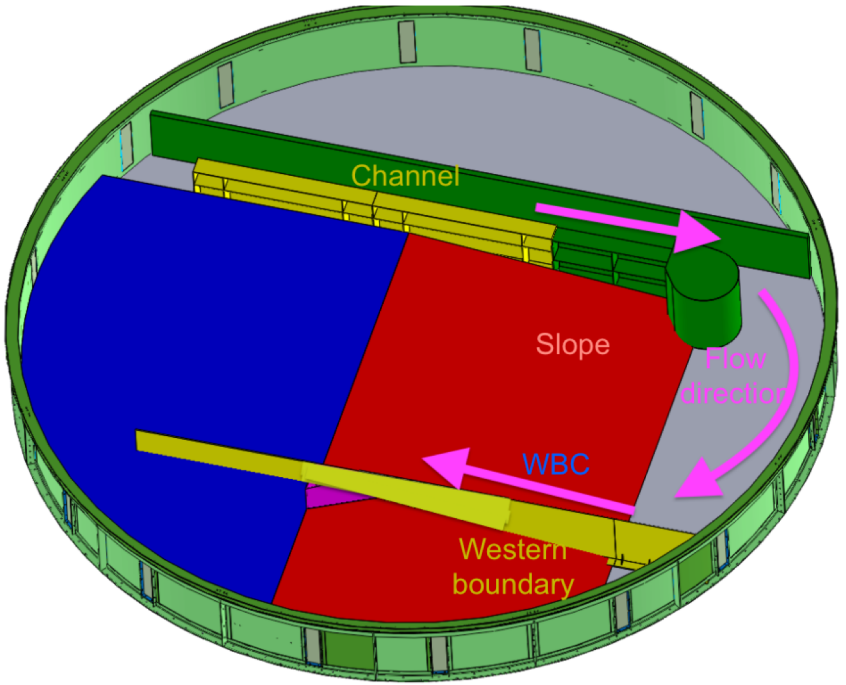
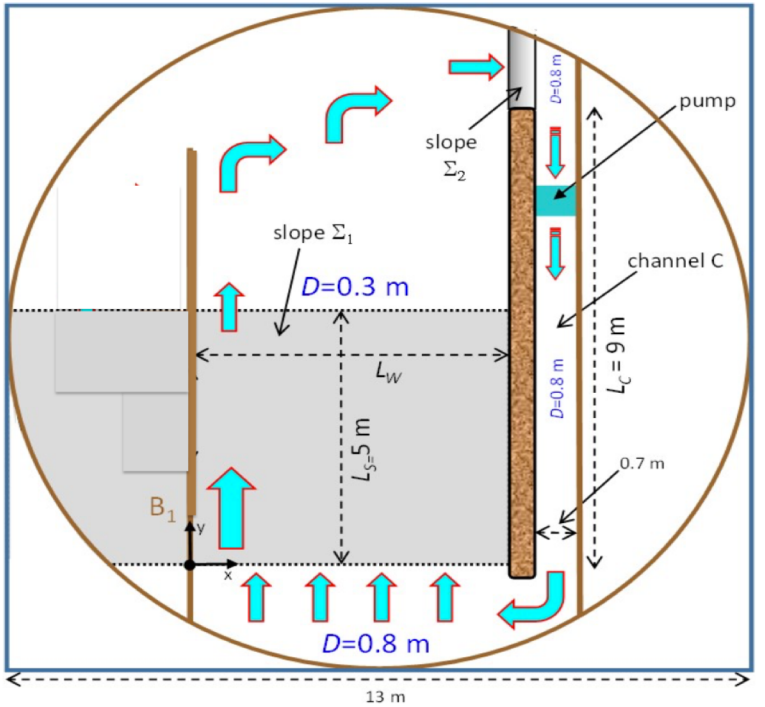
Gapwebs project: WBC (the Gulf Stream)

A pumping system located in the channel C produces a current of constant speed U at its "southern" border; a virtually unsheared flow at the southern entrance of the topographic slope **Σ_1=0.105** is thus formed. The bottom slope provides the topographic β -effect necessary for the intensification along the "western" boundary B_1 of a total length **L_s=5m**. The total water depth at the beginning of the slope till the end of the slope varies linearly from **D=0.8m** to **D=0.3m**, respectively.





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- The dataset in 22TPTMA\GAPWEBS\WBC\ containes **4 experiments** (23-26), whose characteristics are given in the table below.

EXP	T	Q	Gape length
EXP21	30	6	1.2
EXP22	30	8	1.2
EXP23	30	2	NO
EXP24	30	3	NO
EXP25	30	6	NO
EXP26	30	8	NO

- In each experiment, **1000 *.nc files are present**, which contain the instantaneous two-dimensional velocity field (U,V) in the (x,y) plane obtained by PIV in a plane **10cm** below the free surface, where the origin of the axis are on the western boundary, at the beginning of the slope (see figure in the previous slide).

- The time shift between two successive velocity fields (img_i_1.nc - img_i+1$_1$) is **one second**.

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- The Flow rate injected can be estimated using the calibration curve below. Refer also to the sketchs of the set up presented in slide 24.

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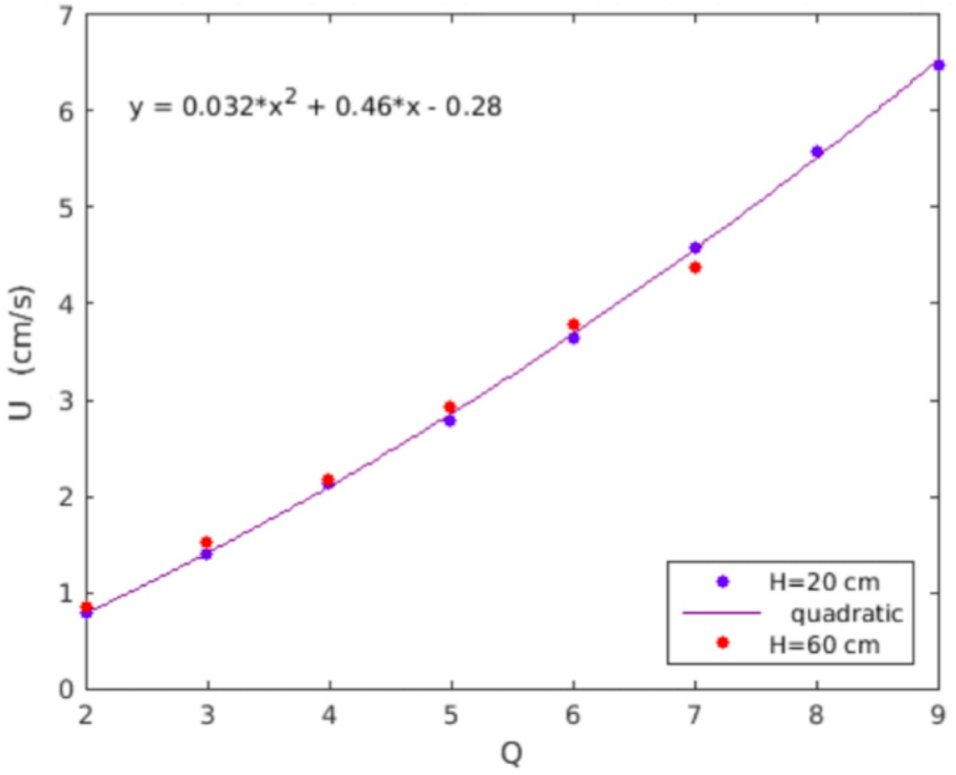
EXP23	30	2	NO
EXP24	30	3	NO
EXP25	30	6	NO
EXP26	30	8	NO



To Do List

1) Determine the averaged velocity fields and the Reynolds shear stresses field for each experiment. Make a comparison and highlight the differences.
2) Determine the averaged potential vorticity field for each experiment. Make a comparison and highlight the differences.
3) Give significant snapshots of the instantaneous velocity and potential vorticity fields and comment them.
4) Plot the transverse meridional velocity profile **v** and zonal velocity profile **u** at three significant **y** positions as a function of x. Do the temporal averaged and instantaneous profiles differ considerably ?
5) Estimate the Kolmogorov length scale and compare it to the PIV spatial resolution of 3mm.
6) In the outer part of the velocity profile v(x) at the three chosen ***y*** positions, calculate the turbulent lateral eddy viscosity coefficient $\mathbf{A_H}$, the vertical eddy viscosity $\mathbf{A_z}$, the turbulent dissipation rate ***e*** and a characteristic mixing length $\mathbf{L_m}$. Compare between the different experiments.
7) Show that the outer part of the velocity profile can be predicted using the conservation of the potential vorticity equation $\zeta + f + \beta y = const.$, where ζ is approximately v_x and $\beta = f\, s/D$ (s is the slope of the bottom and f=4pi/T, with T being the rotation period in the experiment). Can the velocity profile be well fitted using the equation for v_B given in slide 24?

8) Calculate the following quantities characteristics of the WBC boundary layer : $\delta_I = \left(\frac{U}{\beta}\right)^{1/2}$; $\delta_M = \left(\frac{A_H}{\beta}\right)^{1/3}$ $\delta_* = \sqrt{\delta_I A_H / U}$

that are the inertial, viscous Munk and the thin viscous boundary layer widths, respectively. How does the width of the WBC scale with the inertial boundary layer ? And how do the viscous and viscous Munk boundary layer widths scale with the inertial boundary layer widths ? Are the conclusions similar for all ***y*** and for each experiment ? Could the turbulent eddy viscosity $\mathbf{A_H}$ be replaced by the kinematic viscosity of water?