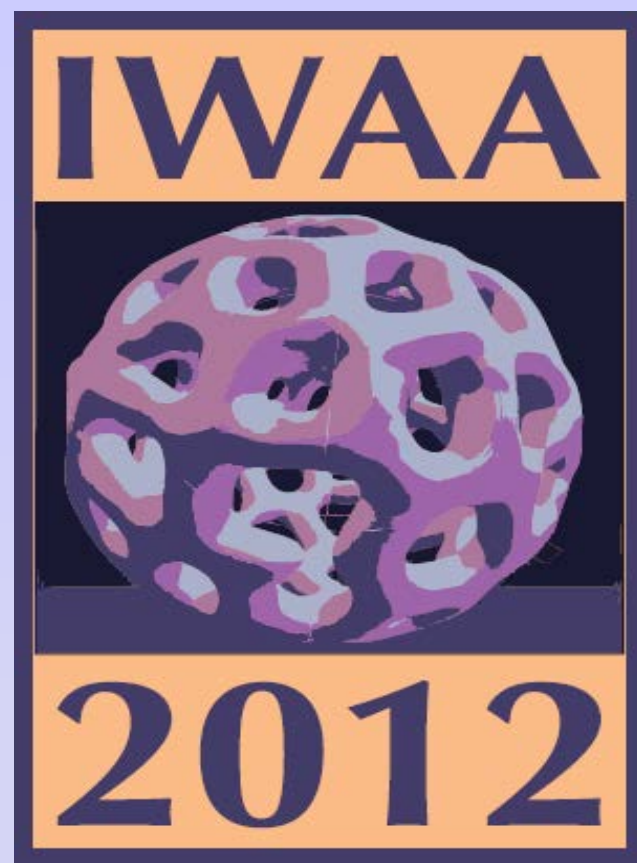# Wireless Operation of the DNA03 at FNAL*

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Abstract

When surveying accelerators, there are two key datum's or networks to be considered, horizontal (X,Y) and vertical (Z). Precision alignment requires that the horizontal and vertical control networks be done independently due to the accuracy limitations of the instruments utilized. This poster outlines the methodology used for data collection and processing of the vertical control networks at FNAL.

1. Background

During any large construction project vertical deformation is anticipated. Deformation may occur for many years but should stabilize within time. Deformations creating an abrupt elevation change or shear is a major source of concern for an accelerator Beamline. A shearing effect will cause the particle beam not to follow the designed beam path in that region. This poses a problem with beam trajectory and beam losses. Deformation surveys, especially after extensive re-construction, are performed to obtain a periodic update of the machine for optimal running conditions. Comparisons between different epochs are then performed.

2. Data Collection

Primary method of data collection is the LEICA DNA03, Barcode reader and laptop. Interactive software developed in-house along with a wireless connection between the computer and instrument significantly reduces the amount of data collection errors. The computer communicates with the DNA03 via a BlueFly RS-232 wireless adapter and a BluePort connected to the instrument thru a Limo cable (See Figures 1 and 2). The BluePort communication range is approximately 150 to 200 feet, depending on interference in the area. Once connected a solid green light indicates the BluePort is functioning properly.

The interactive software combined with a Bar Code Scanner (See Figure 3) are used to record the point names observed. Point names entered erroneously was the most common mistake made when using the DNA03. Point names along with all the desired instrument settings are transmitted to the DNA03. This insures that the desired instrument settings along with the correct point name are being used.

An important feature for accelerators was the design of a portable 24 volt LED lighting system (See Figure 4). Due to the inherently dark nature of the tunnels this has increased productivity dramatically by not requiring bulky halogen lights and extension cords. LED lighting has eliminated safety concerns associated with using extremely hot halogen lighting.

Bar codes are now also being used on beam line components. This facilitates in tracking data and is integrated into the Alignment database which allows for quick retrieval of information. Instrument readings are transmitted from the DNA03 back to the computer which is monitored by an operator. The software performs the following real time checks: data base height vs. measured height, station balance and standard deviation of observations. Real time checks help minimize data collection errors and blunders. Data is formatted and stored for post processing.

The in-house software developed has increased the reliability of the field data collected and has significantly increased productivity. We are presently investigating the feasibility of pads (iPad) that would allow for better portability.

Note: Under certain circumstances it is not feasible to use the interactive software. Software has been developed in-house to incorporate both instrument files (*.dat and *.gsi) into a single file. This program uses codes to determine information the field personnel want communicated to Task Managers. This program merely combines information and flags obvious blunders and or errors occurring in the field. Checks are still required by office personnel which may require further observations.
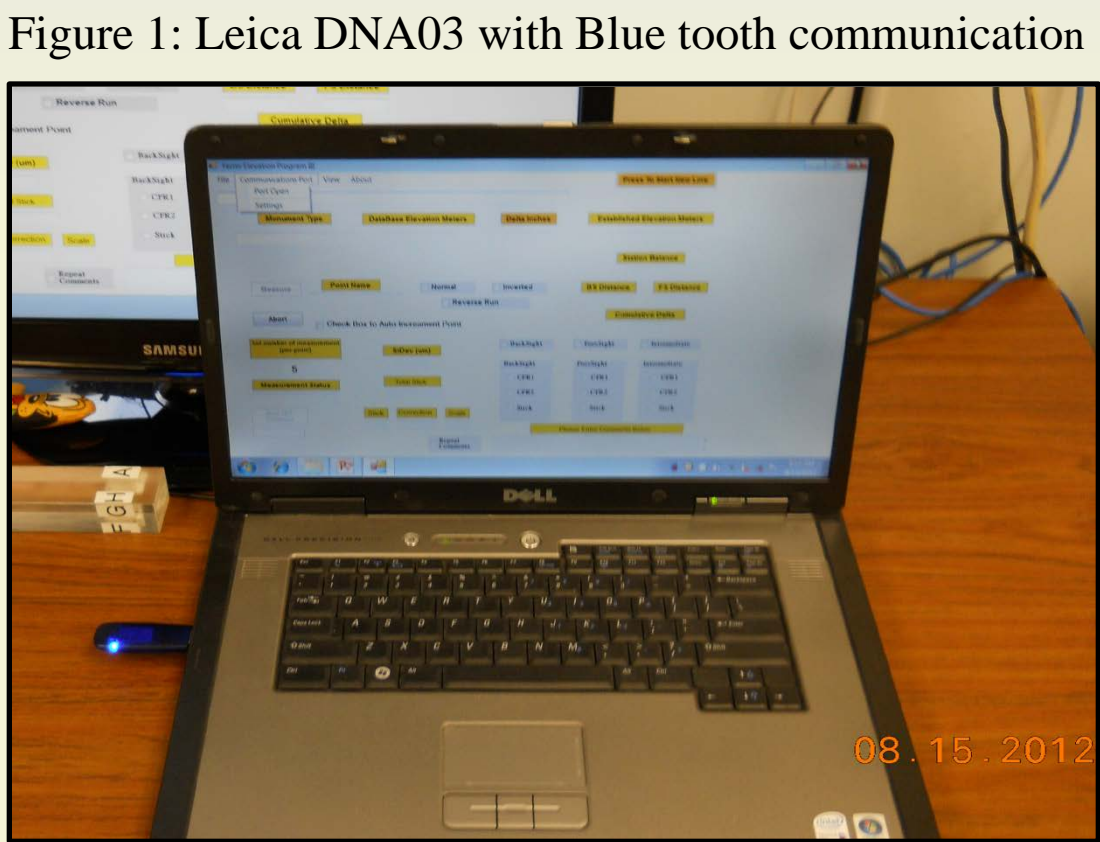

The Team that makes it all come together.
Chuck Wilson, Craig Bradford, Gary Teafoe, Gary Crutcher, Randy Wyatt, Glenda Adkins, Mike O'Boyle

Limo to RS232 cable
Figure 1: Leica DNA03 with Blue tooth communication

RS-232 Wireless adapter
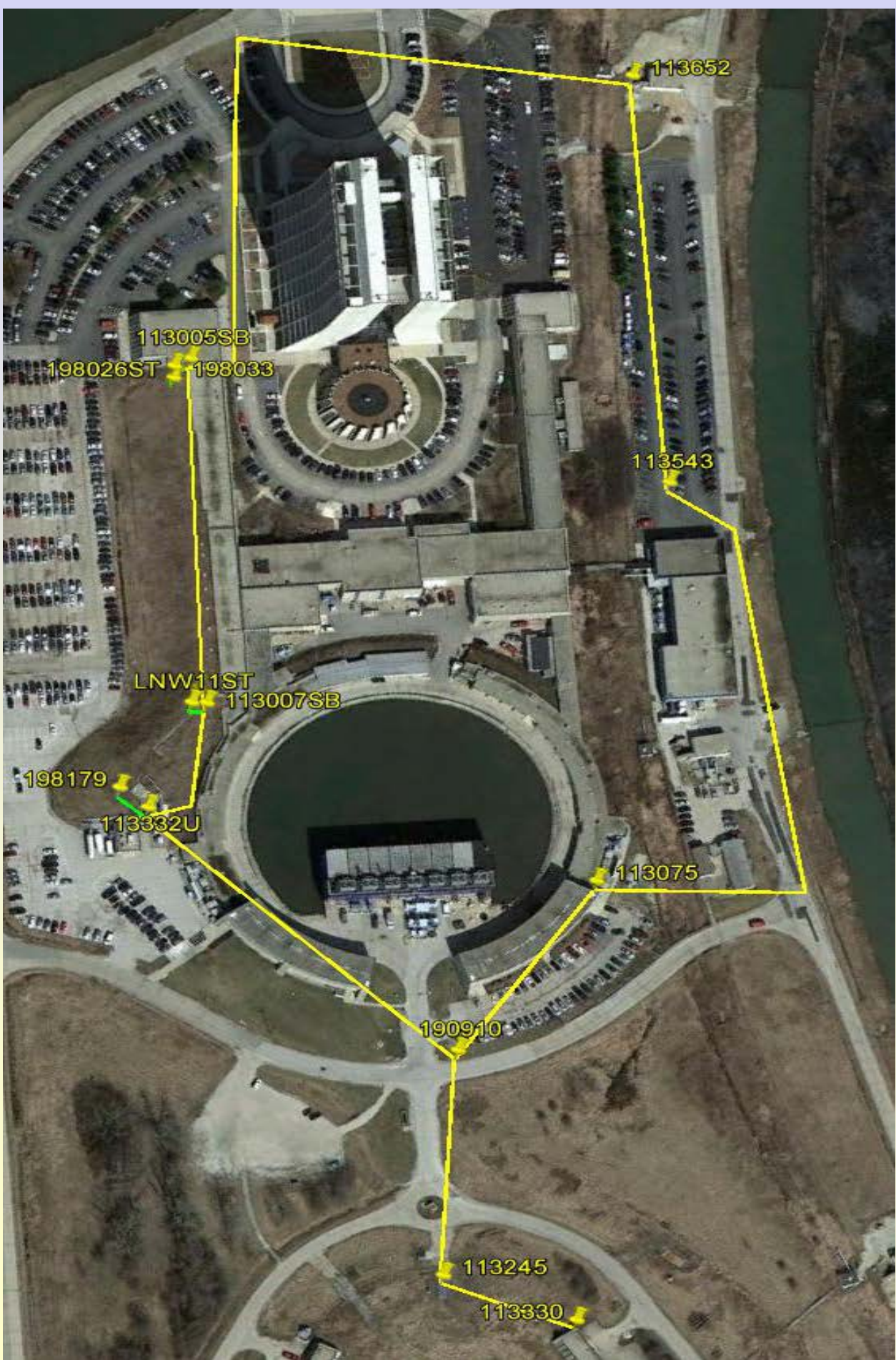Figure 2: Laptop Computer Setup (USB port used)

Barcode Scanner
Barcode Labels
Figure 3: Bar Code Scanner and labels

Figure 4: LED 24 volt lighting used with DNA03

Plot of Surface Network

Figure 5: 2007 observations vs. 2012 observations

Figure 6: 2007 adjusted coordinates vs. 2012 raw measurements

3. Data Reduction/Processing

The in-house software which has been developed has significantly improved the "raw" data coming from the field. Naming issues have been minimized. Data entry of stick and scale corrections has been automated. Even with these improvements, additional checks are performed in the office prior to processing. Software developed by Measurement Sciences Inc. is used to prepare files for further data snooping, data analyses and creation of adjustment files.

Pre-processing includes computing of height differences (*.dh) and comparing current values to historical data. These checks include: comparison of multiple lines (*.srt), comparing "raw observations" between different campaigns (See Figure 6), current observations to current adjusted database values (See Figure 6). The software creates the Adjustment input file, depending on the adjustment package used.

In an effort to increase the redundancy of observations the AMD institutes both traditional elevation runs along with Bundle observations (See Figure 7). Bundle observations have proven invaluable for data snooping points with possible blunders or erroneous measurements. When working with a 2-D or 3-D control network one is able to resect the instrument (See Figure 8). This has proven beneficial when determining the quality of a particular set-up. Bundle points are plotted in SA to determine if there are any possible naming issues and to generate approximate values for the adjustment program.

Adjustment of data is performed with software developed by the University of New Brunswick, Fredericton New Brunswick (DEFNAN Version 2.05) DEFormatioN ANalysis Software. A stabile point analysis of different epochs is performed using an Iterative Weighted Similarity Transformation (IWST) which is part of the DEFNAN software package.

AMD has developed software to generate plots of control points using Google earth kml files. Adjusted values are then plotted via Google Earth. This ability to visually monitor the daily progress of elevation runs has greatly assisted with scheduling and planning purposes. Areas which require further observations are quickly recognized. The likelihood of key data not being collected is minimized thus eliminating the need to wait for tunnel access.

Figure 7: Bundle Set-up

Figure 8: Bundle Check and Resection

Google Earth Plot of Adjusted Control

Plot of Stable Point Analysis (IWST)

4. Conclusion

In summary the AMD is constantly looking at ways to improve the safety, quality and quantity of our daily tasks. The development of new technology and instrumentation requires us to be pro-active in designing new software and methodologies to meet these needs. Safety being of paramount importance has driven us to incorporate wireless technology in an effort to minimize personal radiation exposure. Procedures are continuously being modified and developed in order to allow for higher quality measurements, more redundancy and better statistics. Programs have and will be developed to make data collection and analysis more efficient and reliable.