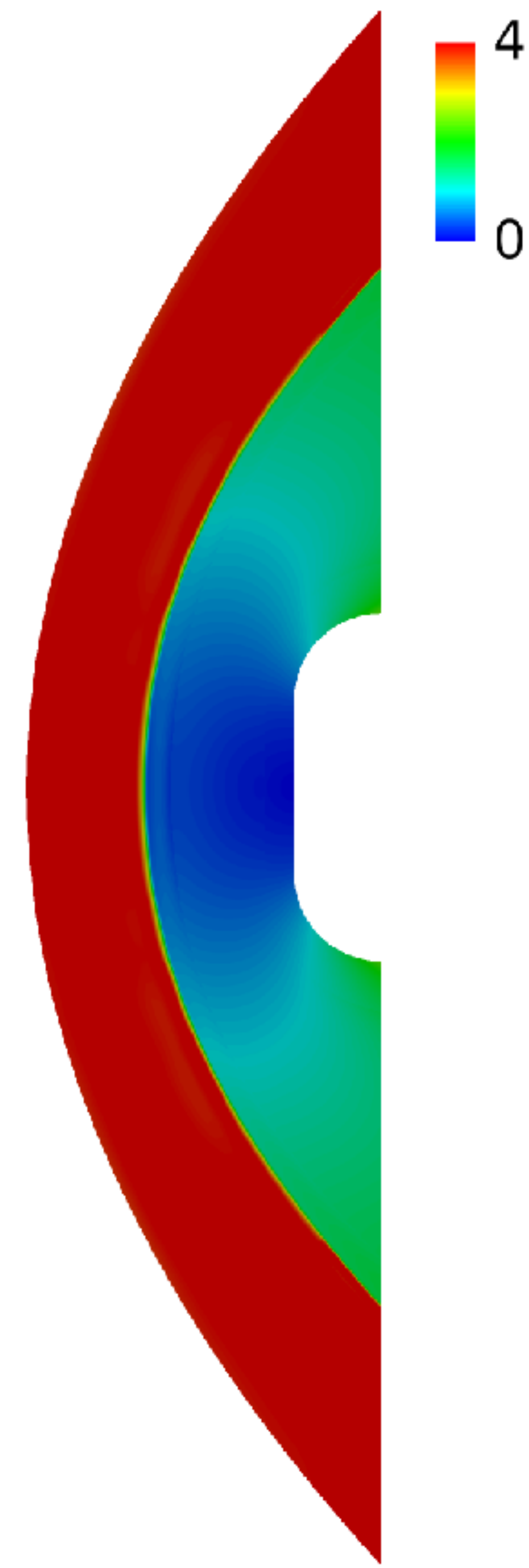
HOW CI1 SHOCK CASE



Overview

- Case designed to be a challenge for high-order solver
  - Accuracy across shock
  - Stability of flow solver at high-speed with strong discontinuity
  - Robustness of linear/nonlinear solvers
- Relatively trivial case for production 2nd-order solvers
- Two analytic functionals
  - Total enthalpy loss in entire volume
  - Stagnation point pressure error
- Supplied meshes at 5 resolutions, adapted to shock location
  - Adaption is not hierarchical
  - Expect between 1st-2nd order convergence for both functionals

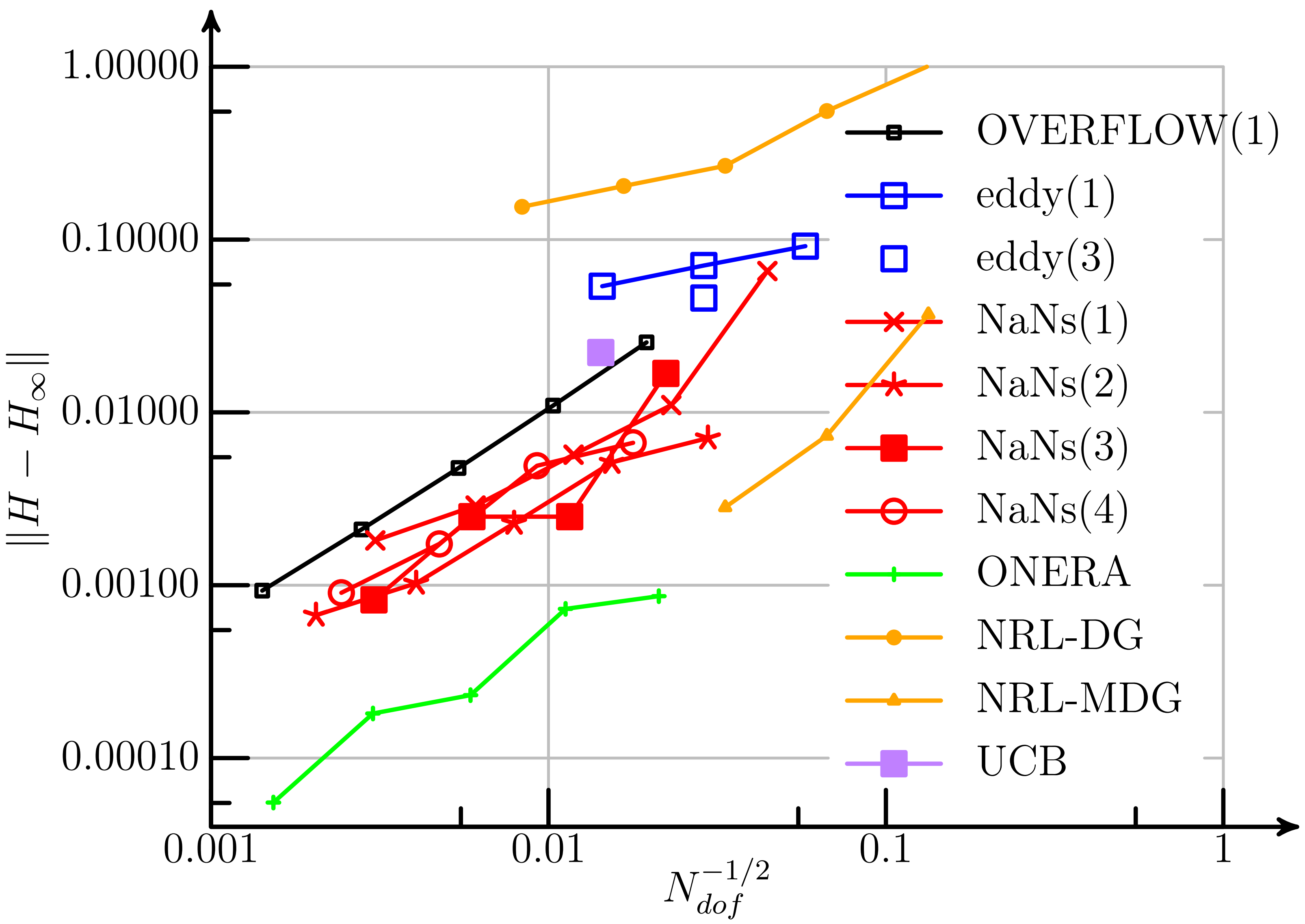
Overview

- No participants in 2016 HOW
- 5 participants in 2018 HOW
- All groups report case met expectations for difficulty
  - Required care/improvements in algorithm, solver, adaptation, *etc.* to generate solutions
- Some groups could not run supplied meshes
  - Generated their own which met their solver requirements
- Some groups could not converge all cases to machine epsilon
- Efficiency (wall clock time) was not a consideration for this 1st iteration of the case
  - Many solvers designed for unsteady and can barely run case

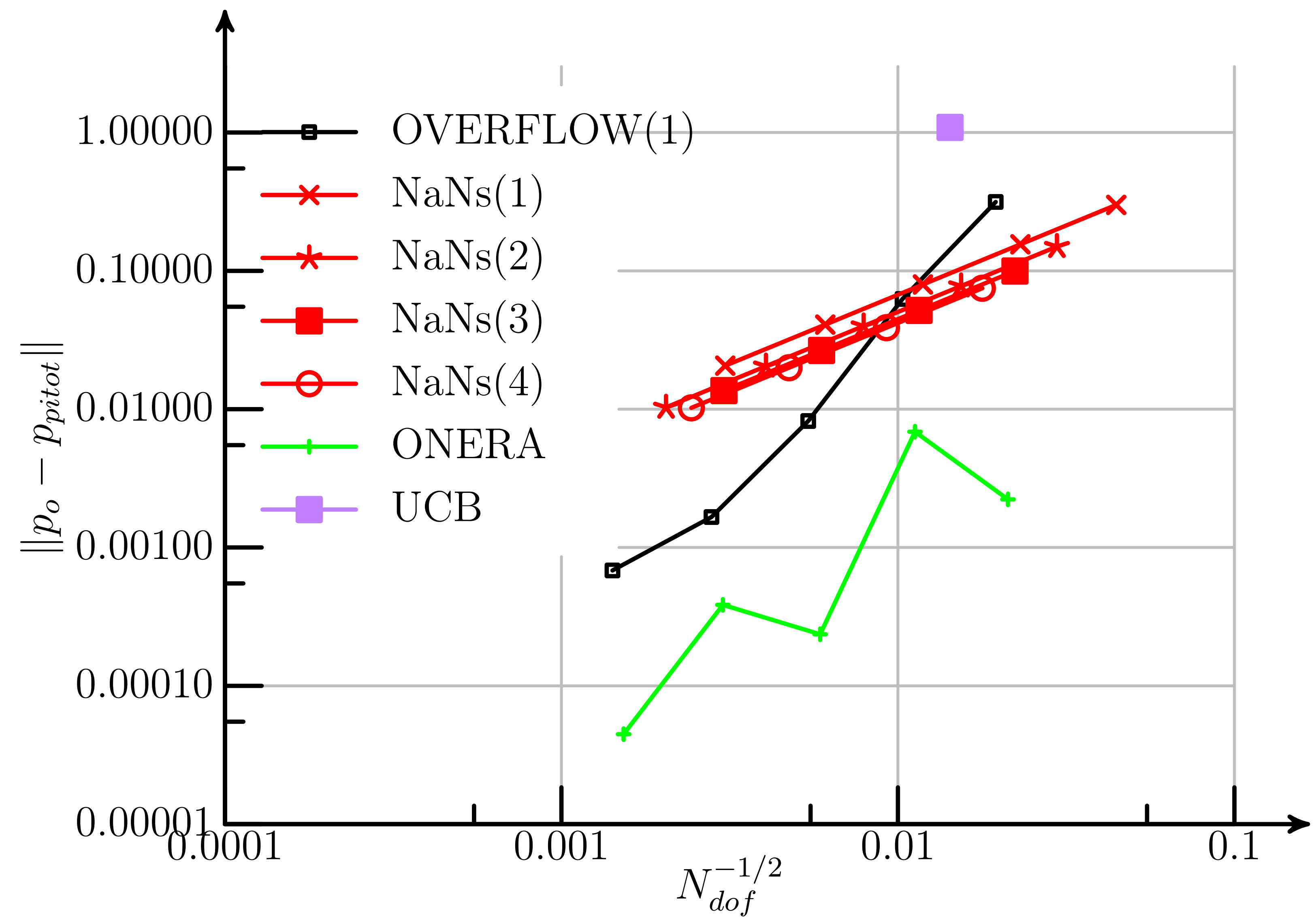
Intermission

- Marshall
  - Do something here

Results Summary



Total Enthalpy



Total Pressure

- Can’t plot NRL pressure results (file format, gnuplot, python, ???)
  - Participants should submit reduced raw data, not scripts

Results Summary

- As expected, all solvers showing between 1st - 2nd order convergence rate
- No methods significantly better than existing standard (OVERFLOW) to justify expense/complication
  - Is goal of high-order to out-compete standard on these cases or simply survive?
- ONERA results generally lower error, NRL-DG results higher
  - Why? are we all using the same norm definition? What can we learn?
- Lack of convergence seems to correlate with lack of monotonicity in stagnation pressure error convergence

Future Work

- Case demonstrates utility of strong shock testing for HOW
- Unclear whether all groups are defining error identically
  - We can’t even get pointwise values of error computed consistently
  - Possible solution: explicitly define discrete error measures for each method - FDM, FVM, FEM, …
- Adaptation
  - Done properly, should demonstrate formal convergence rate
  - Some initial results show non-physical behavior (single implementation or general problem?)
- Other performance metrics
  - Error across shock along stagnation line
  - Mach=1 contour lines (what is truth?)
  - Convergence / computational efficiency