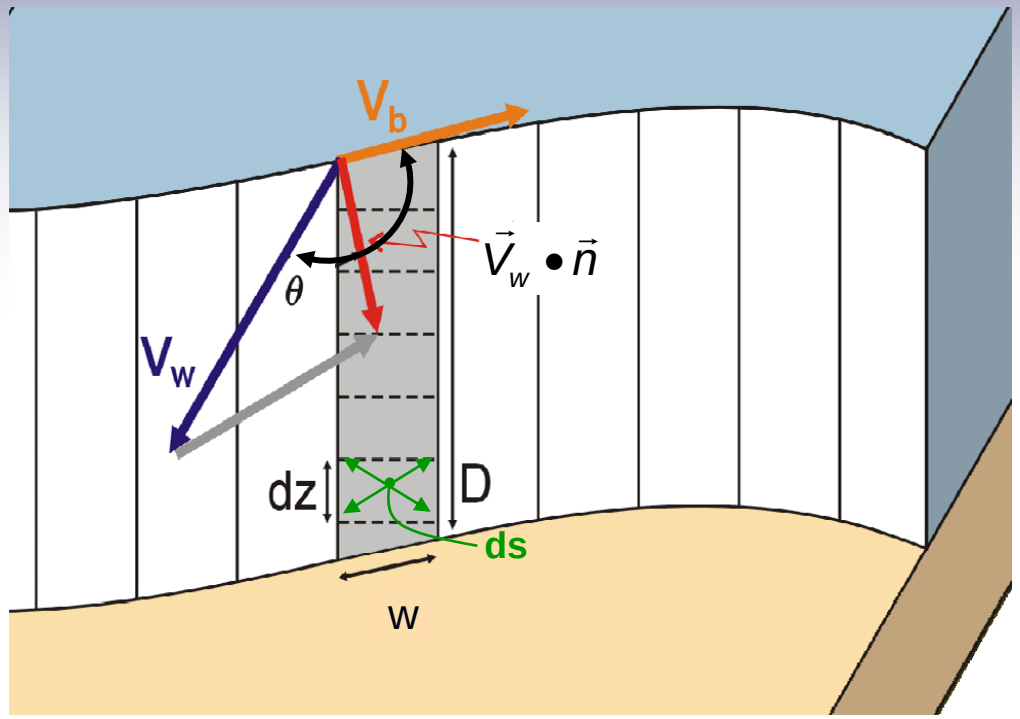
Discharge in a Depth Cell (Bin)



V_b = boat velocity vector
V_w = water velocity vector
$\vec{V}_w \bullet \vec{n}$ = unit normal vector
D = total depth profiled
dz = bin size
w = width of profile
dt = time between pings
ds = area of bin

$$Q = AV$$

$$A = ds = w * dz$$

$$w = \left|\vec{V}_b\right| dt$$

$$ds = \left|\vec{V}_b\right| dt\, dz$$

$$V = \vec{V}_w \bullet \vec{n}$$

$$Q_{bin} = \left(\vec{V}_w \bullet \vec{n}\right)\left|\vec{V}_b\right| dt\, dz$$

NOTE: dt cannot be computed until the second ping (ensemble) has been collected. Therefore, the first ping (ensemble) always has a zero discharge because it has zero width.

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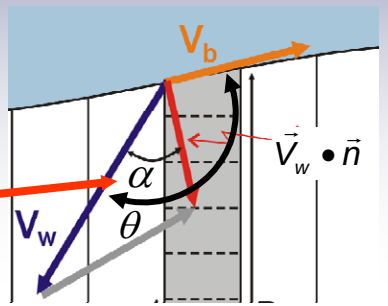
The Cross Product

$$Q_{bin} = (\vec{V}_w \bullet \vec{n})\left|\vec{V}_b\right| dz\ dt$$

$$\vec{V}_w \bullet \vec{n} = \left|\vec{V}_w\right| Cos\alpha$$



$$Sin\ \theta = Cos(\alpha + 90)$$

$$Q_{bin} = \left|\vec{V}_w\right| \left|\vec{V}_b\right| Sin\theta\ dz\ dt$$

$$\left|\vec{V}_w\right| \left|\vec{V}_b\right| Sin\theta = \vec{V}_w \times \vec{V}_b$$

$$\vec{V}_w \times \vec{V}_b = V_{w_x} V_{b_y} - V_{w_y} V_{b_x}$$

$$Q_{bin} = \left(V_{w_x} V_{b_y} - V_{w_y} V_{b_x}\right) dz\ dt$$

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