

**GPU Solutions for PSCAD: IT17112**

Reporting Period	June 11, 2020 - June 18, 2020
Activities	<ul style="list-style-type: none"> <li>• Ran a final check on self-consistency between two compilers of <i>Province</i> data set. See figure 1 for details. Observed that the relative differences between values of <math>\mathbf{x}</math> over all time steps is small on average, but does contain some significant variation, while <math>\mathbf{b}</math> demonstrated a much greater degree of variation.</li> <li>• Compiled and ran QRFactor on both NVIDIA <b>Tesla P100</b> and NVIDIA <b>V100 PCIe</b>. See table 1 for a summary of hardware characteristics.</li> <li>• <b>Best performance:</b> While the V100 card took approximately 9 ms to perform the one-time factoring of the full system matrix <math>A</math>, it provided an average solving time of 0.5 ms per time step. With this timing, the <i>Province</i> data set could be solved for a million time steps in only 8.3 minutes. See figure 2 for a comparison of timings for various hardware.</li> </ul>
Issues	<ul style="list-style-type: none"> <li>• None</li> </ul>
Milestones Accomplished	<ul style="list-style-type: none"> <li>• Ran QRFactor on Telsa P100 and V100 PCIe cards, and collected new timing data.</li> <li>• Significant per-time step speedup achieved on V100 hardware; average per-time step solve time <math>0.5ms</math>.</li> </ul>
Milestones Not Accomplished	<ul style="list-style-type: none"> <li>• None</li> </ul>
Next Week's Milestones	<ul style="list-style-type: none"> <li>• Examine GPU utilization and investigate stream overlapping.</li> </ul>
Forwarded Issues	<ul style="list-style-type: none"> <li>• None</li> </ul>

NVIDIA GPU	Compute Version	CUDA Cores	Double-Precision Performance
<b>Quadro RTX 3000</b>	7.5	2304	198.7 GFLOPs
<b>Tesla P100</b>	6.0	3584	4.7 TFLOPs
<b>V100 PCIe</b>	7.0	5120	7.8 TFLOPs

Table 1: Short summary of hardware specifications for the three types of GPUs used. Links are to the respective hardware datasheets.

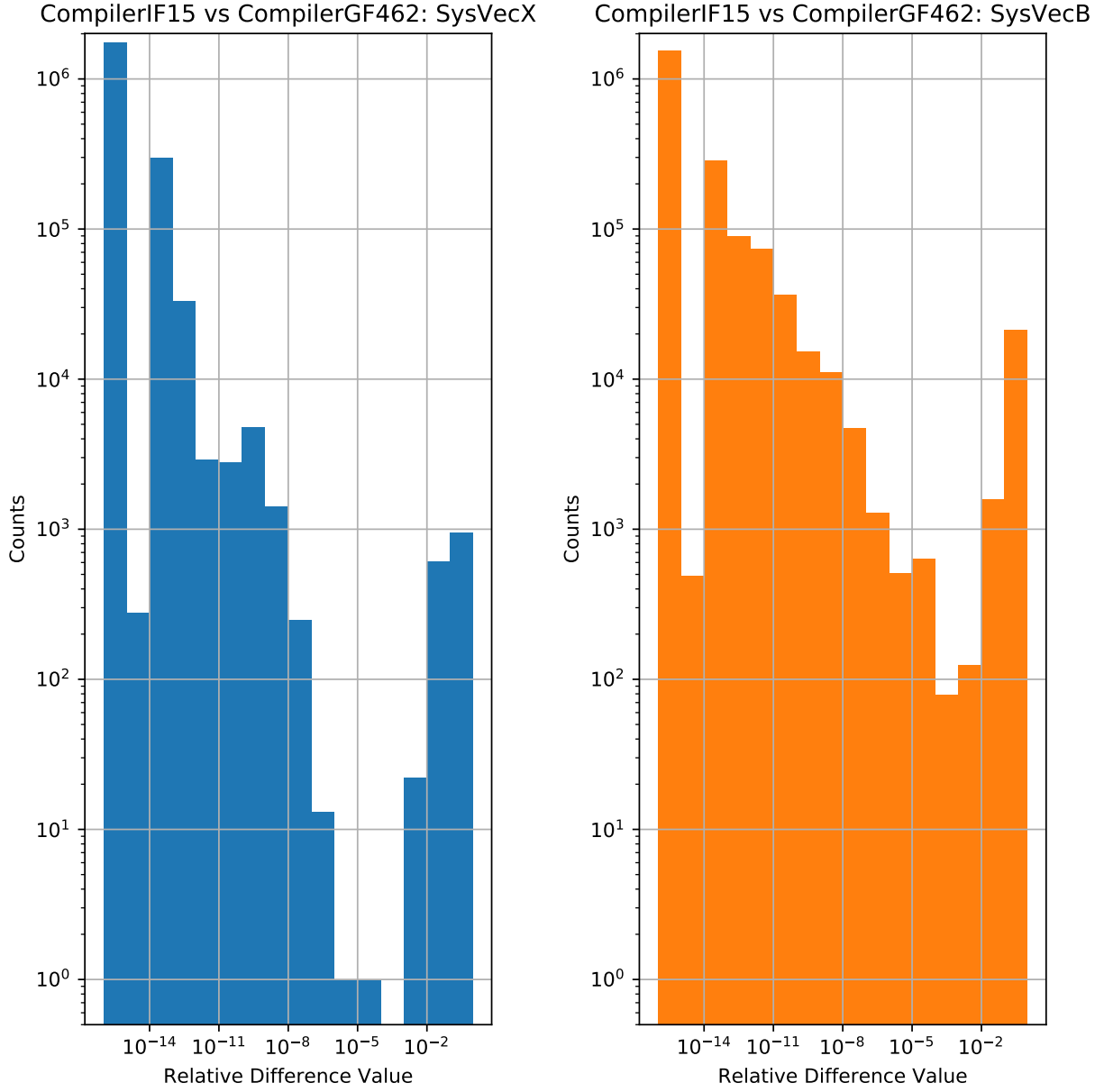


Figure 1: *Left* The relative difference between the full system output vectors  $\mathbf{X}$  in CompilerIF15 and CompilerGF462, over all time steps. *Right* The same comparison, but applied to full system input vectors  $\mathbf{B}$ .

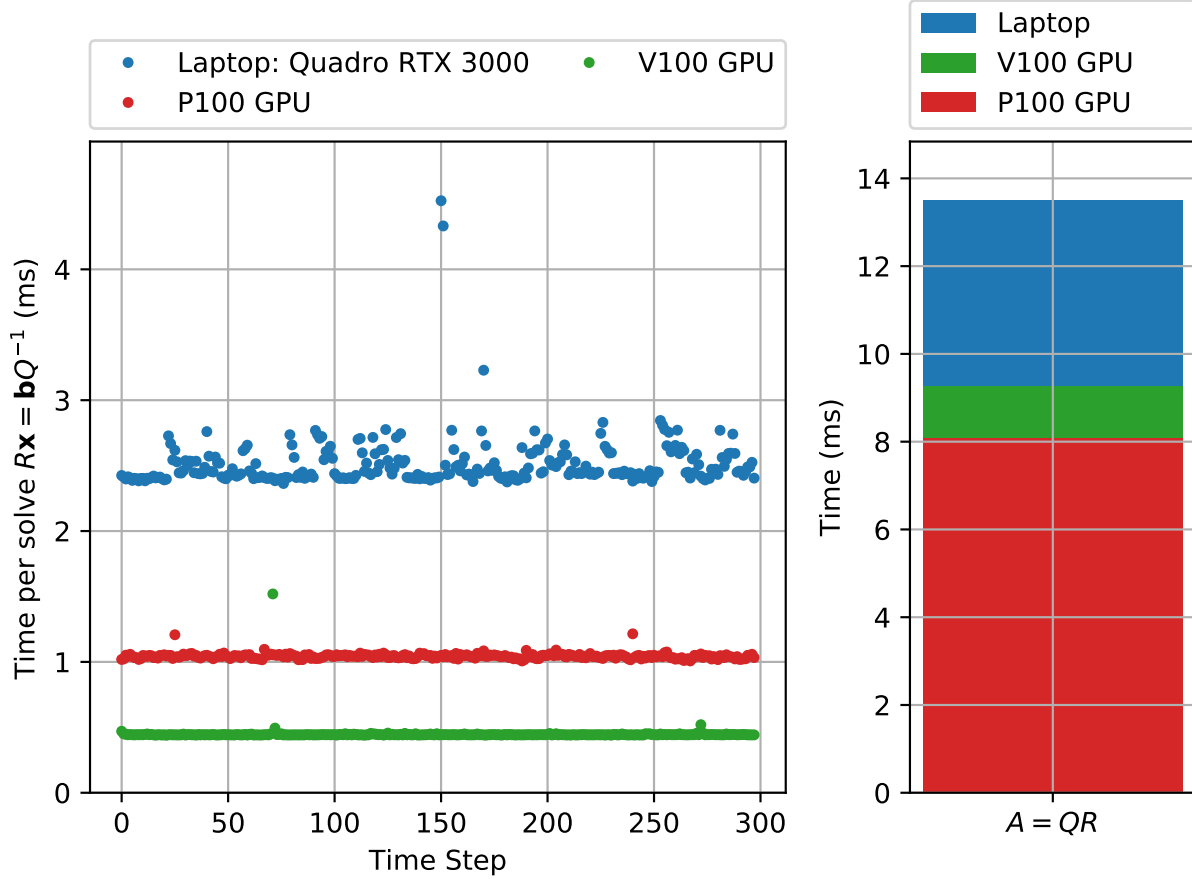


Figure 2: *Left* Time in milliseconds to solve the pre-factored system  $R\mathbf{x} = \mathbf{b}Q^{-1}$  at each time step for the three hardware choices. *Right* Time in milliseconds to perform the factoring of the full system matrix  $A$  into  $QR$  for each of the hardware choices. Note that while the V100 takes slightly longer to perform the one-time factoring of the matrix, it outperforms the other hardware choices after the factoring is done.