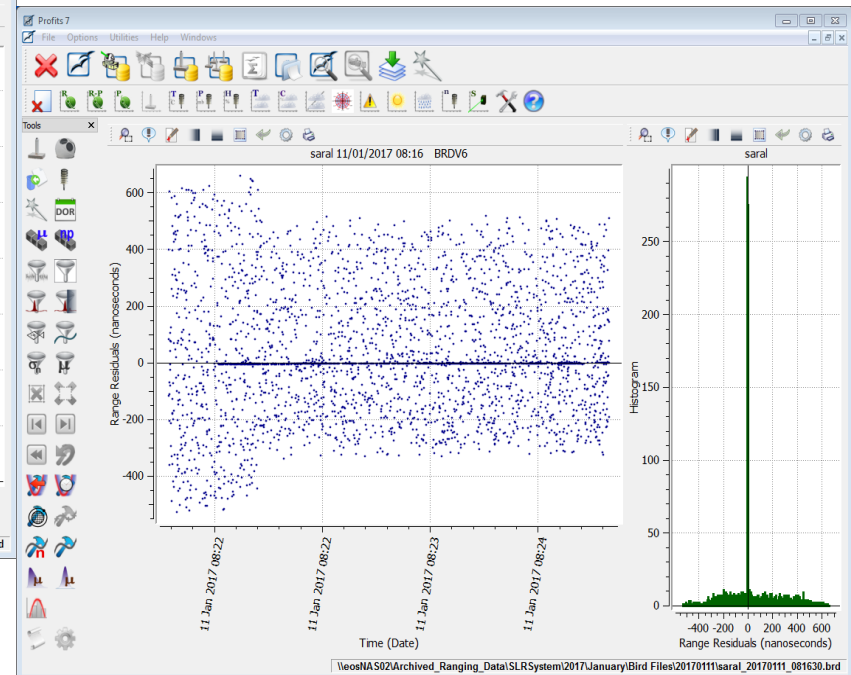
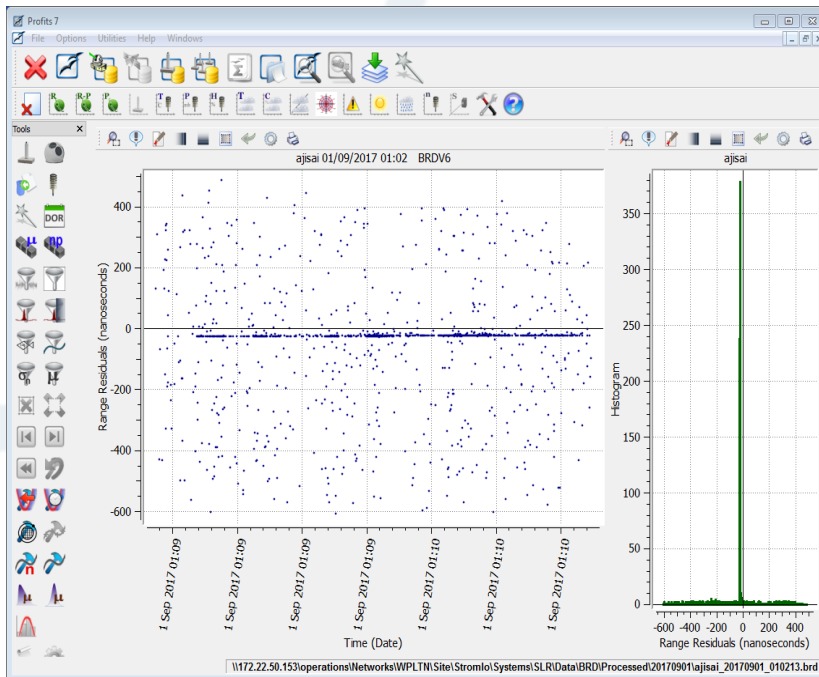


# Autonomous Post Processing

- ❑ Characteristics of Mt Stromlo System SLR ranging data;
  - Timing event epochs ( using CSPAD ).
  - Data collected in BRD files and processed when pre- and post-cals are available
  - Cal data is also collected in BRD files and processed as another target.
  
- ❑ What are the challenges?
  - Managing and applying calibration data
  - Identifying returns from satellites vs noise

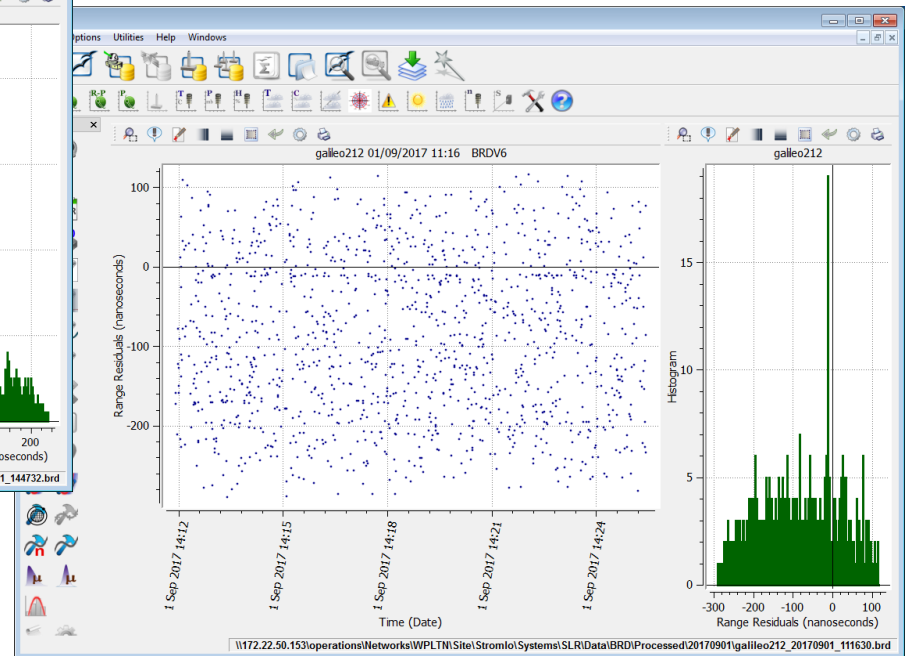
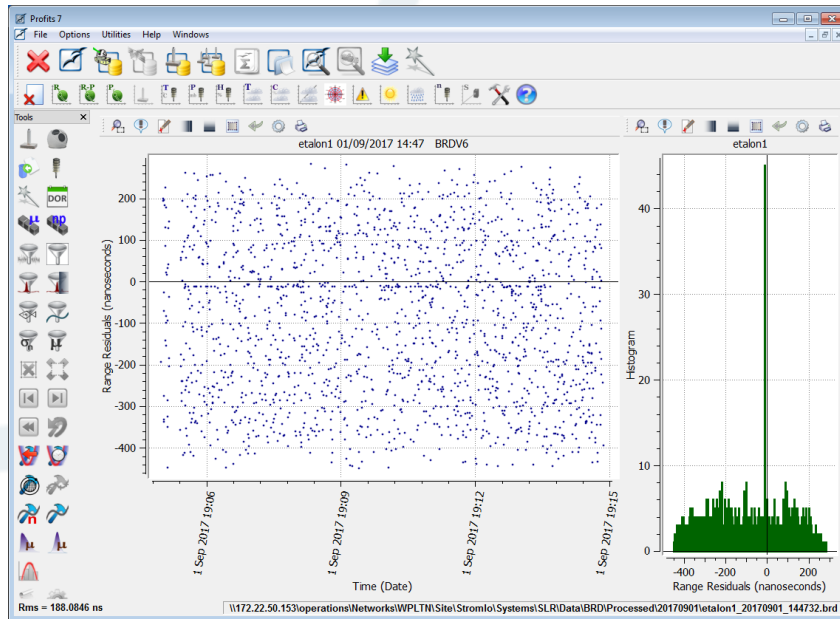
# Autonomous Post Processing

Examples of reasonably strong, flat signals in moderate noise. Easy to identify and extract the required signal.



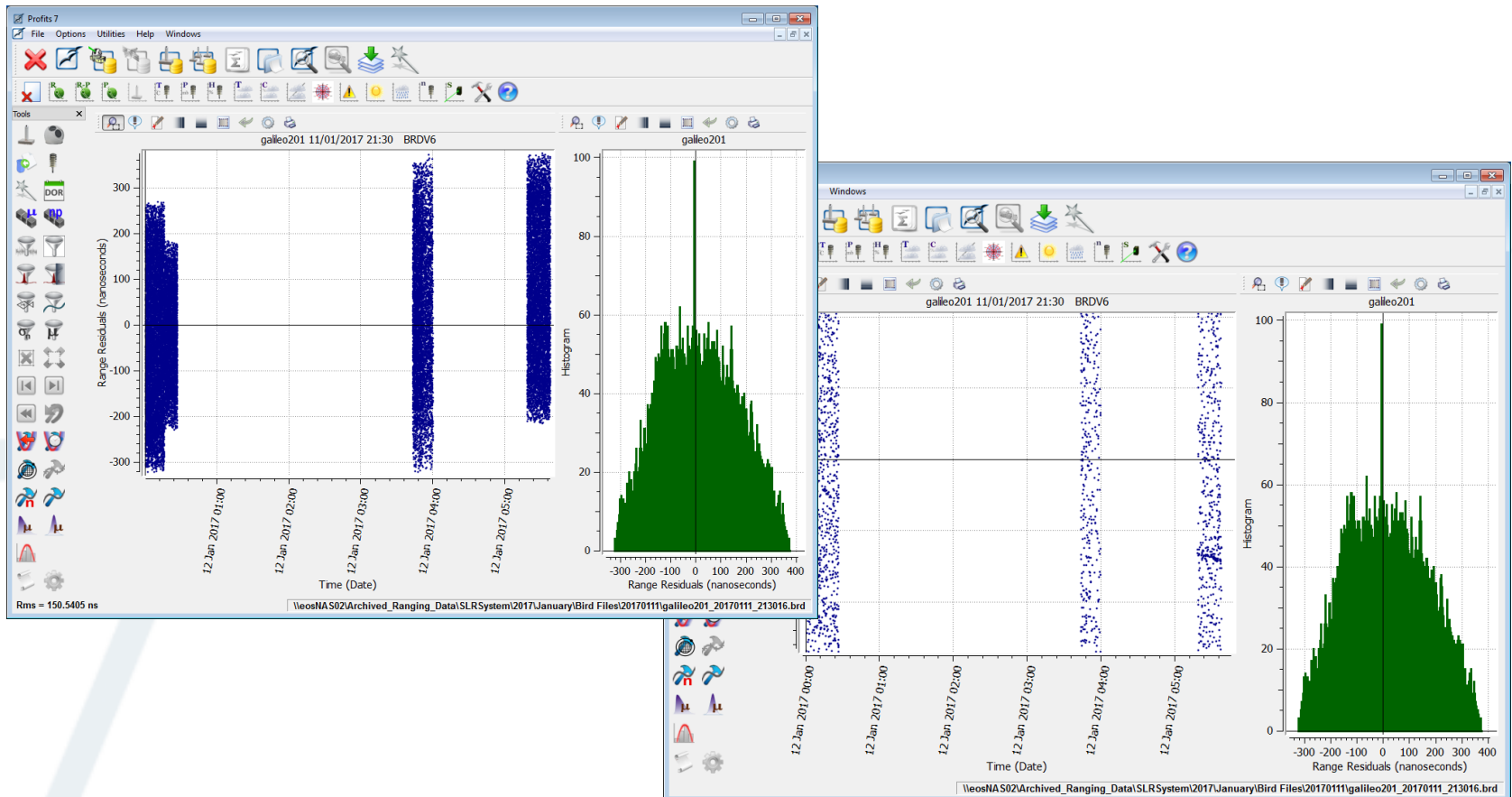
# Autonomous Post Processing

Examples of weak, flat signals in moderate noise. Still reasonably easy to identify and extract the required signal.



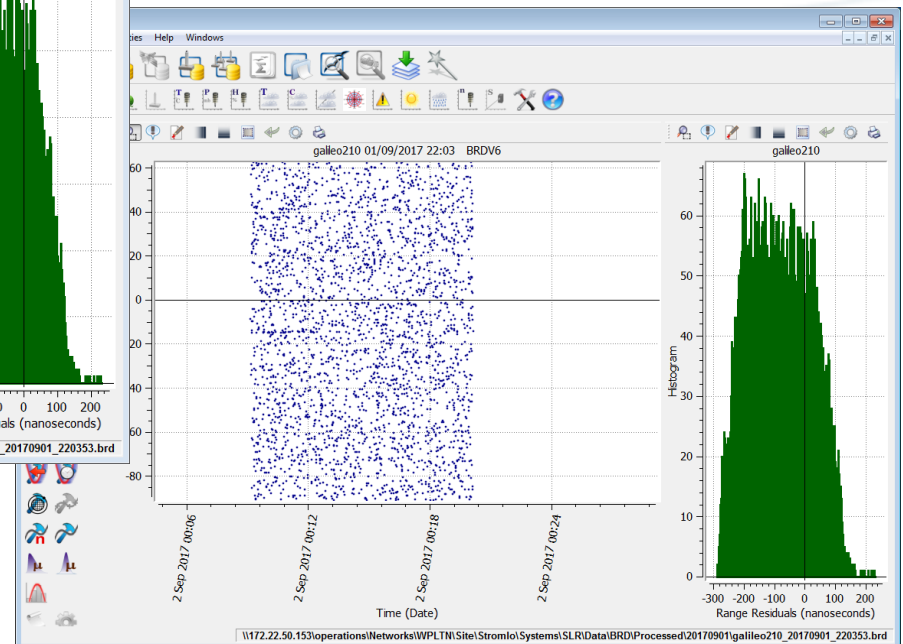
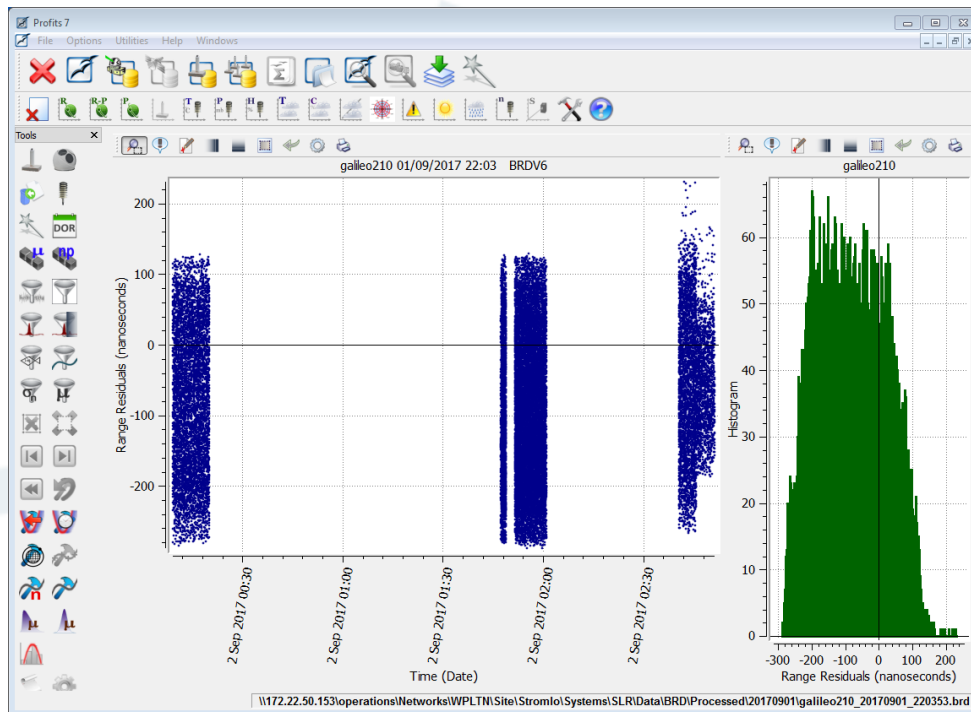
# Autonomous Post Processing

Example of a reasonable strong signal in strong noise. Still able to identify and extract the required signal.



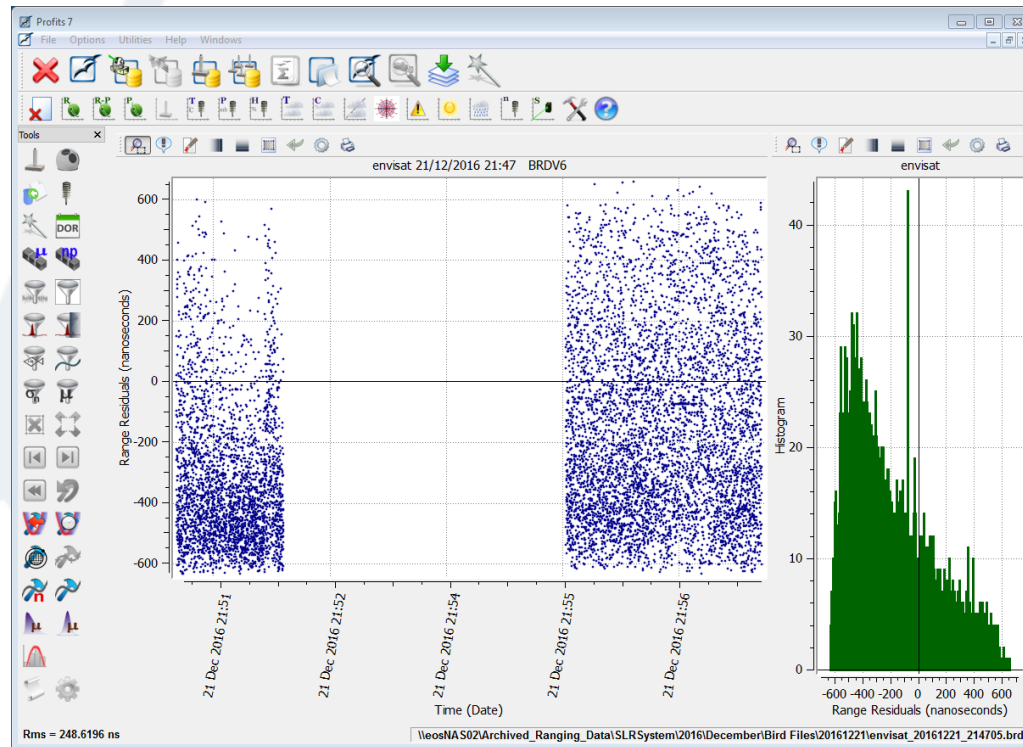
# Autonomous Post Processing

Example of a weak signal in strong noise. Identification and extraction of the required signal is very difficult.



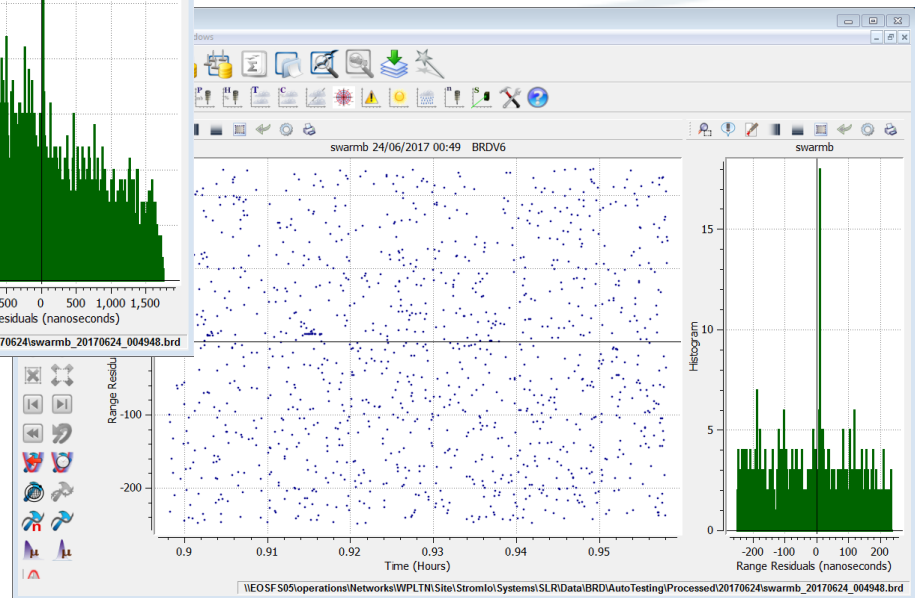
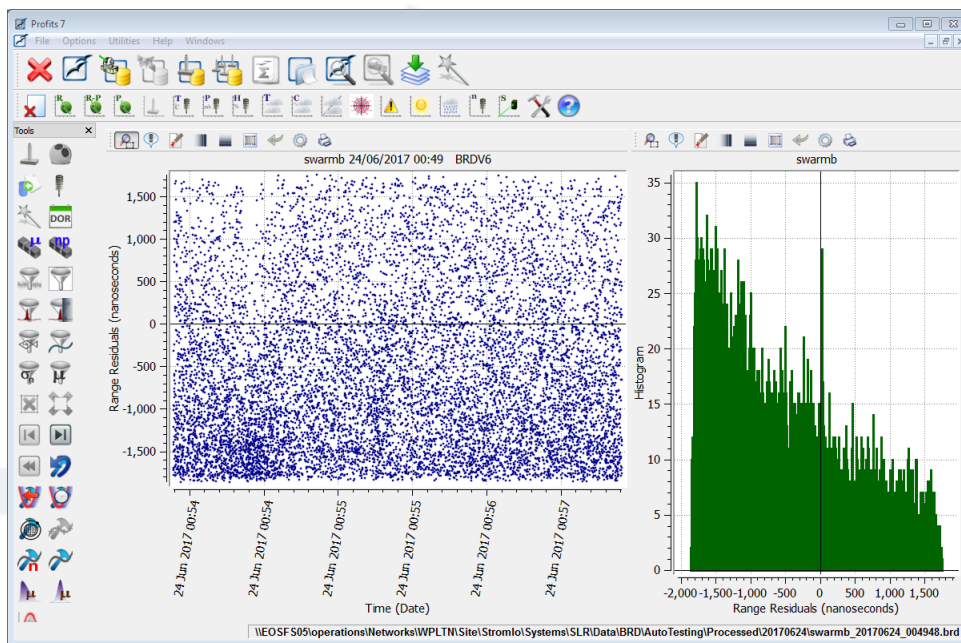
# Autonomous Post Processing

Examples of a signal in cloud noise. More difficult to identify and extract the required signal.



# Autonomous Post Processing

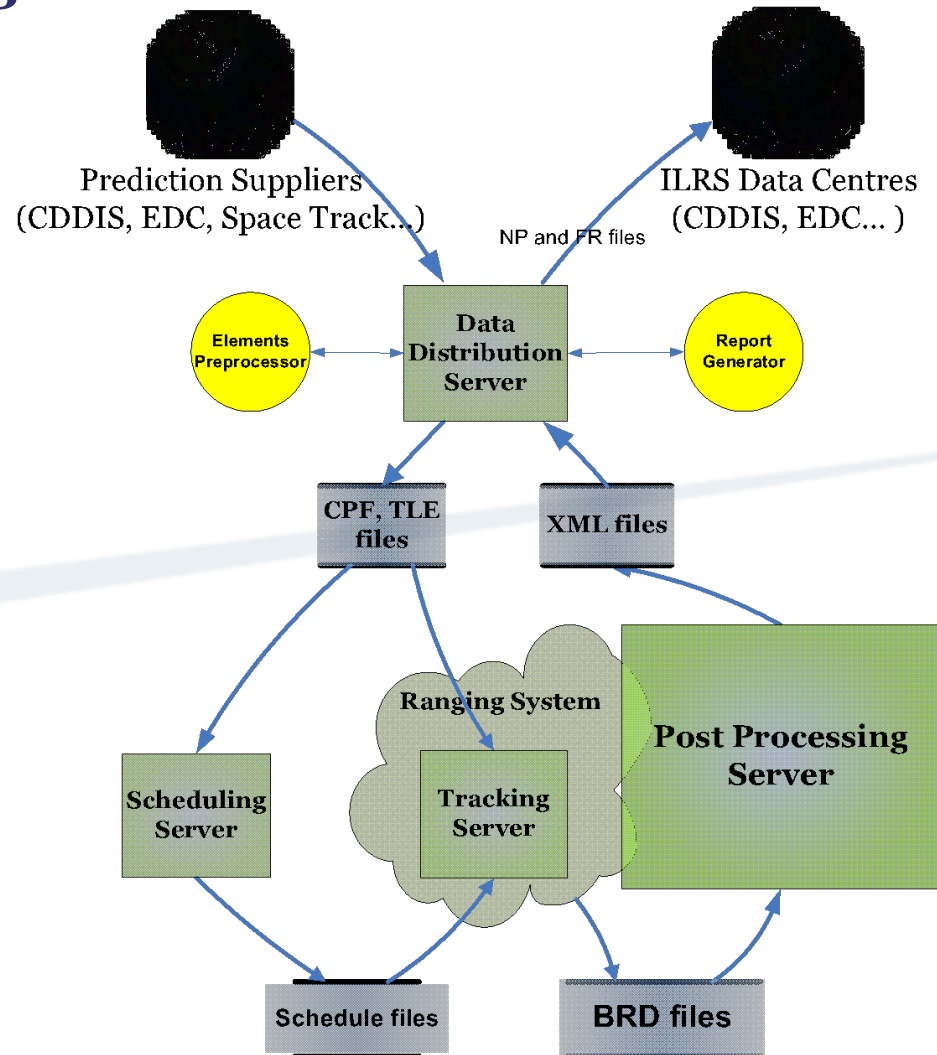
Examples of a weak signal in cloud noise. Very difficult to identify and extract the required signal.





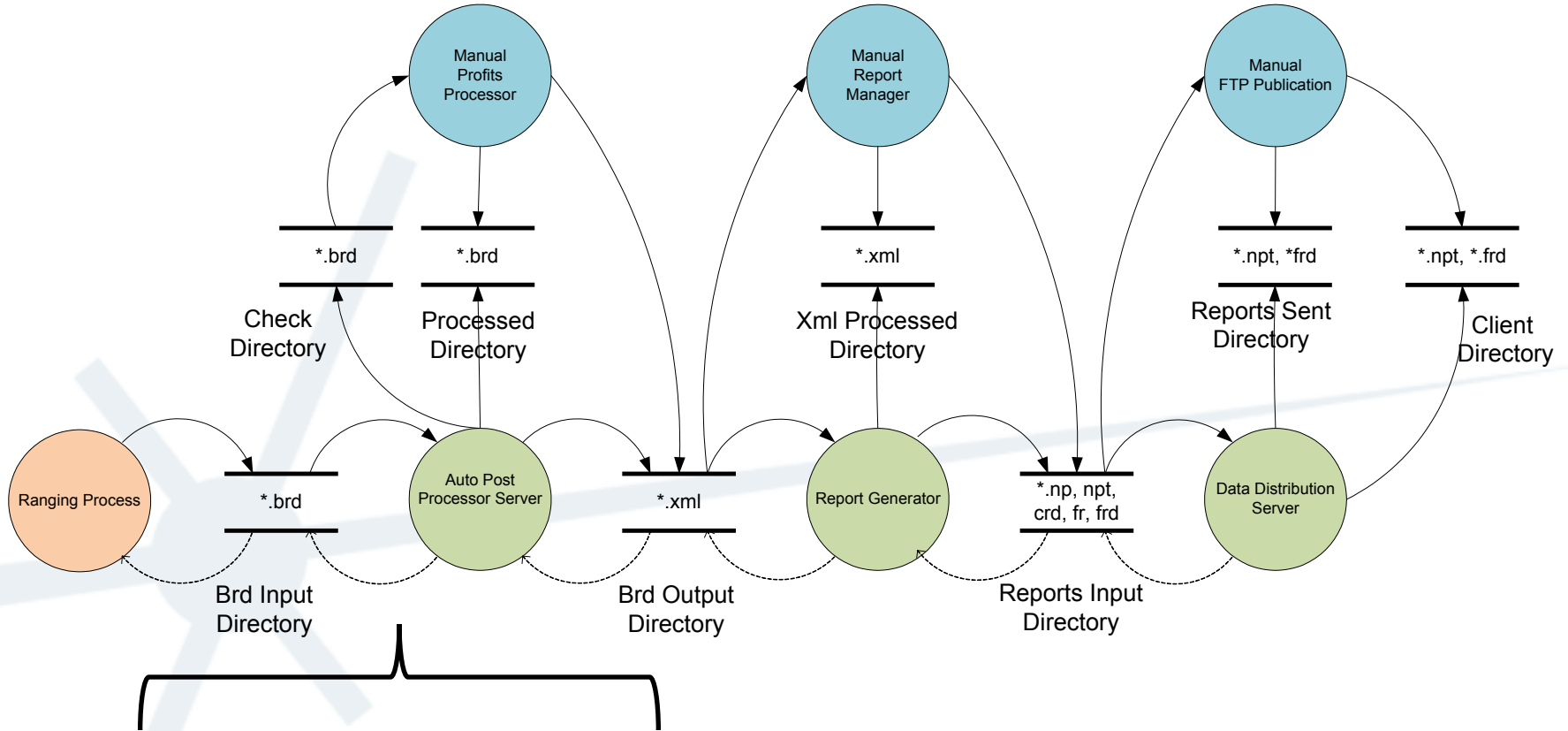
# Autonomous Post Processing

## Mt Stromlo SLR System Schematic of Primary Automation Servers





# Autonomous Post Processing

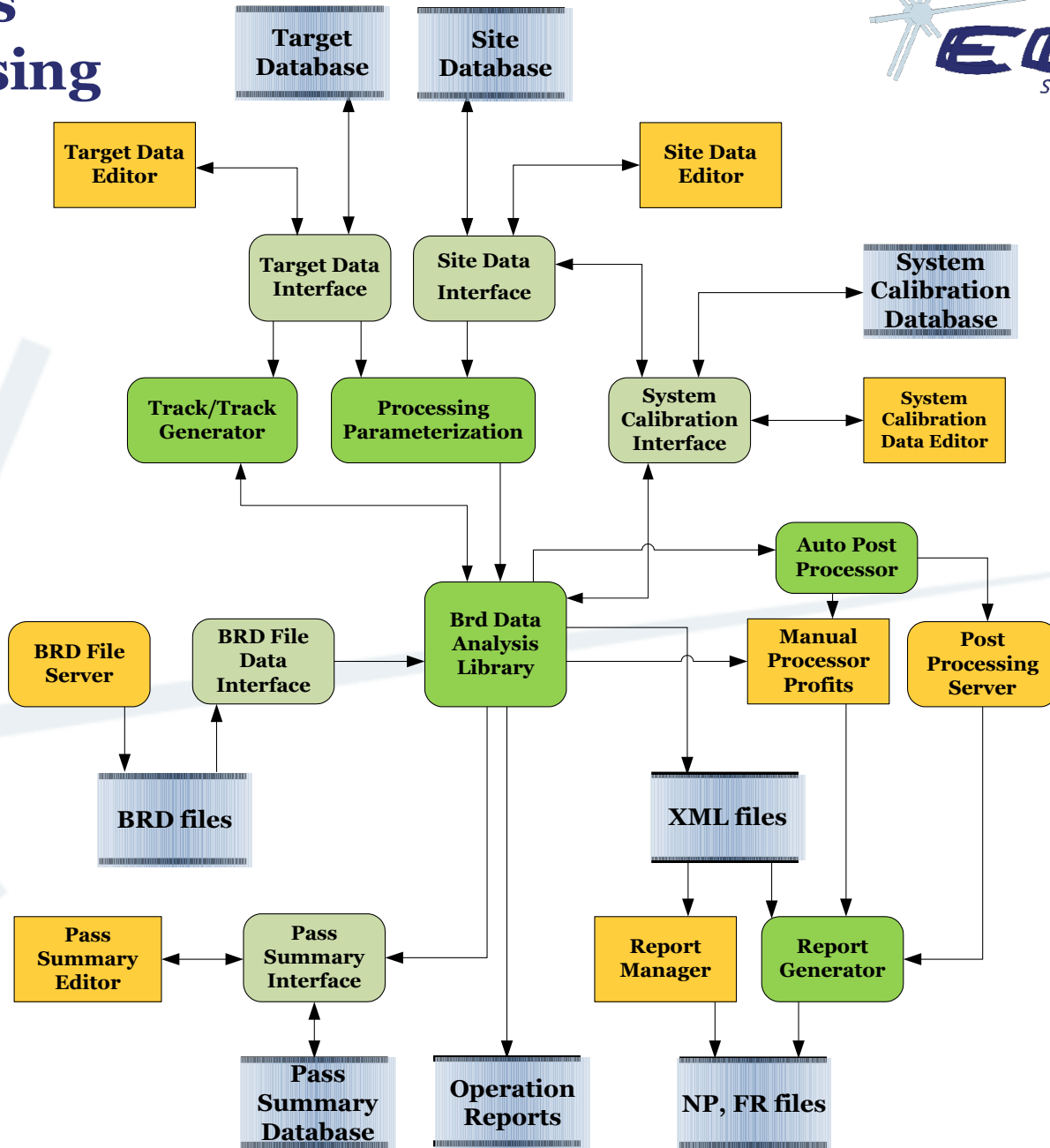


BRD file post processing stream

# Autonomous Post Processing



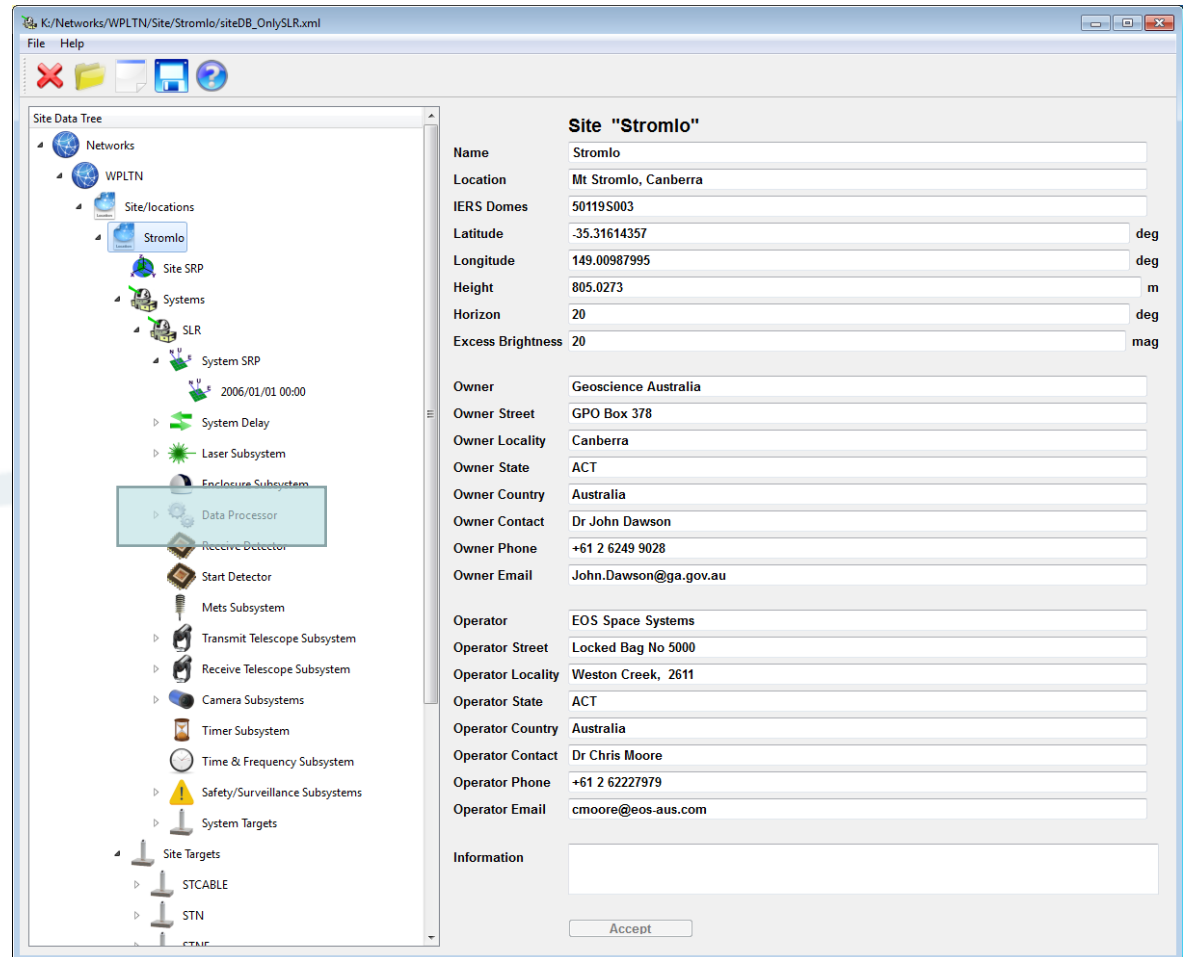
Software modules supporting autonomous range data processing



# Autonomous Post Processing

## Site Database

Site based  
parameterization  
for post processor



The screenshot shows a software window titled "K:/Networks/WPLTN/Site/Stromlo/siteDB\_OnlySLR.xml". The interface is divided into two main sections: a "Site Data Tree" on the left and a "Site 'Stromlo'" configuration panel on the right.

**Site Data Tree:** A hierarchical tree view showing the site structure. The "Data Processor" node is highlighted with a blue selection box. Other nodes include Networks, WPLTN, Site/locations, Stromlo, Site SRP, Systems, SLR, System SRP, System Delay, Laser Subsystem, Enclosure Subsystem, Receive Detector, Start Detector, Mets Subsystem, Transmit Telescope Subsystem, Receive Telescope Subsystem, Camera Subsystems, Timer Subsystem, Time & Frequency Subsystem, Safety/Surveillance Subsystems, System Targets, and Site Targets.

**Site "Stromlo" Configuration Panel:** A form with various fields for site parameters and contact information.

Field	Value
Name	Stromlo
Location	Mt Stromlo, Canberra
IERS Domes	50119S003
Latitude	-35.31614357 deg
Longitude	149.00987995 deg
Height	805.0273 m
Horizon	20 deg
Excess Brightness	20 mag
Owner	Geoscience Australia
Owner Street	GPO Box 378
Owner Locality	Canberra
Owner State	ACT
Owner Country	Australia
Owner Contact	Dr John Dawson
Owner Phone	+61 2 6249 9028
Owner Email	John.Dawson@ga.gov.au
Operator	EOS Space Systems
Operator Street	Locked Bag No 5000
Operator Locality	Weston Creek, 2611
Operator State	ACT
Operator Country	Australia
Operator Contact	Dr Chris Moore
Operator Phone	+61 2 62227979
Operator Email	cmoore@eos-us.com
Information	

An "Accept" button is located at the bottom of the configuration panel.

# Autonomous Post Processing



## Target Database

Target parameterization also used for post processing

The screenshot shows a software window titled 'K:/Targets/targetDB.xml' with a menu bar (File, Tools, Select, Analysis, Help) and a toolbar. The main area is divided into two panes. The left pane, 'Target List', shows a tree view of target categories: Reflector, Transponder, and Tracking Parameters. Under Tracking Parameters, a list of targets is shown with their IDs and names. The right pane, 'Target "stella"', displays detailed parameters for the selected target.

Target List	Target Names
21574	ers1
21853	glonass53
22056	glonass56
22057	glonass57
22076	topex
22195	lageos2
22779	gps35
22824	stella
Reflector	
Transponder	
Tracking Parameters	
22969	meteor36
23027	gps36
23043	glonass62
23044	glonass63
23045	glonass64
23203	glonass65
23204	glonass66
23205	glonass67
23396	glonass68
23397	glonass69
23398	glonass70
23511	glonass71

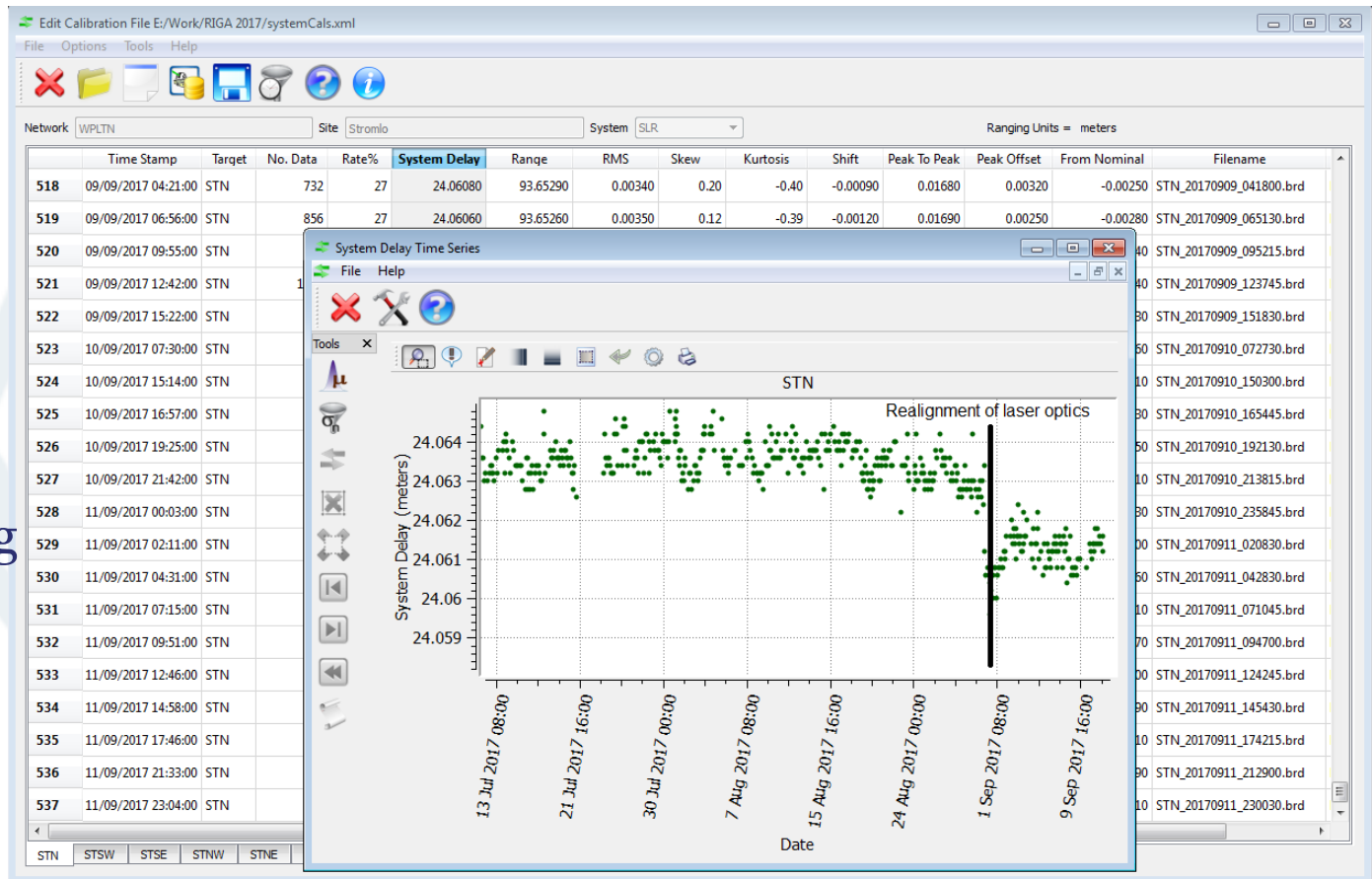
Target "stella"	Value	Unit
Name	stella	
Satellite Catalog Number	22824	
Cospar	1993-061B	
Start Time	1993/9/26 00:00:00	
Expiry Time	7999/12/31 00:00:00	
Launch Year	1993	
Launch Number	61	
Launch Segment	2	
ILRS SIC	0643	
Description		
Area	0.17	sq m
Visual Magnitude	0	
Centre Of Mass Correction	0.0	mm
Signature	4.0	mm
Inclination	98.6	deg
Minimum Altitude	795	Km
Maximum Altitude	802	Km
Debris	<input type="checkbox"/>	
Type	Orbital	
SubType	Geodetic	
Owner	CNES	
Information		

Accept

# Autonomous Post Processing



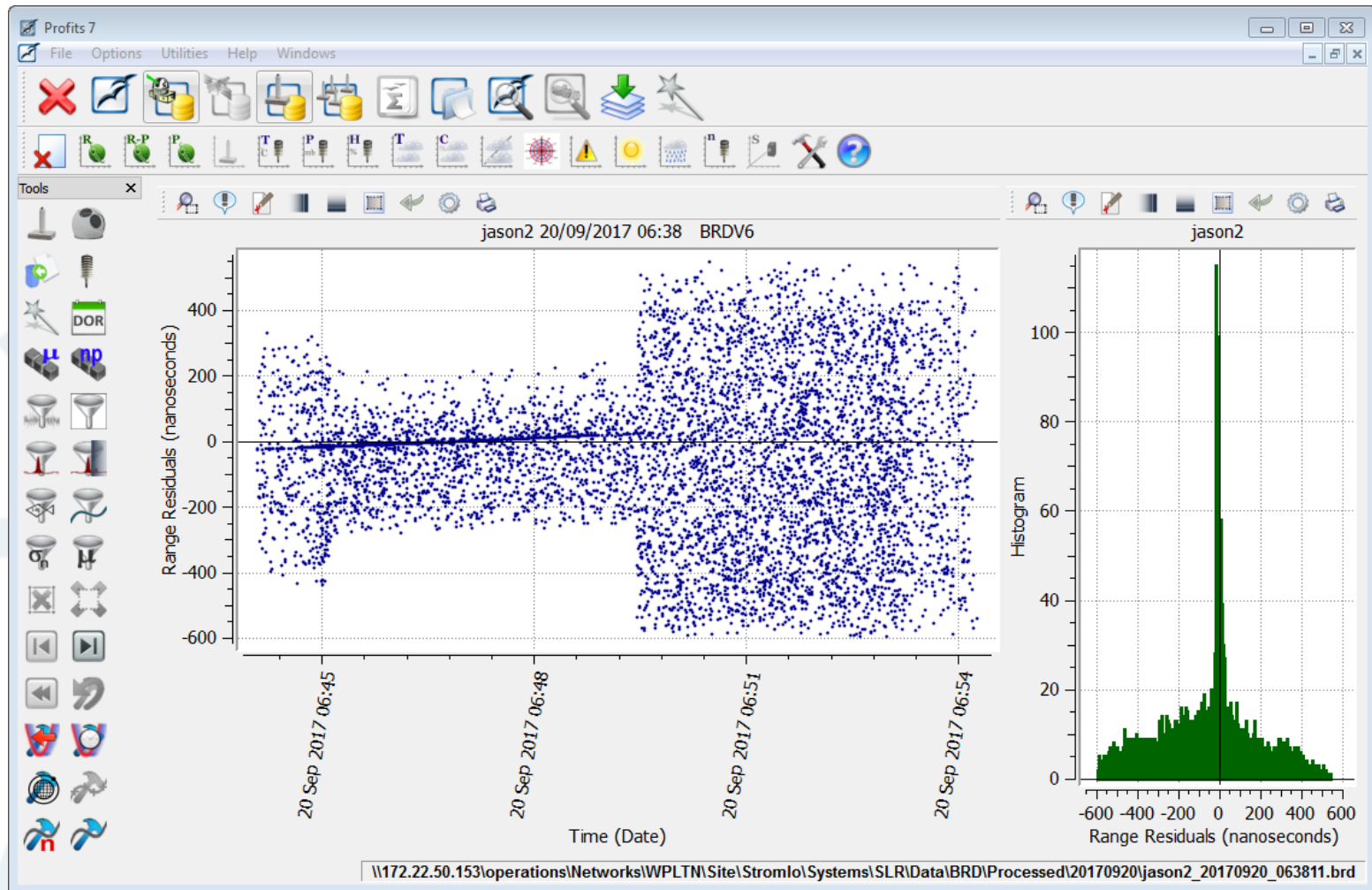
## System Calibration Database



Pre and post system calibrations required for post processing

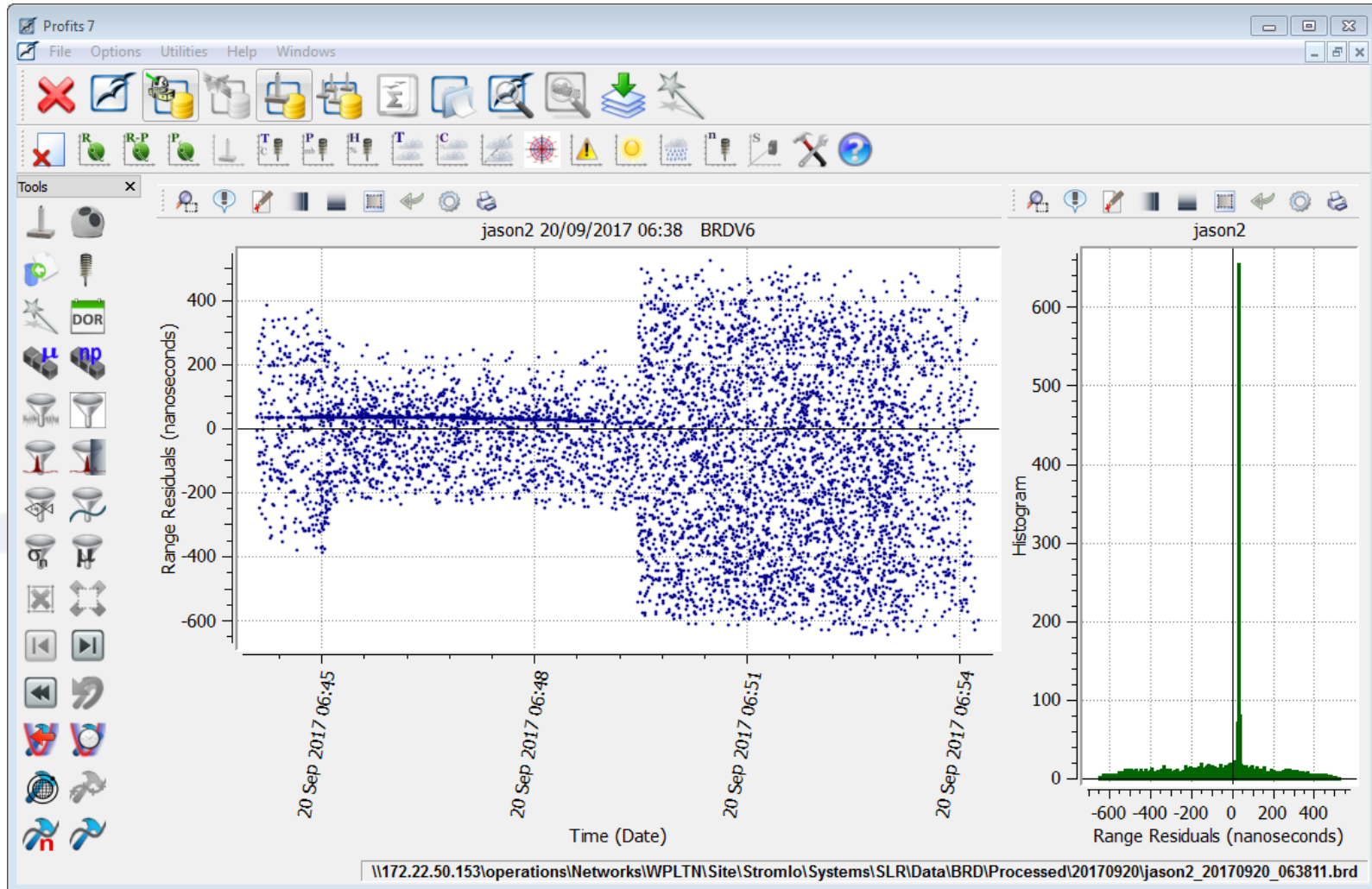
# Autonomous Post Processing

## Post Processing Steps – input range data



# Autonomous Post Processing

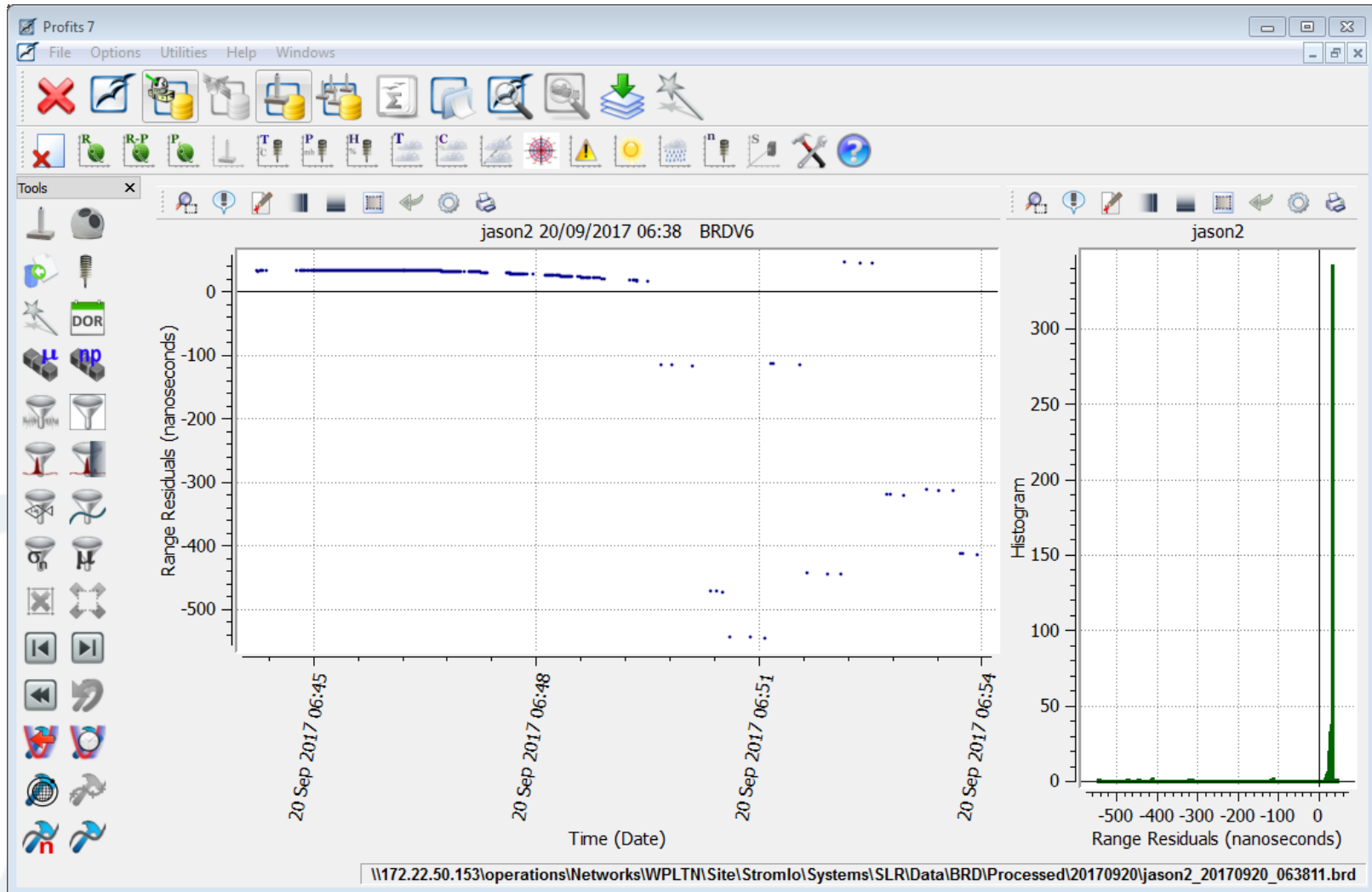
## Post Processing Steps – after time bias sweep





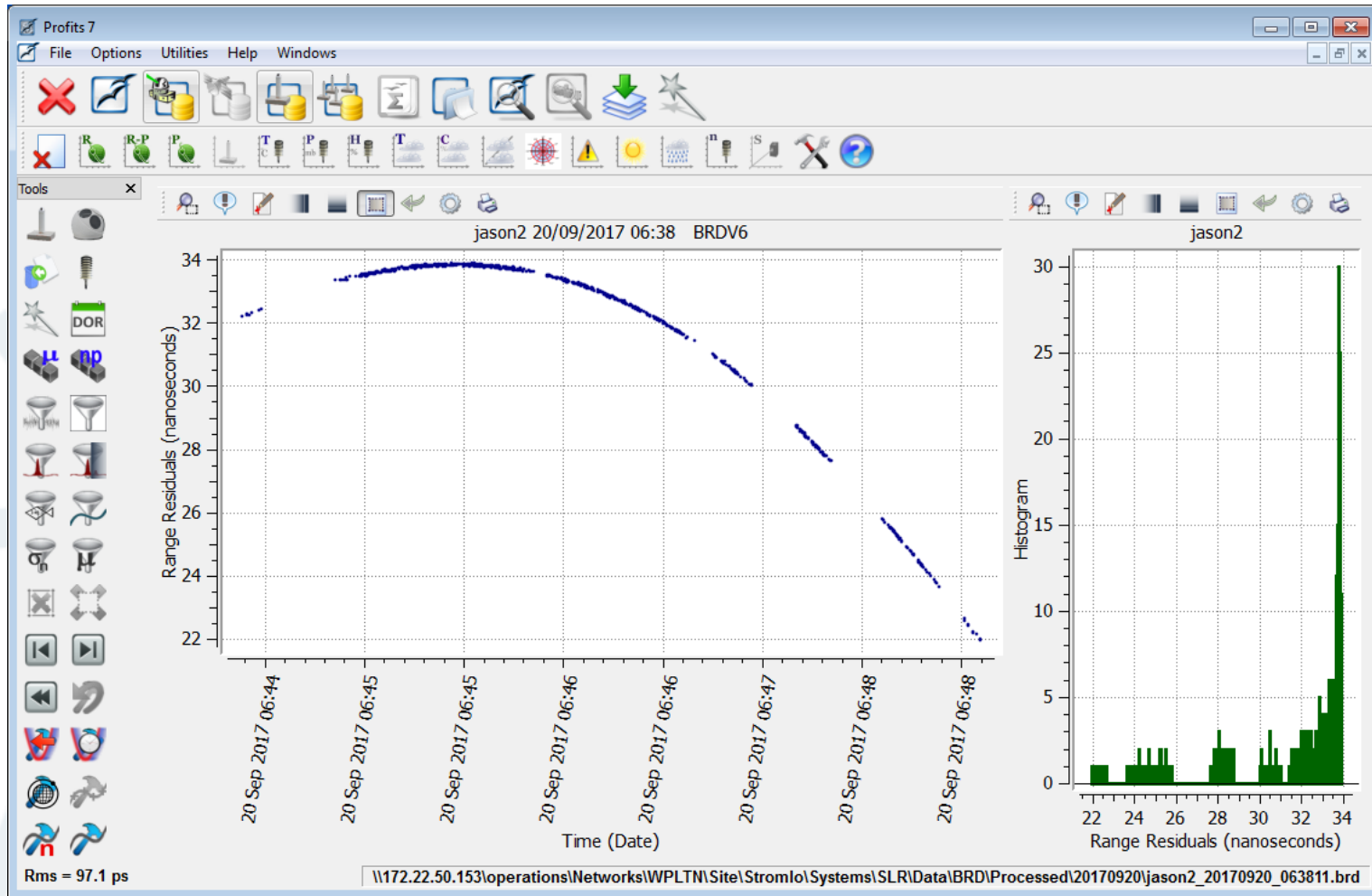
# Autonomous Post Processing

## Post Processing Steps – after Poisson filtering



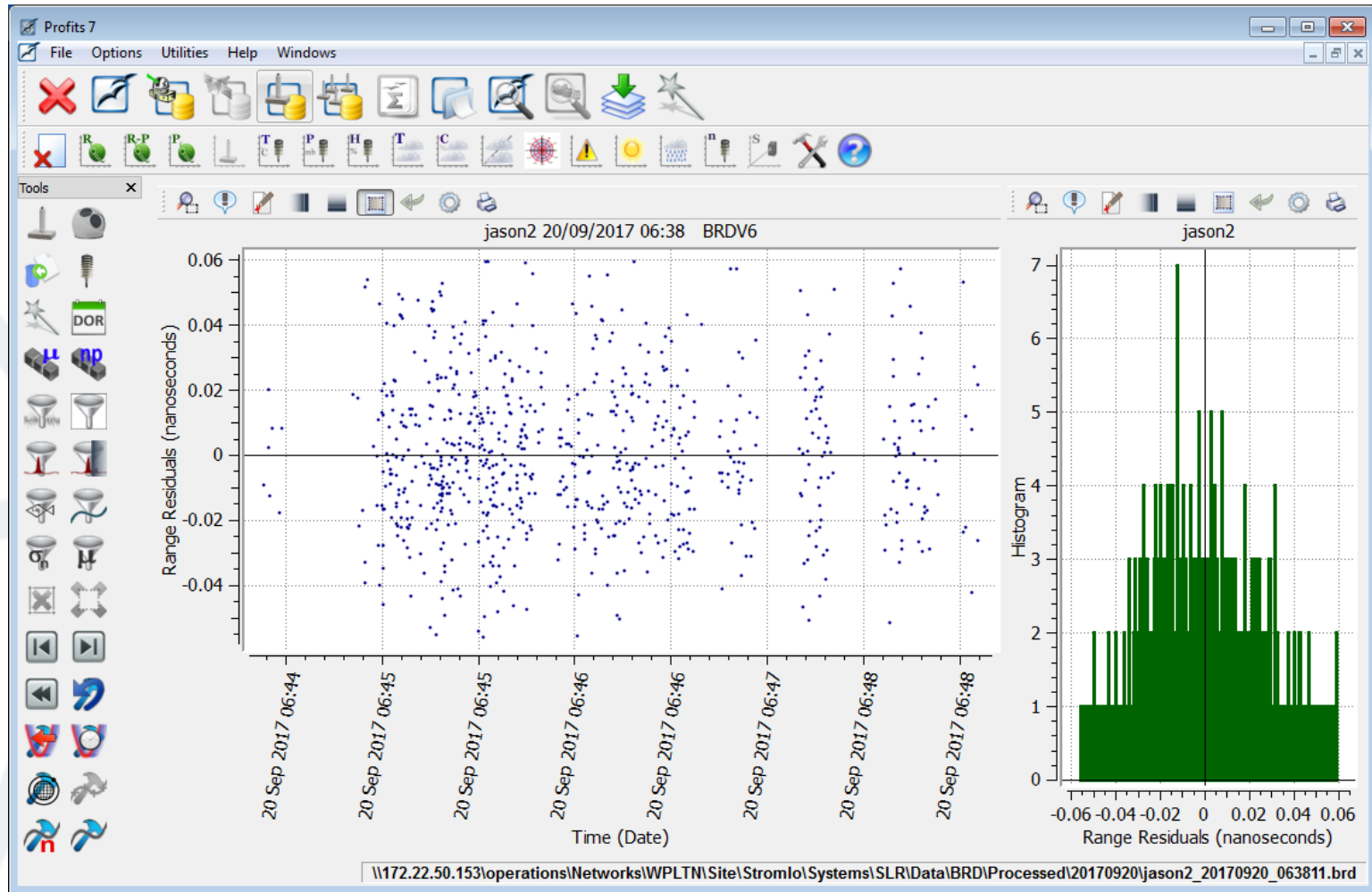
# Autonomous Post Processing

## Post Processing Steps – after polynomial filtering



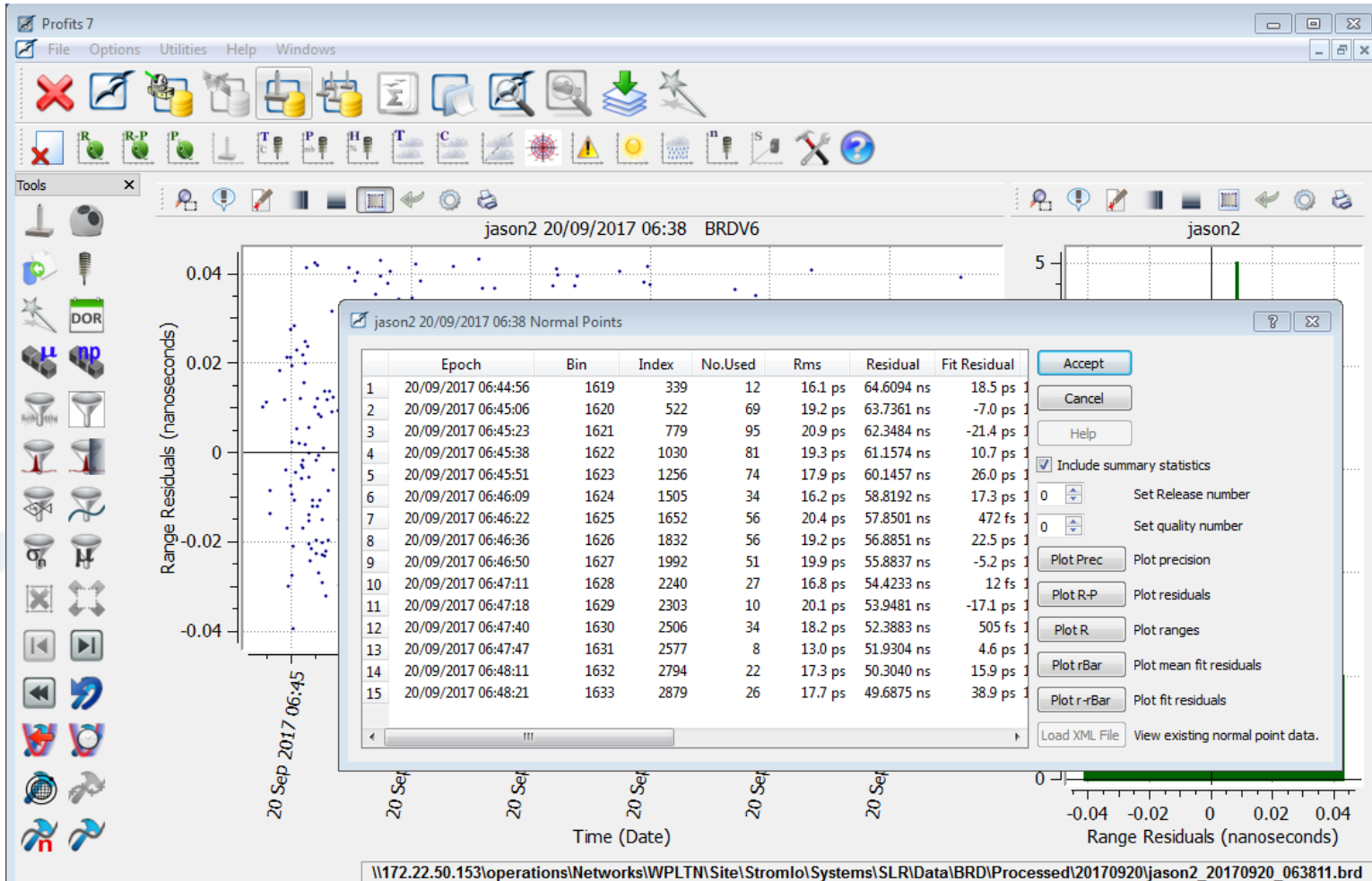
# Autonomous Post Processing

## Post Processing Steps – after polynomial fitting



# Autonomous Post Processing

## Post Processing Steps – Normal Point Generation

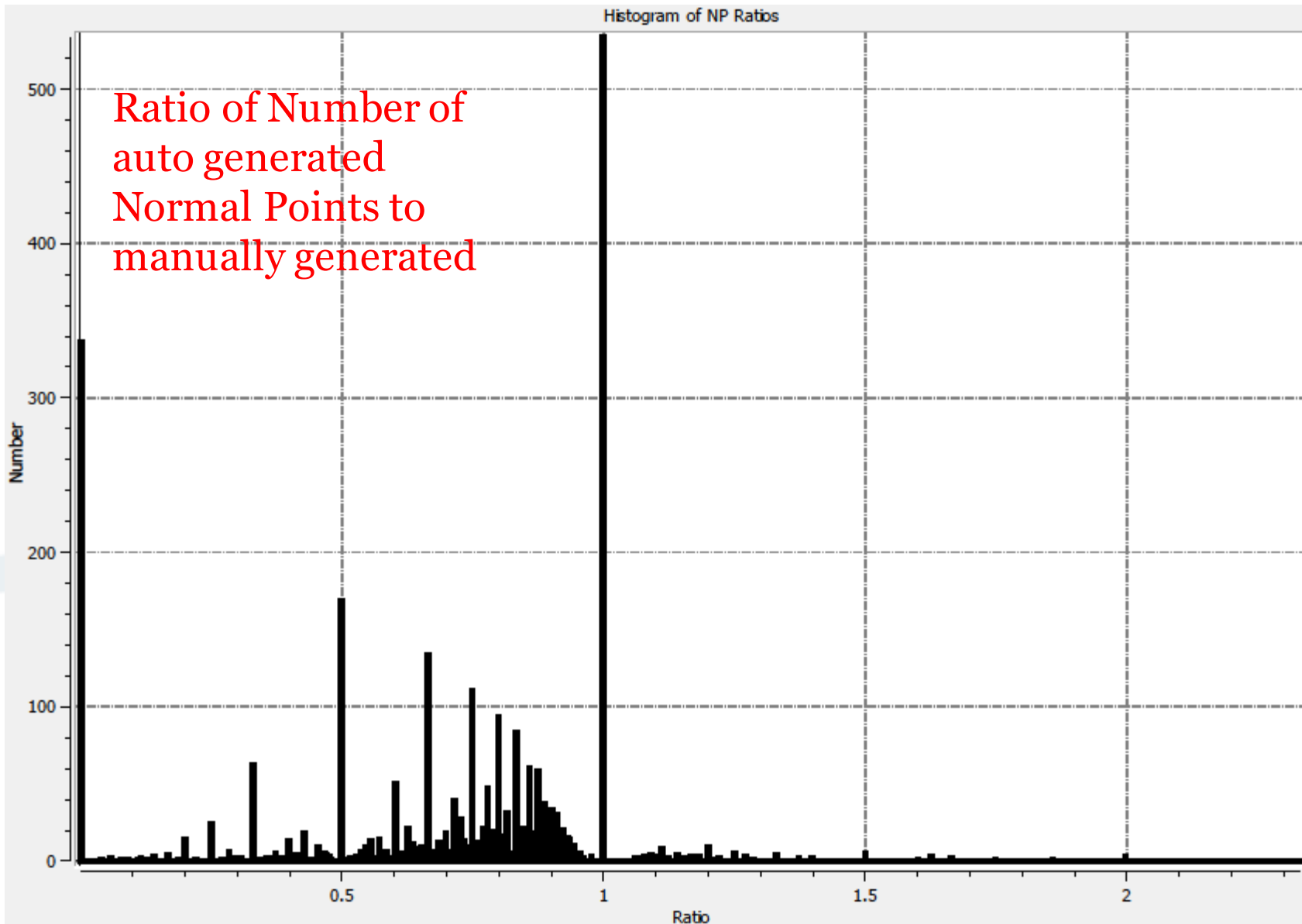


# Autonomous Post Processing Analysis

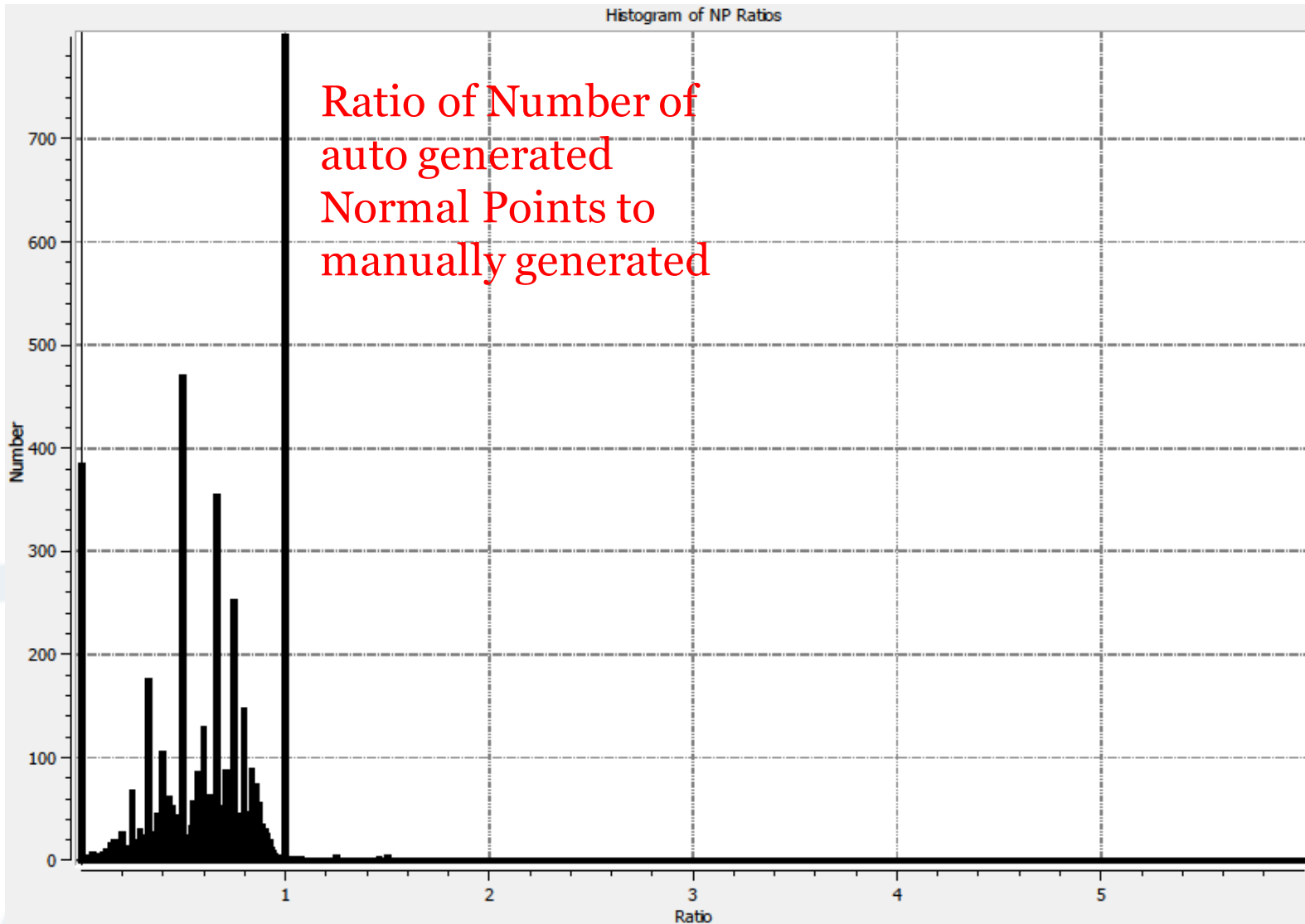


- Analysis of differences between manually and automatically processed BRD files.
- Post processor server supports repeated re-analysis of BRD files.
- Allows comparison of results from ~20000 BRD files (obtained in 2017).
- Able to identify and focus on outliers.
- Provides average statistics.

# Autonomous Post Processing Analysis

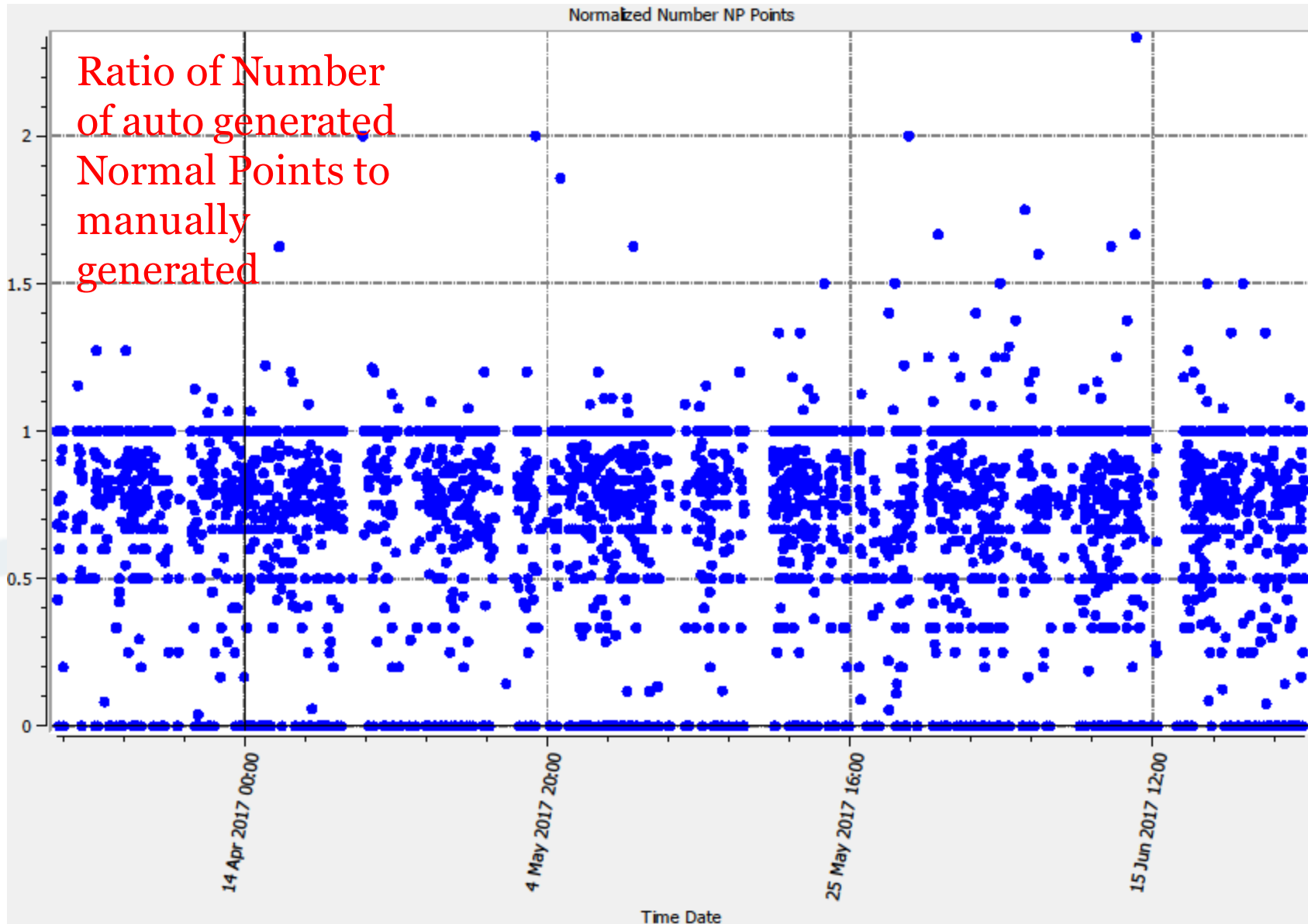


# Autonomous Post Processing Analysis

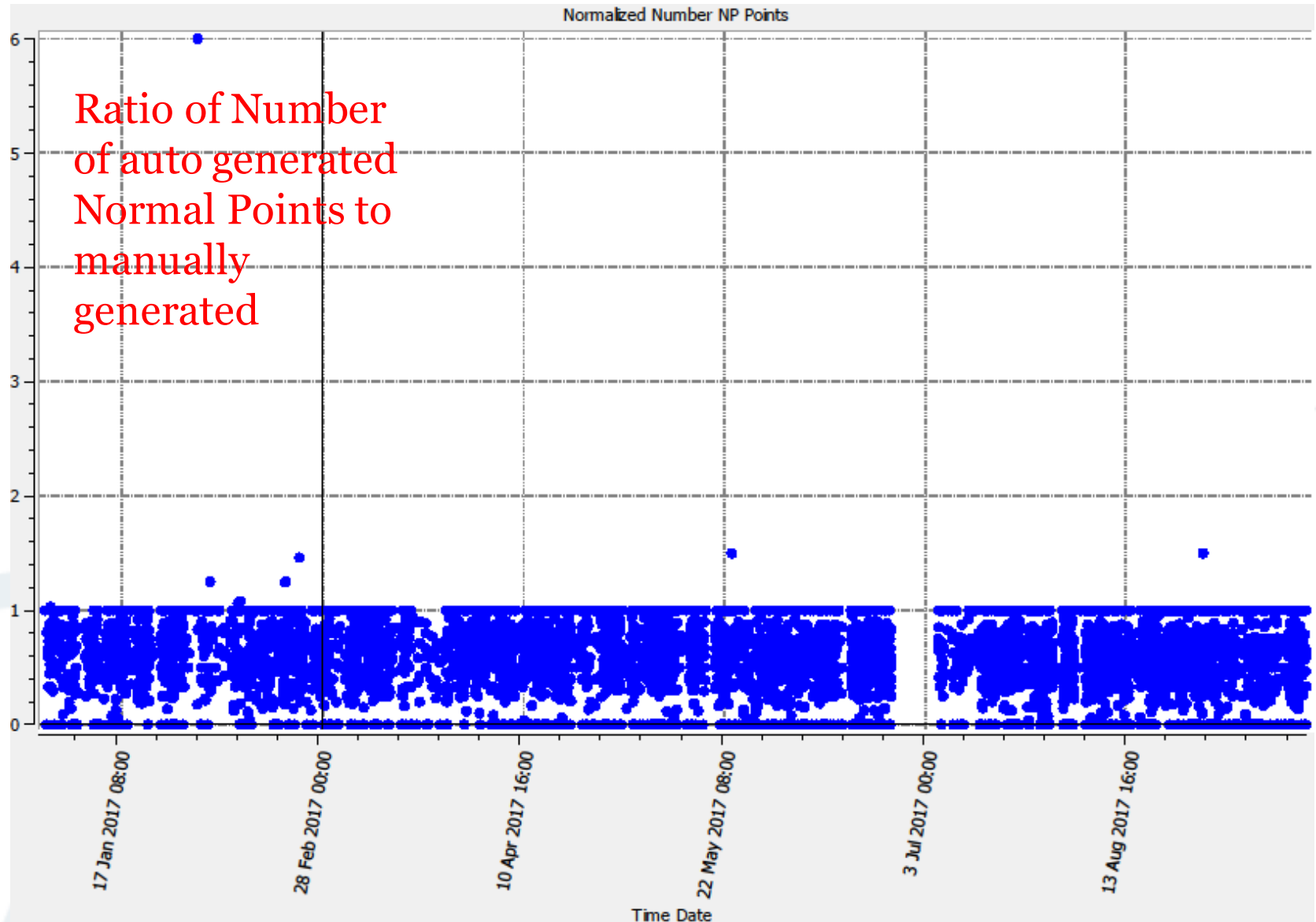




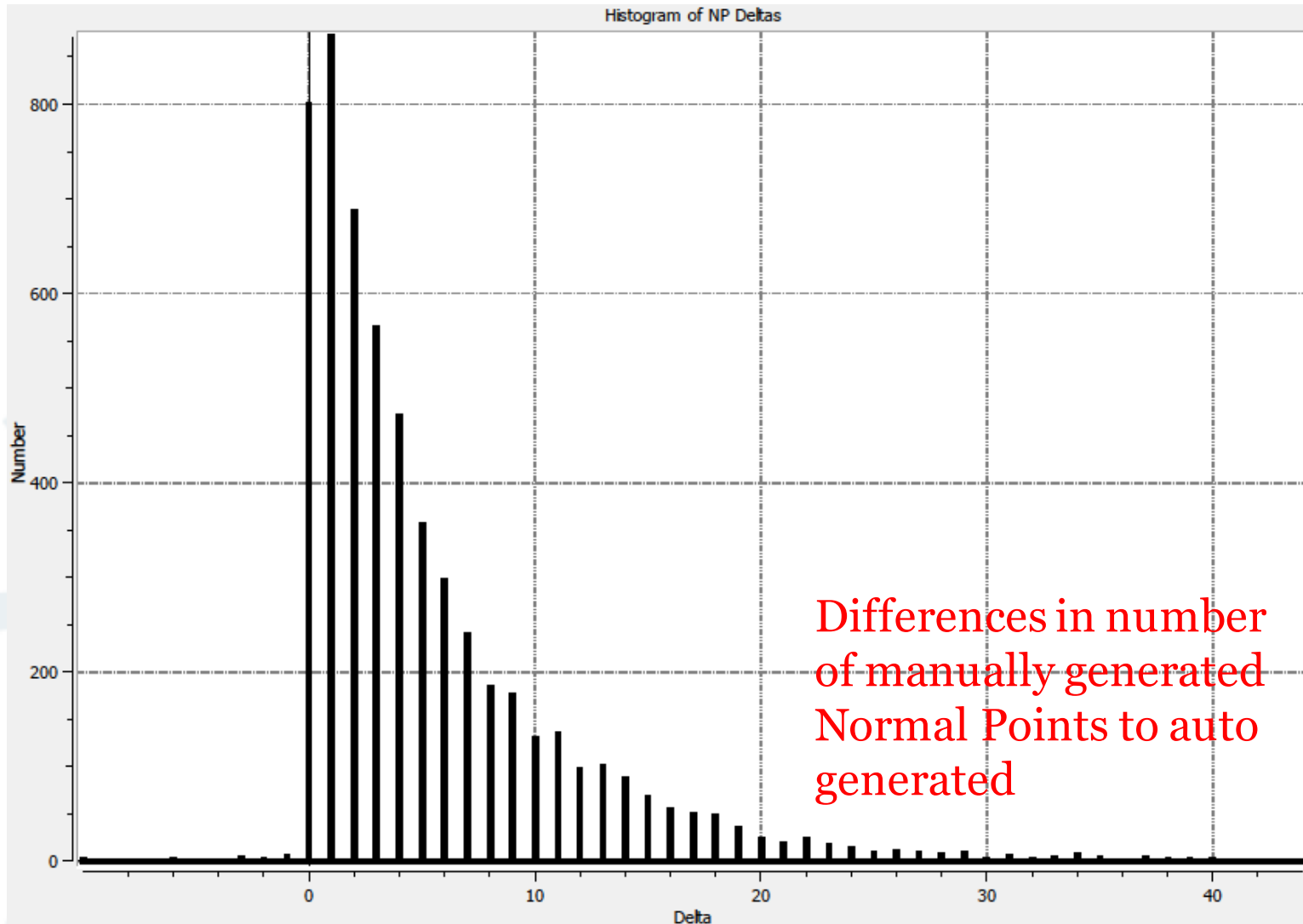
# Autonomous Post Processing Analysis



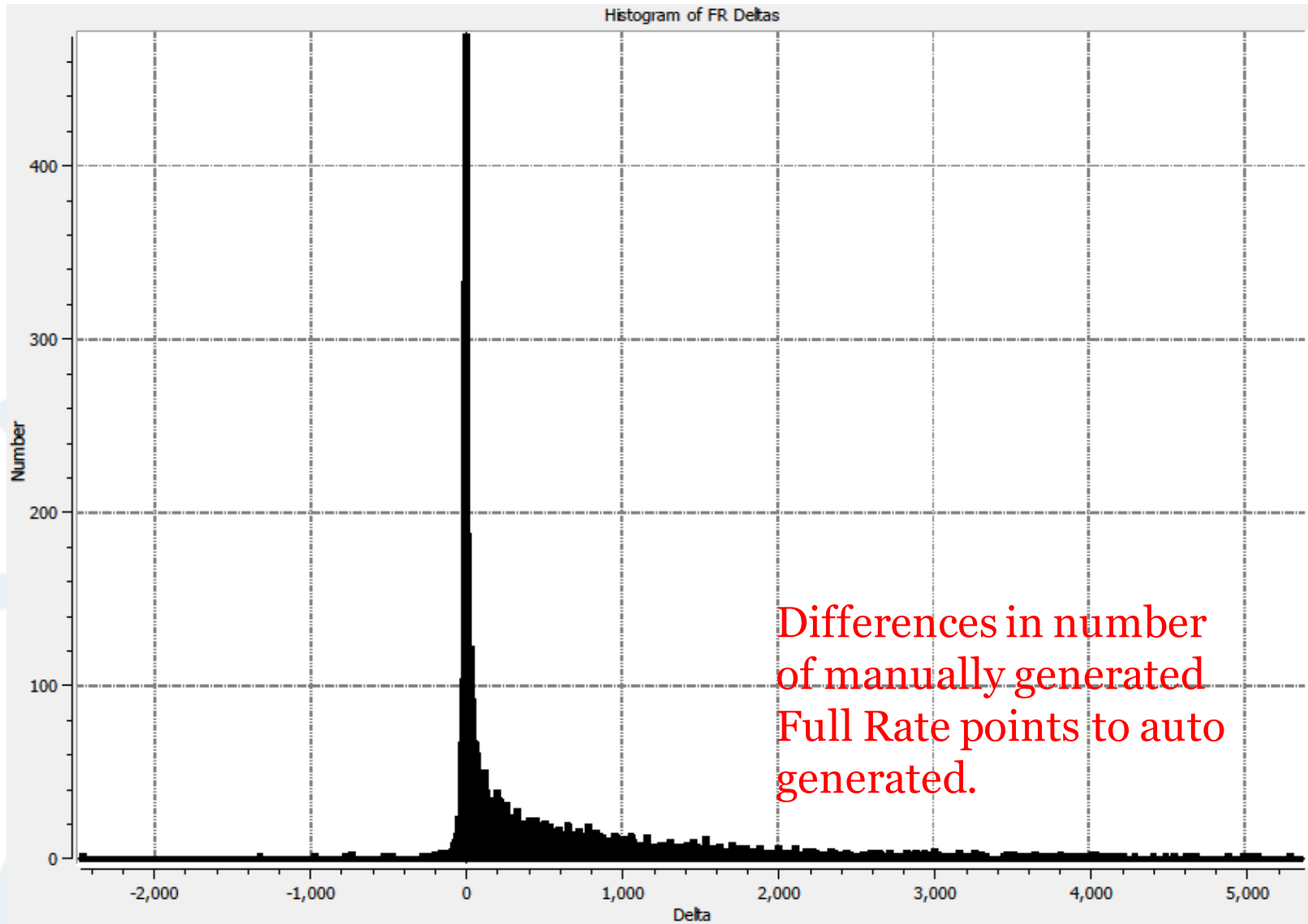
# Autonomous Post Processing Analysis



# Autonomous Post Processing Analysis



# Autonomous Post Processing Analysis



## Summary & Plans

- Automated processing well developed.
- Refinements to remove spurious points.
- Switch publication of results from manually processed to automated.
- Continuous improvement to reduce lost points.

# Binary Range Data files (\*.BRD)

- Captures raw data from the ranging system, including;
  - Pass metadata
  - Shot Events
  - Mets, Cloud data
  - Telescope Pointing
  - Prediction Element(s)
  - System State/Interlocks
  - Current site database
  - Current Target characteristics
- Stored as serialized files using Google's Protocol Buffers.
- Input to post-processing stream.

## Binary Range Data files (\*.BRD)

Protocol Buffers is used to serialize Ranging data into \*.BRD files.

- BRD files <50% size of binary files and much smaller than XML etc.
- Support fast processing.
- Supports backward compatibility.
- Schema based. Maybe support sharing data.



## **Tip: Consider using Google's Protocol Buffers**

Protocol buffers are Google's language-neutral, platform-neutral, extensible mechanism for serializing structured data. A good solution for capturing SLR shot data for subsequent processing. Protobuf files are compact and support fast processing. Content can be easily upgraded while maintaining backward compatibility. Experience has shown that protobuf files of ranging data are 50% (small files) to 80% (large files) smaller than even binary files with fewer fields, yet have the advantages of self-describing formats like JSON or XML.

See: <https://developers.google.com/protocol-buffers/docs/reference/overview>

“Protocol buffers are a flexible, efficient, automated mechanism for serializing structured data – think XML, but smaller, faster, and simpler. You define how you want your data to be structured once, then you can use special generated source code to easily write and read your structured data to and from a variety of data streams and using a variety of languages. You can even update your data structure without breaking deployed programs that are compiled against the "old" format.”

### **Thought:**

Protocol buffers require a *schema* for the definition of the data fields to be stored in protobuf files. If adopted and the schema was common to all SLR stations, then it may be possible for SLR stations to read (and process) each other's ranging data files.

*Could this be a good thing???*