On the possible effect of the signal processing in the meteor-head data at Jicamarca: Preliminary Results

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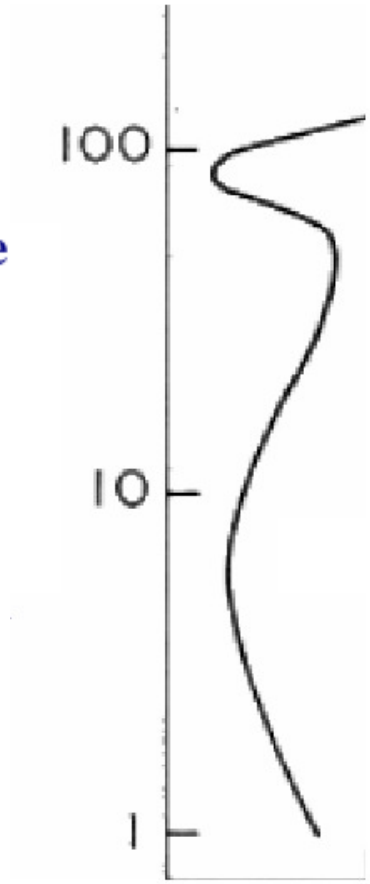
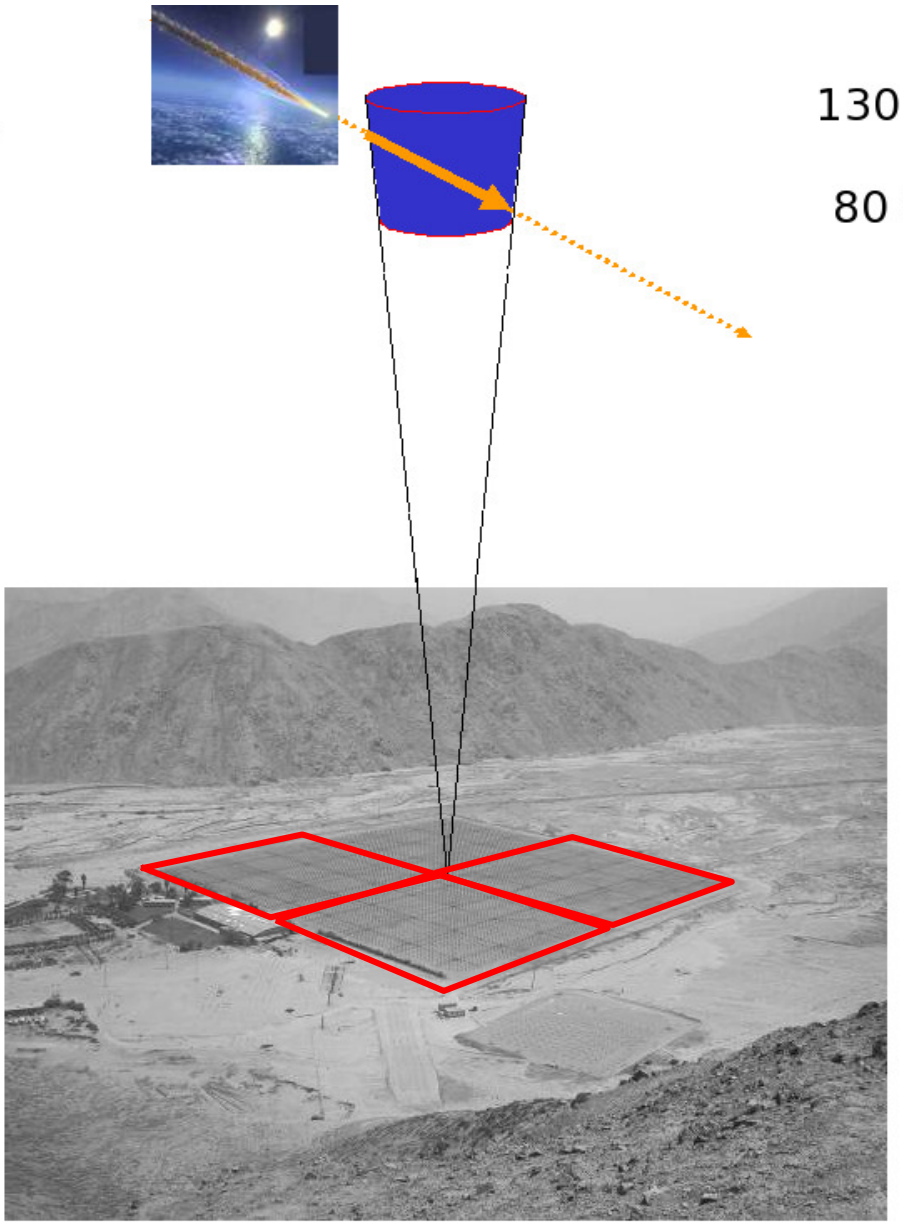
1) Introduction: Meteor-head configuration at Jicamarca

Parameters	Value
Pulse Repetition Period	60 Km
Pulse Width	1.95 Km
Barker Code	13
Sampling rate	0.15 Km
Transmitted peak Power	2 MW





[Chau and Woodman, 2004]

1) Introduction: Examples of meteor-head results

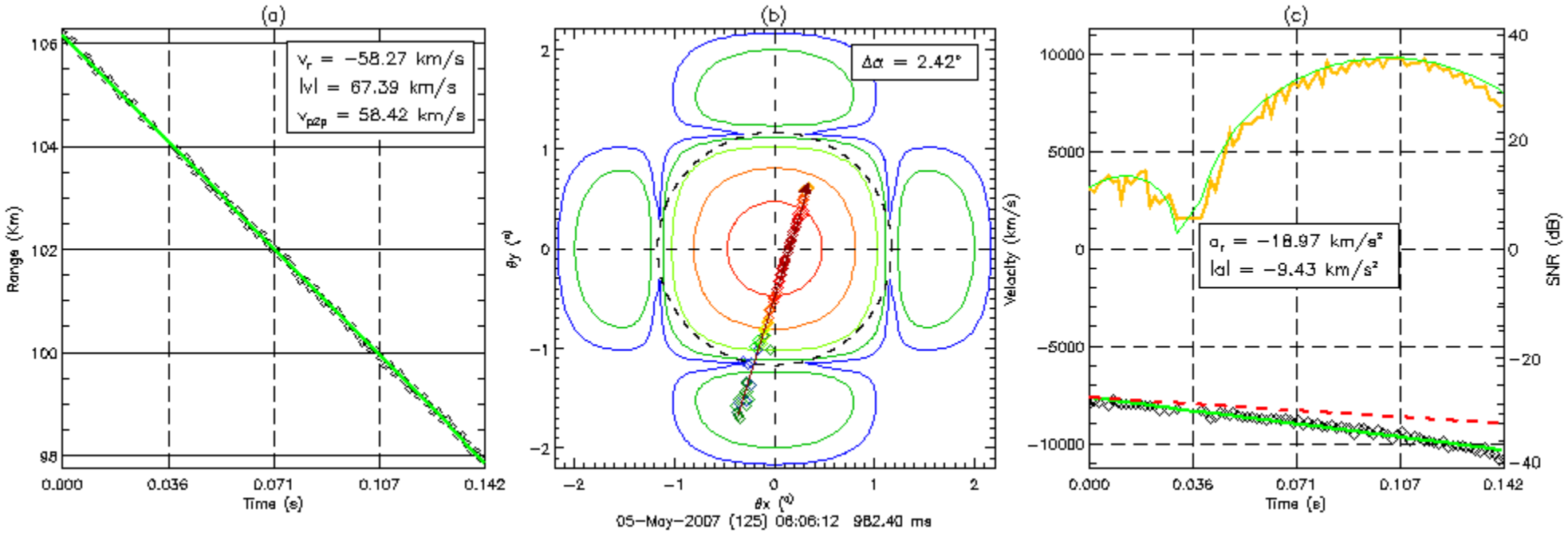
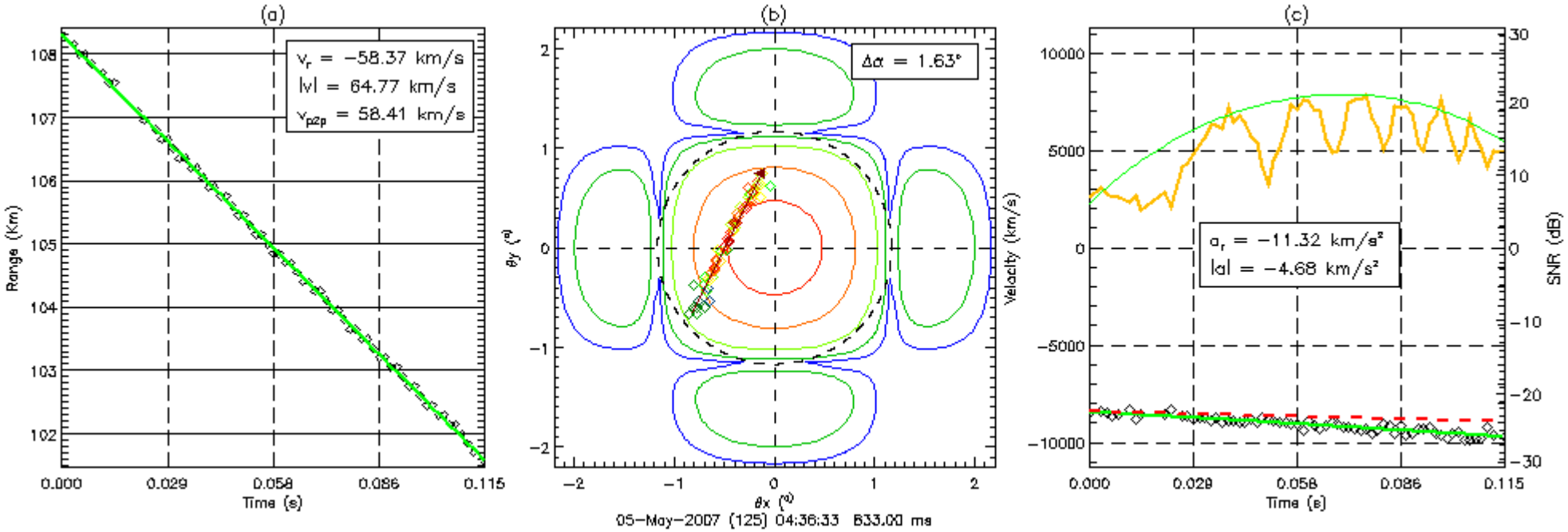


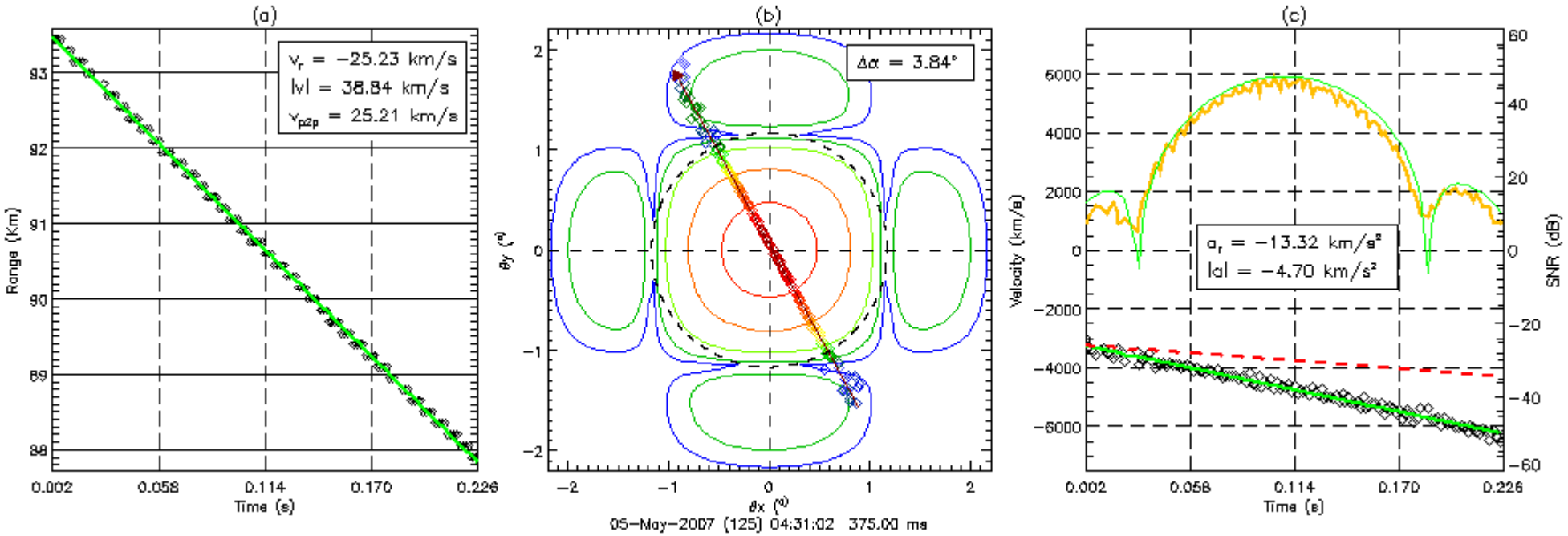
Figure information: Left (a) Range vs. time, Middle (b) Trajectory of the meteor in the radar plane, and (c) Pulse-to-Pulse radial velocity and SNR along the meteor trajectory (in orange).

2) Classifying signatures in meteor-head data



Similar to the previous slide but showing abrupt changes in the SNR value

2) Classifying signatures in meteor-head data



Similar to previous slide but changes in SNR are smaller

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2) Classifying signatures in meteor-head data

Summary:

- We looked over meteor-head data from:
  - 27 Feb 2006 (~15:00-24:00 hrs LT)
  - 05 May 2007 (~04:00-08:00 hrs LT) (*)
  - 14 Dec 2008 (~00:00-08:00 hrs LT)

- From the data observed , the meteor population could be divided in two types of signatures. A third group is related to the population which can not be classified.

- **Signature type (1)** characteristics:
  - The signature **are not correlated** to the changes in range
  - Most of the time the changes in SNR are bigger than ~4dB

- **Signature type (2)** characteristics:
  - The signature **are strongly correlated** to the changes in range
  - The changes in SNR are smaller than ~4dB

2) Classifying signatures in meteor-head data

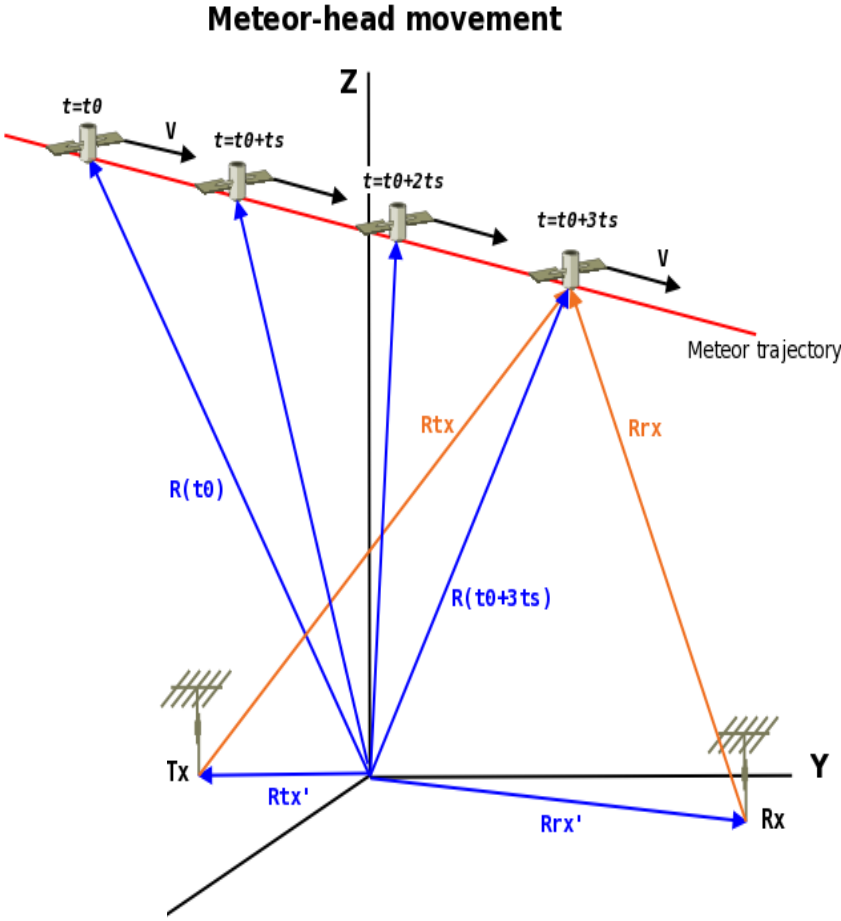
Question?

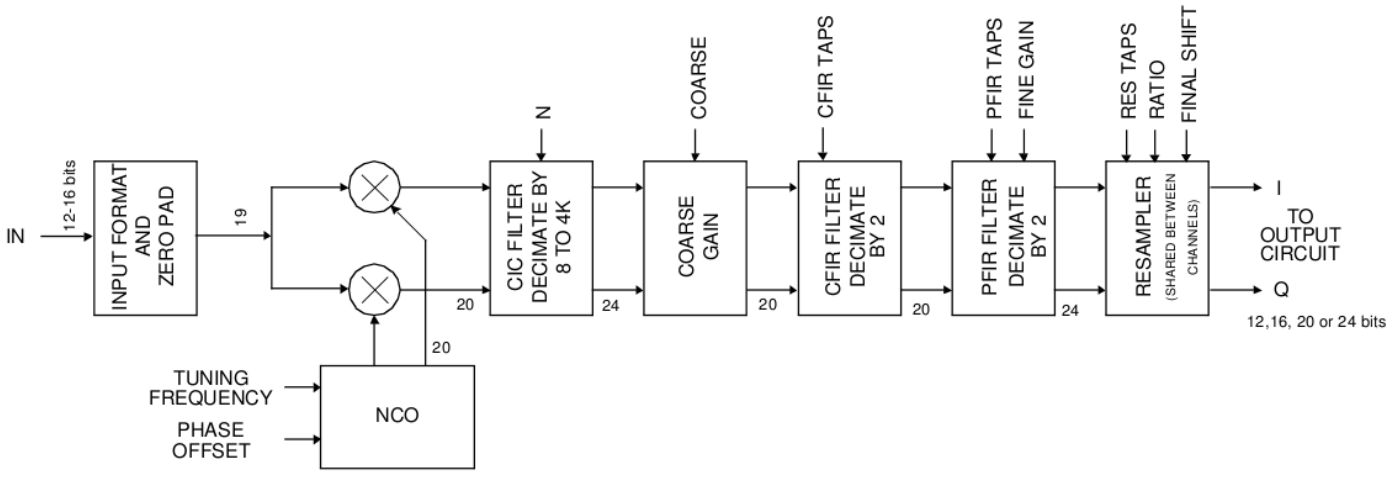
Why does the signature type (2) show correlation with the range?

3) Understanding the oscillation: Head echo – Receiver System ?

To answer our question we need to model:

- Meteor-head echoes:
  - Hard Targets
- Acquisition system:
  - High sampling rate
  - Down-conversion (CIC, CFIR, PFIR)
- Jicamarca antenna beam





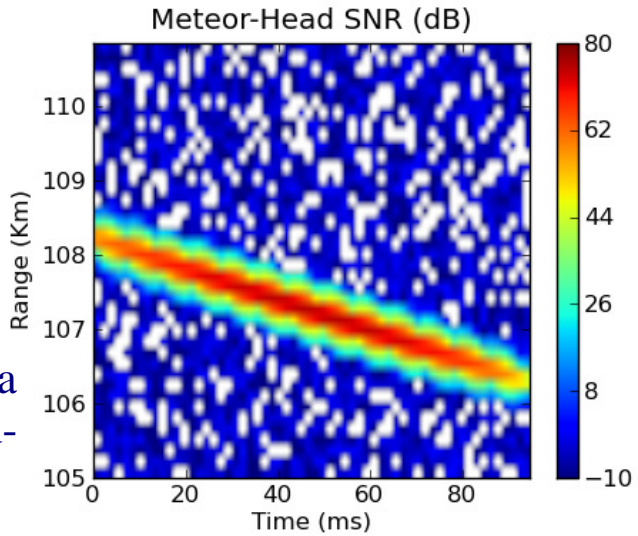
The Down Converter Channel

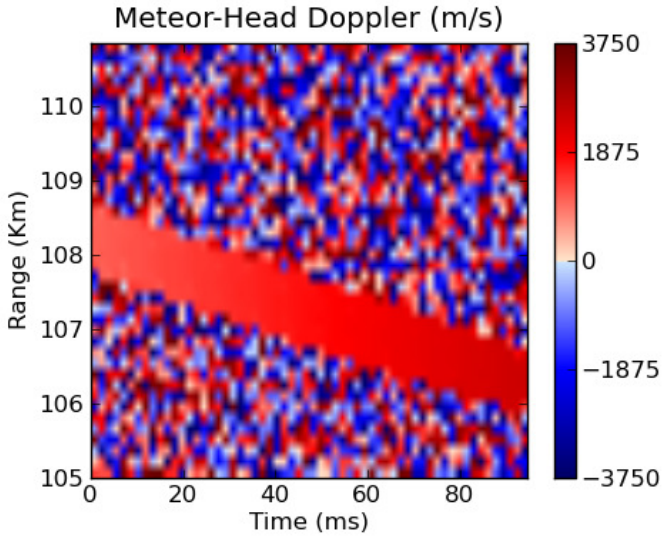
3) Understanding the oscillation: Head echo – Receiver System ?

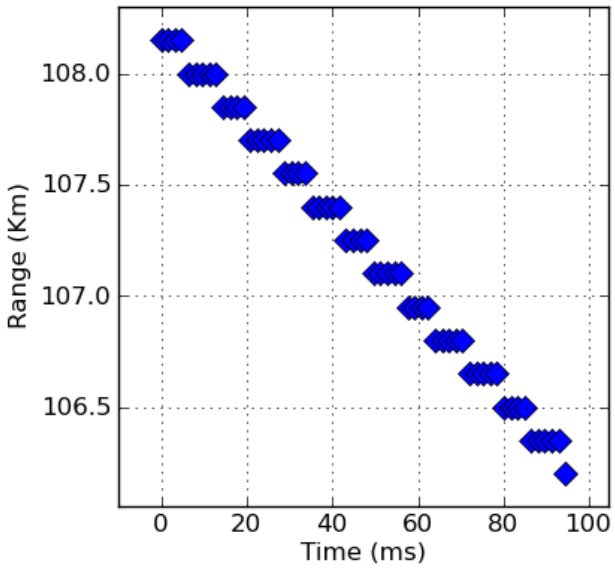
Head echo simulation:

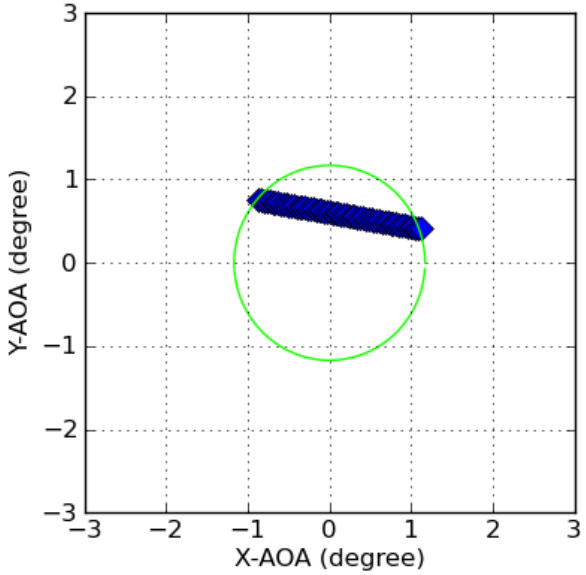
- $(V_x, V_y, V_z) = (39.2, -7.0, -20.8)$ Km/s
- Pulse Repetition Time = 60 Km
- Pulse Width = 0.15 Km
- Sampling rate = 0.15 Km

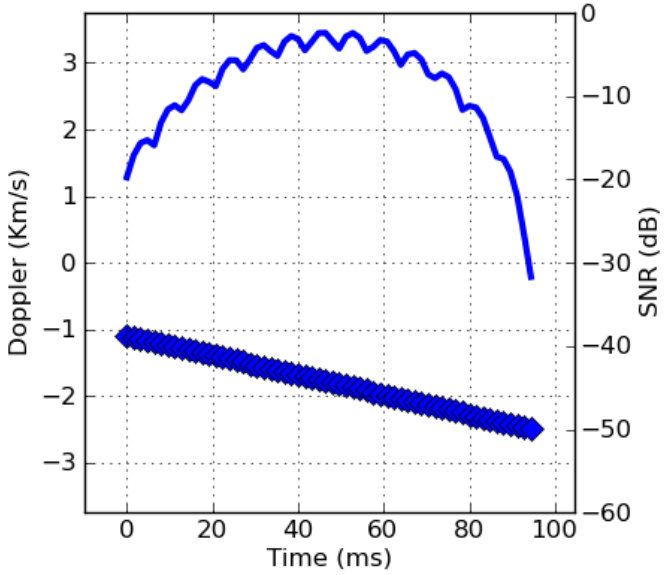
Notice the oscillations seem to be a natural response of the system head-acquisition







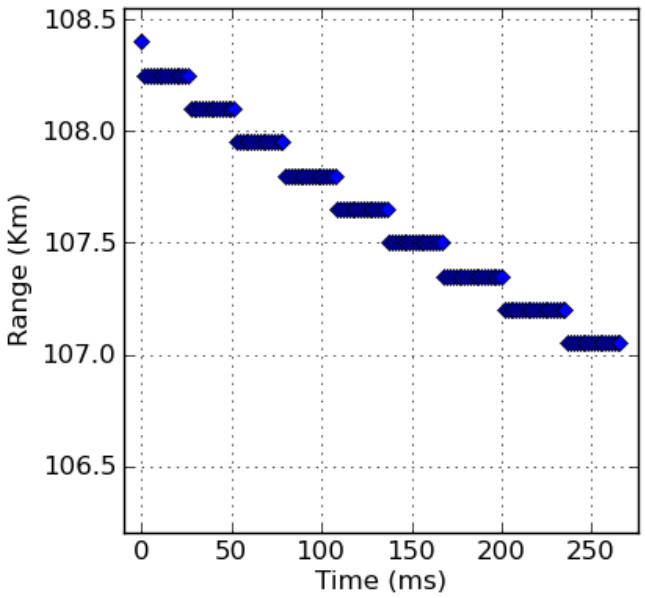


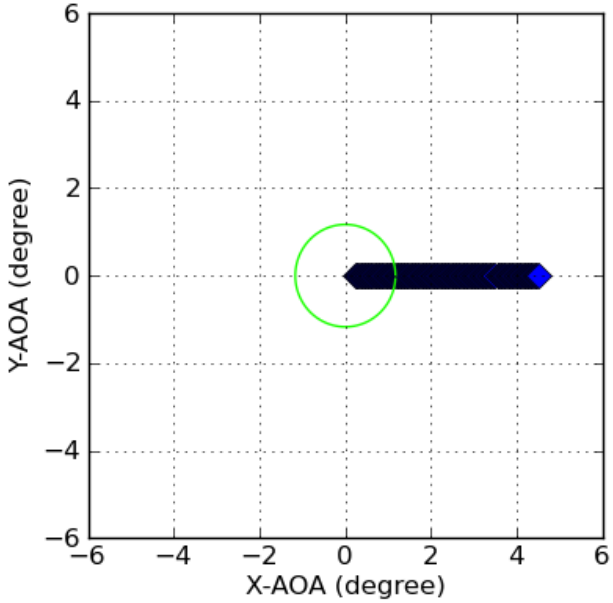


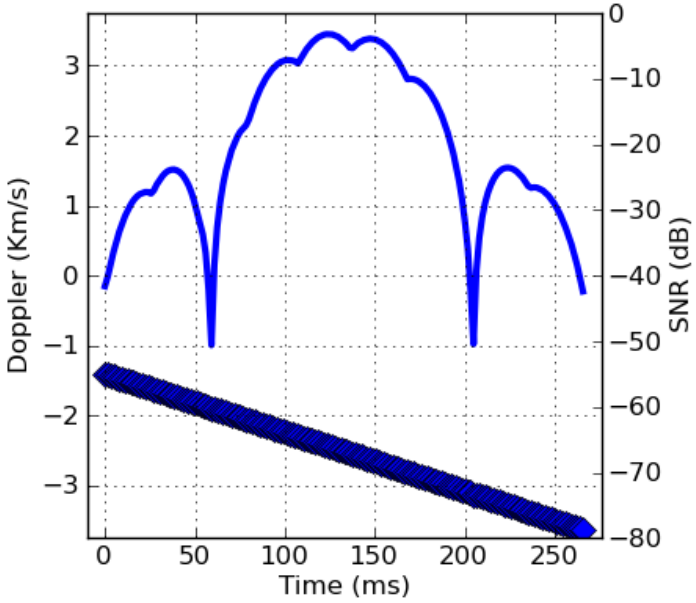
3) Understanding the oscillation: Head echo – Receiver System ?

Other simulations:

Velocity: (V_x,V_y,V_z) = (30, 0.0, -5) Km/s



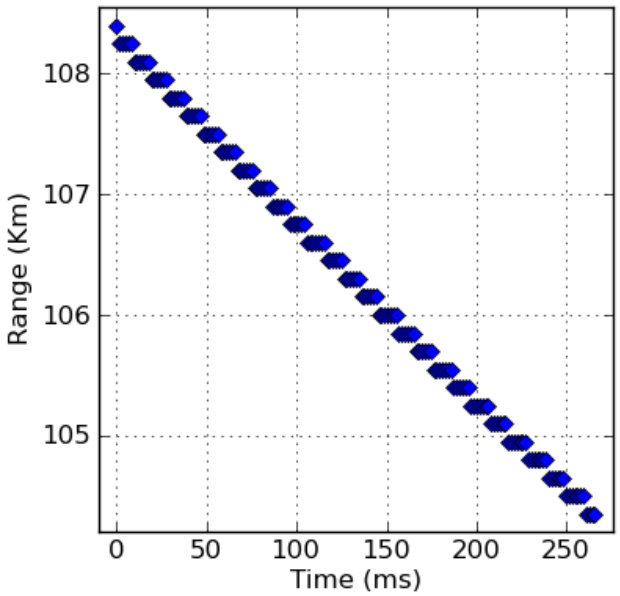


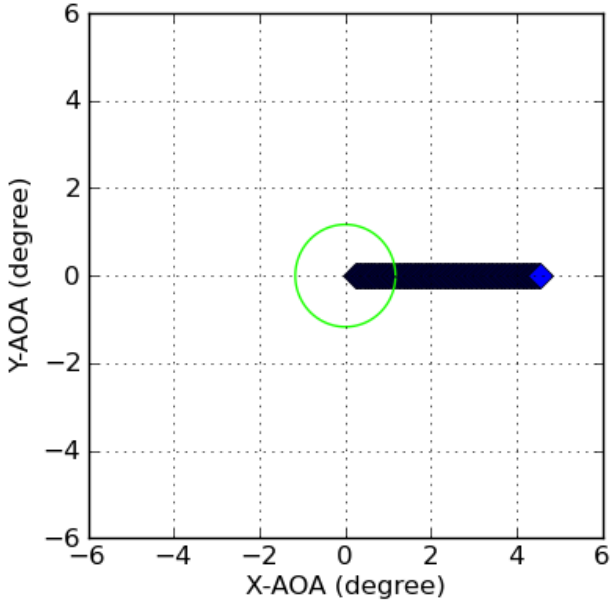


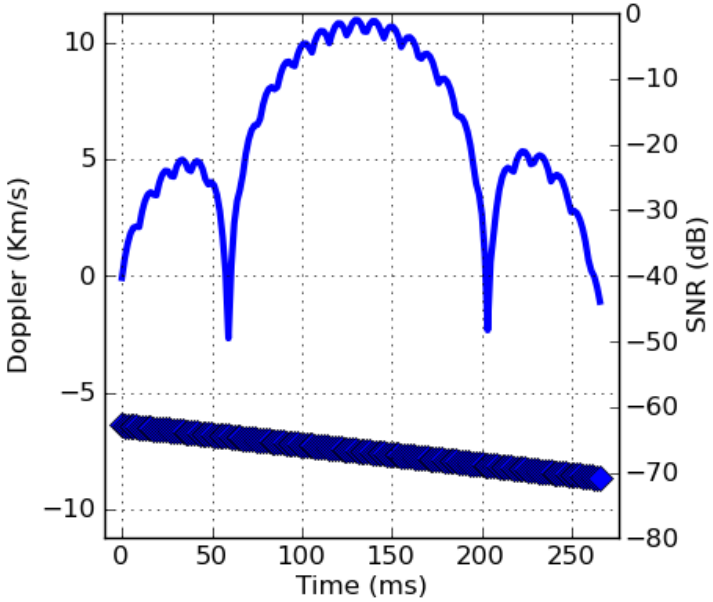
3) Understanding the oscillation: Head echo – Receiver System ?

Other simulations:

Velocity: (V_x,V_y,V_z) = (30, 0.0, -15) Km/s

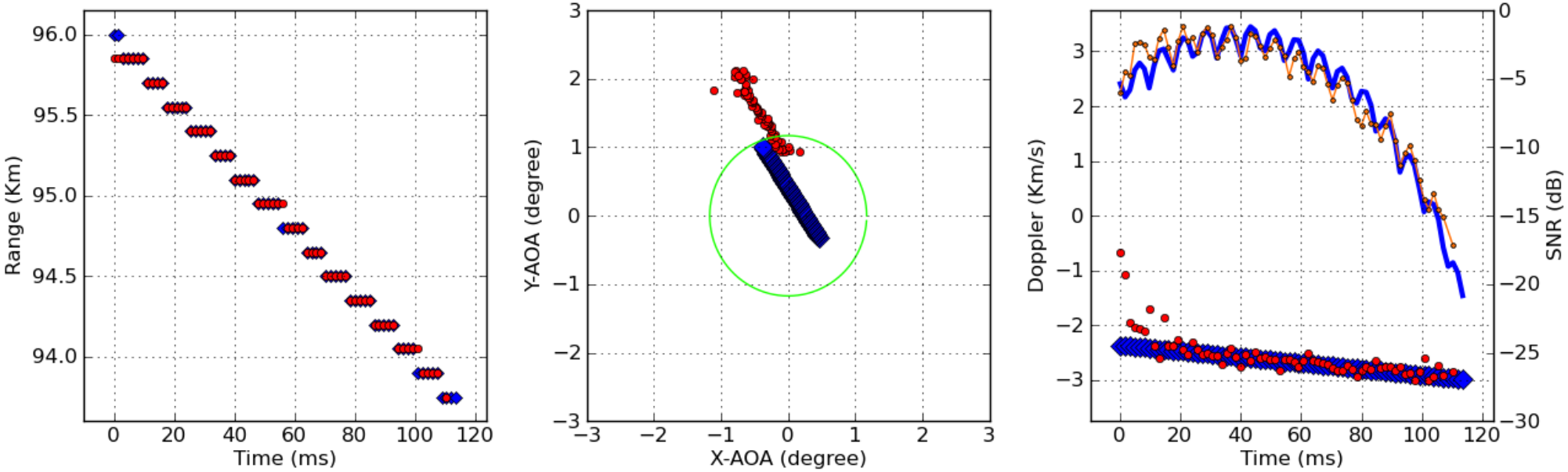






4) Preliminary results:

Comparison of the Simulation and Experiment



Meteor-head Experiment at Jicamarca (in red and orange) 05 May 2007, and its modeled result (in blue). Notice the similarity between the experimental and modeled SNR.

5) Conclusions:

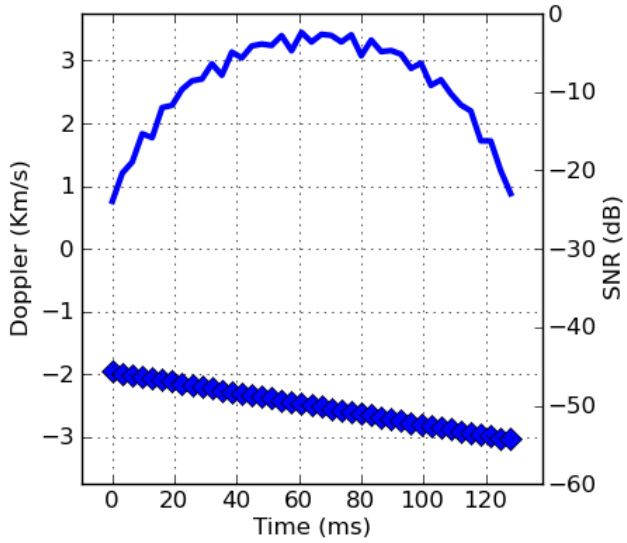
• Signature type (2) seems to be a systematic head-acquisition result. The strong correlation between the changes in range and the ripples could justified this.

• The shape of the signature (2) is defined by the vertical component of meteoroid velocity and and the acquisition system (e.g. values of decimation, sampling rate)

• The shape of the signature (2) is distorted due to the coherent integration. In some cases, this effect would be critical, making difficult to see the relationship between the range and the signature.

• The analysis of one day of experiment (05 May 2007) shows:
  - Signature type (1): ~ 0.5%
  - Signature type (2): ~24%
  - Can not be classified: 75.5%

•Future work:
  - Improve the digital receiver Model
  - Statistics of both signatures
  - Model analog receivers
  - Ryan Seal is modeling receivers with SystemC



Thanks!

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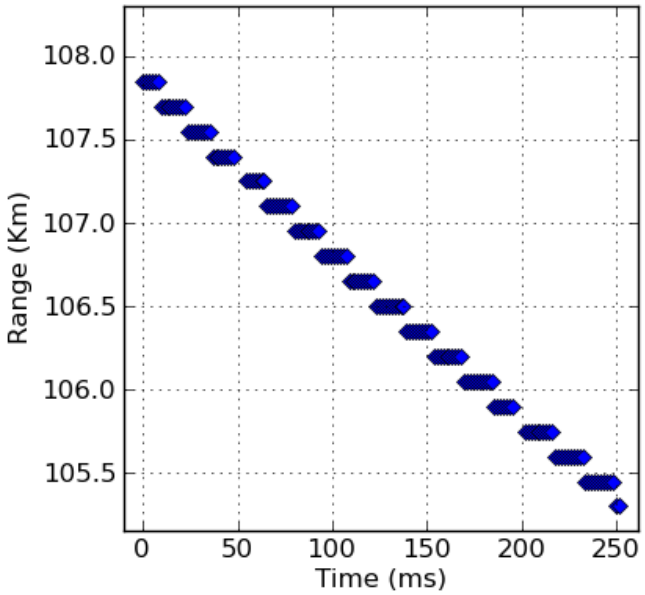
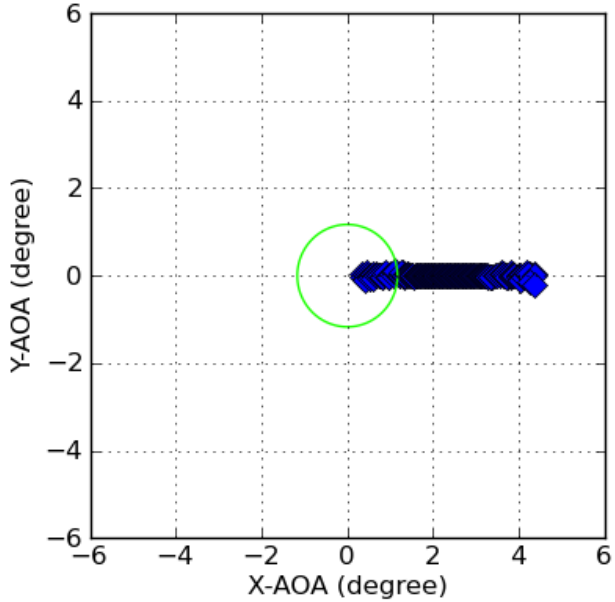
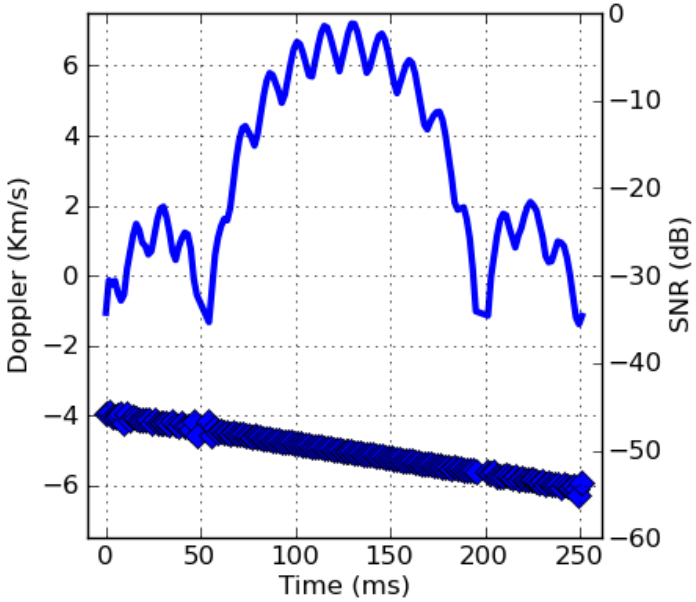
Effect of the Down Converter (1)

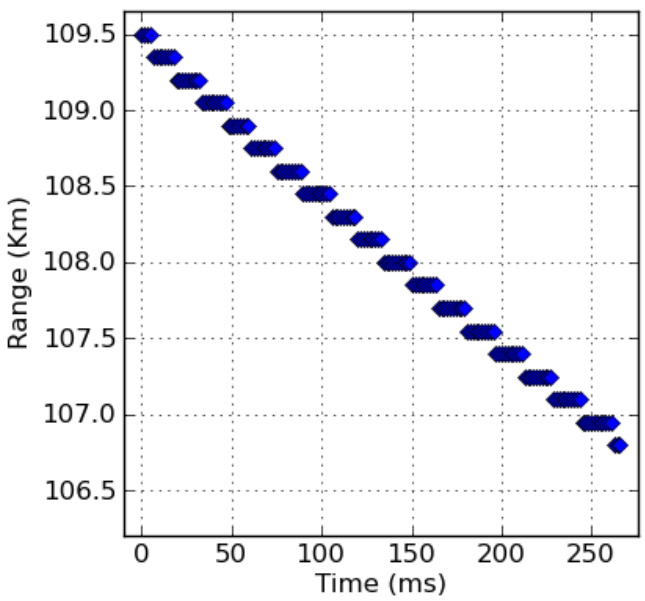


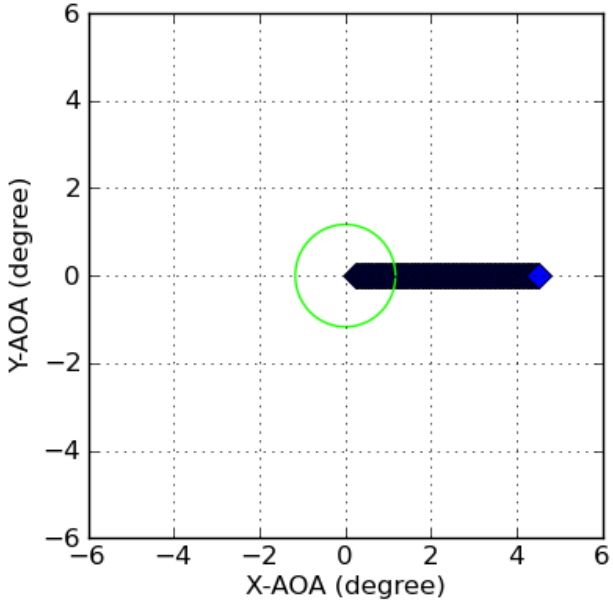


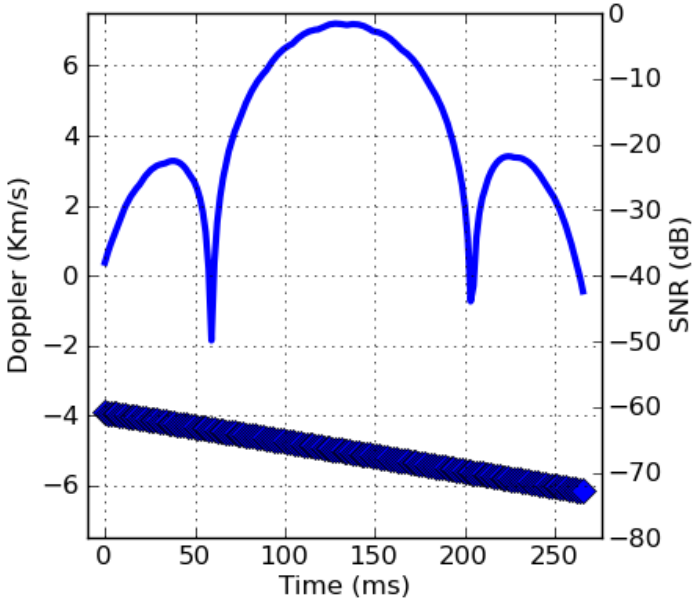


Ripples as a function of the decimation factor. This example shows the results of using 5, 4, 3 for the CIC, CFIR and PFIR scheme of the down converter.

Effect of the Down Converter (2)

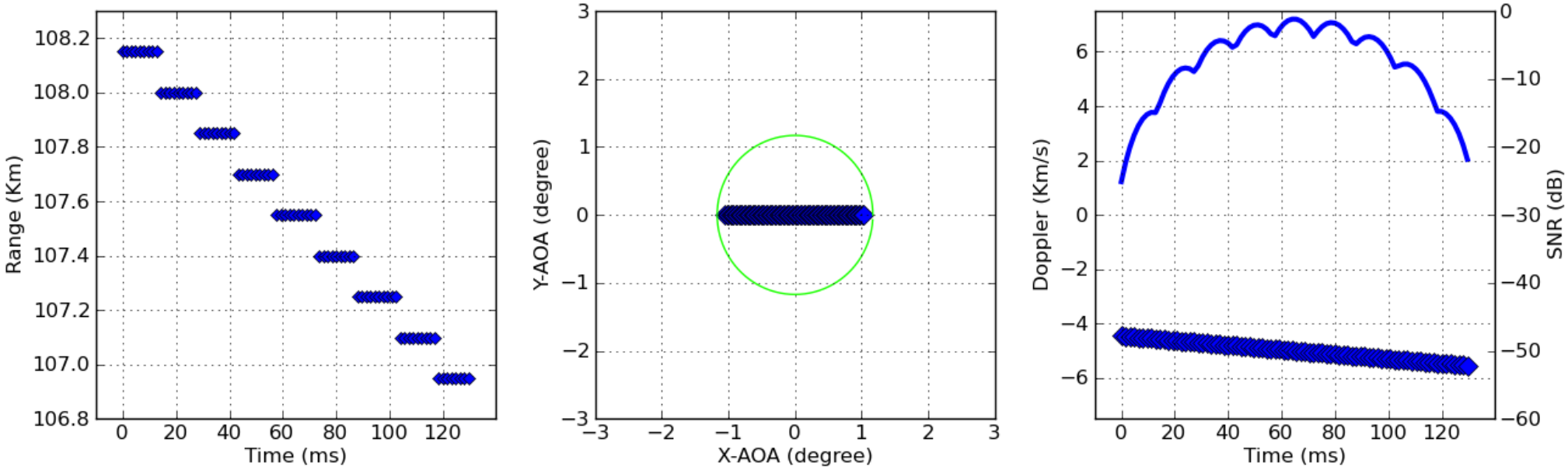






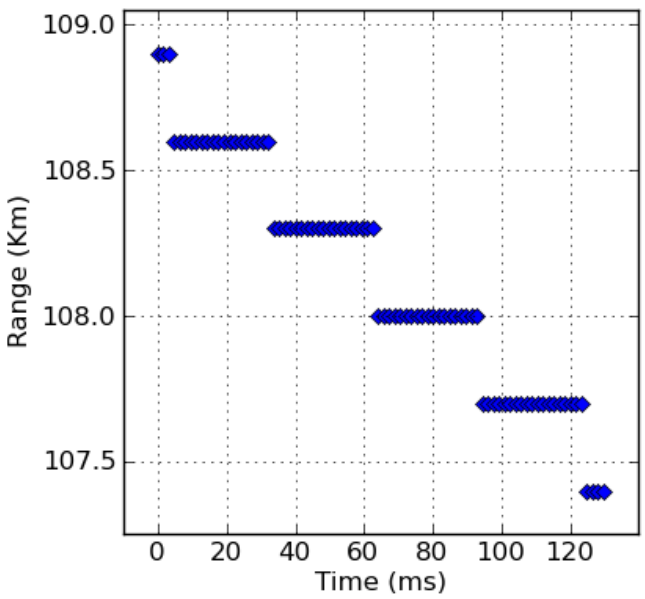
Meteor-head modeled using decimation factors of 60, 1 and 1 for the CIC, CFIR and PFIR respectively.

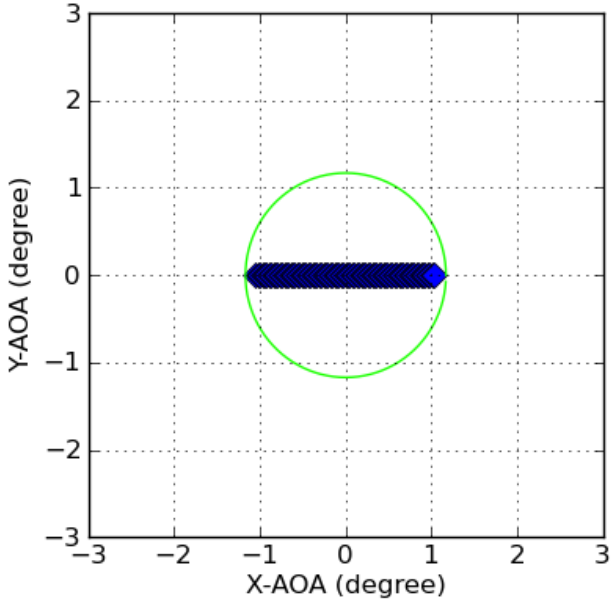
Effect of the Sampling rate (1)

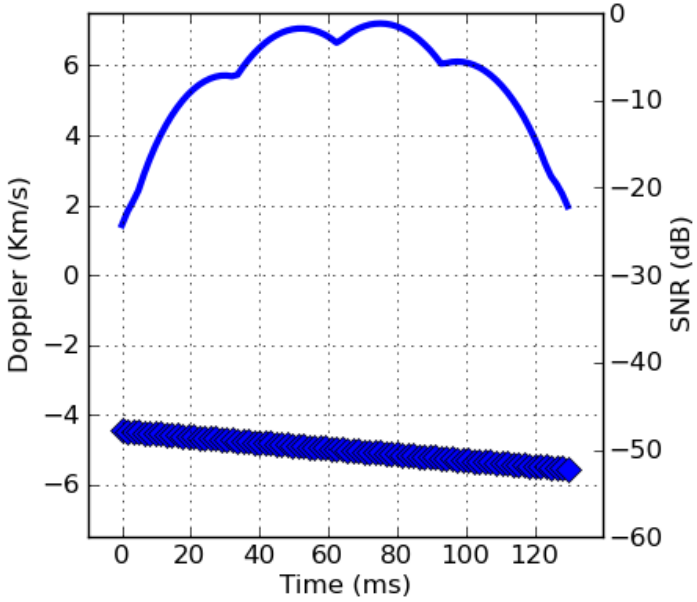


Meteor-head echo sampled with a value of 150m (or 1us).

Effect of the Sampling rate (2)







Meteor-head echo sampled with a value of 300m (or 2us).

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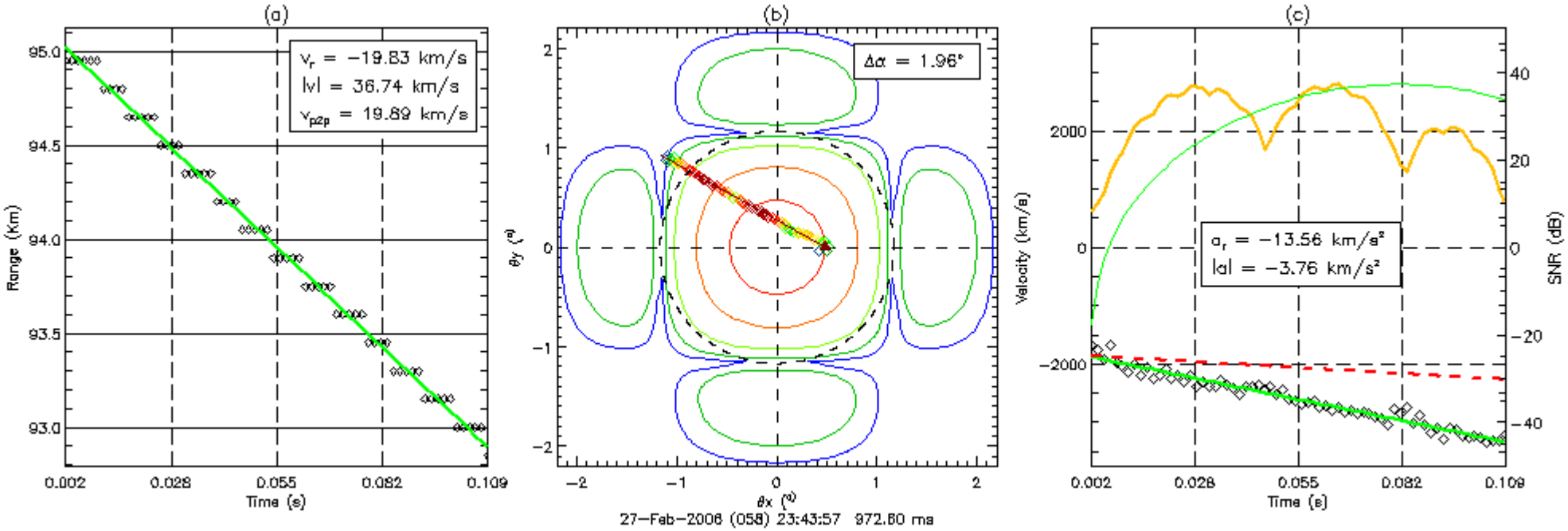
Example of both signatures



This example clearly shows both signatures

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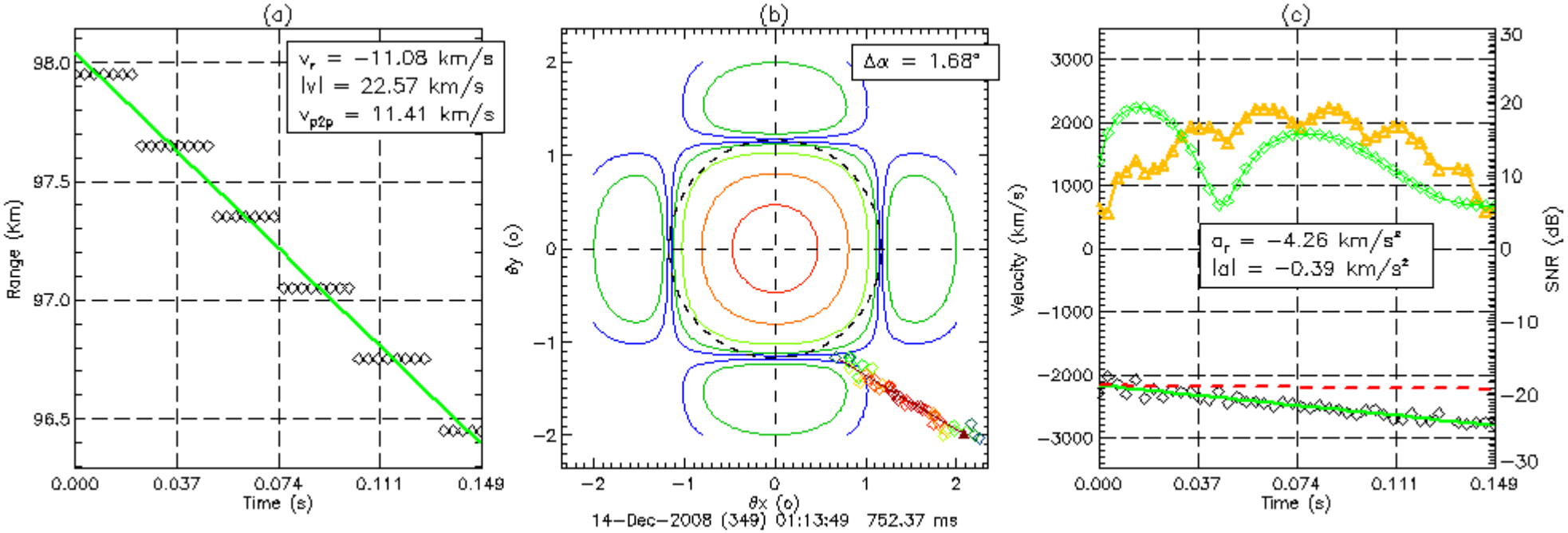
More examples of signature-2



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