

Hidraulička analiza riblje staze (modeliranje turbulencije)

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MEHANIKA FLUIDA
DOKTORSKE STUDIJE
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Uvod (postavka zadatka)

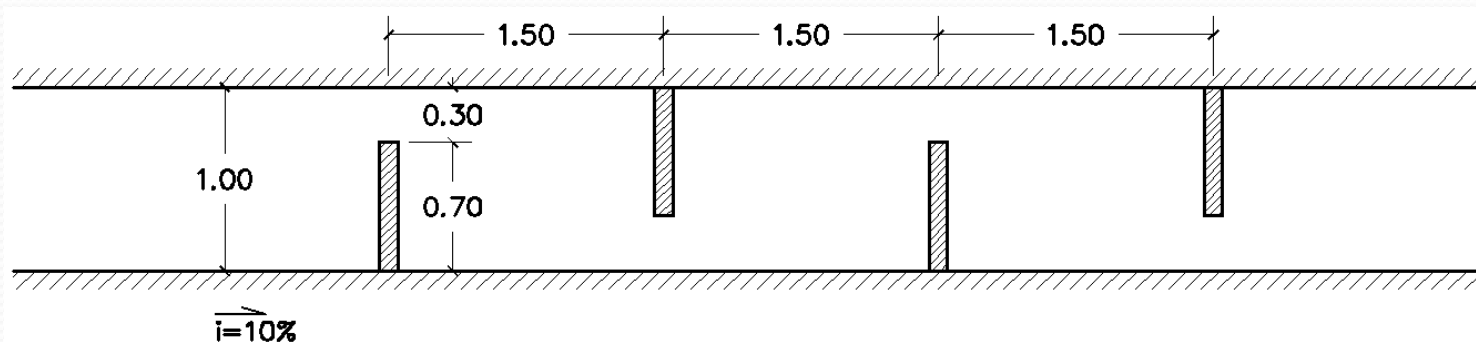
- Softver:



- iRIC (International River Interface Cooperative)
NaysCUBE Solver

- Zadatak – modeliranje riblje staze

- zadana geometrija
- 1. varirati razmak između pregrada
- 2. probati sa rupom u zidu veličine 30x30 cm



Metodologija

- Softver:



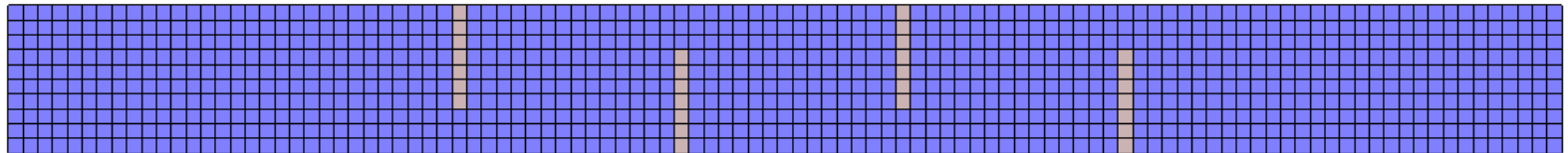
- iRIC provides a comprehensive, unified environment in which data that are necessary for river analysis solvers can be compiled, rivers can be simulated and analytical results can be visualized.



- Nays CUBE is a three-dimensional solver of river flow and bed deformation.

Metodologija

- 1. korak: da proradi proračun



$$\Delta x = \Delta y = 0.1 \text{ m}$$

$$\Delta L = 1.5 \text{ m}$$

$$L_{UL} = L_{IZL} = 3.0 \text{ m}$$

$$L_{UK} = 10.5 \text{ m}$$

$$B = 1.0 \text{ m}$$

$$\Delta t = 0.0001 \text{ s (1/10000 s)}$$

$$t_{UK} = 15 \text{ s}$$

$$Q = 2.0 \text{ m}^3/\text{s}$$

$$H_{NIZ} = 1.0 \text{ m}$$

Metodologija

- 2. korak: variranje parametara
 - $\Delta L = 0.7 \text{ m} / 1.0 \text{ m} / 1.5 \text{ m} / 2.0 \text{ m}$
 - $\Delta x = 0.05 \text{ m} / 0.10 \text{ m}$
 - $\Delta t = 0.01 / 0.001 \text{ s} / 0.0001 \text{ s} / 0.00001 \text{ s}$
 - $\Delta Q = 1 \text{ m}^3/\text{s} / 2 \text{ m}^3/\text{s}$

Rezultati

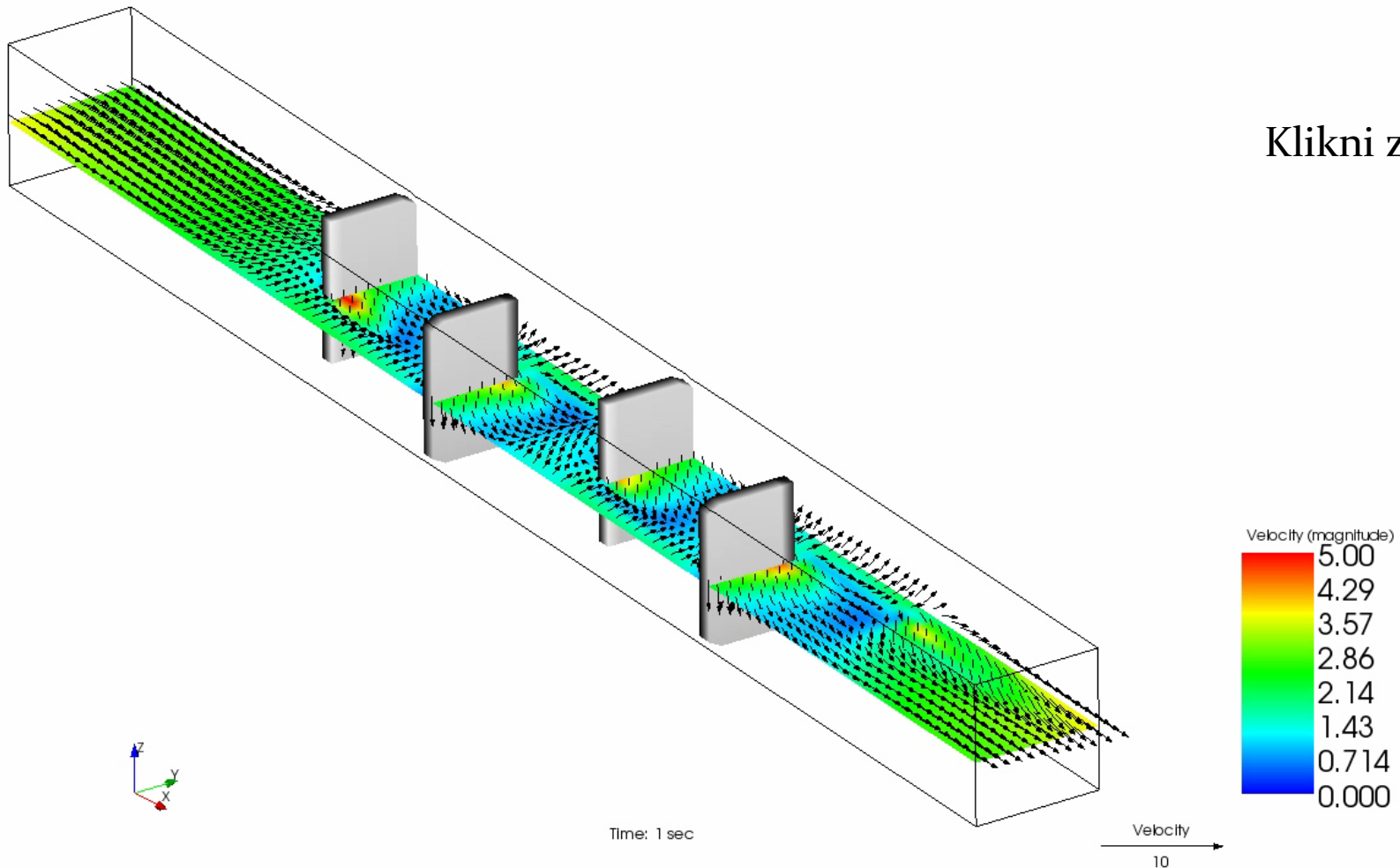
$$\Delta x = 0.1 \text{ m}$$

$$\Delta L = 1.5 \text{ m}$$

$$\Delta t = 0.0001 \text{ s}$$

$$Q = 2 \text{ m}^3/\text{s}$$

Klikni za video



Rezultati

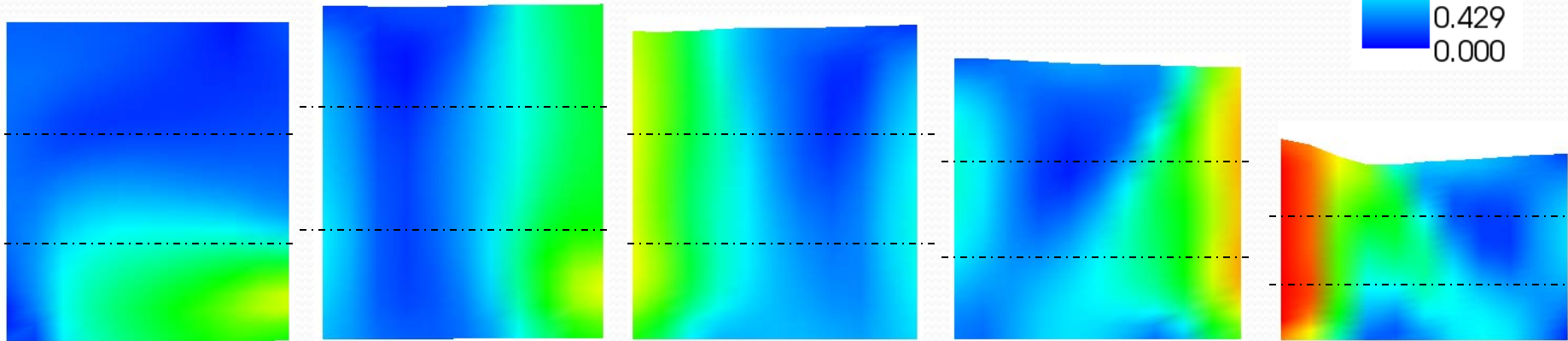
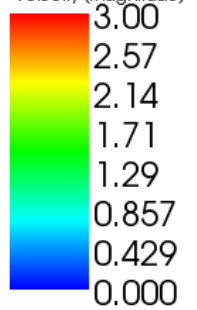
$$\Delta x = 0.1 \text{ m}$$

$$\Delta L = 1.5 \text{ m}$$

$$\Delta t = 0.0001 \text{ s}$$

$$Q = 2 \text{ m}^3/\text{s}$$

Velocity (magnitude)



x=2 m

x=4 m

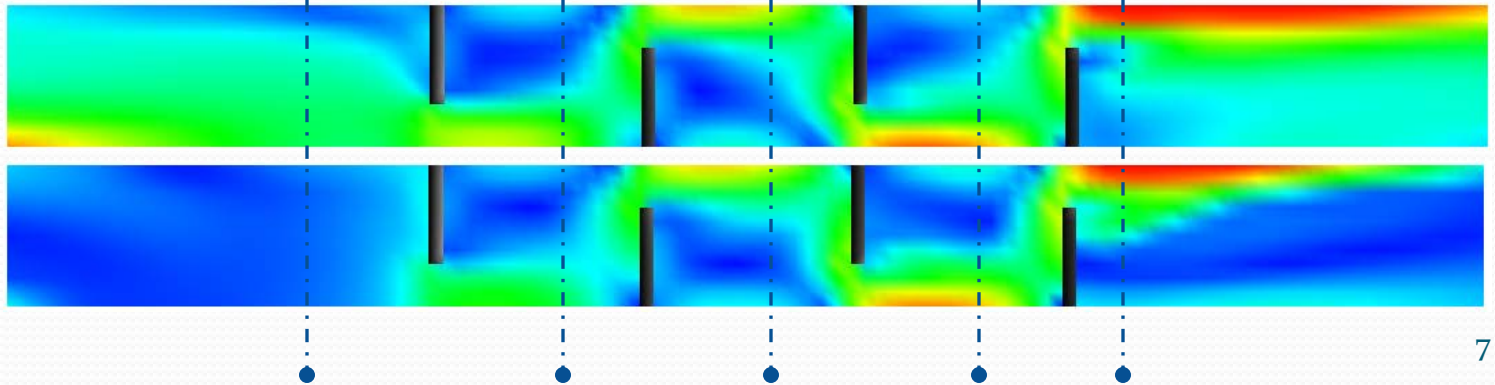
x=5.5 m

x=7 m

x=8 m

z=1/3 h

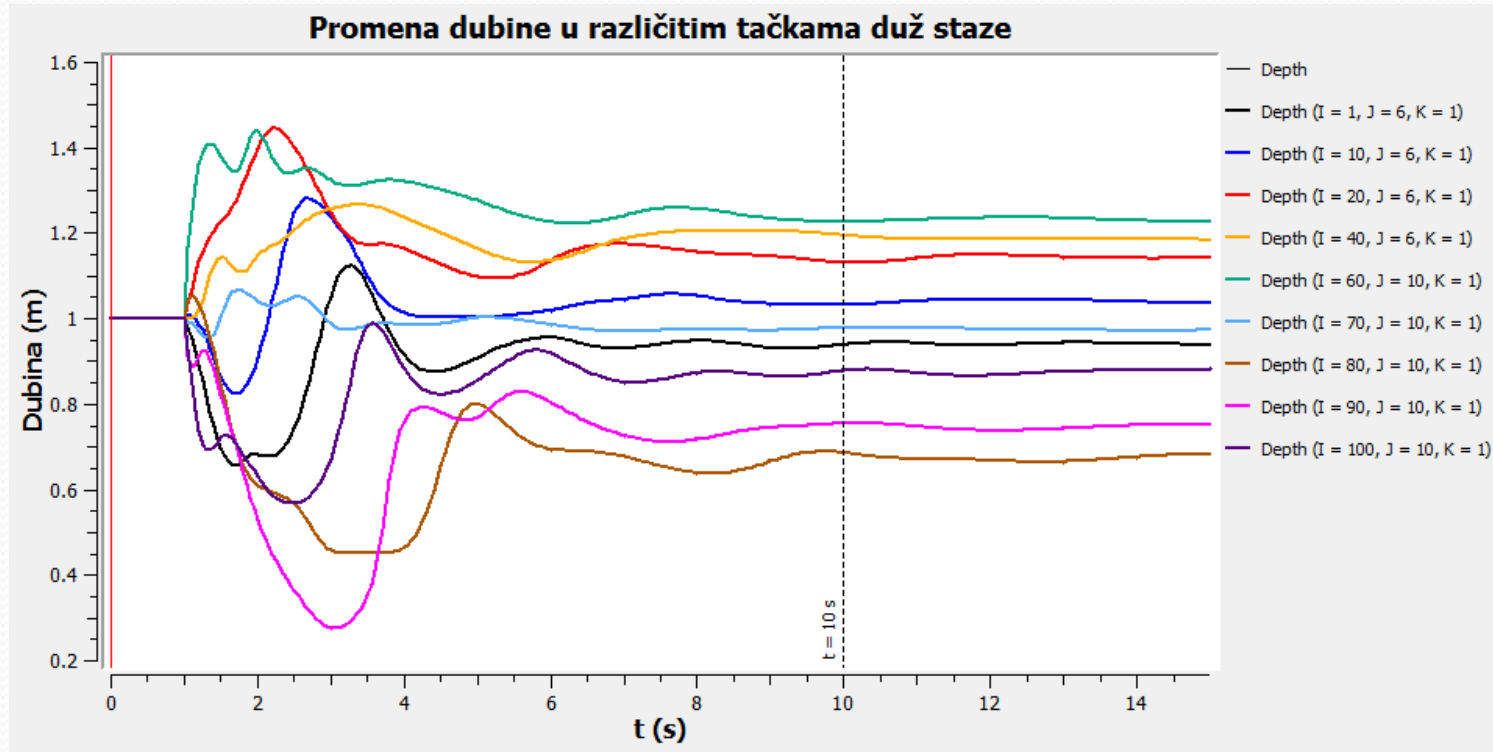
z=2/3 h



Rezultati

Koliko je dovoljno ukupno vreme proračuna?

$\Delta x = 0.1 \text{ m}$
 $\Delta L = 1.5 \text{ m}$
 $\Delta t = 0.0001 \text{ s}$
 $Q = 2 \text{ m}^3/\text{s}$



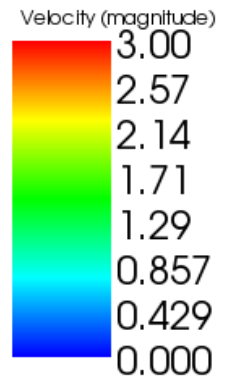
Zašto je ovo bitno? 1s ~ 1h

Rezultati – Variranje ΔL

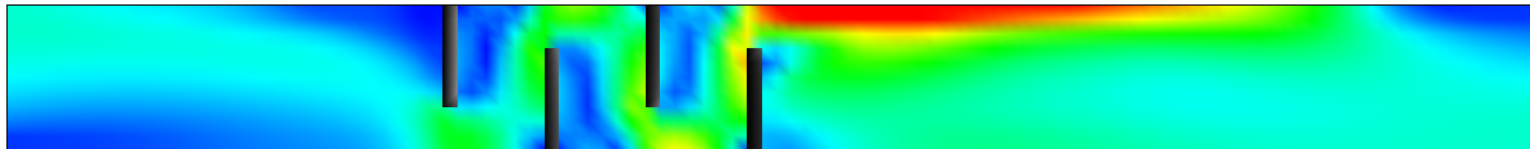
$$\Delta x = 0.1 \text{ m}$$

$$\Delta t = 0.0001 \text{ s}$$

$$Q = 2 \text{ m}^3/\text{s}$$

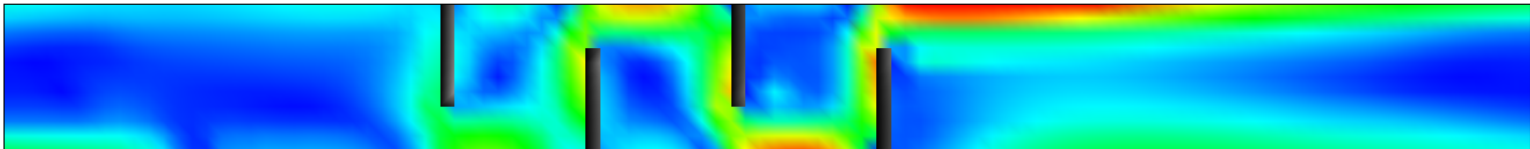


$$\Delta L = 0.7 \text{ m}$$

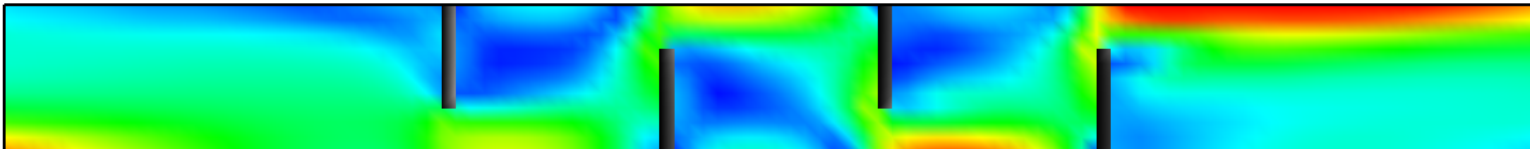


$$\Delta L = 1.0 \text{ m} (*)$$

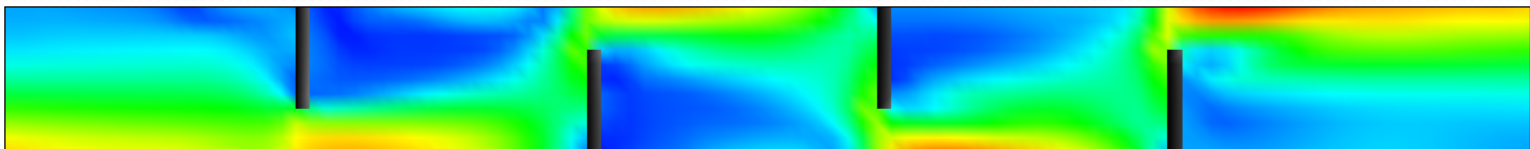
$$\Delta t = 0.00001 \text{ s}$$



$$\Delta L = 1.5 \text{ m}$$



$$\Delta L = 2.0 \text{ m}$$



presek $z=1/3h$

Rezultati – Variranje Δt

$$\Delta L = 1.5 \text{ m}$$

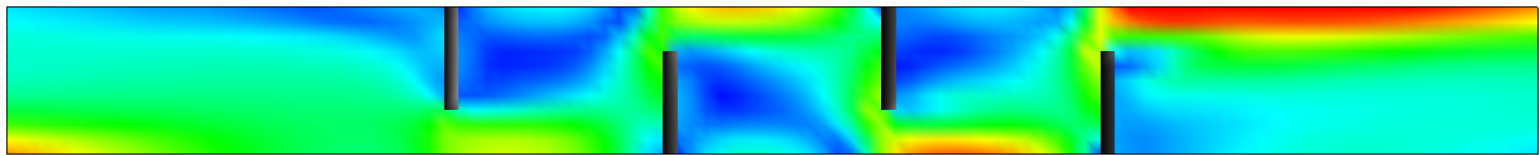
$$Q = 2 \text{ m}^3/\text{s}$$

$$\Delta x = 0.1 \text{ m}$$

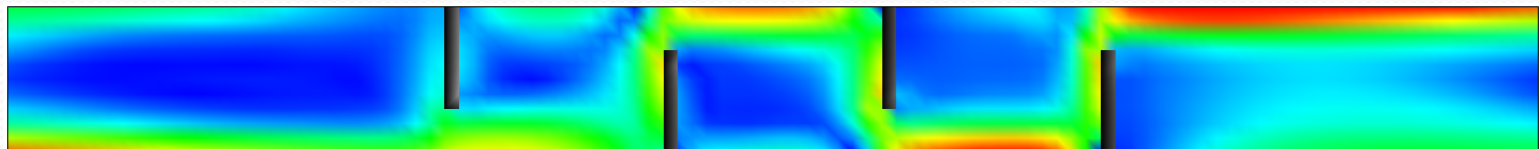
$$\left. \begin{array}{l} \Delta t = 0.01 \text{ s} \\ \Delta t = 0.001 \text{ s} \end{array} \right\} (Q=\text{NaN})$$

(t = 10 s)

$\Delta t = 0.0001 \text{ s}$



$\Delta t = 0.00001 \text{ s}$

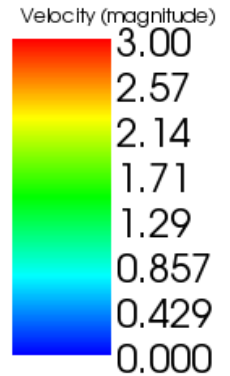


presek $z=1/3h$

Rezultati – Variranje Δx

$$\Delta L = 1.5 \text{ m}$$

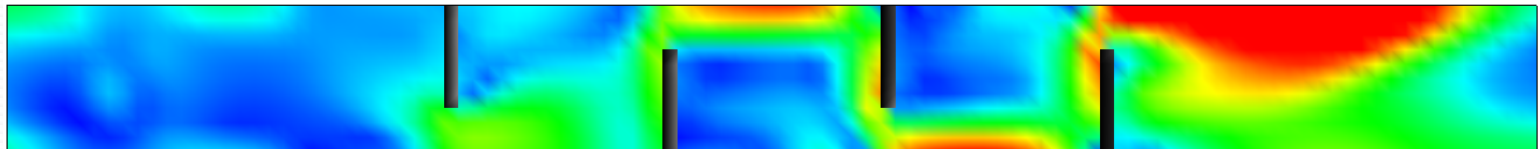
$$Q = 2 \text{ m}^3/\text{s}$$



smanjivanjem Δx , neophodno je smanjivanje i Δt

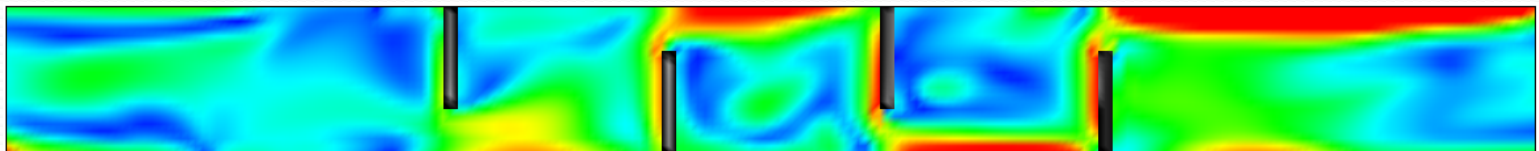
($t = 2.7 \text{ s}$)

$\Delta x = 0.1 \text{ m}$
 $\Delta t = 0.0001 \text{ s}$



1s ~ 1h

$\Delta x = 0.5 \text{ m}$
 $\Delta t = 0.00001 \text{ s}$



1s ~ 1d

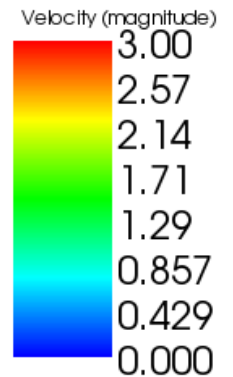
presek $z=1/3h$

Rezultati – Variranje Q

$$\Delta L = 1.5 \text{ m}$$

$$\Delta x = 0.1 \text{ m}$$

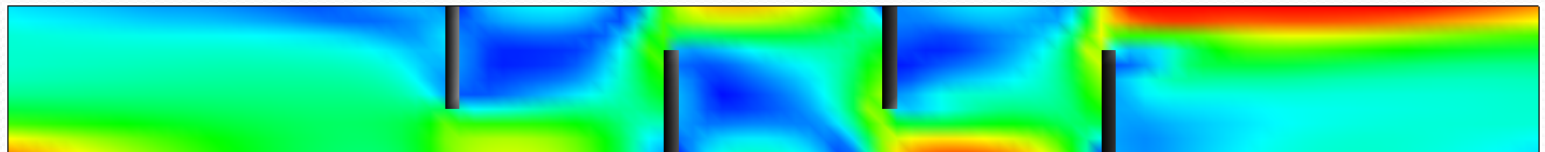
$$\Delta t = 0.0001 \text{ s}$$



(t = 10 s)

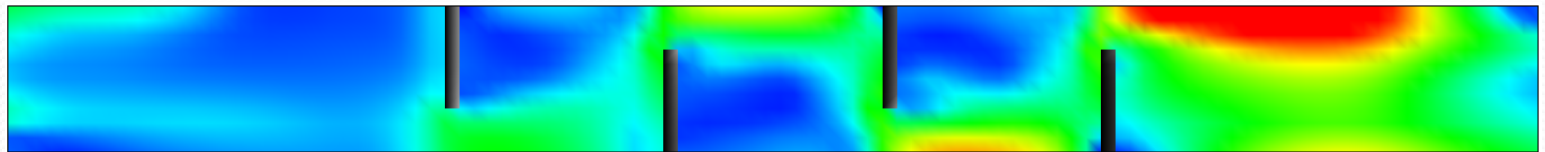
$$Q = 2 \text{ m}^3/\text{s}$$

$$H_{\text{NIZ}} = 1.0 \text{ m}$$



$$Q = 1 \text{ m}^3/\text{s}$$


$$H_{\text{NIZ}} = 0.5 \text{ m}$$



presek $z=1/3h$

Diskusija / Zaključci

- Variranje ΔL :
 - veće ΔL , veće brzine
- Variranje Δt :
 - veća razlika u prilaznoj/izlaznoj deonici
 - manja razlika u “bazenima”
- Variranje Δx :
 - gušća mreža zahteva smanjenje Δt
 - samim tim višestruko povećava potrebno vreme za proračun



To bi bilo to.
Hvala na pažnji.