Pavement Evaluation 2010
October 25-27, 2010 ▼ Roanoke, Virginia

PROVAL

# Automated Fault Measurement (AFM) in ProVAL

By
George Chang, Transtec Group
Abdenour Nazef, FLDOT
James Watkins, MSDOT
Steve Karamihas, UMich


WORK ZONES
NEED OUR
UNDIVIDED
ATTENTION.
TAKE CARE OUT THERE. OVER 700 PEOPLE WERE
KILLED IN WORK ZONE CRASHES LAST YEAR.

# Acknowledgement


- FHWA
  - Bob Orthmeyer
- MSDOT
  - James Watkins, Cindy Smith, Grady Aultman, Alan Hatch, Alex Middleton, and Marta Charria
- FLDOT
  - Abdenour Nazef, Alex Mraz, and etc.
- U Michigan
  - Steve Karamihas

# What is ProVAL AFM

- **Automated Fault Measurement based on profile data**
- **FHWA HPMS requires joint fault data**
- **Implement revised AASHTO R36 "Standard Practice for Evaluating Faulting of Concrete Pavements"**

# Challenges for AFM - Pavements

- Filled joints
- Closed joints
- Spalled joints
- Curl/warp features
- Cracks and other distresses/patches
- Joint spacing patterns
- Skewed joints
- Grade

Courtesy of MSDOT

# Challenges for AFM - Profiles

- Repeatability/accuracy
- Fault validation tests with physical devices
- Sampling intervals
- Repeated profile runs
- DMI drifts

# Revised AASHTO R36-04

- Grade Adjustment (physical devices)
- Automated procedure (profiles)
- Validation devices (automated procedure)

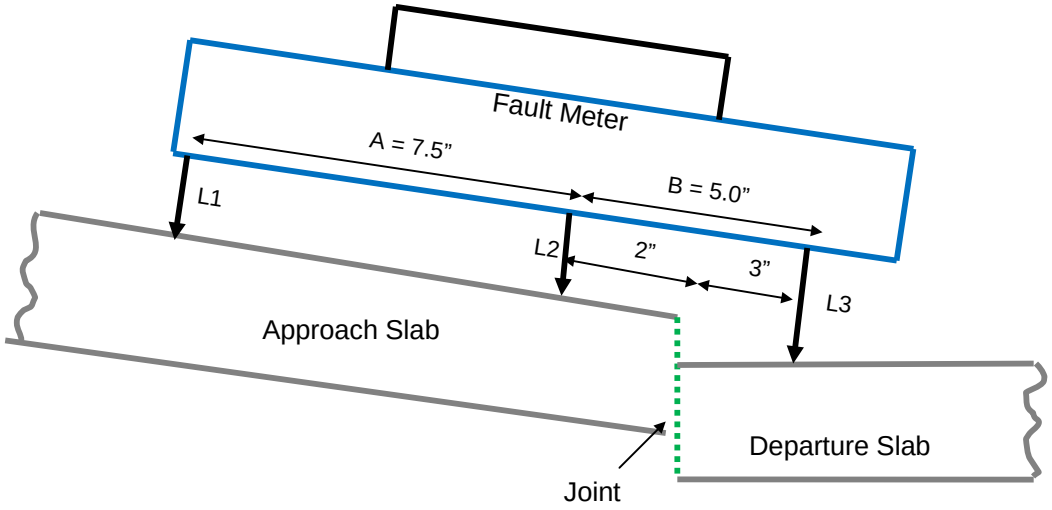
# Physical Fault Devices

## Georgia Fault Meter

Courtesy of FLDOT

# Adjustment for Grades

$$F = (L2 - L3) + (L2 - L3) \times \frac{B}{A}$$




Courtesy of MSDOT

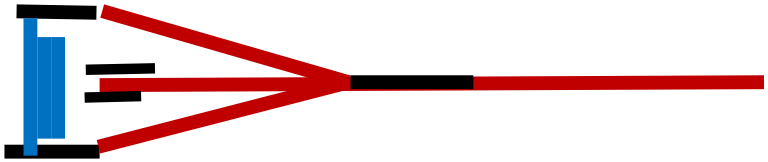
# Profile Requirements

- Repeatability and Accuracy requirements (AASHTO PP49)
- Fault validation with physical devices
- No additional pre-filtering
- Collect profiles at both wheel tracks
- Max sampling intervals
  - Basic level: 1.5” (38 mm)
  - Advanced level: 0.75” (19 mm)

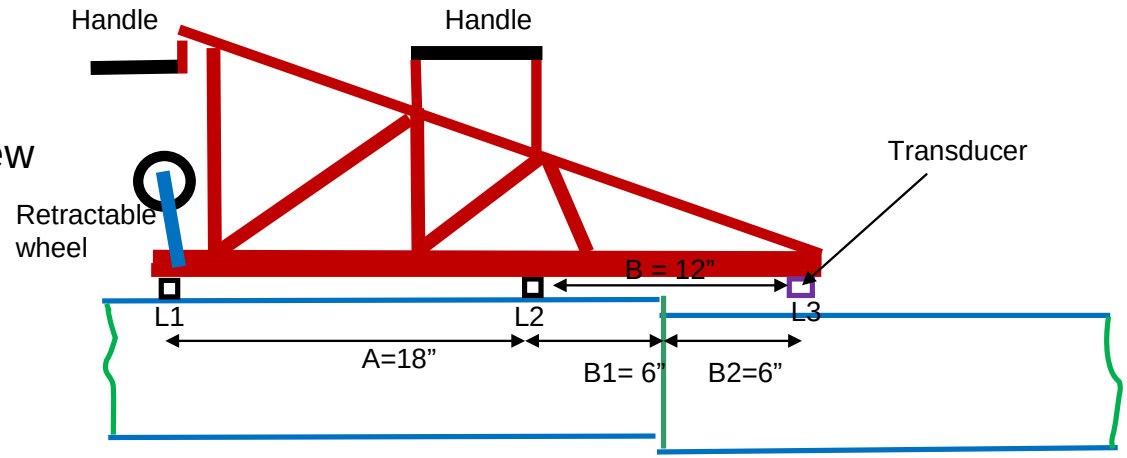
# Candidate Field Validation Devices

## MS DOT

Top View

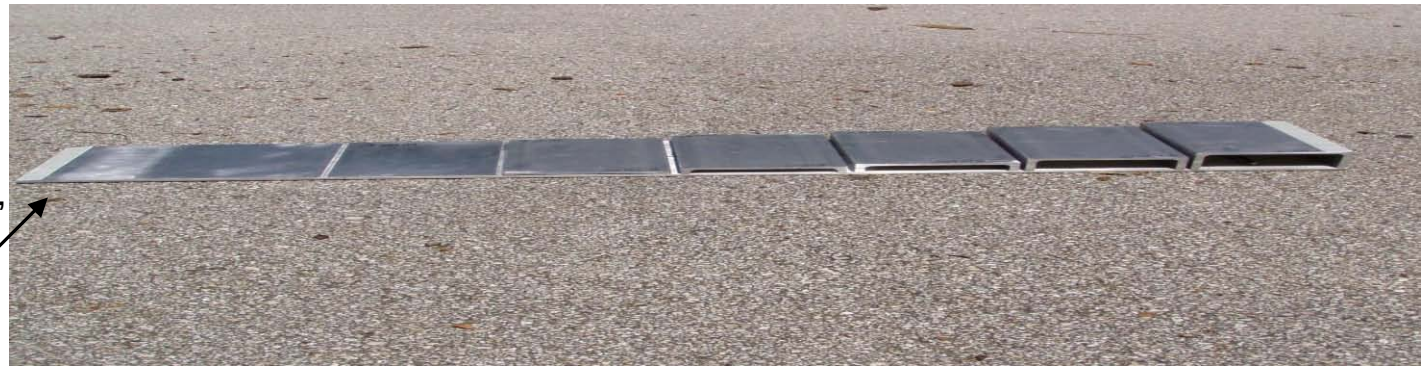


Side View



# Candidate Field Validation Devices

## FL DOT

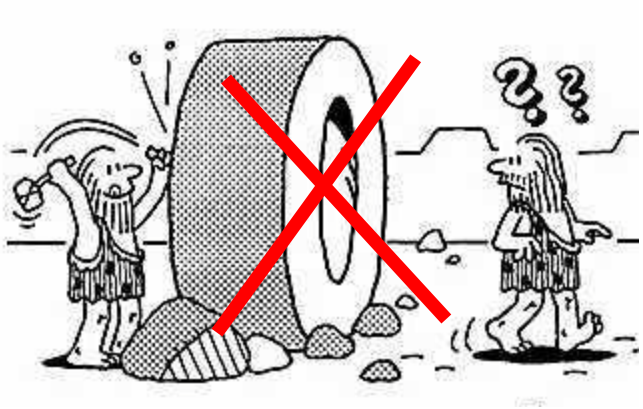


# ProVAL AFM

- Multiple profiles
- Joint locations ID
- Edit joint locations
- Compute faults
- Individual faults and segment summary

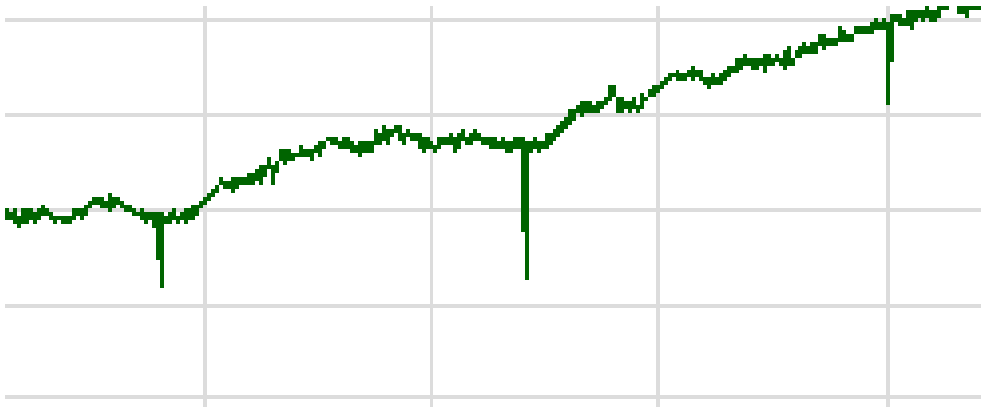
# Joint ID Methods

- **Downward Spike (SMK, FLDOT)**
- **Step (MSDOT)**
- **Curled-Edge**



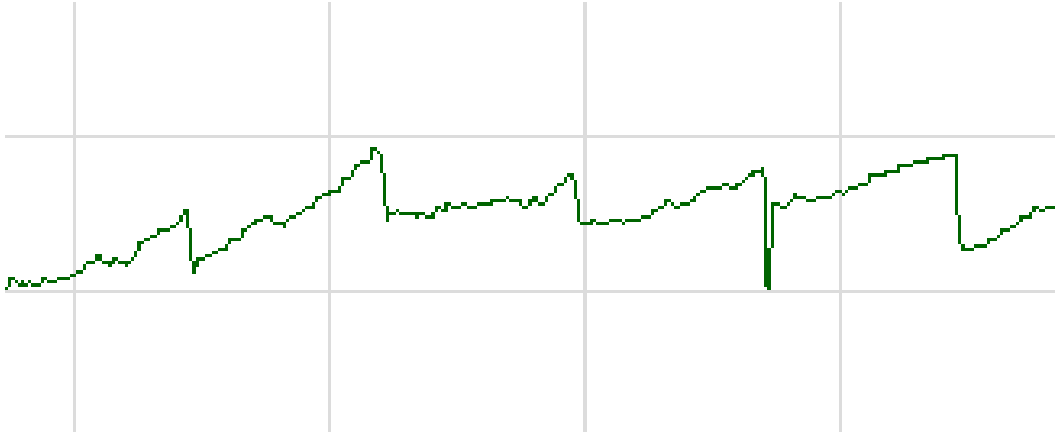
# Downward Spike Detection

- Anti-smoothing filtering
- Normalize the filtered profile (/RMS)
- Detect profile spikes (-4.0)
- Screen joint locations



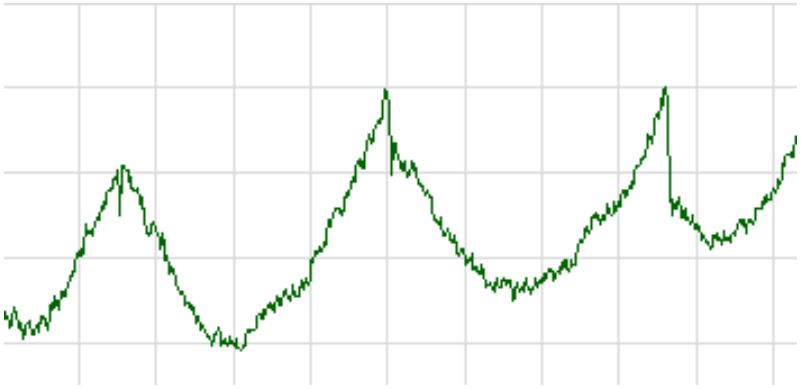
# Step Detection

- Deduct profile elevations between consecutive data points
- Detect large step (0.08 in.)
- Screen joint locations



# Curled-Edge Detection

- Bandpass filtering
- Rolling straightedge simulation
- Detect high RSE (0.12”)
- Screen joint locations

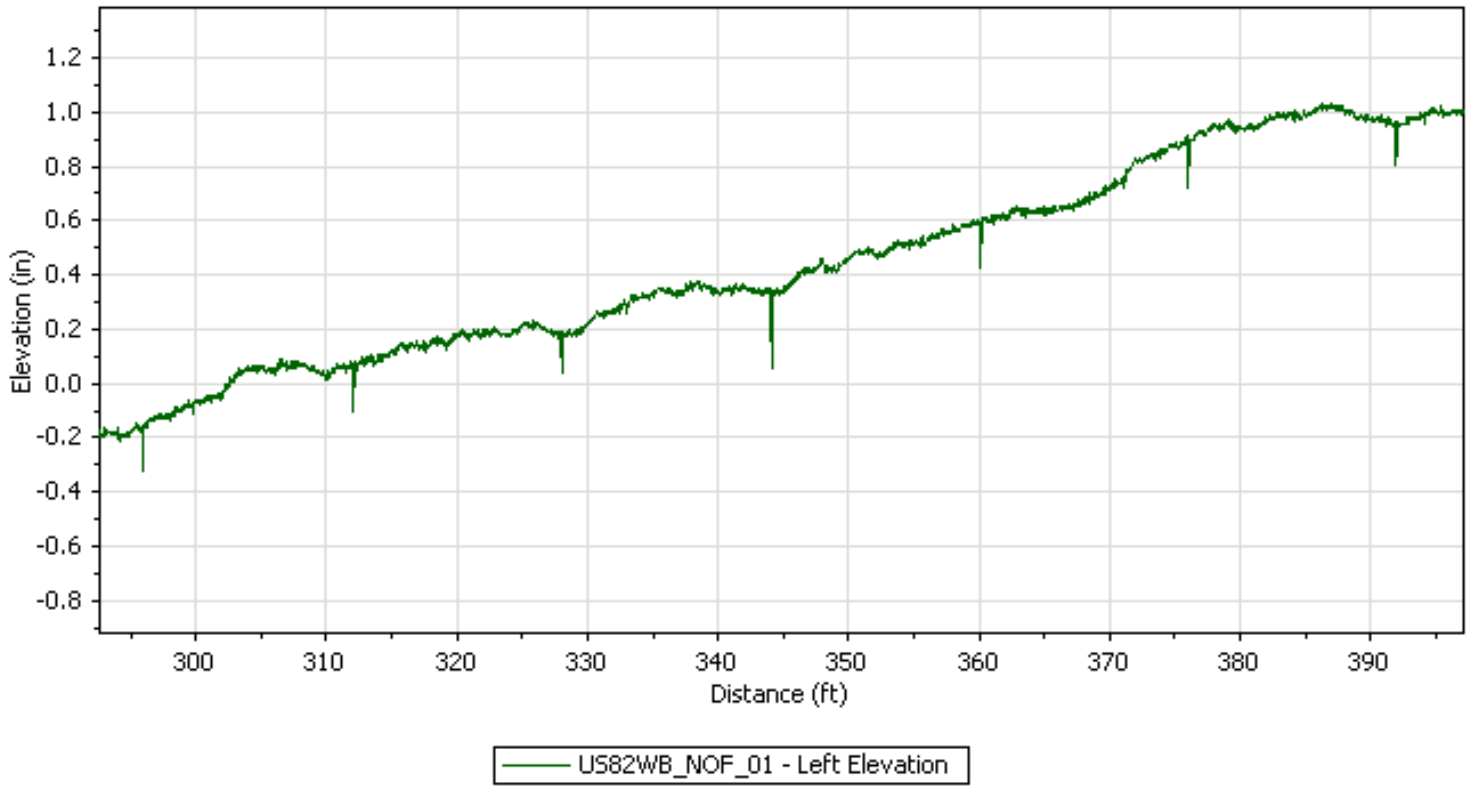


# Joint ID Methods Selection

- **Downward Spike Detection**
  - Shorter sampling intervals
  - Downward spikes present
- **Step Detection**
  - Apparent faults present
- **Curled-Edge Detection**
  - Noticeable slab curling and warping

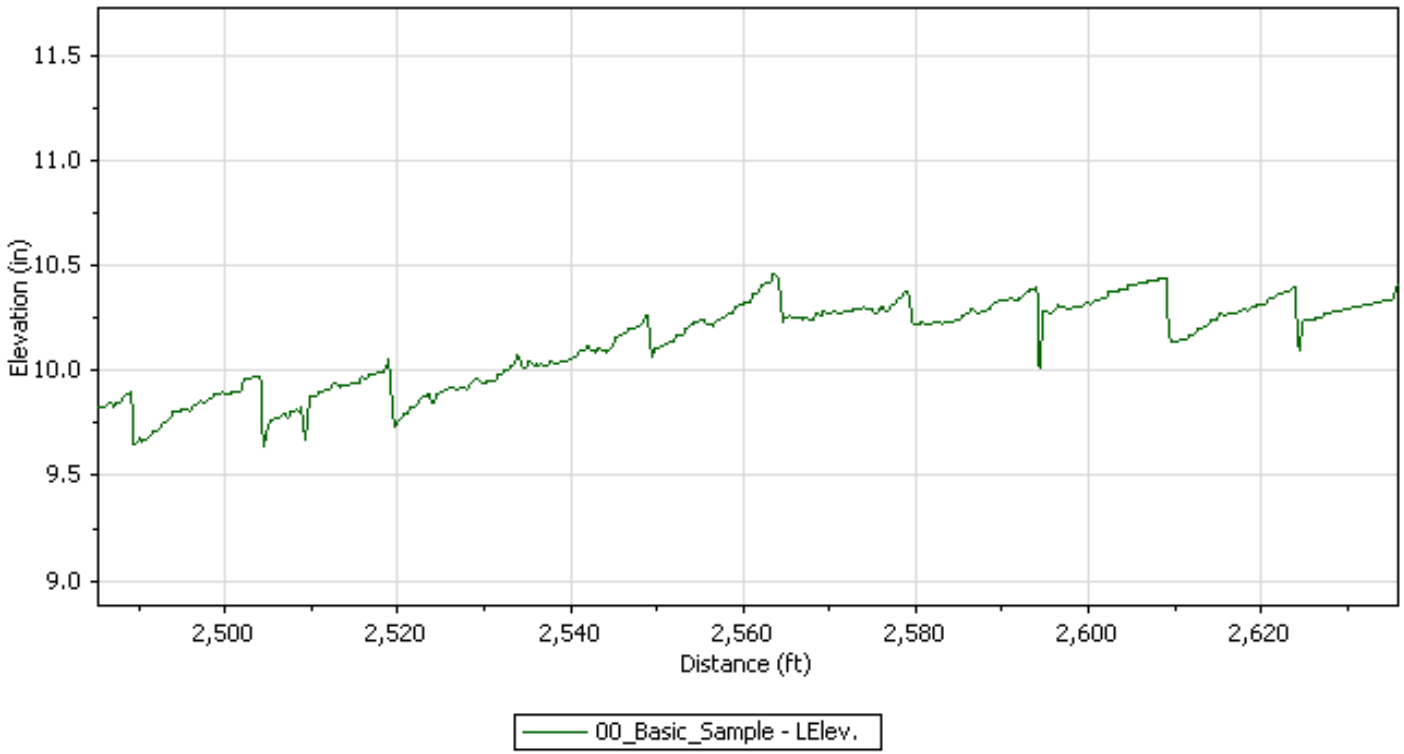
# Joint ID Methods Selection

- **Downward Spike**



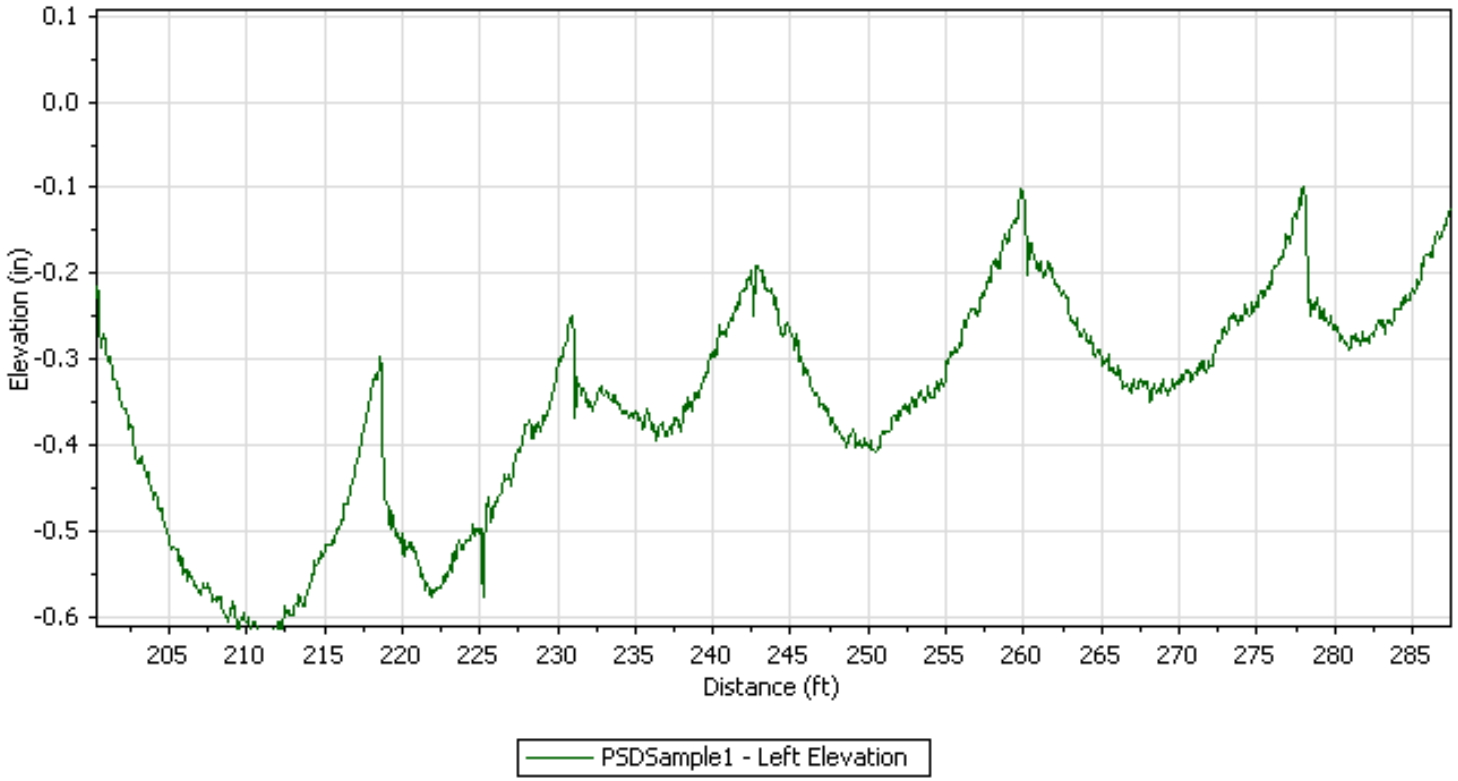
# Joint ID Methods Selection

- **Step**



# Joint ID Methods Selection

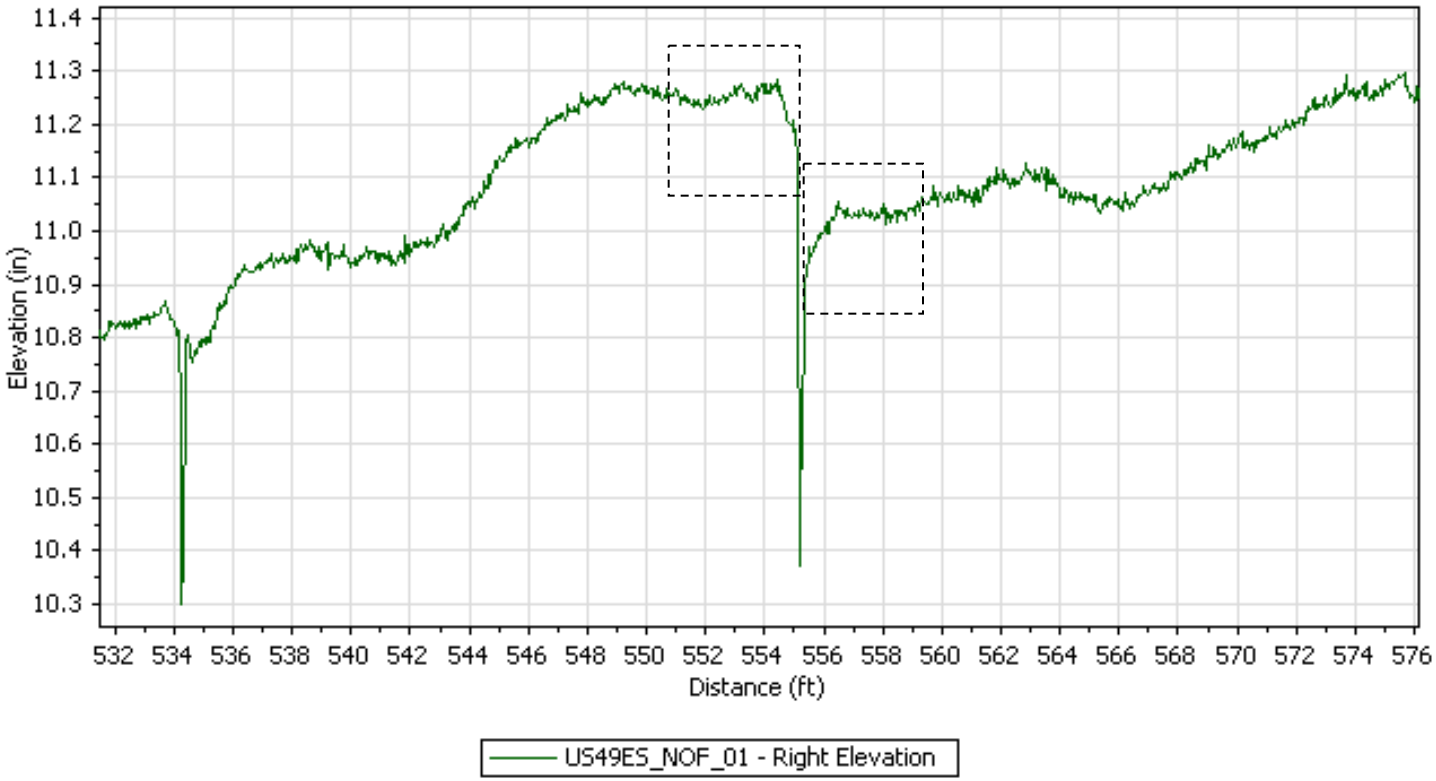
- **Curled-Edge**



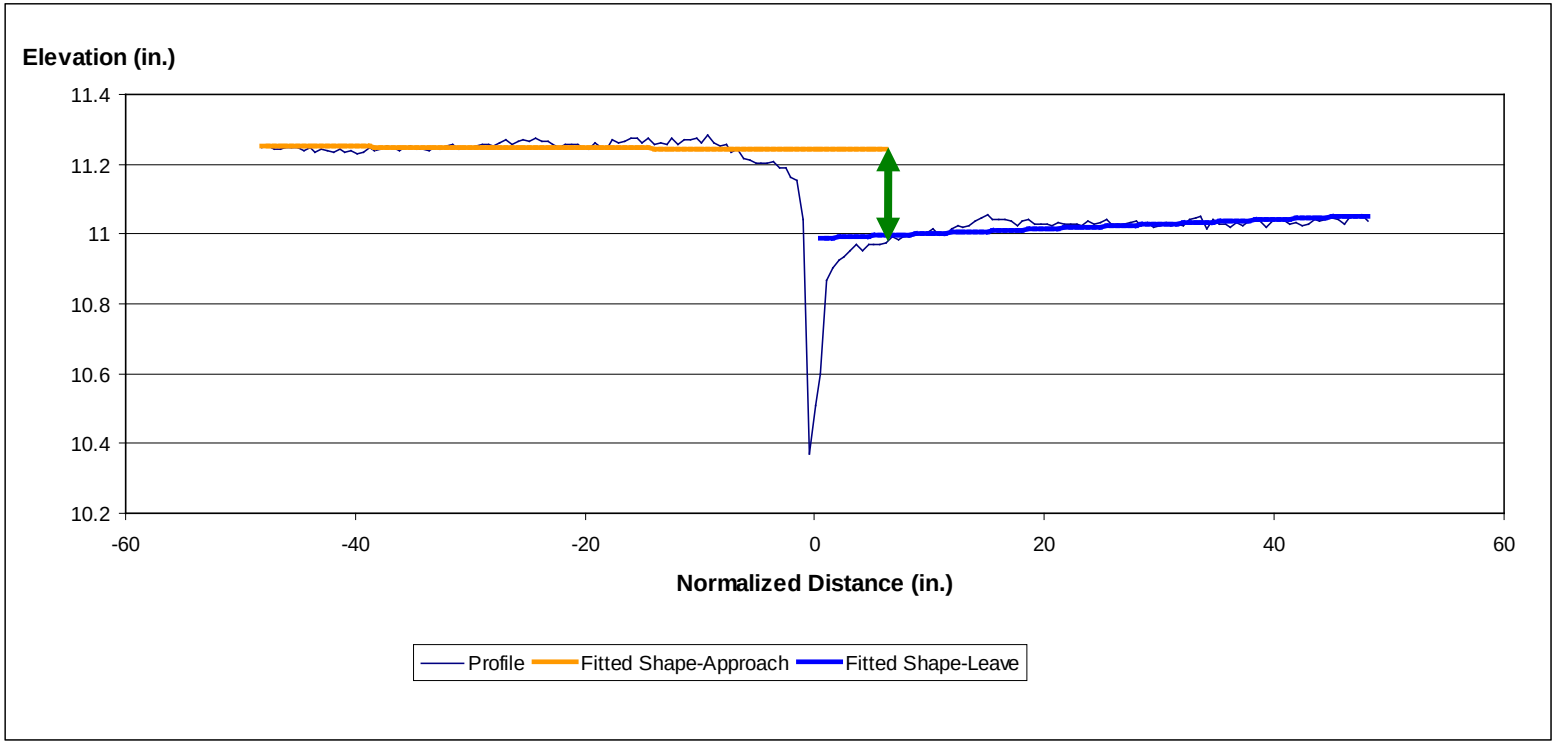
# Fault Computation

- Crop a profile segment
- Separate profile slices
- Least-square fits
- Compute faults

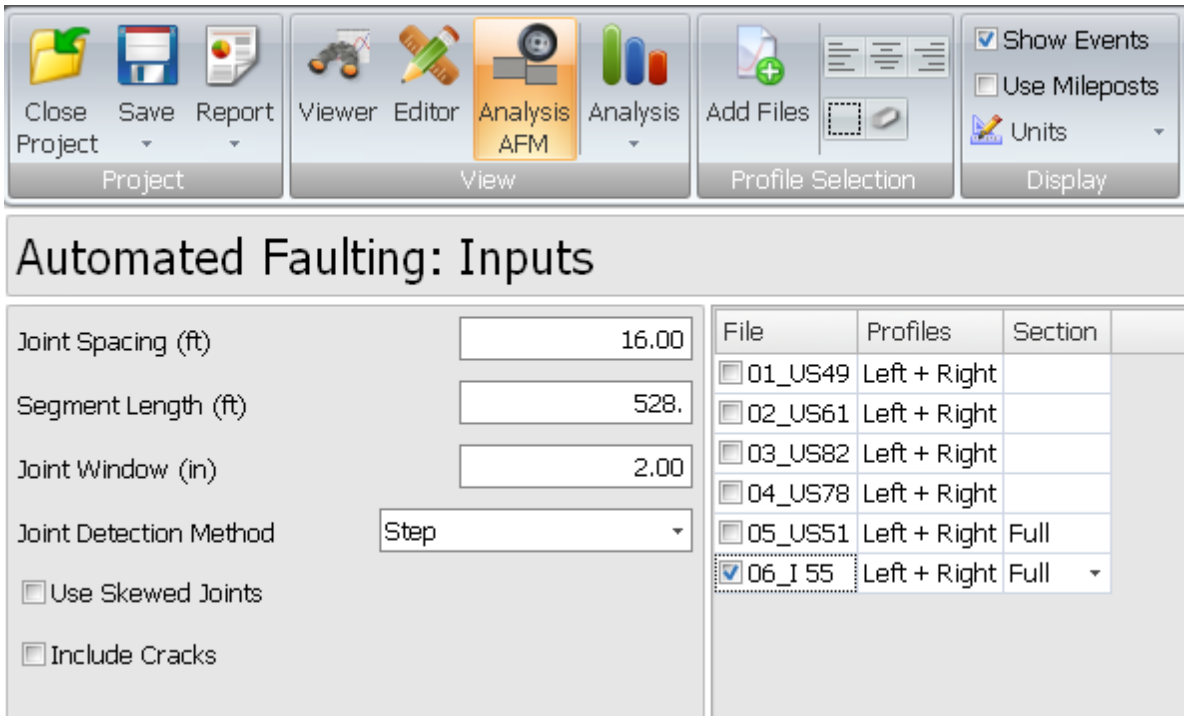
# Profile Slices



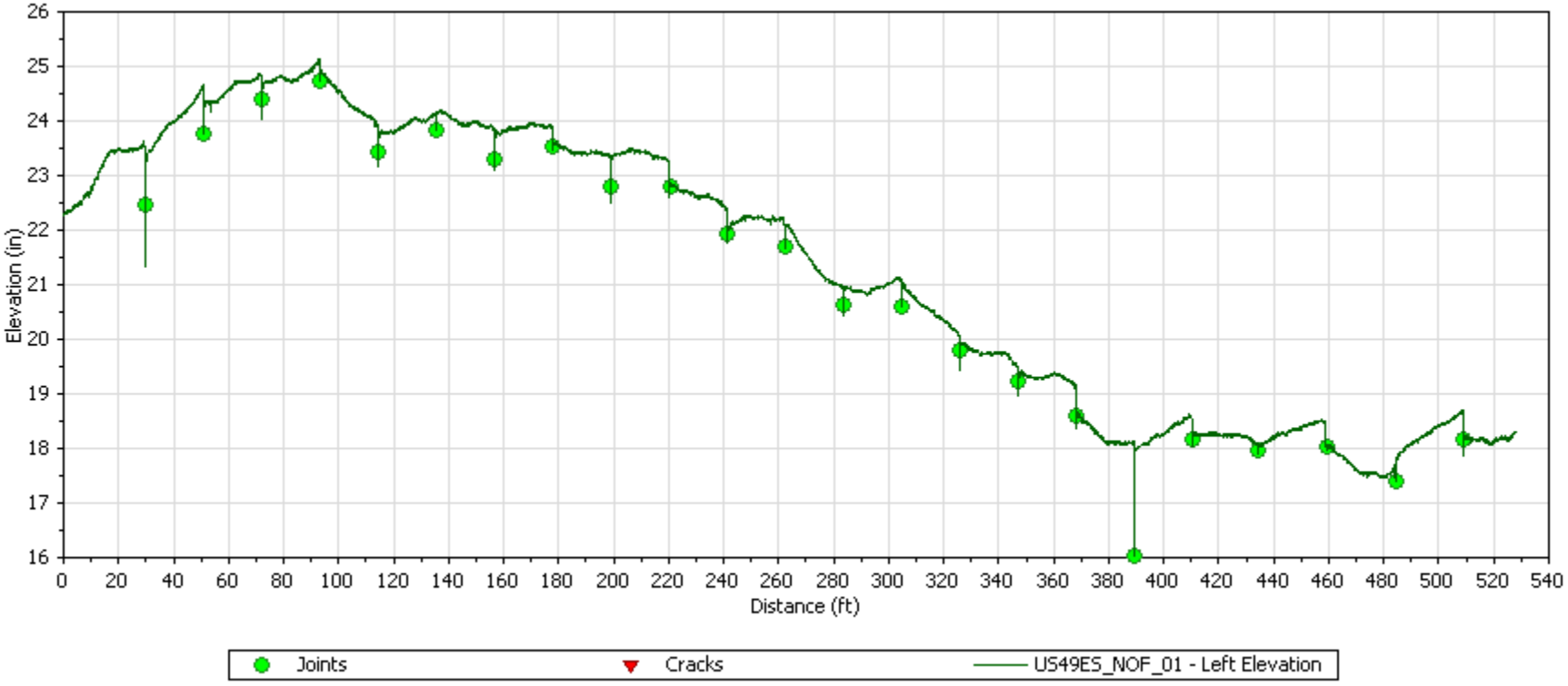
# Fault Computation



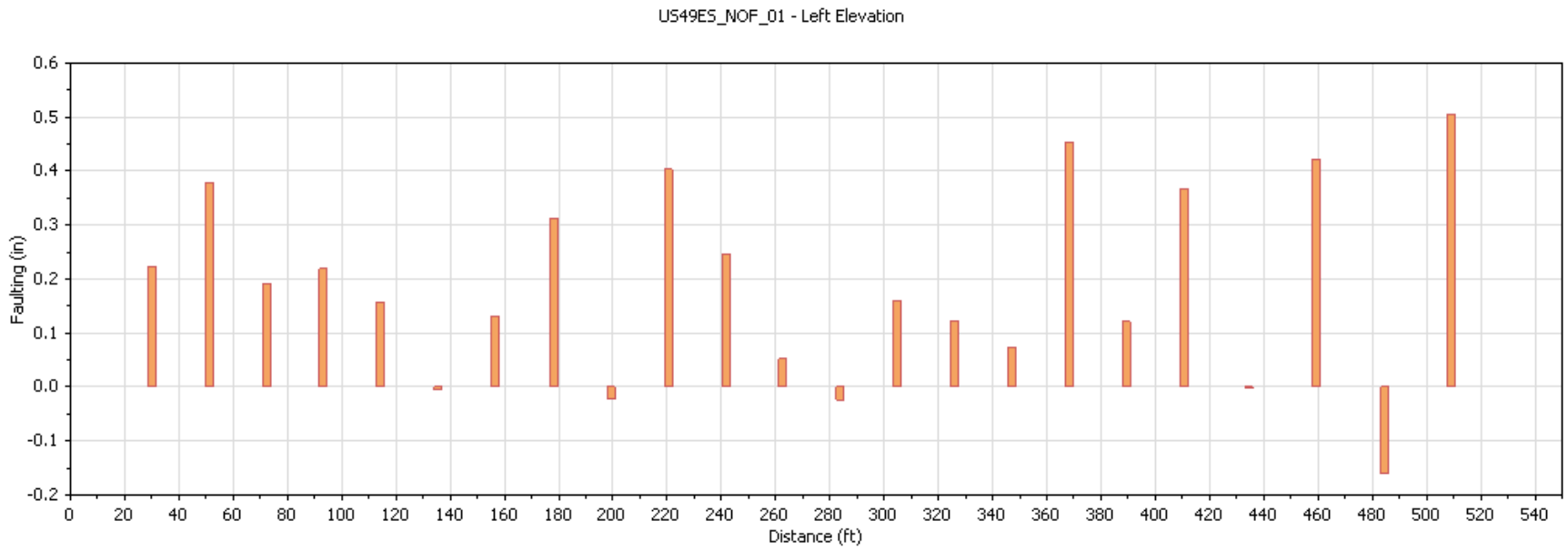
# ProVAL AFM Inputs



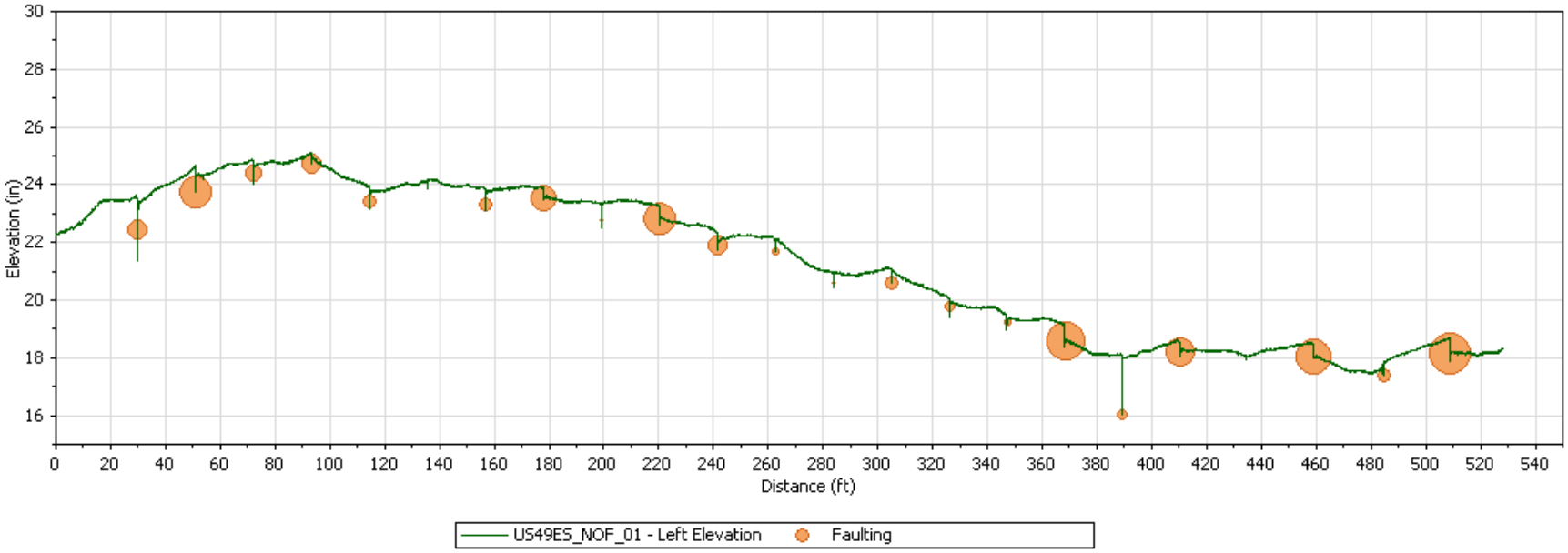
# ProVAL AFM Joint ID



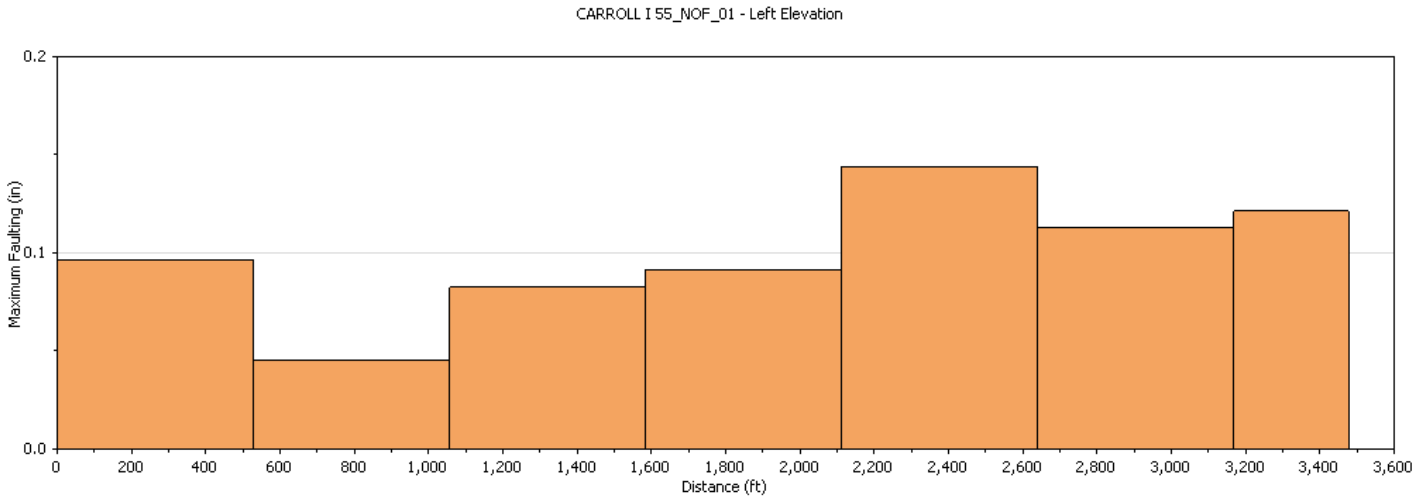
# ProVAL AFM Joint Faults

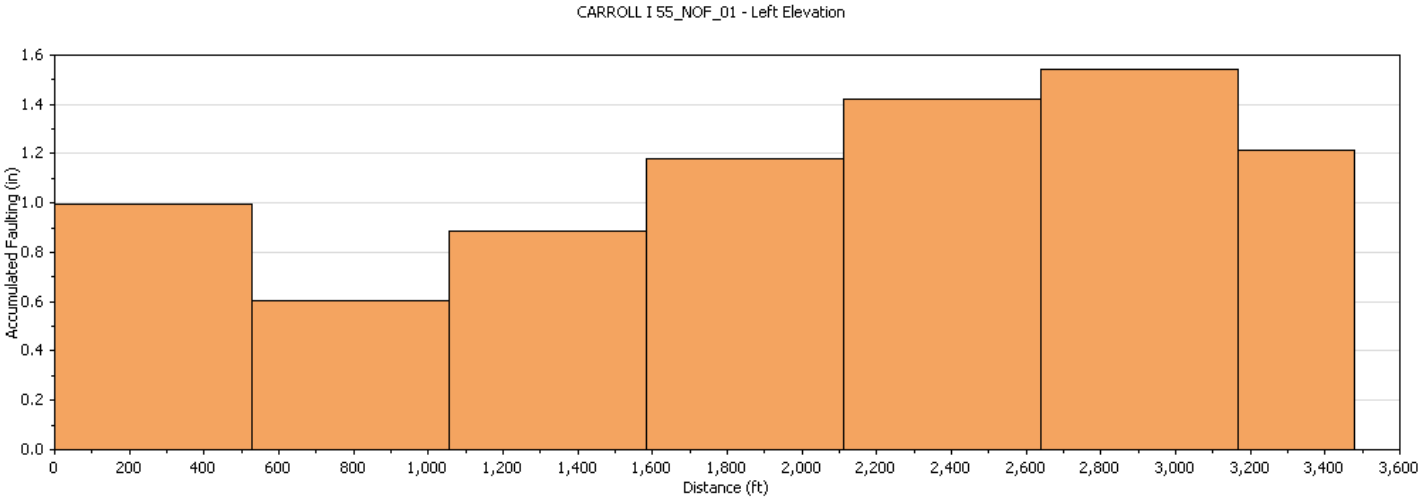


# ProVAL AFM Joint Faults



# ProVAL AFM Joint Faults Summary



# Save Lives with ProVAL AFM