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"United States Bureau of Reclamation Type IX Baffled Chute Spillways, A New Examination of Accepted Design Methodology Using CFD and Monte-Carlo Simulations, Part I"

Companion Slides prepared for the 3rd International E-Conference on Water Sciences sponsored by MDPI, November 2018

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Prelim Study to Revise Design Procedures

- Study of Type IX baffled spillway design procedures using stochastic evaluations and computational fluid dynamics (CFD) simulations.

- General conclusion of the study is that current empirical/experience-based design procedure can result in a wide range of acceptable designs with some much more expensive than others.

- This is a companion presentation for a submitted paper by Christopher J. Brown, P.E. and Raphael Crowley P.E.

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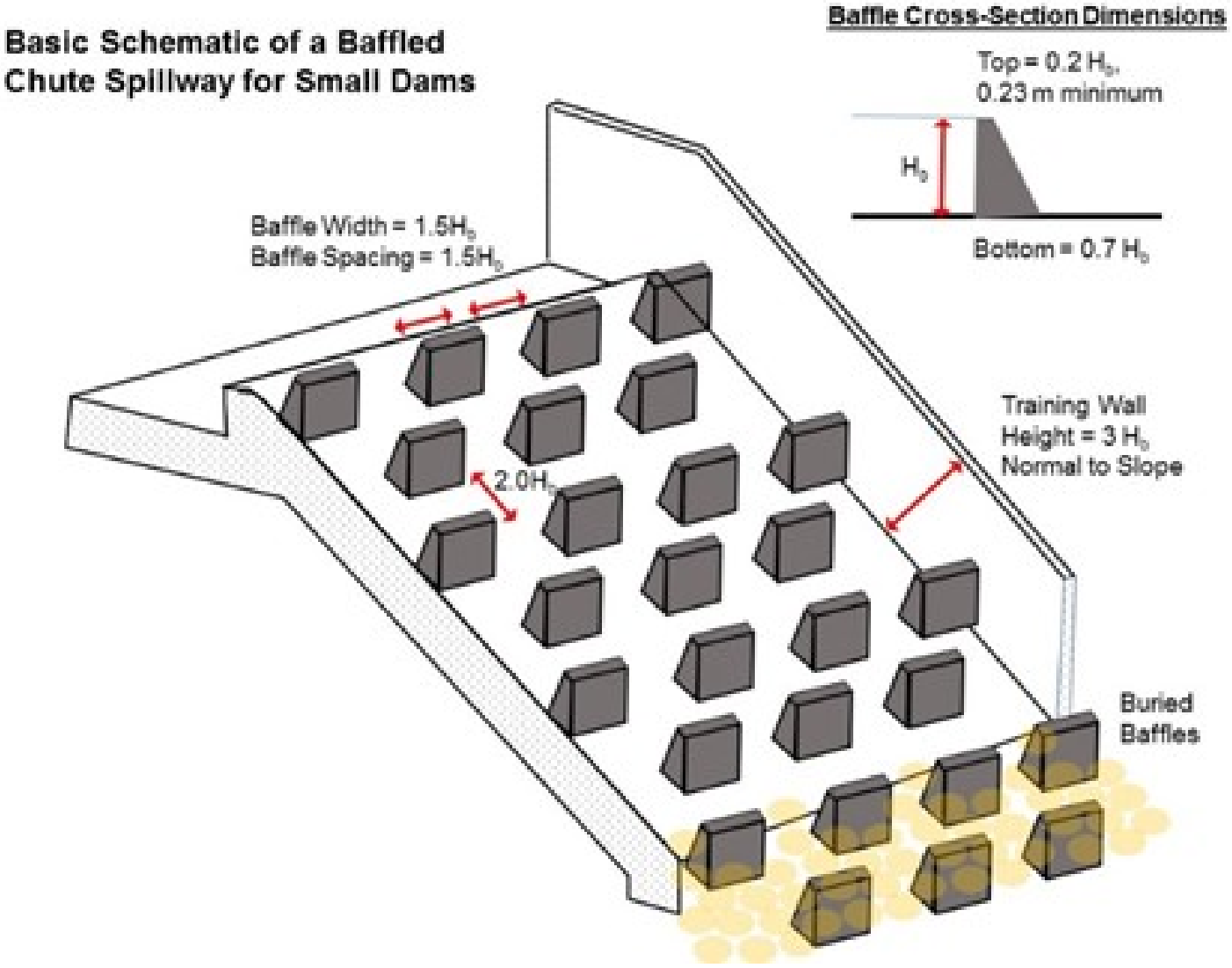
- Type IX Baffled Spillway Schematic:



Prelim Study to Revise Design Procedures

- Example Type IX spillway:

Example baffled chute spillway in Bozeman, Montana USA (photo from C. Brown).

Prelim Study to Revise Design Procedures

- Using the current design procedures published by the United States Bureau of Reclamation, the research team developed two separate spillway designs:
  - The “minimalist” design starting with a baffle height of 80% of the chute critical depth;
  - The “conservative” design starting with a baffle height of 90% of the chute critical depth;
- At the same time the research team simulated the original Bureau of Reclamation prototype spillway from Gila, AZ USA using a CFD model.

Prelim Study to Revise Design Procedures

- Method 1:
  - Monte-Carlo Simulation of Chute Spillway starting from Bureau of Reclamation procedures;
  - Simulation used reasonable range of variable uncertainties and:
    - The “minimalist” design starting with a baffle height of 80% of the chute critical depth;
    - The “conservative” design starting with a baffle height of 90% of the chute critical depth;

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- Method 2:
  - CFD Simulation of original prototype Chute Spillway that was the basis for the current Bureau of Reclamation empirical design procedure;
  - Idea was to develop “proof-of-concept” CFD simulation of spillway prototype and once model fully calibrated, revise the baffle design using Monte-Carlo simulation results for Minimalist and Conservative Designs; and,
  - Revised design procedure ultimately the goal.

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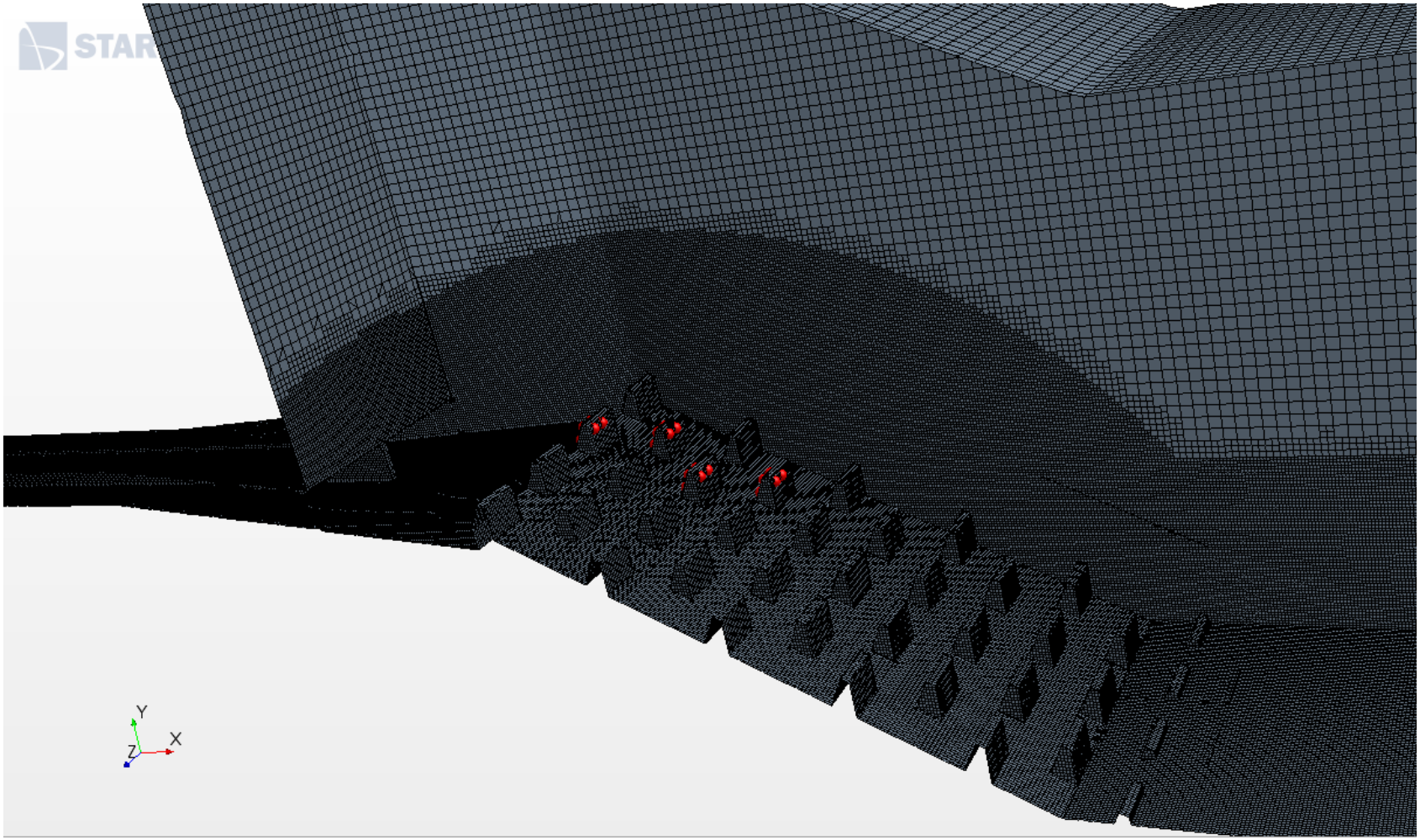
- CFD Model Mesh:



More than 3 million cells…

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- How about some results ?

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- Summary of Data and Analysis from Monte-Carlo Simulation:

Table 1. Monte-Carlo simulation results for the minimalist and conservative designs.

Design Dimension	Minimalist (m)	Conservative (m)
Baffle Height	0.77 [1]	1.13 [1]
Minimum Training Wall Height	2.41	3.26

[1] 10% and 90% range was used from the Monte-Carlo simulation.

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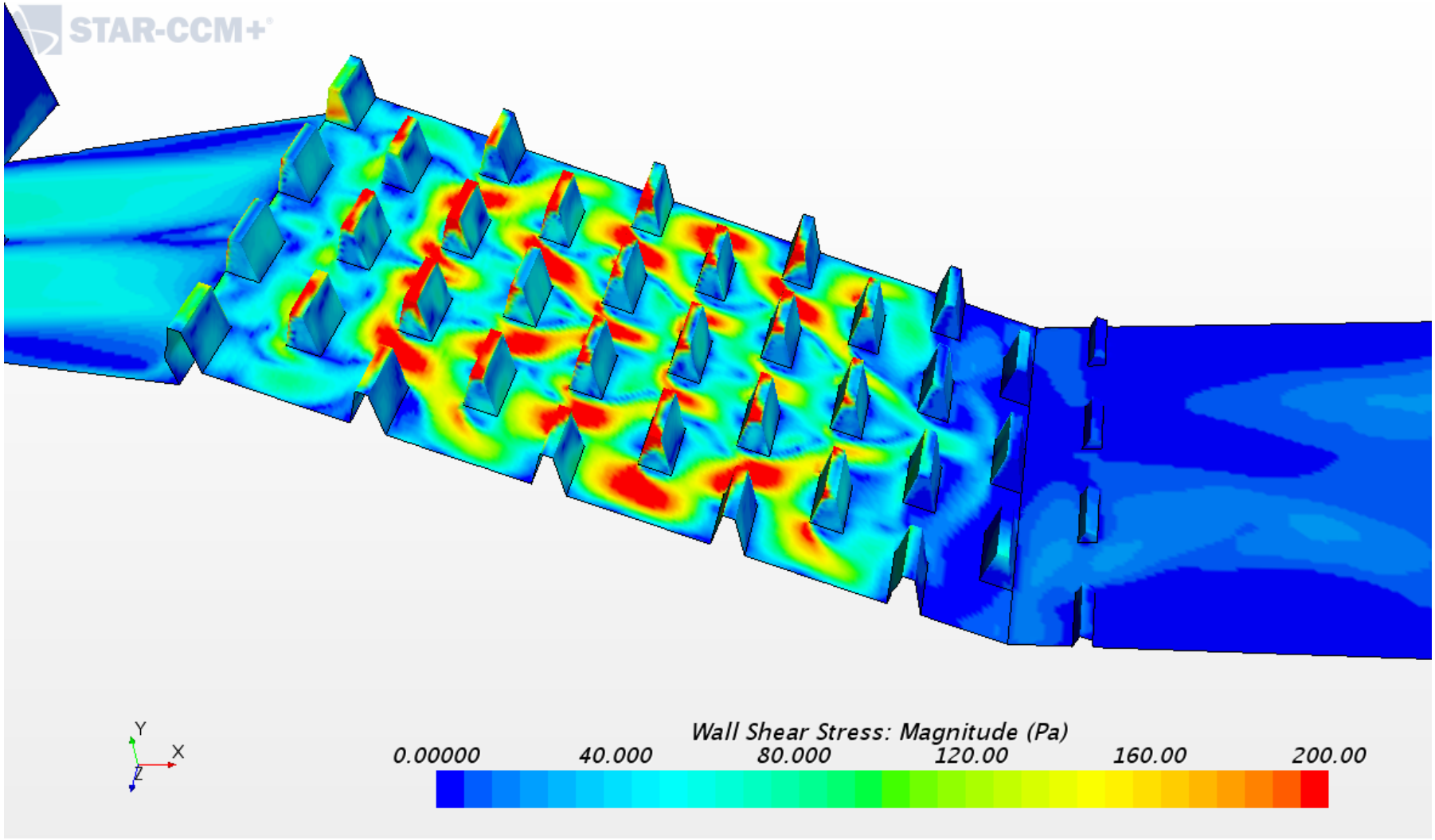
- Summary of Data and Analysis (Shear Stresses):



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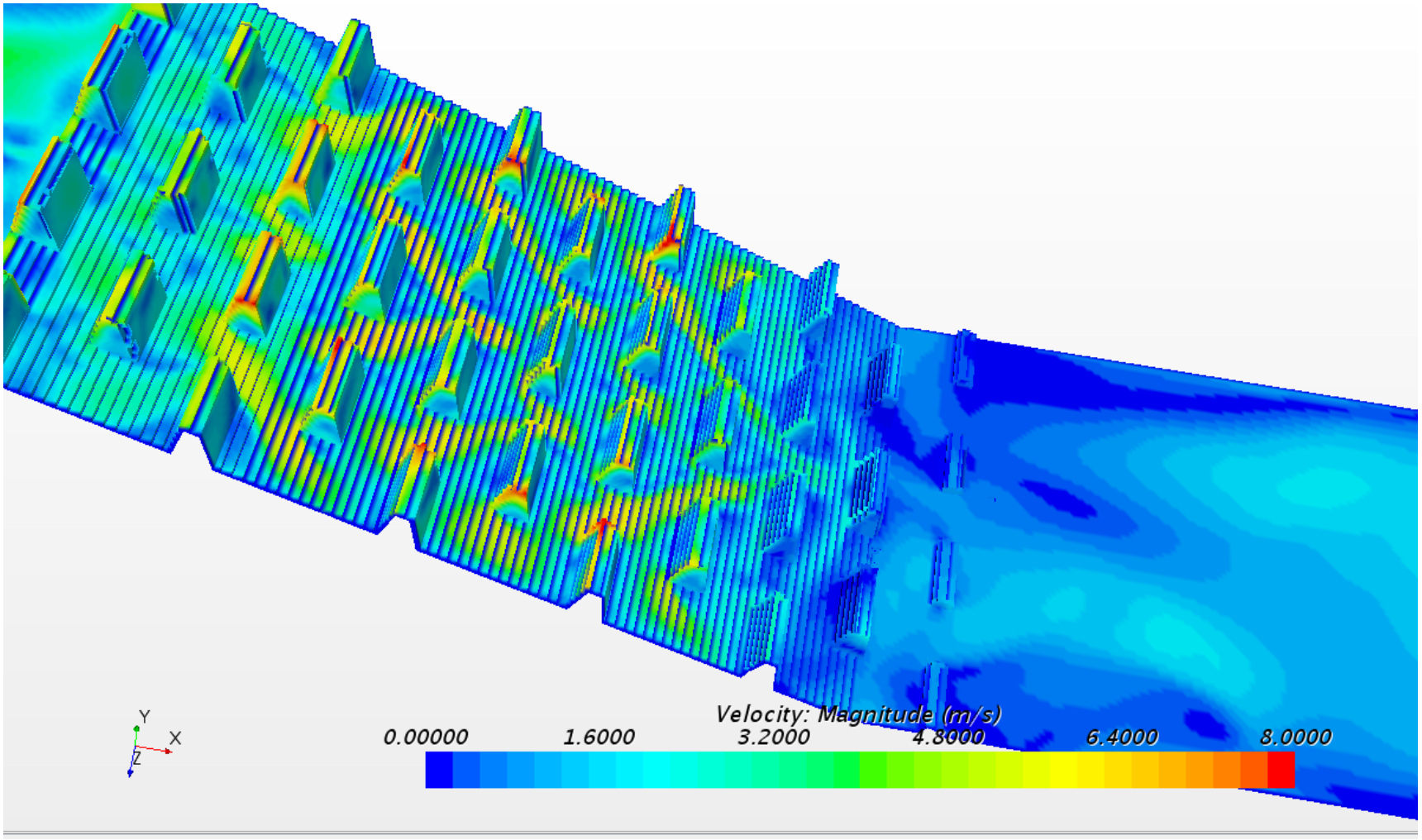
- Summary of Data and Analysis (Near Bed Velocity):



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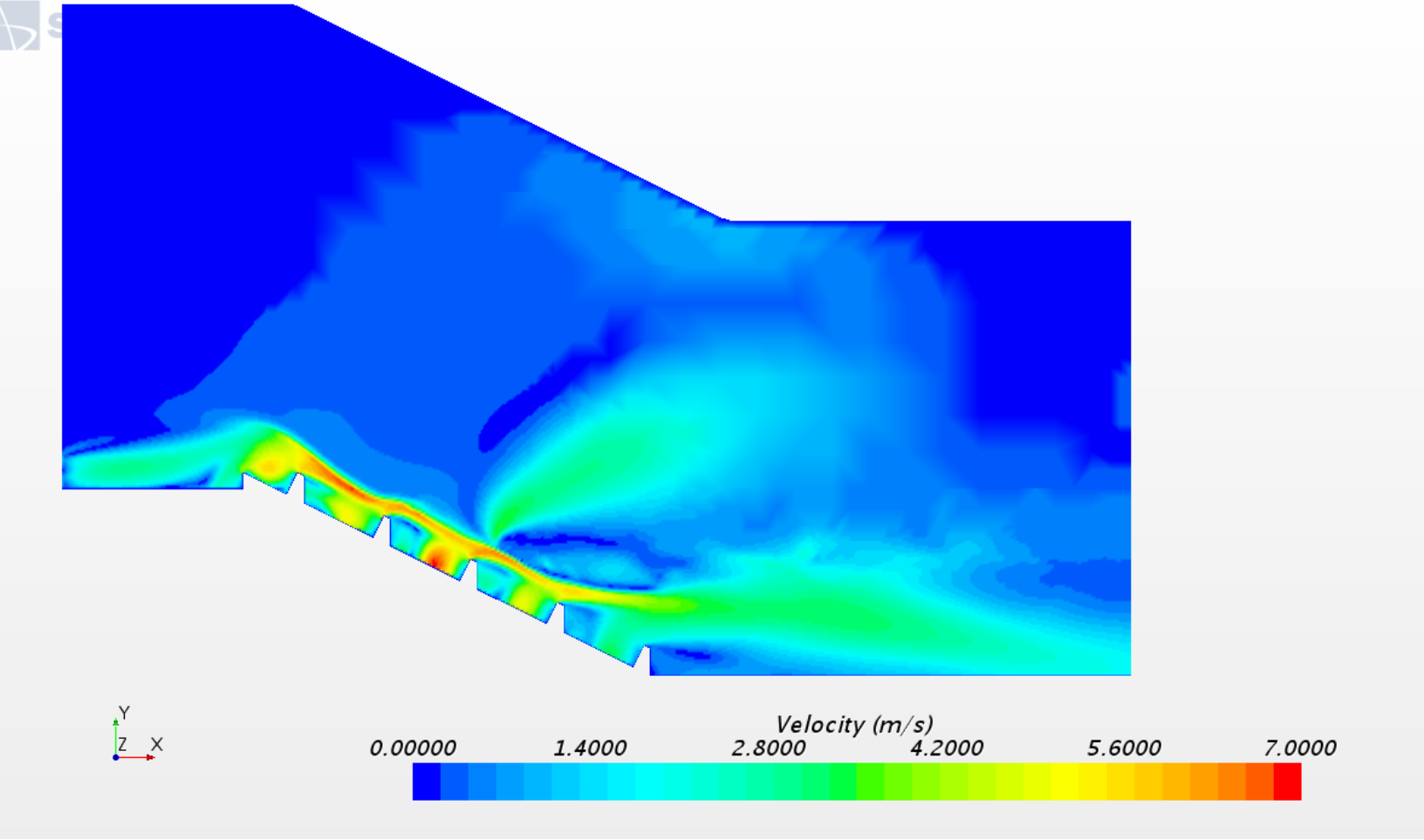
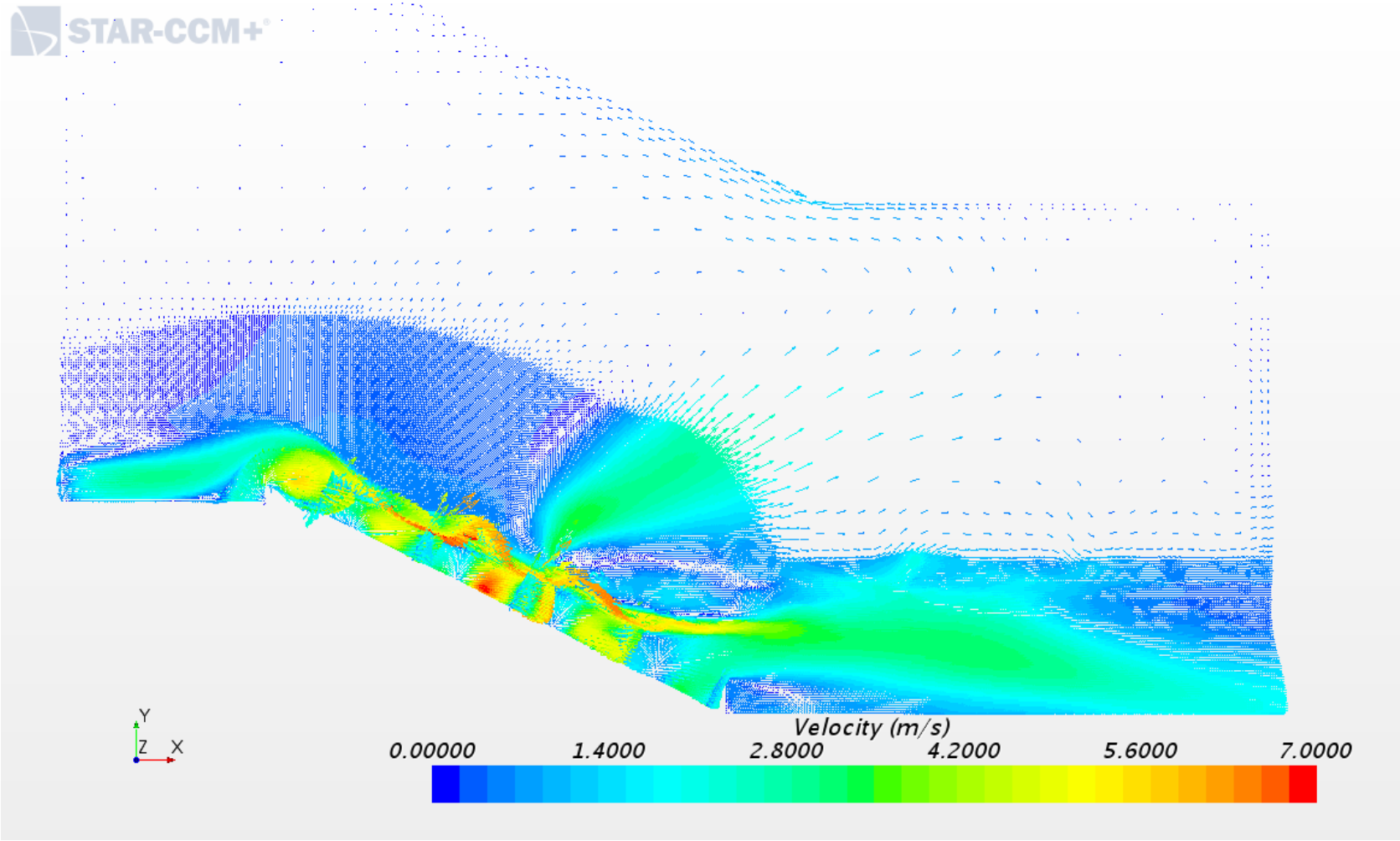
- Summary of Data and Analysis (Velocity Magnitude Cross Section along Spillway Centerline):



Prelim Study to Revise Design Procedures

- Summary of Data and Analysis (Velocity Vectors Cross Section along Spillway Centerline):



Prelim Study to Revise Design Procedures

- Future Research:
  - Finish CFD Calibration and Validation of Prototype Simulation;
  - Build two new CFD models using “minimalist” and “conservative” spillway designs as determined from stochastic study;
  - Compare results of two new CFD models to the prototype CFD model to determine which is more efficient and more cost-effective; and,
  - Develop recommended refinements to the current Type IX spillway design procedure.

Questions

- Thank you for the opportunity to provide this presentation.

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