Study of nano dust impacts on STEREO using the S/WAVES instrument

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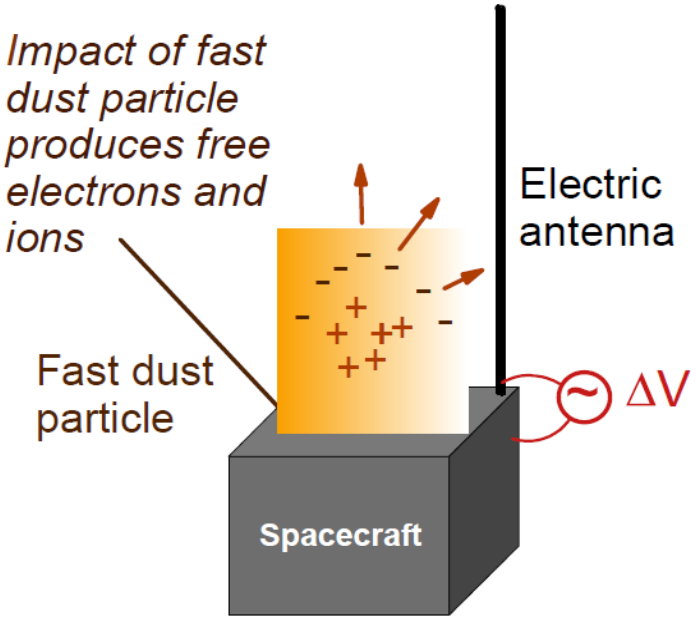
Basics of dust detection with a wave instrument



<u>Electric signal measured is basically a function of the charge Q of the plasma cloud</u>

+ other parameters as :

- the temperature of the plasma cloud
- the local density of the solar wind plasma
- the position of the impact with respect to the antenna
- ...

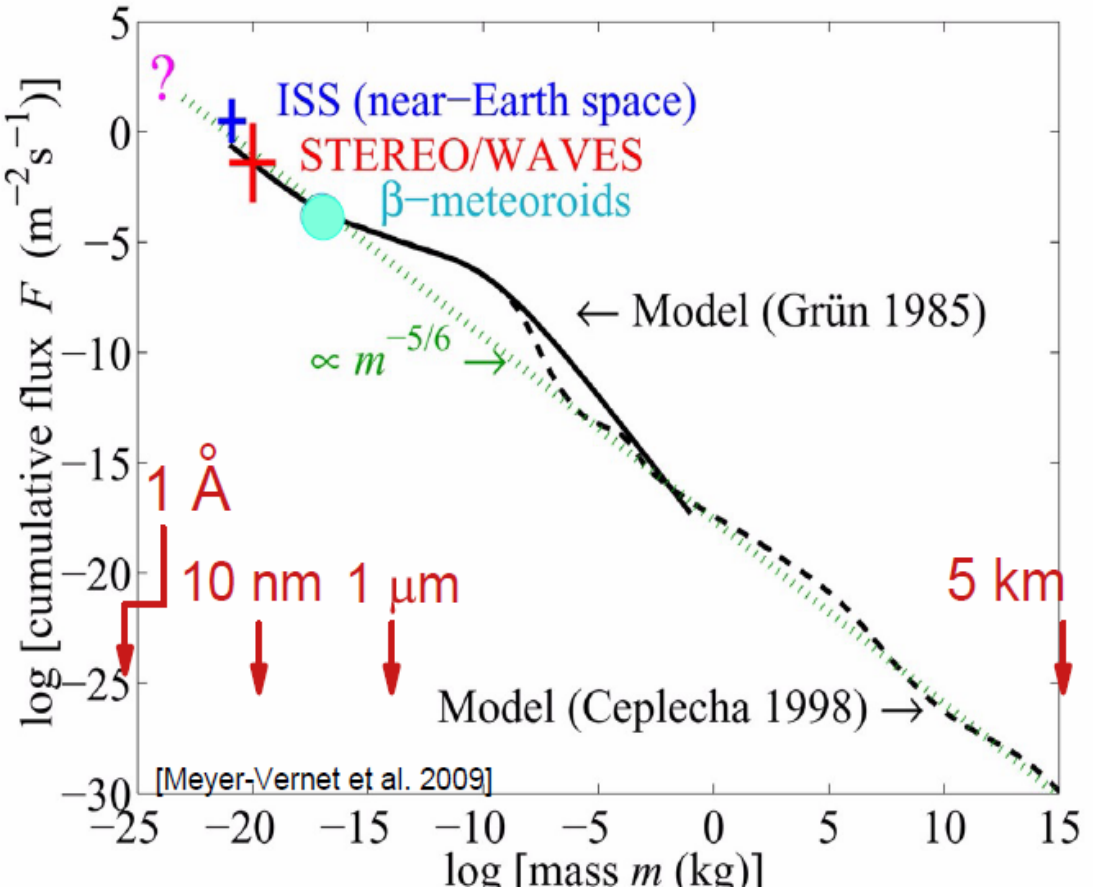
$$Q \propto m\, v^{3.5}$$

grain mass — grain speed

$\Rightarrow$ Nano dust: $r \sim 10$ nm, $m \sim 10^{-20}$ kg, speed $v \sim 300$ km/s

yields same Q as: $r \sim 0.2\ \mu$m, $m \sim 10^{-16}$ kg, speed v ~ 20 km/s

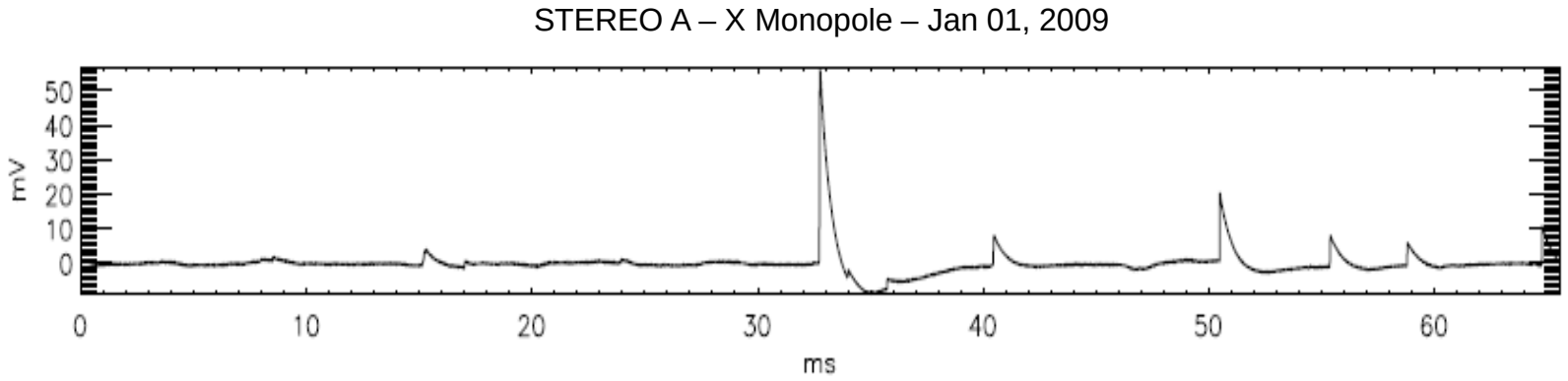
Interplanetary dust flux model



Flux (10 nm) / Flux (0.2 microns) > 2000

We expect to detect essentially nano-sized dust through wave instrument detection

Signal detected by the wave-form sampler TDS

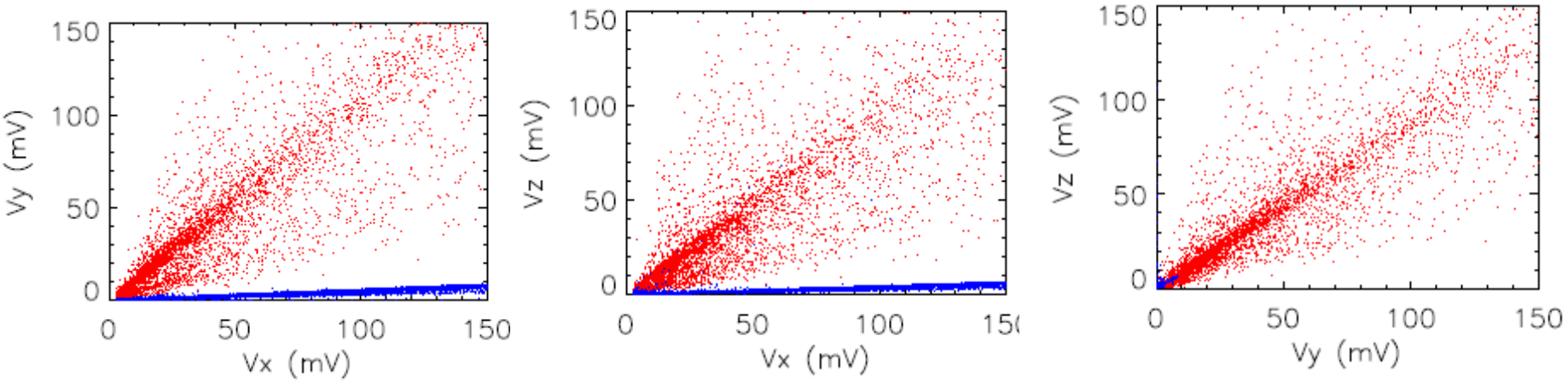


- Observations of impacts with a short rise time, and large amplitude (some mV)
- Coherent with what is expected for a nano-dust signal impact
- During some periods, we can observe up to 20 signals in a 60 ms sampling time period
- **On the 2007-2009 period, around 200 000 signals were detected on STEREO A and around 70 000 on STEREO B.**

STATISTICAL STUDY

Correlations between antenna signals

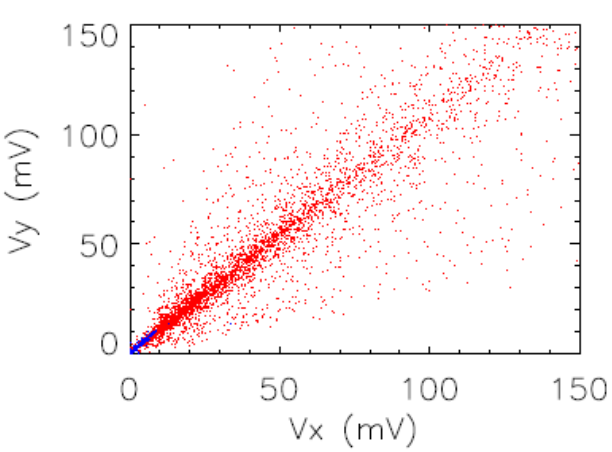
STEREO A :

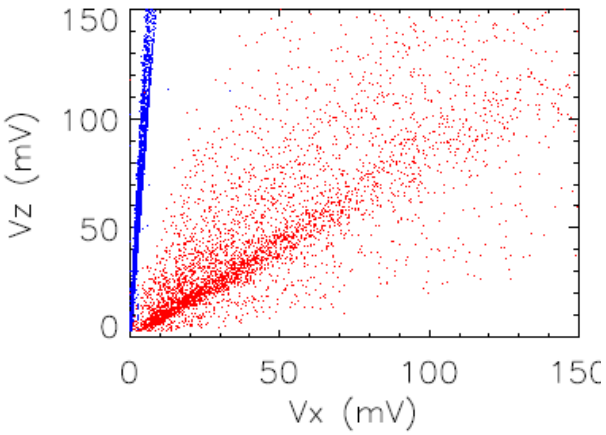


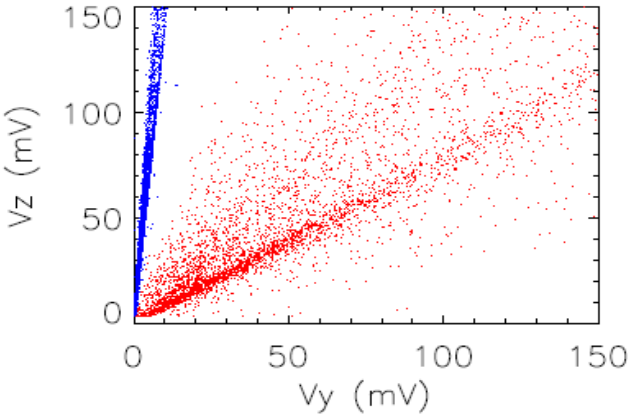
- Two categories of signals are clearly visible :
- Single-hit on the X antenna (Blue)
- Triple-hit with a signal of the same order of magnitude on the three antennas (Red)
- **Nred ~ 5000**
- **Nblue ~ 150 000**

Correlations between antenna signals

STEREO B :

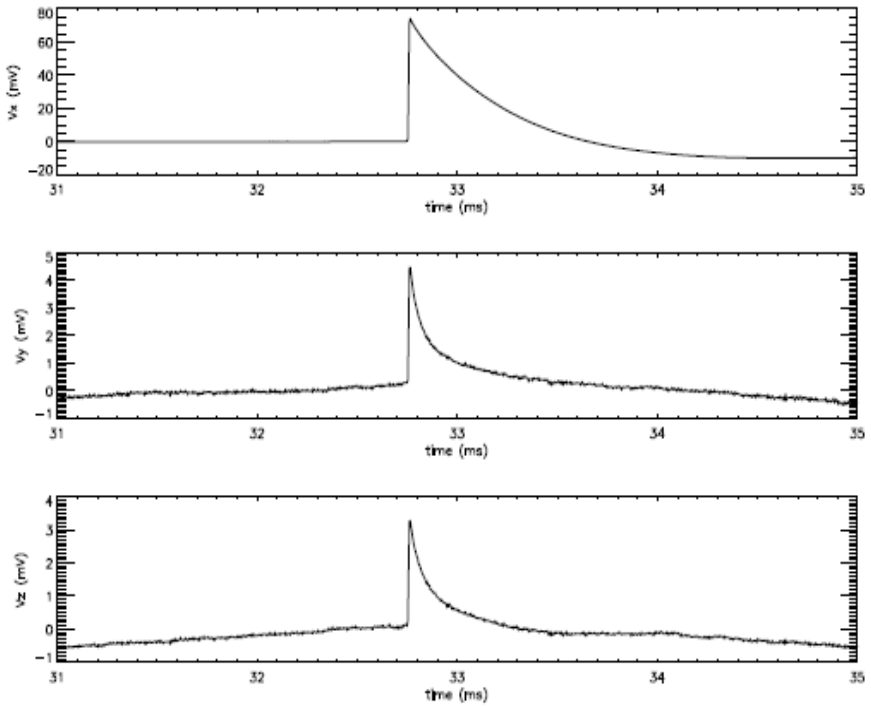


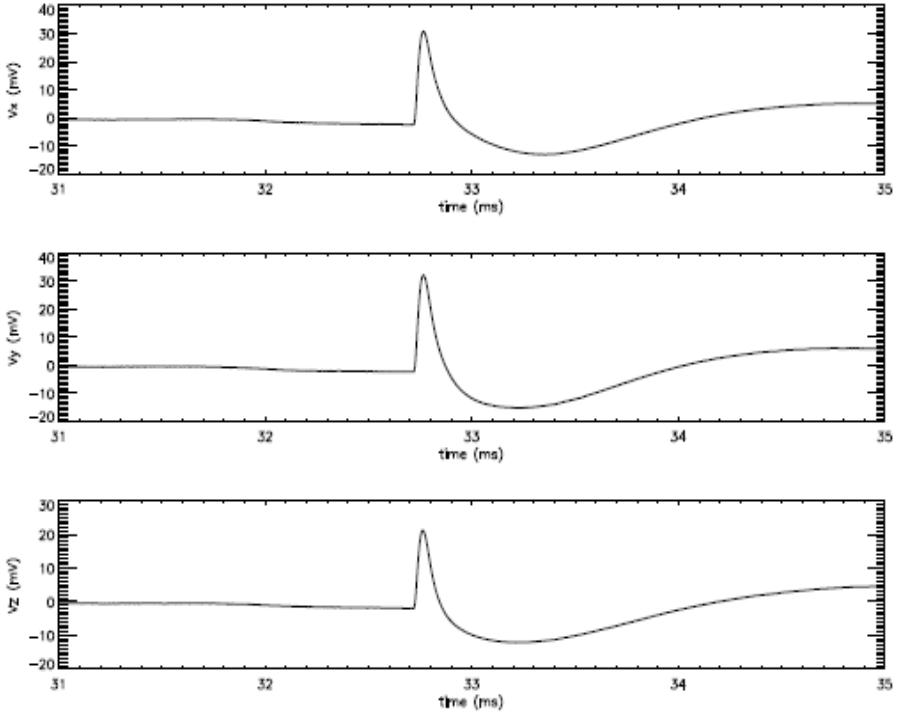




- Same picture as for STEREO A with :
- Single-hits detected on the Z antenna : Effect of Trigger ??
- Triple-hit with a signal of the same order of magnitude on the three antennas (Red)
- **Nred ~ 4000**
- **Nblue ~ 60 000**

Typical signals detected for the Single/Triple impacts





Single antenna impact characterised by :

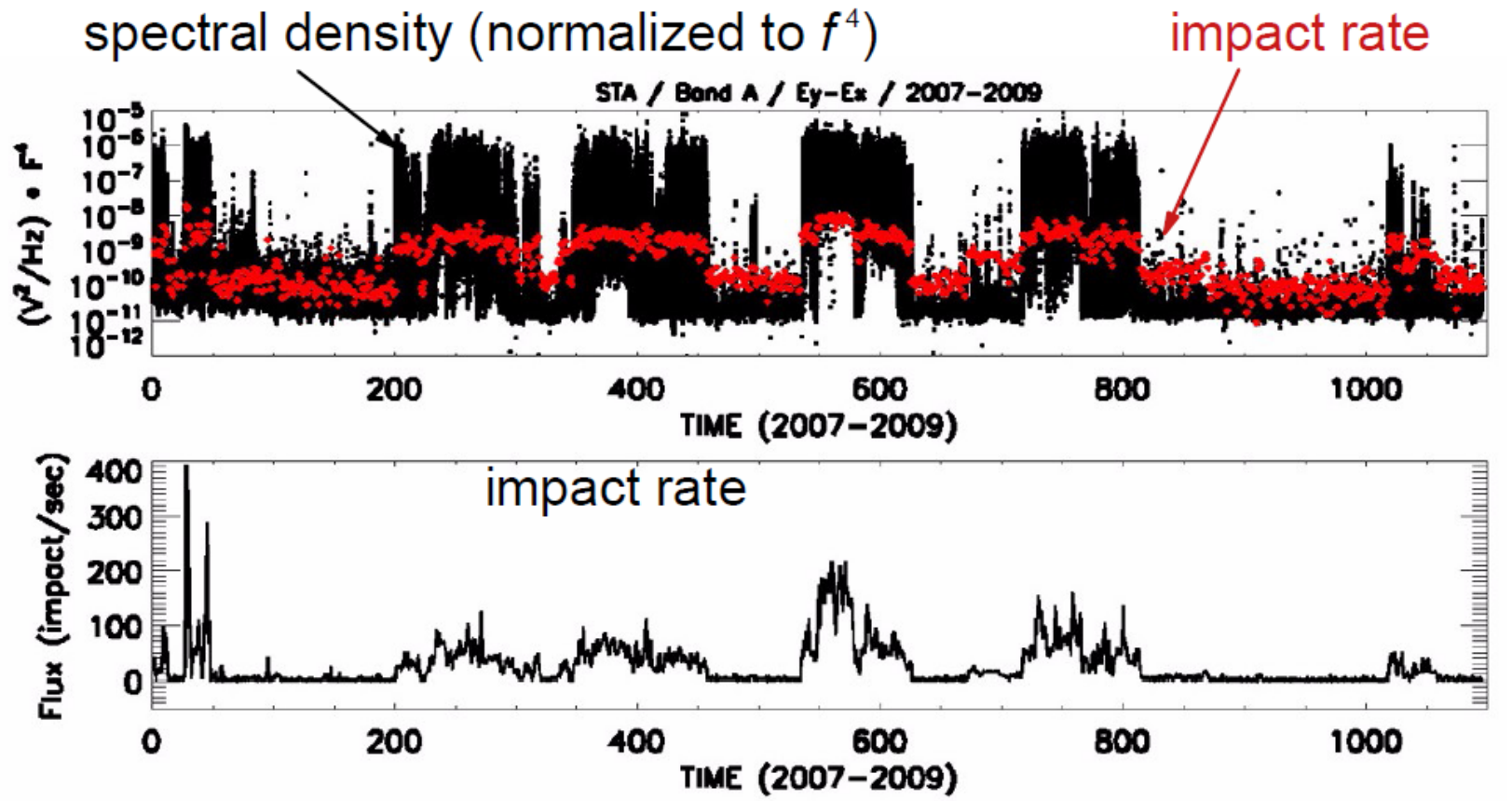
- Vy ~ Vz (STA)
- Vy,z ~ Vx * 5% (STA)
- Rise time : Tr ~ 30 microseconds
- Decay time : Td ~ 1 ms

Triple antenna impact characterised by :

- Vx ~ Vy ~ Vz

- Rise time : Tr ~ 70 microseconds
- Decay time : Td ~ 110 microseconds

Time variation of the dust flux (STEREO A)



• Possibility to determine the impact rate with a good accuracy : the nano-dust are appearing by « bursts » of duration of the order of the month

• Results consistent with the spectral density time variation on the LFR of S/WAVES (figure from N. Meyer-Vernet et al, 2009)

Conclusions

• We analyzed the dust impacts detected by the S/WAVES TDS waveform sampler during 3 years (2007-2009)

• The results obtained in terms of fluxes of detected impacts are improving the previous results obtained with the LFR

• We showed that the impacts are separable in two categories, that seem to have different physical properties (difference in rise and decay time, difference in the total flux)

• **May the « blue » be nano-dusts and the « reds » be micron-dusts ? Then why the observed ratio does not lie on the interplanetary dust mass distribution ?**

• A more detailed work on the physics of an impact, to enable a better understanding of the signal detected by the antennas is in progress