Structures Propagation in Texas Helimak

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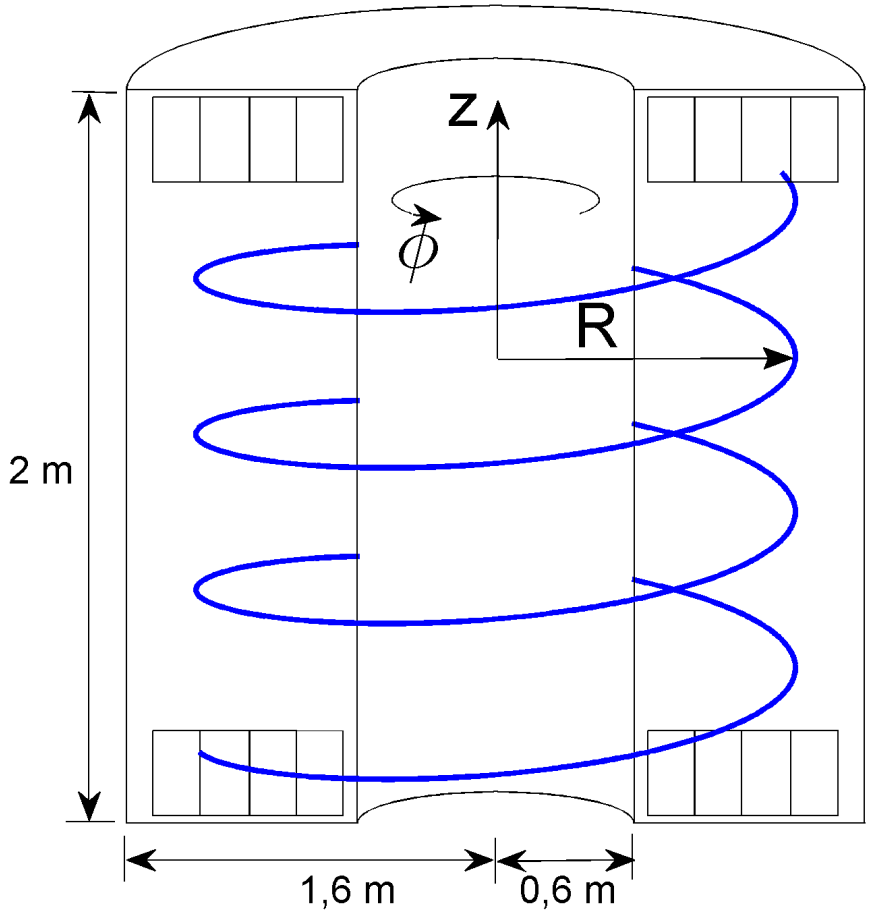
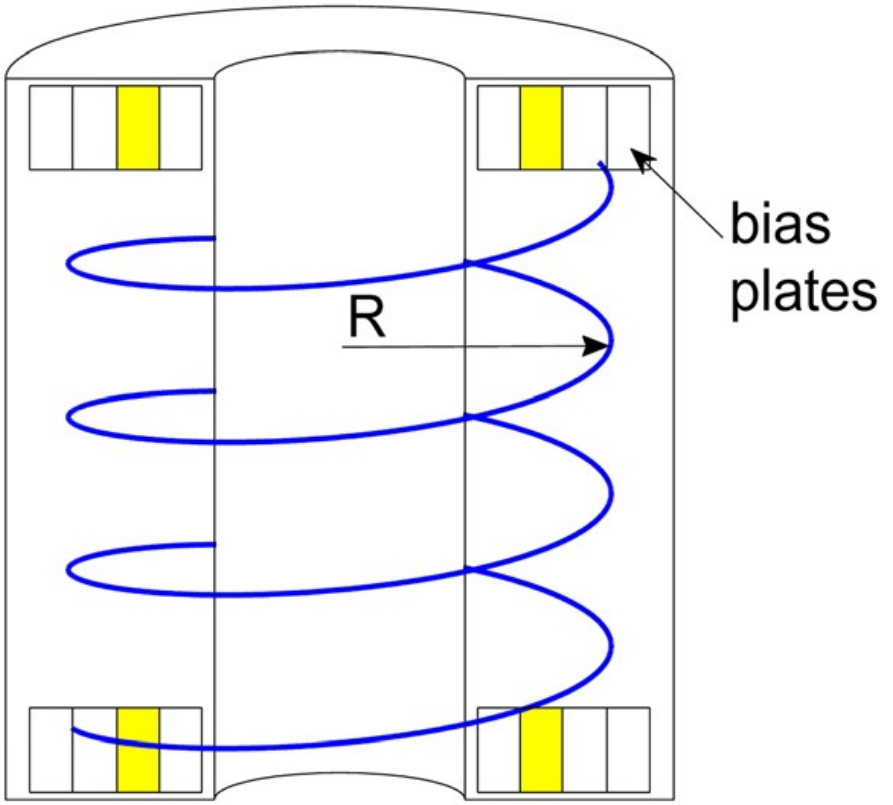
Texas Helimak

- Helicoidal magnetic field lines.
- Cold Plasma similar to the SOL of Tokamaks
- 1D MHD equilibrium
- 16 bias plates with many probes.

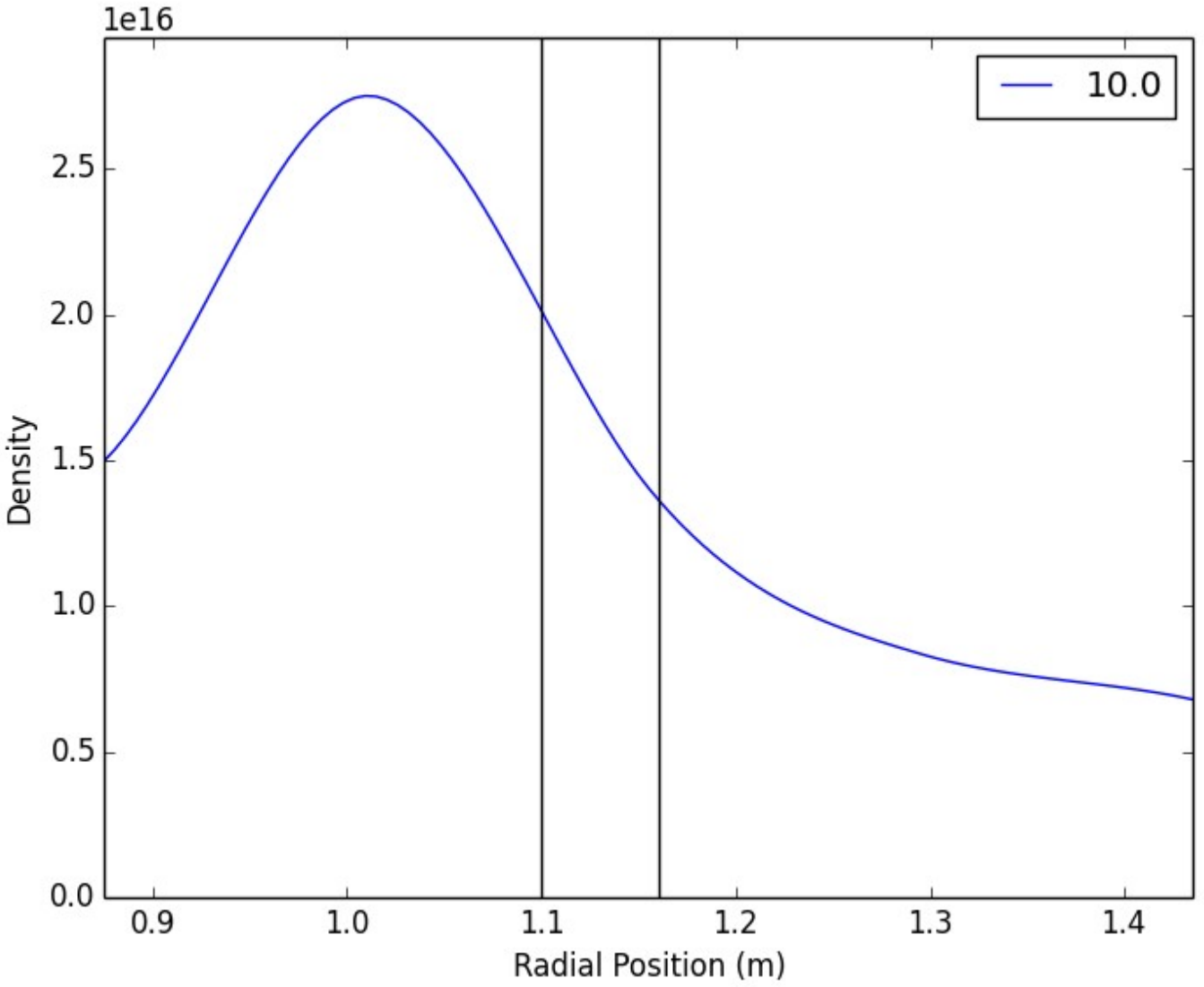


Texas Helimak

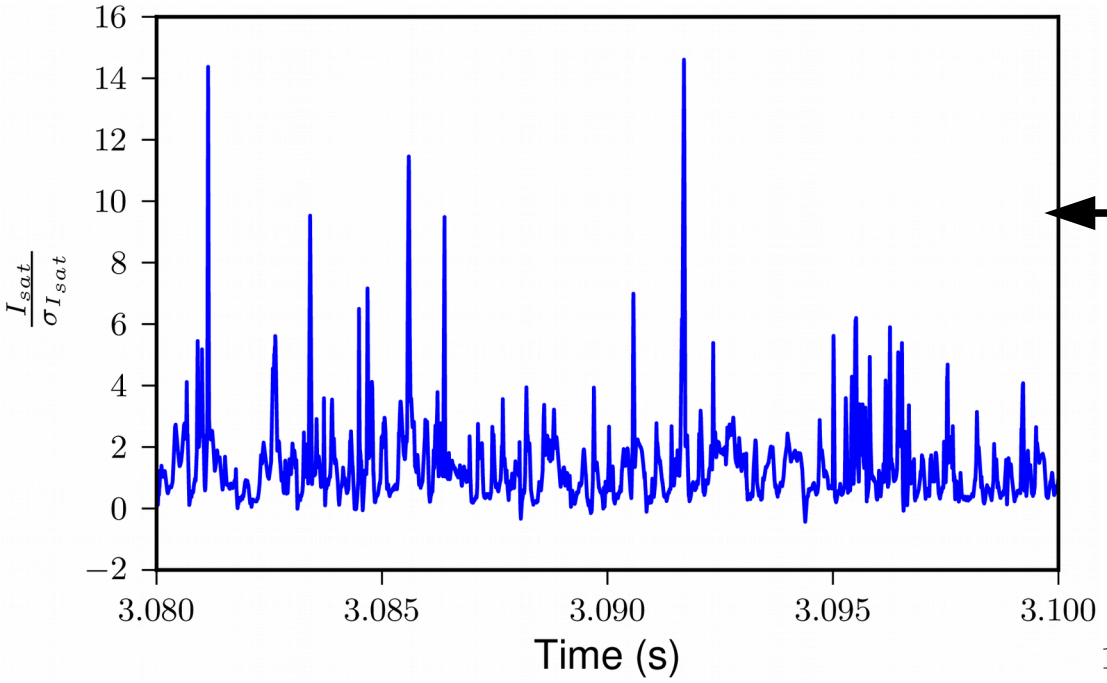
- The electric field profile can be changed by externally applying an bias on the plates.
- This also changes the regime of the turbulence.



Density Profile

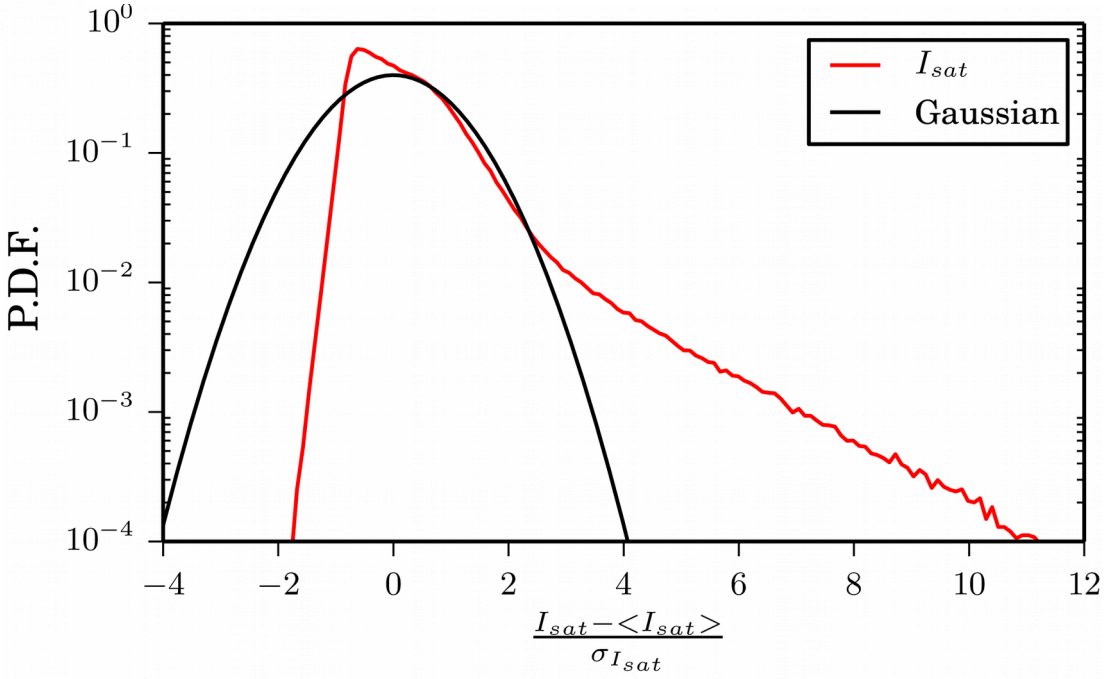


Bursts in Texas Helimak

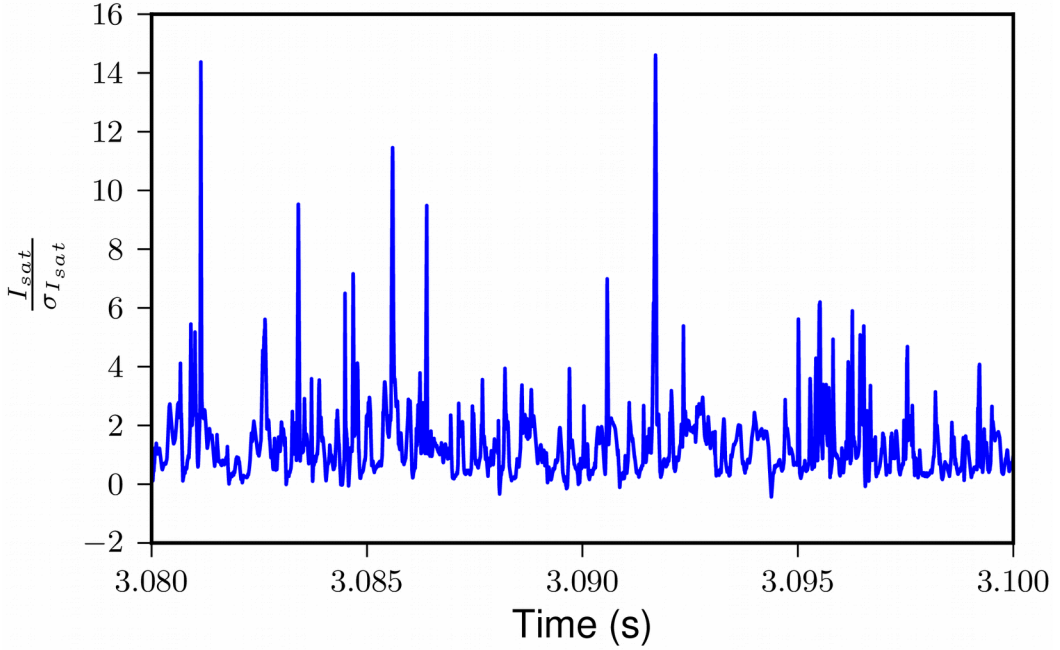


Example of Ionic Saturation Current

P.D.F. of the I_{sat}

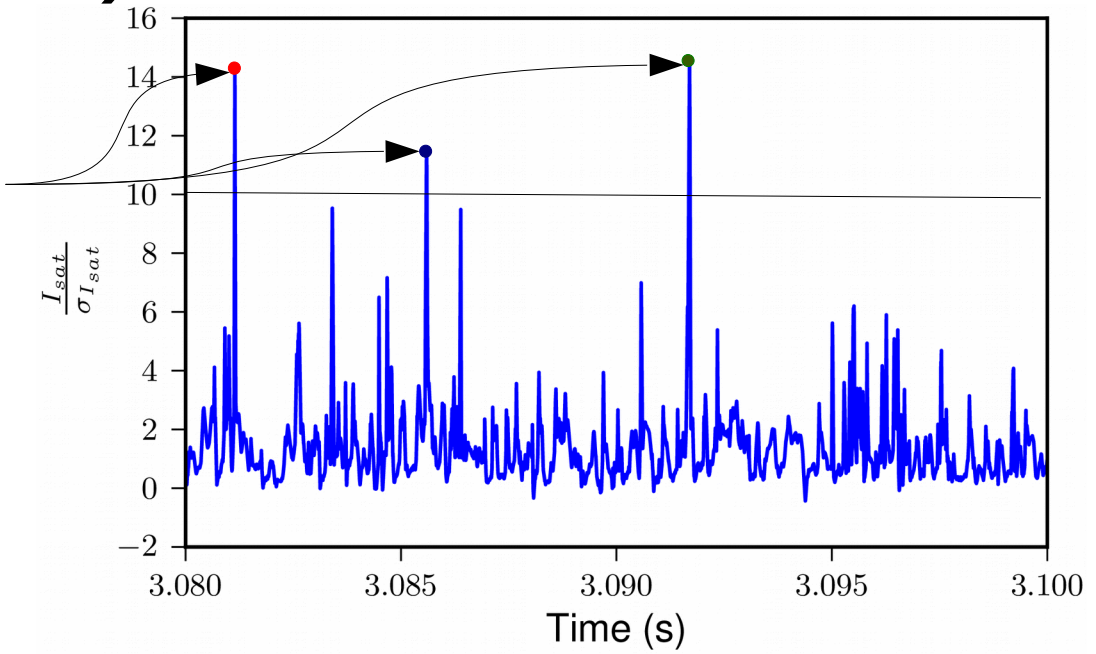


(Self) Conditional Average



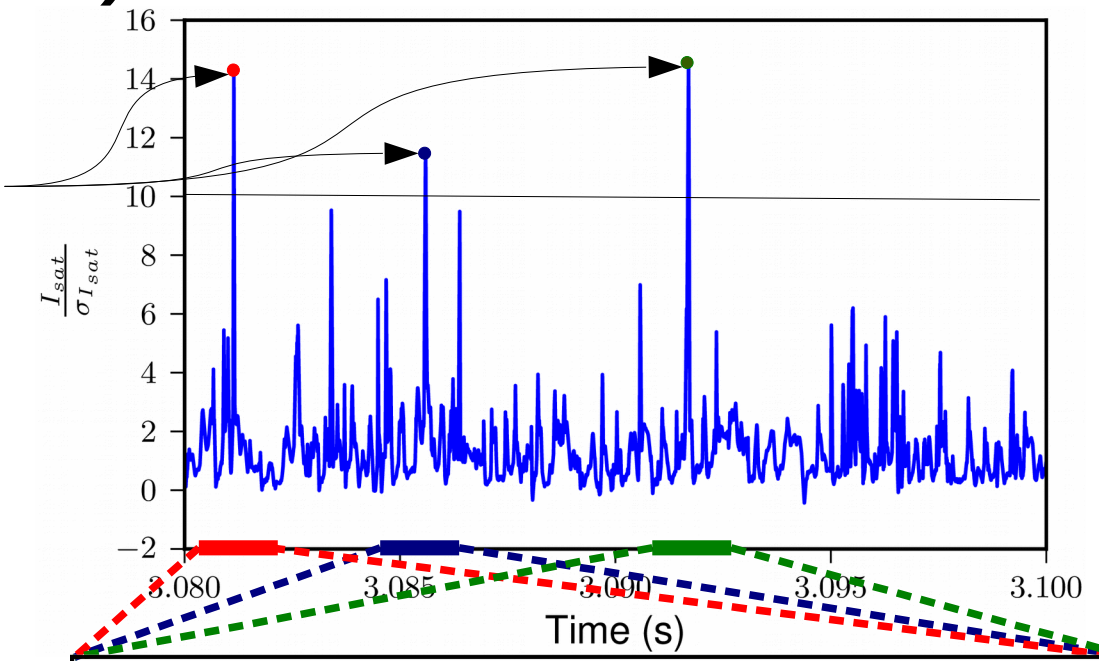
(Self) Conditional Average

Burst instants t_n

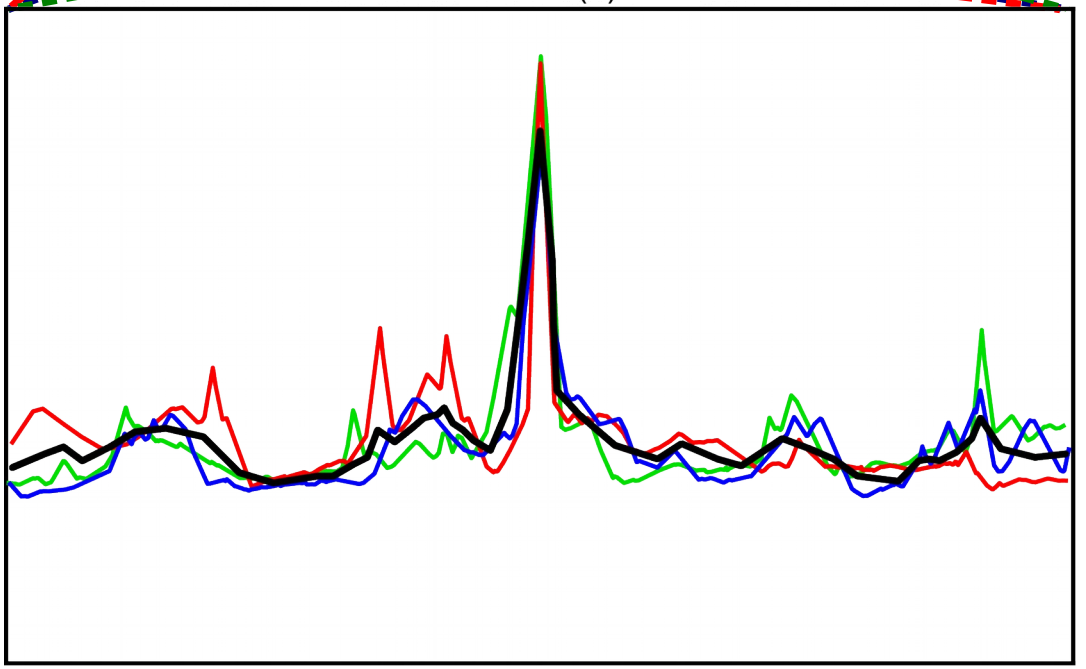


(Self) Conditional Average

Burst instants t_n

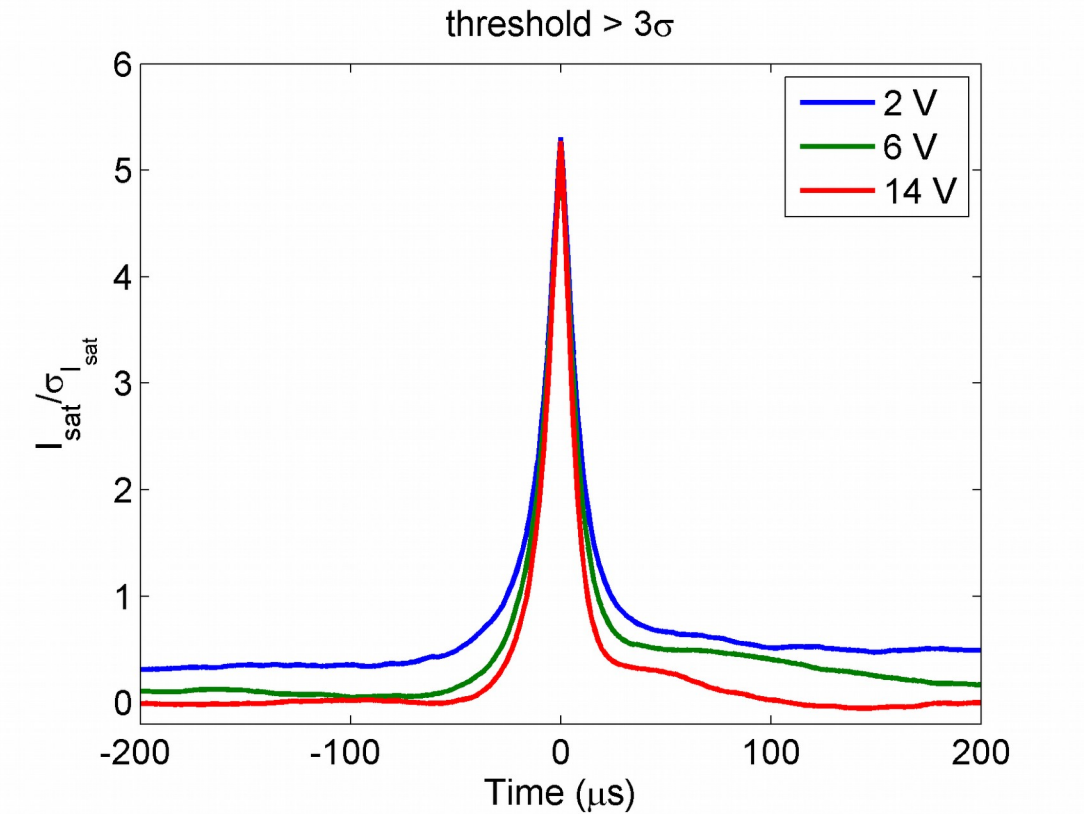


$$I_m(\tau) = \frac{1}{N_b} \sum_{n=1}^{N_b} I(t_n + \tau)$$

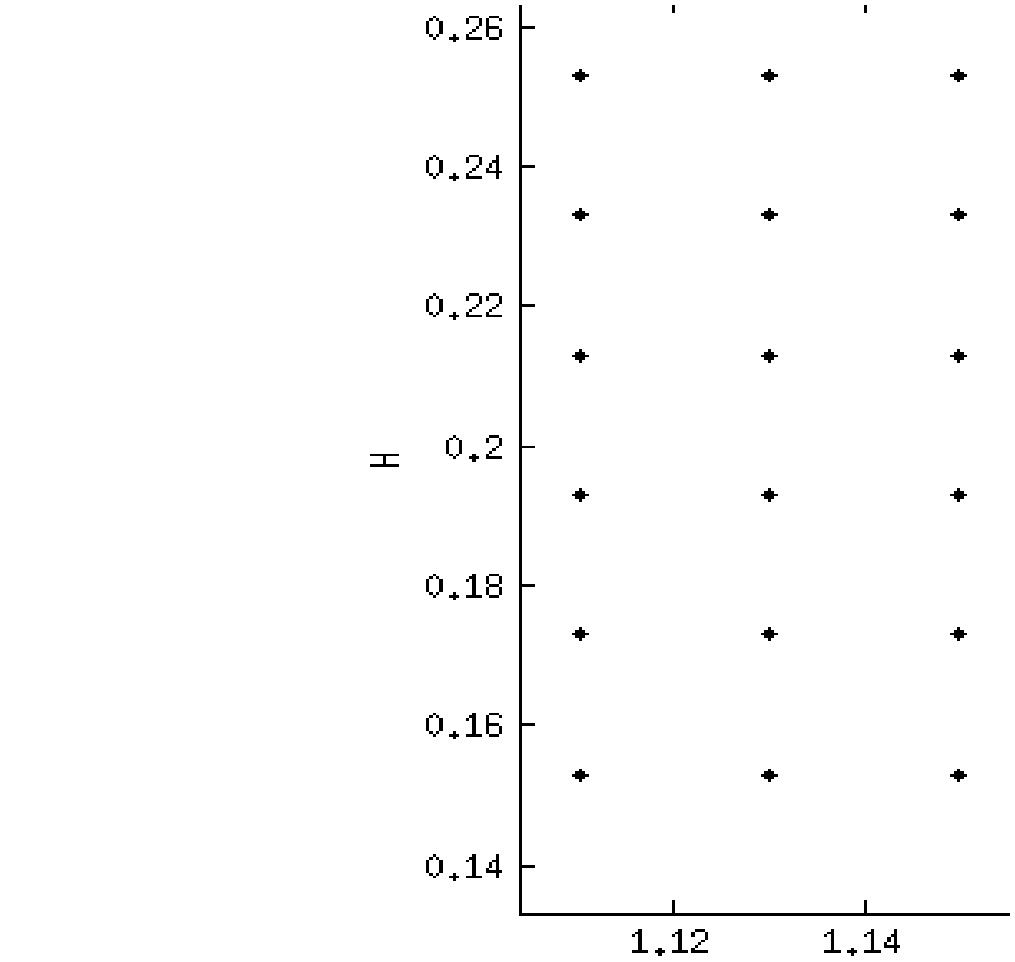


Conditional Average

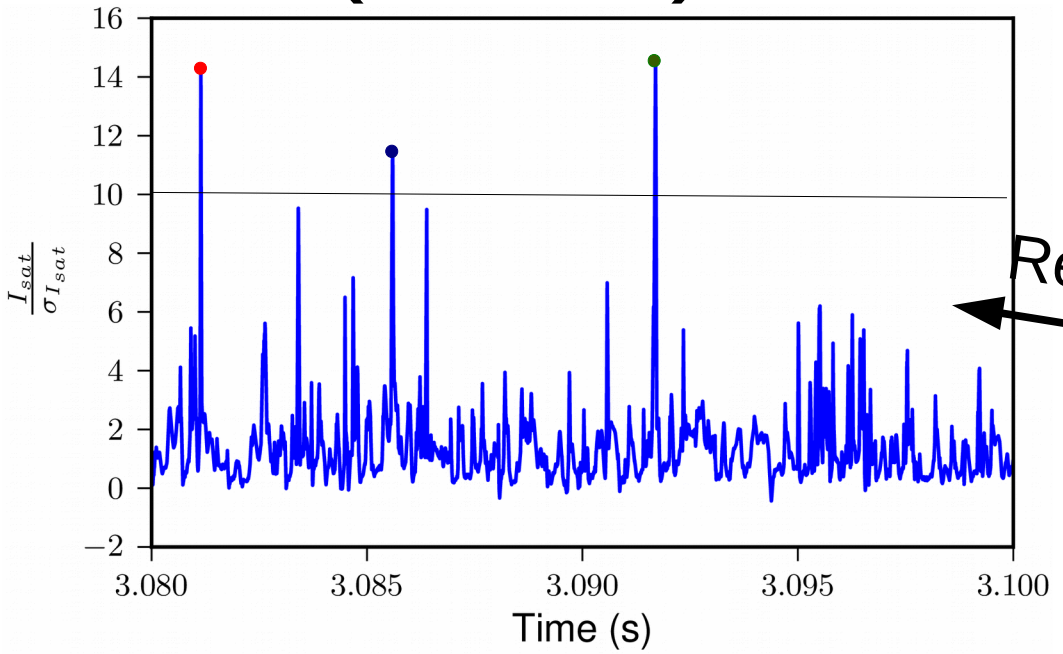
The bias value does not affect the mean pick width, just changing the base line value.

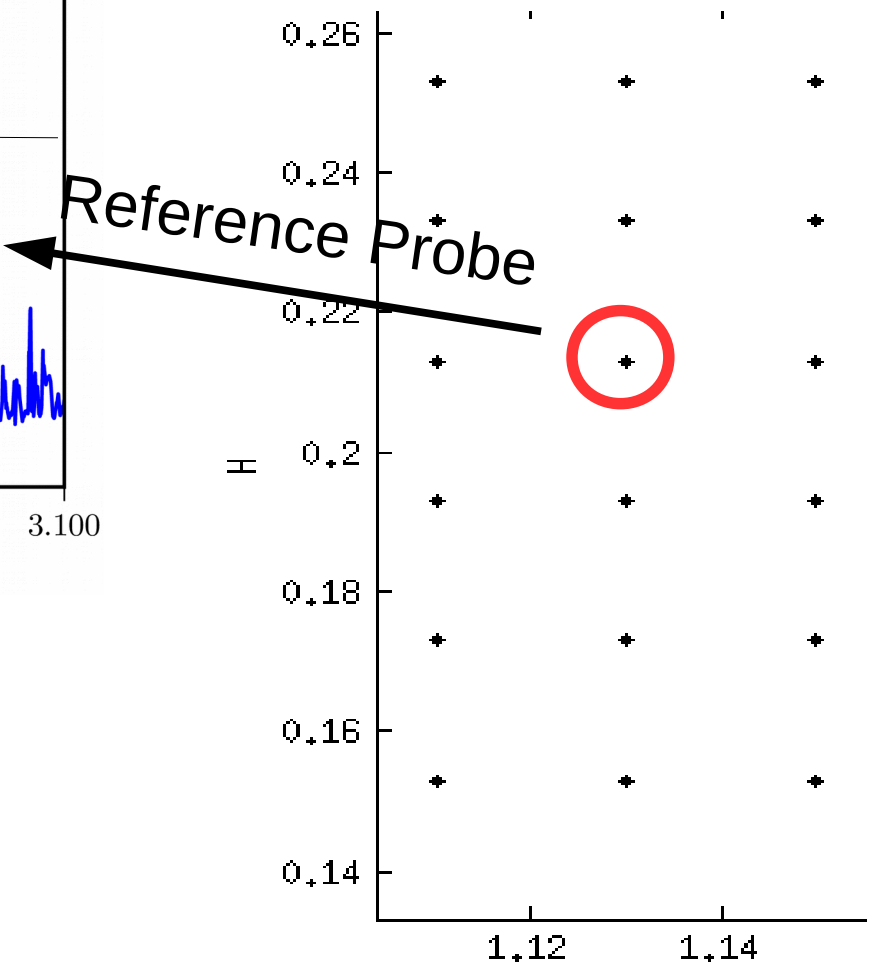


(Cross) Conditional Average

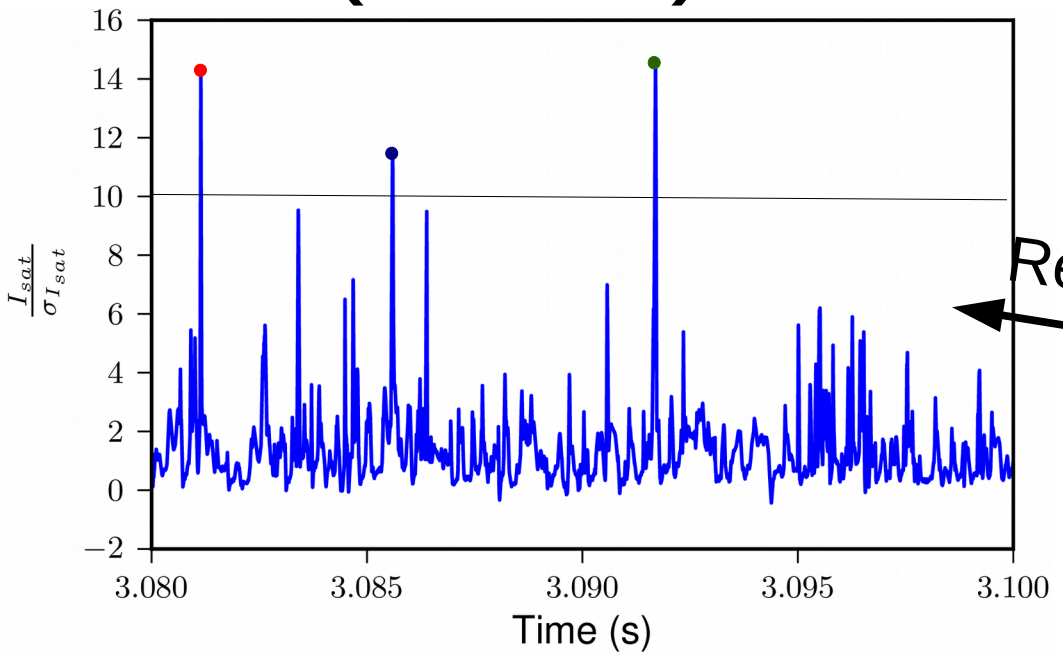


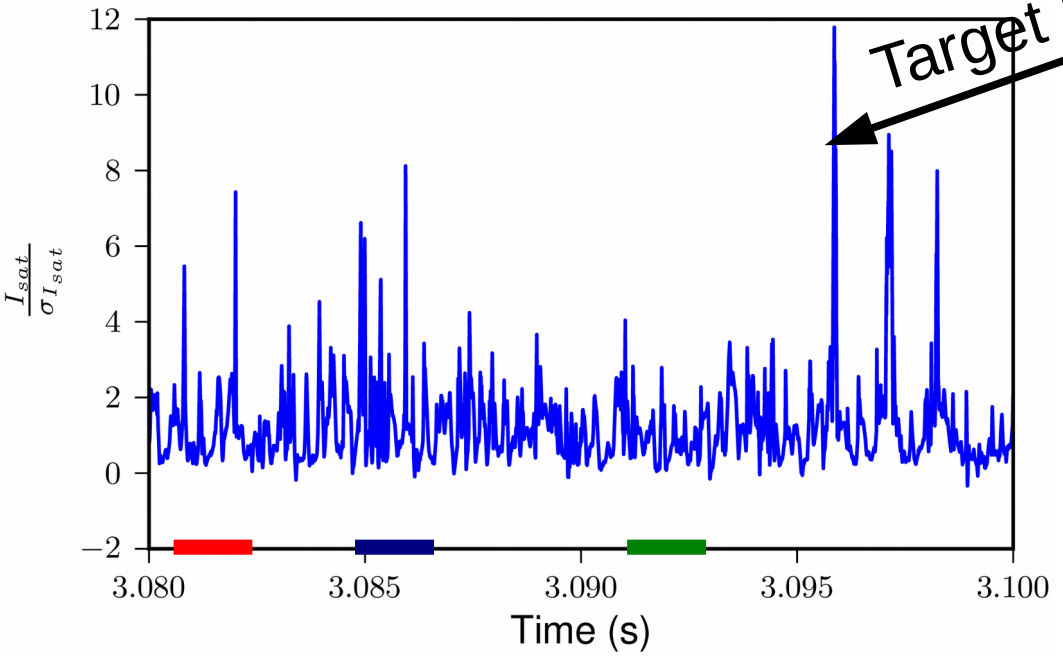
(Cross) Conditional Average

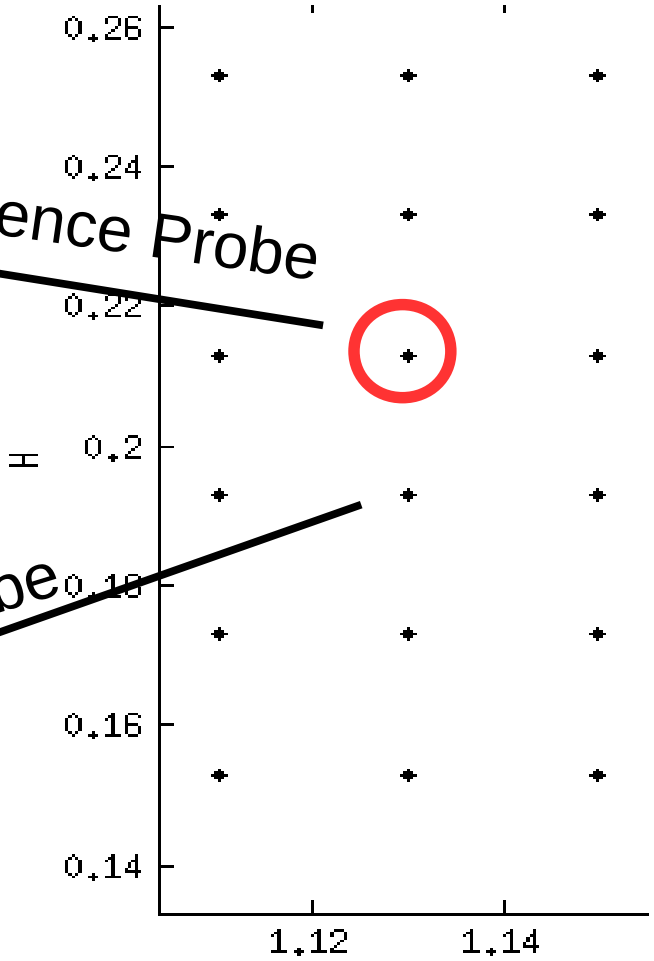




(Cross) Conditional Average



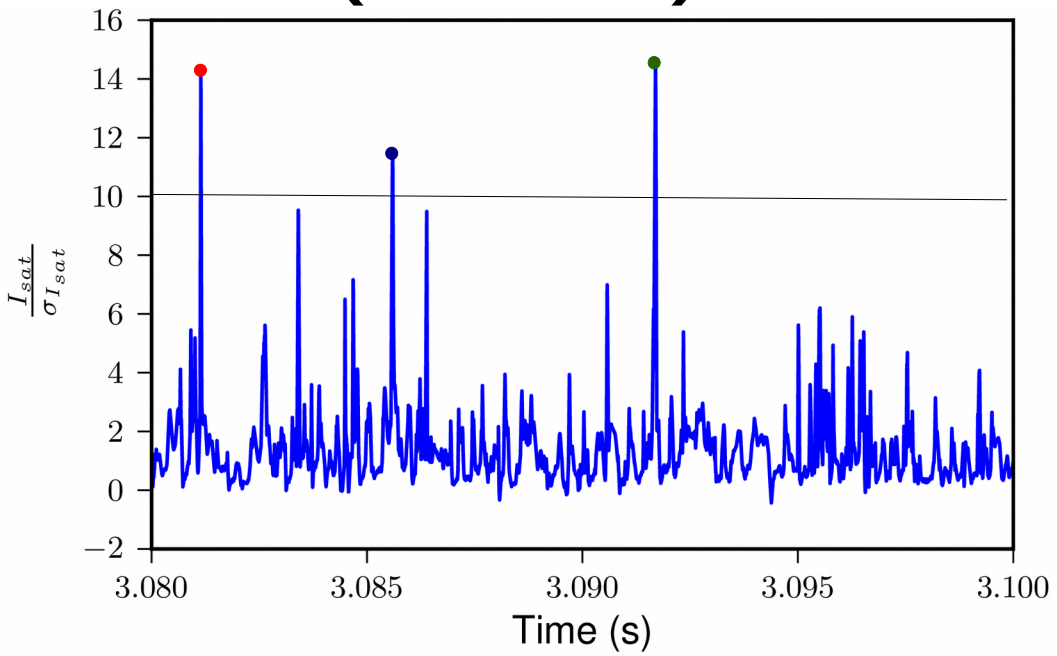




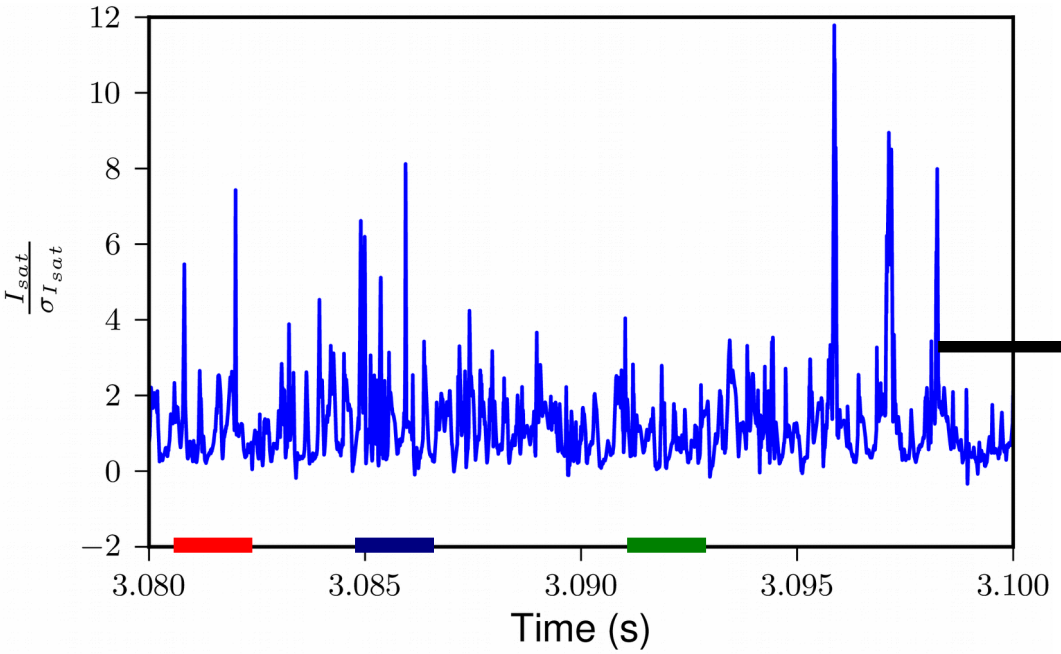
Reference Probe

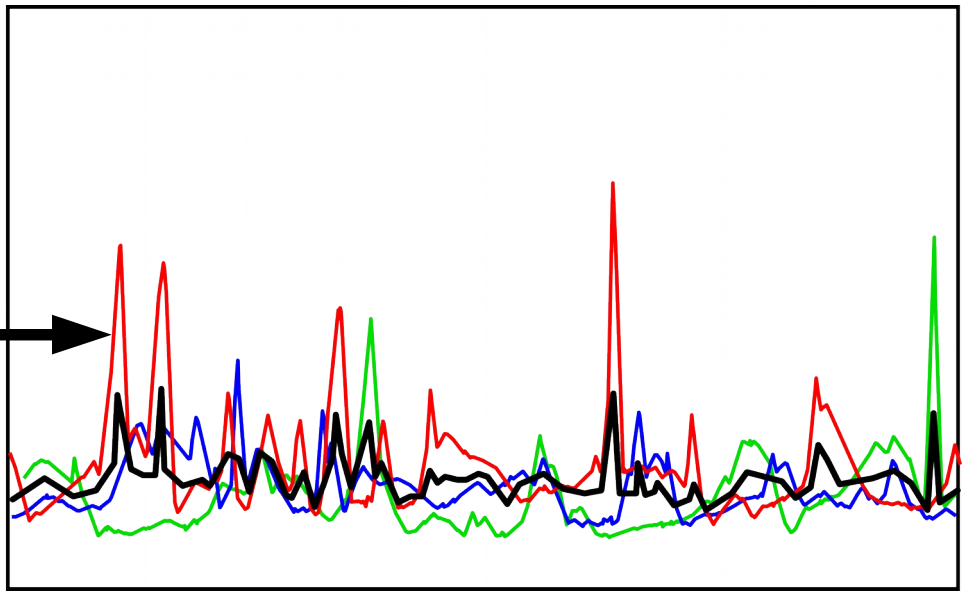
Target Probe

(Cross) Conditional Average

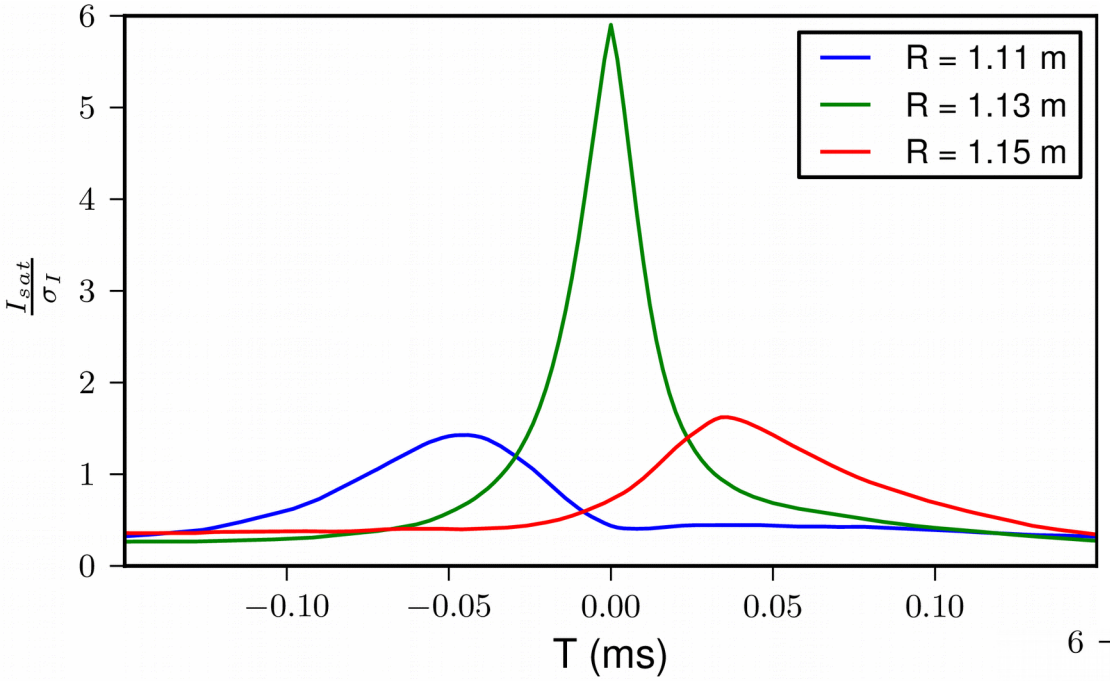


$$I_m(\tau, r, p) = \frac{1}{N_b^{(r)}} \sum_{n=1}^{N_b^{(r)}} I^{(p)}\left(t_n^{(r)} + \tau\right)$$



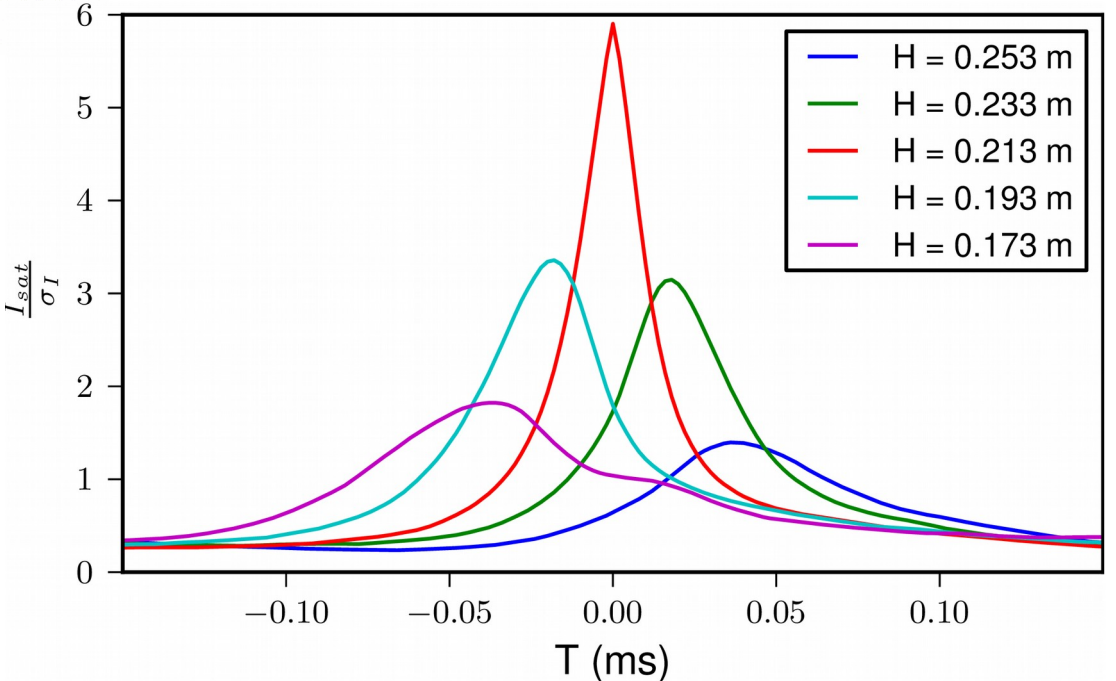


Conditional Average



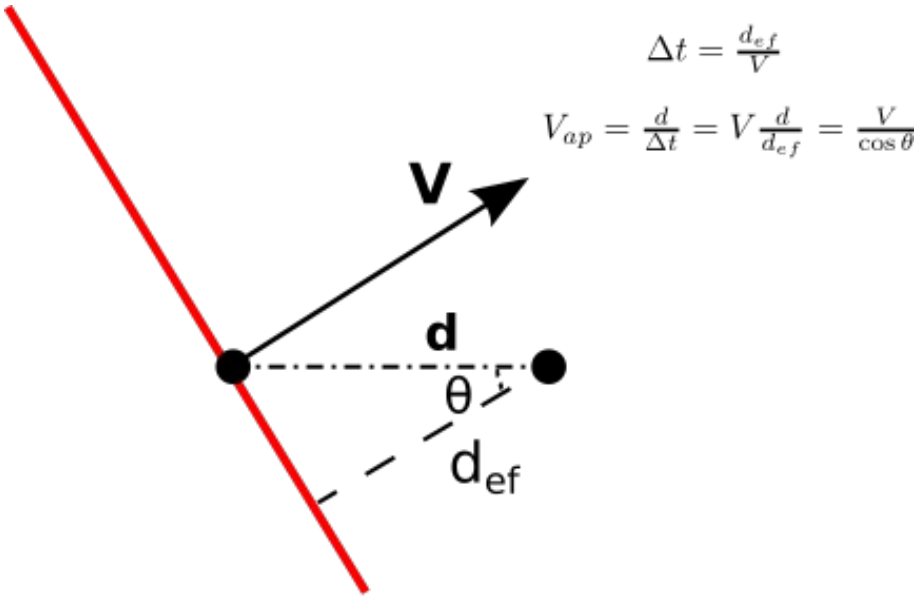
The appearance of trends in the conditional average indicates that the burst structure propagates outwards

And upwards.



How can we measure the velocity?

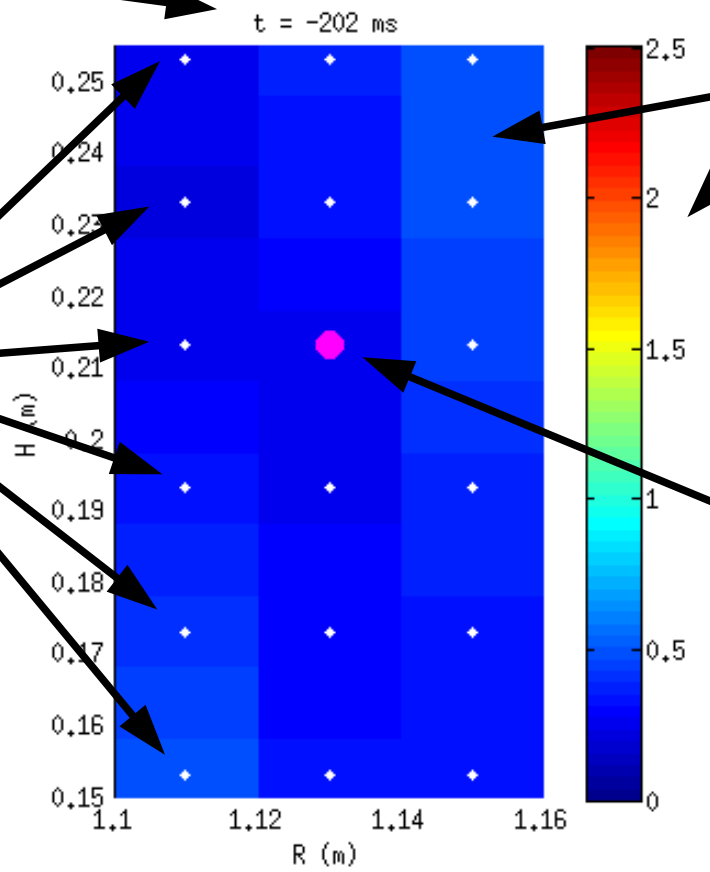
- If we use only the time delays and distances, the measured burst speed will be wrong.
- The actual structure velocity is both smaller and points to another direction



Propagation of Bursts

Time
(0 is when the burst appears in the reference probe)

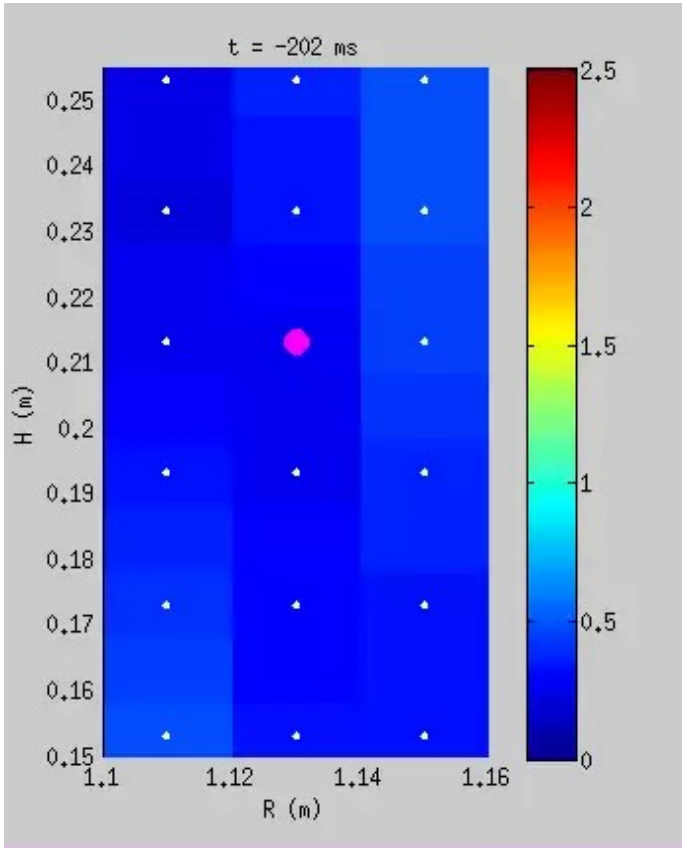
Probes



Conditional
Average values

Reference Probe

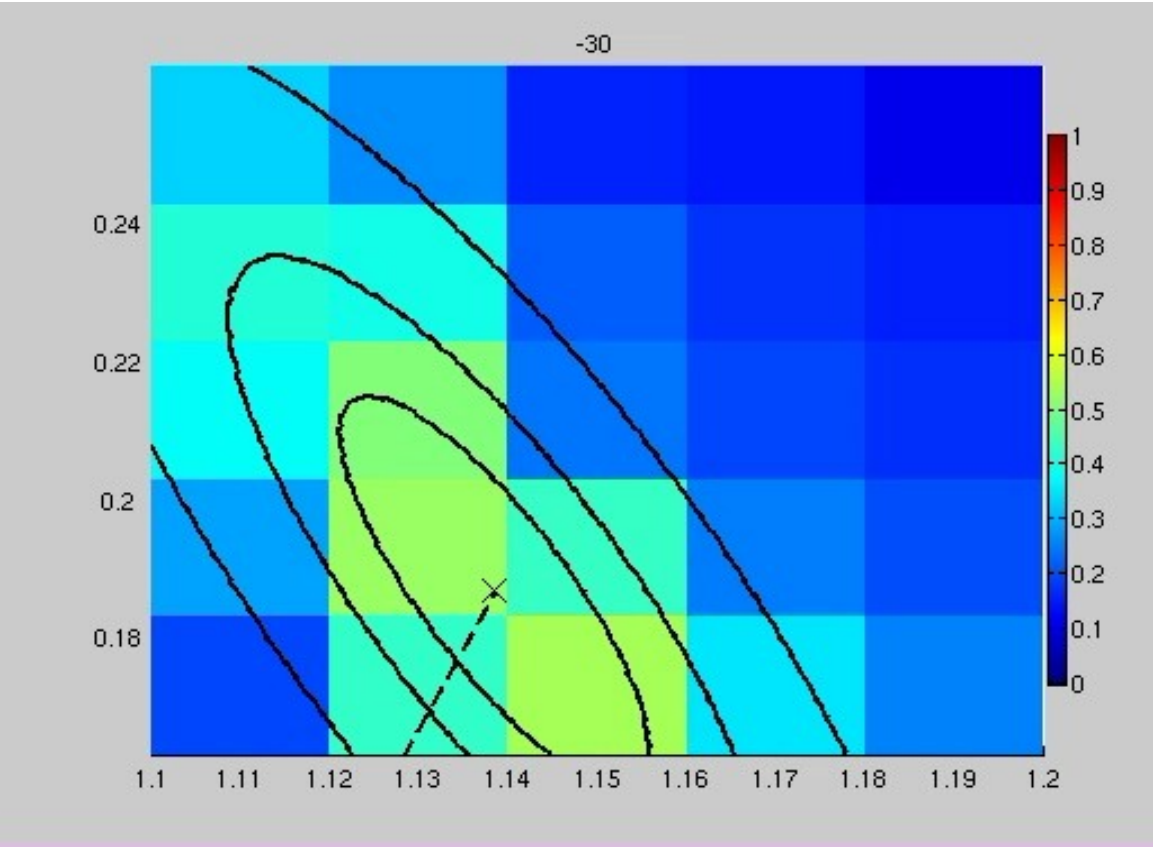
Propagation of Bursts



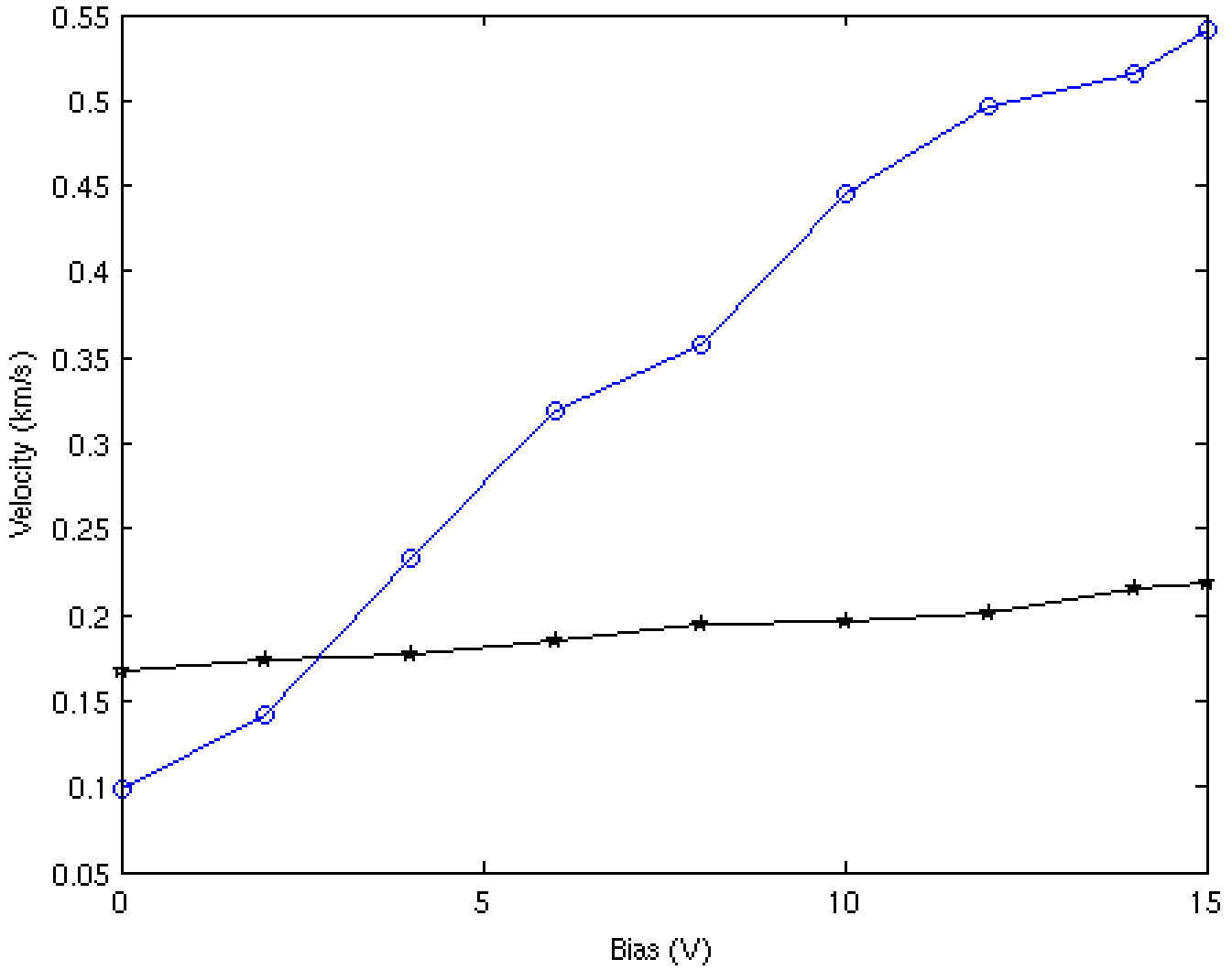
Burst Fit

- Constant velocity,
- Two characteristic lenghts,
- The intensity decreases as the burst gets further from the reference probe,
- Lorentzian shape (best fit)

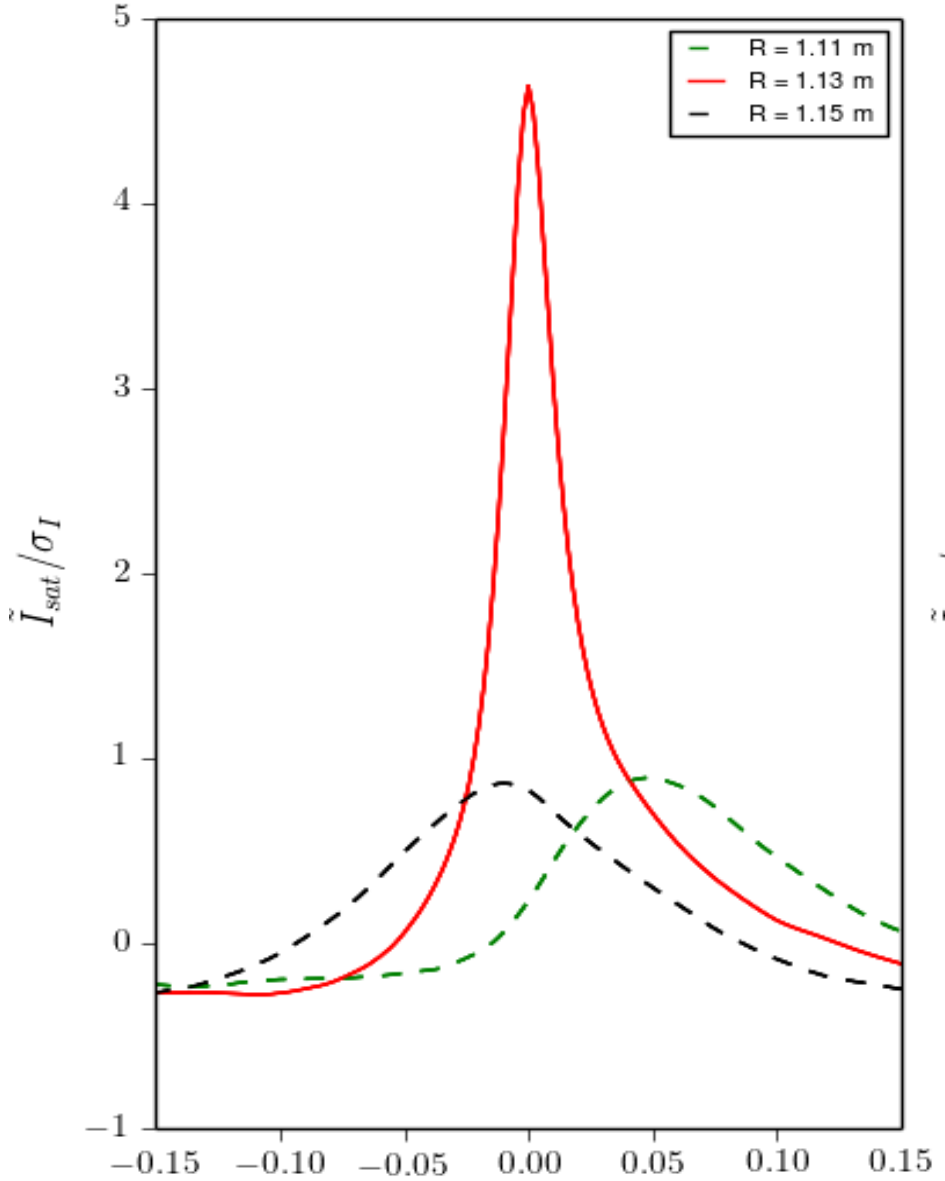
Burst Fit

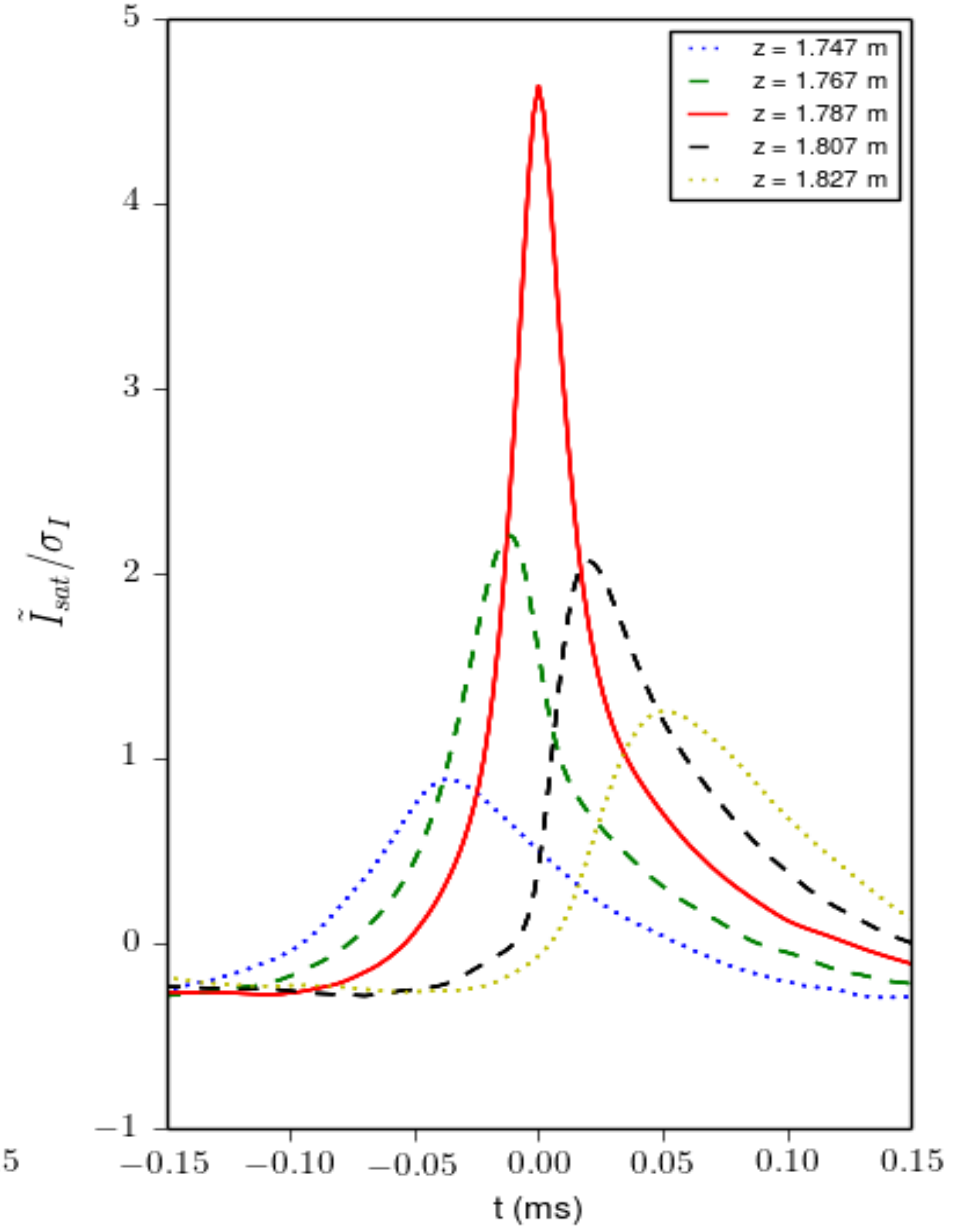

-30
0.24
0.22
0.2
0.18
1.1
1.11
1.12
1.13
1.14
1.15
1.16
1.17
1.18
1.19
1.2
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

Burst Fit

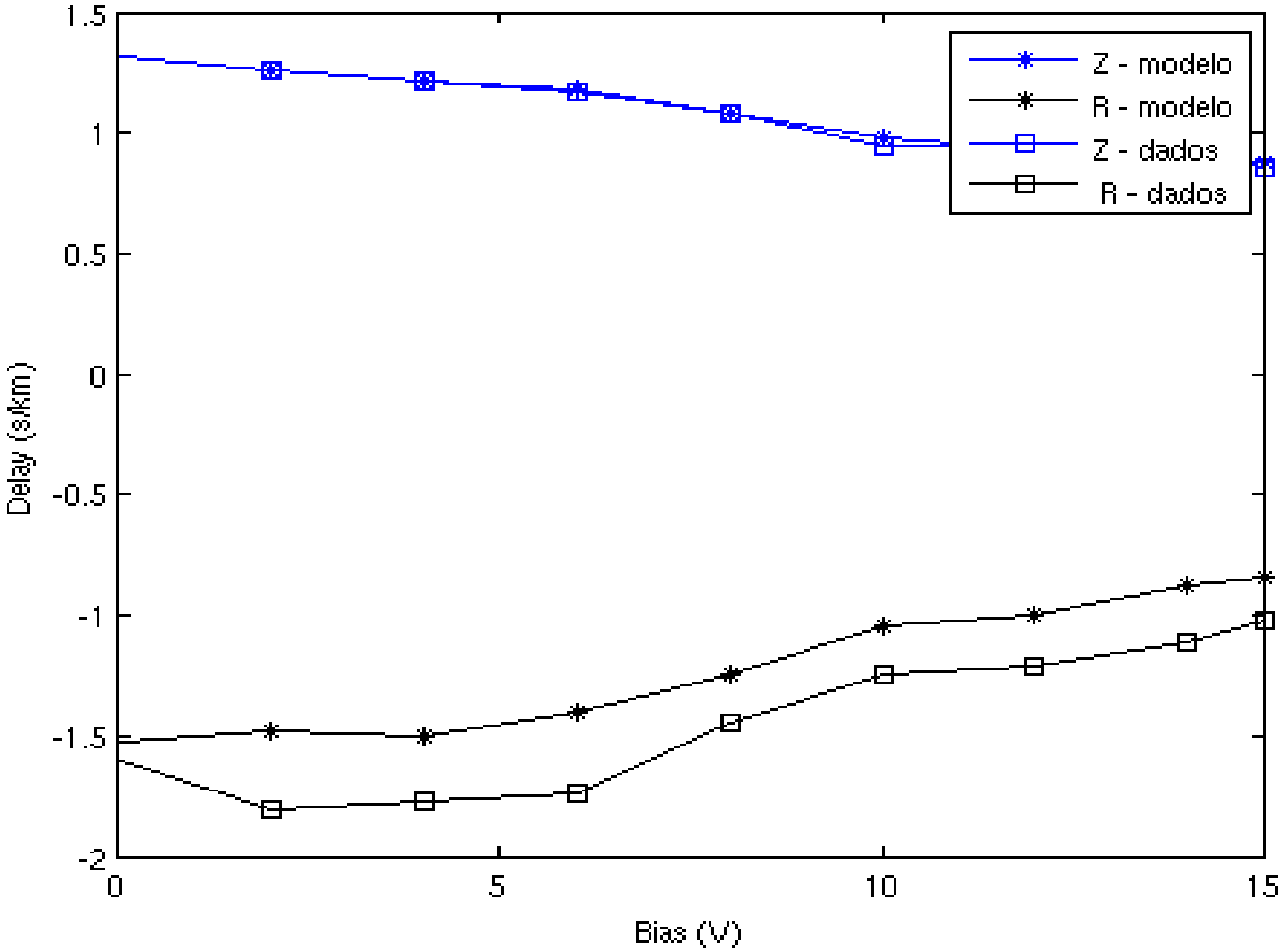

0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
Velocity (km/s)
0
5
10
15
Bias (V)

Top Plate

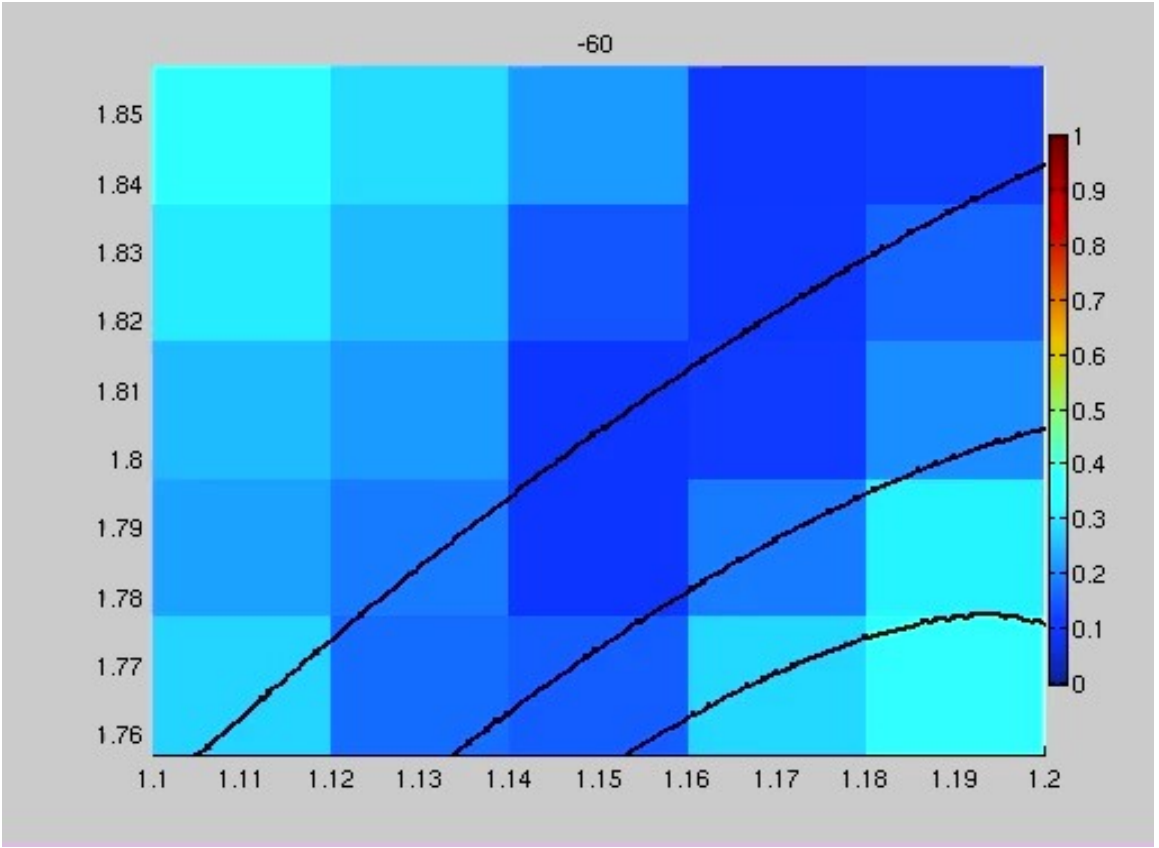

R = 1.11 m
R = 1.13 m
R = 1.15 m
$\tilde{I}_{sat}/\sigma_I$
5
4
3
2
1
0
−1
−0.15
−0.10
−0.05
0.00
0.05
0.10
0.15


z = 1.747 m
z = 1.767 m
z = 1.787 m
z = 1.807 m
z = 1.827 m
$\tilde{I}_{sat}/\sigma_I$
5
4
3
2
1
0
−1
−0.15
−0.10
−0.05
0.00
0.05
0.10
0.15
t (ms)

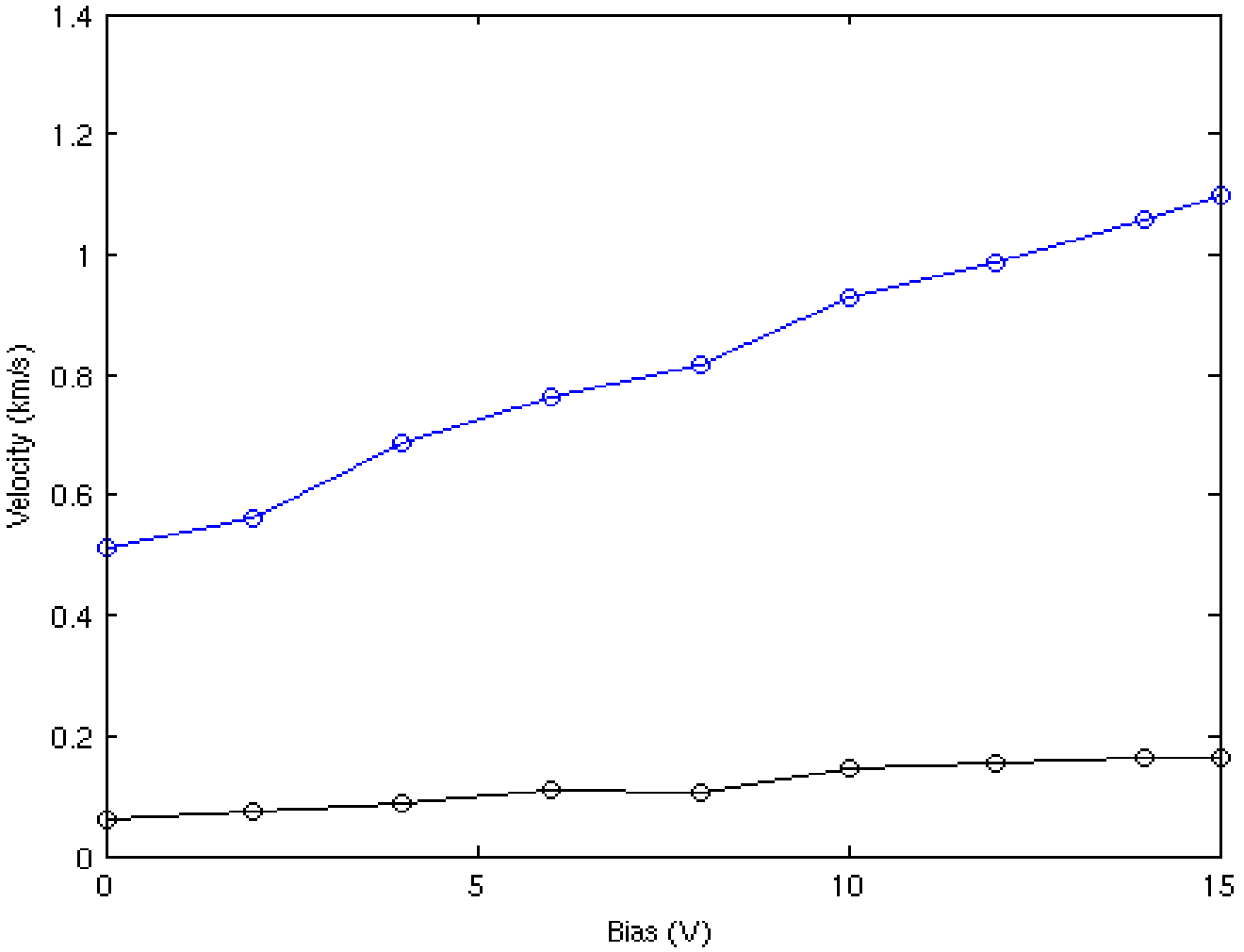
Top Plate


Z - modelo
R - modelo
Z - dados
R - dados
Delay (s/km)
Bias (V)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
5
10
15

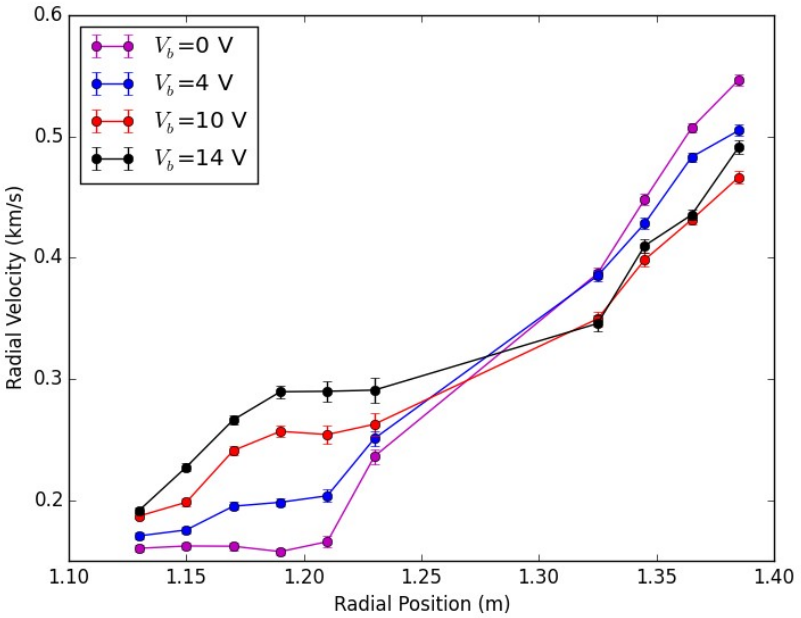
Top Plate

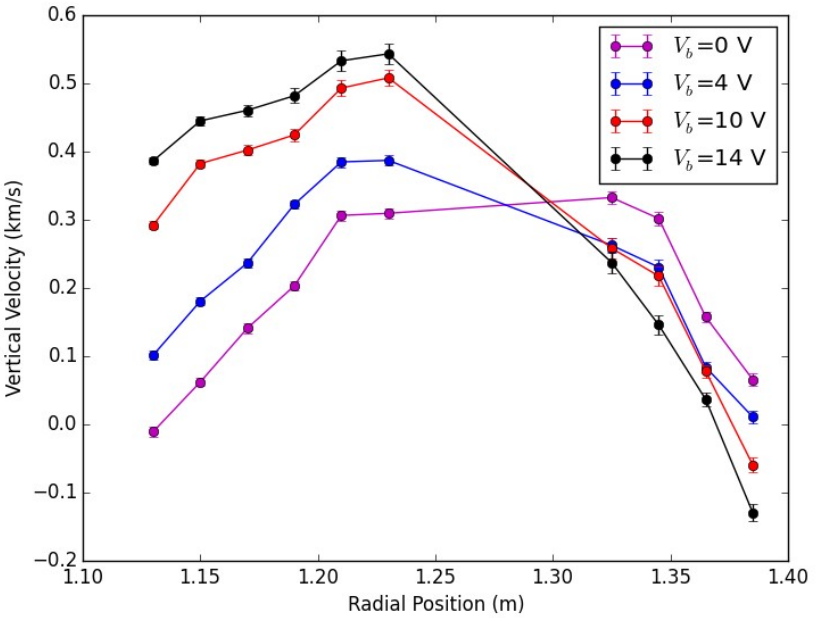

-60
1.85
1.84
1.83
1.82
1.81
1.8
1.79
1.78
1.77
1.76
1.1
1.11
1.12
1.13
1.14
1.15
1.16
1.17
1.18
1.19
1.2
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

Top Plate

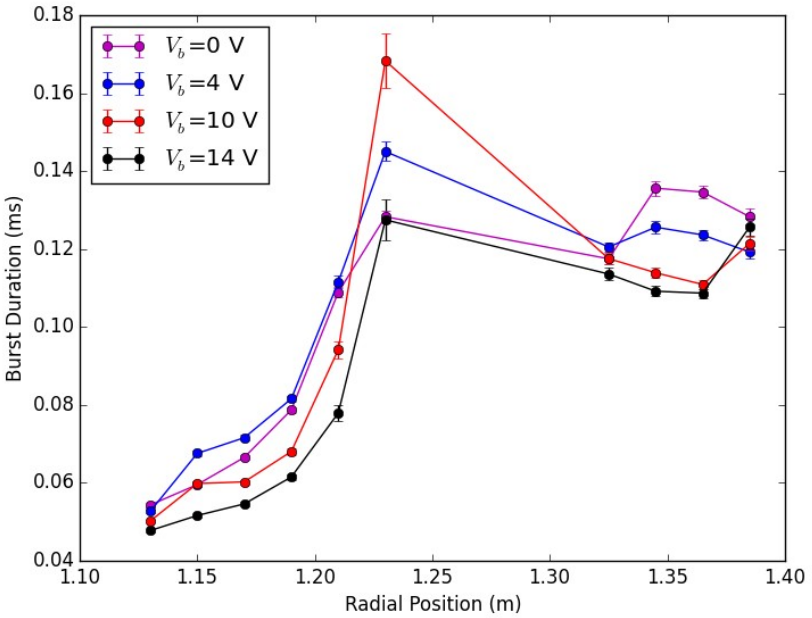


Radial Dependence





Radial Dependence



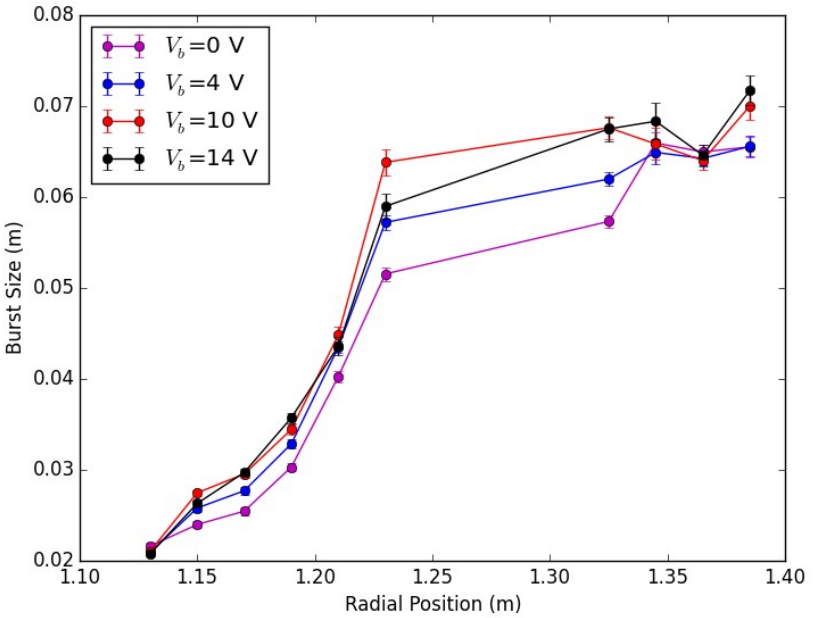
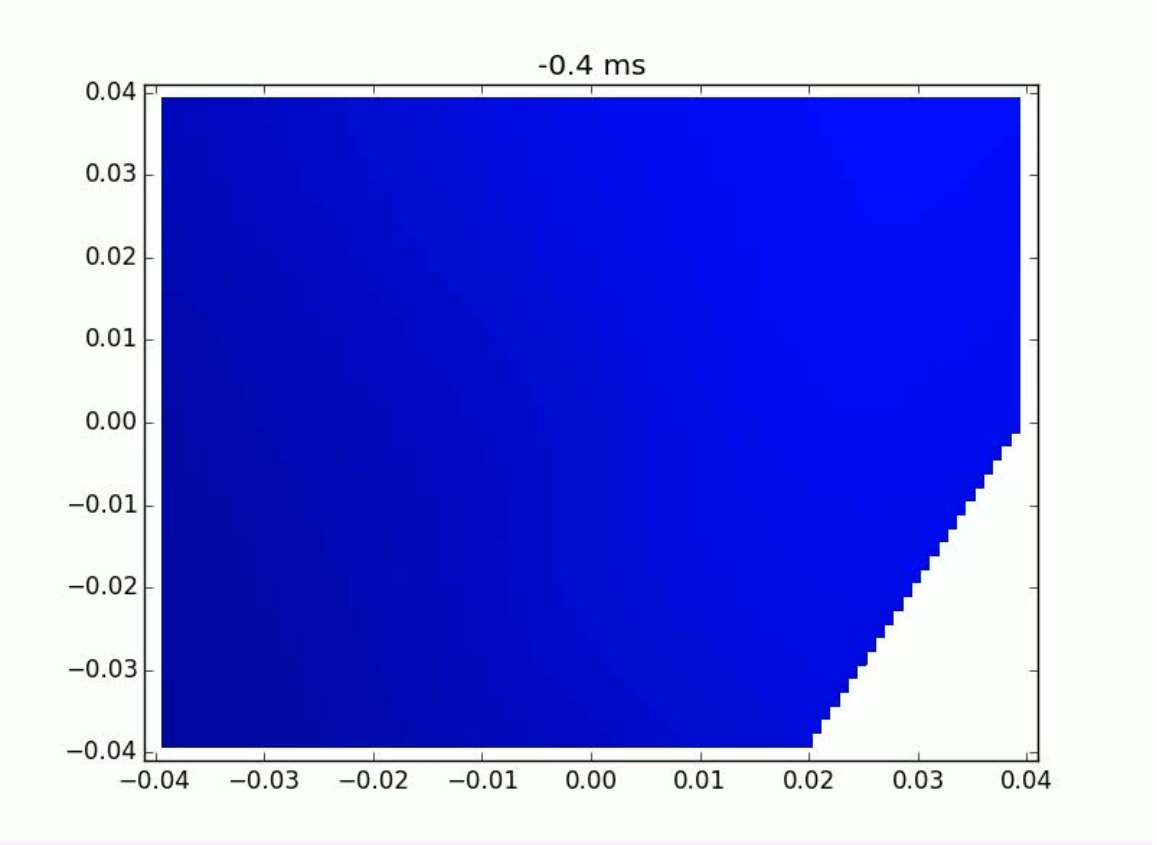


Plate 4 Burst



Conclusions

- The conditional average fit shows that the structures that generates the bursts propagates in the vertical and radial direction.
- Estimate velocities using time that takes to an object pass two different probes may give absurd results.
- The bursts radial velocities, size and duration increase with the radial position.