SOMaR3 – Meeting

Dynamics of Near Shore Wave Breaking observed by Coherent Marine Radar

Michael Streßer, Jörg Seemann, Ruben Carrasco, Li Chung Wu

July 15th, 2015 / Seattle

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Outline

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

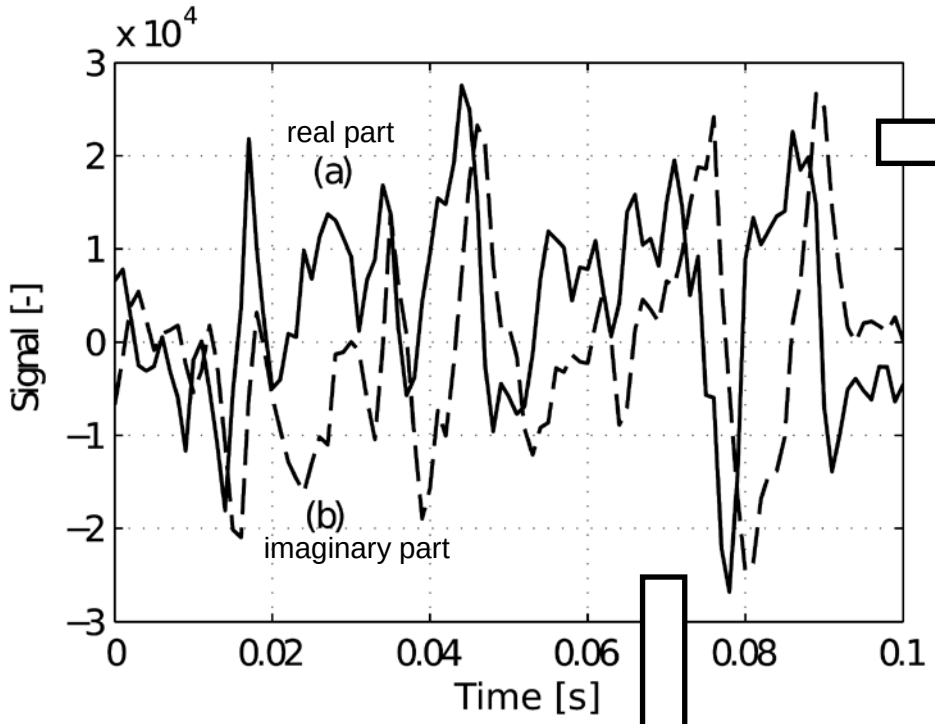
1. Part - Doppler processing

→ pros and cons of common Doppler calculation methods

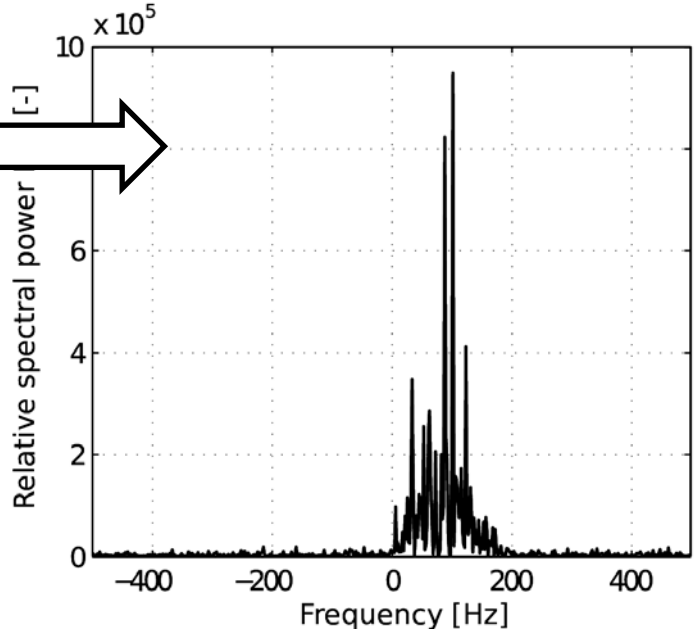
2. Part – characteristic patterns of breaking waves in grazing incidence coherent radar backscatter

→ how can we identify wave breaking in range time images

Doppler processing



FFT

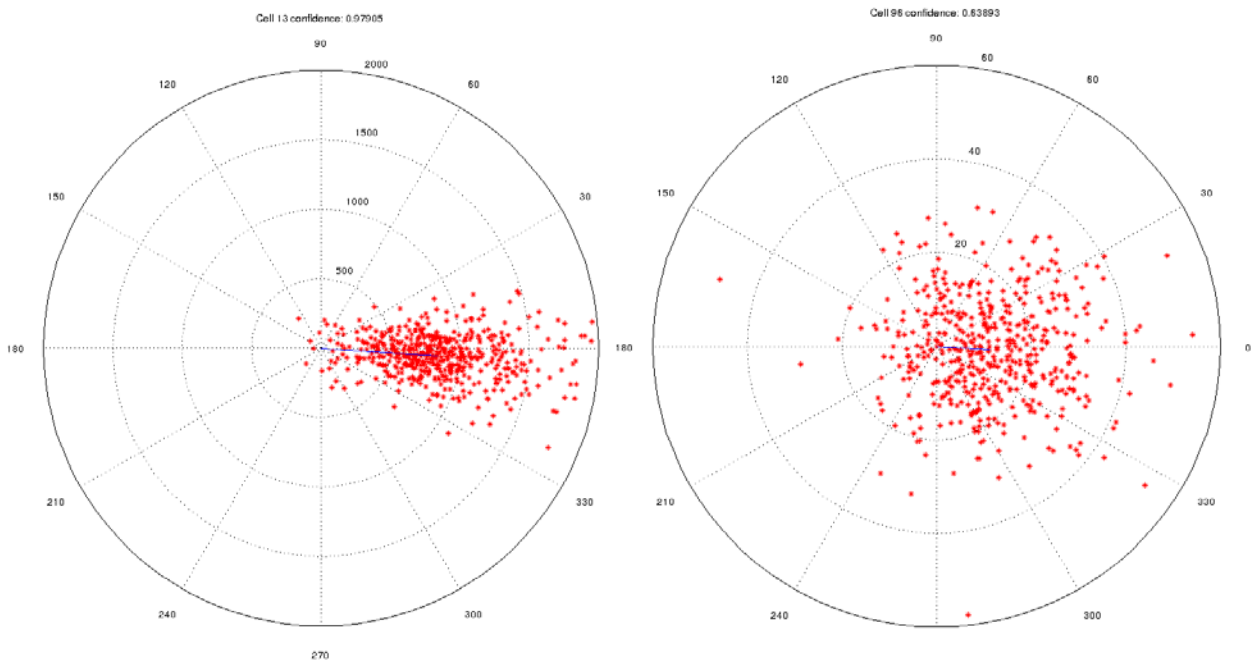


phase difference

$$v_D = \frac{\lambda}{2\cos\alpha} f_D$$

$$v_D = \frac{c\,\Delta\Phi\,\mathrm{f_S}}{4\,\pi\,f_R}$$

Phase difference method



0.97

0.64

Benefits

- robust and fast method
- confidence as indicator of reliability

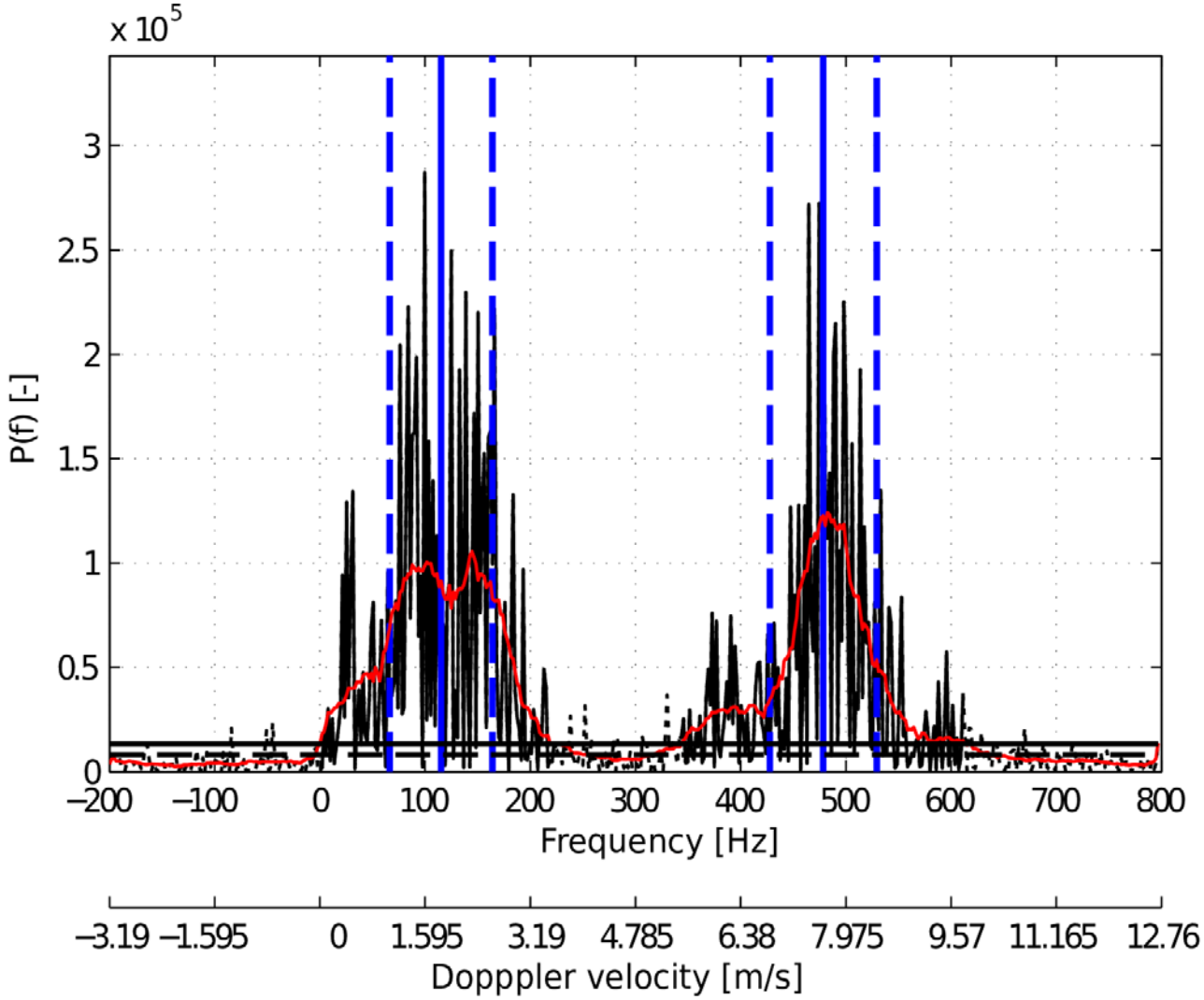
Disadvantages

- no additional information

$$C_i = \frac{A_{j+1}{}^{\mathrm{i}\Phi_{j+1}}}{A_j{}^{\mathrm{i}\Phi_j}}$$

$$conf = \frac{|\sum C_i|}{\sum |C_i|}$$

FFT - Method



Benefits

- Doppler peaks are easy to seperate
- spectral moments can be extracted

-> extracted parameters like number of peaks, std, skewness or kurtosis may provide information about the scatterer behaviour inside one radar footprint

Disadvantages

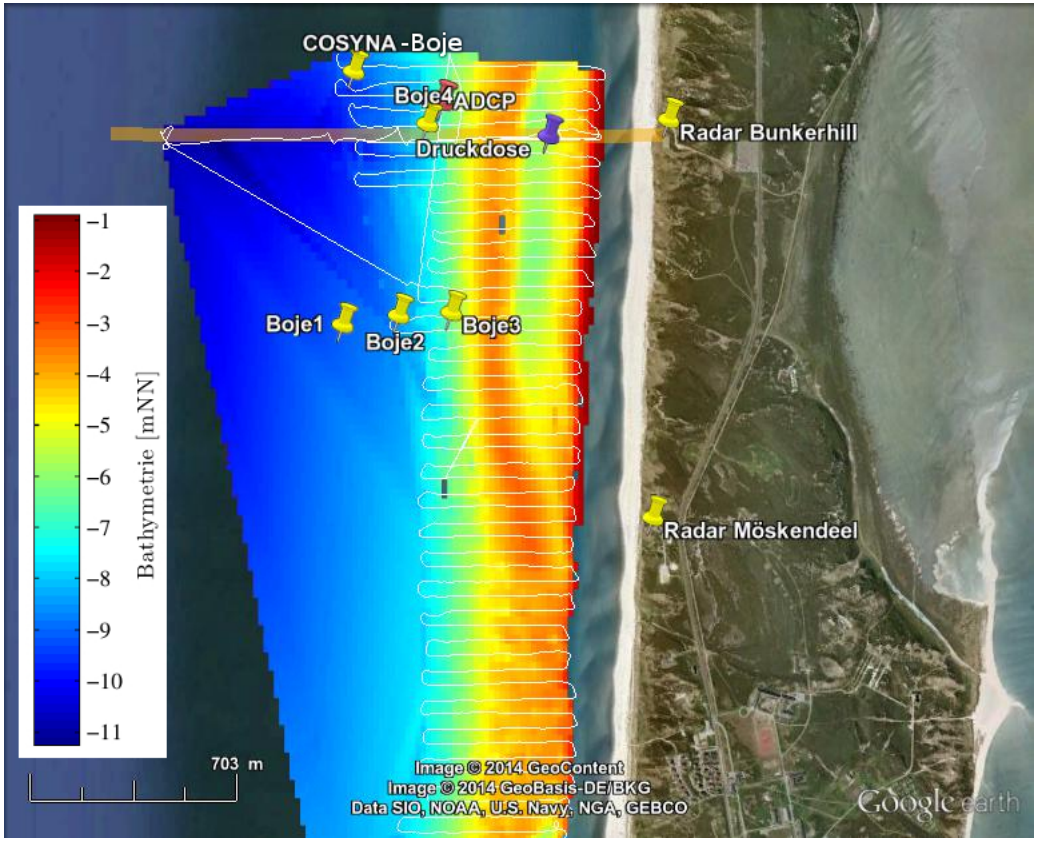
- computational time
- time resolution

Measurement site

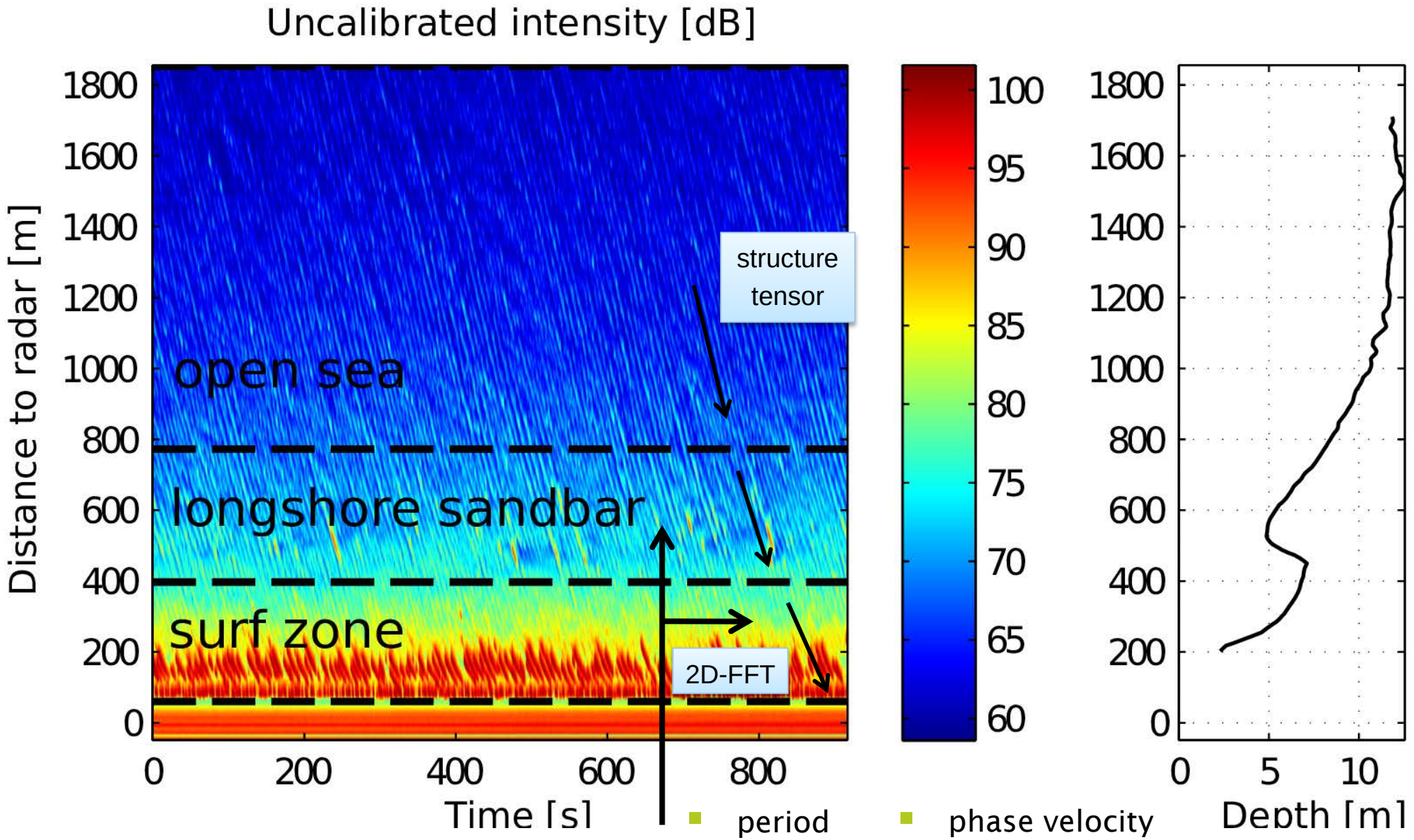
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Permanently: X-band radar, meteorology, Waverider bouy

Temporary: pressure gauges, ADCP, smaller GPS-Waveriders

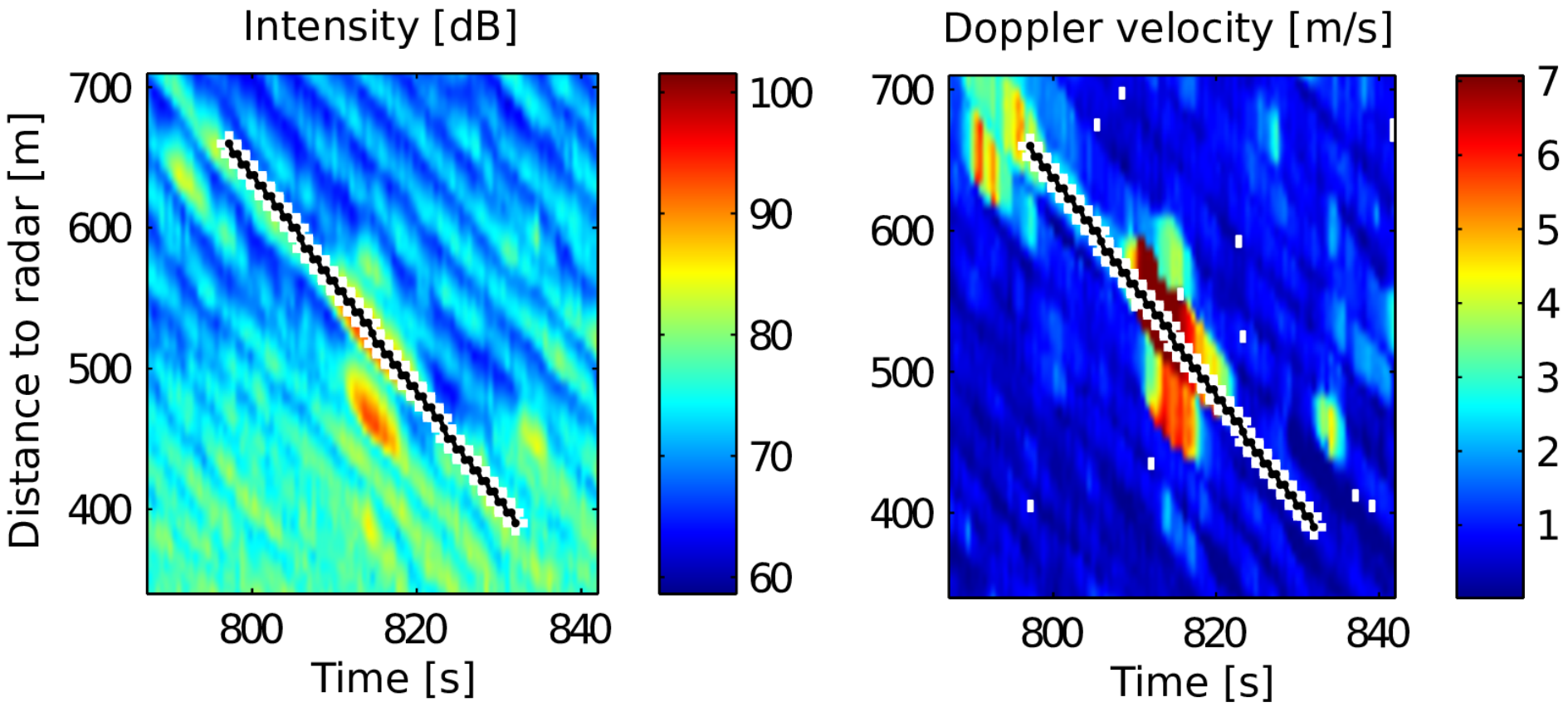


Range-time radar data



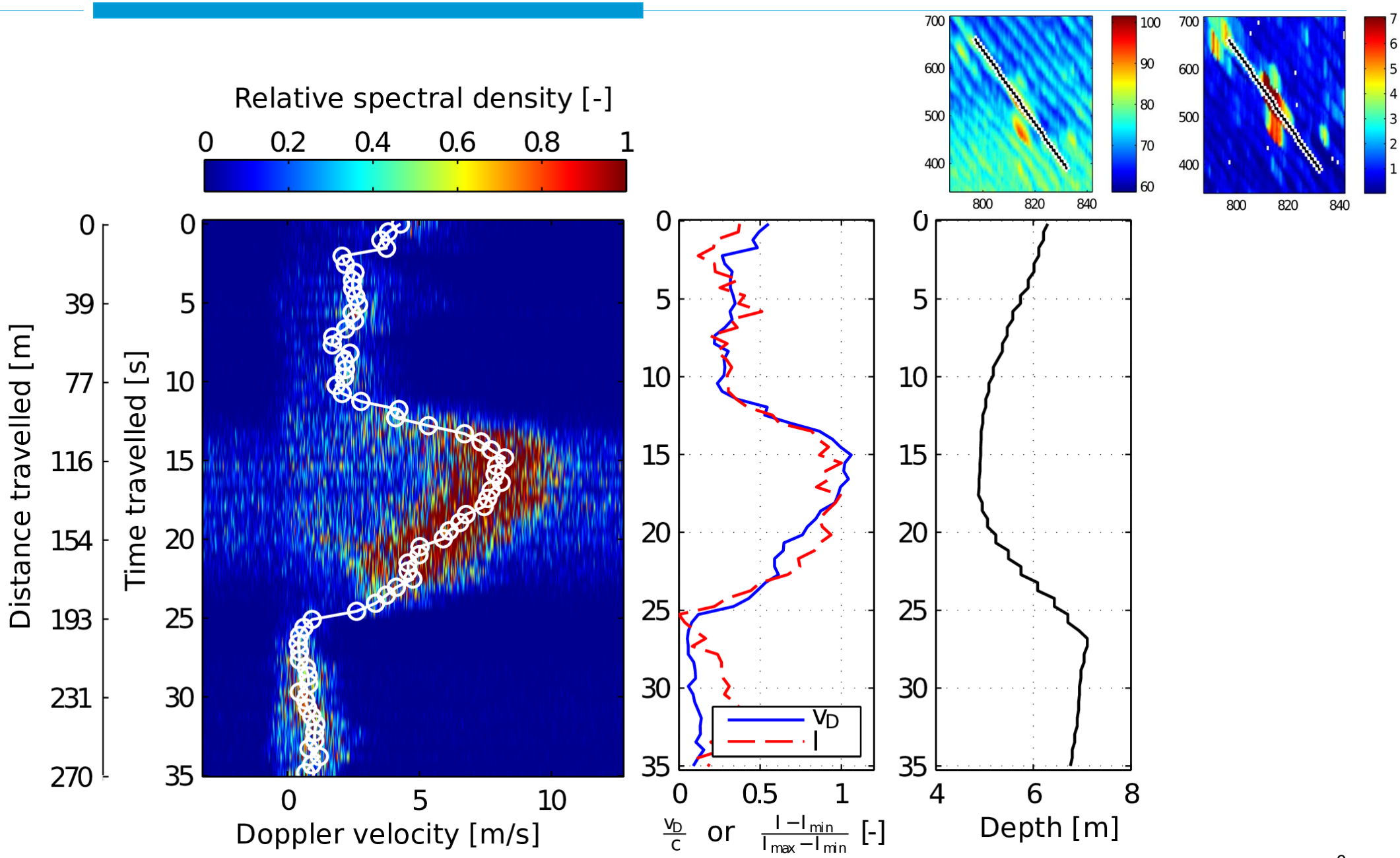
Manually tracked breaker

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



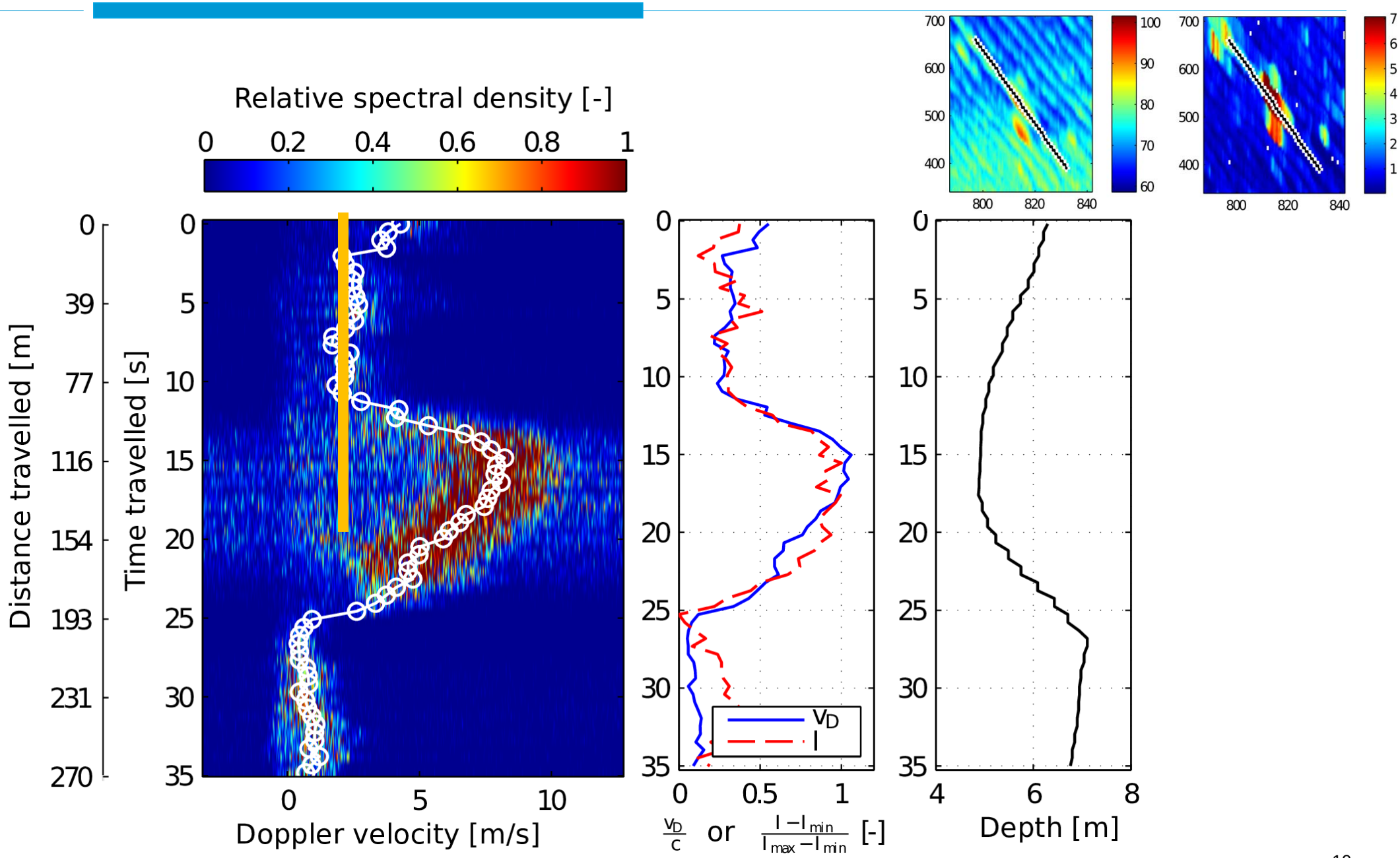
Manually tracked breaker spectrogram

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



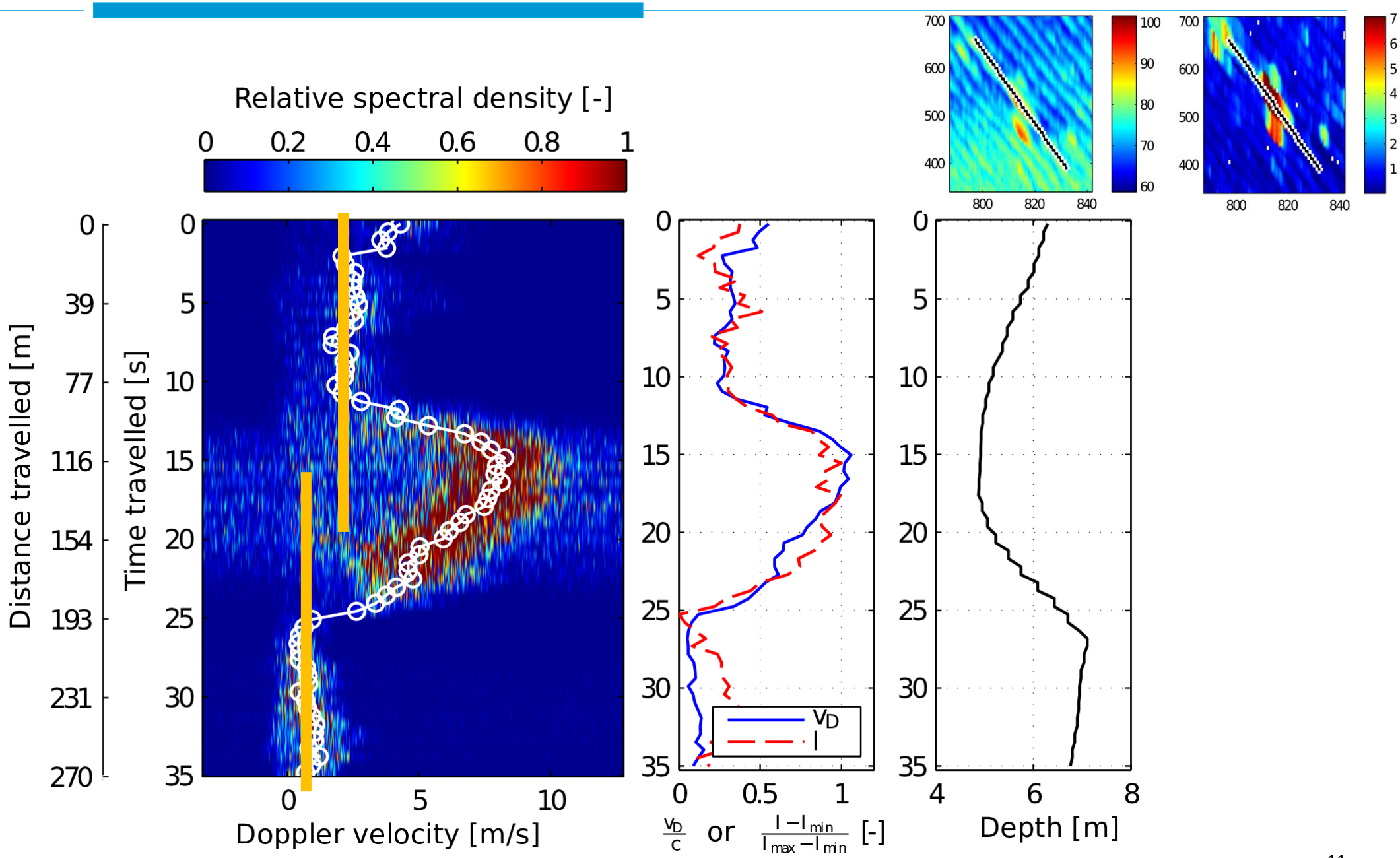
Manually tracked breaker spectrogram

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



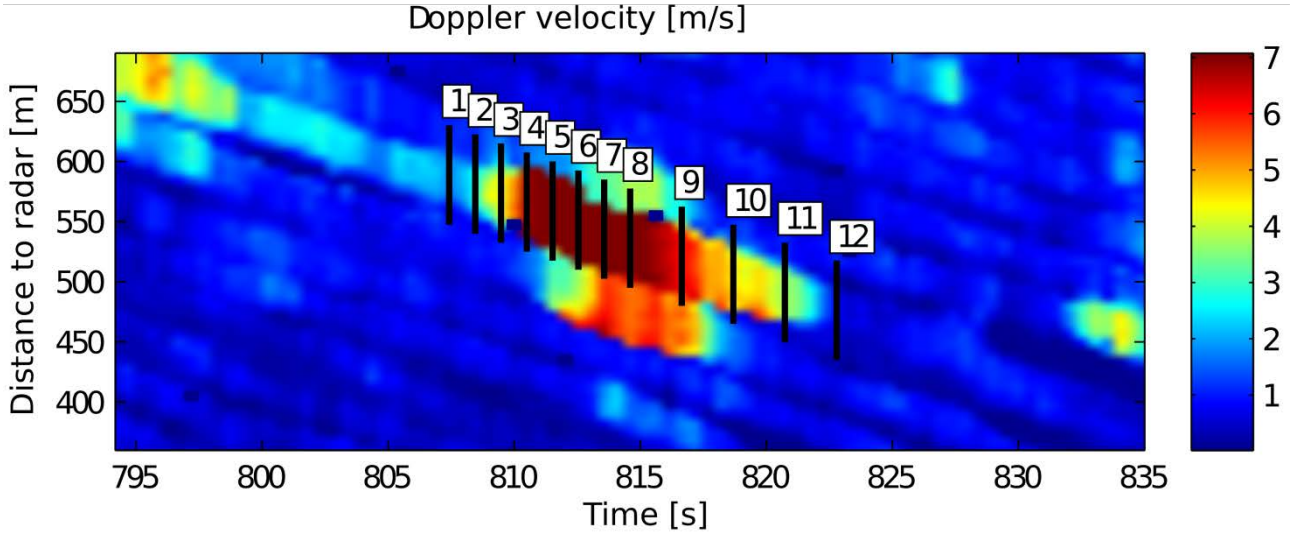
Manually tracked breaker spectrogram

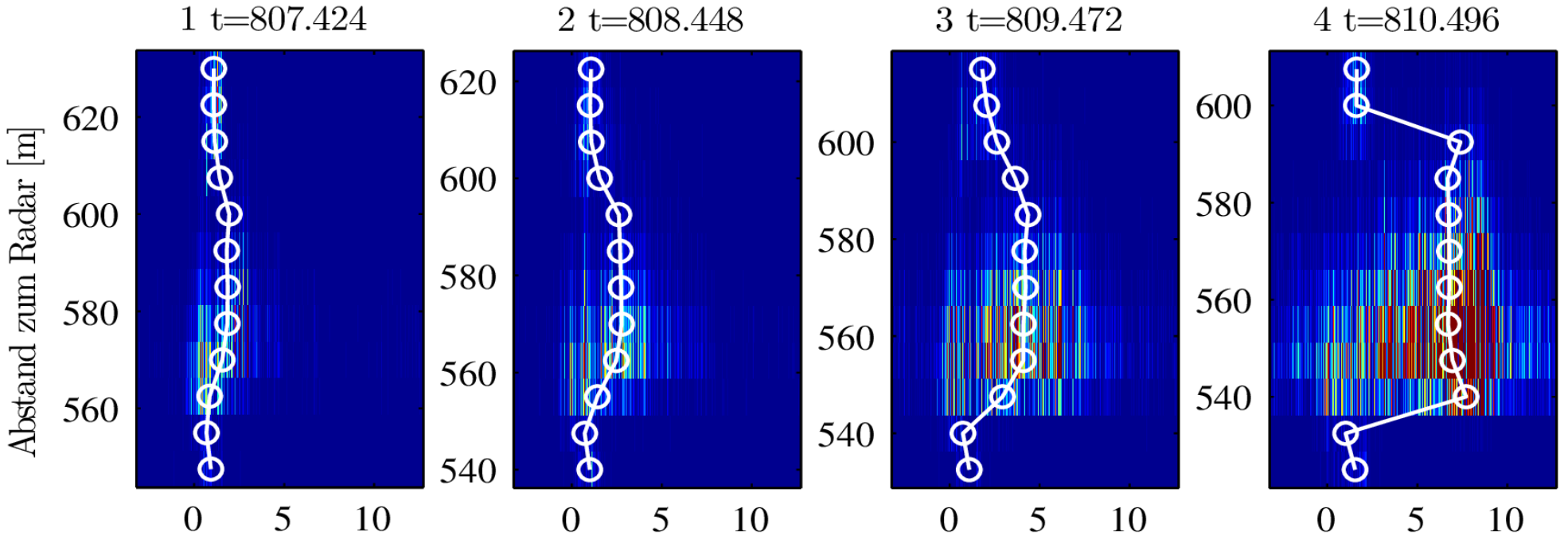
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



Spacial behaviour of Doppler spectra at different stages of the breaking process

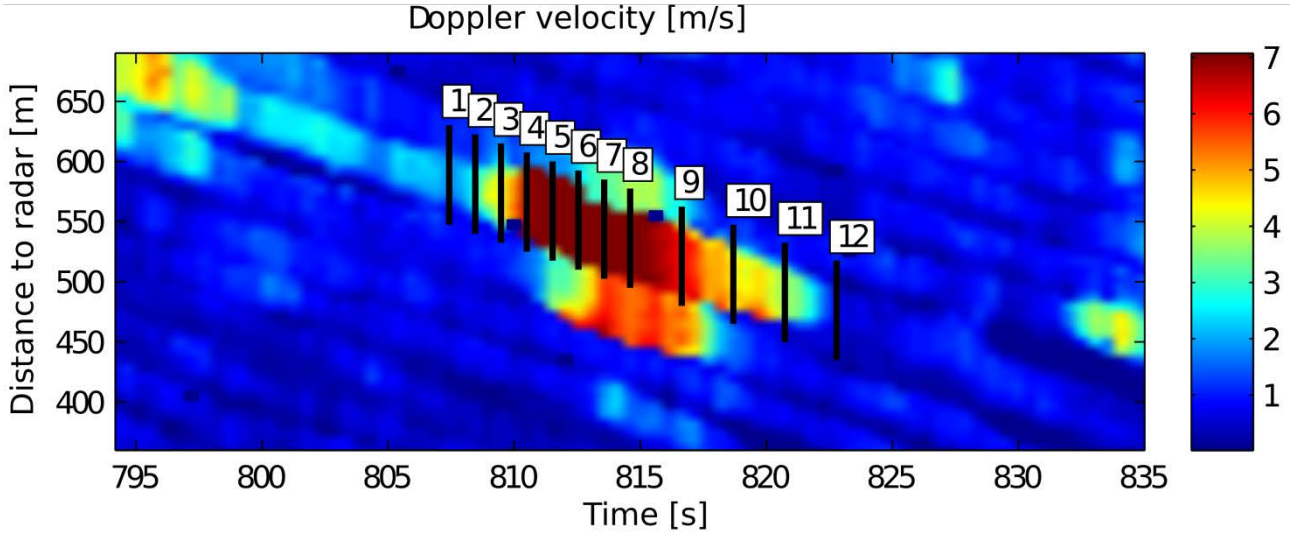
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

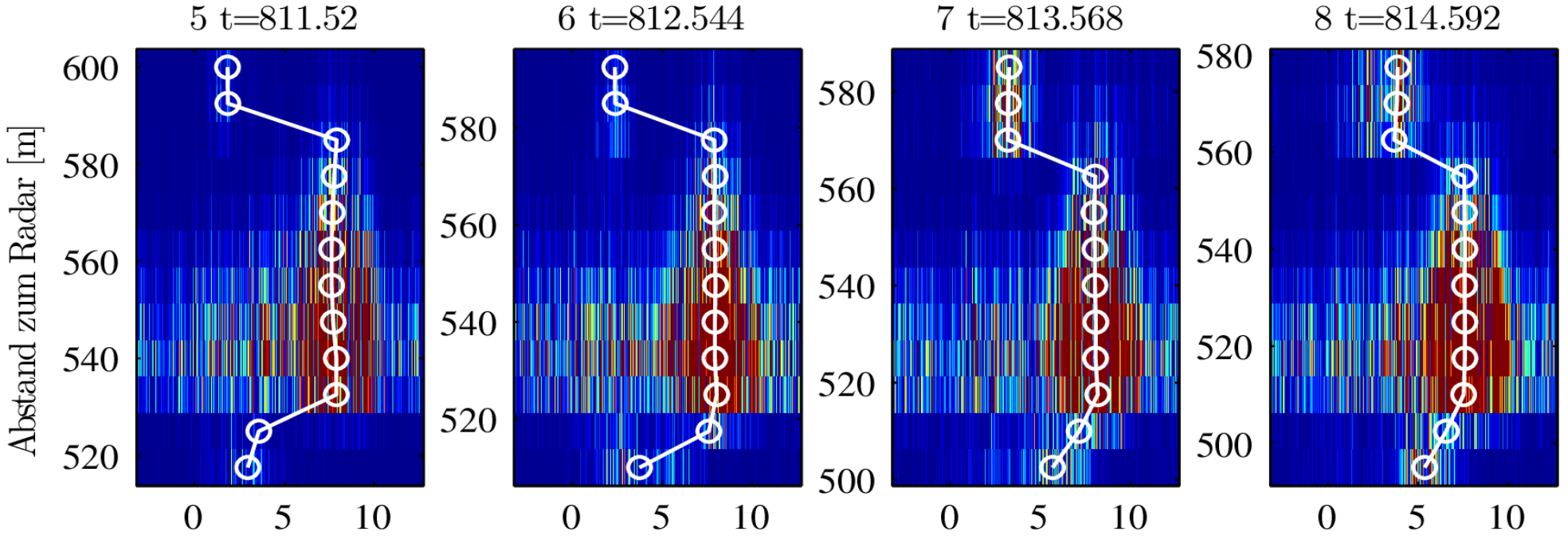




Spacial behaviour of Doppler spectra at different stages of the breaking process

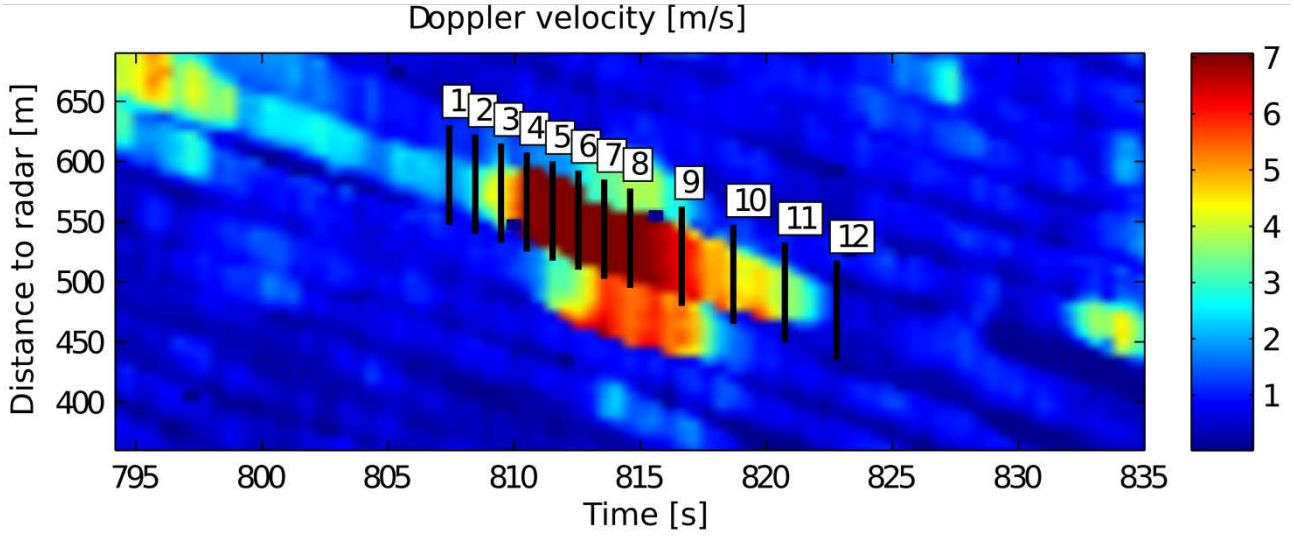
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

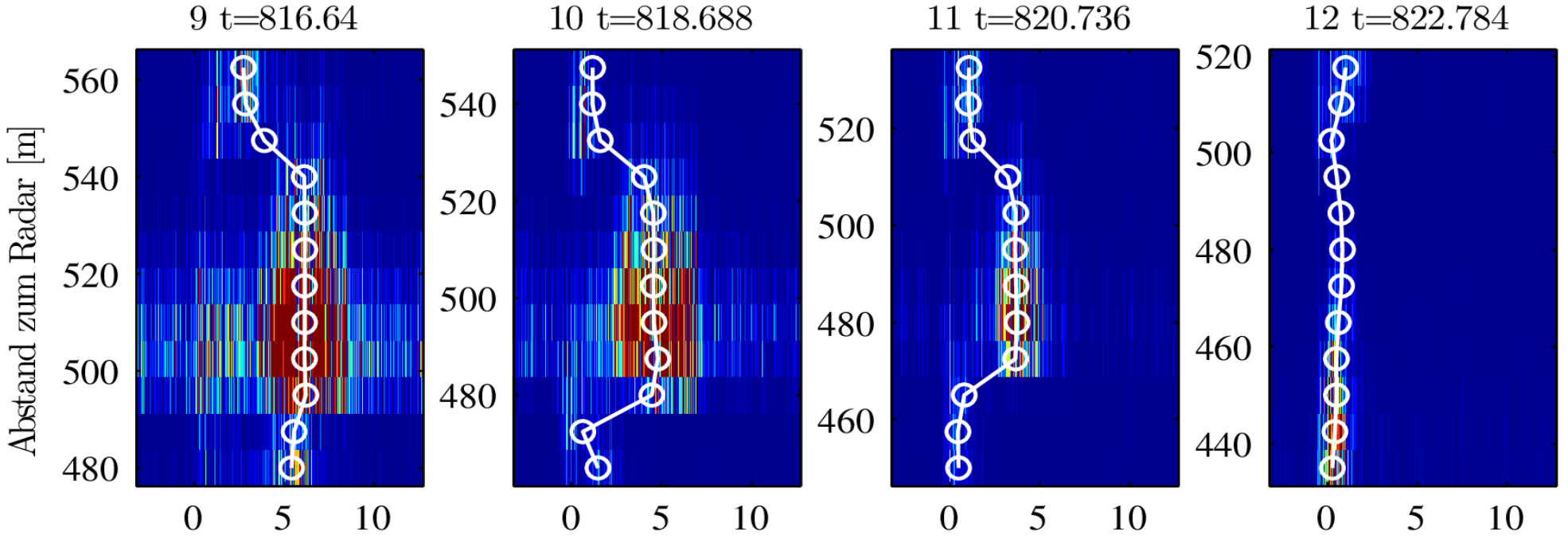




Spatial behaviour of Doppler spectra at different stages of the breaking process

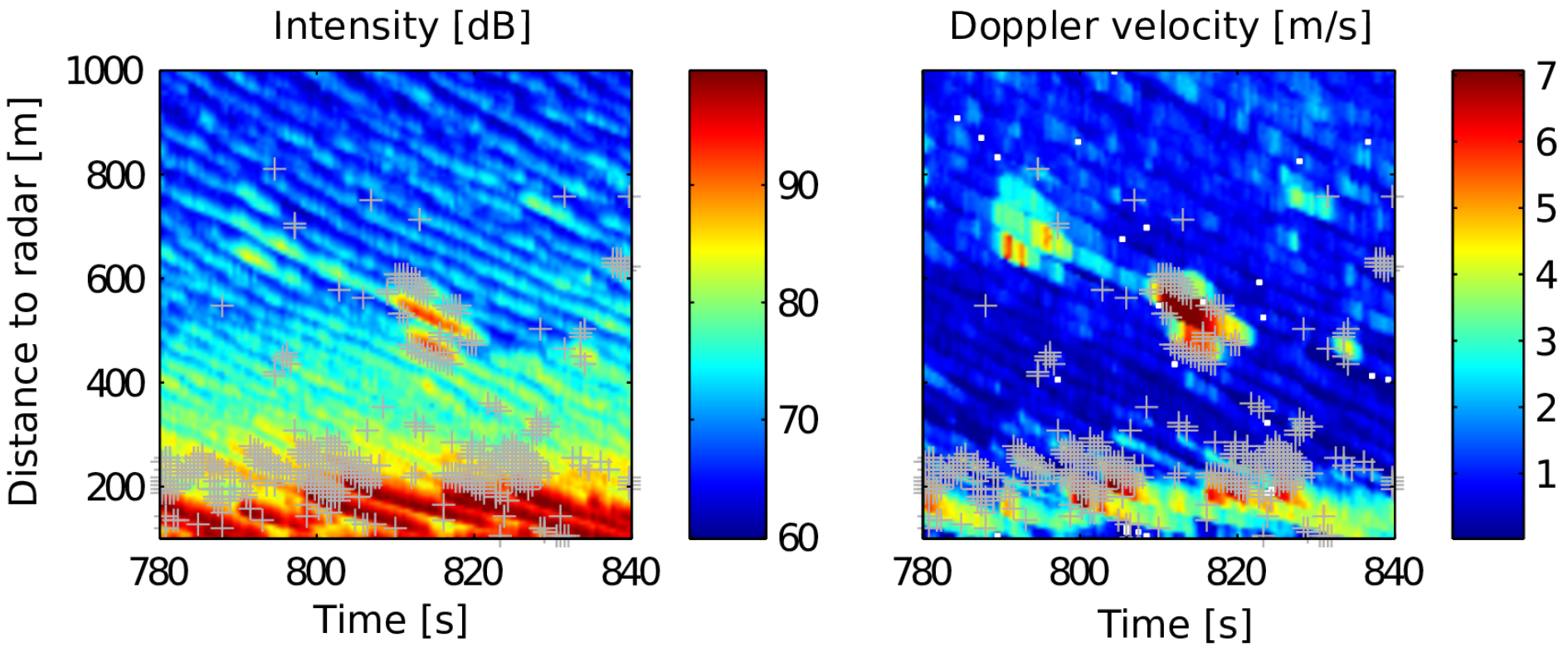
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research





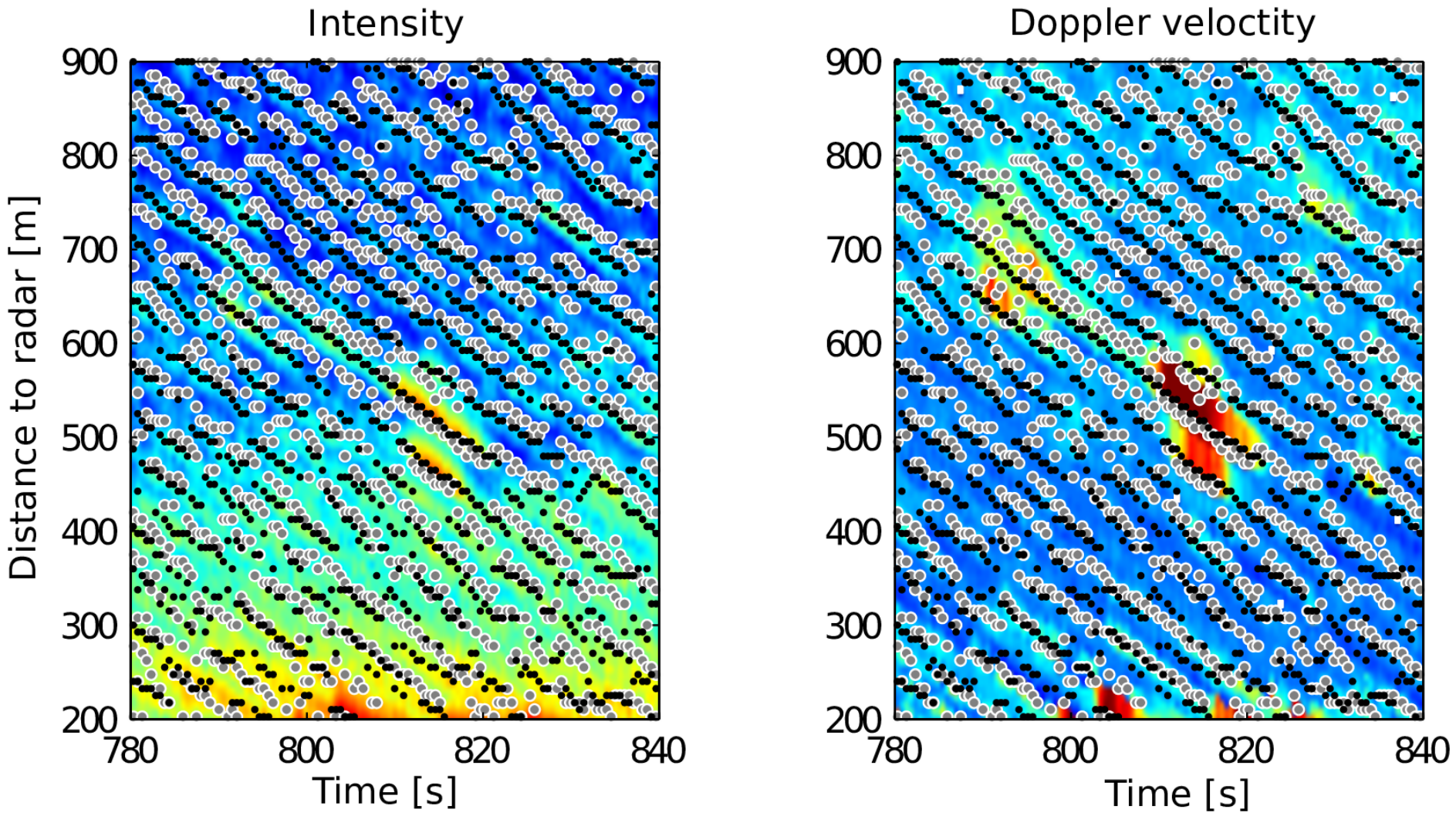
Bimodal Doppler spectra

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



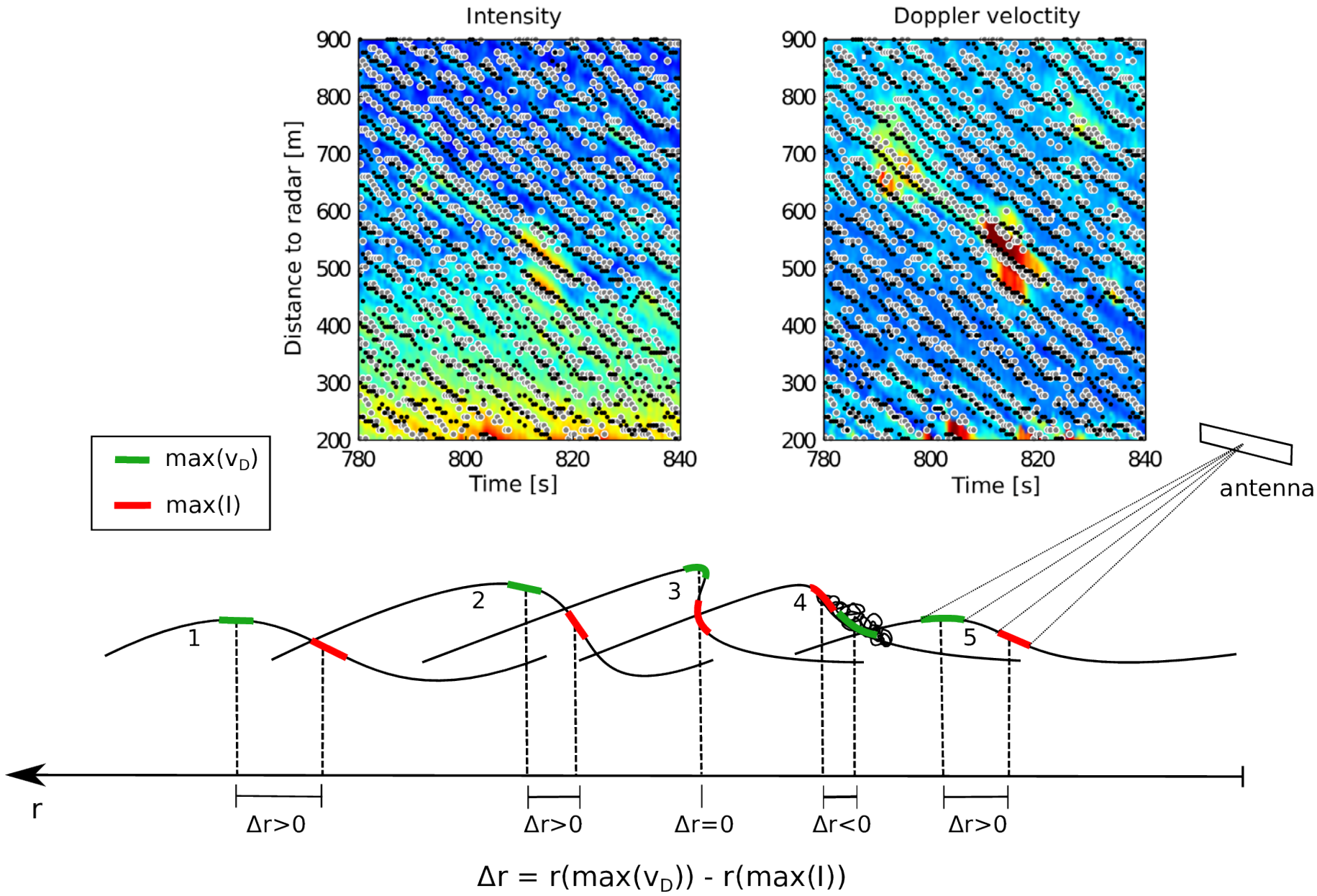
Max intensity vs. max Doppler velocity

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



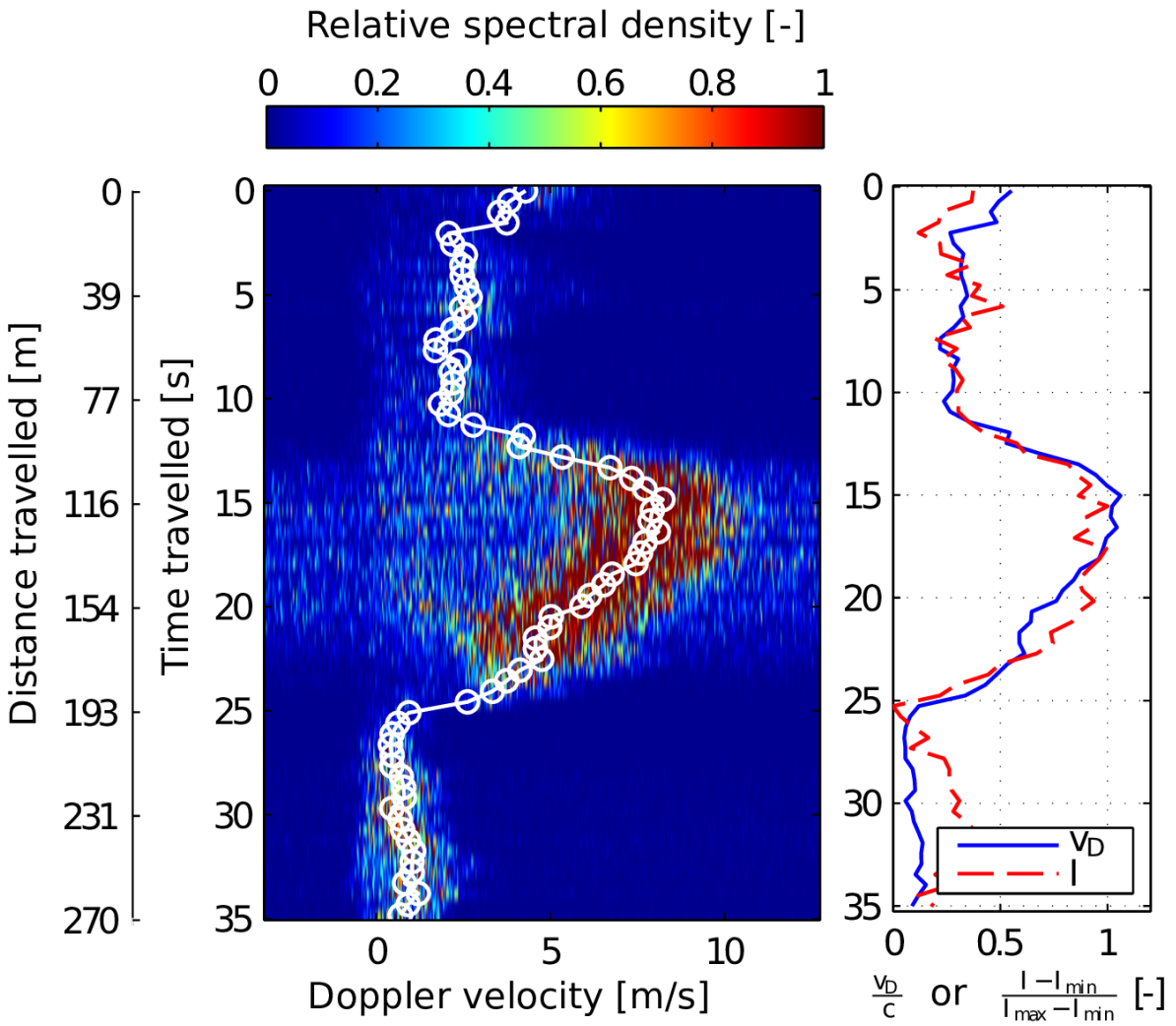
location of local maxima (calculated in space) of intensity (black dots) and doppler velocity (gray dots)

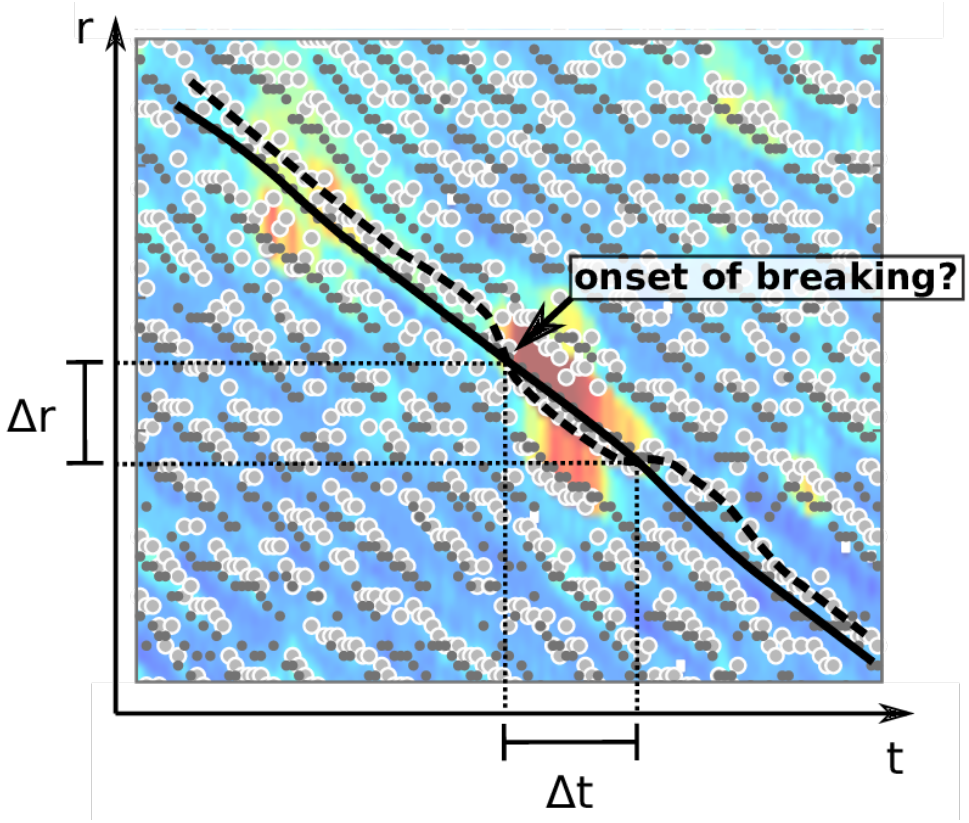
Max. intensity vs. max. Doppler velocity



$$\Delta r = r(\max(v_D)) - r(\max(I))$$

Breaking criteria





⇨ kinematic

⇨ geometric

Summary and open questions

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

- characteristics of Doppler spectra can provide useful hints about the breaking process

- detection of wave breaking is possible from a kinematical as well as from a geometrical point of view

Questions:

- how do we define the onset of wave breaking?

- are there any chances for a validation of the detection methods?

- automation of detection methods?

Thanks for you attention!