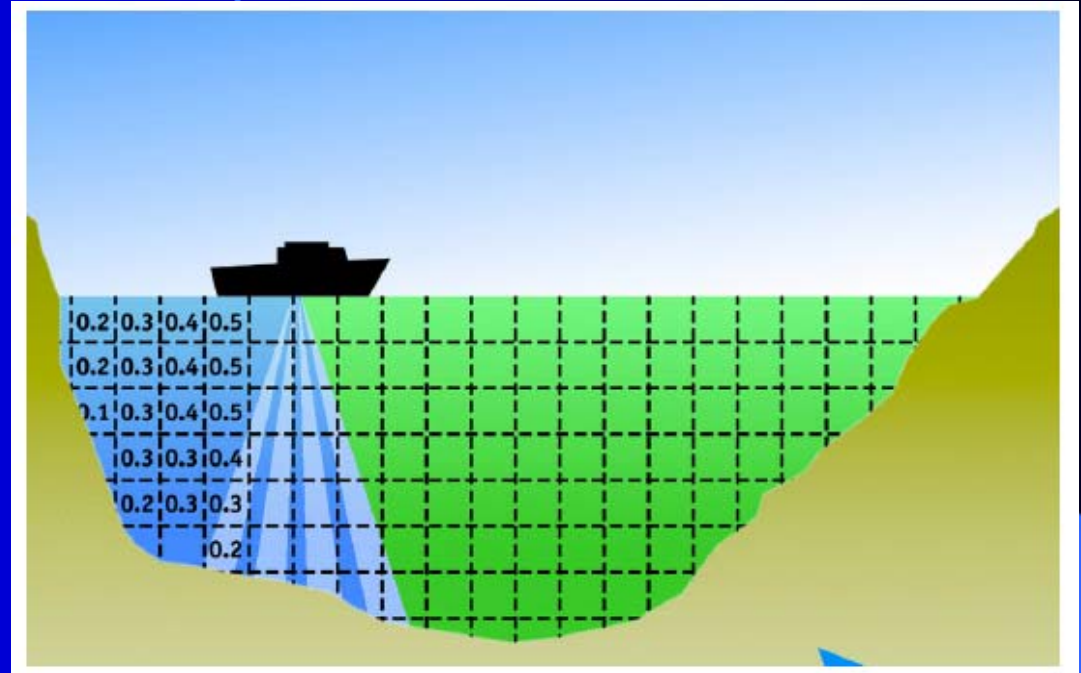


Acoustic Doppler Current Profilers (ADCP) Principles of Operation

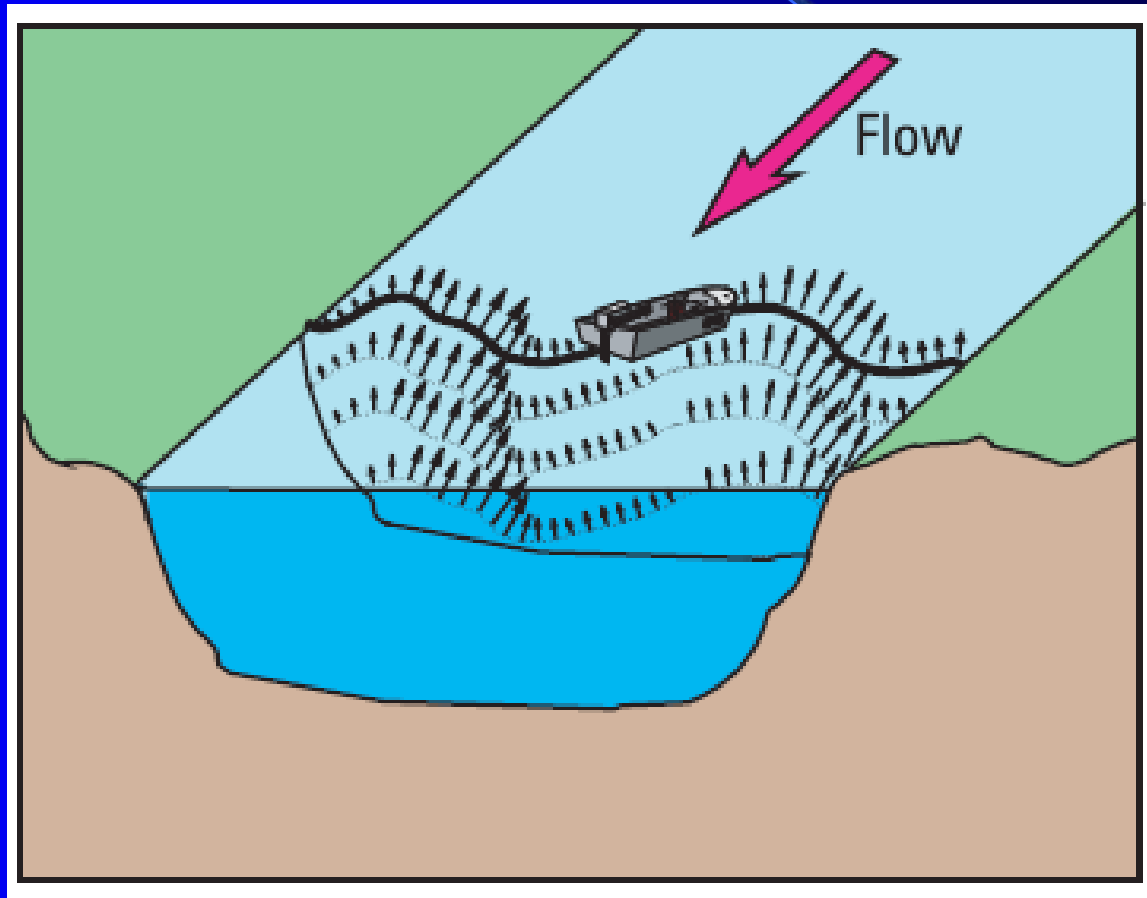
Iwona Conlan

What is an ADCP?



- Acoustic Doppler Current Profiler
- Each beam emits an acoustic pulse (ping) into the water column at 1-3 second intervals as the boat travels slowly across the river
- ADCP measures
 - Water velocity (3 dimensions)
 - Depth
 - Distance and direction of boat travel between each ping
- Velocity x width x depth = Discharge

You don't have to drive the boat in a straight line

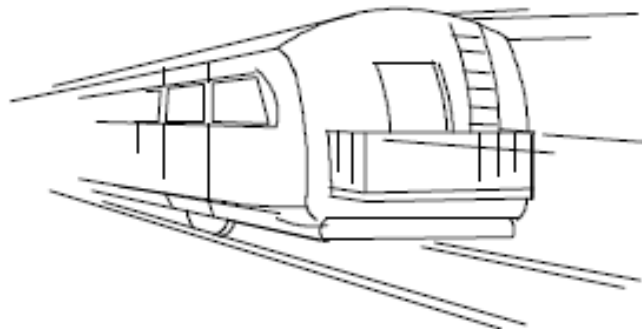
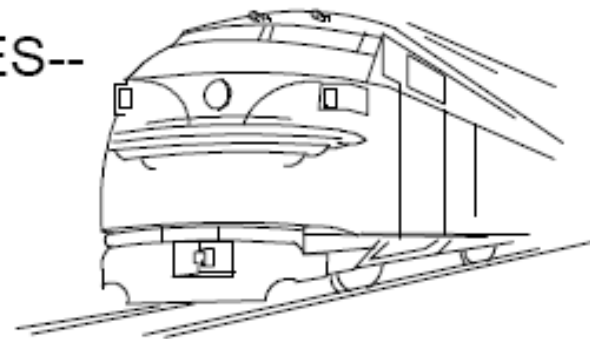


Source: Simpson (2001) Discharge measurement using a Broad-Band Acoustic Doppler Current Profiler. USGS Open File Report 01-1.

How does the ADCP measure velocity?

Doppler Shift When a Train Passes

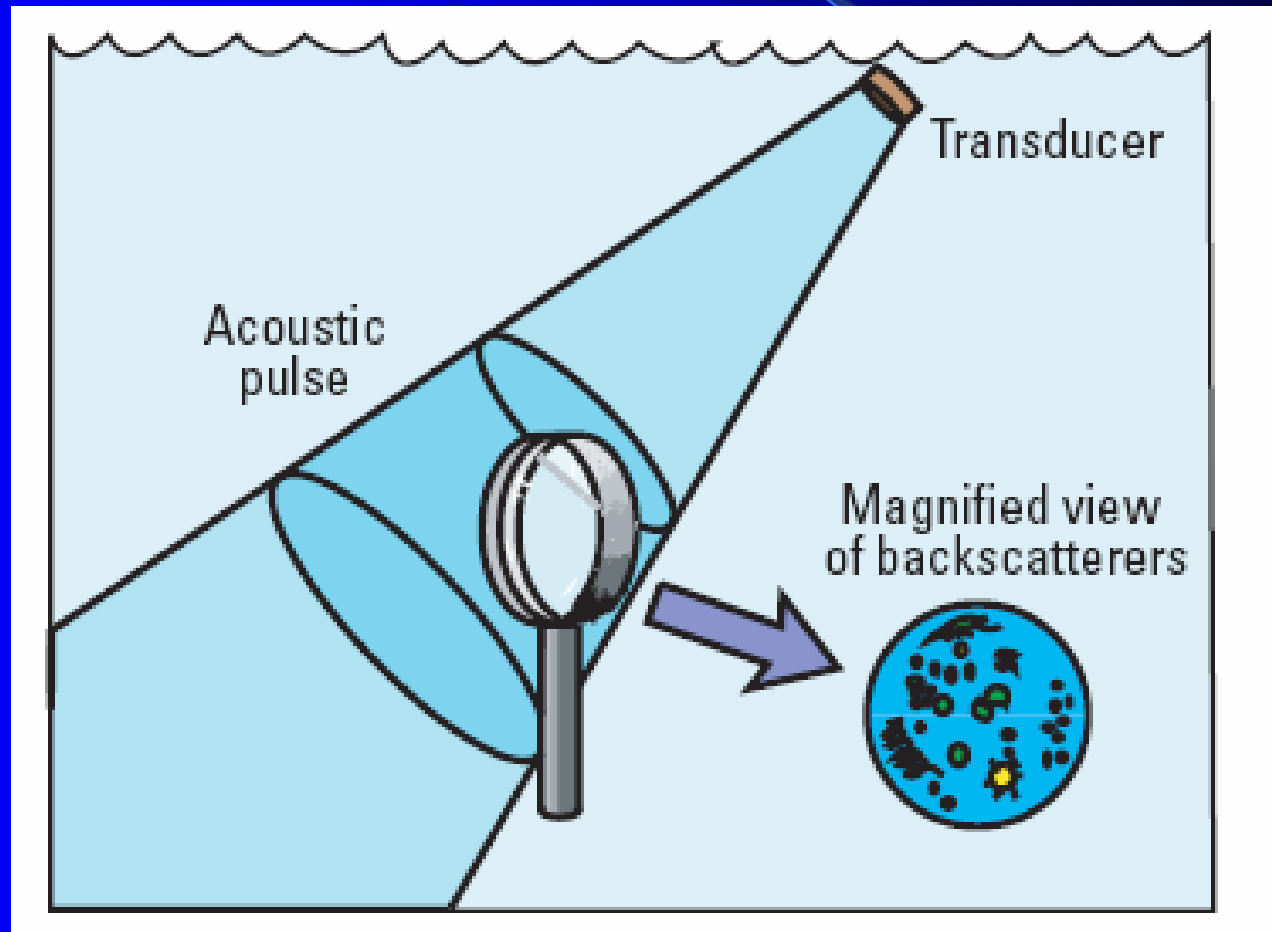
TRAIN APPROACHES--
Higher Pitch



TRAIN RECEDES--
Lower Pitch

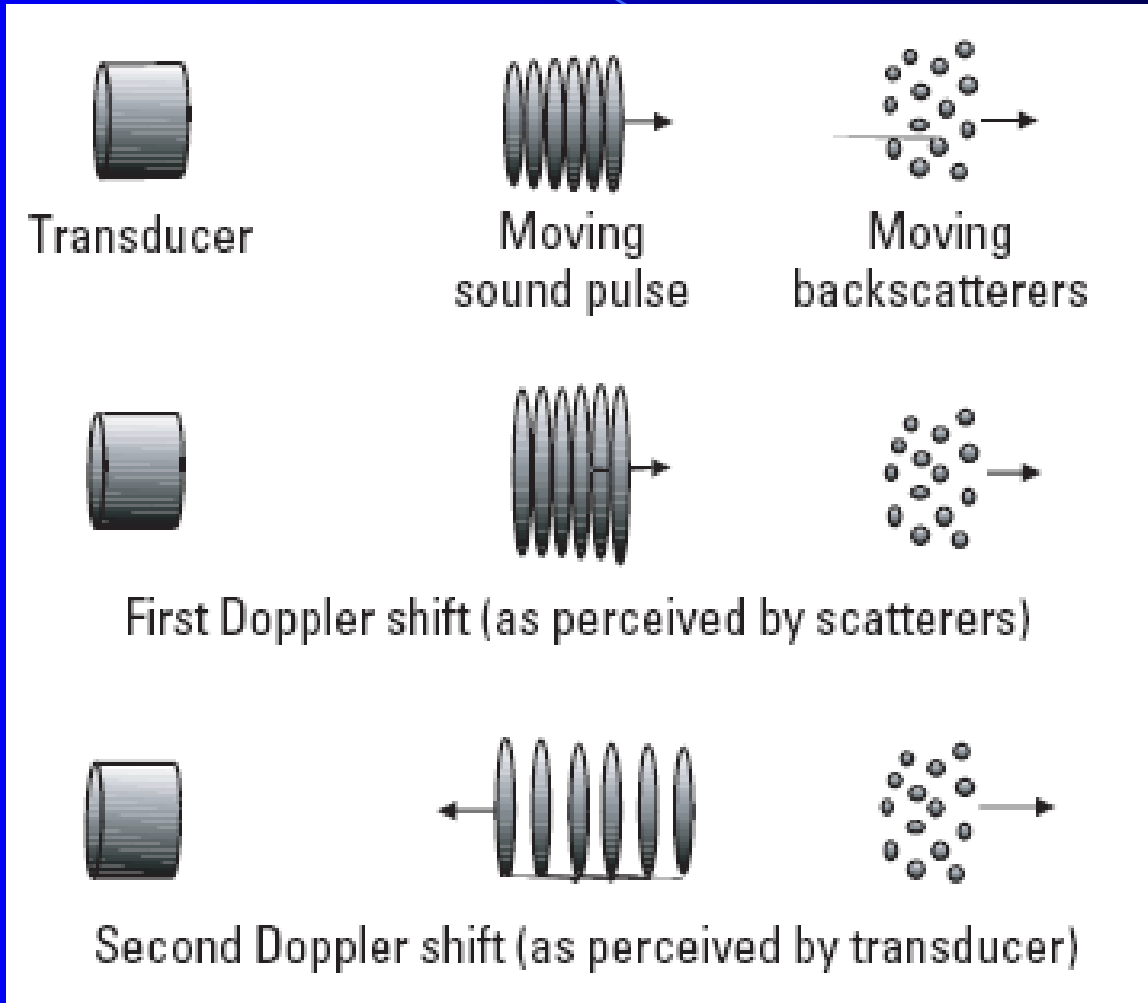
*Source: RD Instruments (1996) Acoustic Doppler Current Profiler
Principles of Operation: A Practical Primer.*

The sound pulse is reflected by suspended particles in the water column



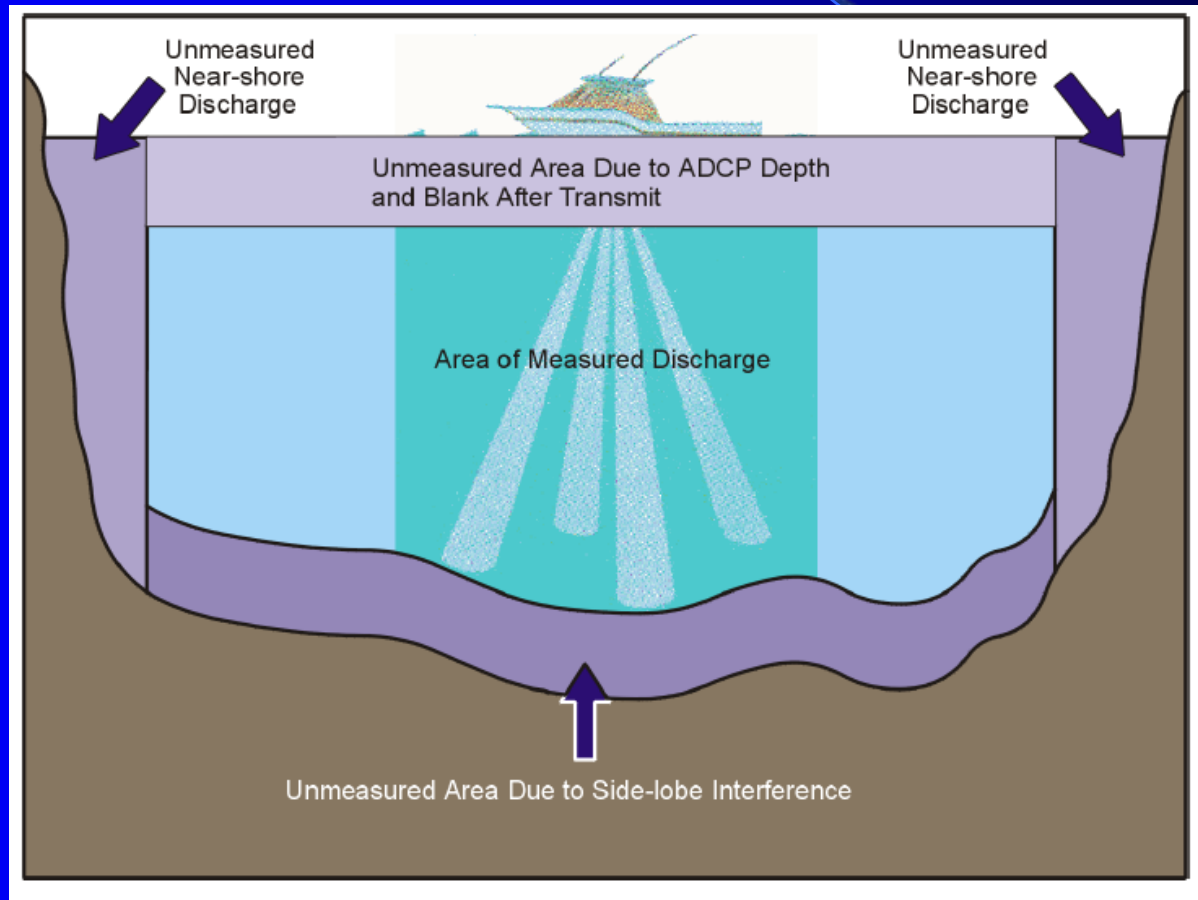
Source: Simpson (2001) Discharge measurement using a Broad-Band Acoustic Doppler Current Profiler. USGS Open File Report 01-1.

Doppler shift



Source: Simpson (2001) Discharge measurement using a Broad-Band Acoustic Doppler Current Profiler. USGS Open File Report 01-1.

Measured and unmeasured zones



Source: RD Instruments (2003) WinRiver User's Guide International Version

Equipment requirements



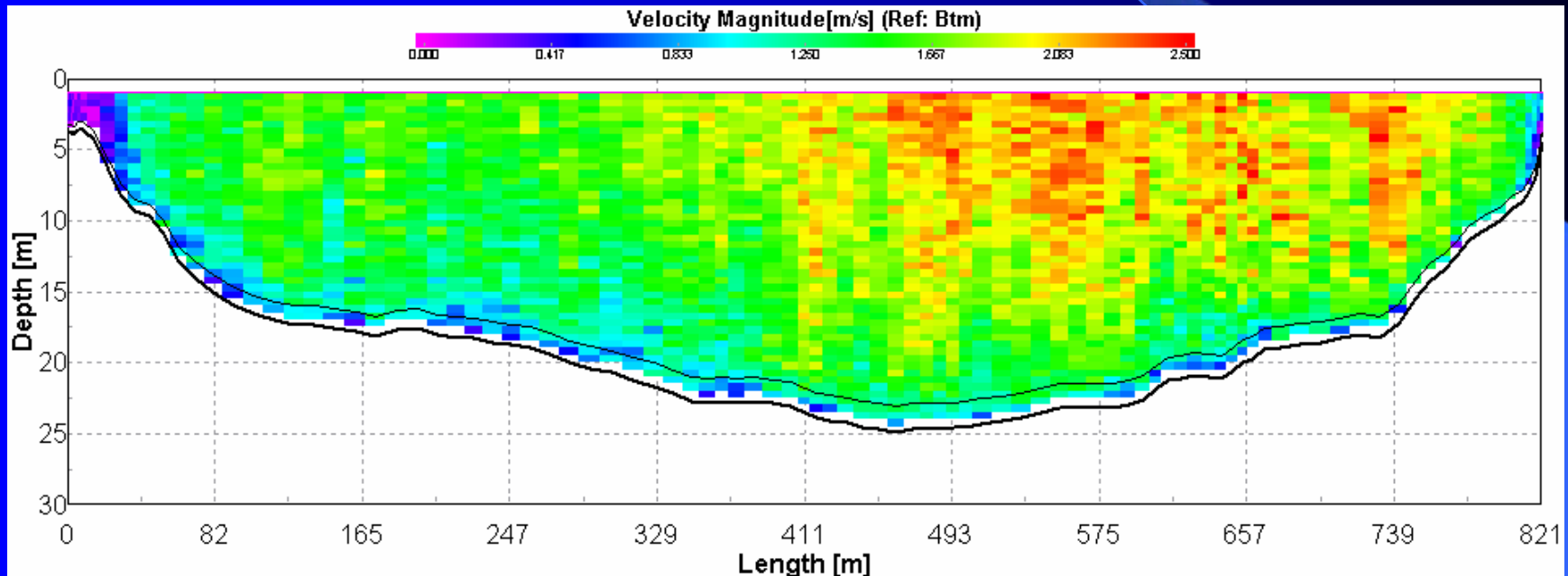
Source: Oberg et al. (2005) Quality-Assurance Plan for Discharge Measurements Using Acoustic Doppler Current Profilers. USGS Scientific Investigations Report 2005-5183

How accurate is the ADCP?

Velocity measurements

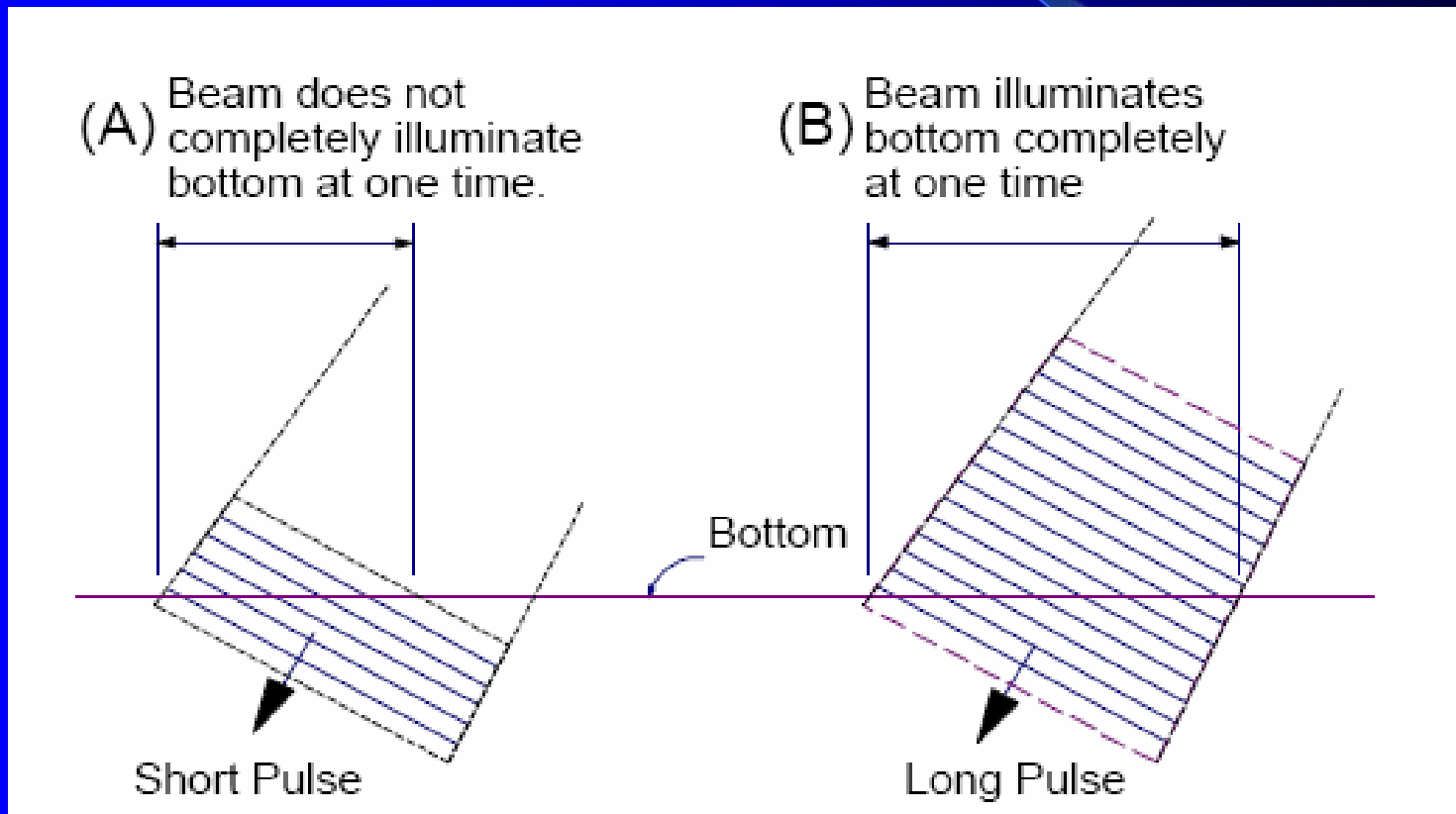
- Resolution: 0.1 cm/s
- Accuracy: $\pm 0.25\%$ (water+boat) velocity +0.25cm/s
e.g. For water and boat V of 1 m/s, Accuracy is 0.75 cm/s
- Precision:
1 ping/ens, 0.5m bins st.dev = 14 cm/s
3 pings/ens, 0.5m bins st.dev = $14\text{cm/s} / \sqrt{3} = 8 \text{ cm/s}$

How accurate is the discharge measurement with an ADCP?

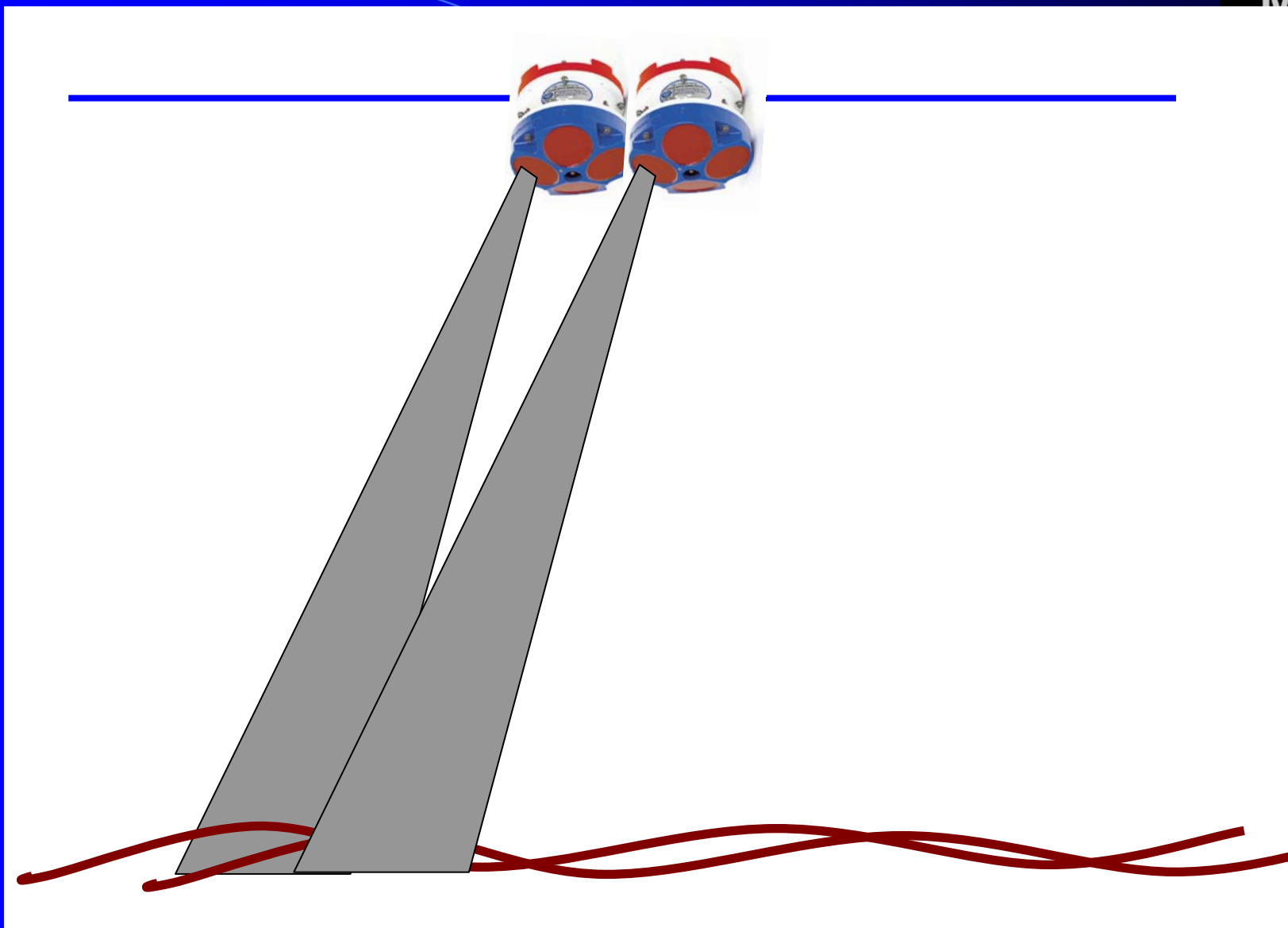


Data: ADCP transect on the Mekong River at Pakse, Iwona Conlan

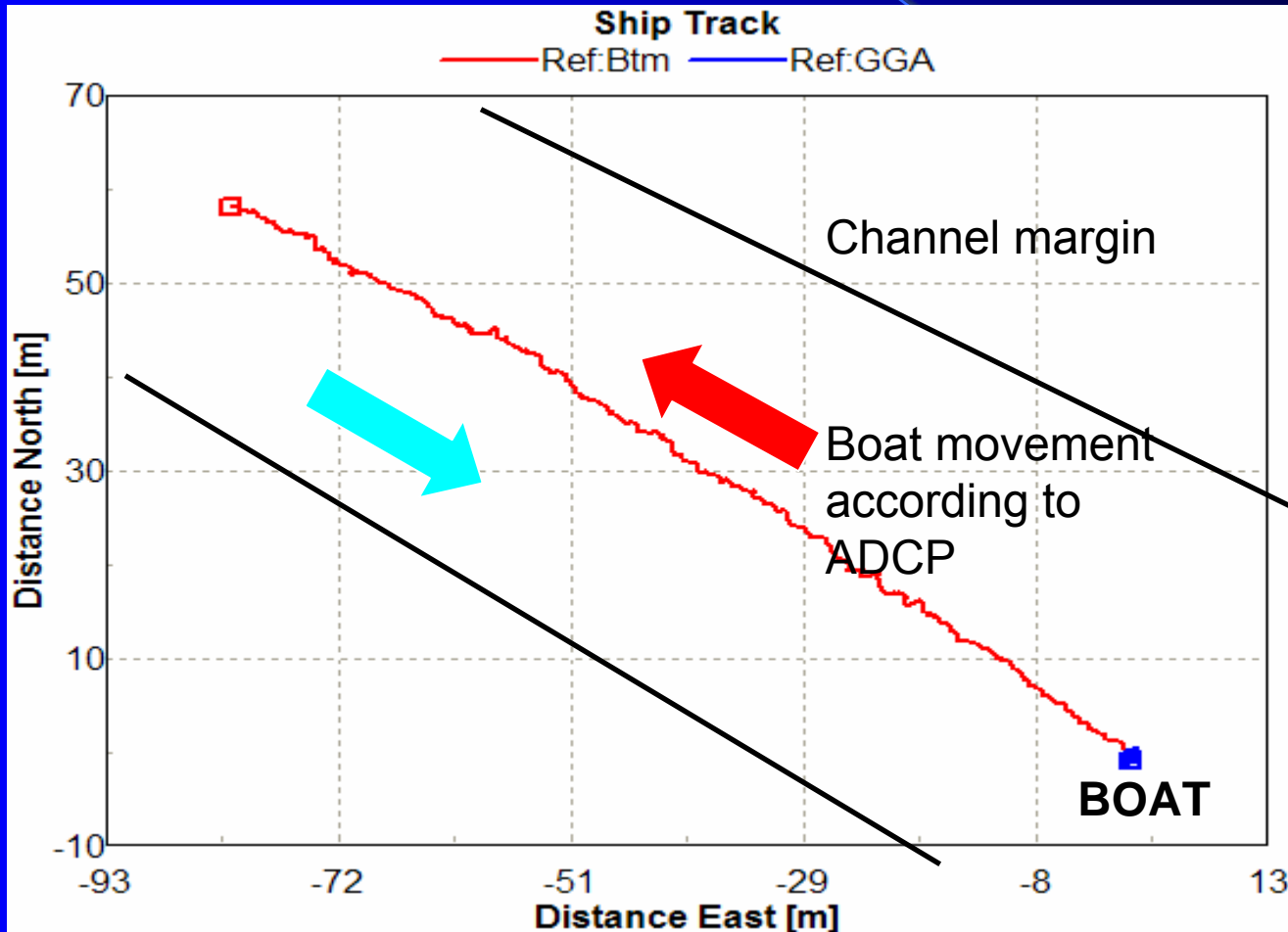
Bottom tracking measures both depth and boat speed



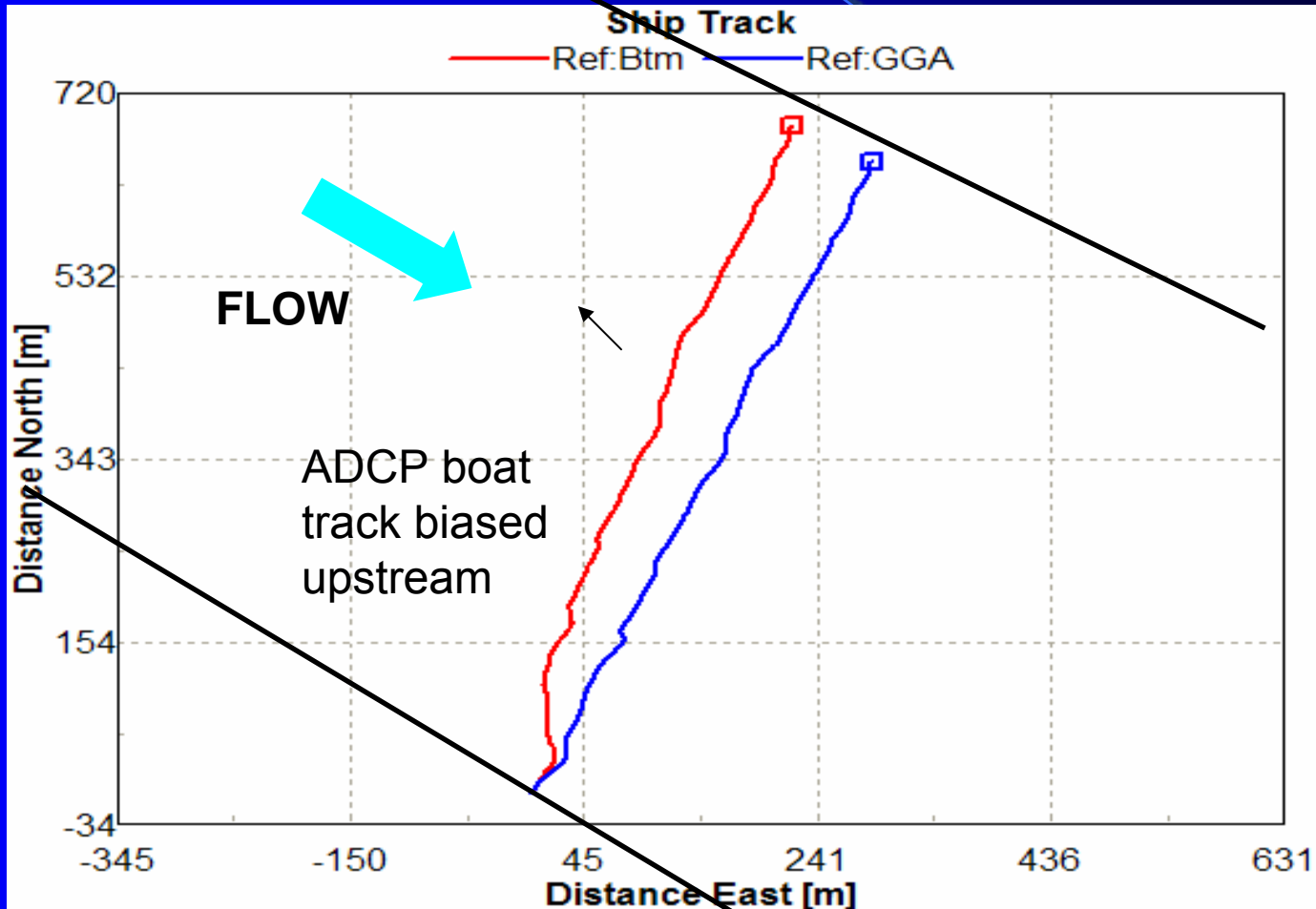
*Source: RD Instruments (1996) Acoustic Doppler Current Profiler
Principles of Operation: A Practical Primer.*



Moving bed test



Example offset of bottom track from true path under mobile bed conditions



How accurate is bottom tracking?

- Resolution of depth measurement = 0.1m
- Accuracy of bottom tracking = “a few mm/s” (RDI 1996)

Accuracy is reduced if sediment is moving along the bed

Effect on discharge (Mekong River)

= 5 -25 % error in discharge

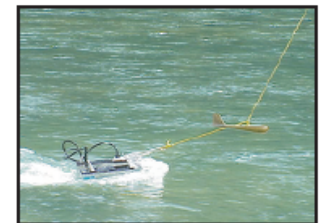
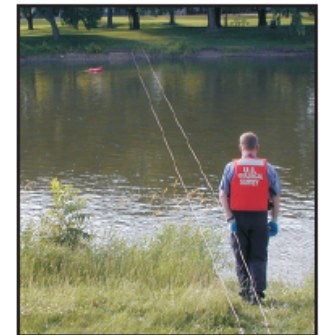
Quality Control

- Multiple transects
- Moving bed test
- Correction for moving bed
 - Loop method
 - Differential GPS
- Compass calibration
- Data checking



In cooperation with the U.S. Army Corps of Engineers, Detroit District

Quality-Assurance Plan for Discharge Measurements Using Acoustic Doppler Current Profilers



Scientific Investigations Report 2005-5183

Oberg et al. (2005) Quality-Assurance Plan for Discharge Measurements Using Acoustic Doppler Current Profilers. USGS Scientific Investigations Report 2005-5183

Loop method

*Source: Mueller & Wagner (2006)
Application of the Loop Method for
correcting Acoustic Doppler
Current Profiler Discharge
Measurements by sediment
transport. USGS Scientific
Investigations Report 2006-5079*

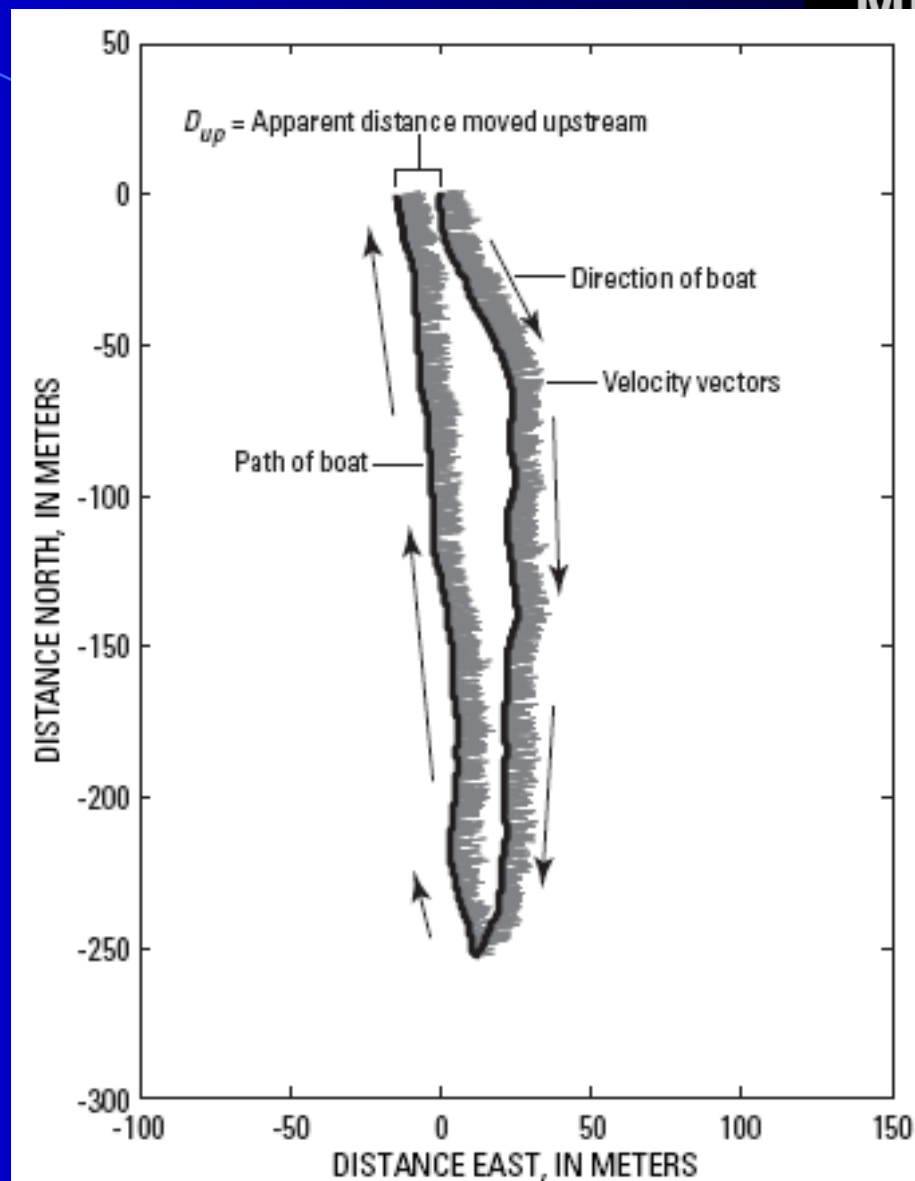


Figure 1. Example of the distorted ship track in a loop caused by a moving bed.

Comparison of the Loop Method against DGPS (Mueller & Wagner, 2006)

- Comparison at 9 sites in Canada and USA
- Discharge corrected for moving bed using DGPS and Loop Method
- Discharge (Loop) was within -5.4 to 1.3 % of Discharge (DGPS)