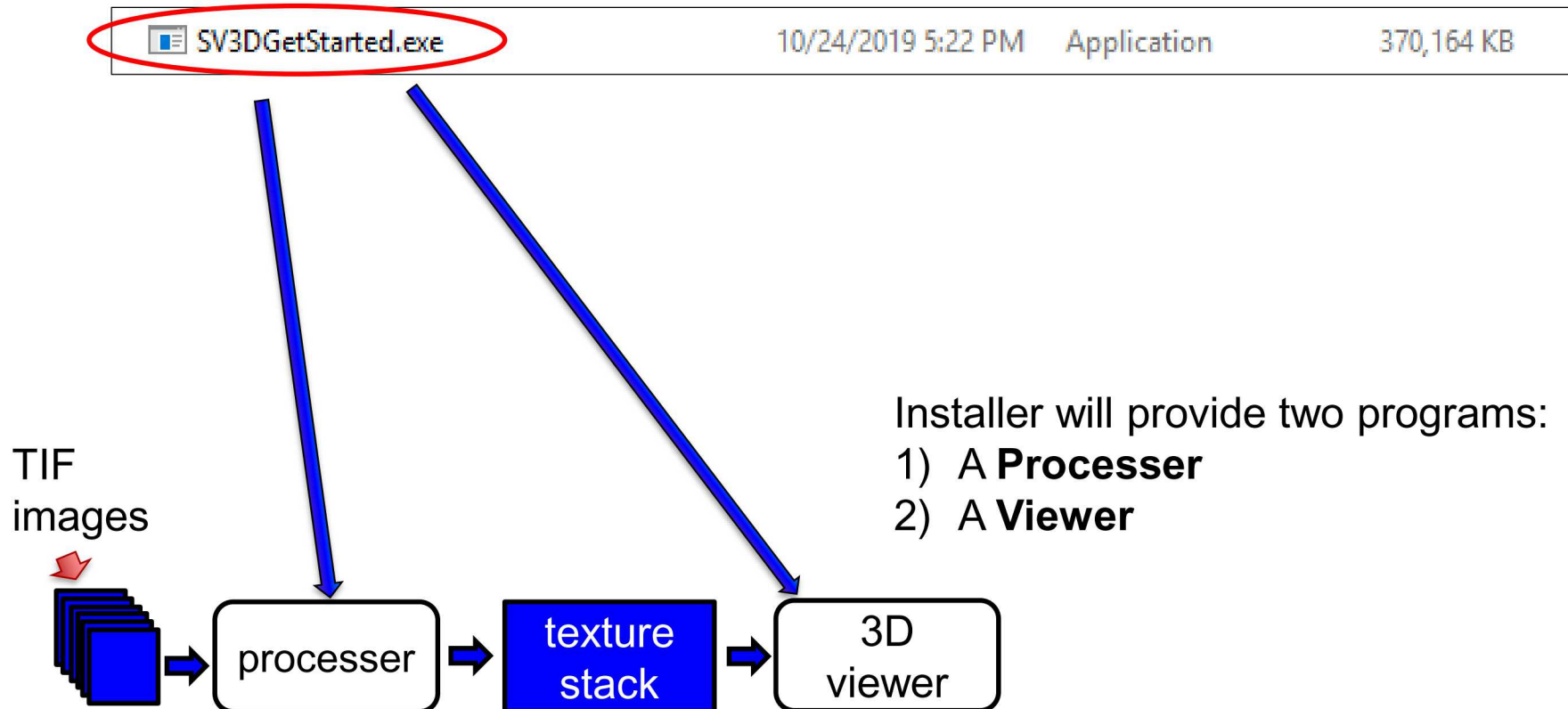




# You need two programs to get going.

\\sn\collaborative\view3D

\\sn\collaborative\view3D\sv3Dinstall



# Where are your fast PCs to view my data?

Dashboard / Sandia Virtual Volume Visualization Diagnostic

## Dedicated User Stations

Created by Tod T Amon, last modified by Jonathan D Madison yesterday at 10:44 PM

In addition to downloading SV<sup>3</sup>D for use on your own workstation, if desired, personnel may use one of our dedicated user stations for the purpose of visualizing 3D data within the diagnostic. If downloading the diagnostic is your preferred route, please contact the primary contact for the station.

### Building 701, Room 1207 – (s# -

**\*\*this is your best option for very large datasets\*\***

- OMEN X 290 PC; 512SSD; 3TB Hybrid Drive, 22GB RAM; GEFORCE RTX 2080 Ti Graphics Card
- Windows 10 Home
- HP Business Z32 31.5" LCD Monitor
- (1) HP standard keyboard
- (1) Dell scrolling mouse
- (1) Xbox One Controller Model 1708 (approved for use inside LTA)
- primary contact: [Jonathan Madison](#) (Org. 1851)

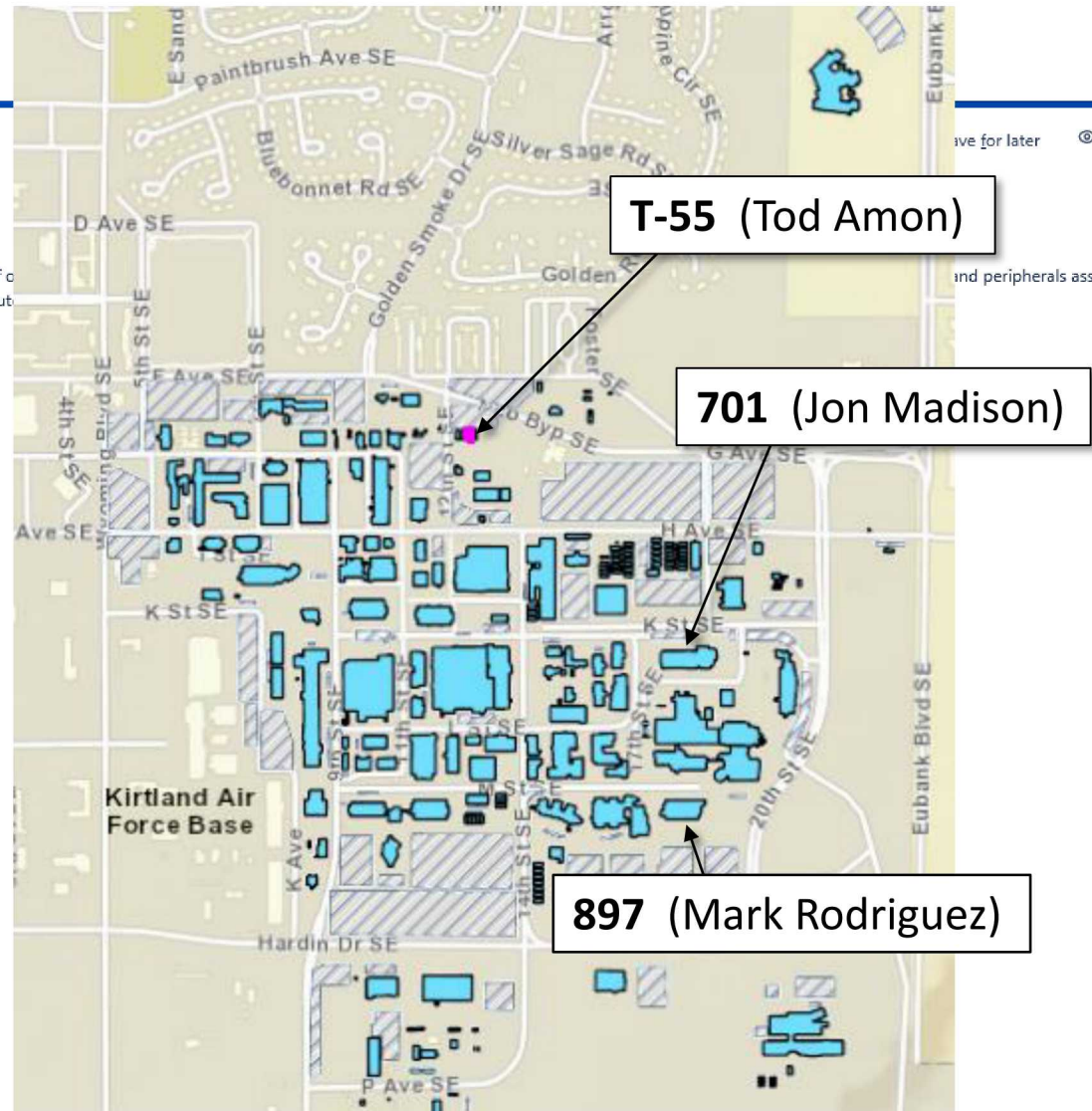
### Building T55, Room 1 – (s# )

- Desktop PC, 2 mobile laptops, all with 1080 Graphics Card
- Windows 10 Home
- Specify Monitor Type here.....
- (1) HP standard keyboard
- (1) Dell scrolling mouse
- (1) Xbox One Controller Model 1708 (approved for use inside LTA)
- primary contact: [Tod Amon](#) (Org. 9368)

### Building 897, Room 2475 – (s# )

- Desktop PC, with 1080 Graphics Card
- Windows 10 Home
- Specify Monitor Type here.....
- (1) HP standard keyboard
- (1) Dell scrolling mouse
- (1) Xbox One Controller Model 1708 (approved for use inside LTA)
- primary contact: [Mark Rodriguez](#) (Org. 1819)

Jonathan D Madison likes this



# Glass beads in Epoxy: fly-through video of $\mu$ -CT data with contrast level adjustment





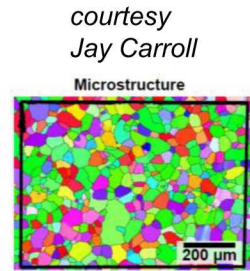
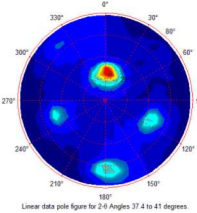
# Collaborative Viewing over the Network





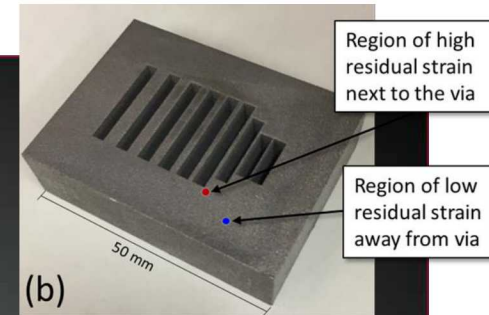
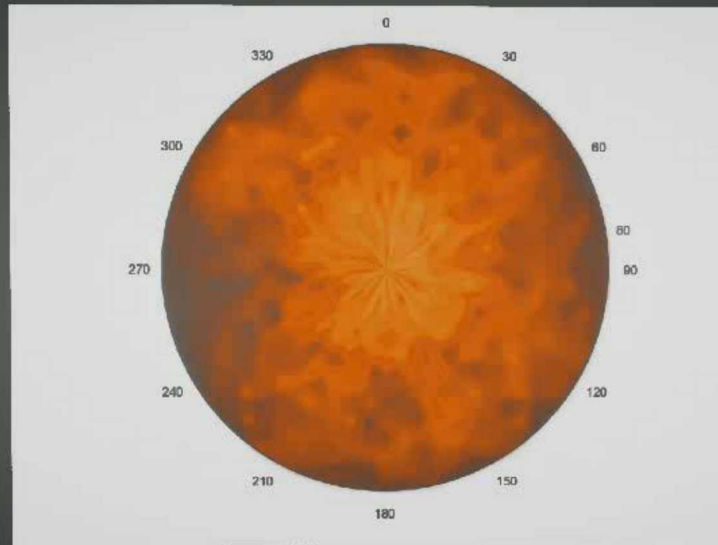
# We have looked at other times of multi-dimensional data using Virtual Reality

- X-ray Diffraction (XRD) is used for characterizing material structure and composition.
- XRD often is employed to measure the degree or polycrystalline orientation (via pole figures)
- XRD can ***also detect*** residual strain in materials
  - residual strains, resulting from materials processing can result in failure modes
- Pole figure data is multidimensional and sometimes hard to visualize
- Why not use VR to look at pole figure data to try and detect strain visually?



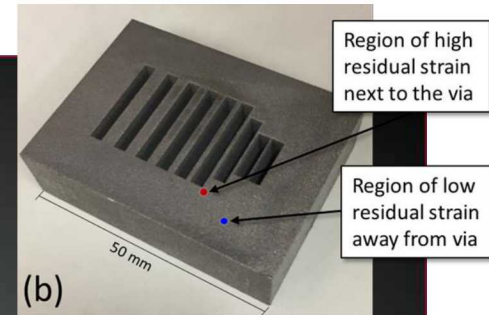
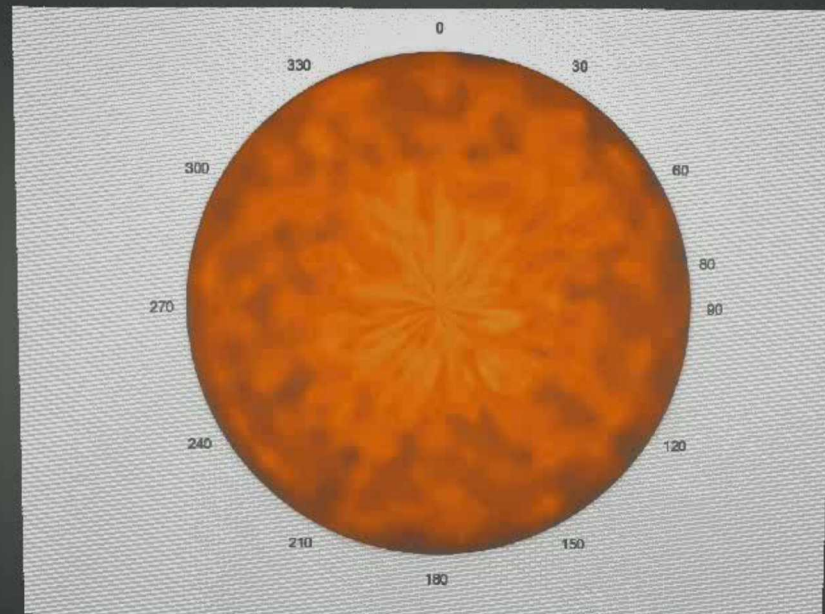
# We have diagnosed residual strain in XRD datasets via distortion of intensity distribution in pole figures

● high residual strain



# Unstrained region in AM part shows uniform intensity distribution in pole figure

● Low residual strain



# Summary

- Virtual Reality visualization allows for fast and flexible diagnosis in an immersive 3D environment.
- Tool is available now (help us test it!).
- Visualization can be performed on-screen or with VR headset.
- Works in Tech Area (buildings T-55, 701, 897, more to come).
- VR tools and options are available for data manipulation, marking, and measurement.
- Software is network capable for collaborative and interactive viewing via the internet.
- Generic TIFF stack format translates easily for viewing 3D data from additional diagnostics.
- Project plans for FY20 include collaborative viewing via SCN network.



# Acknowledgments

- A special thanks to James Griego for creating the XRD videos.
- Thanks to student interns Devon Oberdan and Bao-Loc Trinh for demonstrating the collaborative VR experience.
- Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC., a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA-0003525.