Real-time multi-core PDE-solvers in LabVIEW

Shawn McCaslin
Michael Cerna, Michael Chen, Bin Wang, Lothar Wenzel, Nanxiong Zhang

National Instruments
Austin, TX

Shawn.McCaslin@ni.com

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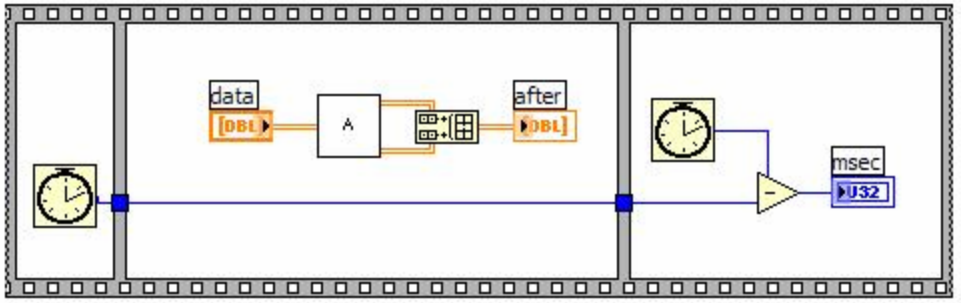
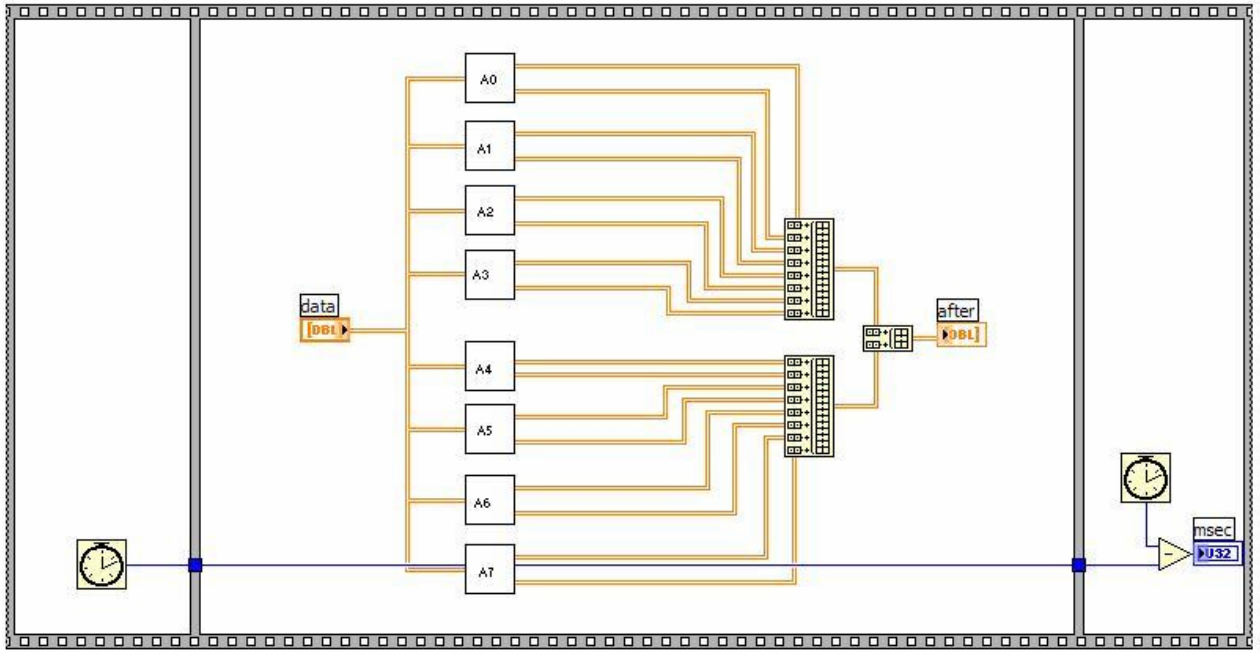
From 1 core…

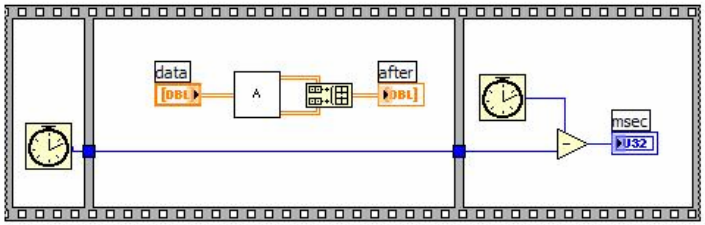


To 8 cores:

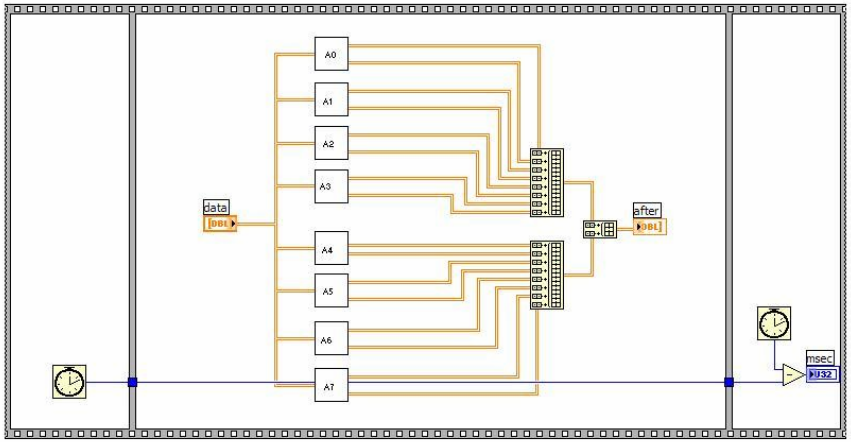


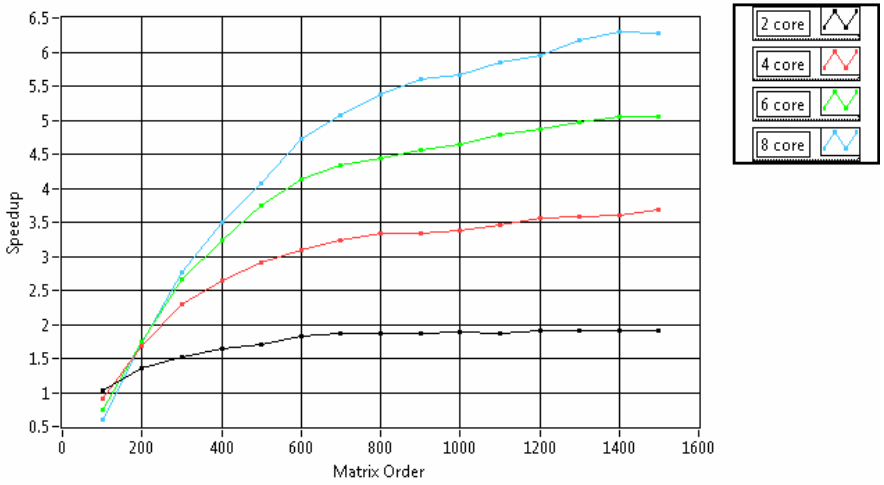
Natural Parallelization – Matrix Multiply

From 1 core…

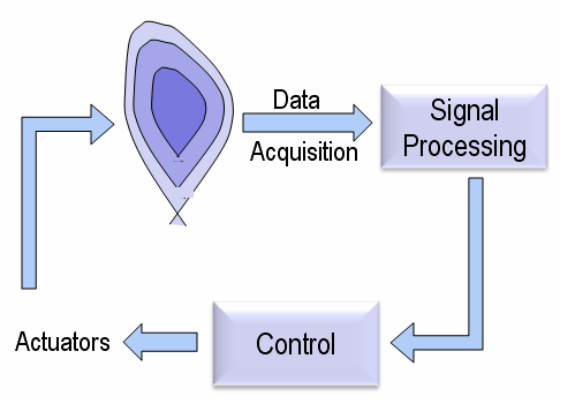


… to 8 cores



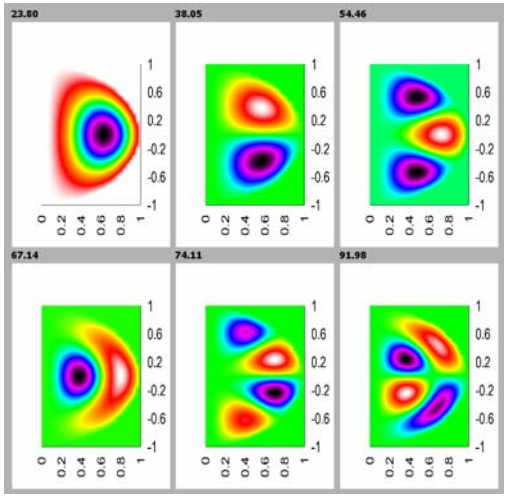


Grad-Shafranov PDE for Real-Time Use

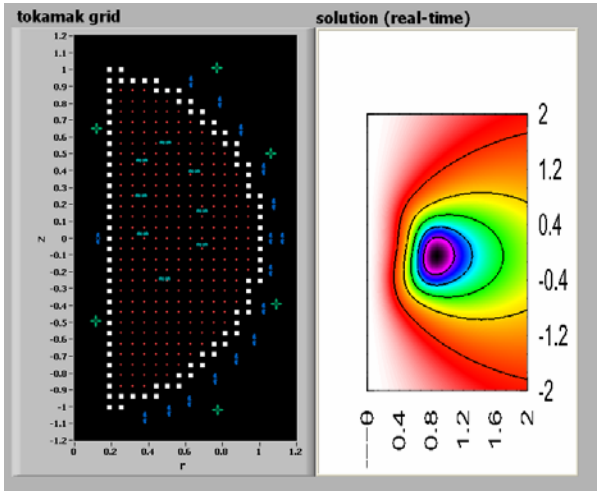


$$R\frac{\partial}{\partial R}\left(\frac{1}{R}\frac{\partial \psi}{\partial R}\right)+\left(\frac{\partial^2 \psi}{\partial Z^2}\right)=-\mu_o R j_\vartheta$$

Some eigenfunctions



Real-time solution



$$\omega(a,b)=\iint_N da'db'\left[\left\{\sum_{i=1}^{I}\frac{1}{B_i}\Phi_i(a,b)\Phi_i(a',b')\right\}\sum_{j=1}^{J}c_j\varphi_j(a',b')\right]$$

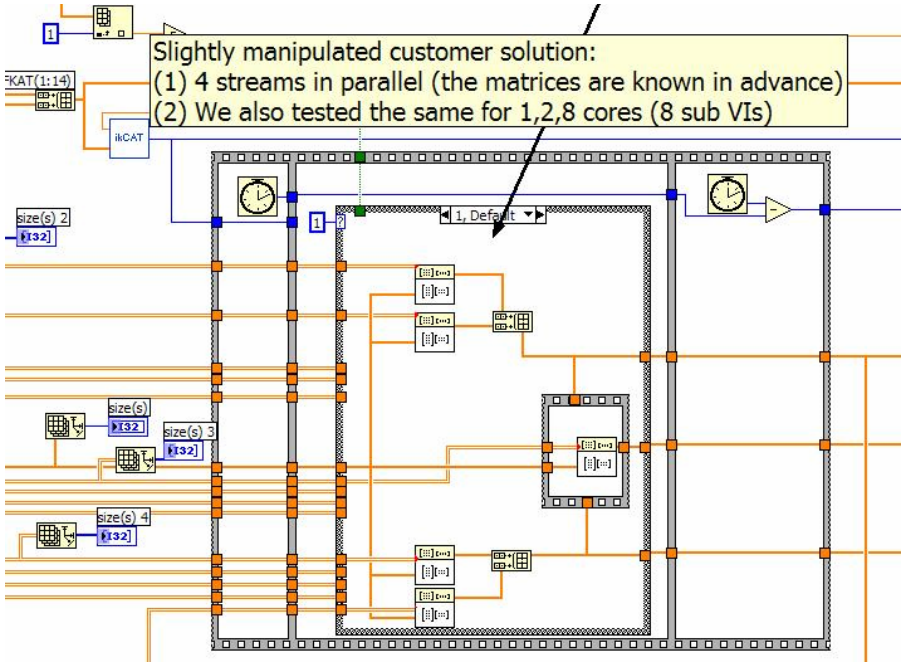
$$=\sum_{j=1}^{J}c_j\left\{\sum_{i=1}^{I}\left[\iint_{\Omega(D)}da'db'\Phi_i(a',b')\varphi_j(a',b')\right]\frac{1}{B_i}\Phi_i(a,b)\right\}$$

$$=\sum_{j=1}^{J}c_j\left\{\sum_{i=1}^{I}\frac{\alpha_{i,j}}{B_i}\Phi_i(a,b)\right\}$$

Replacement For Grad-Shafranov For Real-Time Use

- 2691-by-159 matrix operations

cores	time [ms]
1	4.2
2	2.3
4	1.2
8	0.6



What if multi-core isn't good enough?