Hydraulic study of a combined sewer overflow using 3D modelling

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Lyon

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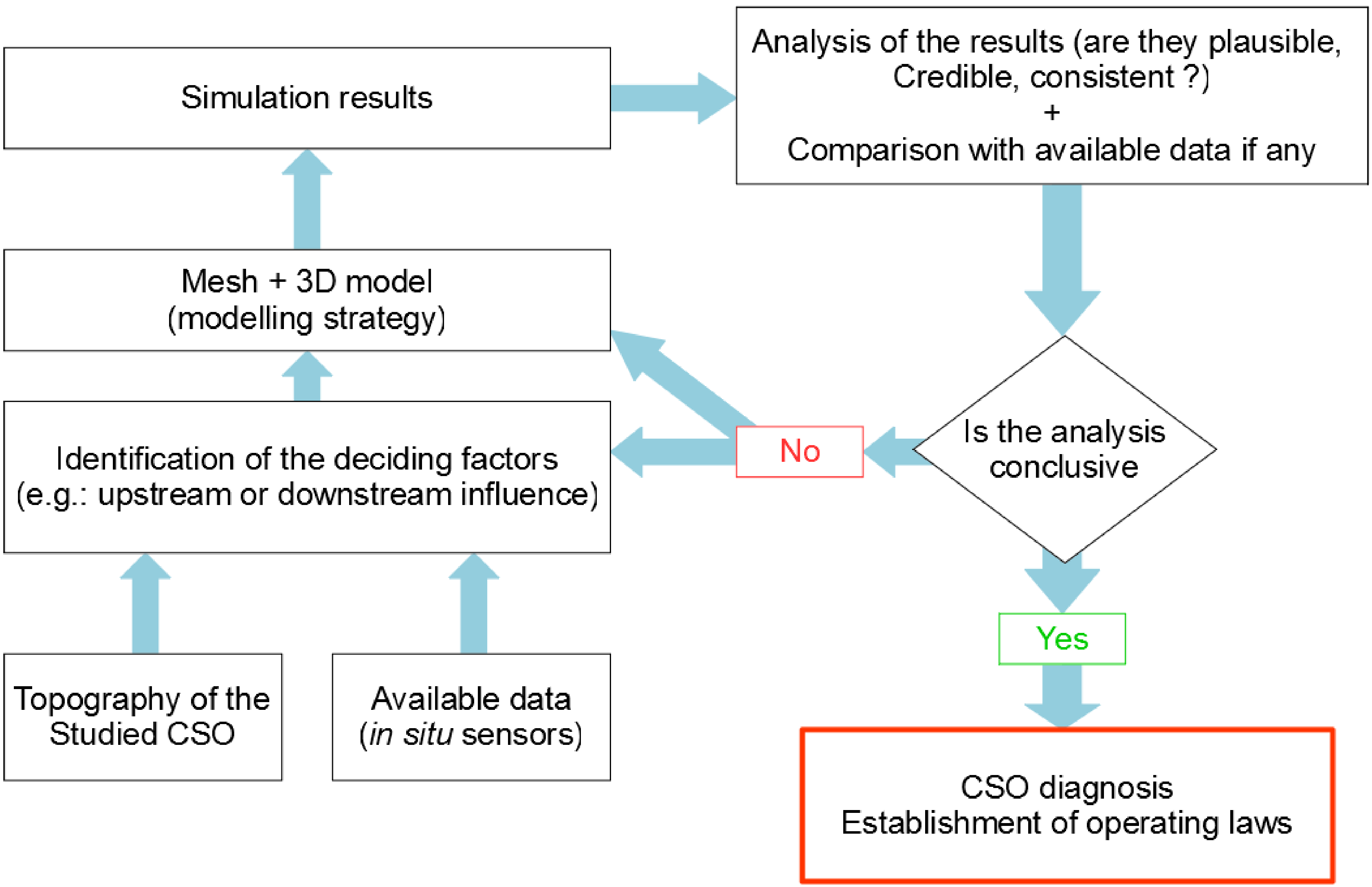
SUMMARY

- Methodology
- CSO background
- 3D model and mesh
- Results
- Conclusions

METHODOLOGY



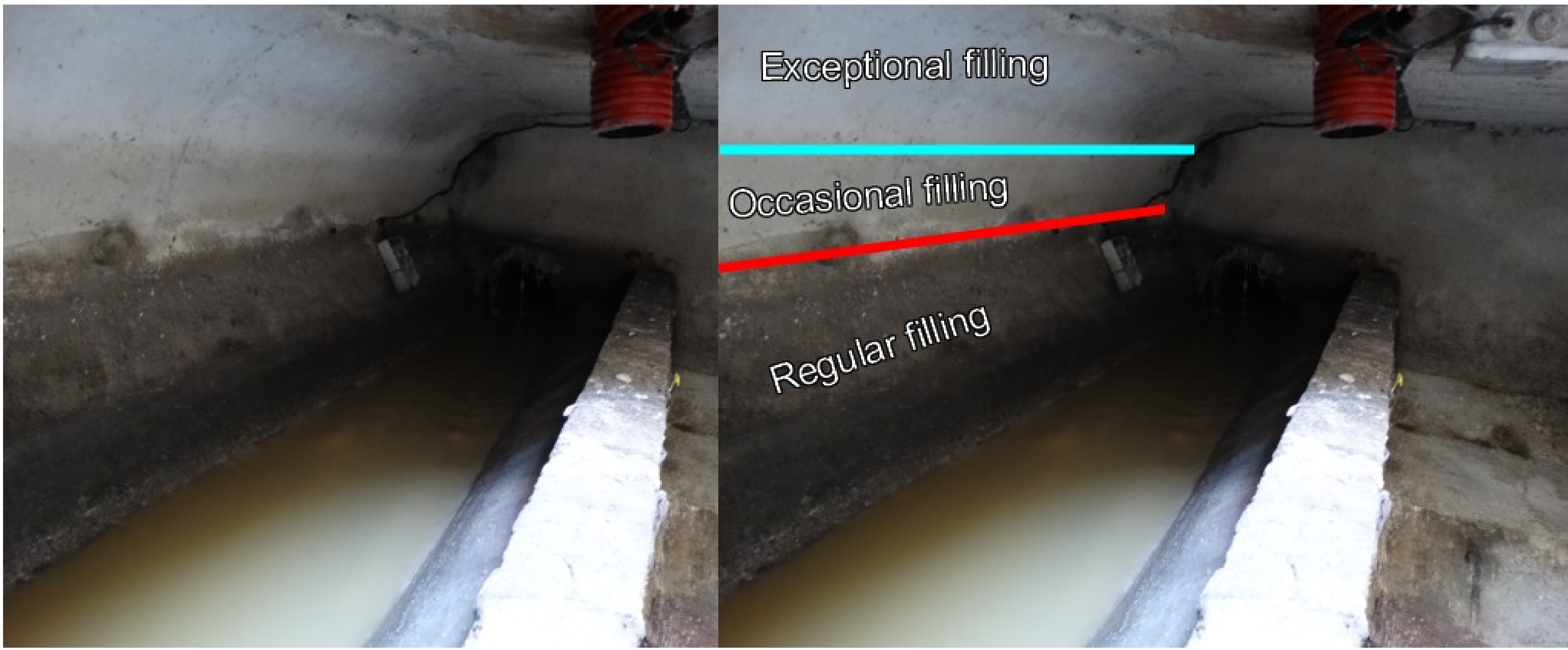
CSO BACKGROUND

CSO BACKGROUND

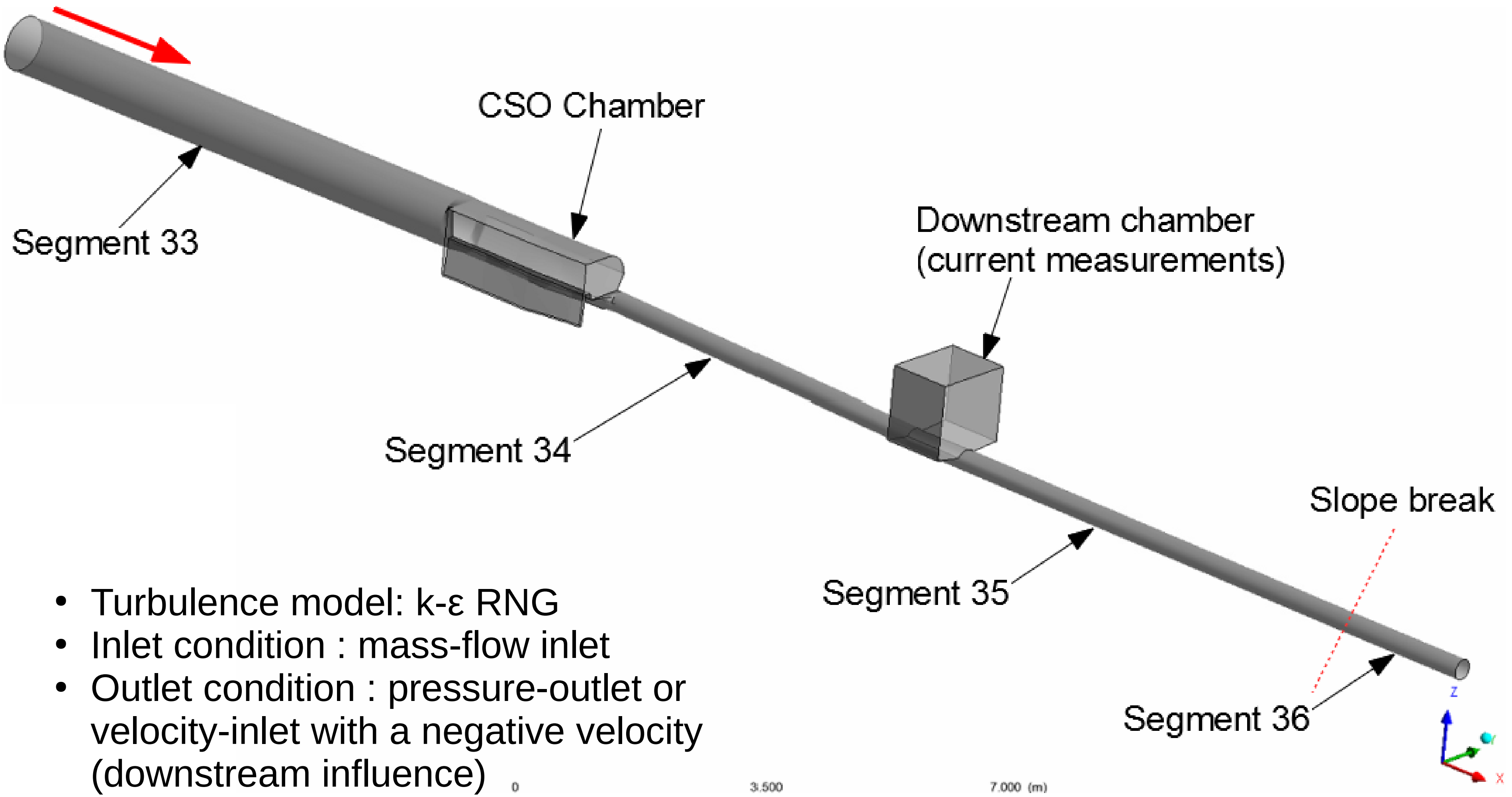
- Current measurements monitor the flow sent to WWTP
- Sensors are settled in the downstream chamber
- Sensors are height (aerial ultrasonic sensor) and velocity (inflow Doppler sensor) measurements
- Needs to monitor discharge and inlet flows

CSO BACKGROUND

CSO Chamber

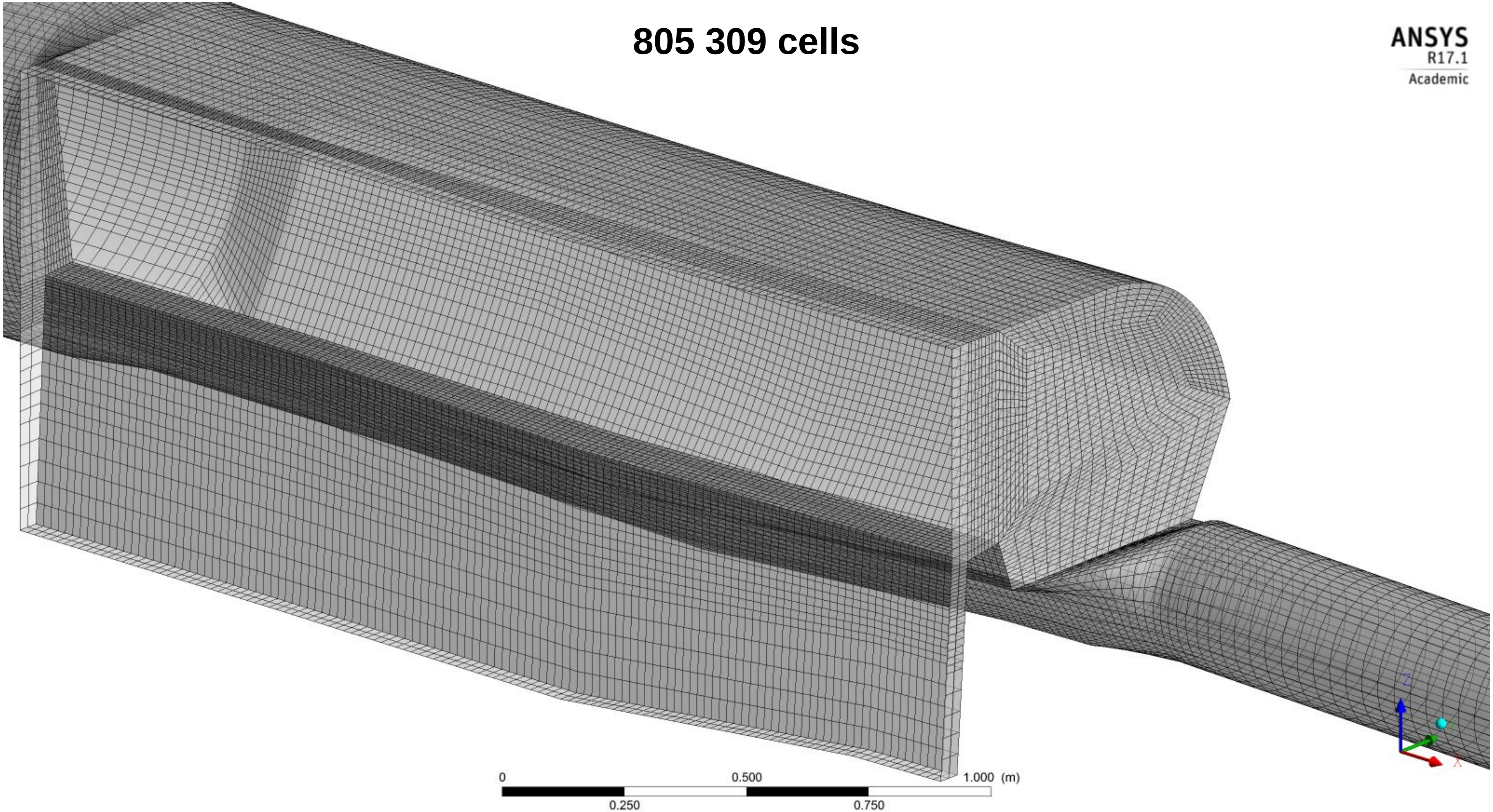


3D MODEL AND MESH



- Turbulence model: k-ε RNG
- Inlet condition : mass-flow inlet
- Outlet condition : pressure-outlet or velocity-inlet with a negative velocity (downstream influence)

3D MODEL AND MESH

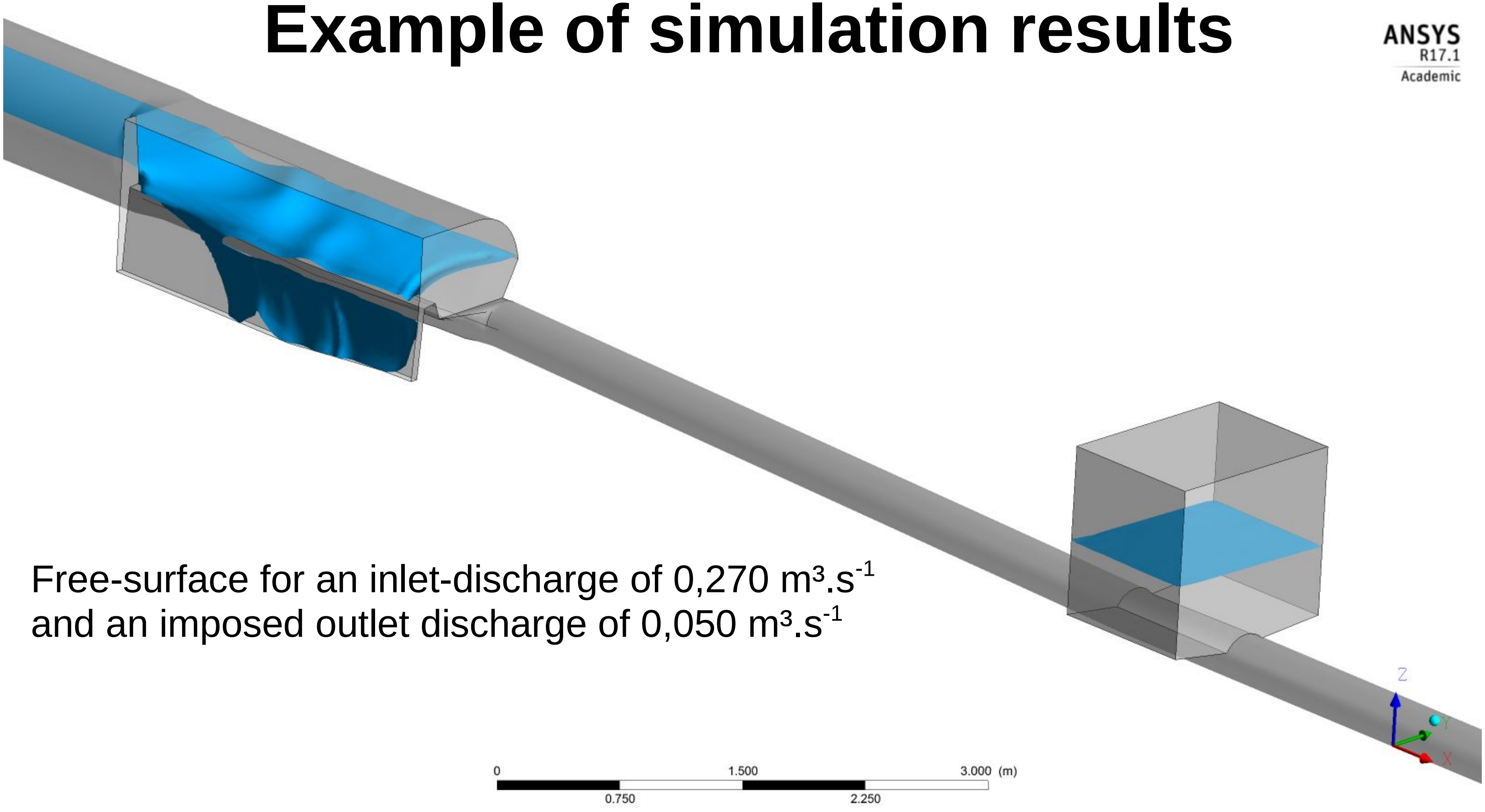


RESULTS

- A campaign of 30 calculations is planned (due to the downstream influence)
- The 30 free-surfaces are analysed to:
  - find where to settle an aerial height sensor in order to monitor the inlet flow
  - find where to settle an aerial height sensor in order to monitor the discharged flow
- The 30 velocity fields are analysed to:
  - check the reliability of the current measurements

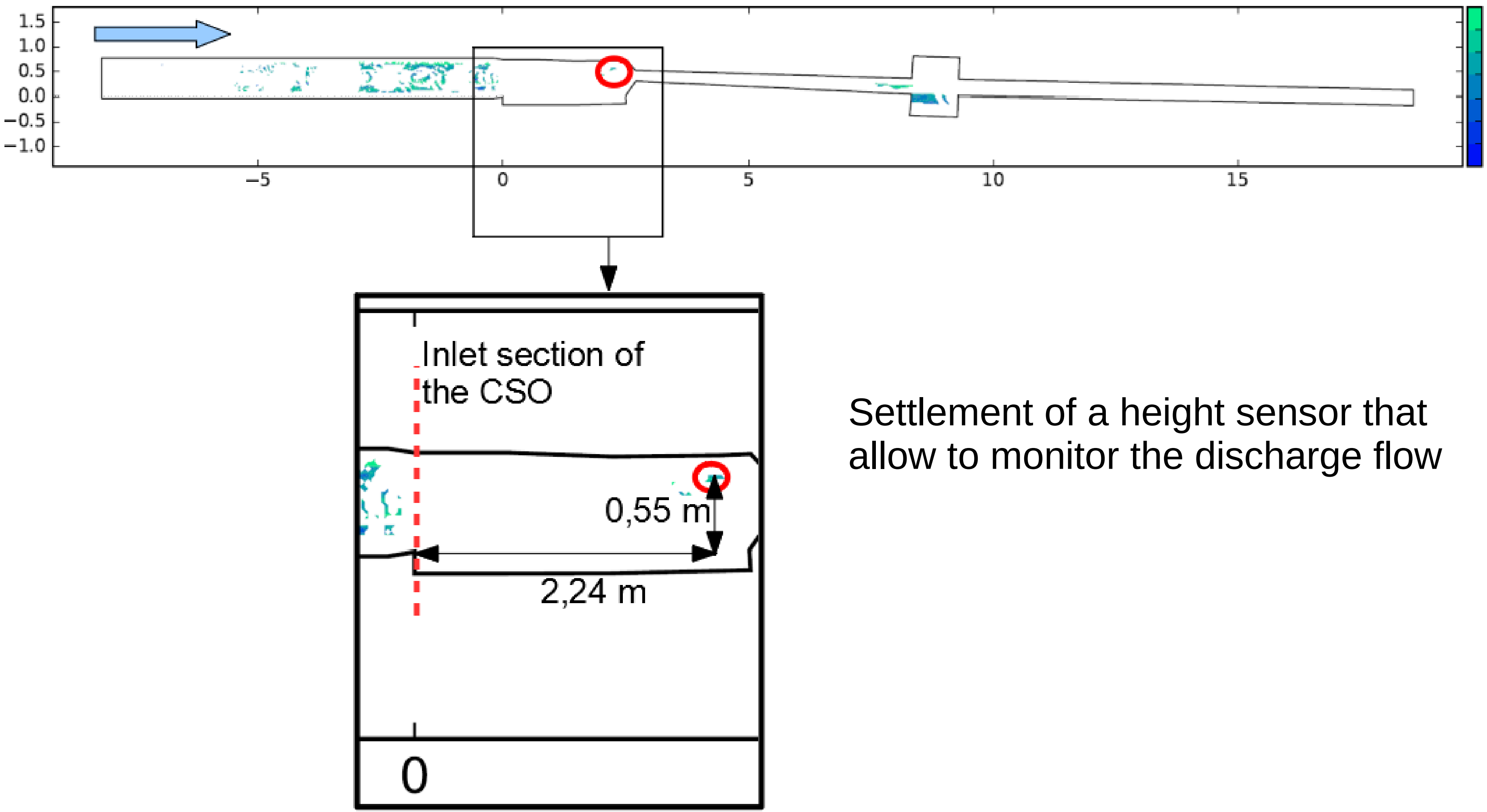
RESULTS

Example of simulation results



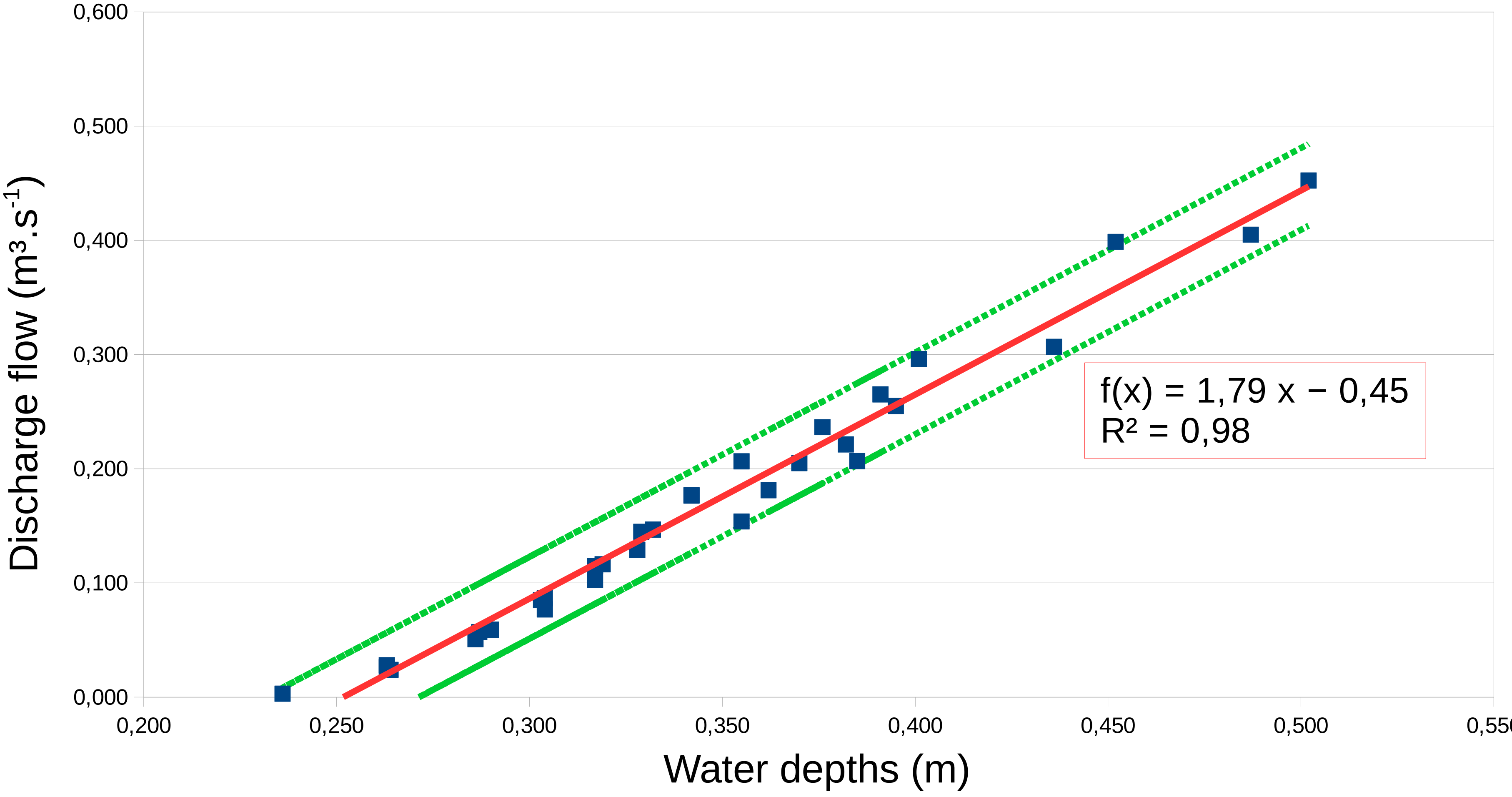
Free-surface for an inlet-discharge of 0,270 $m^3.s^{-1}$ and an imposed outlet discharge of 0,050 $m^3.s^{-1}$

RESULTS



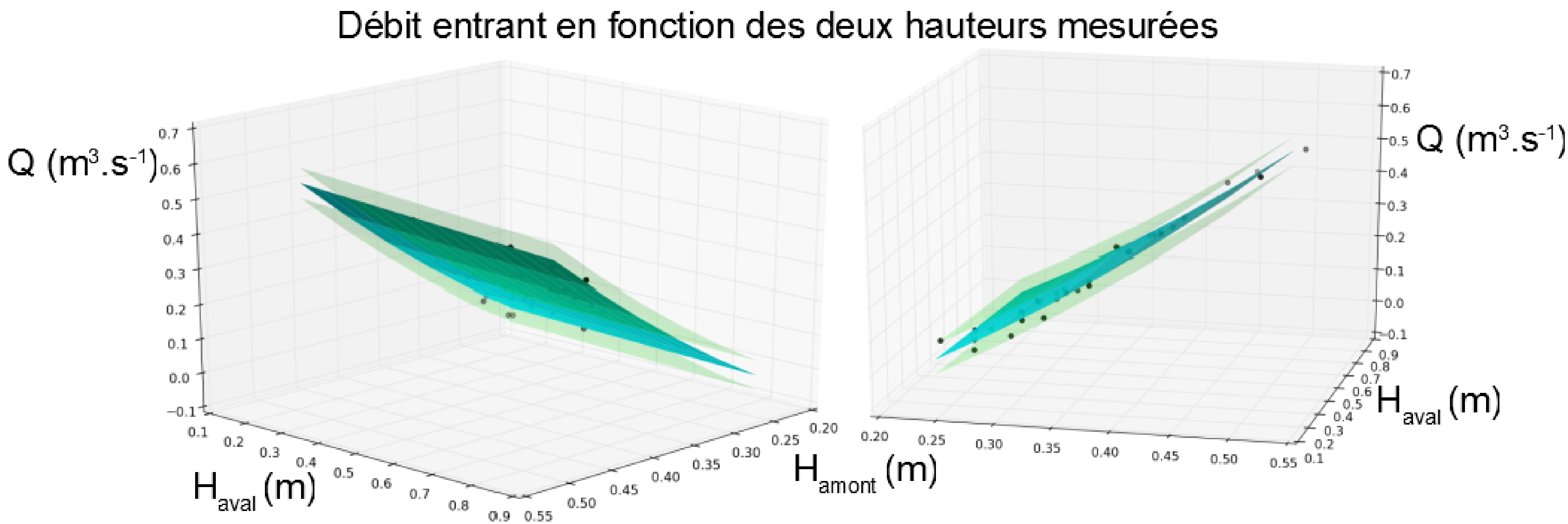
Settlement of a height sensor that allow to monitor the discharge flow

RESULTS


0,600
0,500
0,400
0,300
0,200
0,100
0,000
Discharge flow (m³.s⁻¹)
0,200
0,250
0,300
0,350
0,400
0,450
0,500
0,550
Water depths (m)
f(x) = 1,79 x − 0,45
R² = 0,98

RESULTS

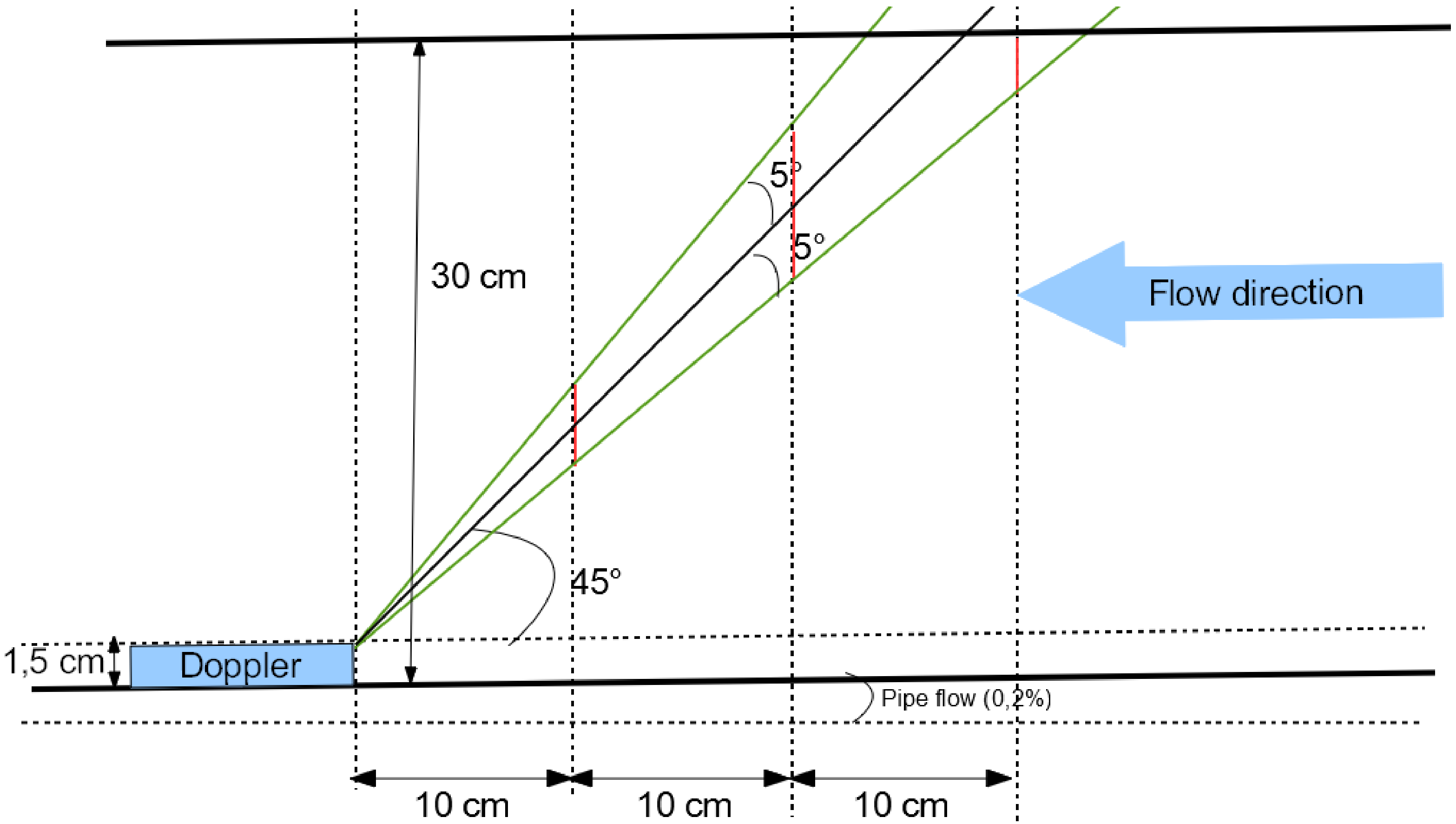
- Using both height measurements (the new one and the current one), we can establish a law to monitor the inlet flow



$$Q_{inlet} = 0{,}925 * H^2_{upstream} + 0{,}125 * H^2_{downstream} + 1{,}363 * H_{upstream} - 0{,}201 * H_{downstream} - 0{,}316$$

RESULTS

- Using the calculations result, we can check the Doppler measurements reliability



RESULTS

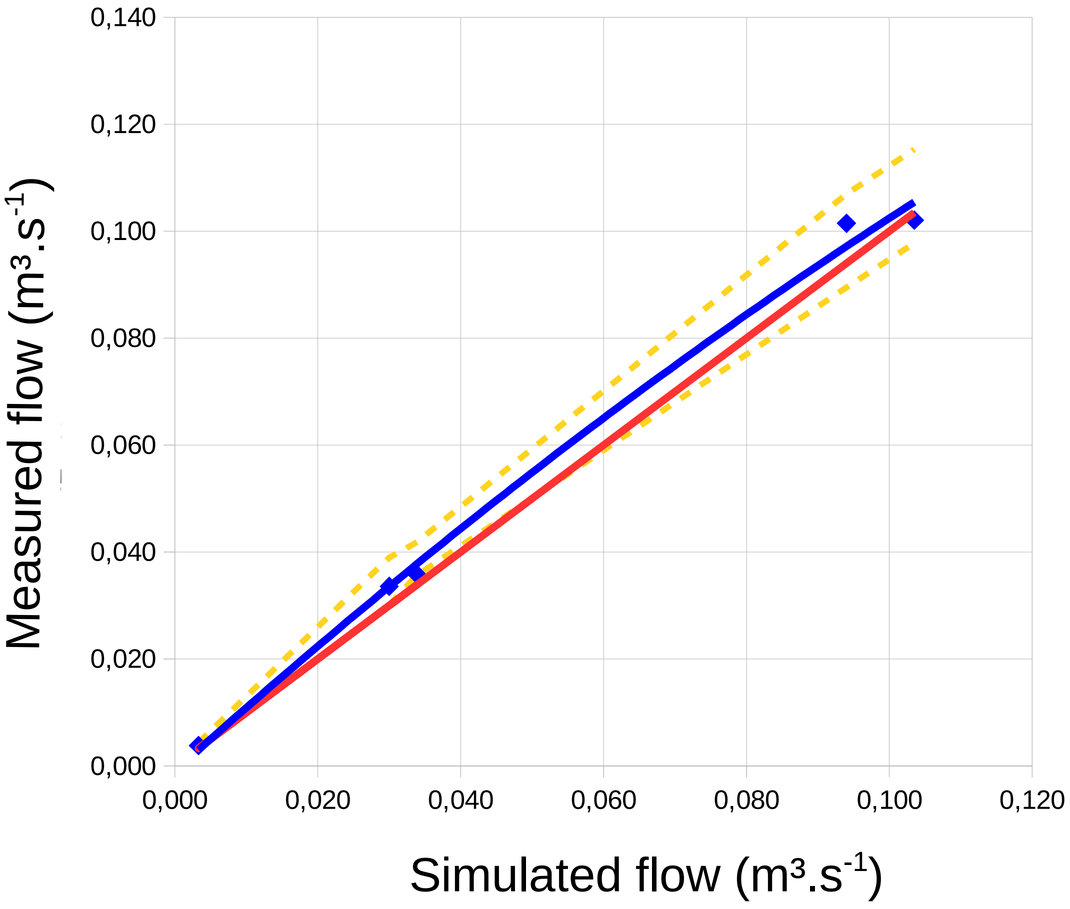
- Doppler velocities are calculated using the following formula :

$$V_{moyDoppler} = \frac{\sum_{i=1}^{n} \frac{V_i}{d_i^4}}{\sum_{i=1}^{n} \frac{1}{d_i^4}}$$

	V10cm (m/s)	V20cm (m/s)	V30cm (m/s)	Vitesses Doppler (m/s)
1	0,557	0,547	-	0,55
4	0,508	0,503	0,359	0,51
8	0,056	0,030	0,006	0,05
27	1,436	1,376	1,127	1,43
32	1,431	1,557	1,302	1,44

RESULTS

- The red line represents the ideal case (measurements and calculations are concordant)
- The blue line represents the real case : measurements tend to overestimate slightly the flow



CONCLUSIONS

- Current measurements are validated (both uncertainties and accuracy are acceptable)
- Discharge flow can be monitored with a unique height sensor in the CSO chamber
- Using the current height sensor and the new one defined in the CSO chamber, it is possible to monitor the inlet discharge with reasonable uncertainties and accuracy

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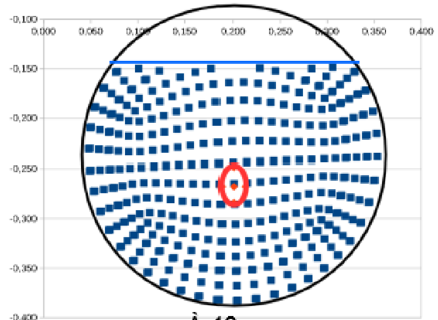
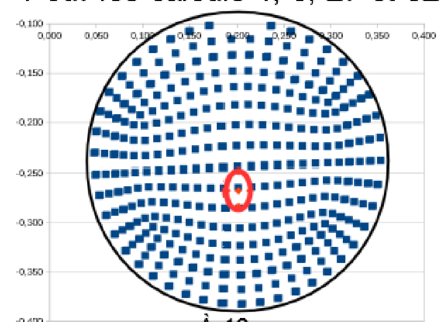
Annexes

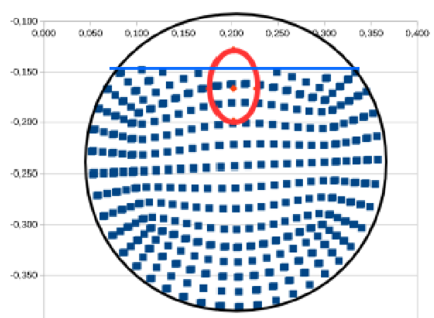
Pour le calcul 1 | Pour les calculs 4, 8, 27 et 32



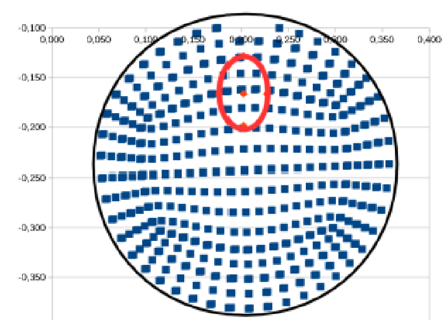
À 10 cm



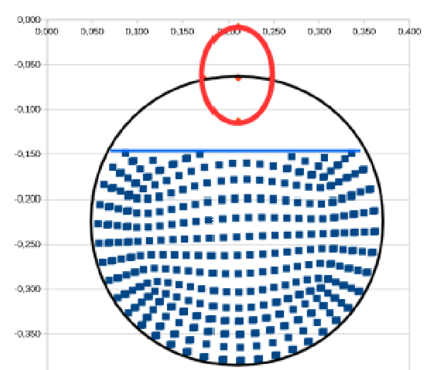
À 10 cm



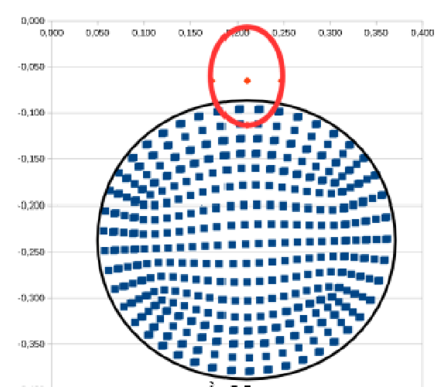
À 20 cm



À 20 cm



À 30 cm



À 30 cm