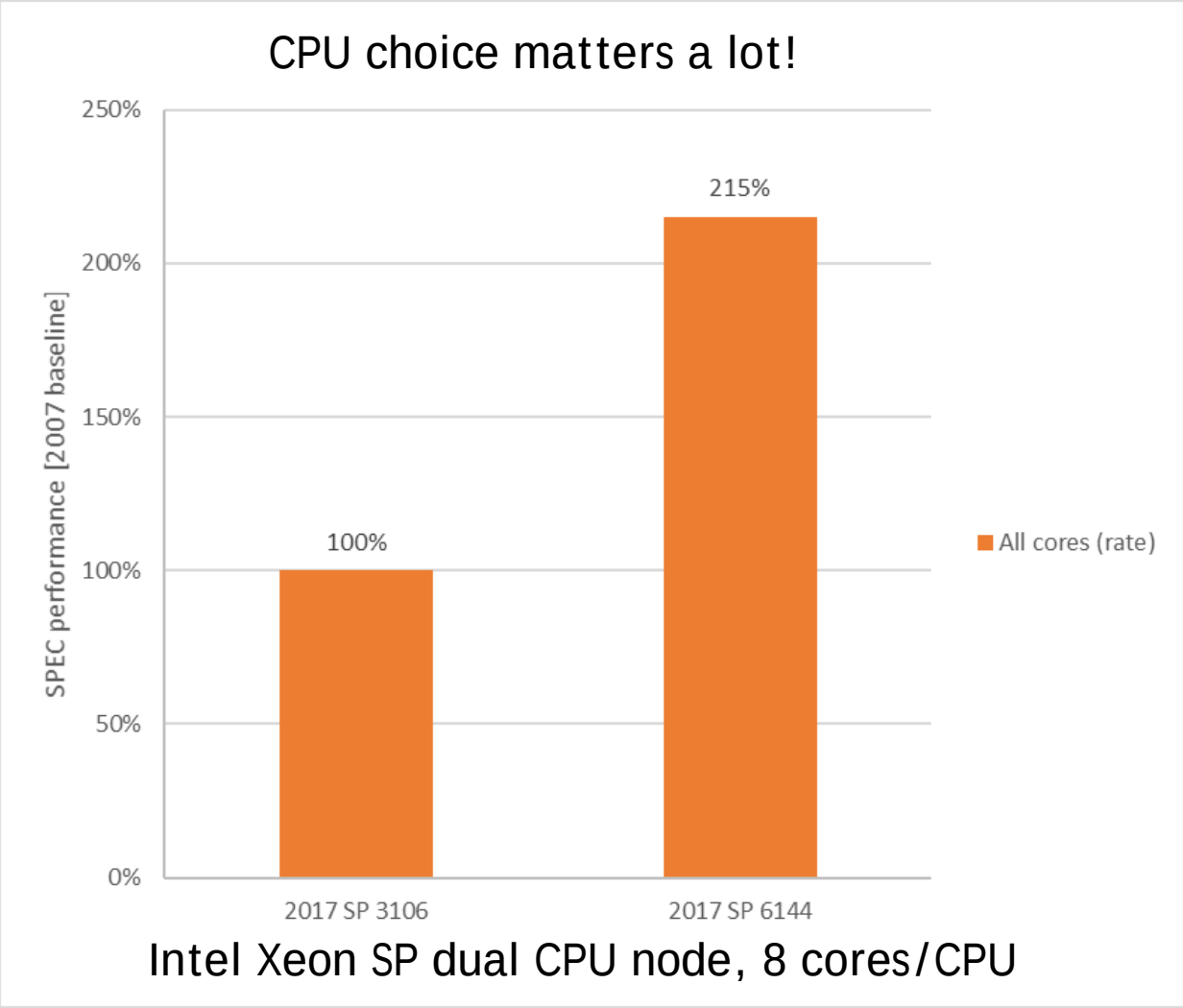
HPC – LSTC Winsuite – Defense Applications

Daniel Hilding, DYNAmore Nordic AB

HPC – Some trends

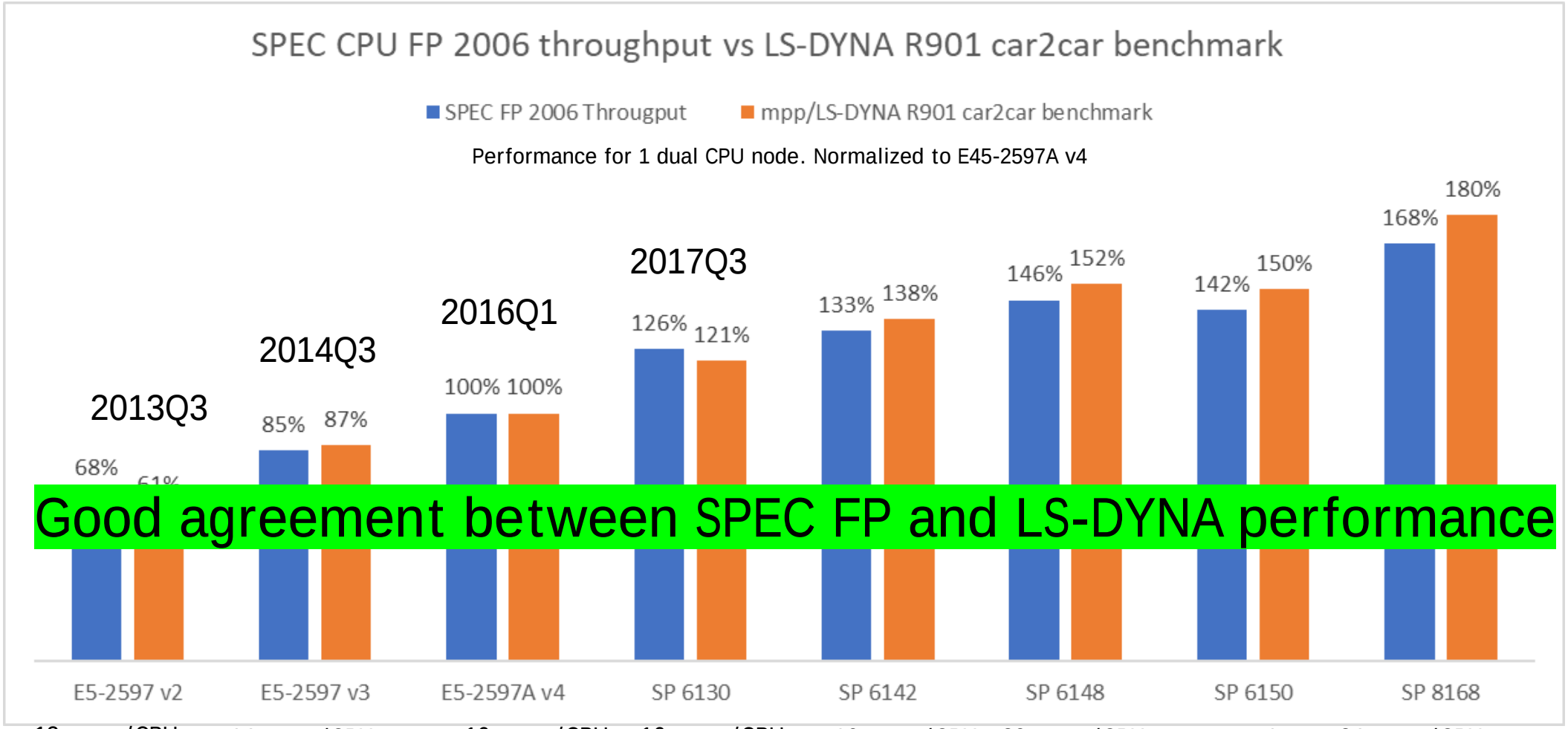
Daniel Hilding

Hardware matters



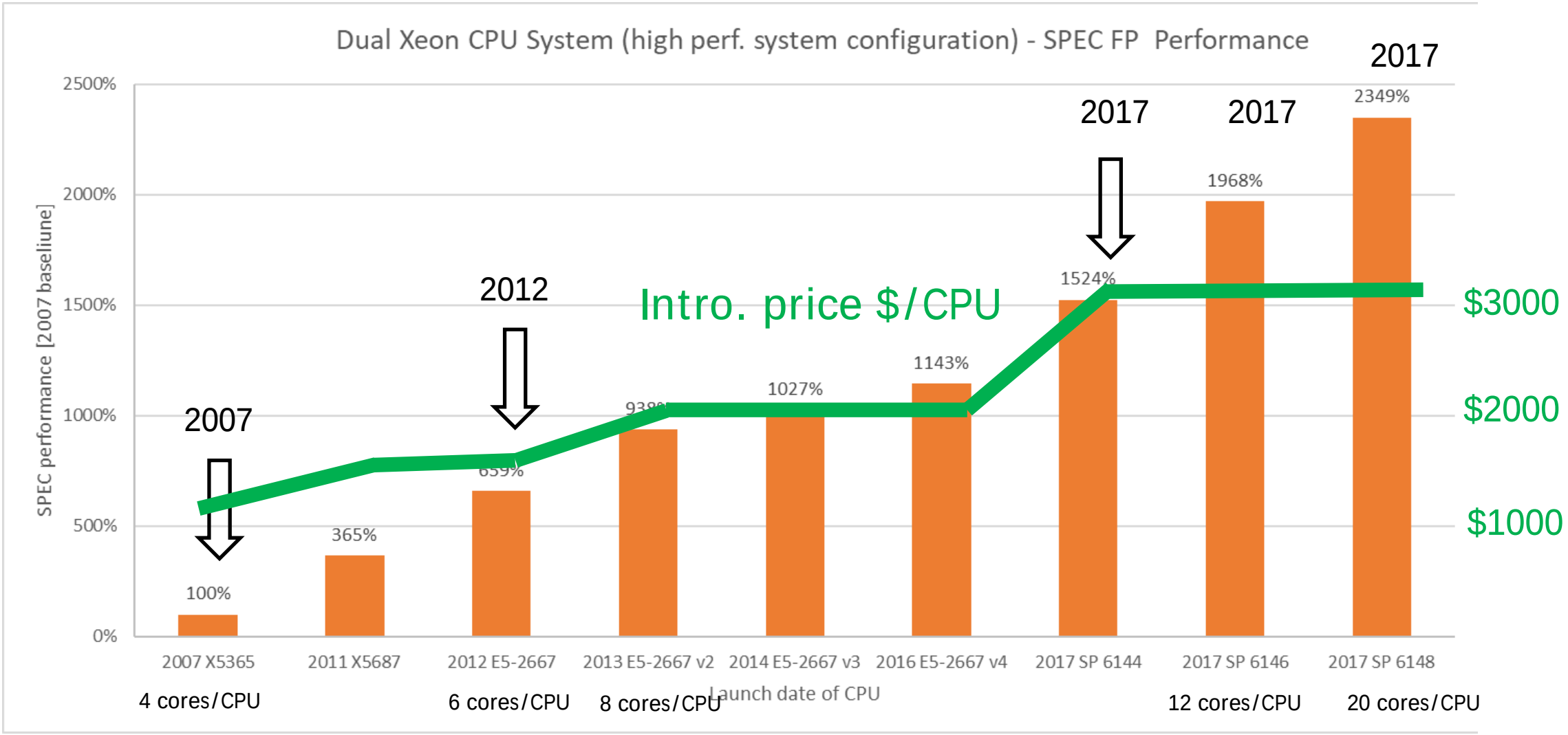
- How to reduce performance
  - Low performance CPU
  - Low performance memory
  - Poor memory set up
    - e.g. not using all memory channels
  - Bad set up of the MPI-environment
    - e.g. Pinning, Communication flags
  - Bad BIOS settings
    - e.g. use of HyperThreading
  - Bad OS-settings
    - e.g. use of aggressive power saving
  - Non-optimal LS-DYNA binary
    - AVX2 version probably gives significant on Intel CPUs released 2016 an later.

Comparison of SPEC FP CPU Throughput vs LS-DYNA explicit benchmark



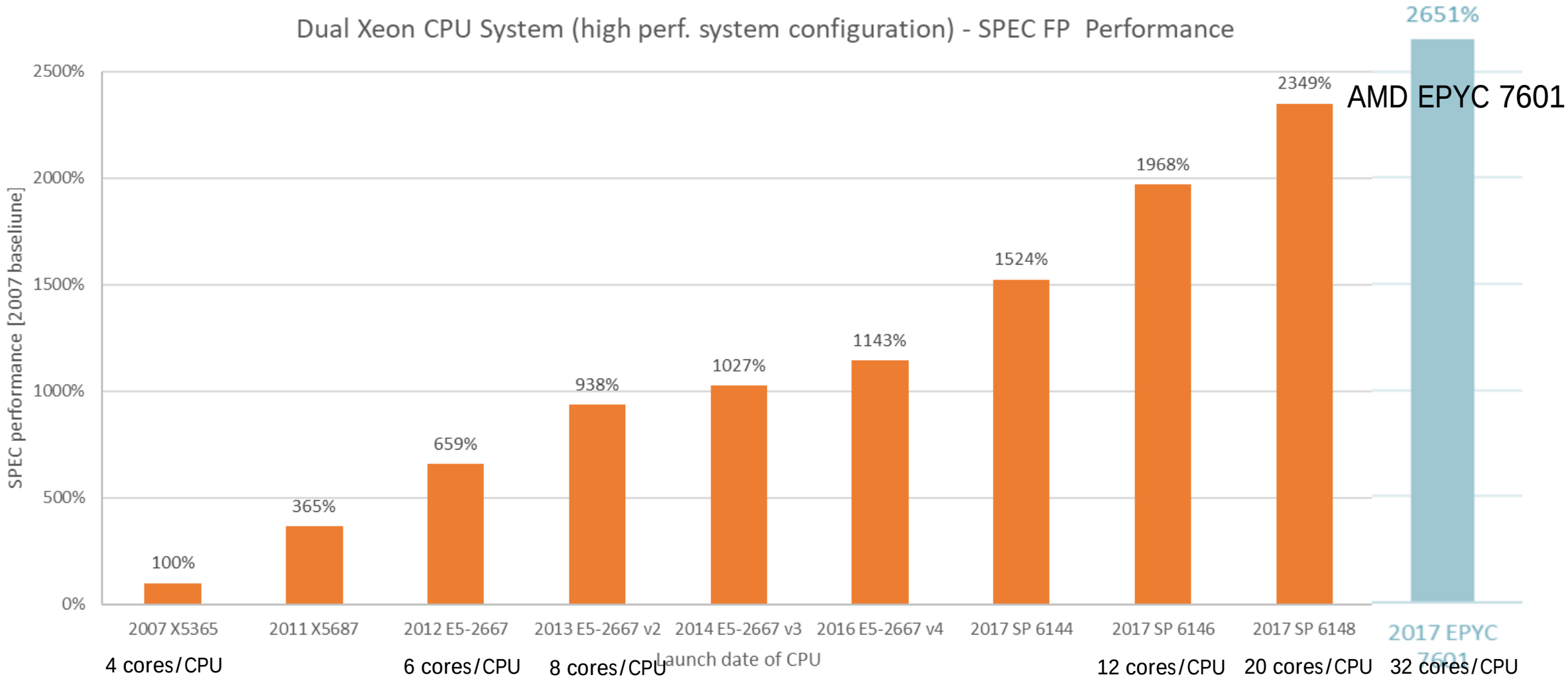
Source spec.org: SPEC CPU 2006 Floating Point Benchmark, Base optimization
Source:"14G with Skylake – how much better for HPC?", Dell EMC HPC Innovation Lab, September 2017

HPC performance of Intel Xeon - 10 years of SPEC benchmarks



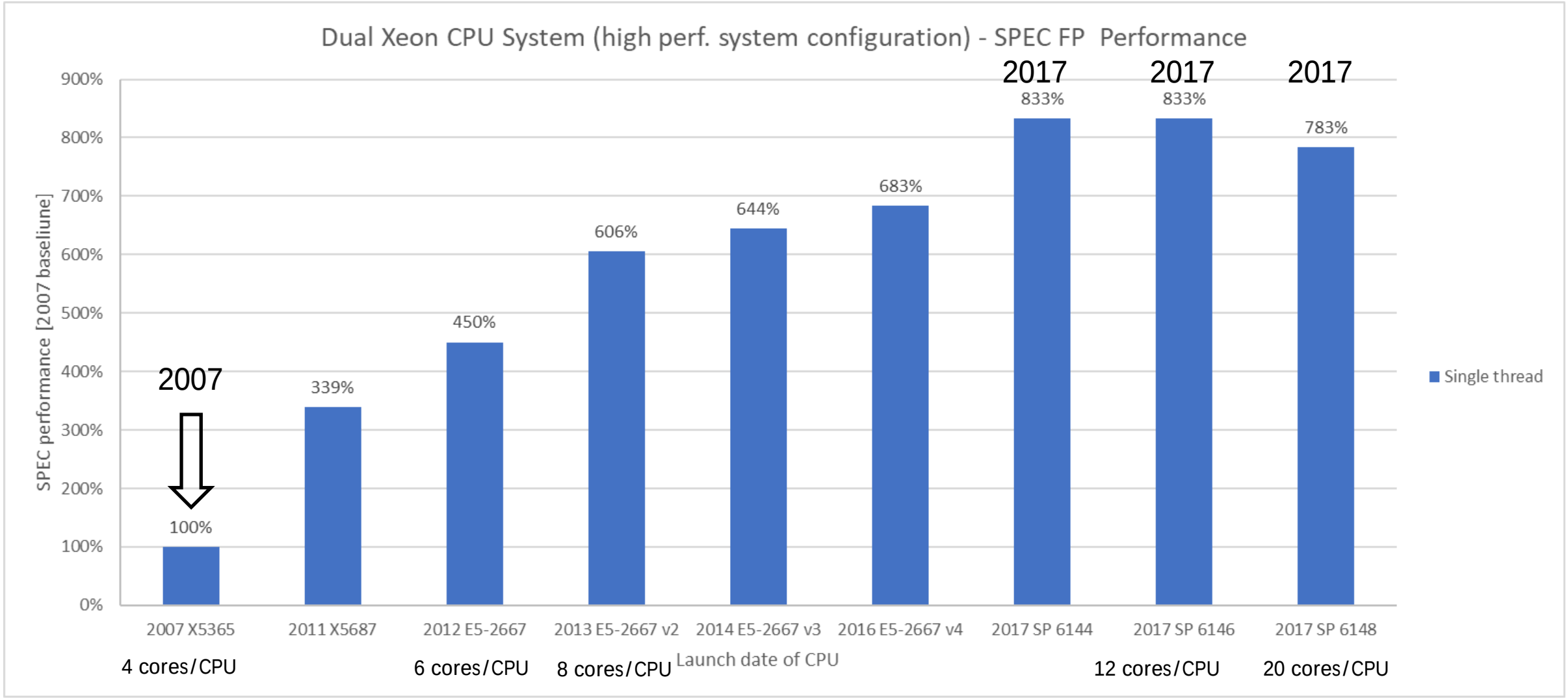
Source spec.org: SPEC CPU 2006 Floating Point Benchmark, Base optimization
Source introduction price: Intel product specifications, ark.intel.com

HPC performance – AMD EPYC 7601



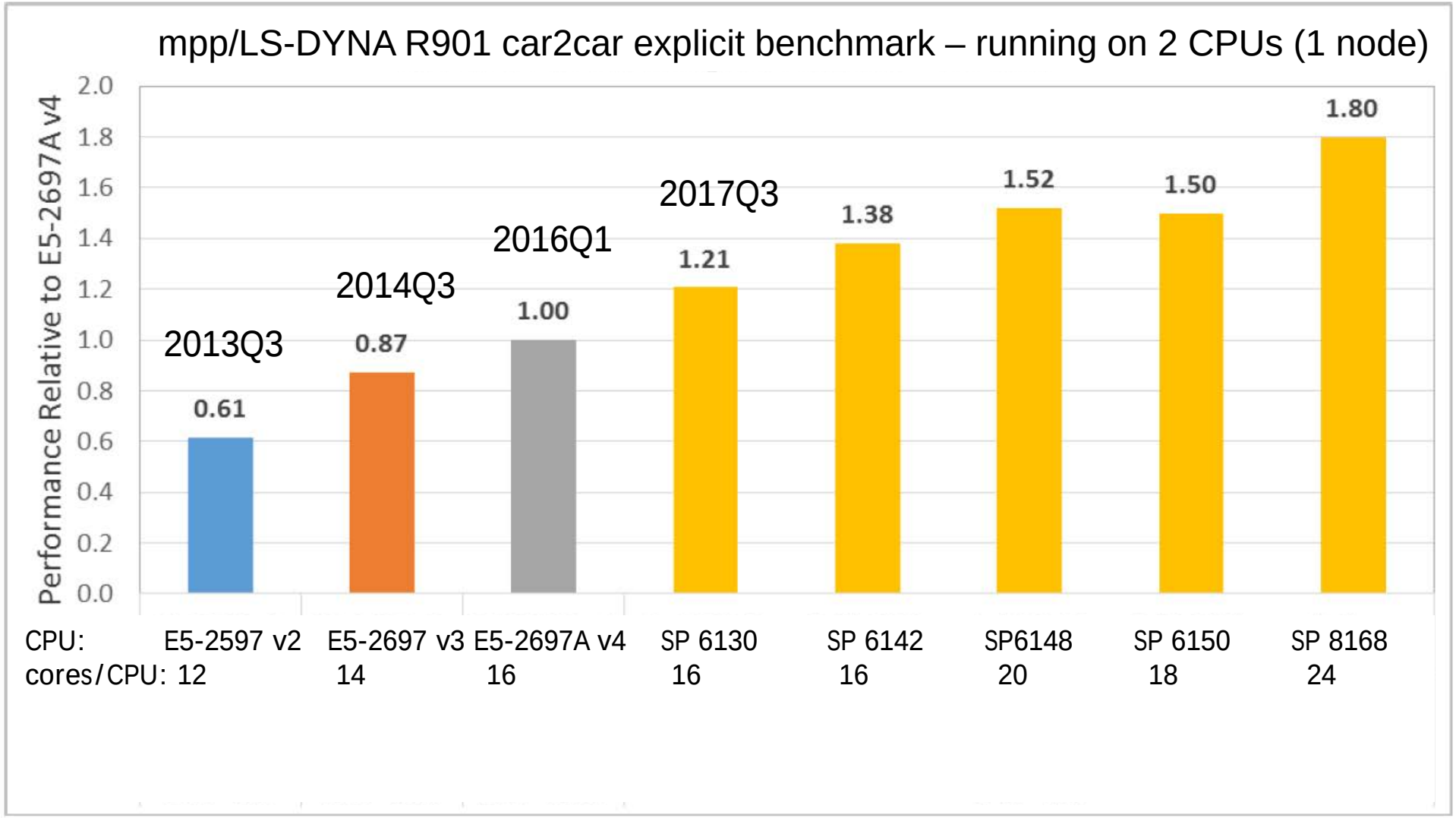
Source spec.org: SPEC CPU 2006 Floating Point Benchmark, Base optimization

HPC performance of Intel Xeon - 10 years of SPEC benchmarks – Single core performance



Source spec.org: SPEC CPU 2006 Floating Point Benchmark, Base optimization

Performance 2013-2017, including 2017Q3 Intel Xeon Scalable Processors (SP)



Source:"14G with Skylake – how much better for HPC?", Dell EMC HPC Innovation Lab, September 2017

Offerings from Intel and AMD – Specified for high performance explicit

- 40 core workstation under 99 kSEK
  - Example: Supermicro 7049A-T, 2xIntel Xeon SP 6148 , 128 GB RAM, Nvidia K600, 2TB HDD, Windows 10
- 64 core workstation under 125 kSEK
  - Example: Supermicro 4023S-TRT, 2xAMD EPYC 7601, 128 GB RAM, Nvidia K600, 2TB HDD, Windows 10
    - Note: Author is has not seen any LS-DYNA benchmarks for the AMD EPYC 7601.

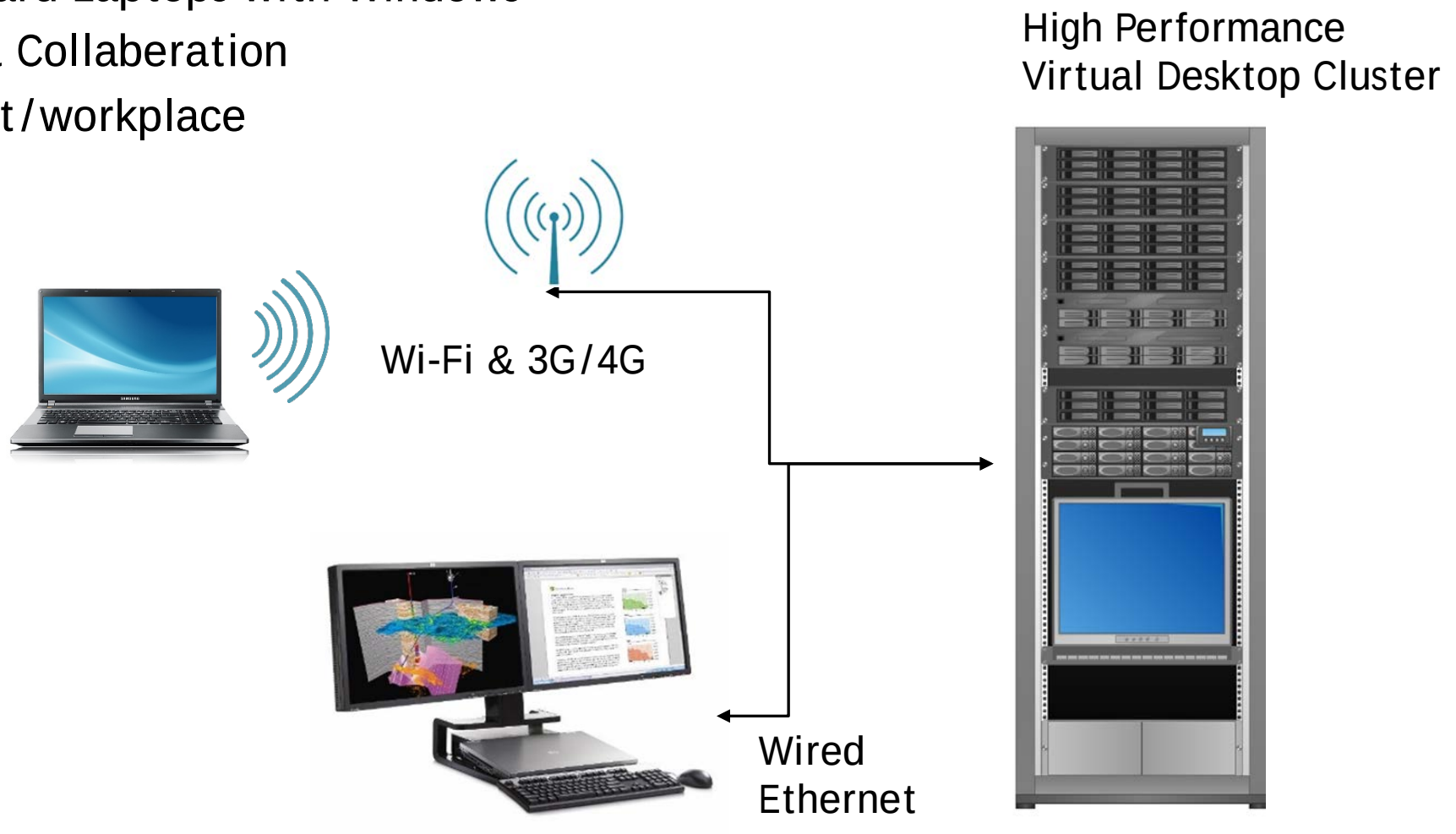
- Conclusions
  - More cores/$
  - Workstations can run large models efficiently

Offerings– Specified for high performance implicit

- 1.0 TB RAM Workstation with 40 cores ~ 225 kSEK
  - Example: Supermicro 7049A-T, 2xIntel Xeon SP 6148, 1 TB RAM
- Allows non-linear implicit incore simulations possibly up to 70 - 100MDOF depending on the type of structure on a single server.
  - Assuming 10-15 GByte/MDOF as a rule of thumb for sparse direct solvers.

Remote Desktop solutions the CAE-workplace

- Use standard Laptops with Windows
- Mobility & Collaberation
- Lower cost/workplace



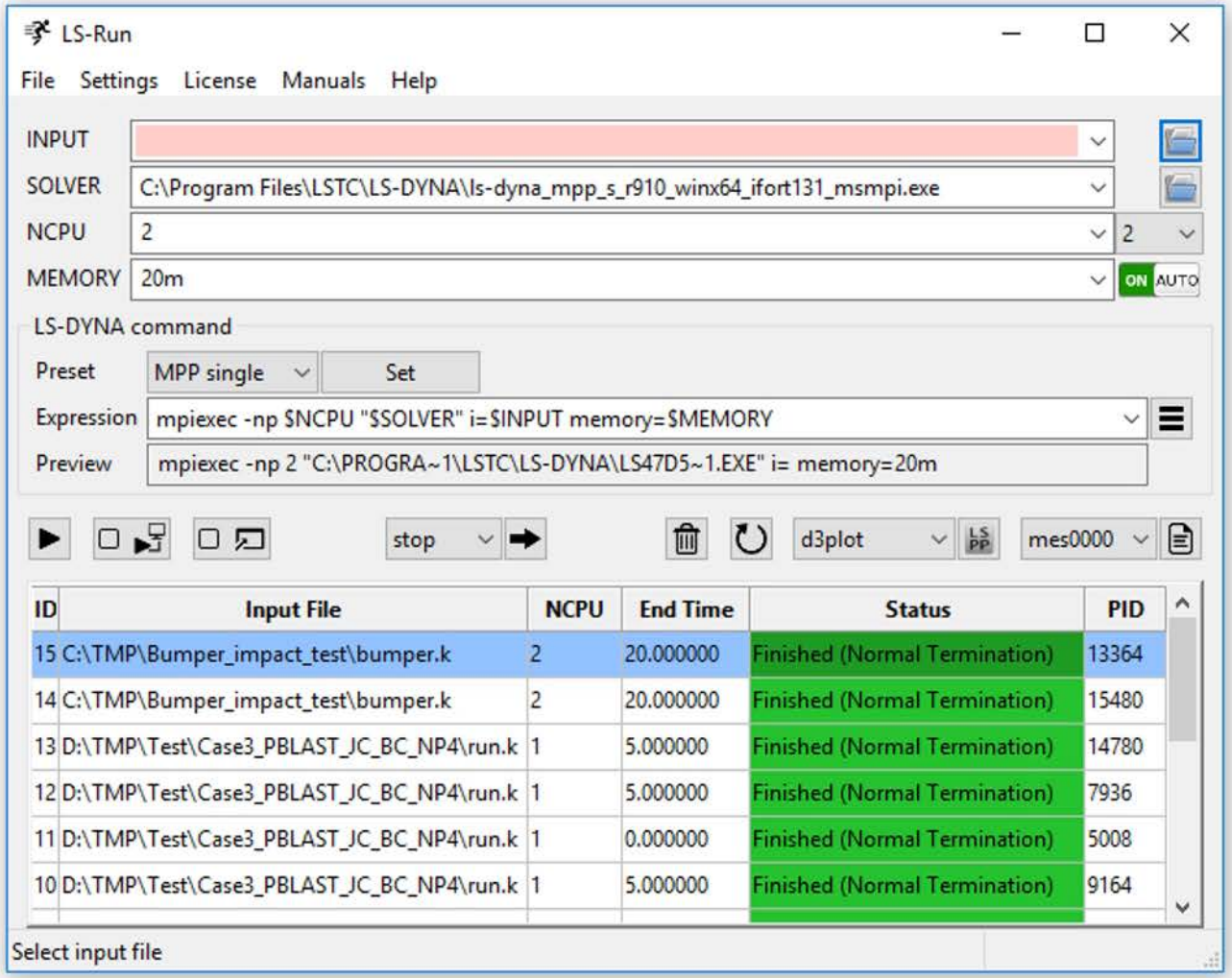
Summary

- To get good performance, it is crucial to
  - Get the right hardware (CPU & Memory)
  - Have a proper setup of the MPI-system, BIOS, OS, and queuing system.
- New 2017 Q3 Intel Xeon SP provides up to 40-50% higher performance than Xeon E5 v4 from 2016 Q1 for LS-DYNA explicit.
- Remote desktop solutions are getting more popular for good reasons.
- Cost efficient workstations are now available with many cores and a lot of memory for small CAE-workgroups.
- **If you have questions on these matters (HPC, Hardware) you are welcome to contact DYNAmore!**

LSTC Winsuite

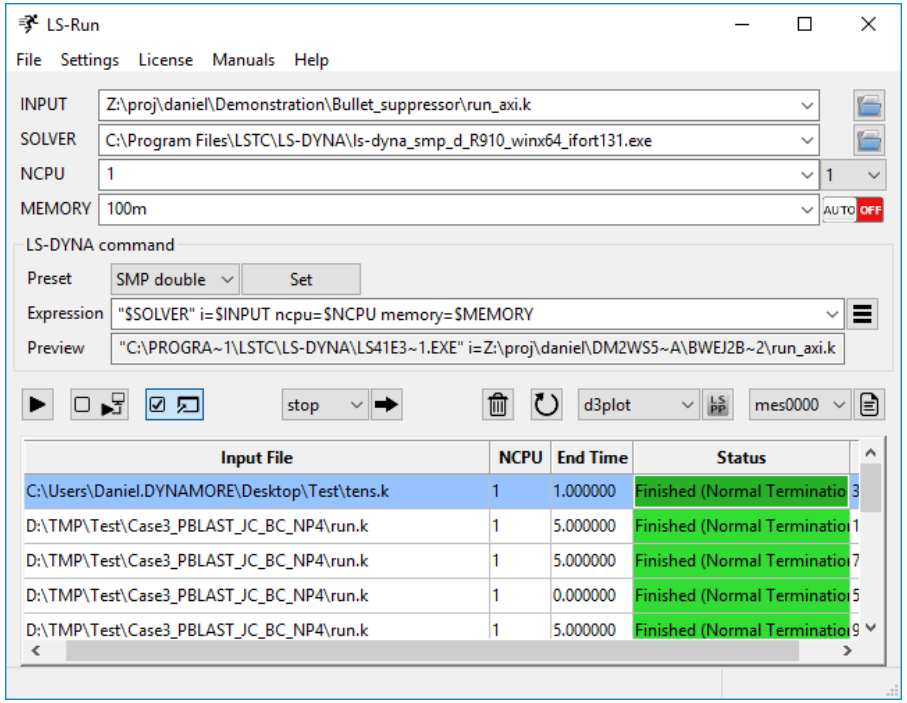
Anders Jernberg, Daniel Hilding

LSTC Winsuite R10 for Windows



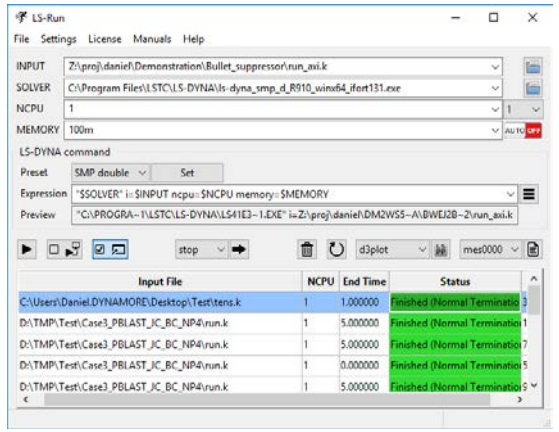
LSTC Winsuite R10 for Windows

- Complete easy automatic setup of complete LSTC software environment
  - mpp and smp/LS-DYNA
  - LS-PrePost
  - LS-OPT and LS-TaSC
- Features
  - LS-Run command center with queuing system
    - Queue jobs on local machine and remote Windows and Linux servers/clusters.
  - Manuals
  - Easy license management
  - Self study course for LS-DYNA
  - Demonstration models & Benchmarks
  - IT-administrators: Remote deployment



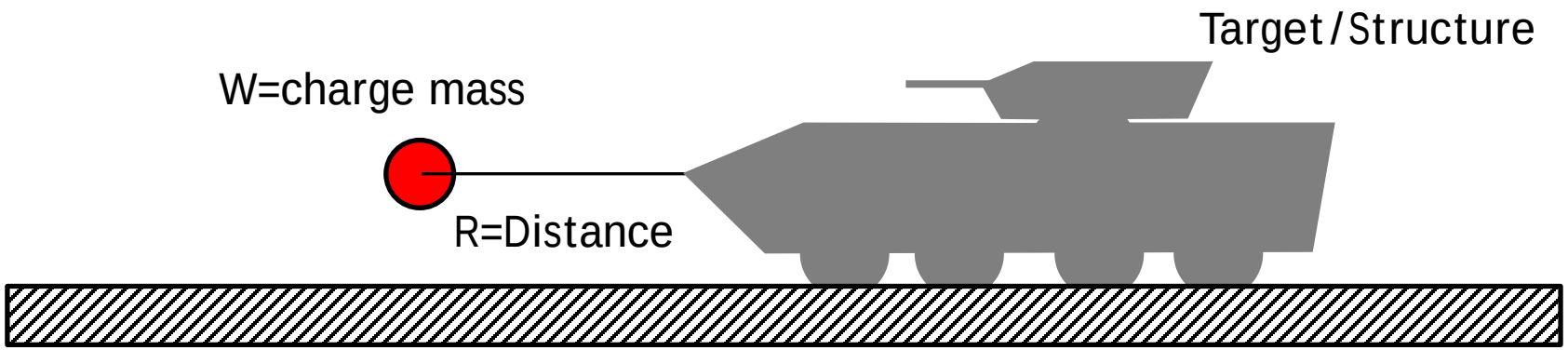
LSTC Winsuite – Future development

- Improved integration with Windows Server clusters
  - Graphical status overview of cluster use.
- Improved integration with Linux clusters
  - Target: “Allow integration with almost all queuing systems”
- Provide installation package also for Linux users?
  - Unclear user demand/benefits.
- Continuous improvements based on user feedback



Defense applications

Daniel Hilding



LS-DYNA for defense - Applications

- Homeland security – blast loads on buildings & infrastructure
- Mine and IED (Improvised Explosive Device) blasts on vehicles personnel including loads on personnel (dummy models).
- Penetration mechanics
- Warhead performance, fragmentation
- Explosively formed projectiles and shaped charges
- Munitions/Guns/barrels, dynamics and stresses
- Submarine and surface vessel loads from underwater shocks using the USA Code (requires special license) or empirical methods.

Defense application characteristics

- Short duration large deformation events
- Supersonic / compressible CFD
- Explosives and shock wave propagation
- Materials subject to extreme loading and failure

Solver technology

Material mechanics

Material models for high strain rate and extreme loading

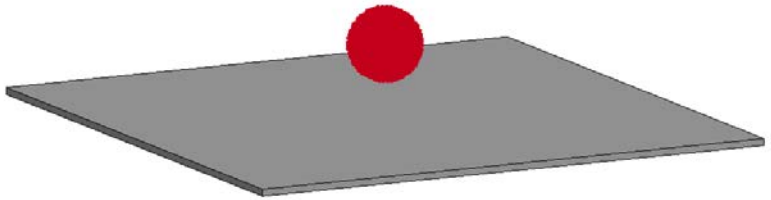
- Metals, e.g. Johnson-Cook type of model
- Concrete, e.g. RHT, Winfrith
- Ceramics, e.g. Johnson-Holmquist model
- Fibre Reinforced Polymers, e.g. Continuum Damage Model (Mat 161/162)
- Gas models, e.g. ideal gas, real gas
- Explosives, e.g. Jones-Wilkins-Lee E.O.S.

Complete solution for defense applications

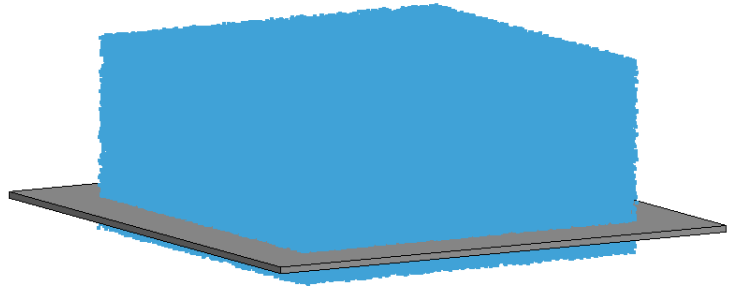
- Empirical load models – easy to use & very fast
  - US Army Conwep – Air blast model
  - US Army TACOM Mine blast model for vehicles
  - SSA - Underwater shock analysis model
- High performance continuum solvers for explosive simulation, penetration et c
  - MMALE & S-ALE, SPH, FEM remeshing
- New technology solvers
  - Particle Blast
  - Discrete element sphere - soil models
  - CE/SE compressible CFD solver

Comparison of methods – the Neuberger et al. experiment – 5 approaches

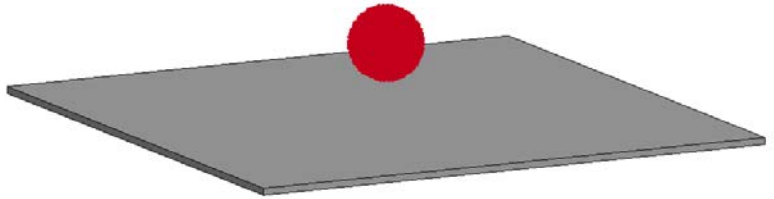
t=20 mm, R=200mm, W=8.75 kg TNT, Z=0.097 kg/m$^{1/3}$



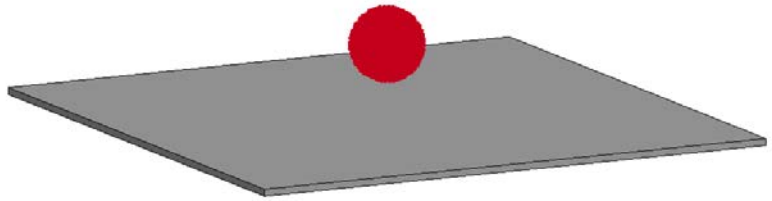
SPH



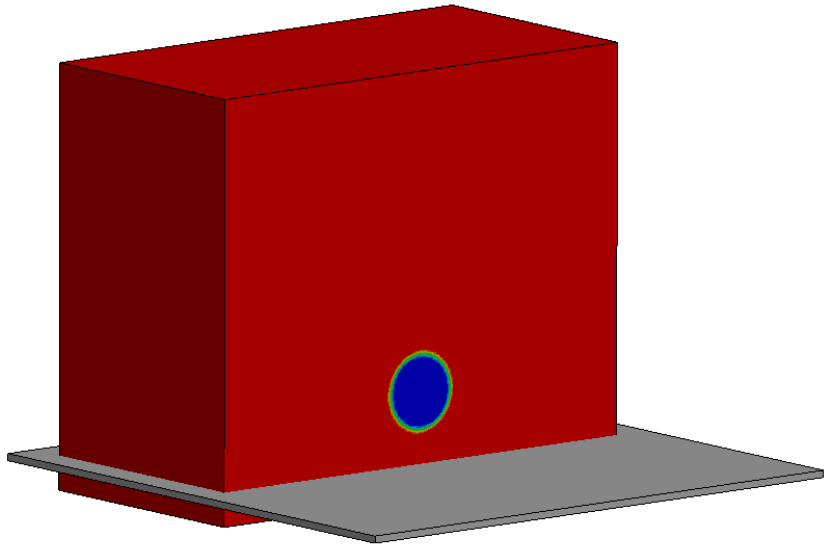
Particle blast, with air



Particle blast, no air

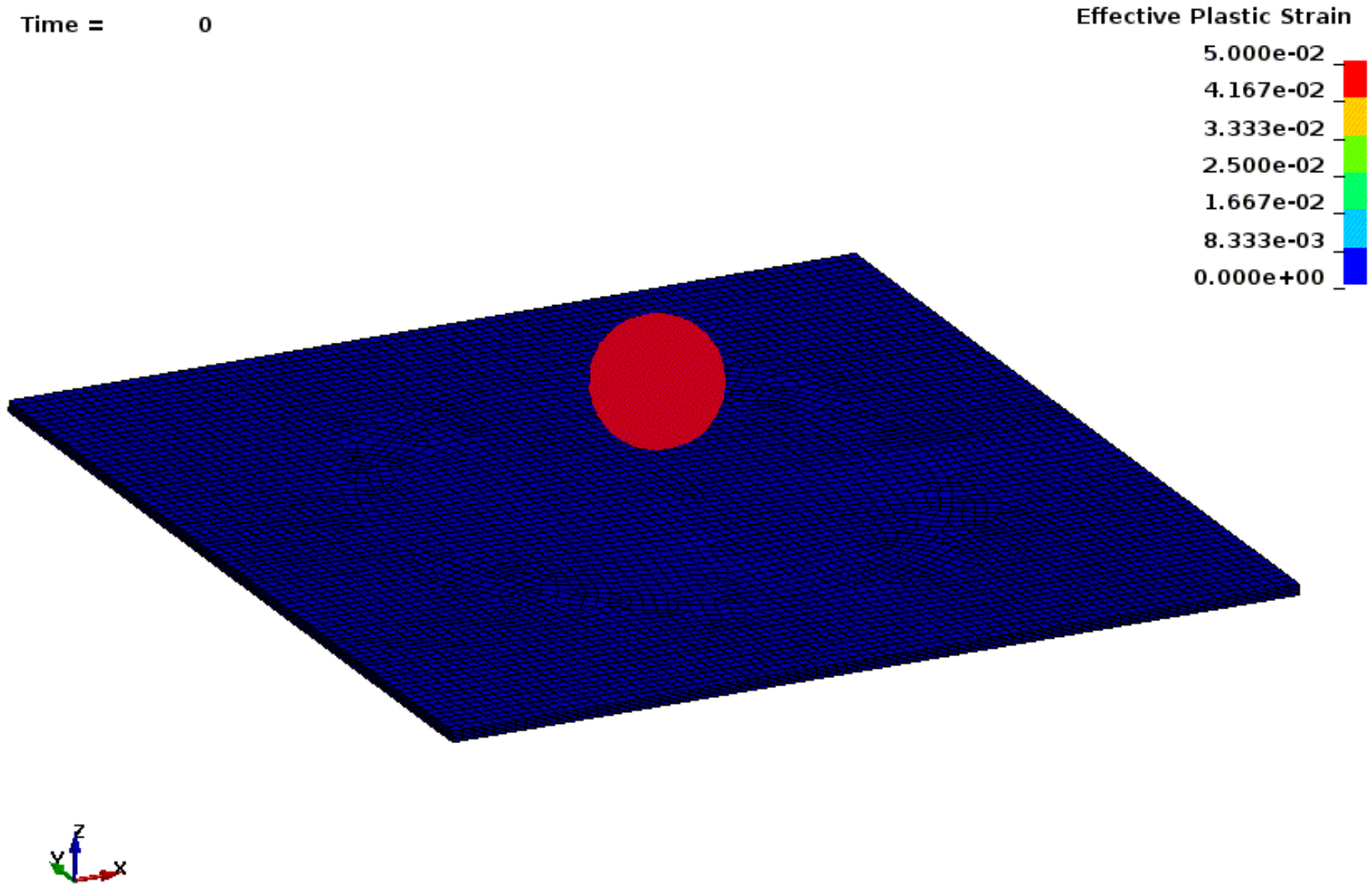


*LOAD_BLAST

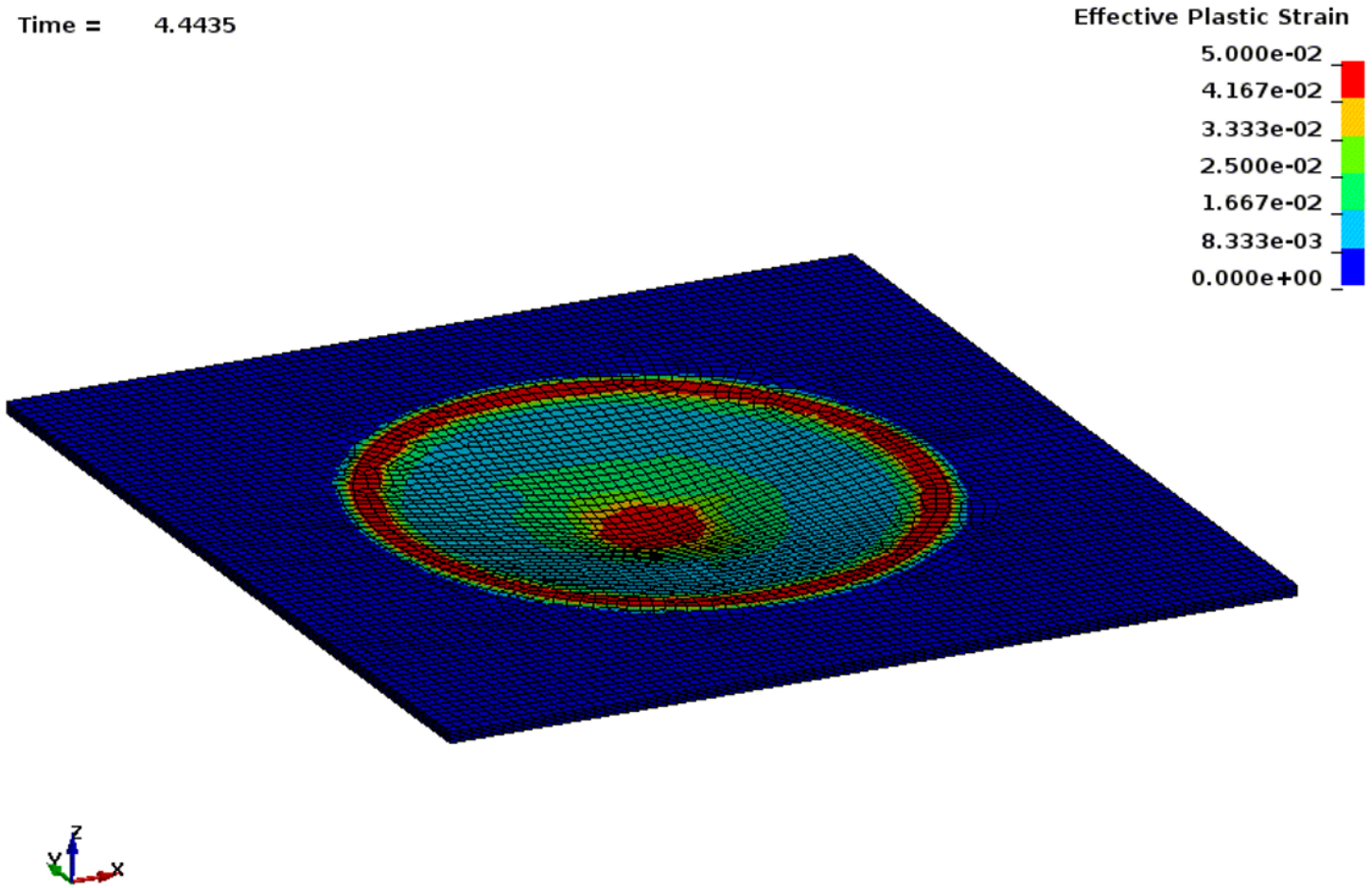


MMALE (S-ALE), with air, cross section.

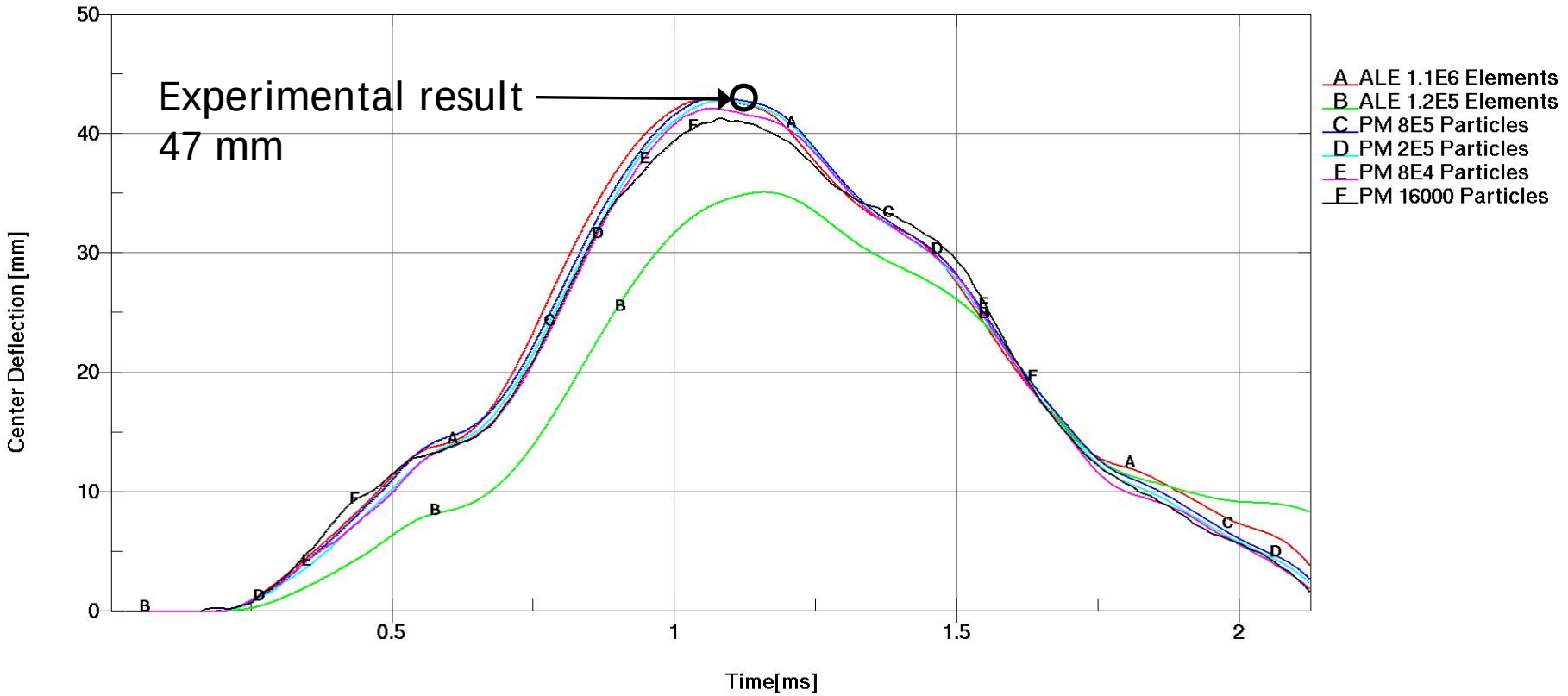
Comparison of methods – the Neuberger et al. experiment (*PARTICLE_BLAST)



Comparison of methods – the Neuberger et al. experiment (*PARTICLE_BLAST)



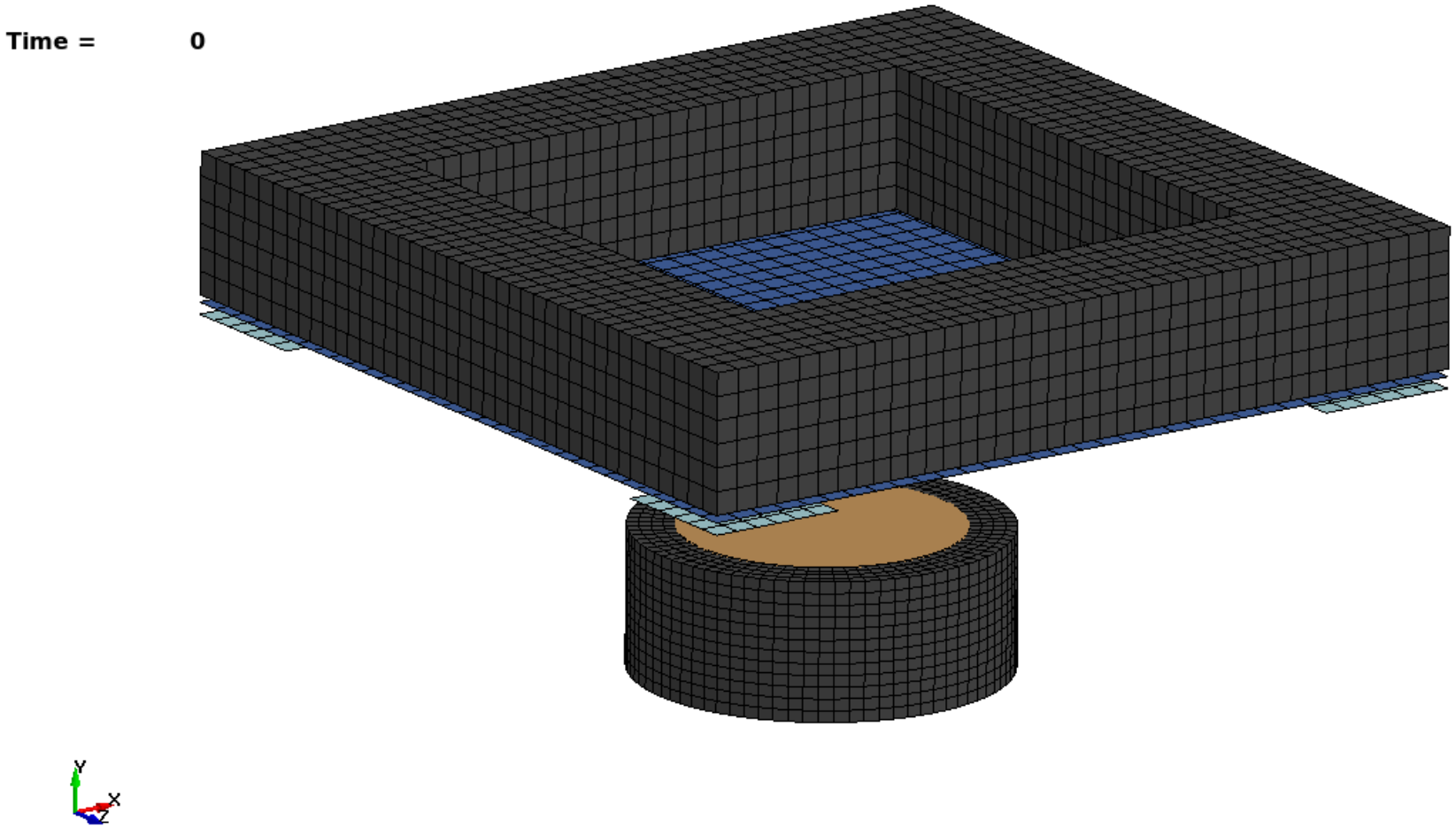
Simulation results - Convergence rate



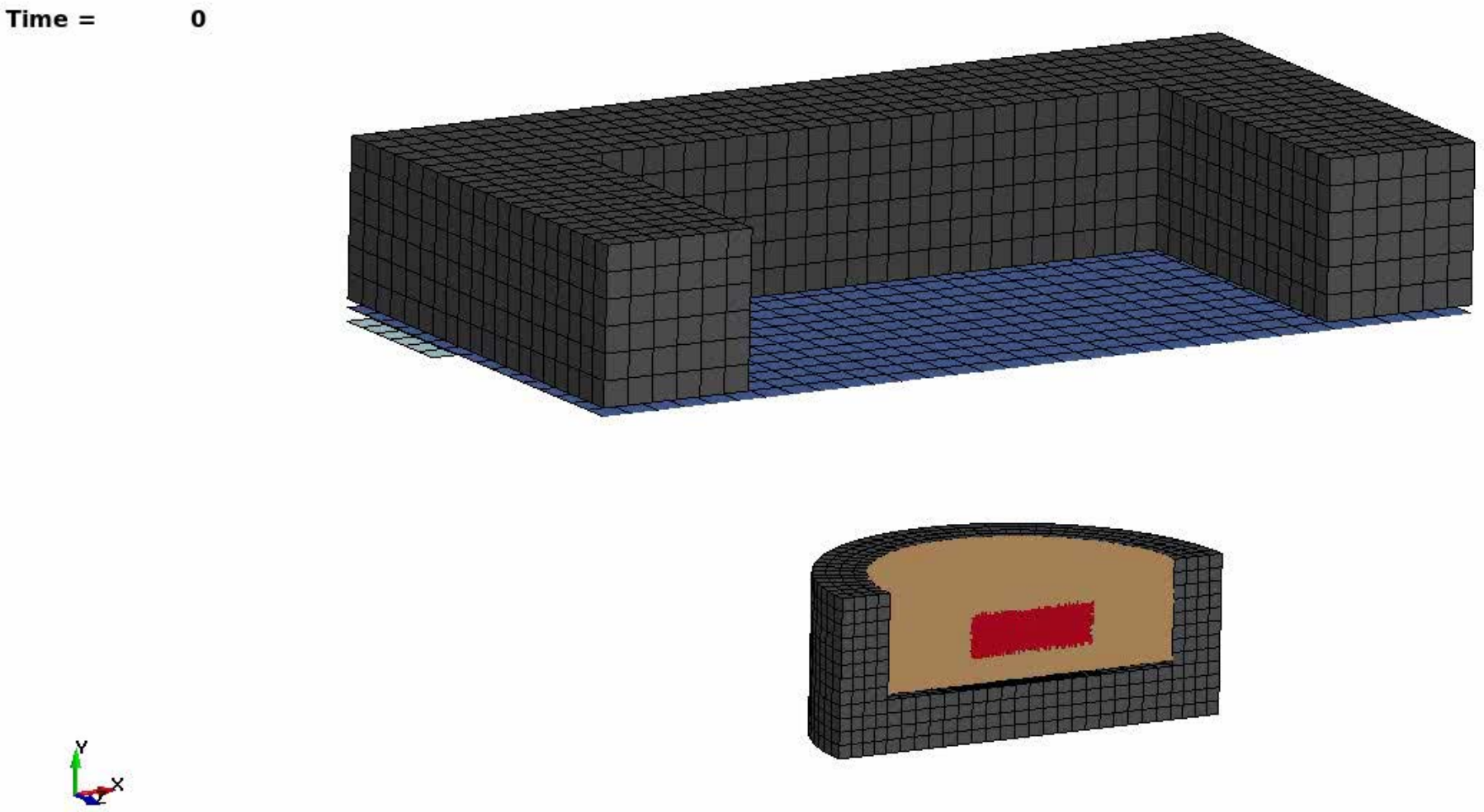
The peak deflection in the experiments has been estimated to 47mm (Neuberger et al. 2009)

Study by Hailong Teng, LSTC

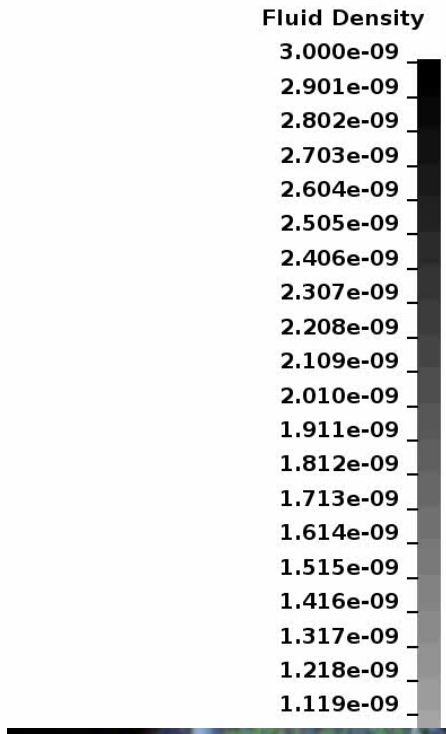
Particle Blast – Land mine simulations



Particle Blast – Land mine simulations



Simulation of bullet – NATO 5.56



Thank you!

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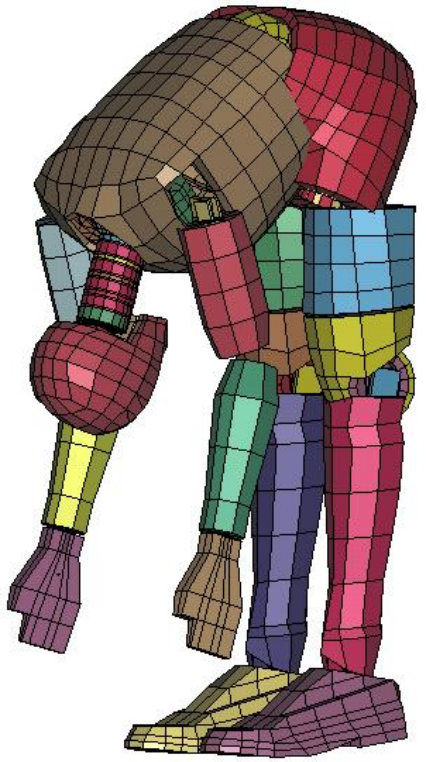

International LS-DYNA Conference

- 10-12th of June 2018, Detroit, Michigan, USA
- Abstract Submission Deadline: 15th November 2017
- Paper Submission Deadline: 14th February 2018
- More info: www.ls-dynaconferences.com.

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Nordic LS-DYNA User's Conference 2018

- October 2018, Gothenburg
- User presentations
- Training/Seminars

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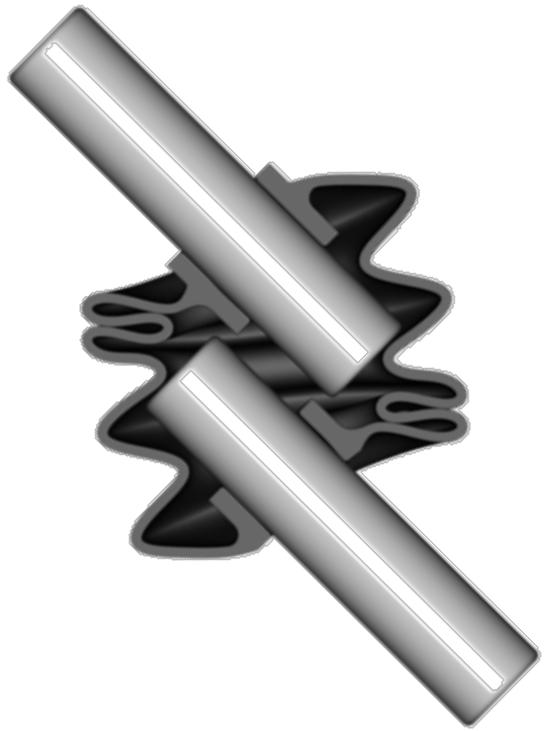

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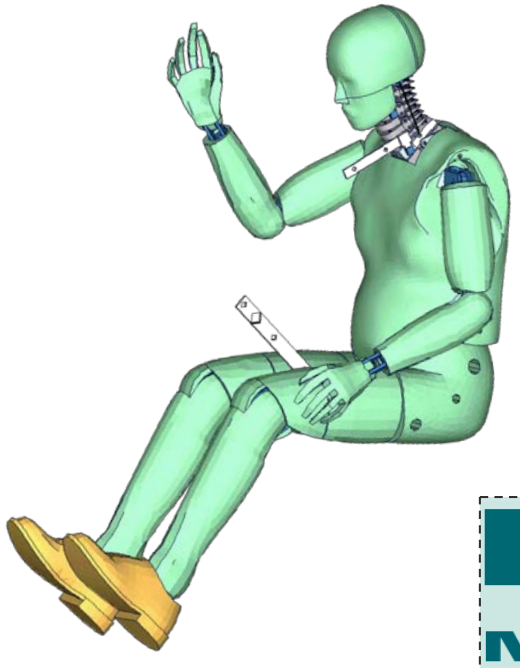

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