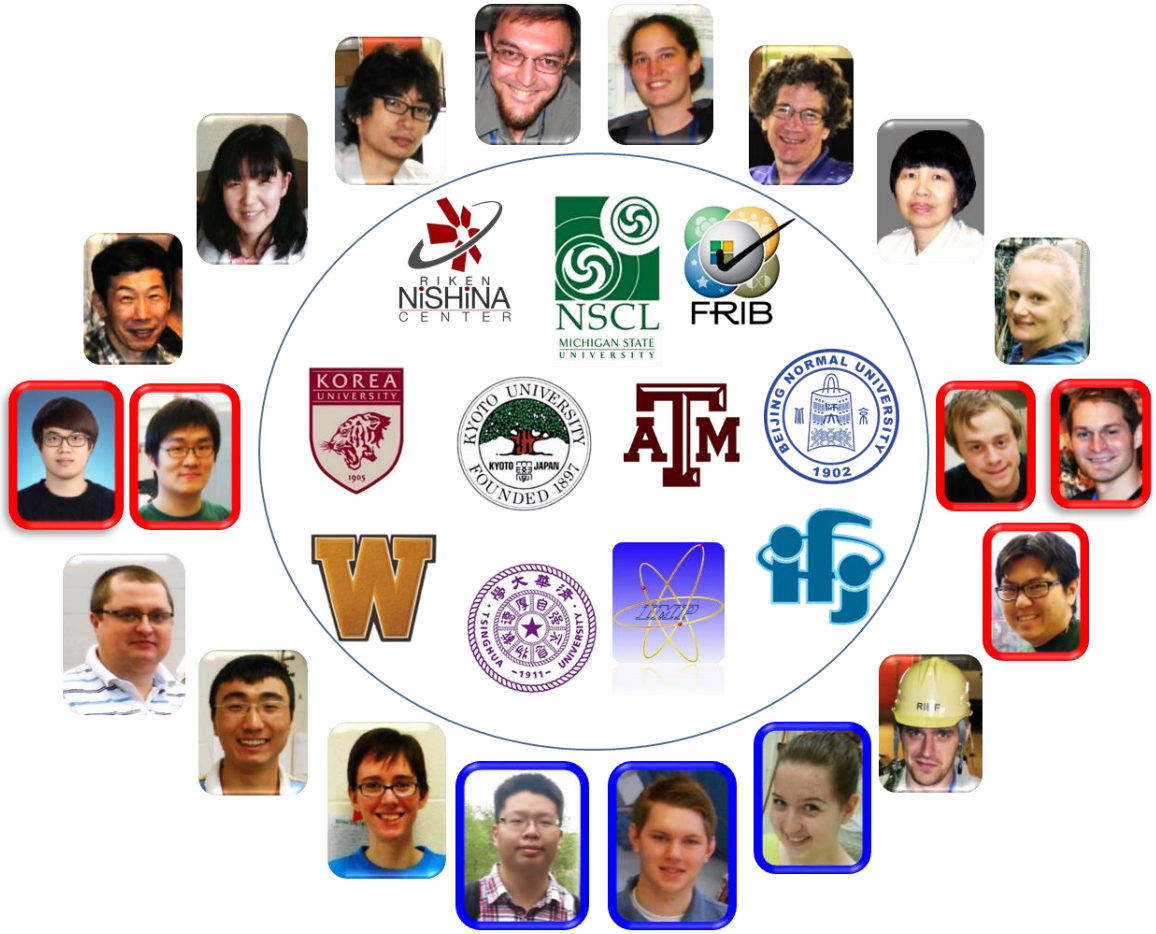
# Photogrammetry measurements of the SπRIT TPC




U.S. DEPARTMENT OF ENERGY
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文部科学省
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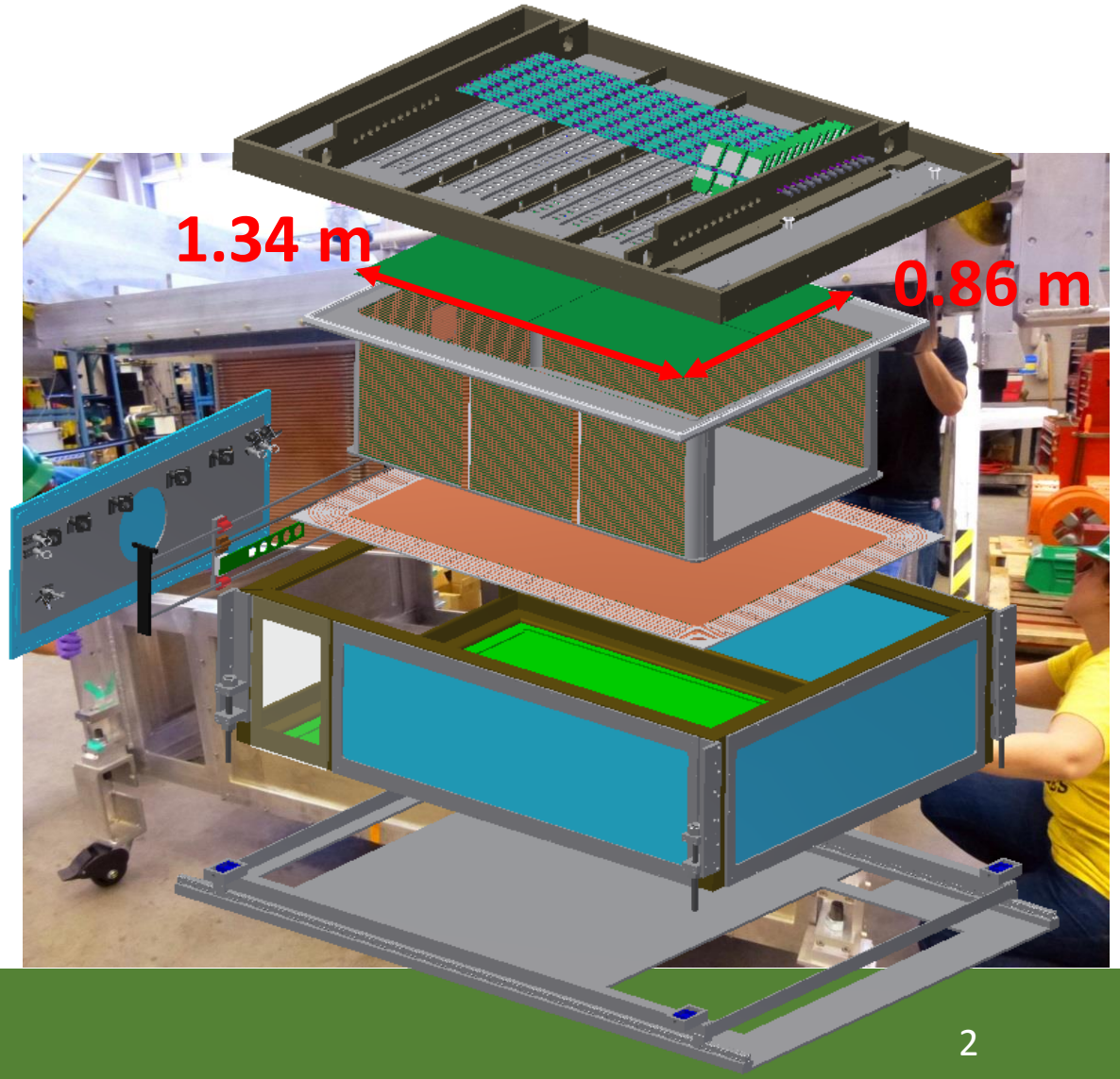
MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY-JAPAN

SπRIT

Jonathan Barney for the sTPC collaboration

# SπRIT Time Projection Chamber

- Built to study the symmetry energy at ~$2\rho_0$
- Multi-wire proportional chamber
- Large pad plane for particle detection (12,096 channels)
- Designed, constructed and assembled at MSU & TAMU



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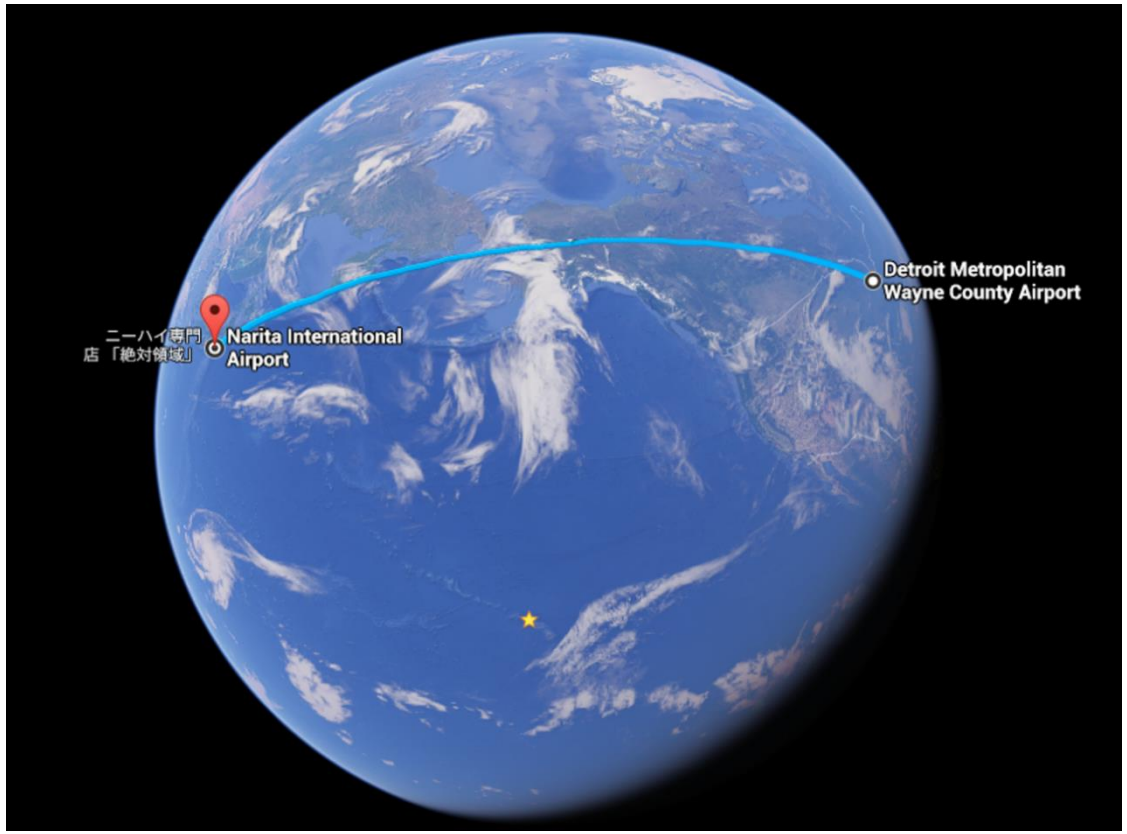

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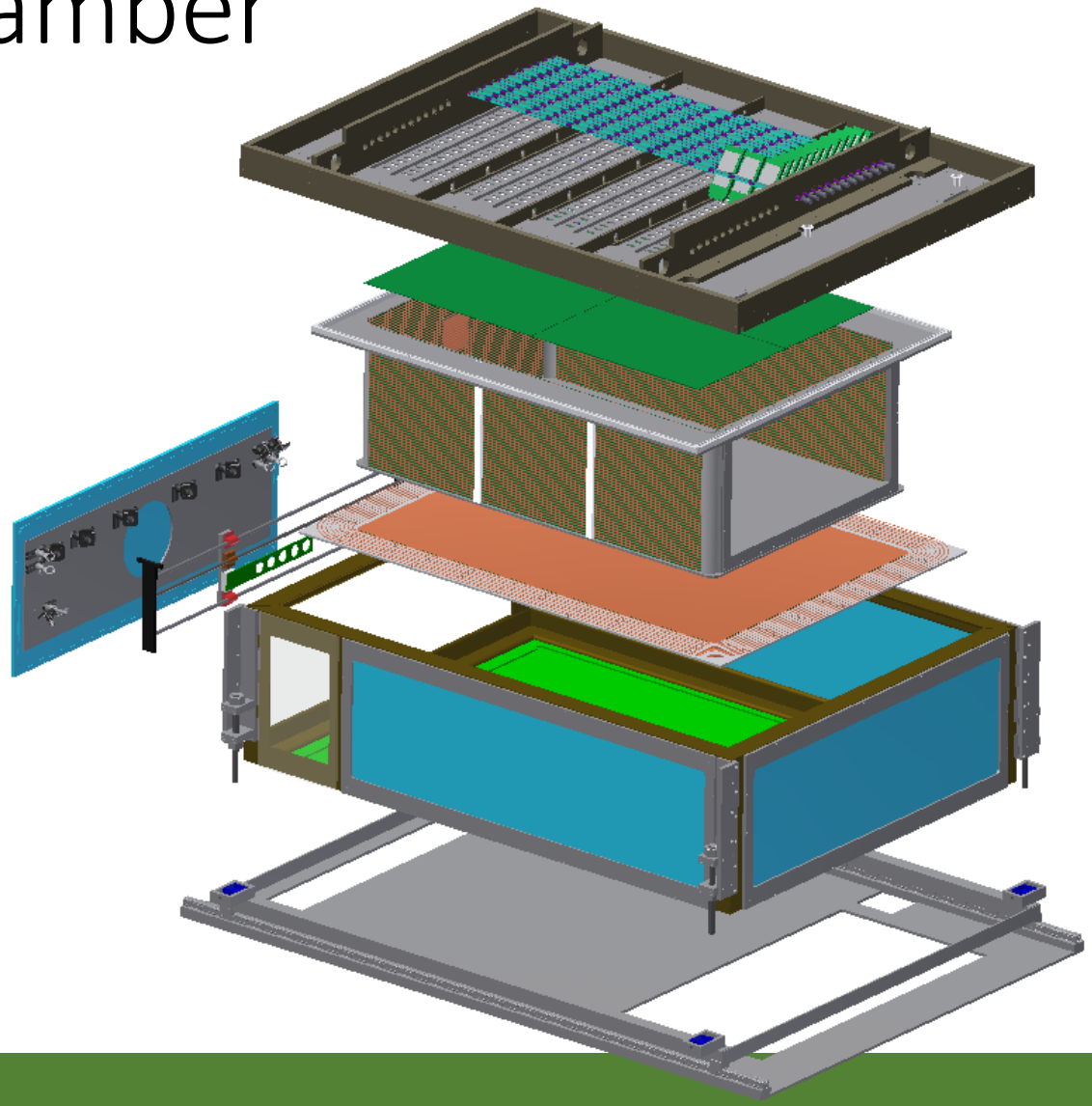
- Shipped to RIKEN (~10,000 km trip)
- Will operate inside SAMURAI magnet at RIKEN

# SπRIT Time Projection Chamber

- Thin walled enclosure with angle iron (aluminum) frame
- Field cage made of G10 circuit board
- Thick aluminum plate with ribs designed to keep detection elements fixed

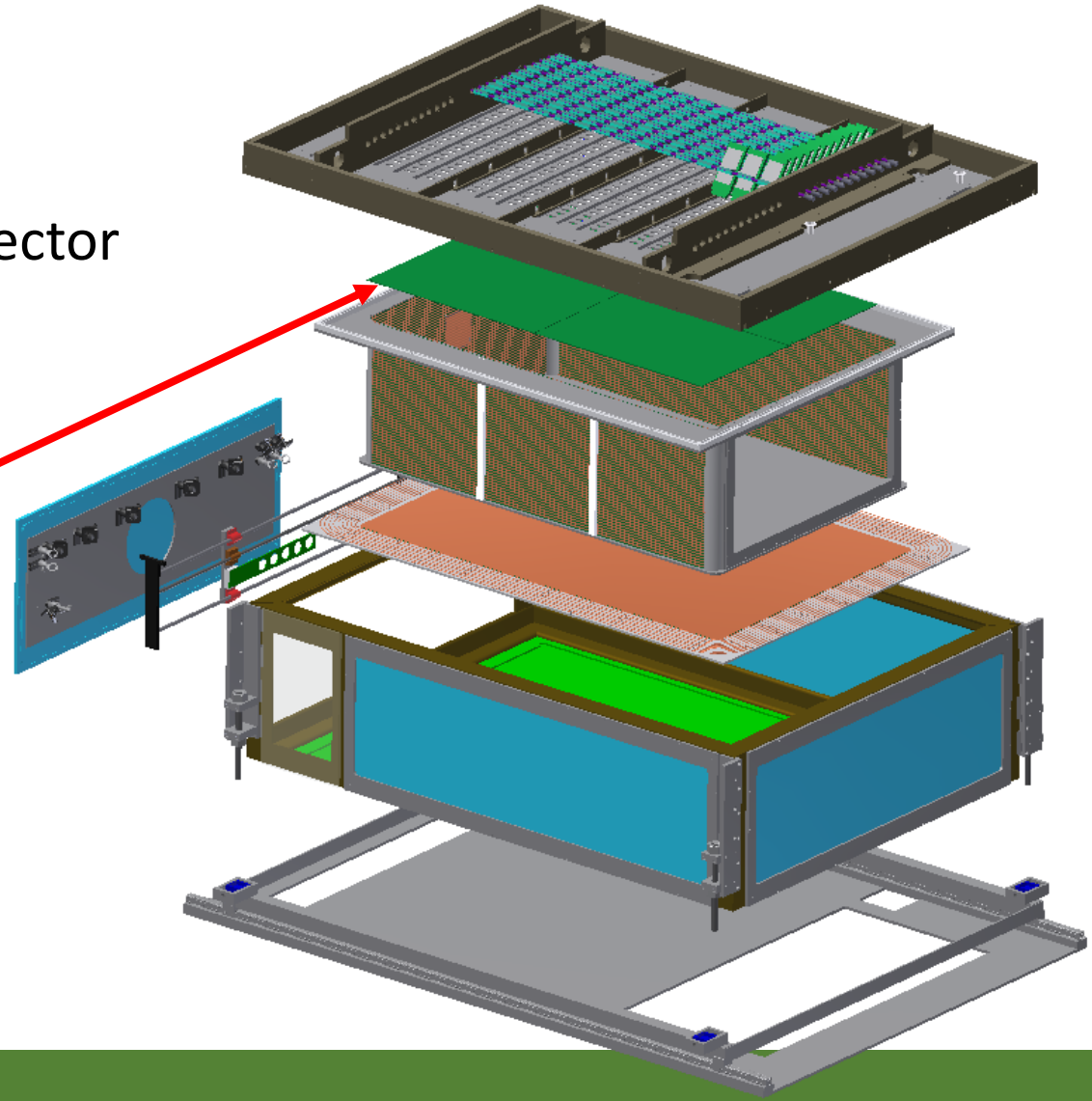


# Important measurements

**Flatness of the pad plane**

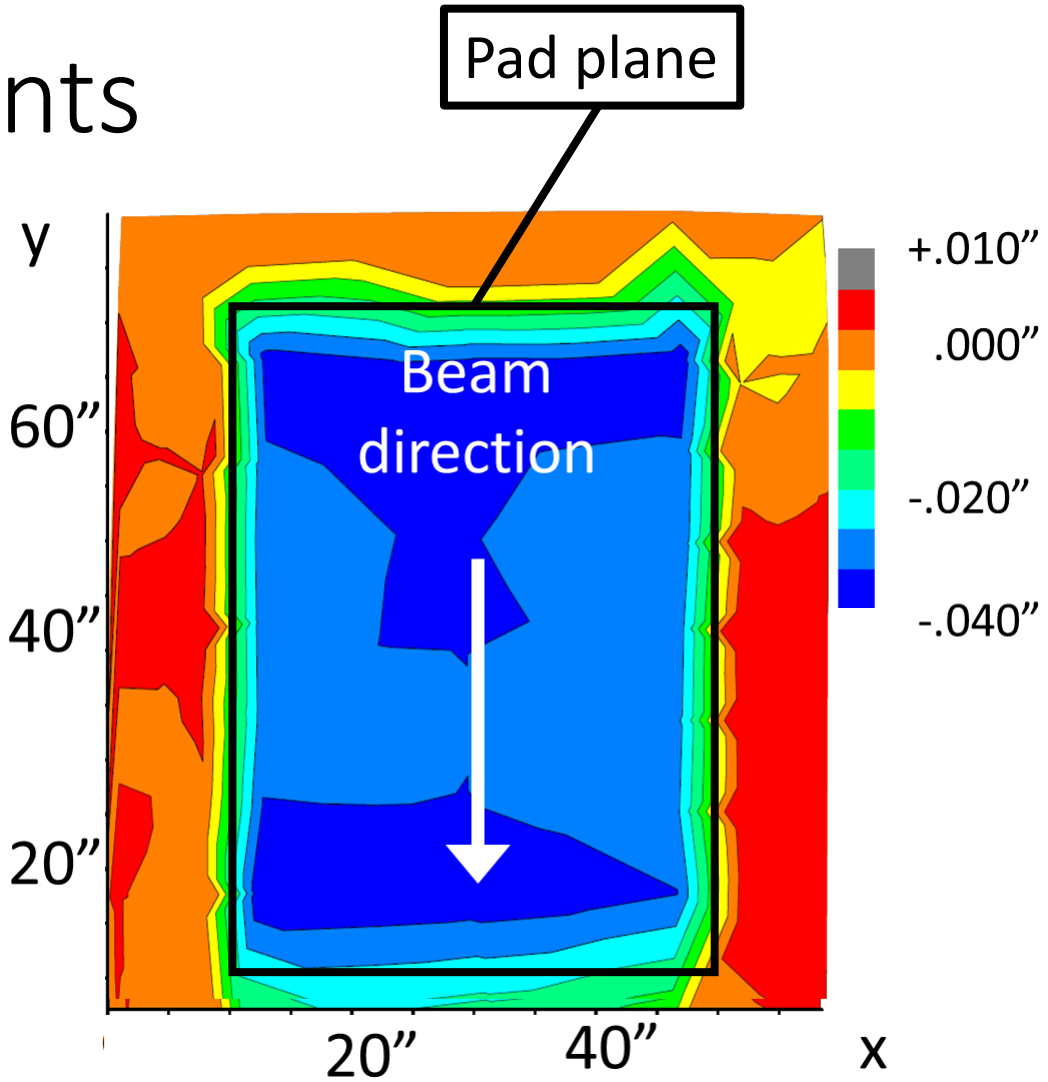
- Distance from pads to wires affects gain of detector
- Measure pad plane by measuring top plate

Pad plane is attached to large aluminum plate



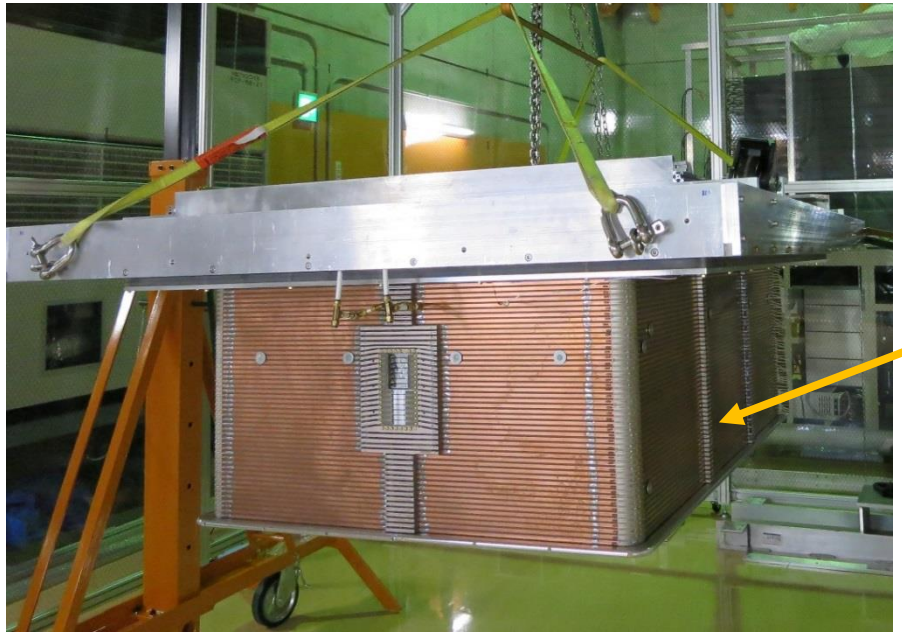
# Original Laser measurements

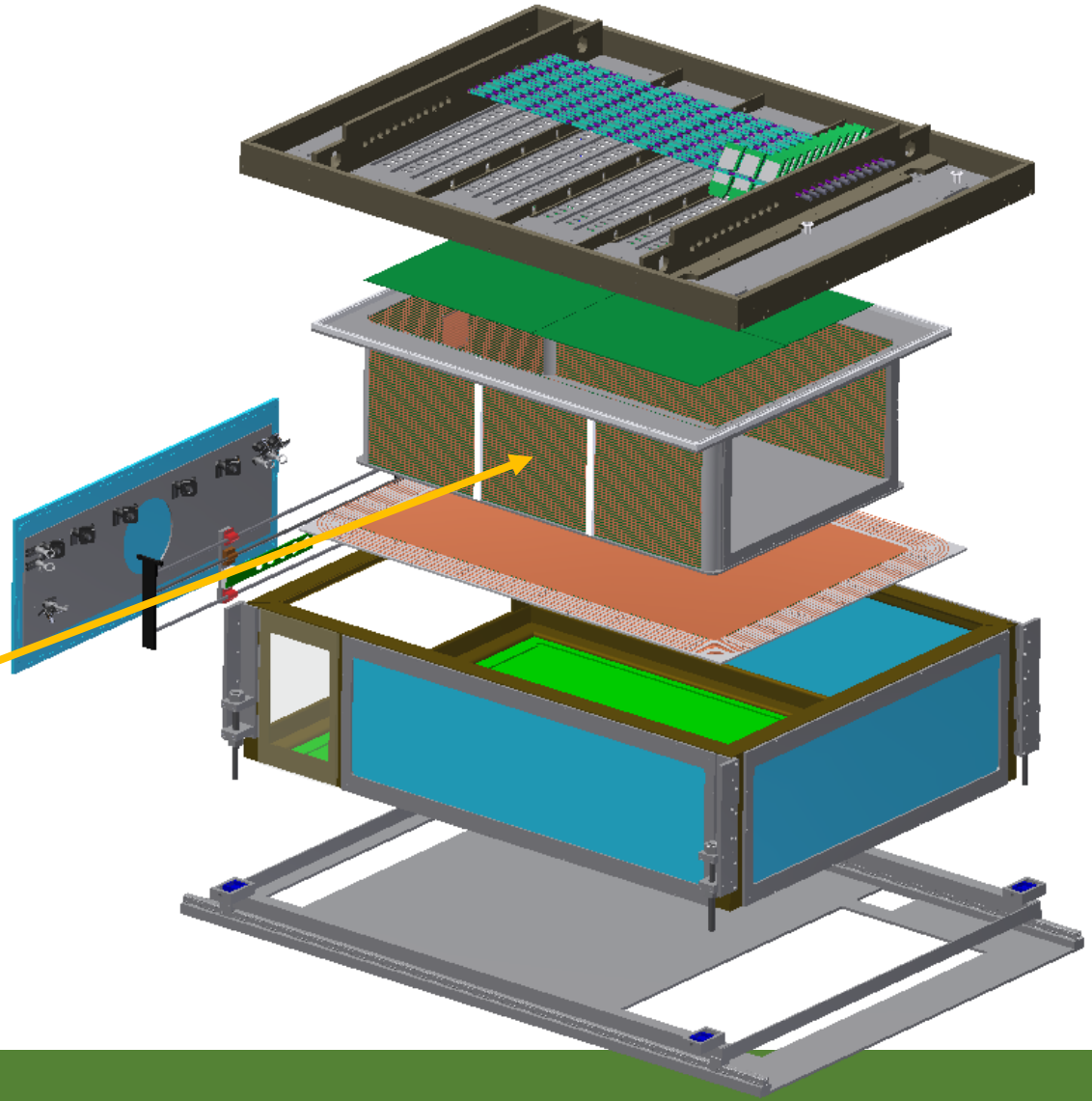
- Flatness measured using FARO laser system at NSCL during assembly
- Flat within 125 μm
- Flatness of pad plane within machining tolerances of top plate



# Important measurements

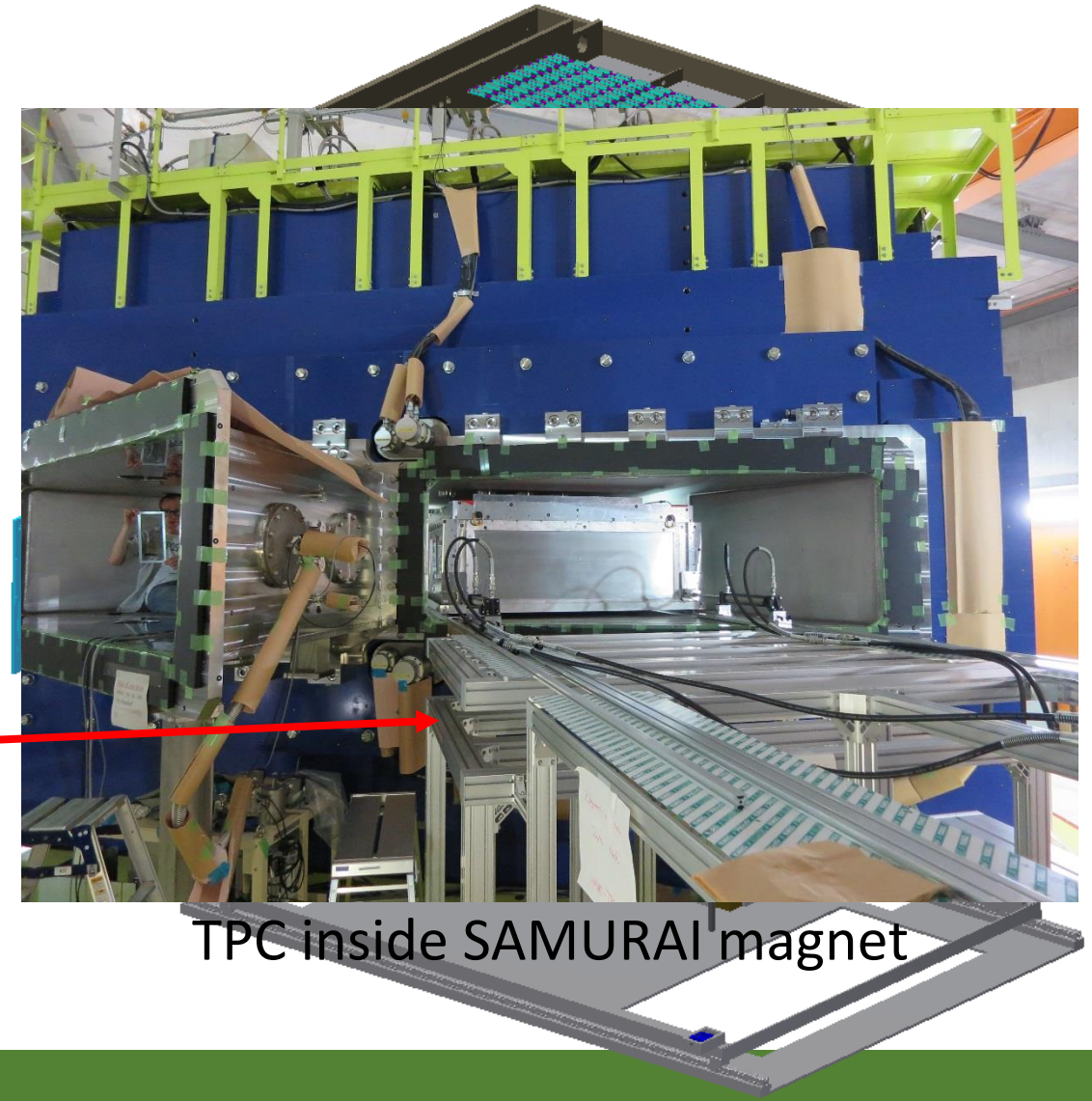
- **Angle of field cage to pad plane**
  - Affects drift path of electrons
  - Also affects simulations





# Important measurements

- **Check position inside magnet chamber**
  - Adjust so that E field is parallel to B field
  - Check position of detection elements relative to beam line



TPC inside SAMURAI magnet

# Photogrammetry measurements on the TPC

- Photogrammetry is the measurement method available at RIKEN
- Study performed by Justin Estee, July 2014
- 3 studies:
  - Flatness of top plate
  - How parallel is field cage
  - Changes to TPC on uneven surface

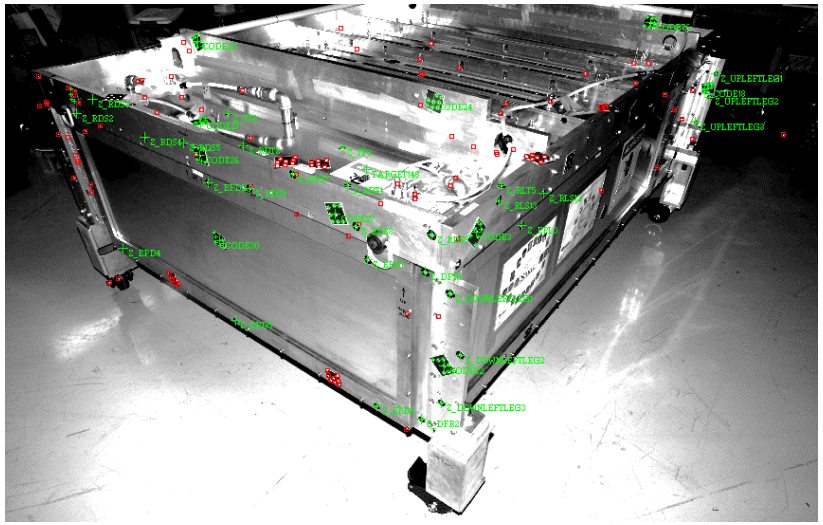
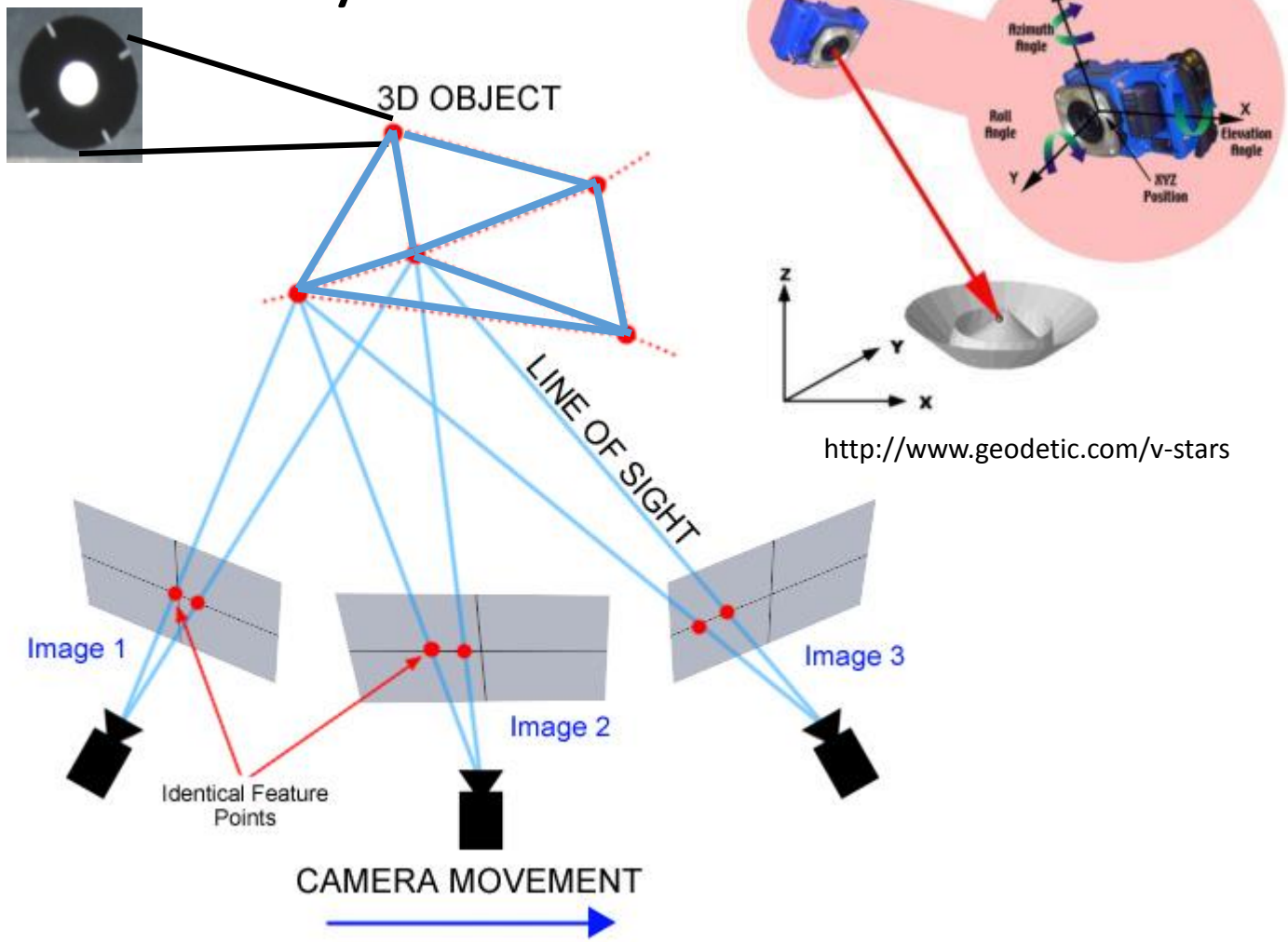


Figure courtesy B. Brophy

# How does photogrammetry work?

- Use multiple images to triangulate points on a 3D object
- “Resection” to determine the position of the camera for each photo
- Geodetic V-stars program reconstructs a 3D image of the points

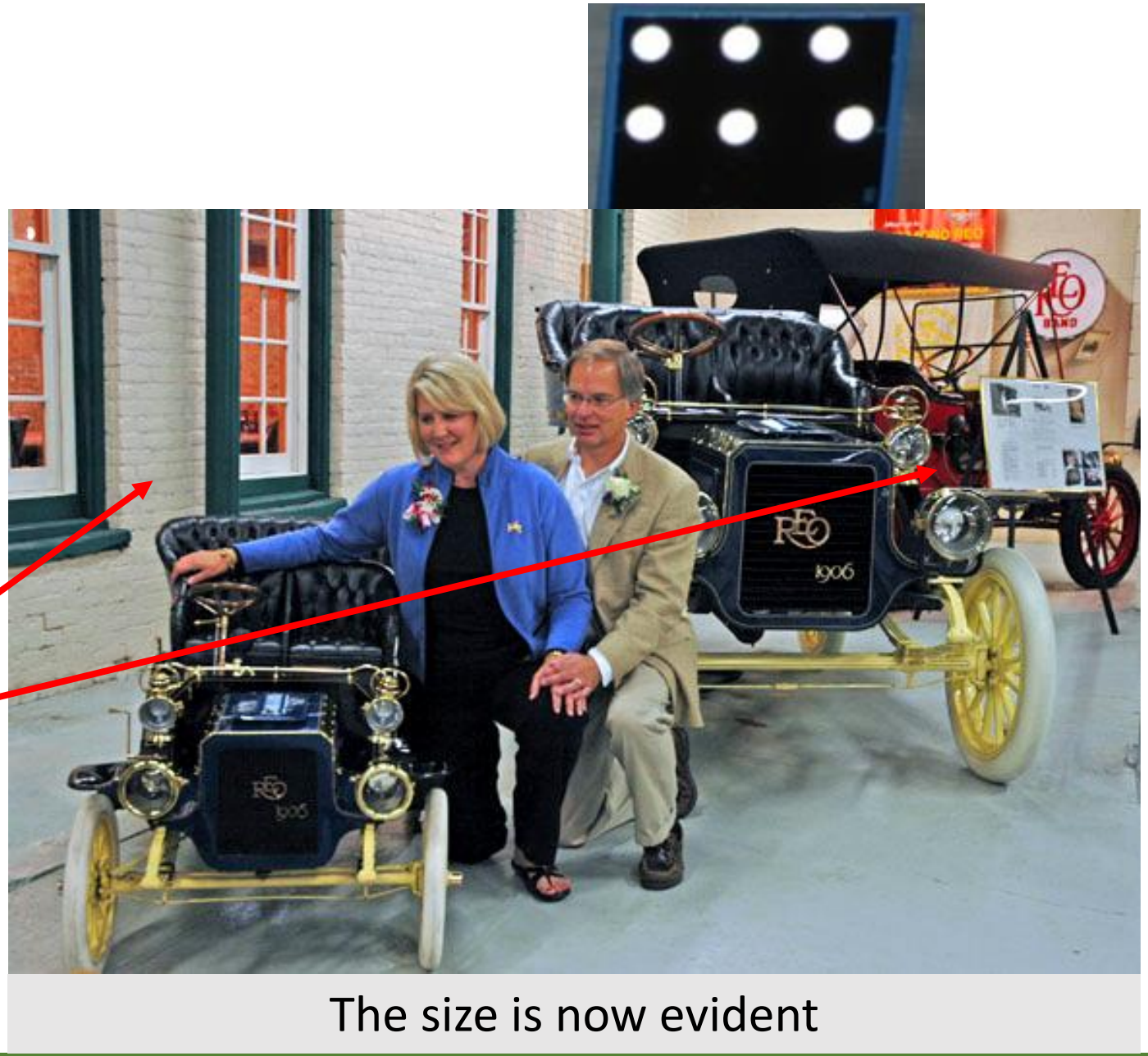



http://www.geodetic.com/v-stars

http://www.clemson.edu/restoration/wlcc/equipment_services/equipment/photogrammetry.html

# Resection

- Use coded targets as unique points
- Coded targets in picture help identify which face is photographed
- Requires a scale
- Scale bar included in measurements



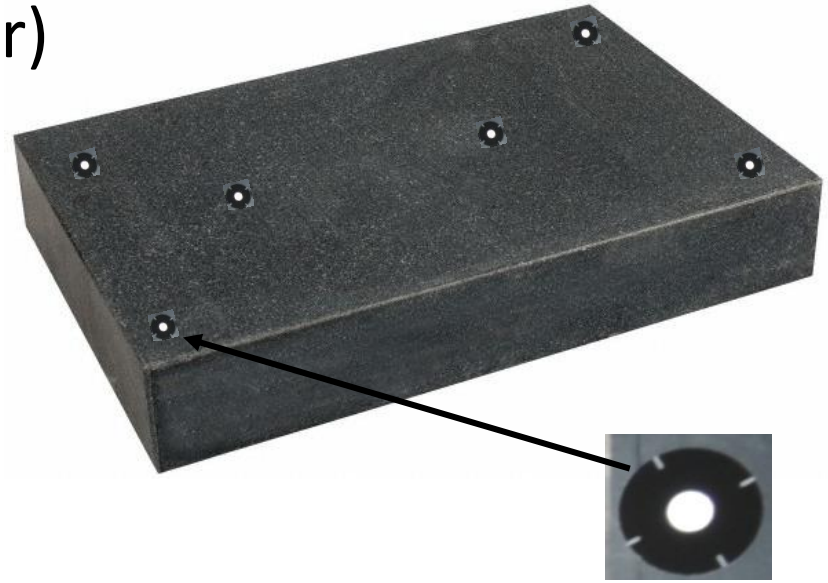

The size is now evident

http://www.clemson.edu/restoration/wlcc/equipment_services/equipment/photogrammetry.html

# Study of accuracy

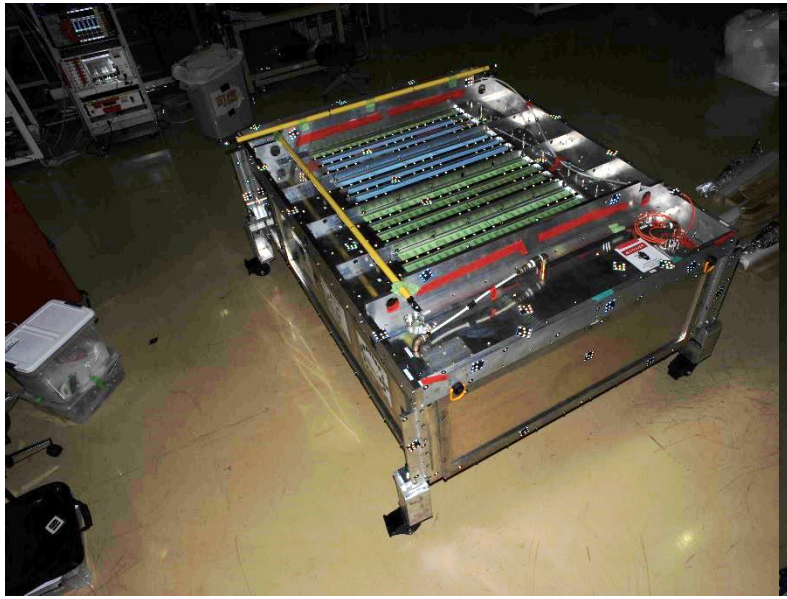
- Measurement of a granite flat plate (1.35 x 0.9 m)
- Flatness expected to be within 125 μm (or better)
- Measured with photogrammetry

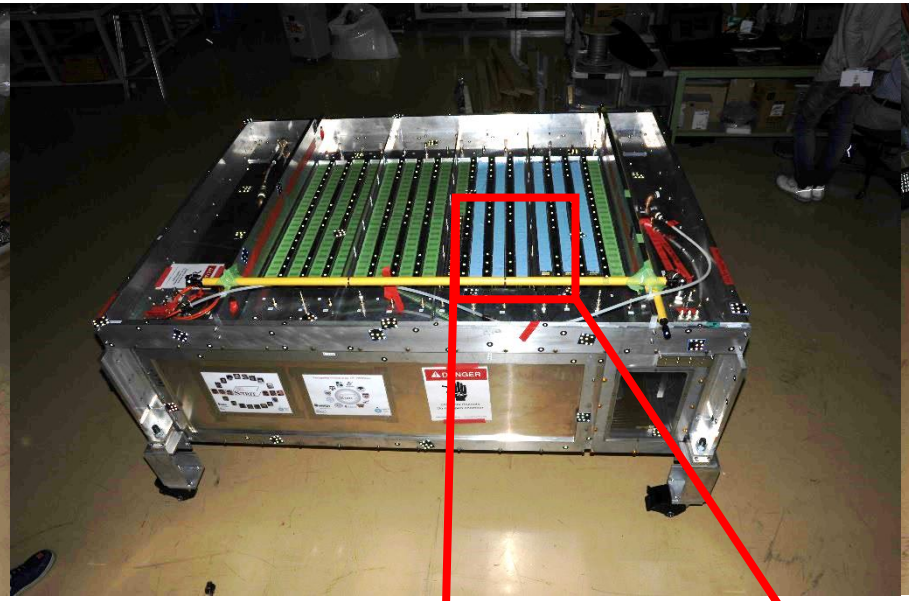
| Target style | Standard Deviation [μm] | Max/Min [μm] |
|---|---|---|
| 6-Single targets | 20 | +16/-19 |
| 38-tape targets | 24 | +52/-47 |
| 42-tape targets | 23 | +57/-46 |

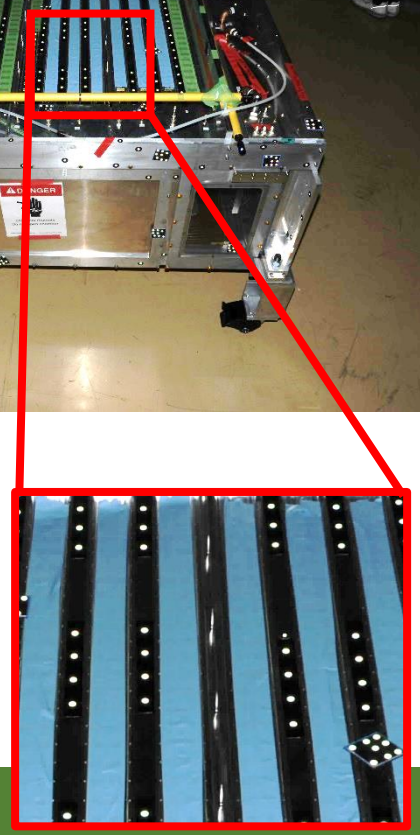


- Accuracy of photogrammetry measurements is within machining tolerance

# Photogrammetry measurements on the TPC





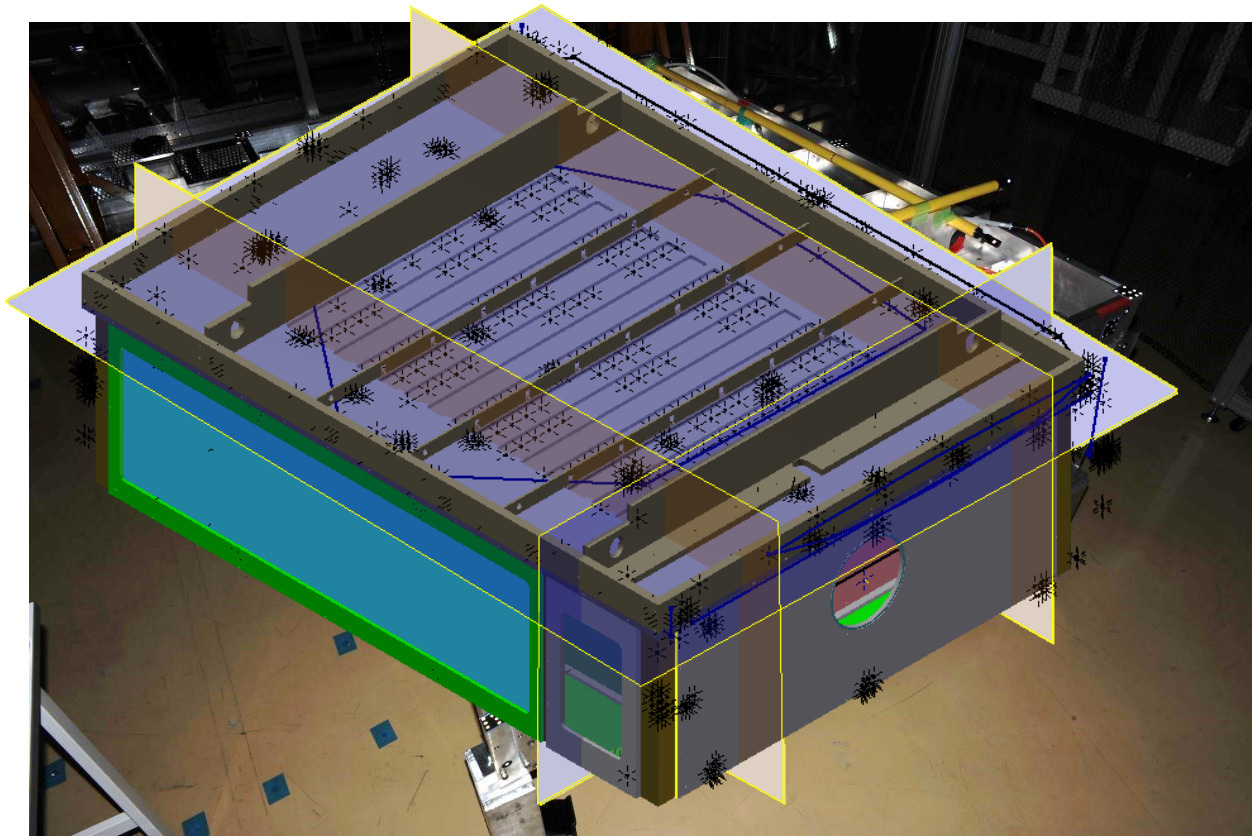


Unilluminated retro target

Illuminated retro target

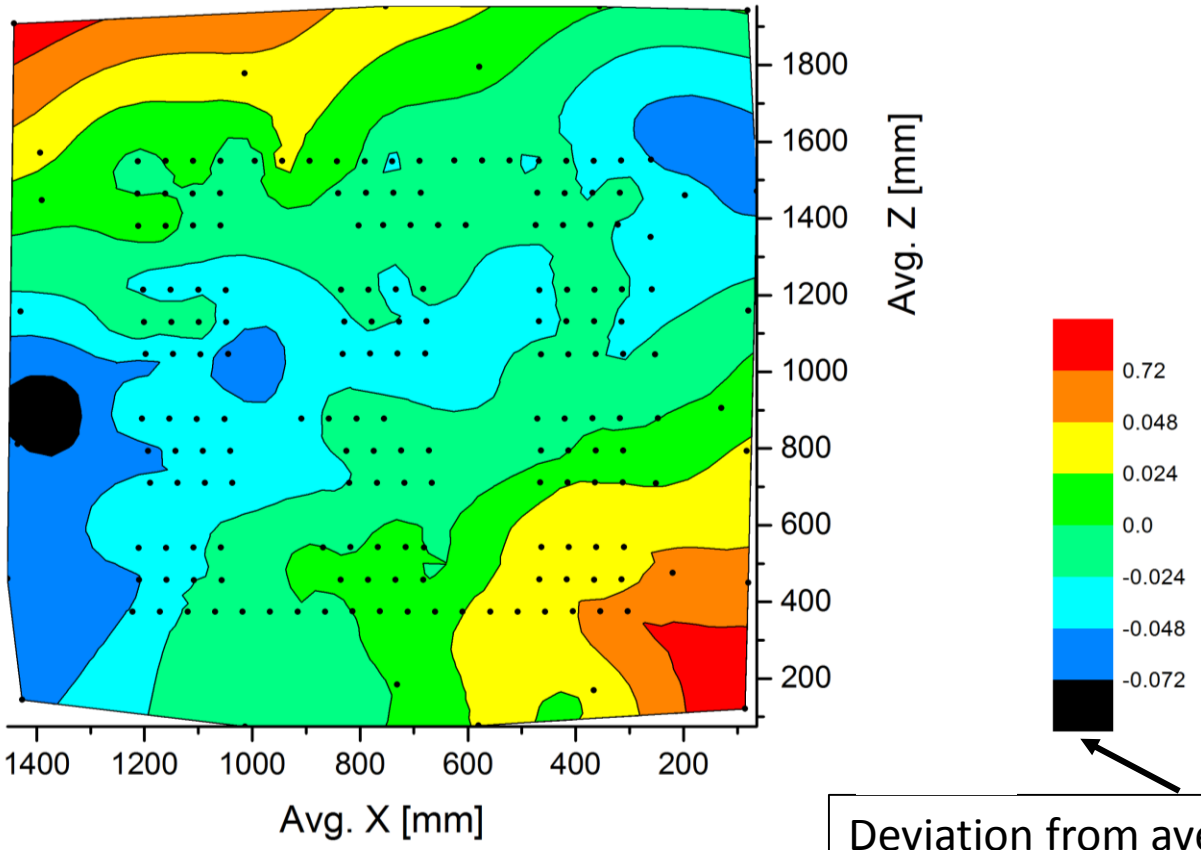
# Checking measurements

- The measured points can be analyzed with V-stars program
- Points can also be exported to check against 3D design
- Check position of field cage relative to reference points



# Initial location

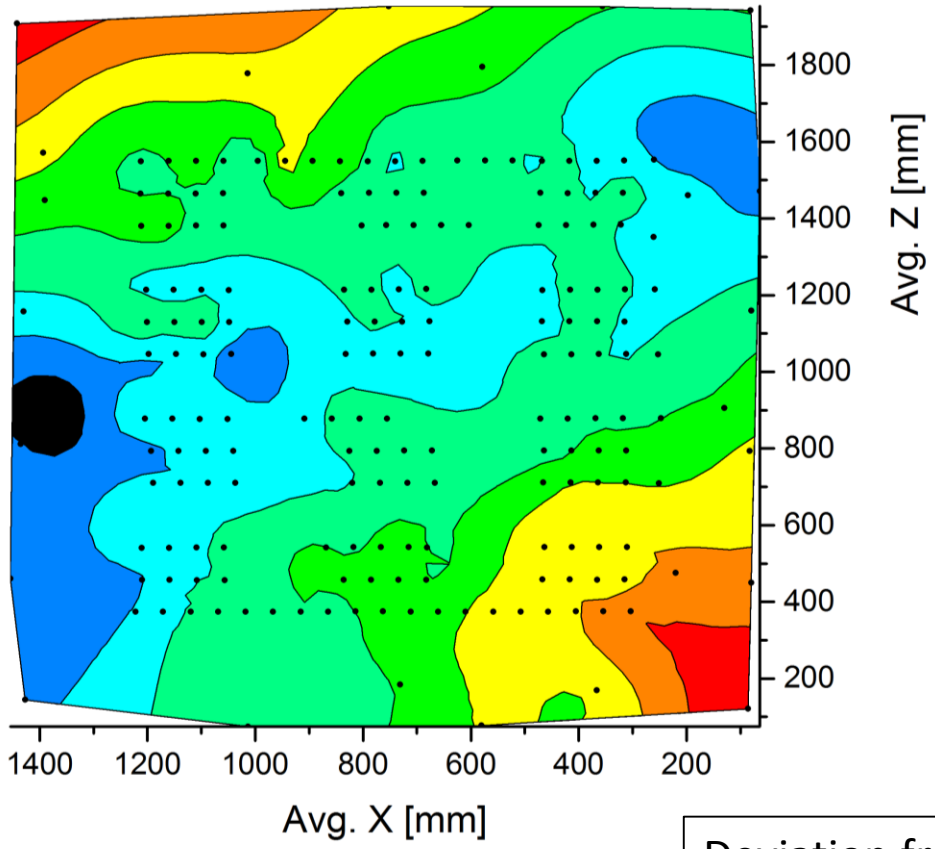
83% within +/-48μm

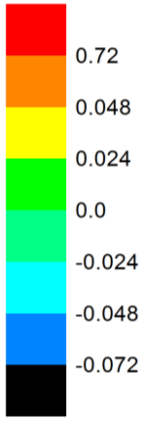



- Baseline measurement to see how flatness changes

# Initial location

83% within +/-48μm

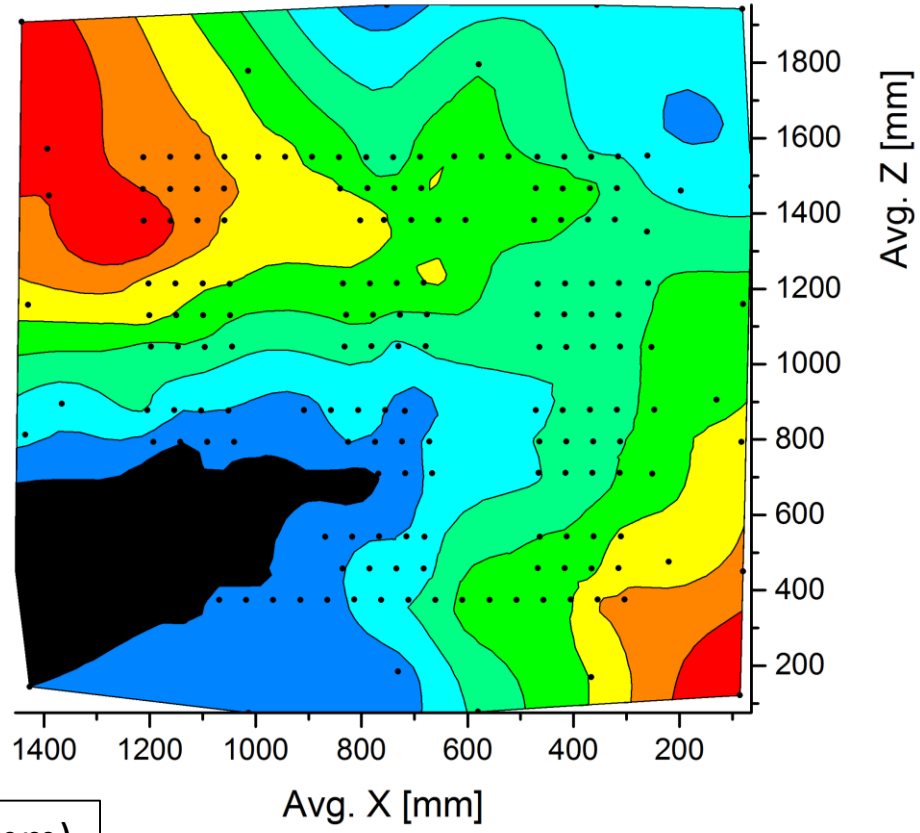



Deviation from average plane (mm)

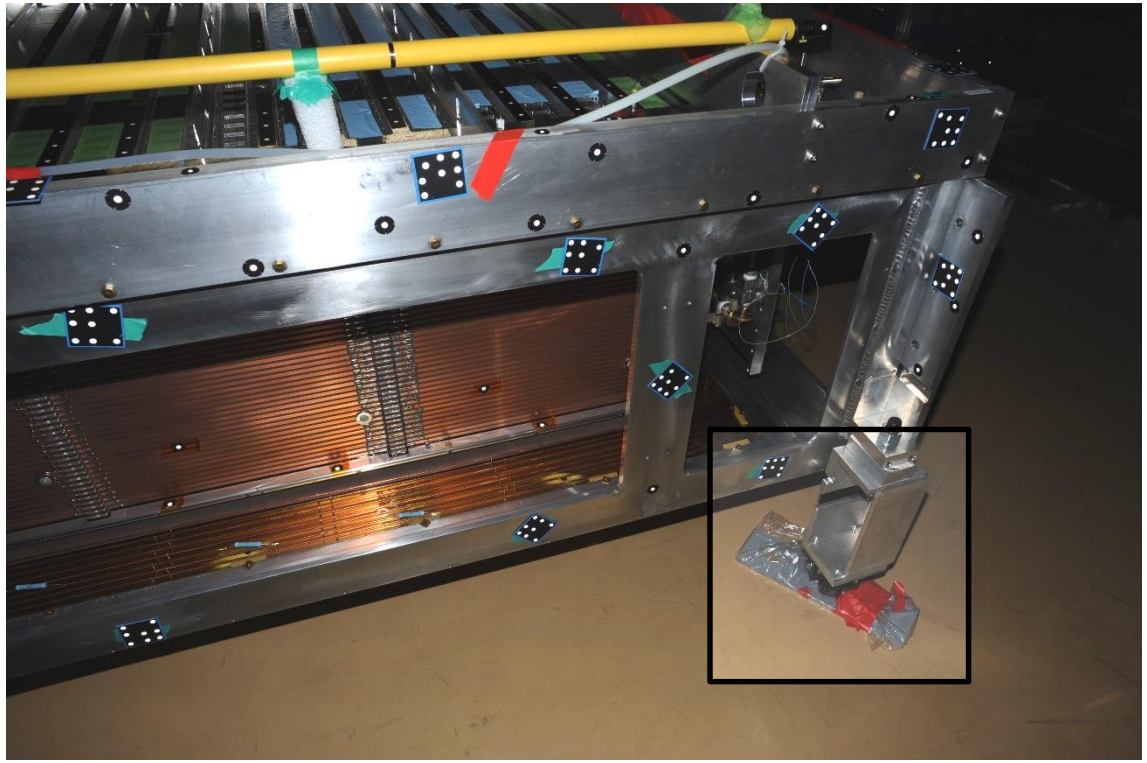
# Moved across floor

~72% within +/-48μm



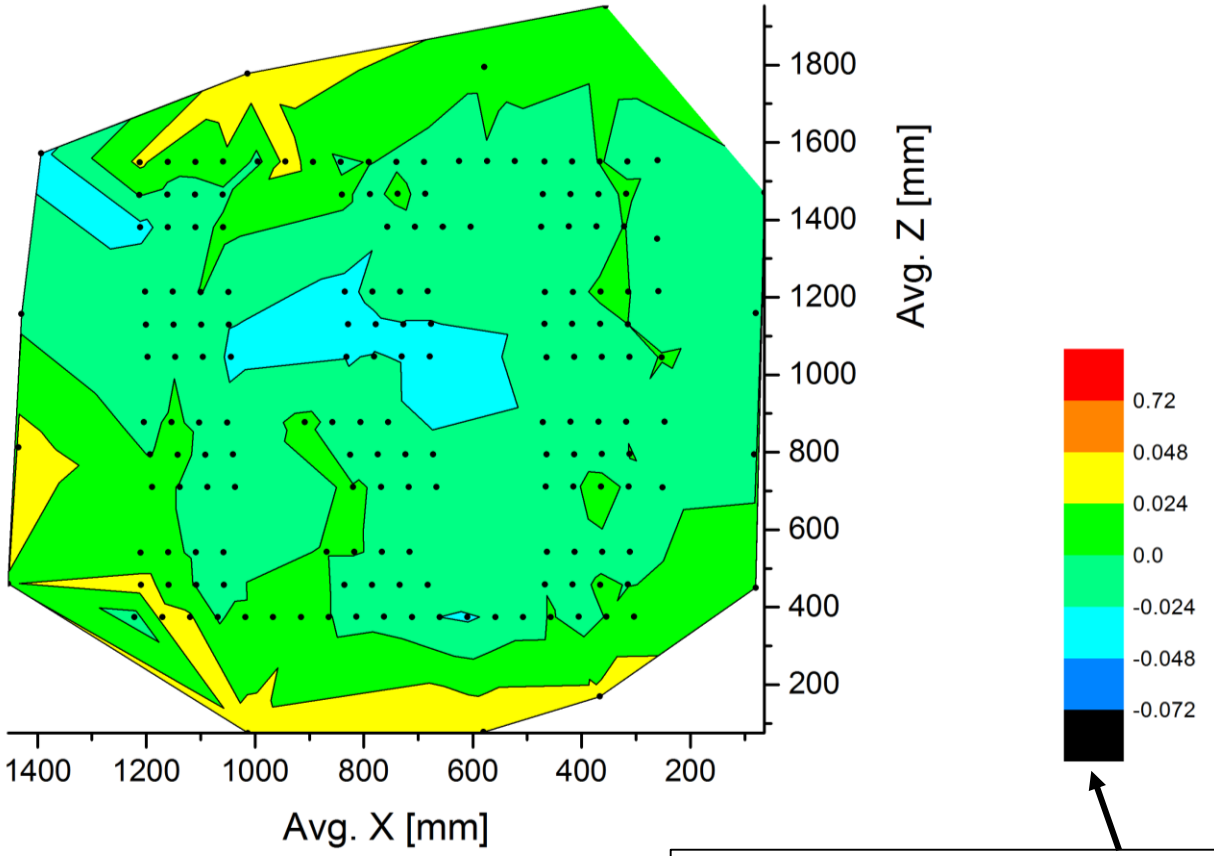
# Changes to TPC on unleveled surface

- Lifted one side to determine if warping occurs
- Also check field cage to determine if position changes



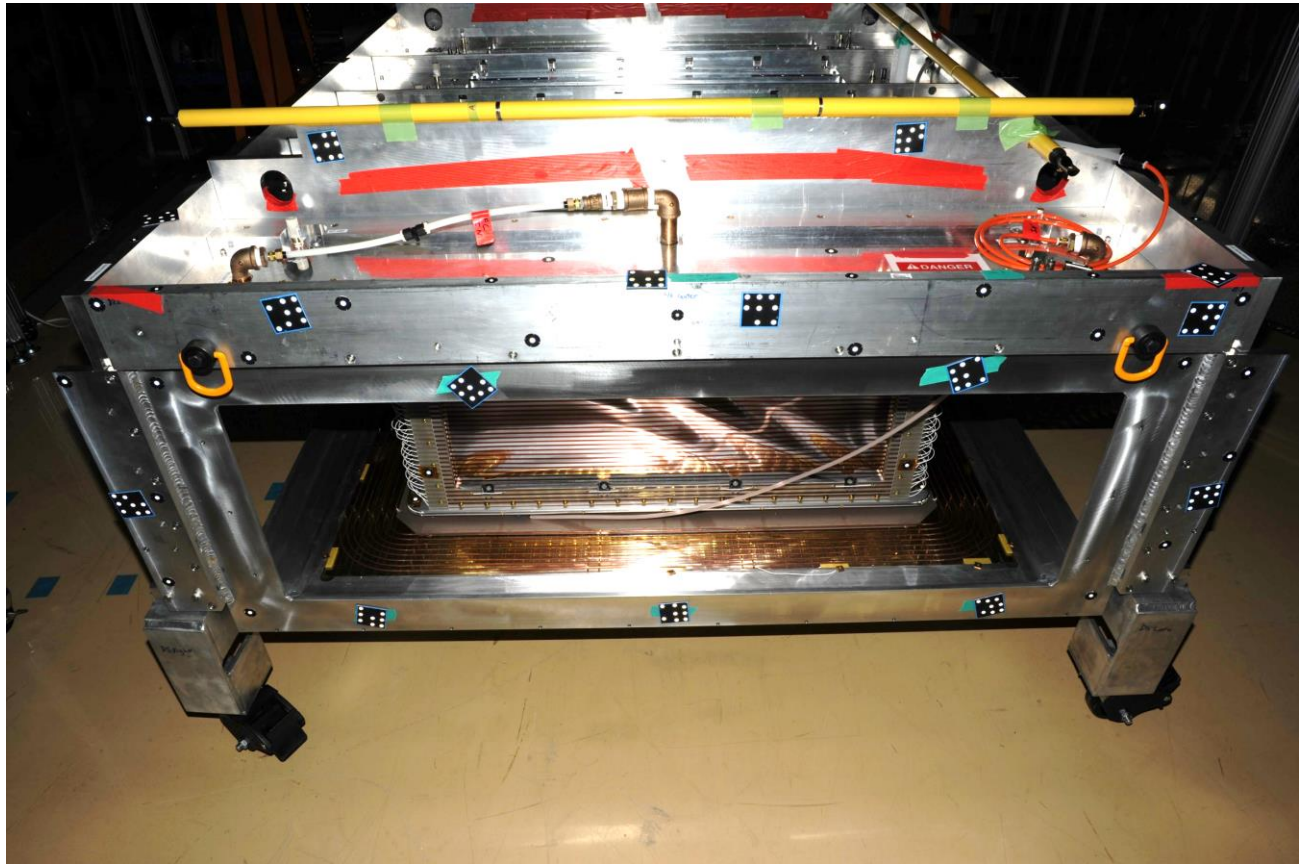
# Lifting up one side of TPC

- Minimal deviation from original measured plane – within 48 μm
- Overall flatness does not change more than +/- 75 μm



# Orientation of field cage

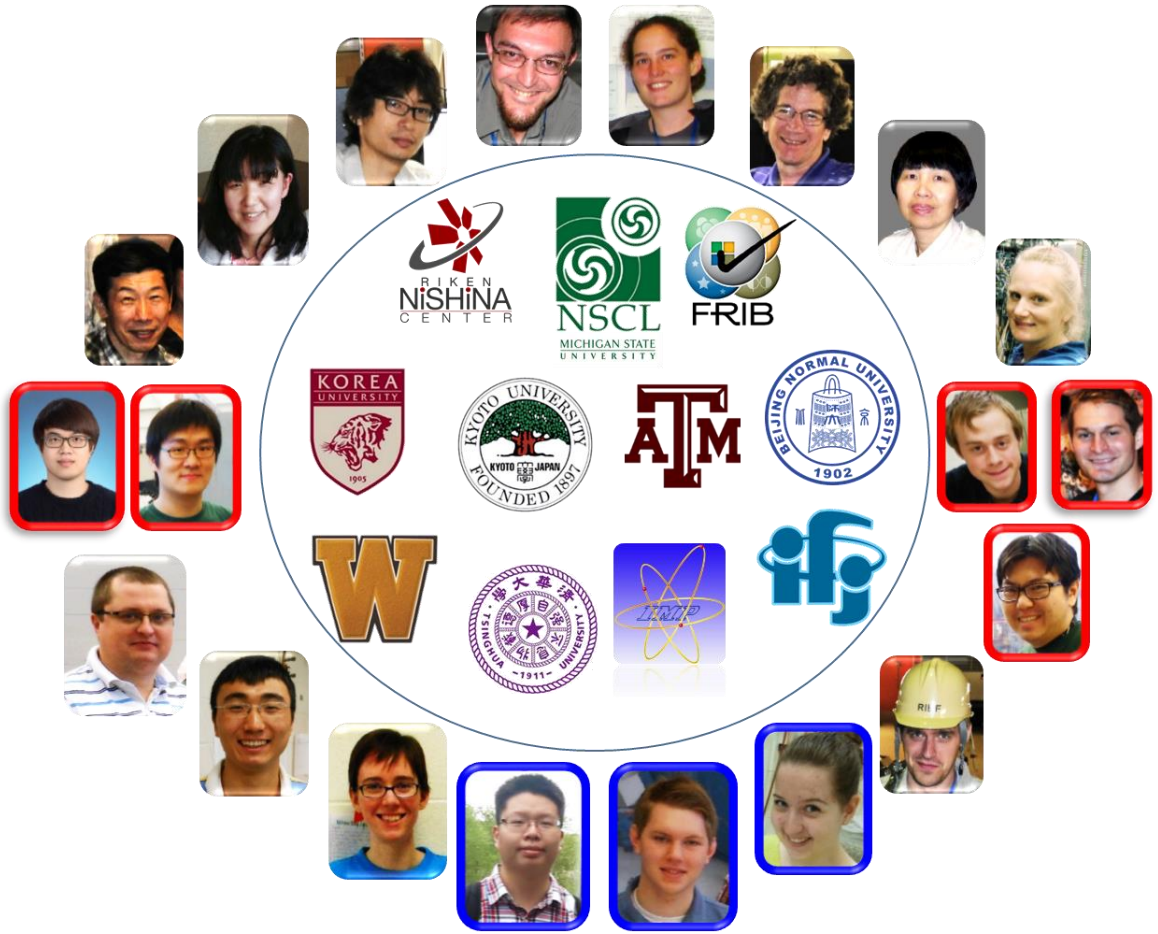
- The exact angle of the field cage determines the electrical field.
- Panels were removed to measure the field cage
- Within 2 miliradians of design value for all measurements
- Provides position of field cage against reference points



# Summary

- SπRIT TPC pad plane is within expected flatness, even when not on a level surface
- Field cage is within 2 miliradians of expected value
- We will be able to position and level detector using photogrammetry

# Thank you!

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