Improving Vector Performance using the Vector Advisor Tool

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DL_MESO_LBE

- **Lattice Boltzmann code: Models fluids at mesoscale.**
- **Hybrid MPI/OpenMP running natively on Phi.**
- **Using Intel compiler 16.0.042 (beta).**
- **fGetEquilibriumF identified as hotspot**
- **Vector Advisor used to guide our optimizations**
- **Baseline characteristics**
  - Double precision
  - Array of Structures (AoS) data storage.
  - No data alignment (prevented by data structure).
  - Low trip count loop (19).
  - Trip count is not a multiple of vector lengths.
  - Both Peel and remainder loops present.

Performance - fGetEquilibriumF

- **V-Advisor recommendations**
  - MAP analysis points to AoS -> SoA.
  - Remove Scalar remainders.
  - Align data accesses.

- **SoA and padding improved vectorization. More about this on data layout section of the workshop.**
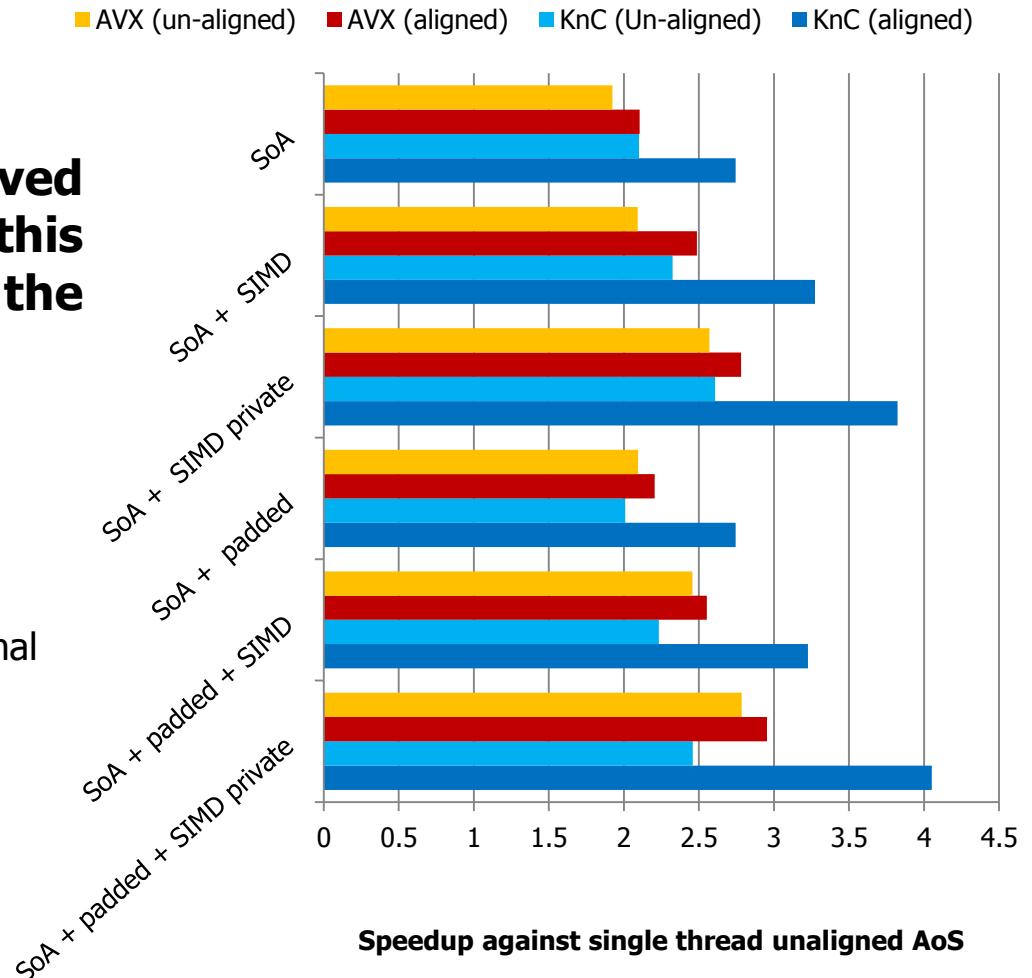
- **Vectorization**
  - #pragma SIMD outperformed auto-vectorization
  - Private SIMD clause allowed additional compiler optimizations.

- **Phi speed up x4.05**
- **Xeon speed up x2.95**

fGetEquilibrium optimizations (single threaded)

Legend: AVX (un-aligned), AVX (aligned), KnC (Un-aligned), KnC (aligned)

Categories: SoA, SoA + SIMD, SoA + SIMD private, SoA + padded, SoA + padded + SIMD, SoA + padded + SIMD private

Speedup against single thread unaligned AoS

Insights

- **#pragma SIMD private() achieved our best results, but analysis only done in one hotspot (~15%)**

- **Vector Advisor was a useful tool to guide our optimizations.**
  - Highlights the problems, easy to read
  - Static Memory Analysis
  - Give recommendations

- **Vector Advisor tool for MIC architecture desirable.**

- **Future Work**
  - Investigate effects of vectorization at differing "levels" of the LBE calculation.
  - Currently at bottom level loops.
  - Could vectorize the calculation over lattice points however.