Data Analysis for experiments with 4-m telescope

Bhal Chandra Joshi
On behalf of Radio Physics Laboratory

Recap

- Main features of a radio telescope
- Review of astronomical coordinate systems
  - Horizon system
  - Equatorial system
  - Galactic system
- Coordinate conversions
- Aim of the experiment
  - Pointing offsets
  - Beam width

Observations log

3.2.1 Observation Table for Azimuth Scans

	Azimuth Scan- 1	Azimuth Scan - 2
Azimuth angle	Start: End:	Start: End:
Altitude angle End: Slew speed Time/Step	Start: End:	Start:
Scan Rcvr Data file name 1 Scan Encoder Data file name 1 Scan Data file name 2 hline Scan Encoder Data file name 2		

Observations log

- **Information useful during analysis**

- **Conditions during the experiment**

    - **Files where data are recorded**
    - **Sequence of observing / experimental procedure**
    - **Misbehaviour of instrument during the experiment**
    - **Radio frequency interference (RFI)**
    - **Any information that could potentially be a source of error**

- **Usually unpredictable information not recorded in the header**
- **Routinely recorded information can go into a computer generated header - GMRT header as an example**

- **Time/step, altitude during azimuth scan (?)**

Header

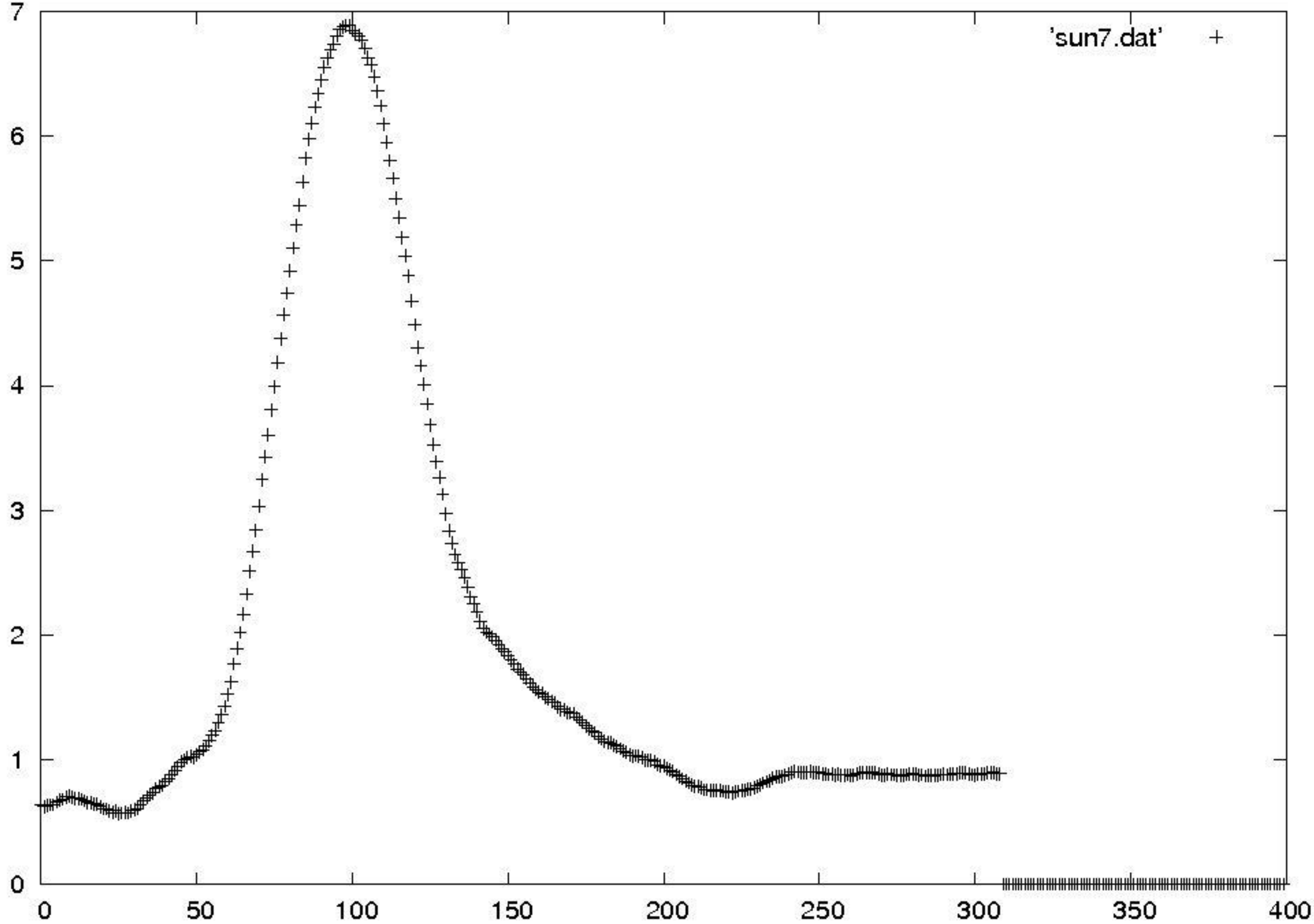
c 12 20 2011 15 19 26 0.200000 0 360 5 0
3.520499
3.522940
3.525382
3.525382
3.530264
3.535147
3.535147
3.537589
3.540030
3.542471
3.542471
3.544913
3.549796

Analysis

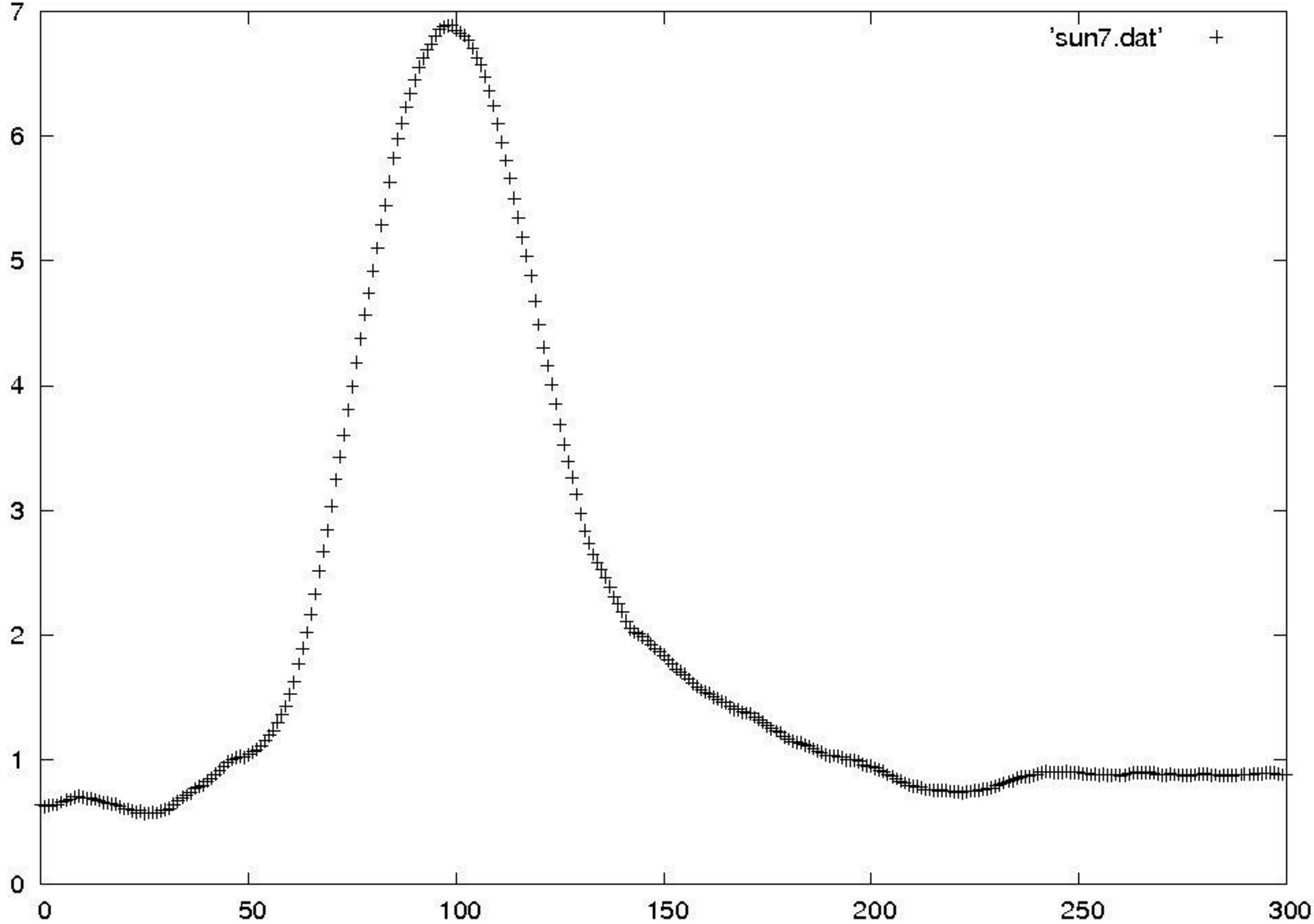
- **Standard steps in data analysis**
  - **Data exploration**
  - **Data selection**
  - **Data calibration and modeling**
  - **Measurements from the model with errors**
  - **Estimation of sources of errors**
  - **Interpretation**
- **Each is required in our experiment though in a simple minded manner**

Data exploration

- **Motivation**
  - **Determine bad or corrupted data**
  - **Possibility of systematic errors**
    - **Is data compromised beyond repair – repeat exp**
    - **Errors are tolerable – likely contribution to error budget**
  - **Look for trends in data for suitable models**
- **Utilities for GMRT like data**
  - **Tax, xtract, utilities in AIPS**

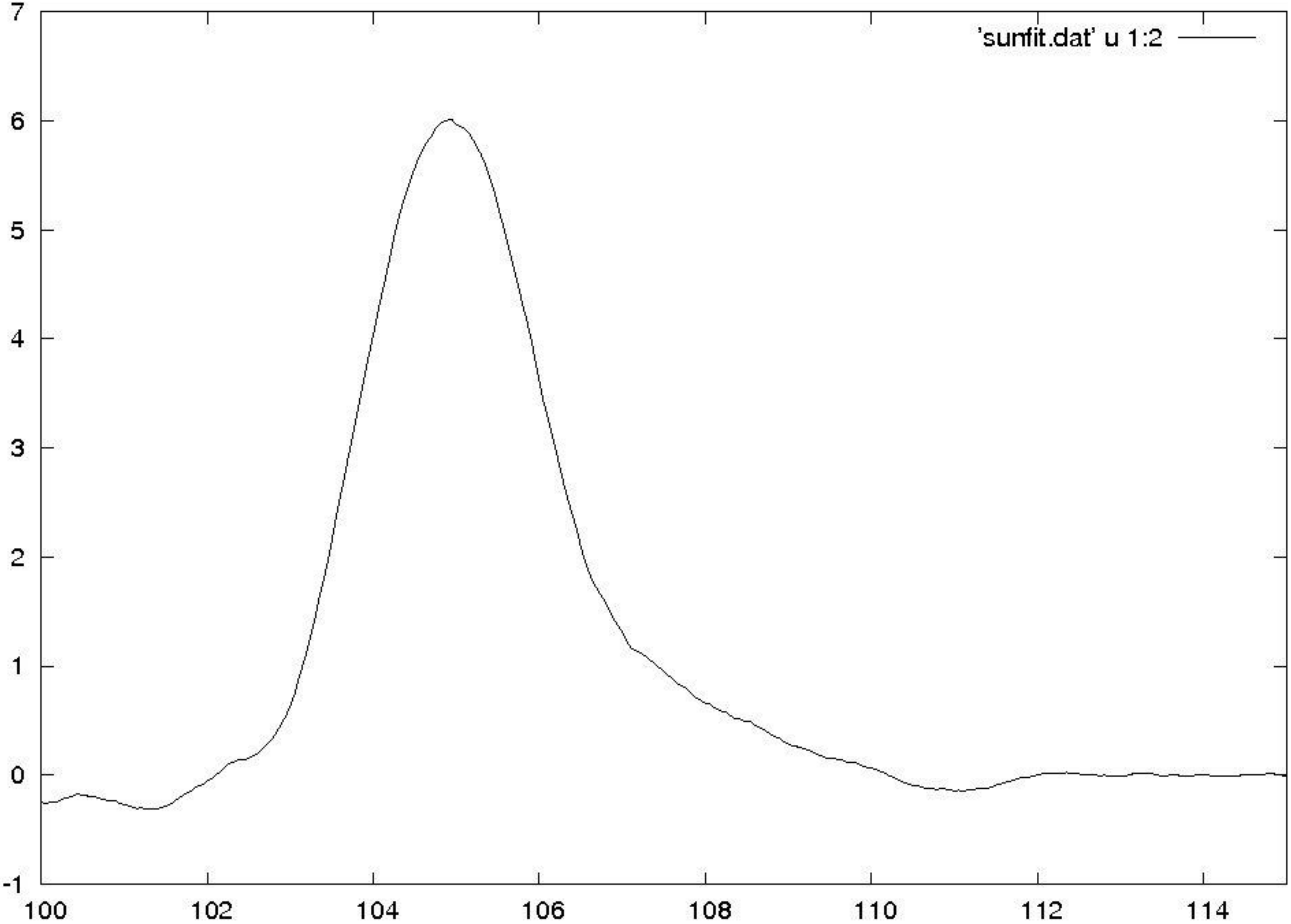


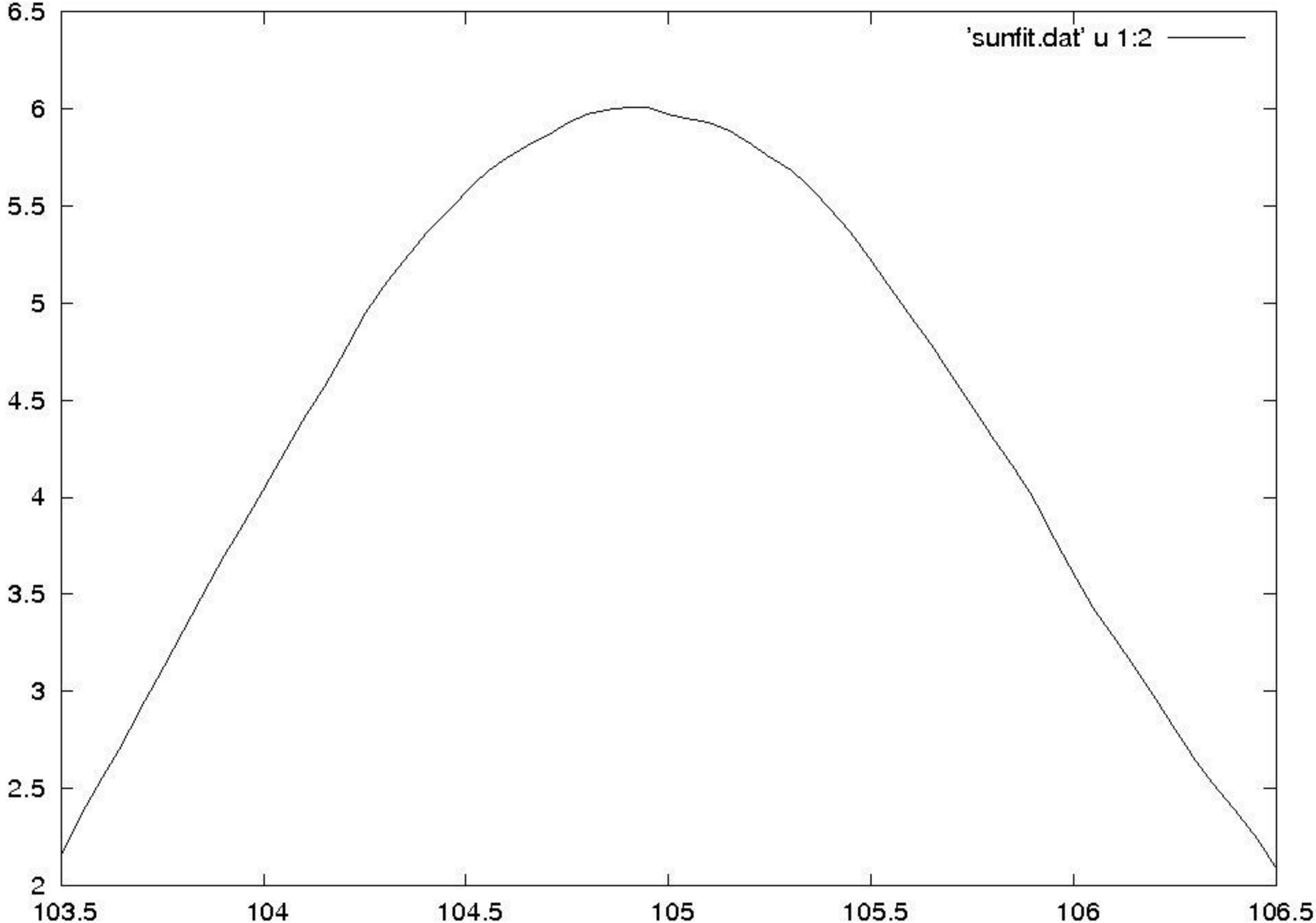
RAS -2013-Aug 20, 2013


'sun7.dat'
0
1
2
3
4
5
6
7
0
50
100
150
200
250
300

Calibration

- **Scaling x-axis and y-axis for data**
- **Assigning units by comparison with standards (calibrator sources in case of astronomy)**
- **Determining bad data**
- **General examples**
  - **Assigning flux density in Jy to output of telescope or correlation amplitude counts of an interferometer**
  - **Assigning phase in degrees to the phase of the complex visibilties**
- **4-m experiment – simple assignment to x-axis in units of degrees**


'sunfit.dat' u 1:2
7
6
5
4
3
2
1
0
-1
100
102
104
106
108
110
112
114



'sunfit.dat' u 1:2
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
103.5
104
104.5
105
105.5
106
106.5

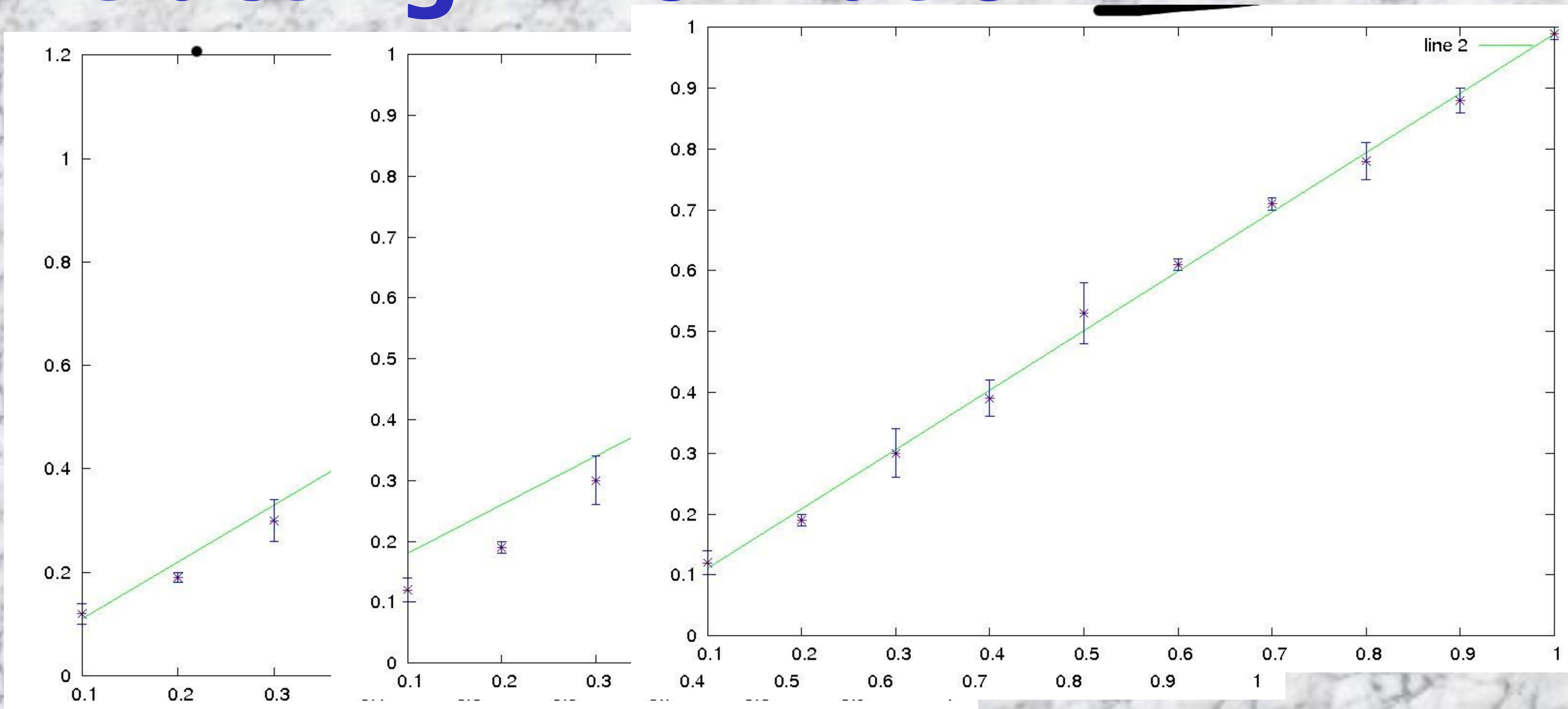
Modeling the data

- **Position of the Sun – peak of our plot**
- **Models – polynomial, Gaussian, sin x/x**
- **Approximate Gaussian**
  - **$F(x) = a * \exp [- ((x-b)/c)^2]$**
  - **a,b,c – b position of Sun as observed by 4-m**
- **Fitting data to F(x) - least squares fit**

Least Square Fit

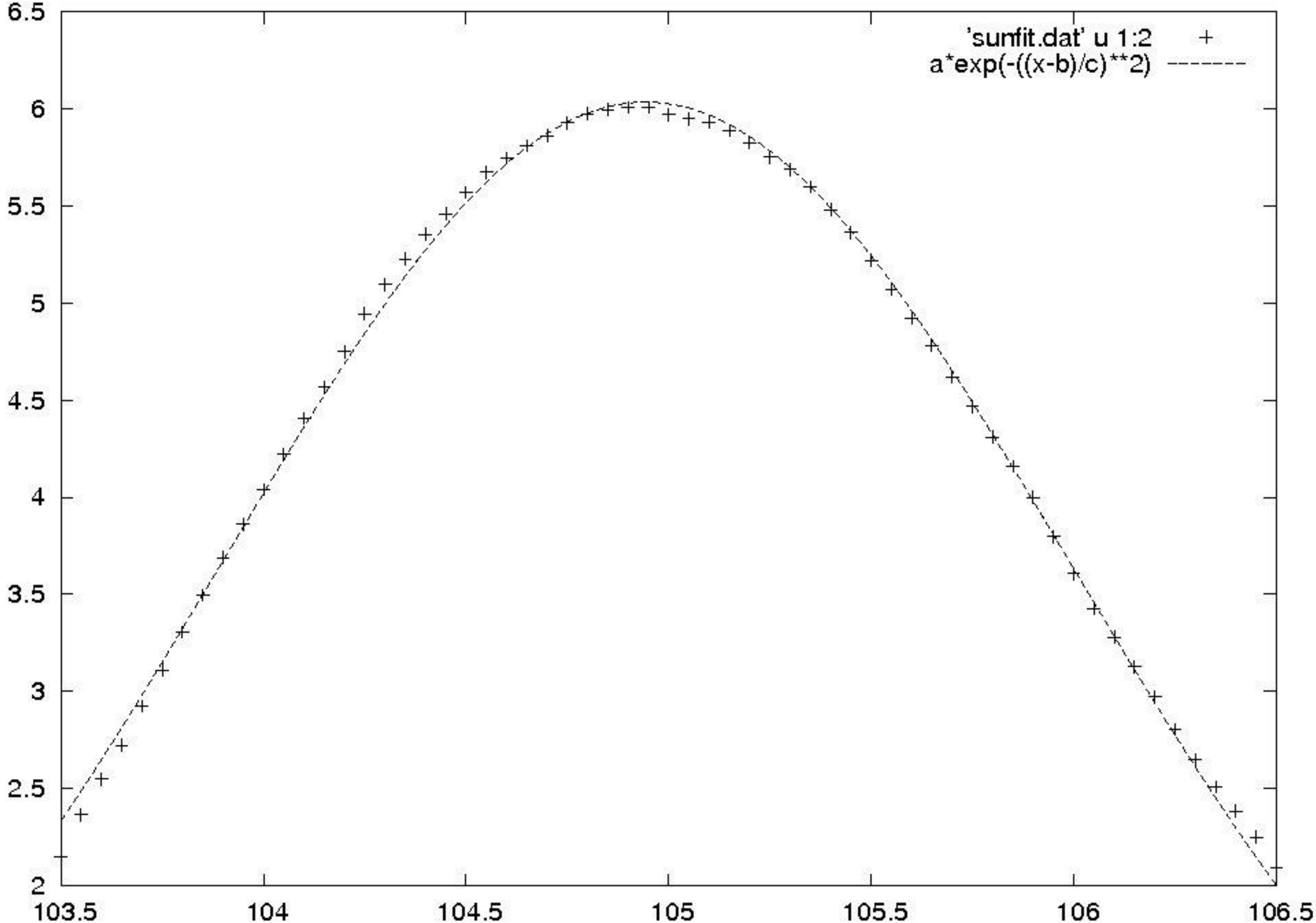
- **Model with closest parameters – minimization of SSD**
- **Errors in measurements**
  - **Measurement noise in instrument**
  - **Fluctuation in source strength**
  - **Fluctuation of background**
  - **Standard deviation OFF the source**
- **Linear in parameter and non-linear models**
- **Goodness of fit**

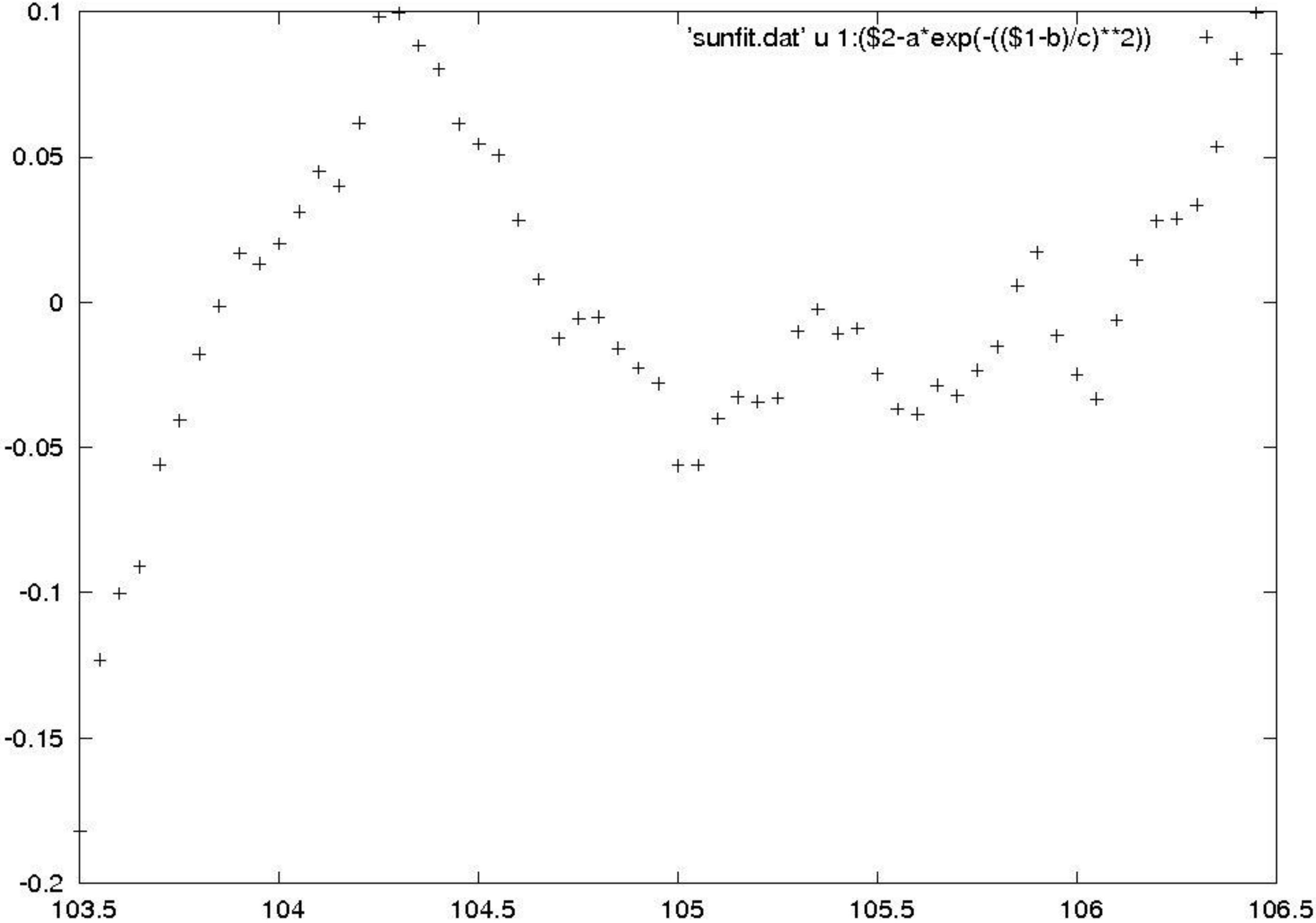
Extracting information



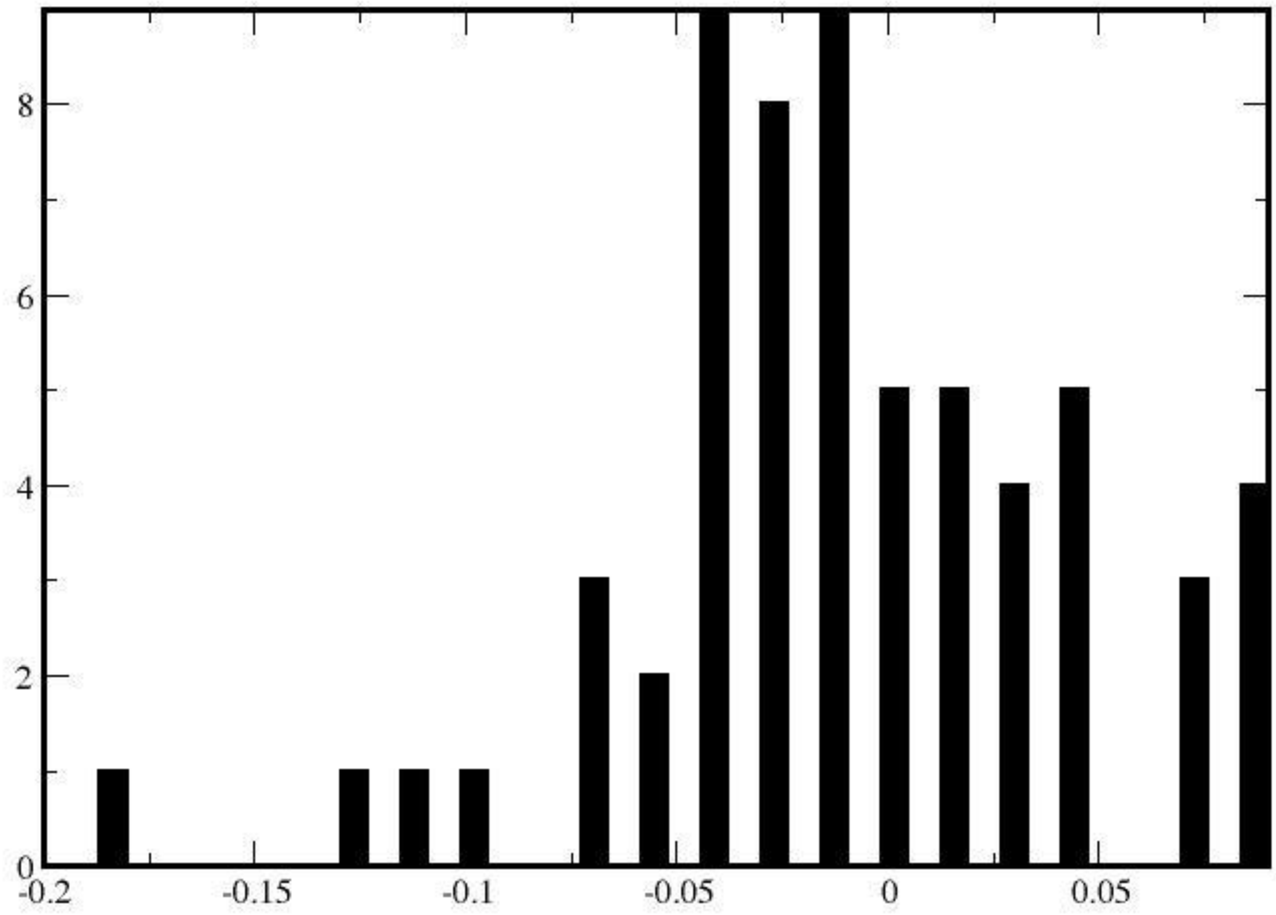
Interpretation

- **Look for trends**
- **difference in velocity ??**


'sunfit.dat' u 1:2
a*exp(-((x-b)/c)**2)
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
103.5
104
104.5
105
105.5
106
106.5


'sunfit.dat' u 1:($2-a*exp(-(($1-b)/c)**2))
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
103.5
104
104.5
105
105.5
106
106.5

R



Thank you

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- M

R

Extracting information

Assumptions for analysis

- **Frequency of line is red or blue shifted by doppler effect due to relative velocity**

- **Multiple peaks are due to different clouds with different velocities**

- **Line profile is Gaussian**

$$y(x) = A \exp(-((x-B)/C)^2)$$

A = strength of line
C = width of line
B = position (frequency of the line)