

# **Height Modernization Data Processing**

**CSRC Semi-annual Meeting  
San Francisco, May 14, 2004**

**([ftp.geodeticsolutions.com/pub/download/csrc/present.ppt](ftp://geodeticsolutions.com/pub/download/csrc/present.ppt))**

# **Data processing guidelines**

- ? Accuracy**
- ? Consistency with CSRS procedures (“ Implementation of the CSRS”)**
- ? Archiving of projects with NGS and CSRC databases**

## **Topics**

- ? Velocity models**
- ? Differential leveling**
- ? GPS polyhedra**
- ? Constraints, regional and global IGS solutions**
- ? Case studies**
- ? Contractor procedures**

## **Summary of Tuolumne County results**

- ? GPS and Bench Mark Leveling Ties**
- ? Submillimeter agreement horizontally**
- ? Agreement in adjusted ortho heights less than 2 mm**
- ? Order B accuracy, 2-cm height mod standards**
- ? Published data sheets**
- ? Geoid model data processing**

# **Update on South San Francisco Bay project**

- ? Blue-booking the GPS component**
- ? Blue-booking the leveling**
- ? Implement the data stream to the XML Campaign**
- ? Prepare a Case Study for the CSRS Document**
  - Contractor requirements for GPS campaigns**
  - Inflated standard error of unit weight**

**✍ Constraints**

**✍ Relaxed constraints and IGS solutions**

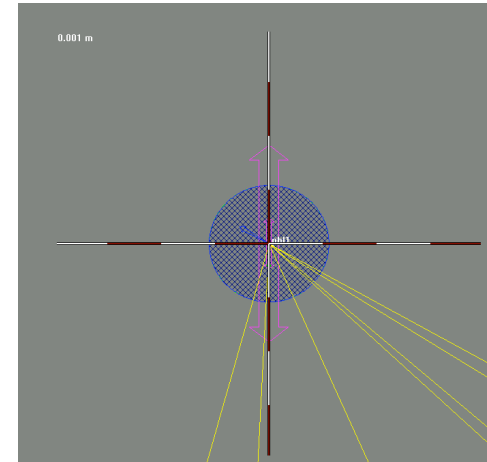
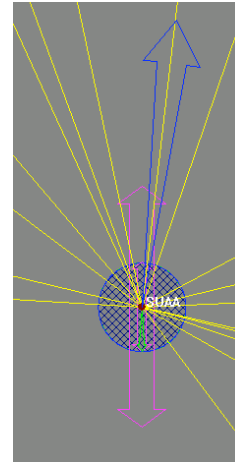
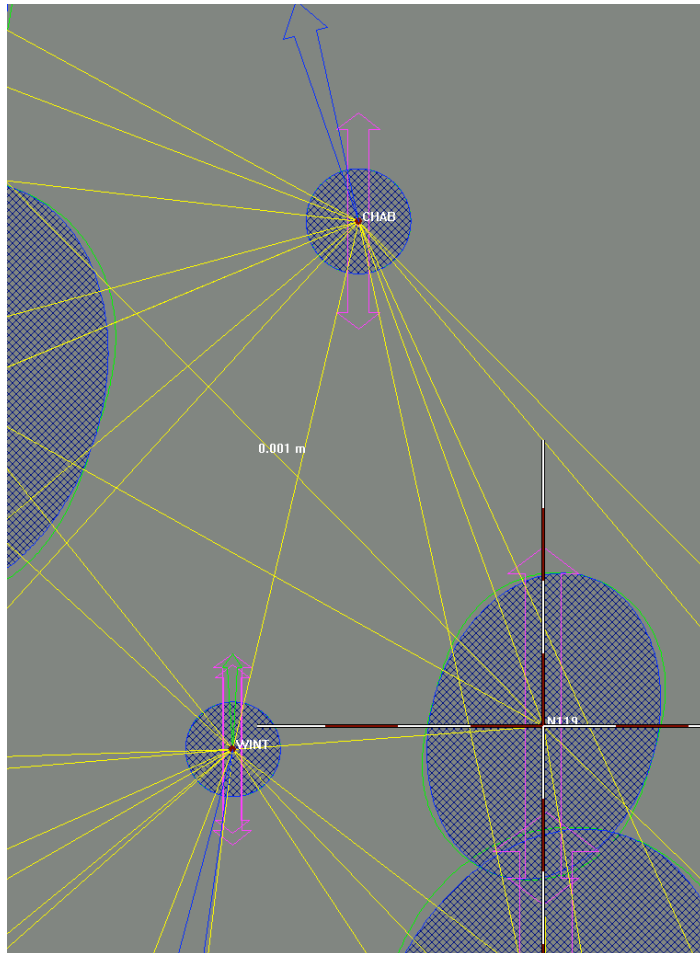
**✍ Observations**

**✍ Evaluating multi -baseline GPS solutions for Height Mod**

## **GPS Contractor Requirements (for CSRS document)**

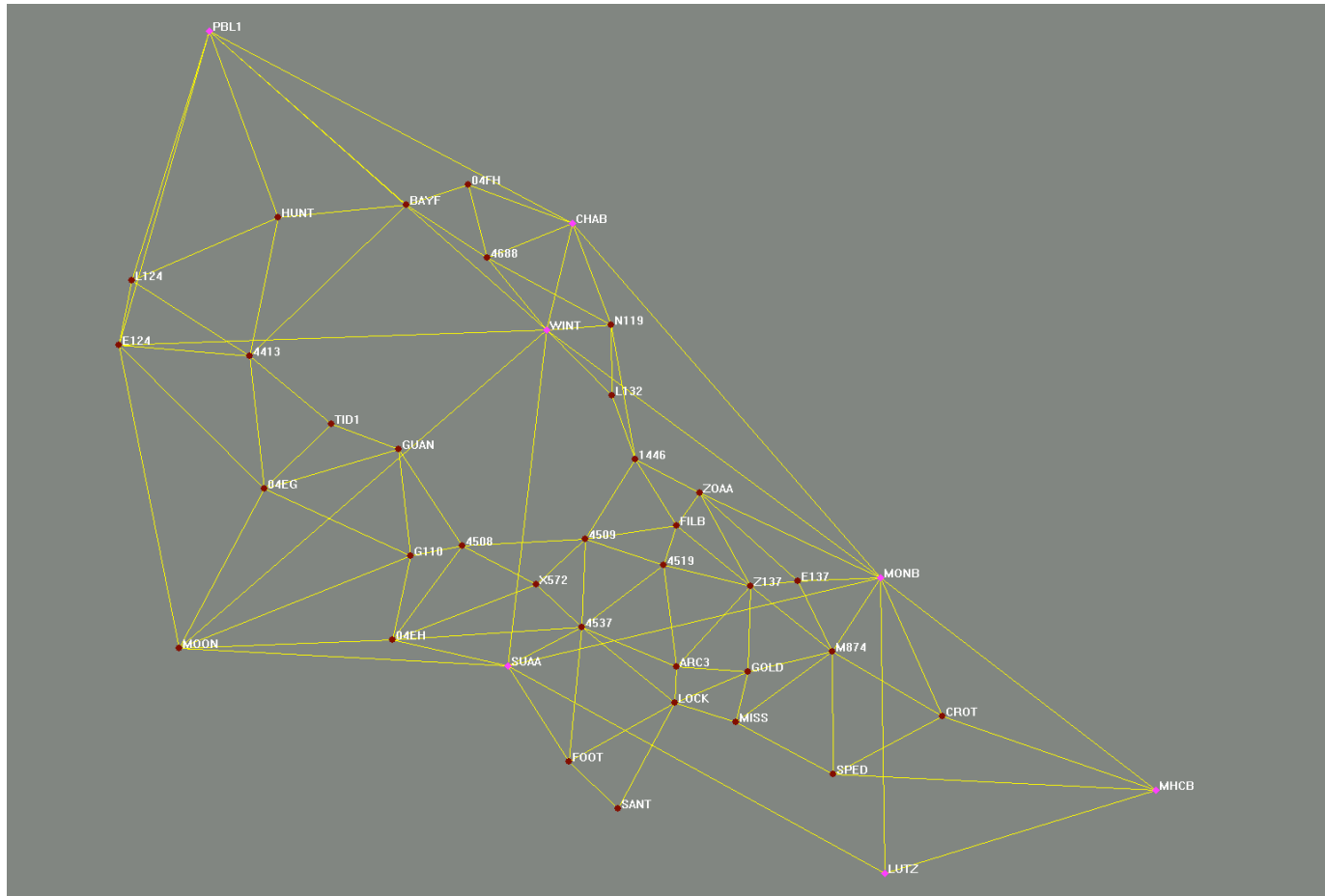
- ? Record times in UTC, not local**
- ? Upload equipment identifiers into the data collector or receiver**
- ? Baseline processing seed coordinates in current I TRF2000 (SECTOR)**
- ? Measure antenna heights to ARP**
- ? Use NGS antenna models**
- ? Consistency with station names, avoid duplicating IGS names on local stations**

# Relaxed constraints and IGS solutions

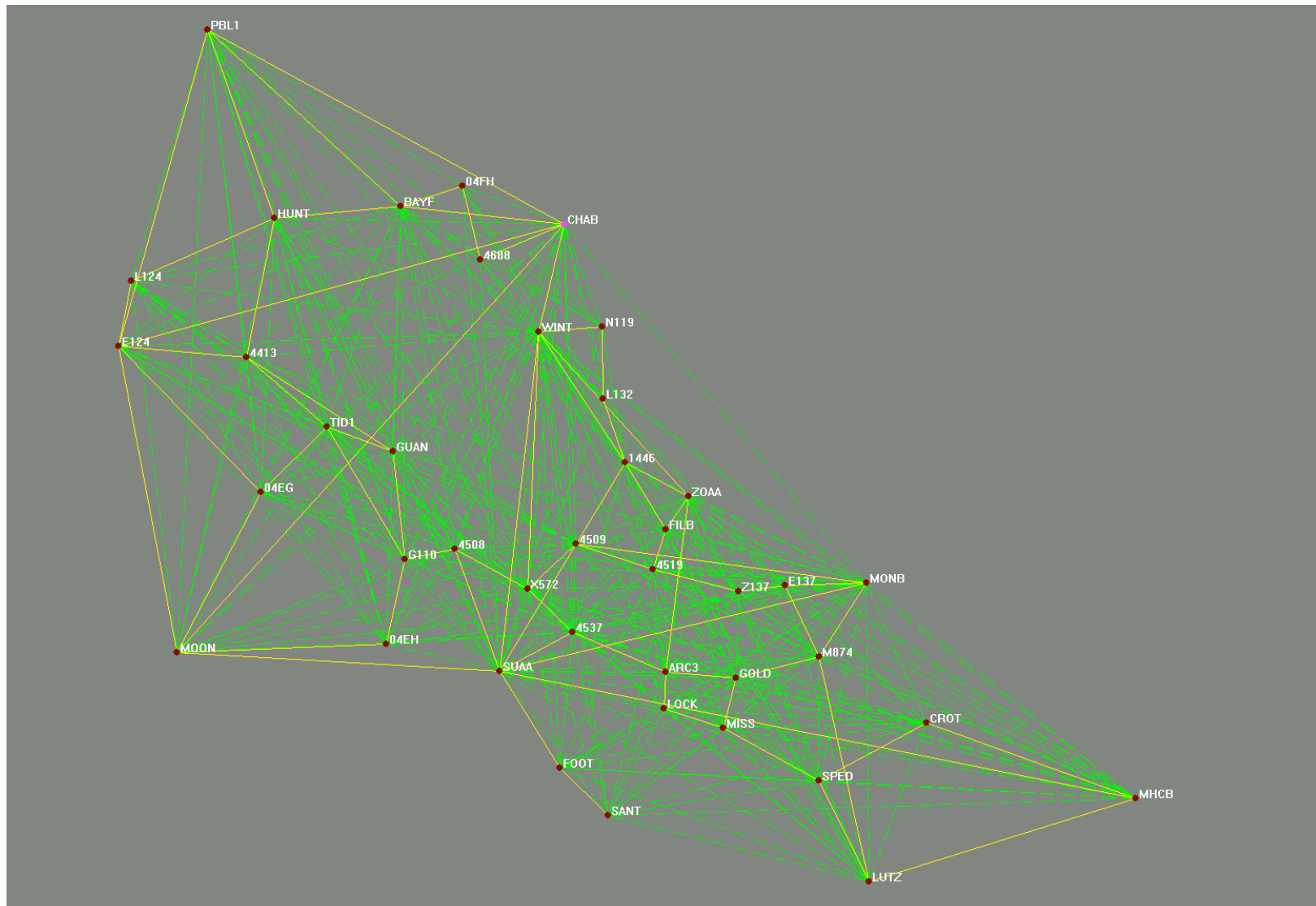


Coordinate shifts that exceed the formal errors on the constraints are candidates for exclusion from the final, fully-constrained network adjustment

## Networks constructed from single-baseline and multi-baseline GPS solutions



The blue-booked (WAVE single-baseline) GPS NETWORK



SSFB network produced by multi-baseline GPS processing



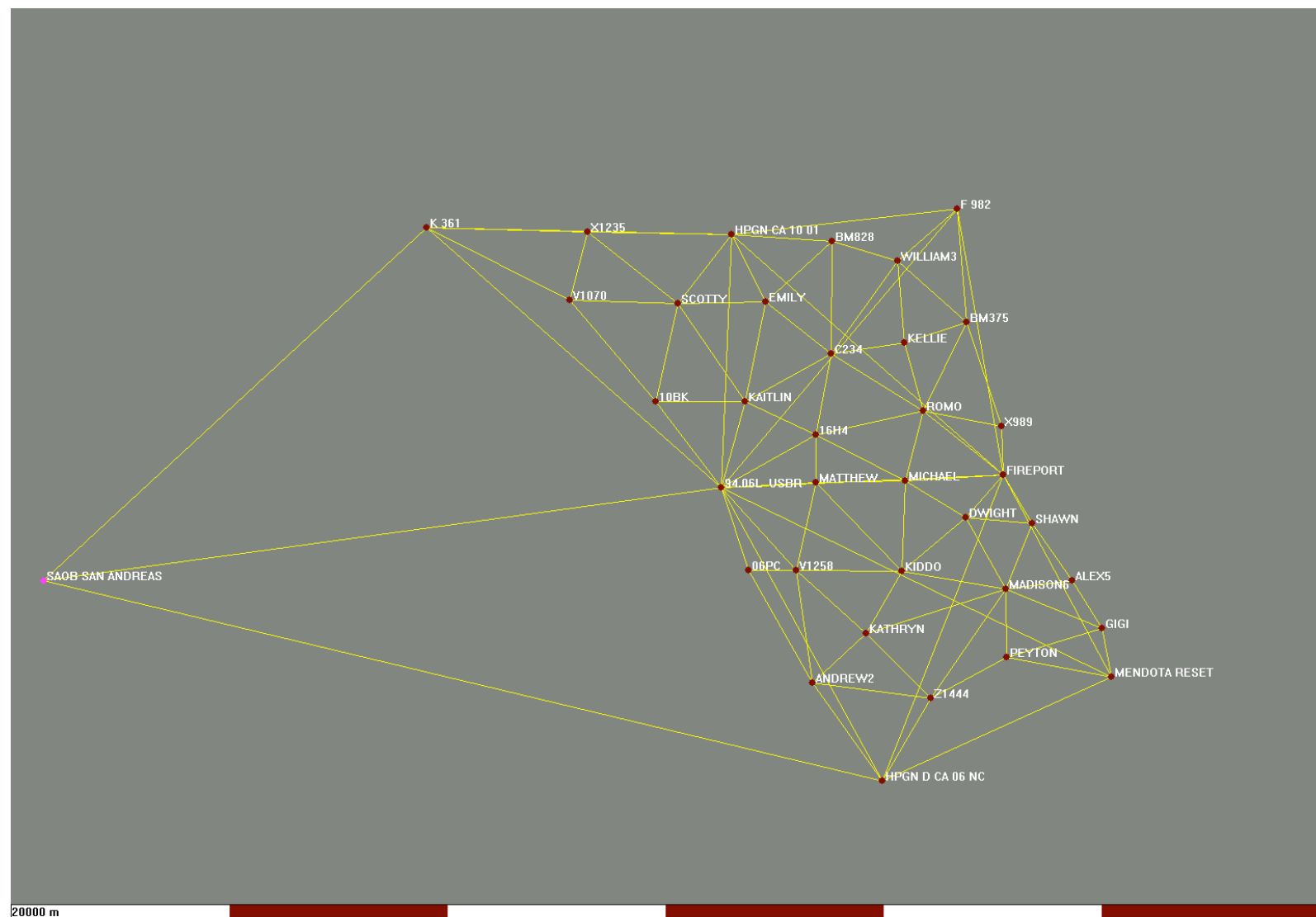


## **Evaluating multi-baseline solutions for Height Modernization projects**

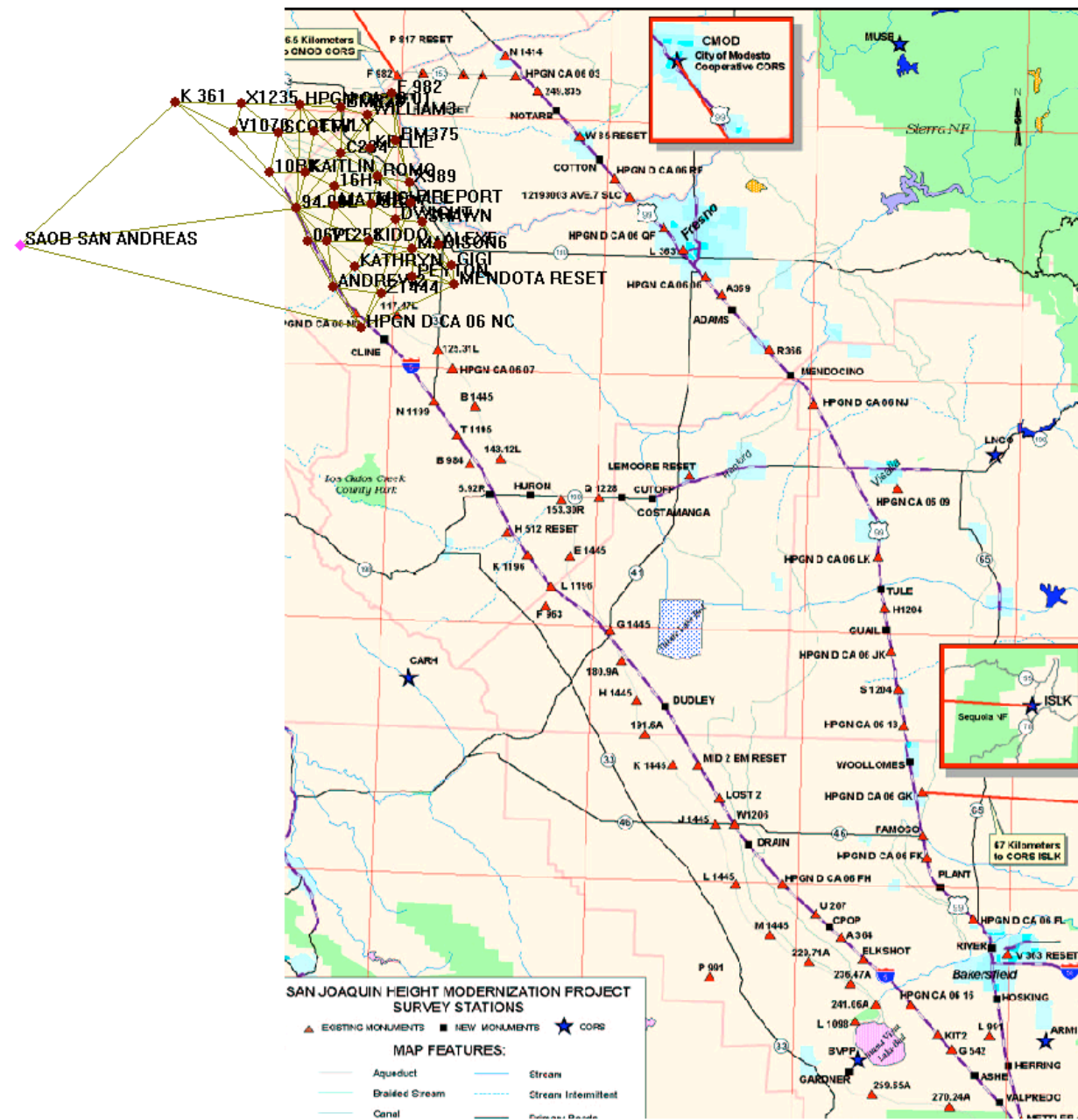
- ? Break out each multi-baseline solution into its vector geometry (independent plus trivial baselines)**
- ? Subject these baselines to the geometrical testing for height modernization guidelines**

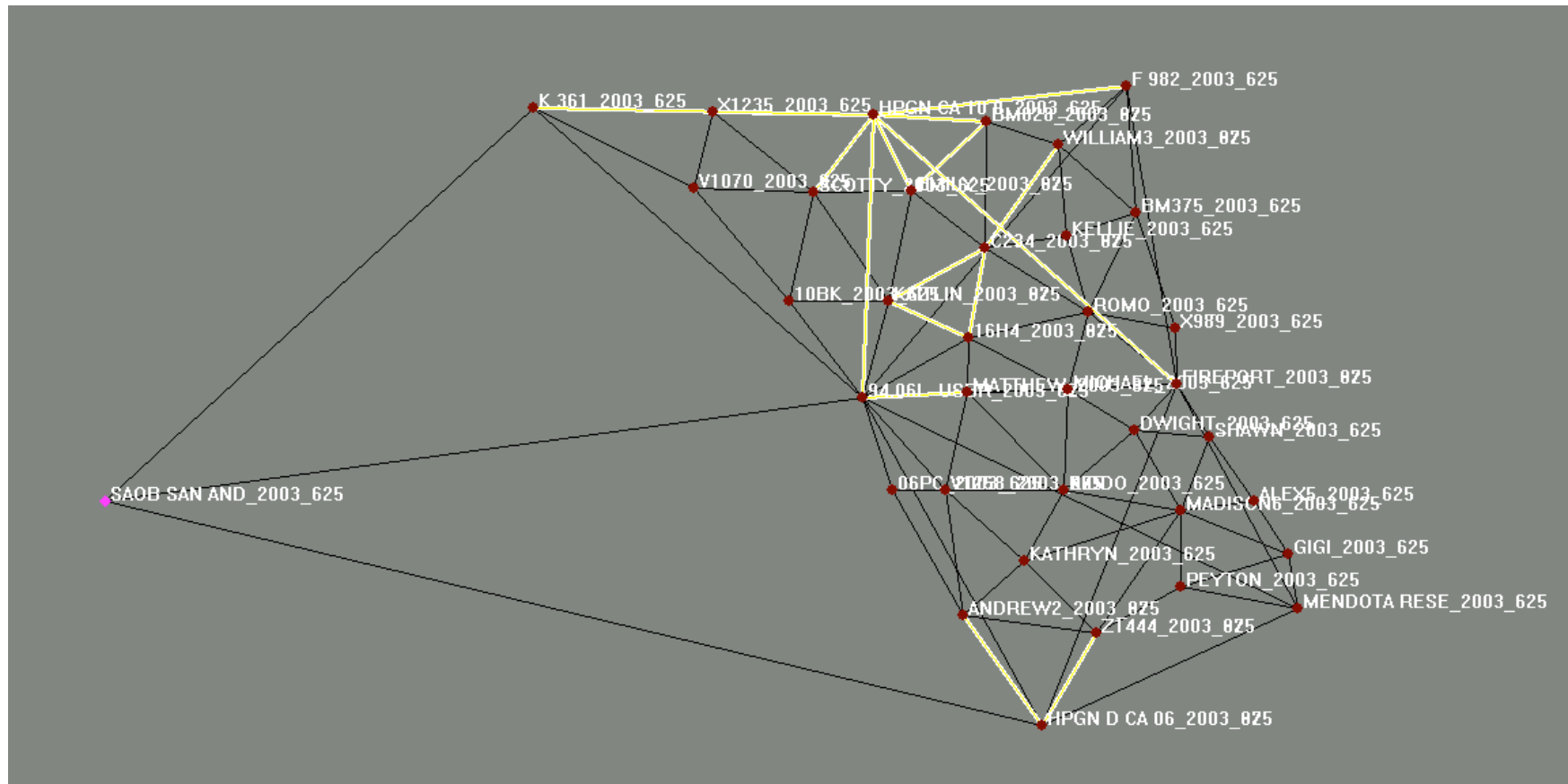
# **Data processing for the San Joaquin Valley Height Modernization project**

- ? The GPS polyhedron as the basis for precise network adjustment**
- ? Extensive differential leveling**
- ? Project composed of multi-epoch polyhedra**
- ? Requirement for correlated, adjusted velocity models**
- ? Requirement for combined adjustment of GPS, geoid, and leveling observations**
- ? Use of regional and global IGS solutions for constraints**

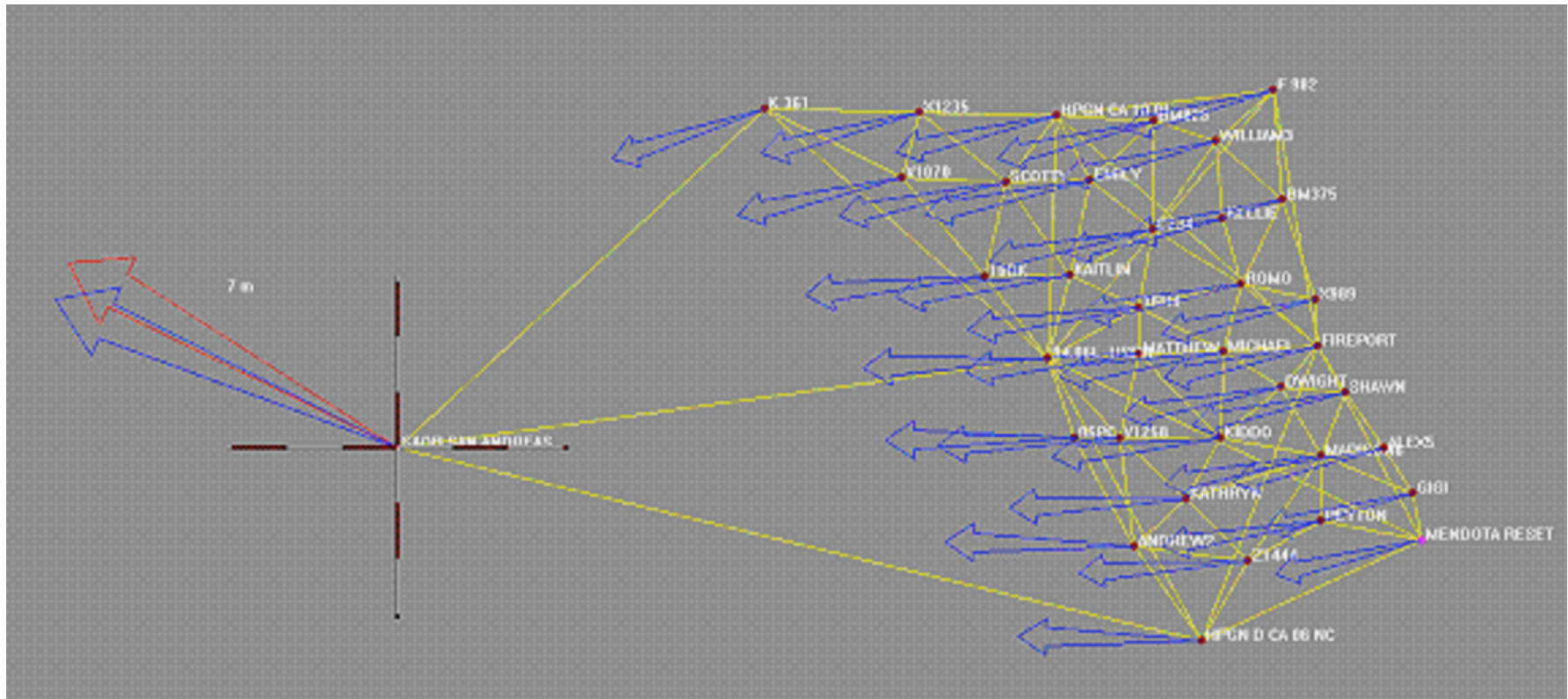


The CalTrans GPS network in the northwest corner of the project area

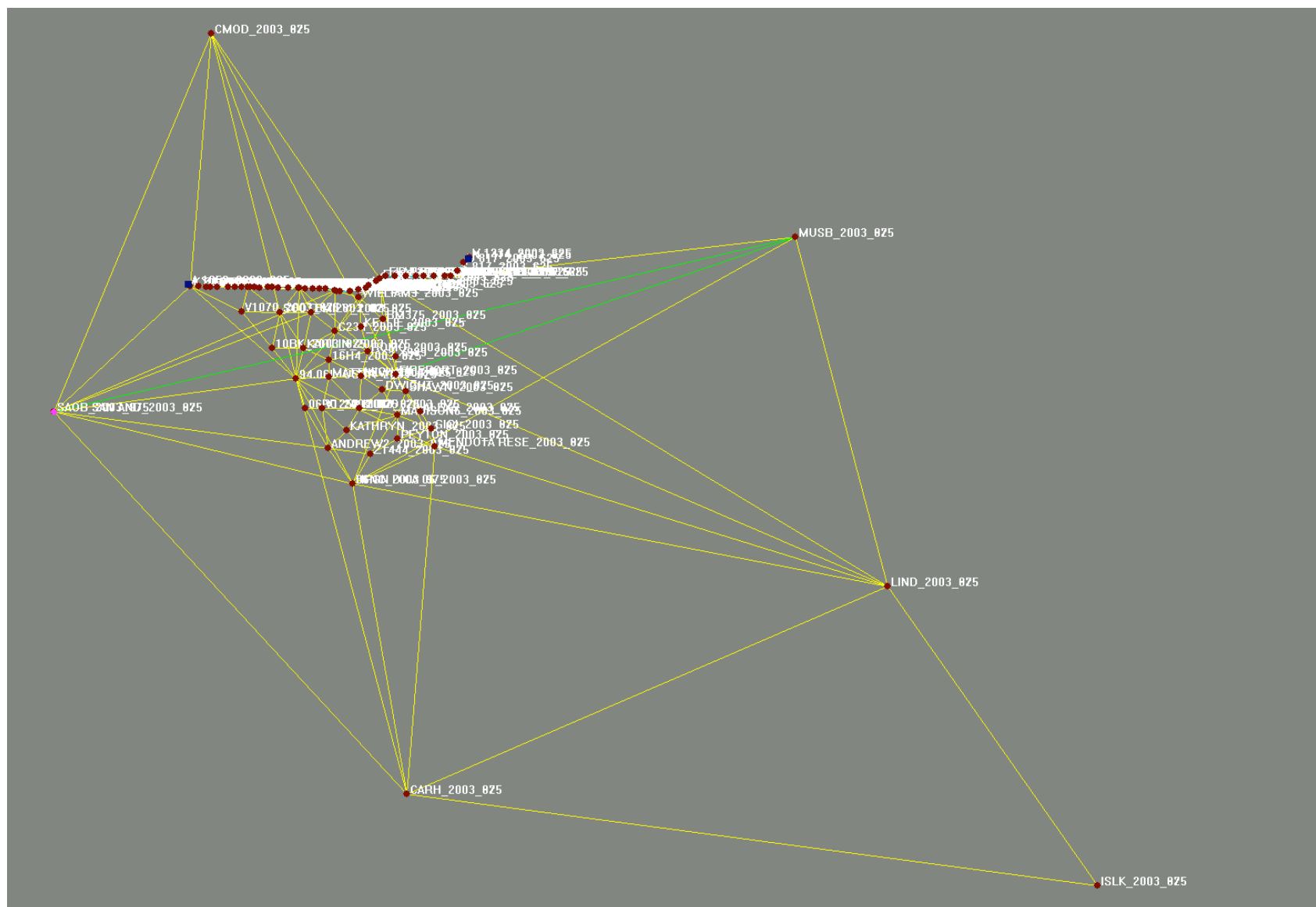




**The Epoch 2003.975 polyhedron, observed December 2003 and January 2004. Those baselines not highlighted are for Epoch 2003.625 (August 2003).**



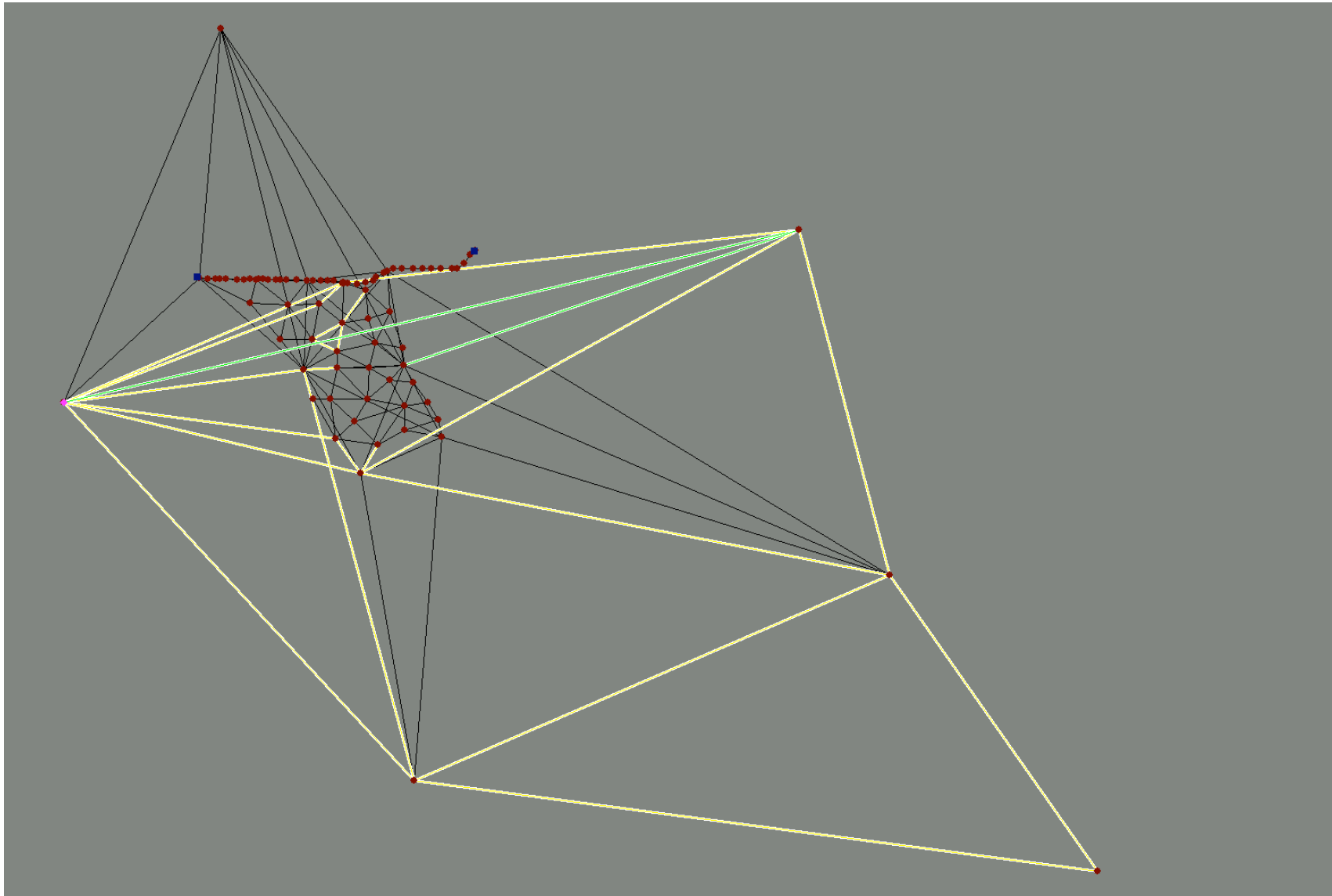
**Initial HTDP prediction of horizontal time-related displacement from Epoch 2003.625 to Epoch 2003.975. The constrained displacement of CGPS site SAOB (as given by SECTOR) is shown in red.**



## Adding CGPS constraints for both epochs to the network.







**New polyhedra for Epochs 2003.625 and 2003.975**

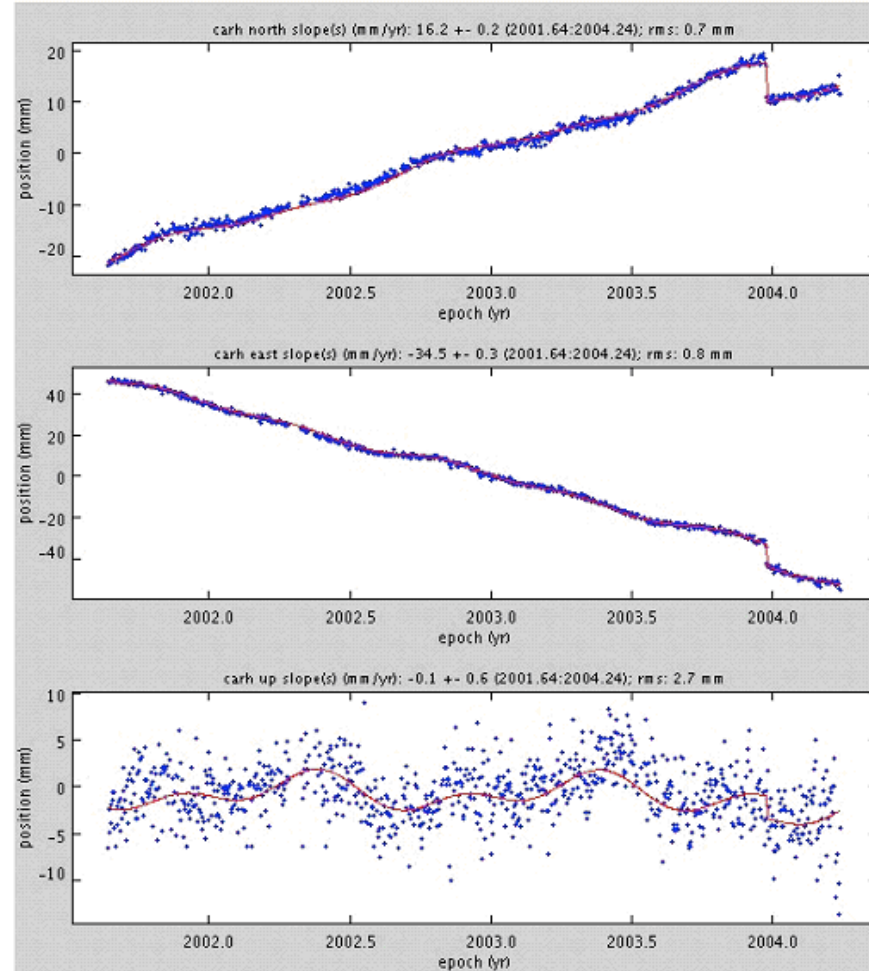
# SOPAC Refined Model GPS Site Position Time Series (ITRF 2000)

## Select Time Series Parameters

Current site: **carh** [Documentation](#) [Download time series data](#)

Enter [site code](#):  Filter type:  Trends, offsets:

Scatter plot (model-data):



## Refined Model Terms (neu)

[Documentation](#)

site: carh

### n component

slope 1: 16.21 +/- 0.19 mm/yr (2001.6425 - 2004.2009)  
 offset 1: -7.54 +/- 0.27 mm (2003.9795)  
 annual: 1.07 +/- 0.16 mm; phase: 5.60  
 semi-annual: 0.52 +/- 0.12 mm; phase: 4.13

### e component

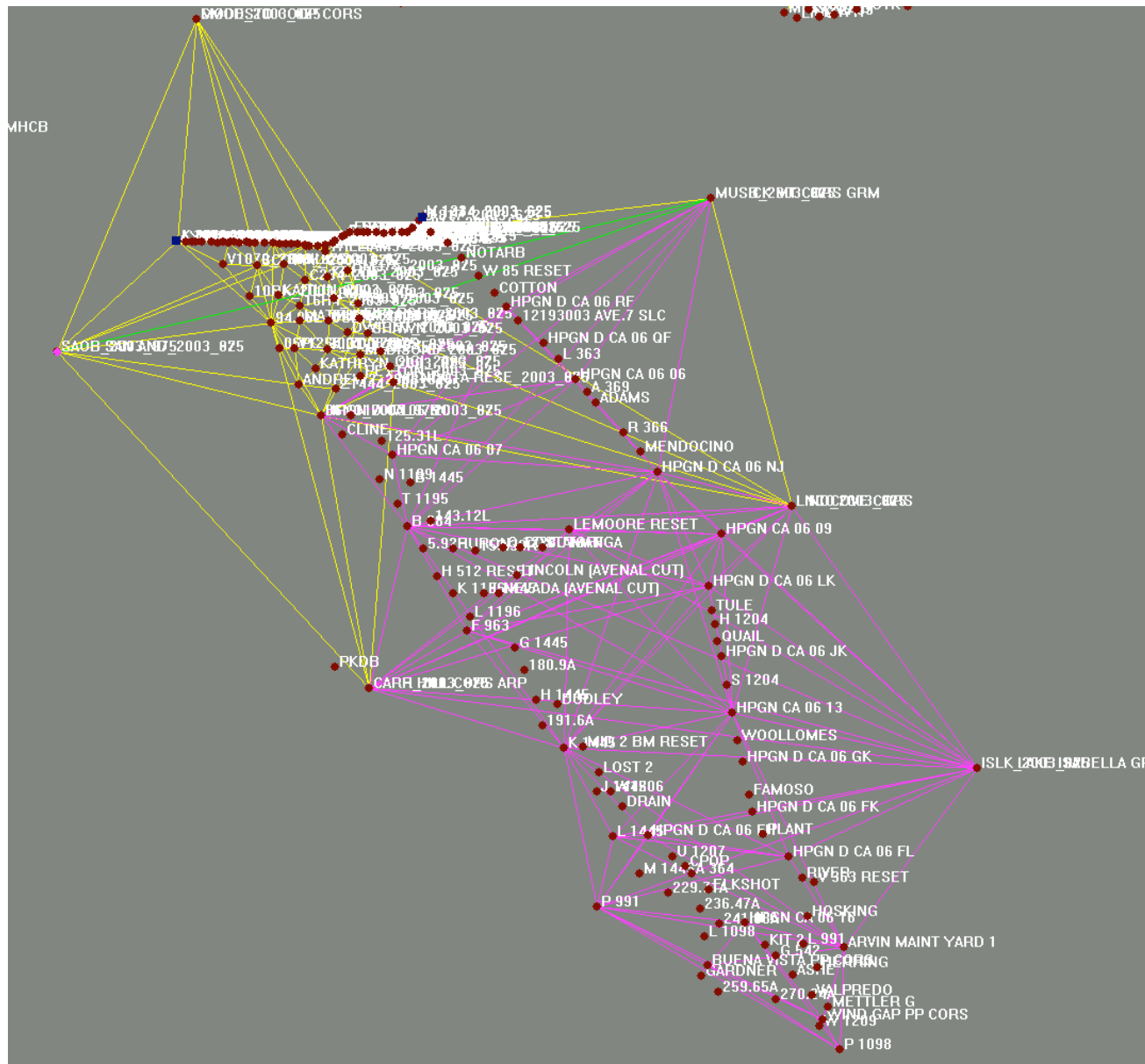
slope 1: -34.56 +/- 0.27 mm/yr (2001.6425 - 2004.2009)  
 offset 1: -10.52 +/- 0.39 mm (2003.9795)  
 annual: 1.13 +/- 0.24 mm; phase: 6.07  
 semi-annual: 1.25 +/- 0.17 mm; phase: 3.95

### u component

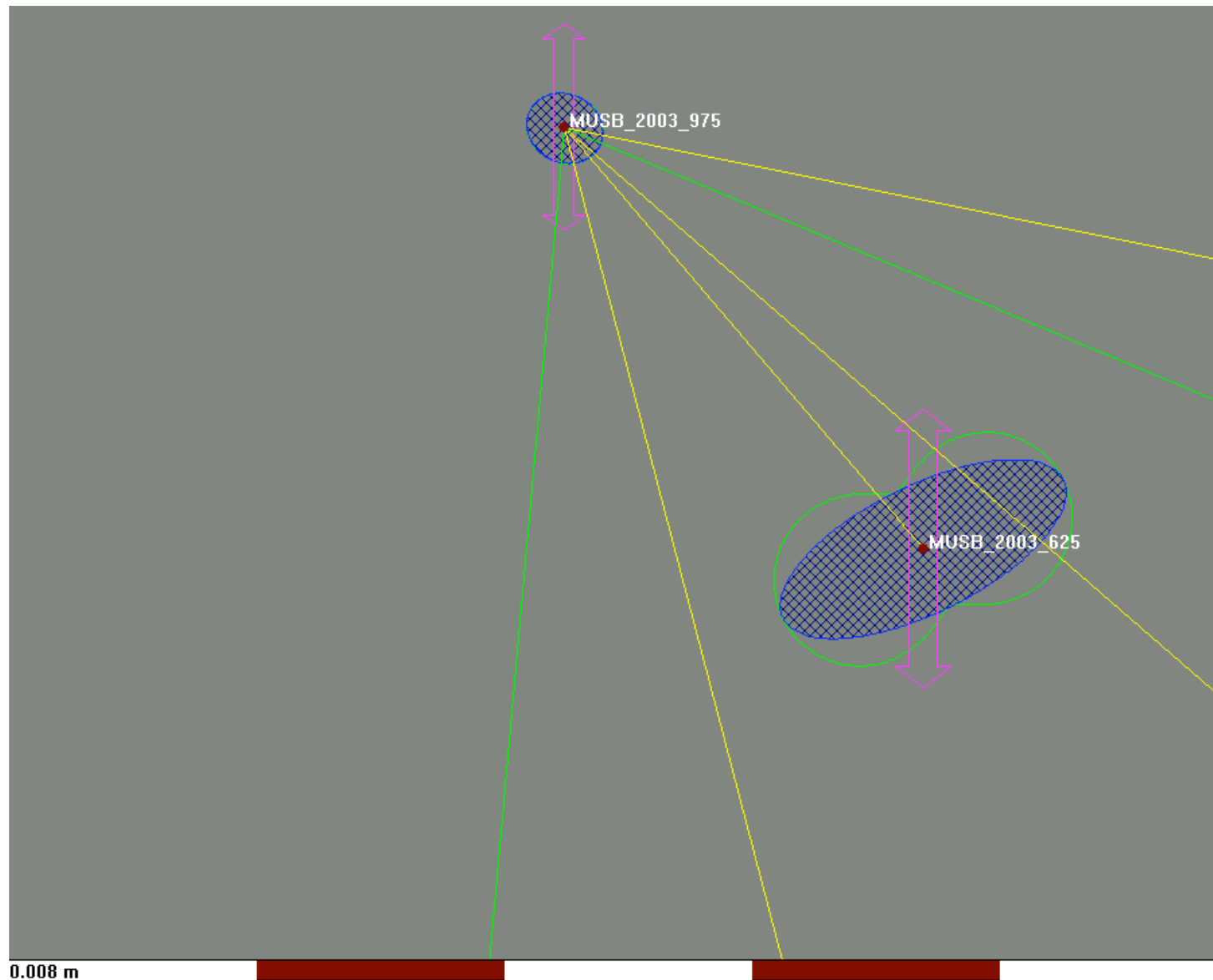
slope 1: -0.06 +/- 0.59 mm/yr (2001.6425 - 2004.2009)  
 offset 1: -2.06 +/- 0.93 mm (2003.9795)  
 annual: 1.58 +/- 0.52 mm; phase: 2.15  
 semi-annual: 1.26 +/- 0.38 mm; phase: 4.83

**The San Simeon earthquake at CARH (Carr Hill, Parkfield)**



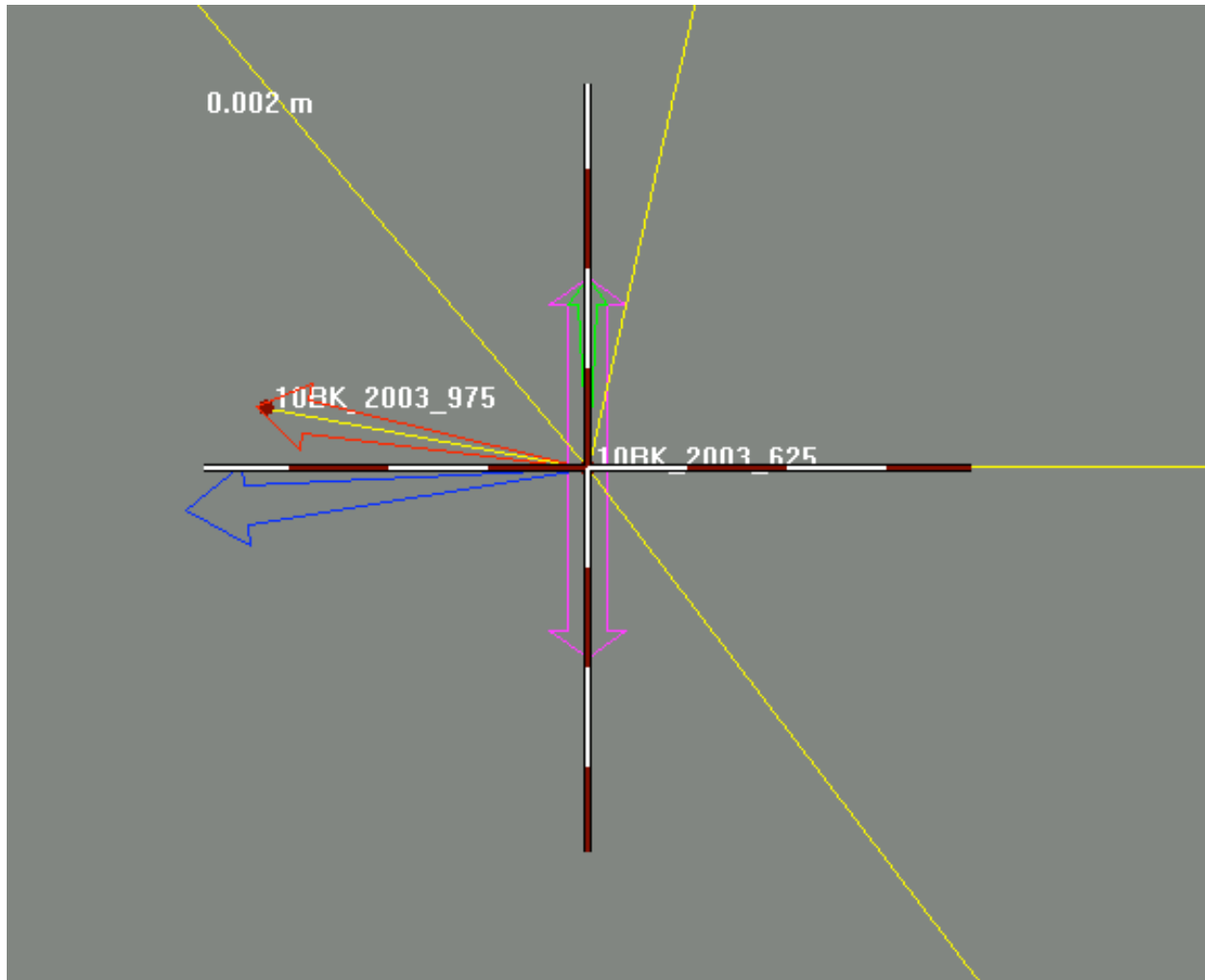


**Remaining GPS observations (Route 198 leveling not shown)**



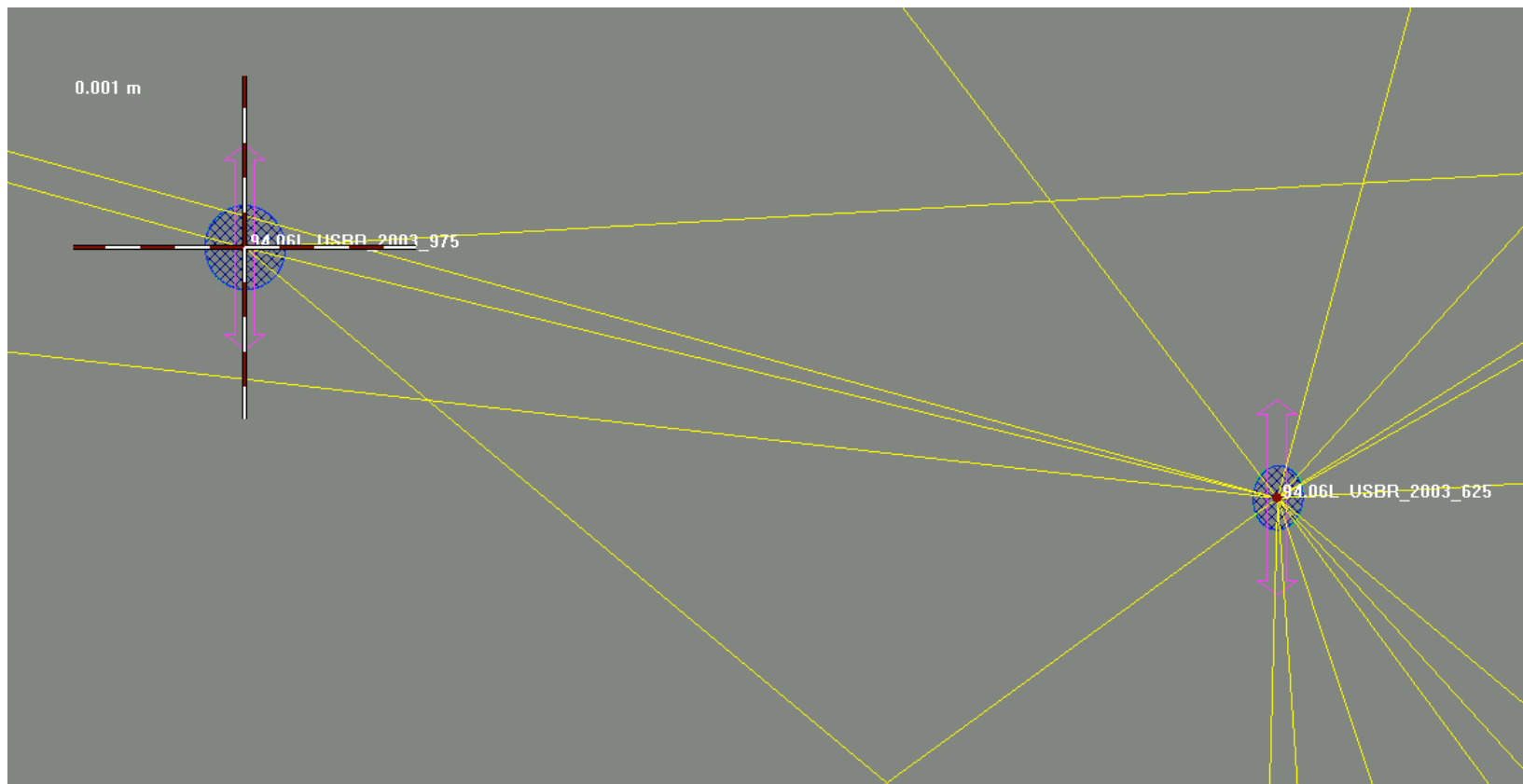
**Close-up view of velocity-derived displacements (MUSB was not observing at Epoch 2003.625)**



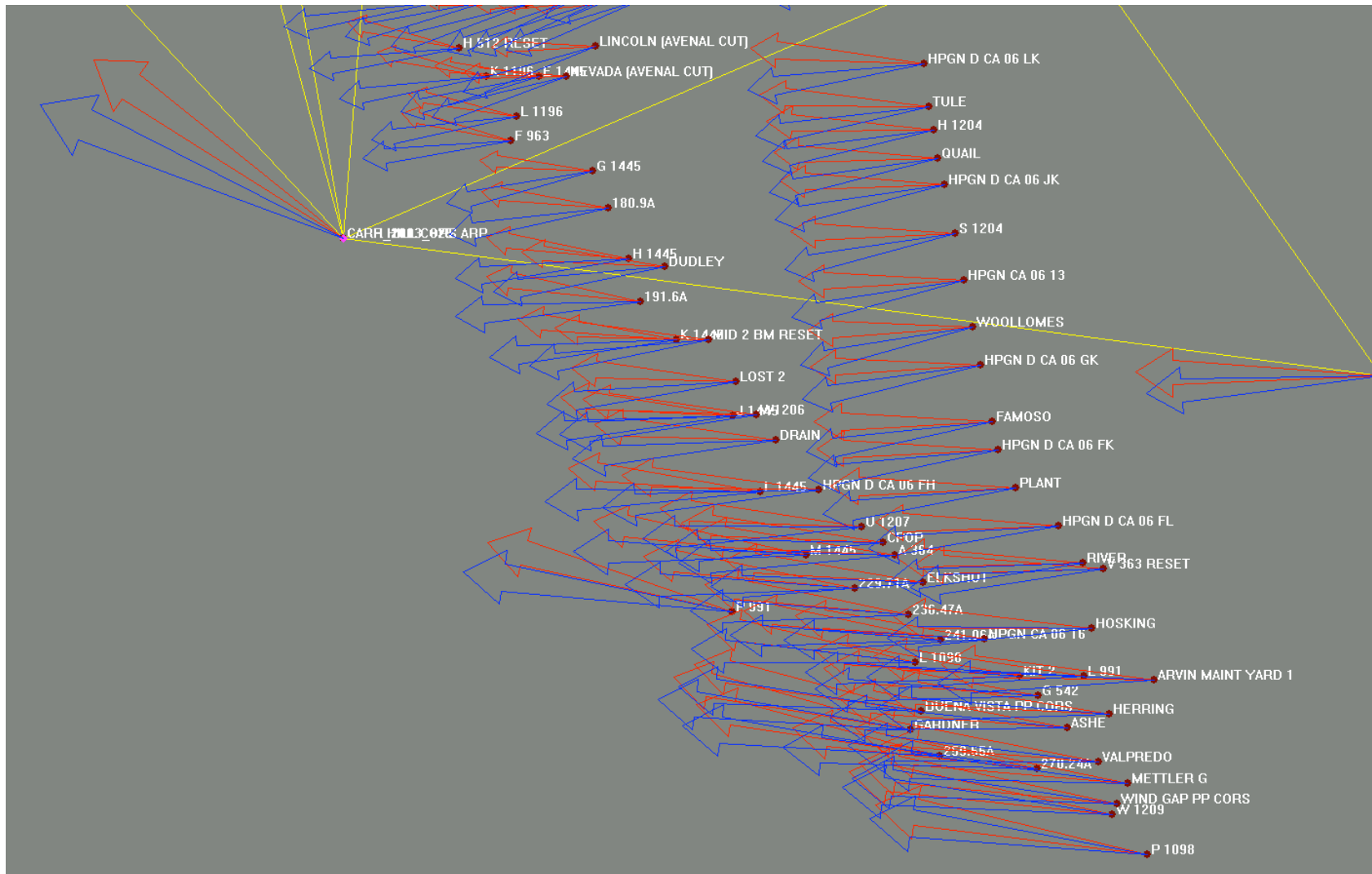


**Predicted (adjusted) velocities at HPGN D CA 10 BK. This station was not observed in Epoch 2003.975.**

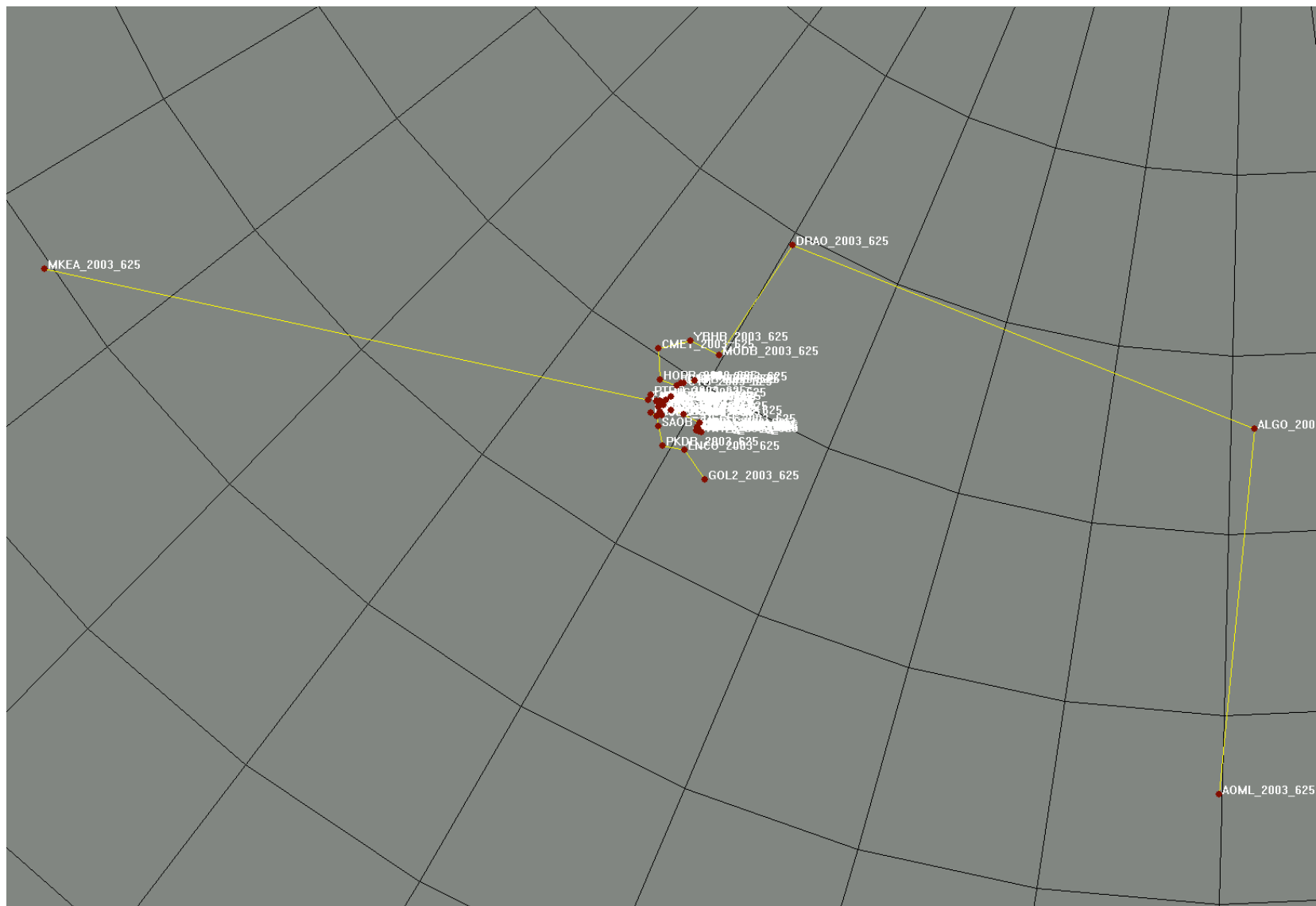




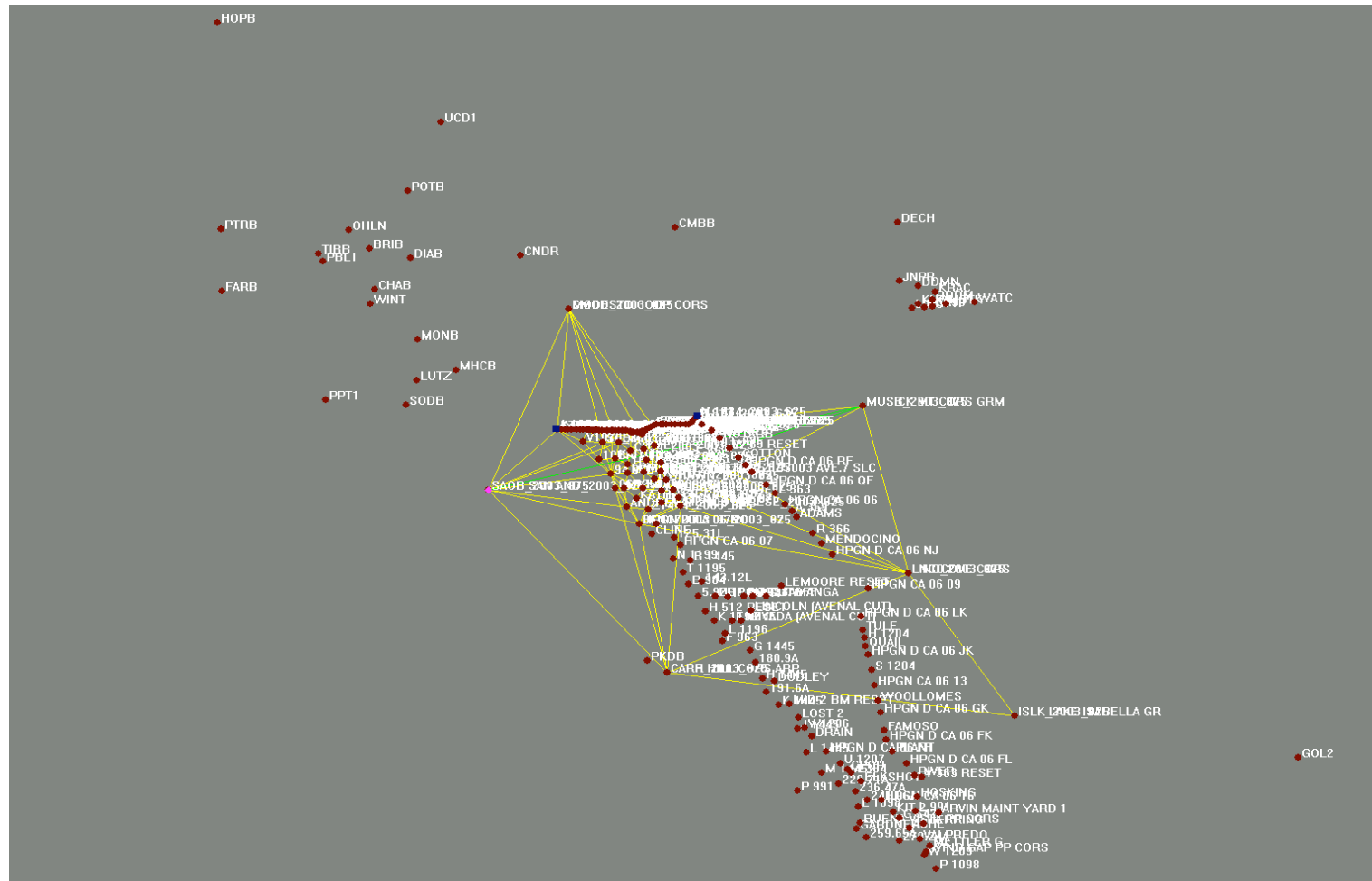
**Overdetermined velocities are used to predict improved velocities anywhere in the network region. Method used is collocation, with an autocorrelation function based upon distance. The closer together two points are, the more closely correlated are their predicted velocity residuals.**



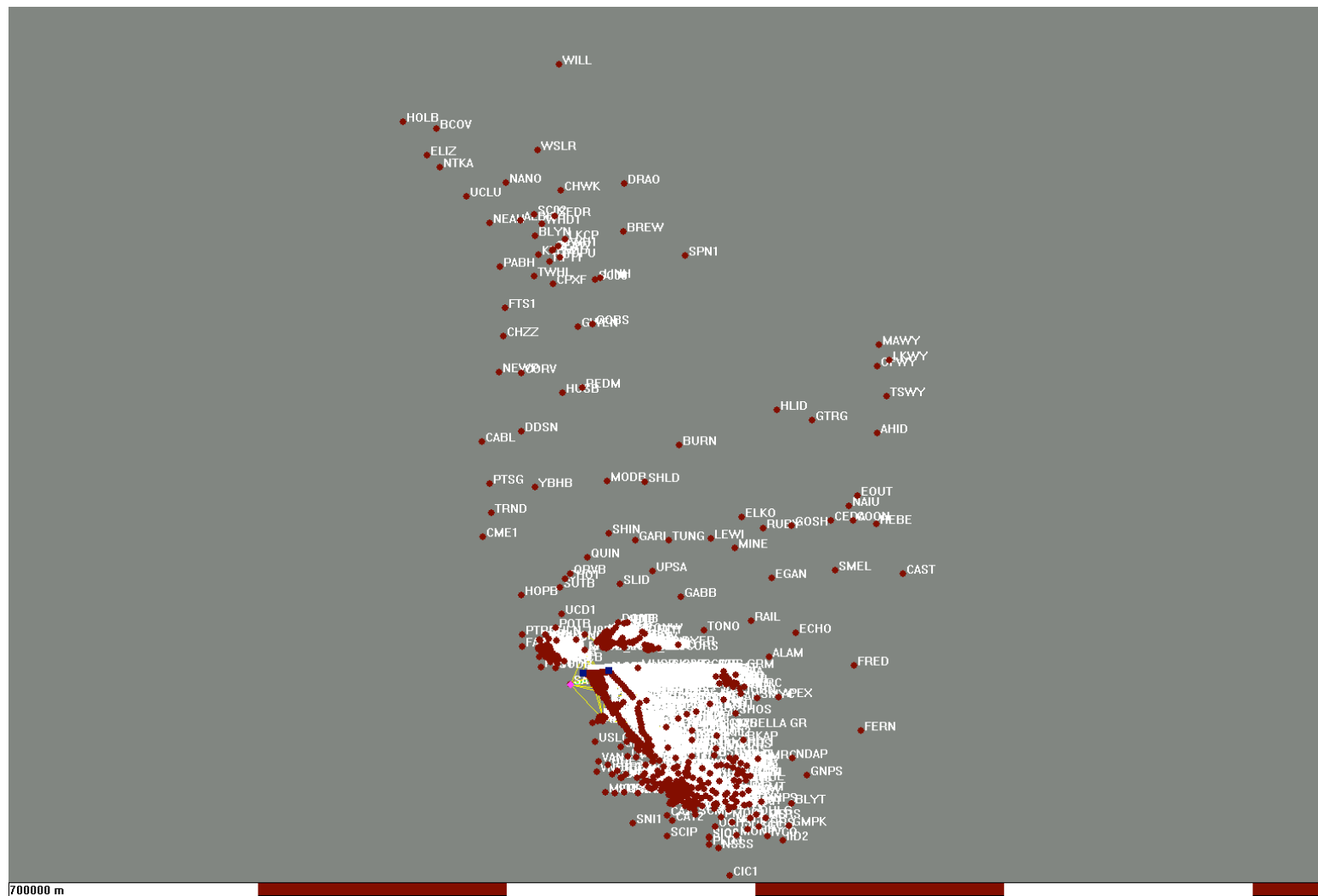
**Predicted improved velocities in unobserved portion of the network. As you move away from the overdetermined (adjusted) velocities, the improvement signal weakens.**



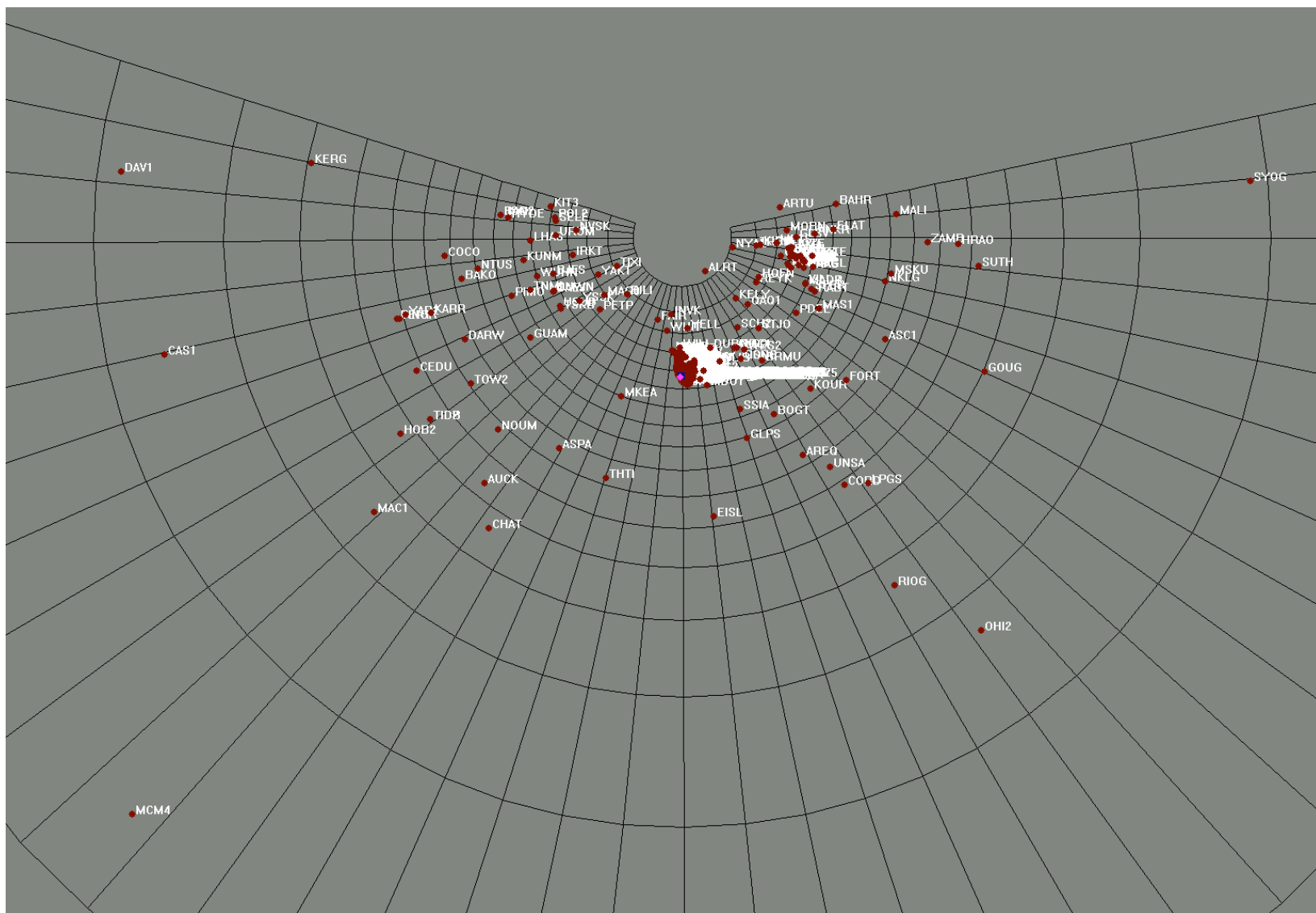
**The daily GAMIT solution (2003.625) for the BARD network. Hawaii, Ontario, Miami, and B.C. are ties to the global solutions.**



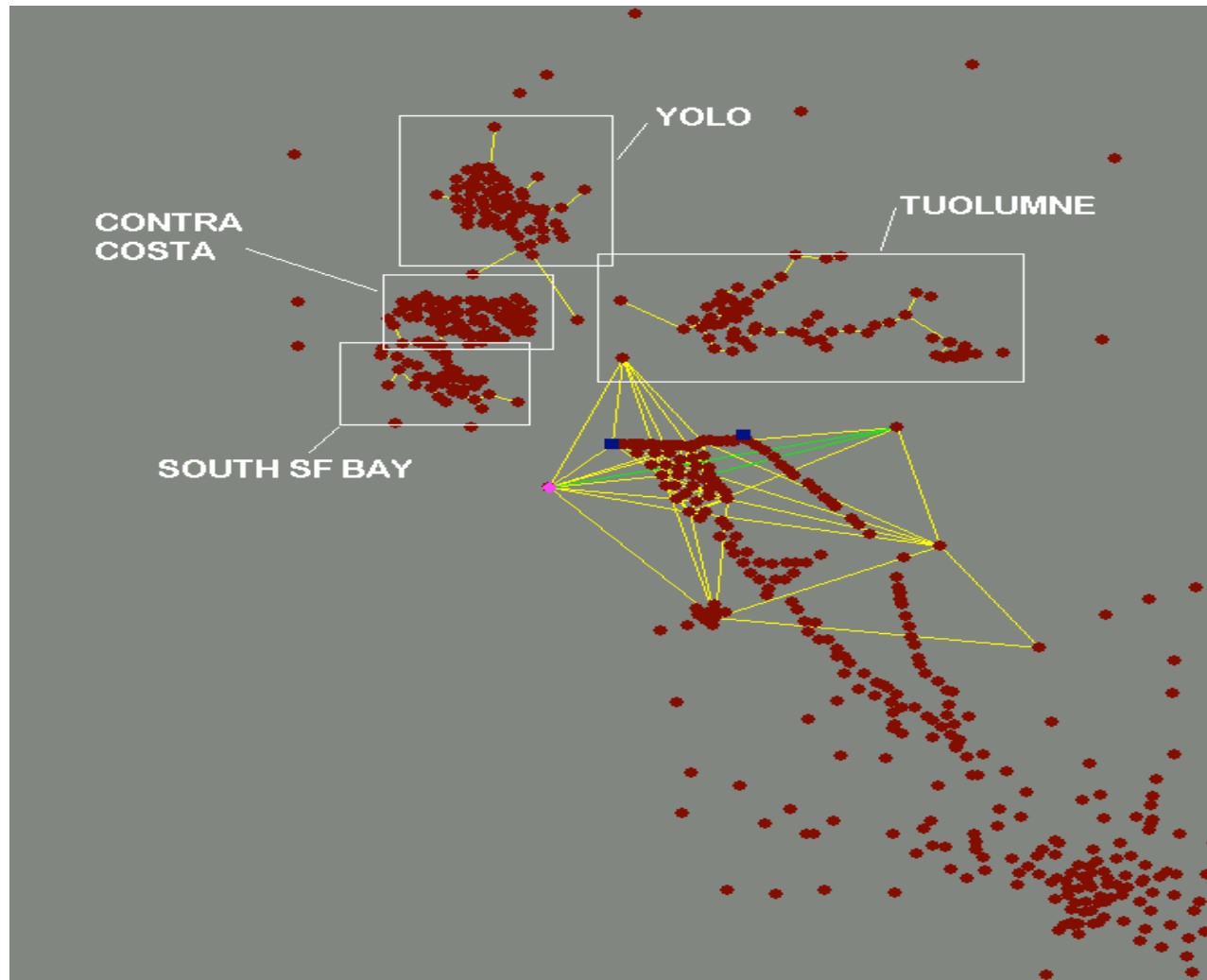
**Integrating the San Joaquin Valley network with the regional (GAMIT) daily solution for the BARD network, Epoch 2003.625. The GAMIT solution for Epoch 2003.975 would be used in the final adjustment. These are observed coordinates with a full covariance matrix.**



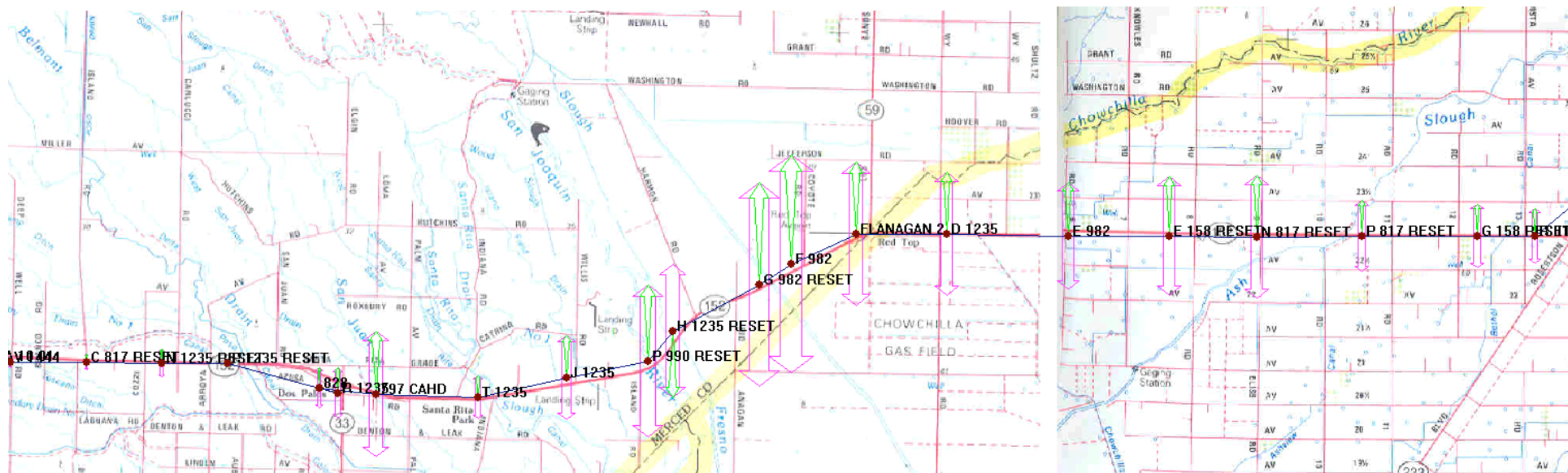
**Daily solution (Epoch 2003.625) for the PBO-SIO array (SINEX solution)**



**Weekly global SIO solution. Lambert projection, origin at Hollister, CA.**

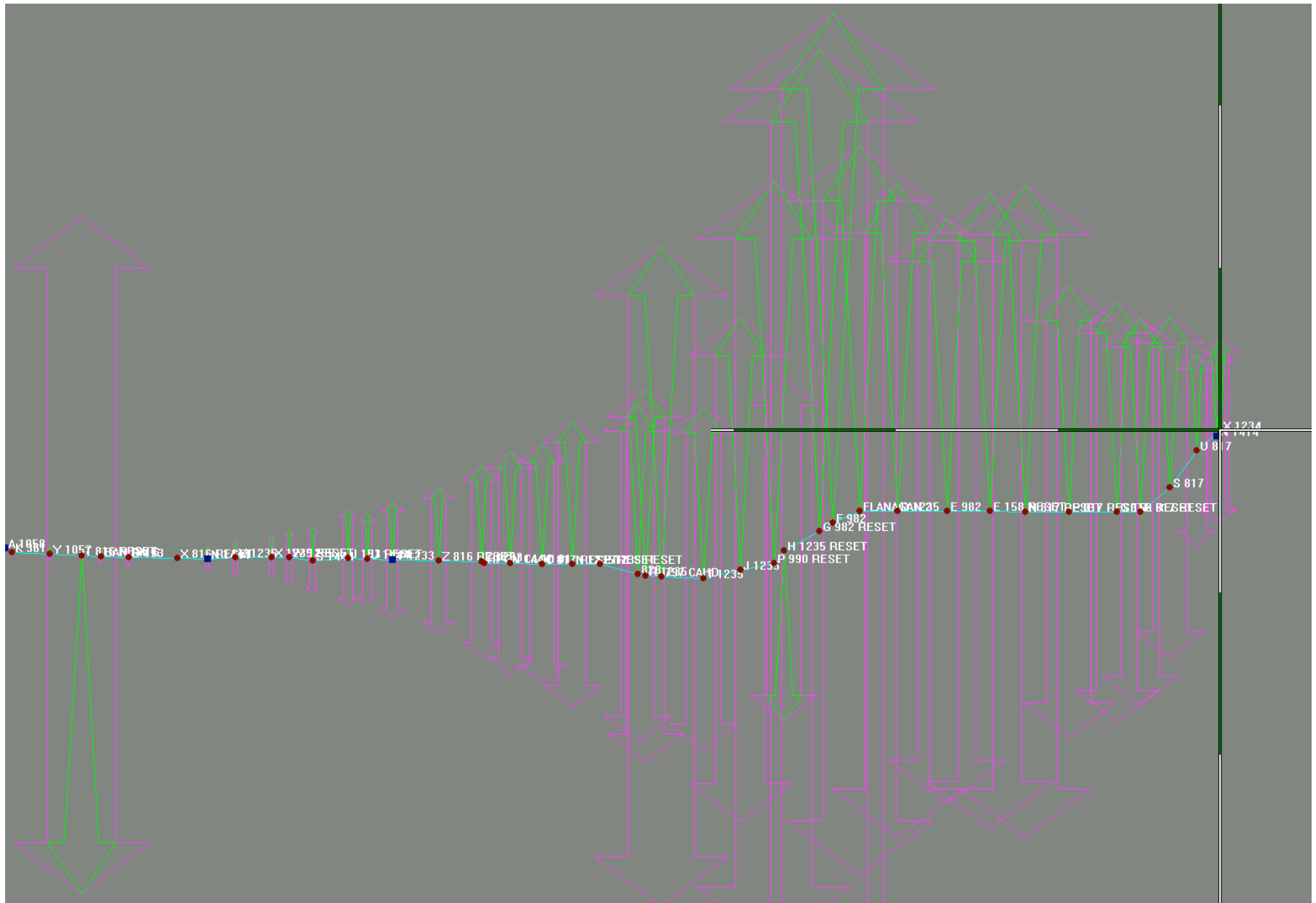


**Integration of CSRS passive networks into ITRF2000. Conversions to NAD83 or any other datum accomplished by mathematical transformations.**

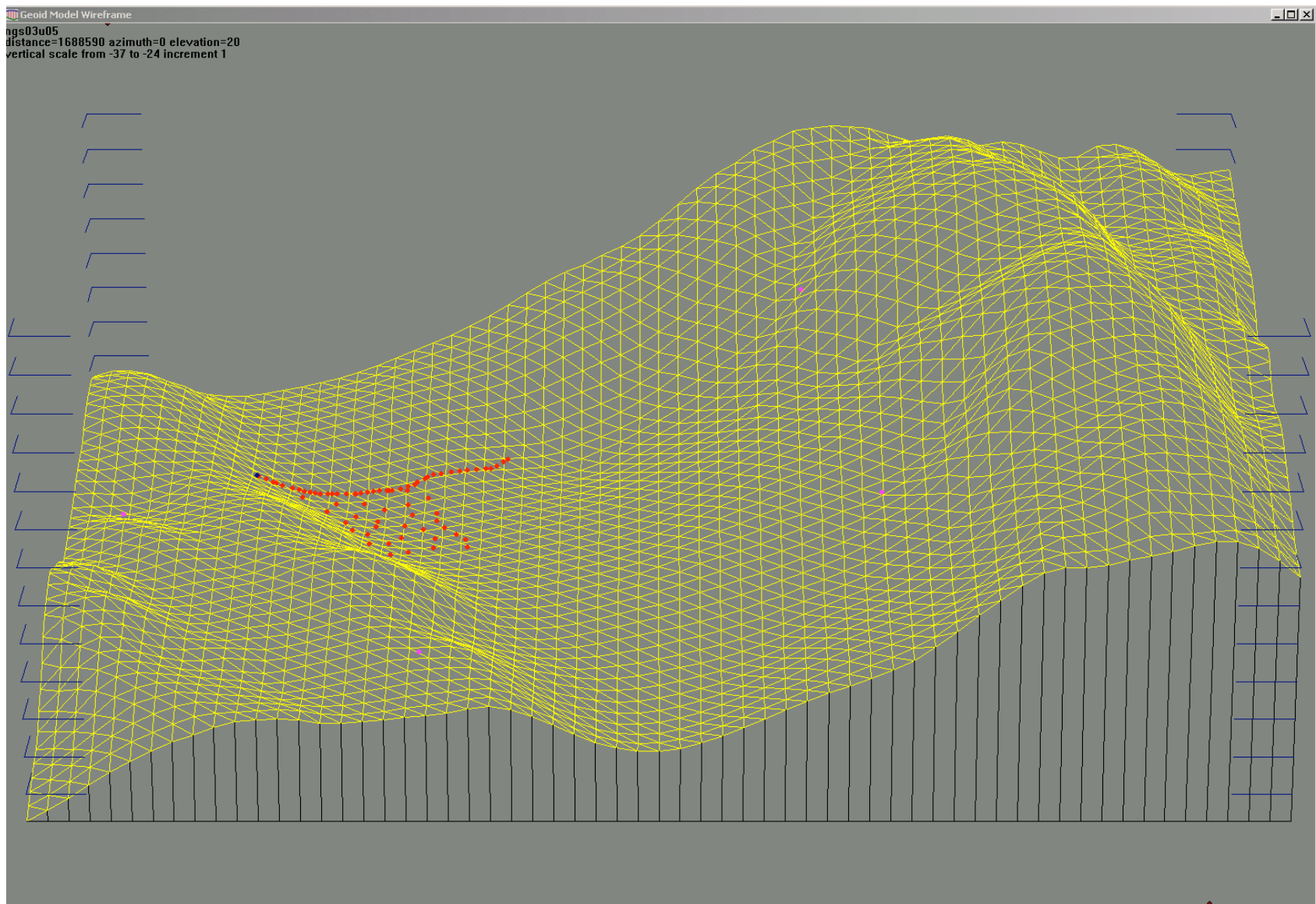


**CalTrans (Gigi Cardoza) leveling circuit along Route 152.  
Subsidence between 1988 and 2003 at F 982 is 1 meter.**

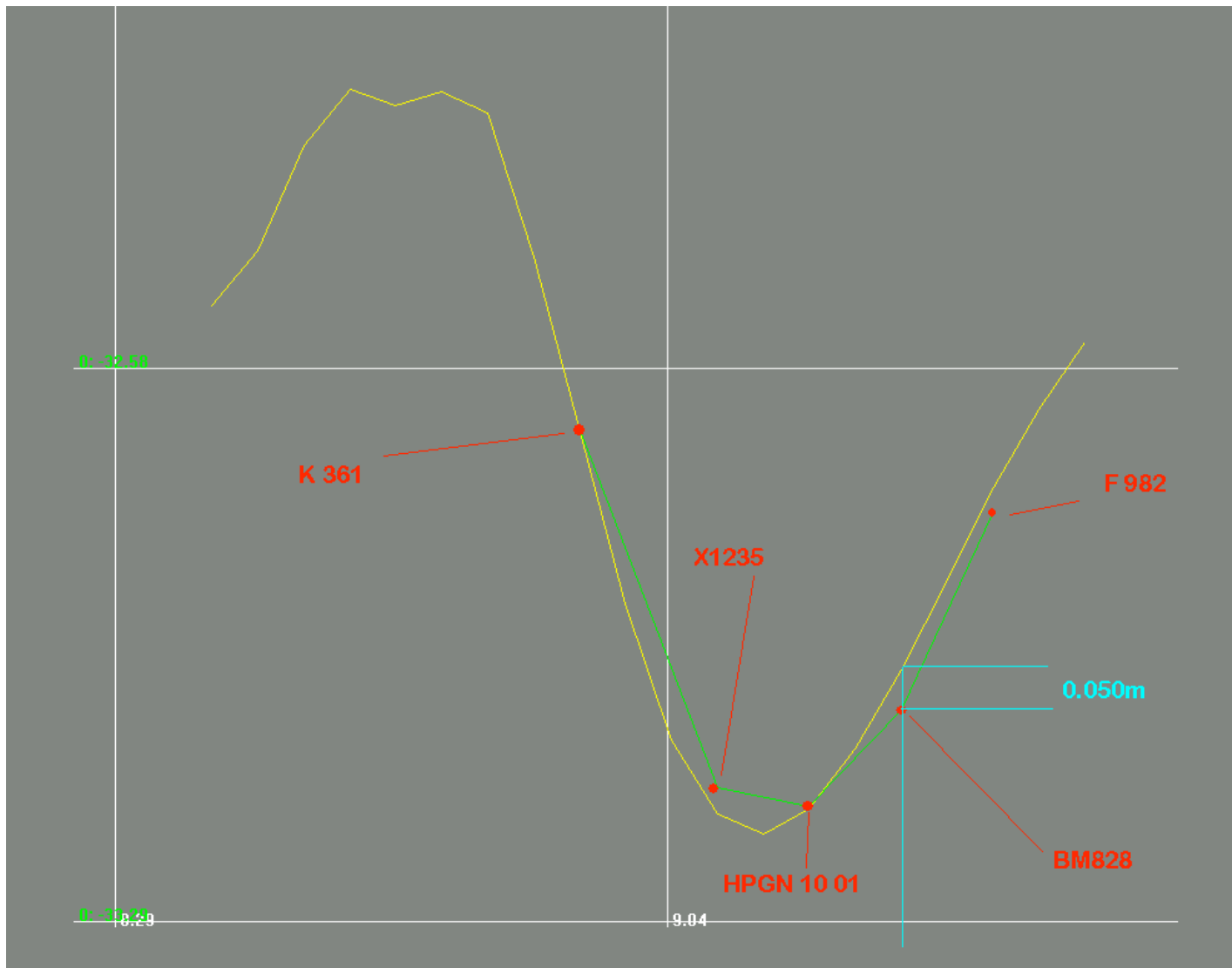




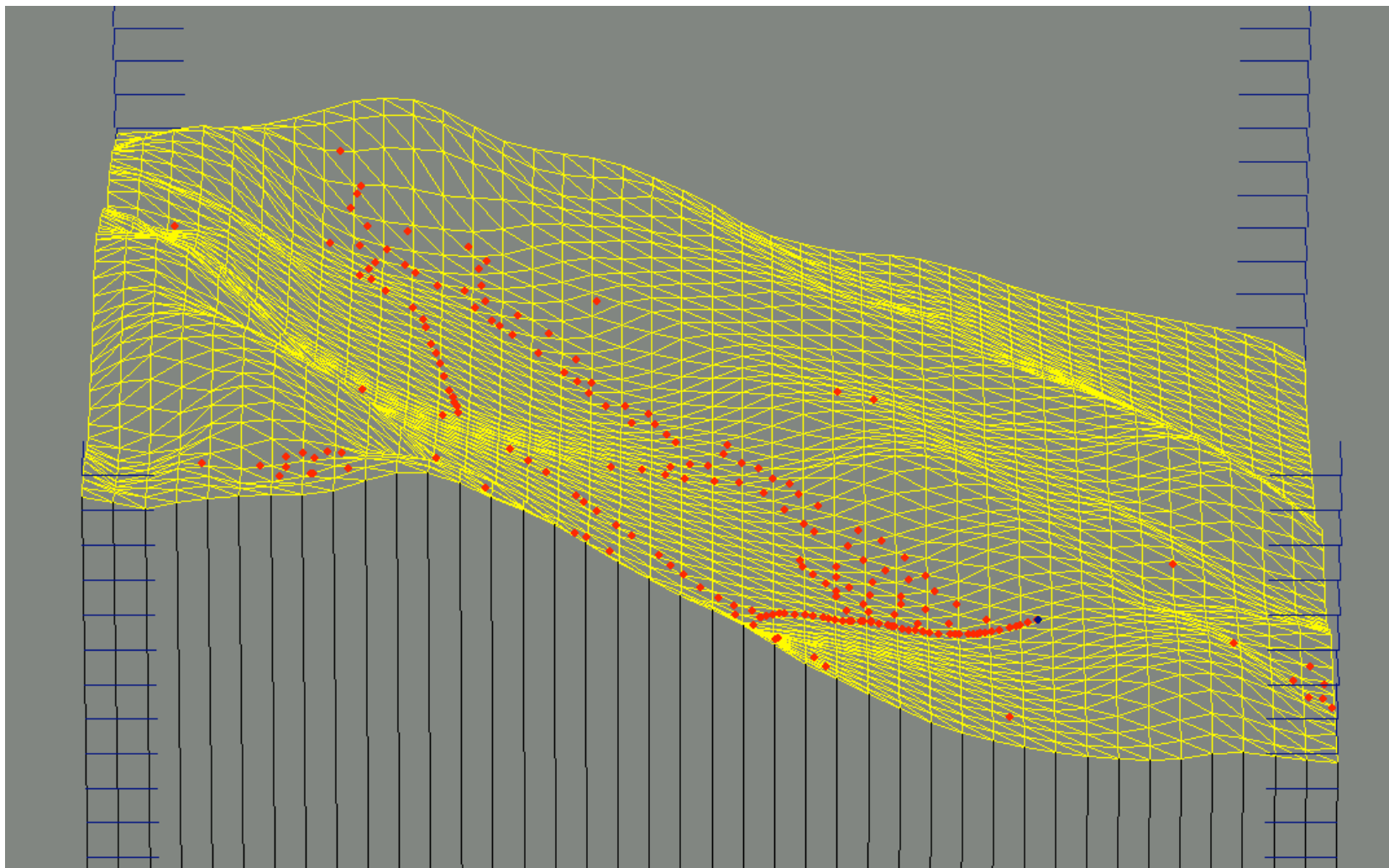
**Entire Route 152 circuit, A 1058 fixed. Trend obvious.**



**GEOID03 in northerly region of the San Joaquin Valley project.**



**Geoid profile along Route 152, showing BM's observed with GPS.**



**GEOID03 for all of the San Joaquin Valley**

## **Data Processing issues**

- ? More precise modeling of velocities, including offsets and periodic effects and correlation distances for vertical deformation**
- ? Archiving of velocity models**
- ? Archiving of improved geoid models**
- ? Archiving of leveling data**
- ? Precise definition of coordinate constraints used for CSRC campaigns**
- ? Continuing work on the CSRC XML Campaign database**

