Introduction
Due to the nature of the governing equations, viscoelastic flow simulations require special numerical solution algorithms. Several stabilizing techniques have been proposed to overcome the loss of stability observed with increasing Weissenberg numbers. However, for time dependent flows, the important question remains: What are the temporal stability properties of the different mixed FEM under investigation?

Problem Definition
To assess the stability of a computational method, the inertia-less planar Couette flow (figure 1) of a Maxwell fluid is considered. The slowest decay rate of a spatially periodic disturbance $\epsilon = \tilde{\epsilon} \exp(\sigma t)$ for this mathematically stable problem is [1]:

$$\text{real}(\sigma) \approx -\frac{1}{2\text{We}} \quad \text{for} \quad \text{We} \gg 1$$

Direct time integration of the finite element equations evaluated about the steady base flow provides an indication of the temporal stability properties of a computational method.

Results & Discussion
Figure 3 and 4 show the regular $L_2$ norm of a superimposed disturbance integrated in time. It is clear that:

- DG unstable
- DEVSS/DG unstable
- DAVSS-G/SUPG stable provided that $A = E$

One major drawback of the DEVSS-G/SUPG method involves the additional cost for solving the large system of equations. An attractive and stable alternative is the $\Theta$-scheme which sequentially solves smaller subsets of equations.

References: