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Adaptive time stepping in reservoir simulations

Results

Theory

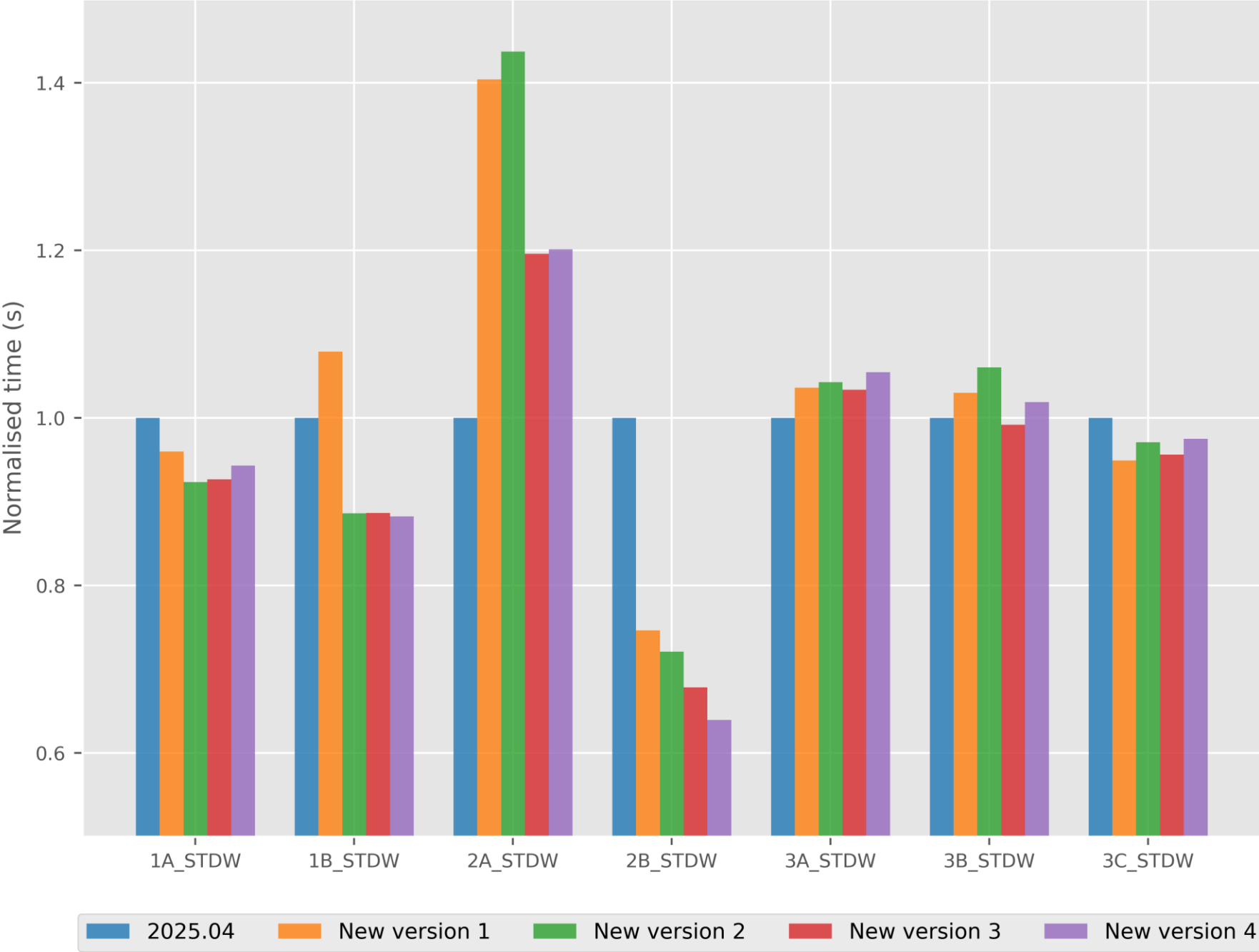
How to use it in OPM Flow

Results for Norne prediction cases

Available at <https://github.com/OPM/opm-tests>

Only results for STDW cases

Simulations for Norne prediction models



What about 4C?

2025.04

Newton iterations: 922

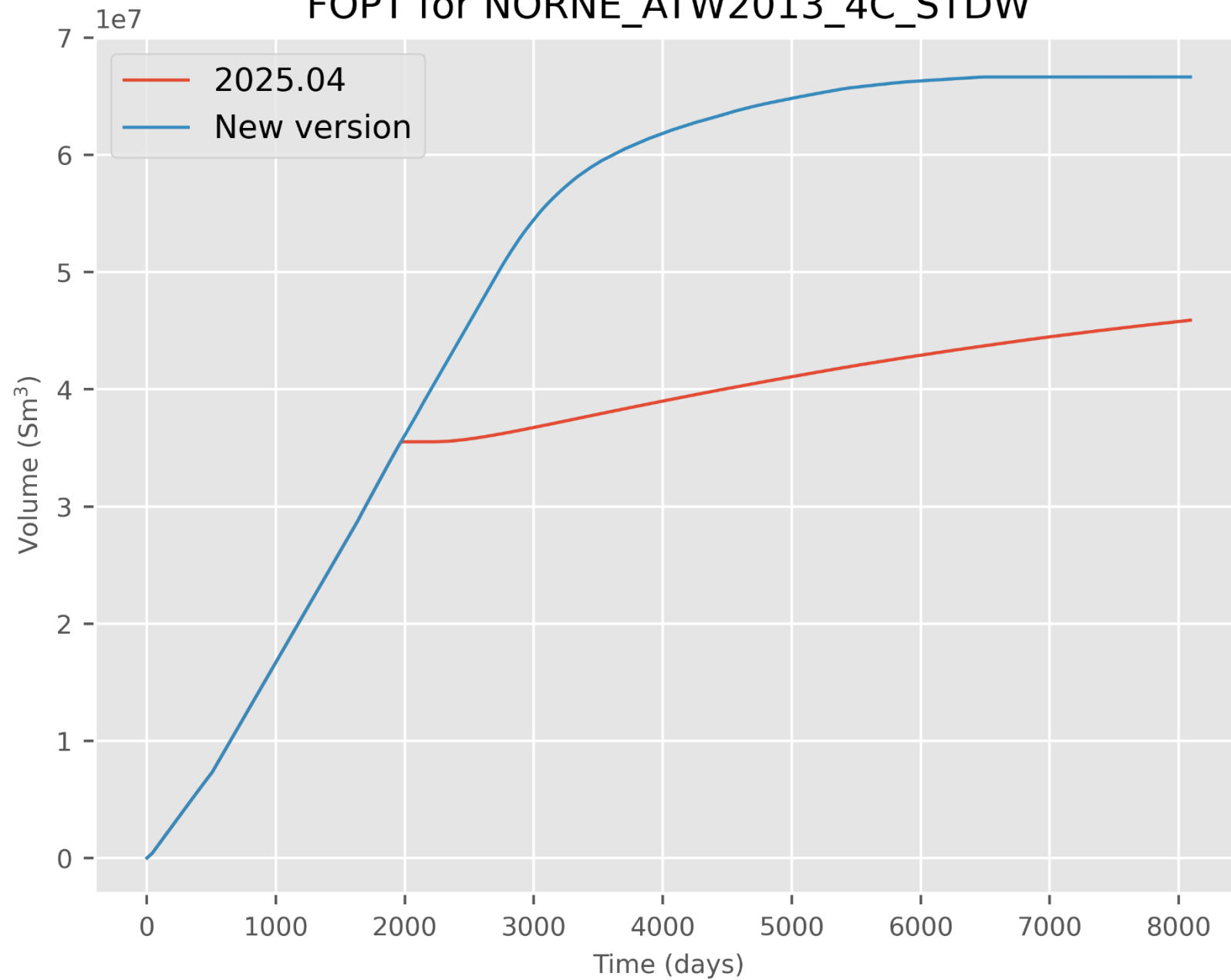
Linear iterations: 1870

New version

Newton iterations: 236 102

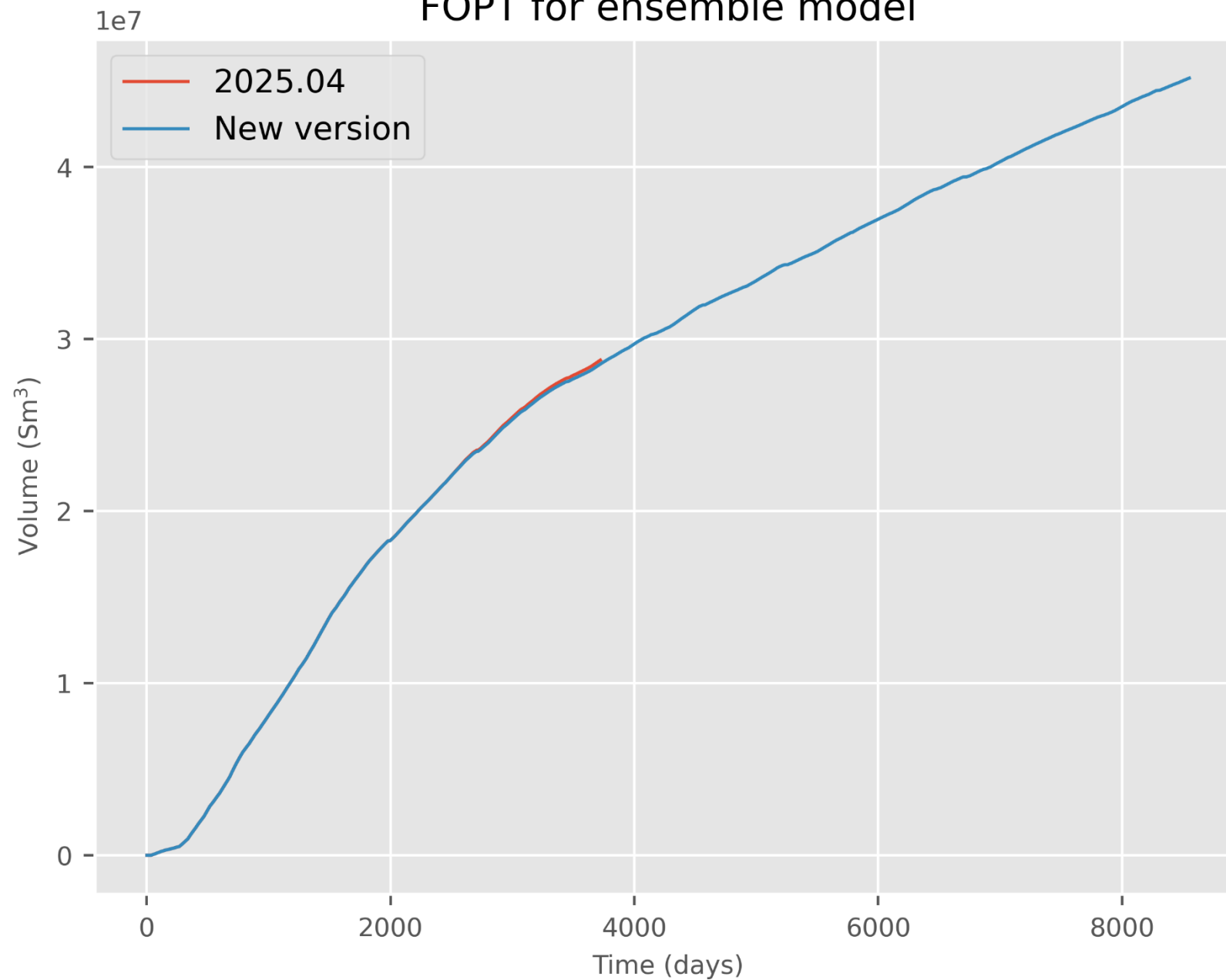
Linear iterations: 101 041

FOPT for NORNE_ATW2013_4C_STDW



Proprietary model from ensemble

FOPT for ensemble model



Controller approach to adaptive time
stepping

Estimate of error

Target error

Previous time steps

~~Estimate of error~~

Relative change

~~Target error~~

Target relative change

Previous time steps

~~Estimate of error~~

Relative change

$\hat{r}_n, \hat{r}_{n-1}, \hat{r}_{n-2}, \dots$

~~Target error~~

Target relative change

Previous time steps

~~Estimate of error~~

Relative change

~~Target error~~

Target relative change

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Previous time steps

~~Estimate of error~~

Relative change

~~Target error~~

Target relative change

Previous time steps

$h_n, h_{n-1}, h_{n-2}, \dots$

$$h_{n+1} = h_n \left(\frac{\varepsilon}{\hat{r}_n} \right)^{\beta_1} \left(\frac{\varepsilon}{\hat{r}_{n-1}} \right)^{\beta_2} \left(\frac{\varepsilon}{\hat{r}_{n-2}} \right)^{\beta_3} \left(\frac{h_n}{h_{n-1}} \right)^{-\alpha_2} \left(\frac{h_{n-1}}{h_{n-2}} \right)^{-\alpha_3}$$

Using the new time stepping in Flow

