

# Scientific Data Management in Computational Electrodynamics



TECHNISCHE  
UNIVERSITÄT  
DARMSTADT

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Workshop zum Forschungsdatenmanagement  
in den Ingenieurwissenschaften

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# Overview

- Electromagnetic field simulation
- Data stream
- Data management for scientific computing (field simulation)

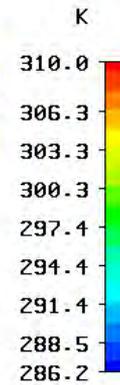
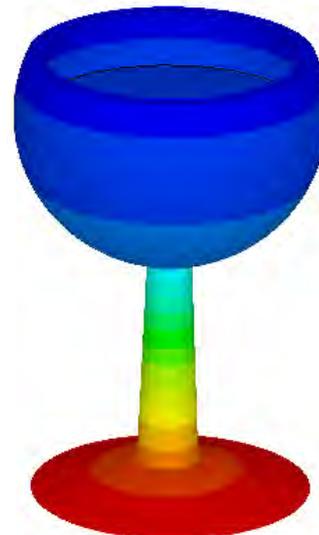
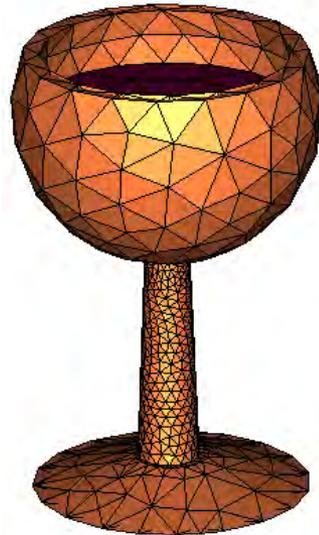
# Field Simulation

geometry

comput. mesh

field solution

post-processing  
results



```
% Column 0: Length, m  
% Column 1: Potential, Volt  
0.00000000e+000 9.98299967e  
1.67785235e-005 9.60682936e  
3.35570470e-005 9.33737611e-001  
5.03355705e-005 9.10240365e
```

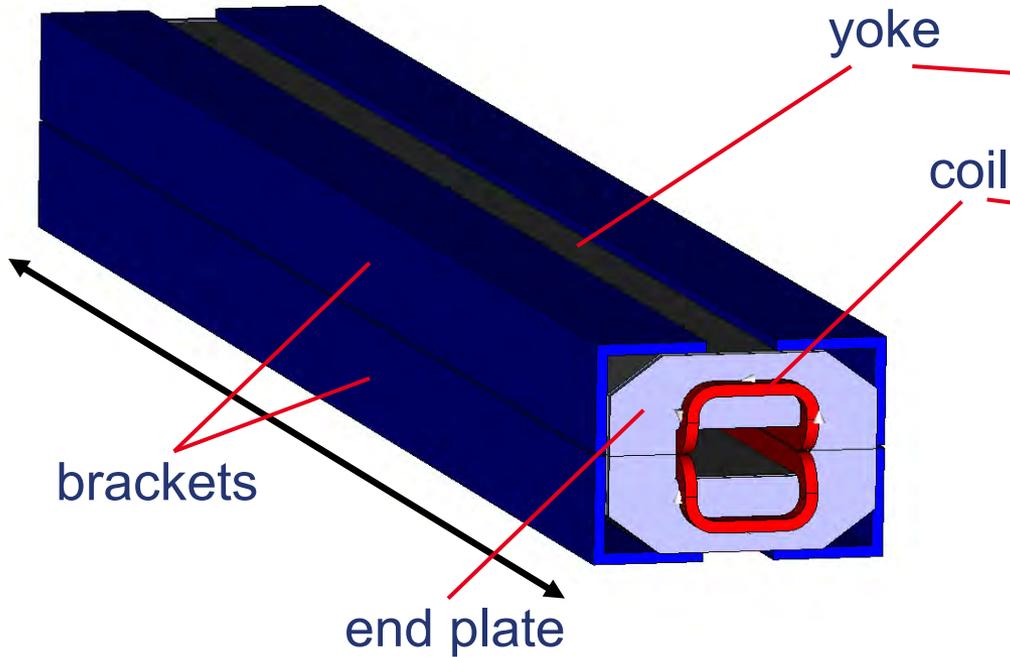


mesher

solver

post-processing

# Example 1: GSI-SIS-100 magnet



SIS100 dipole (prototype)

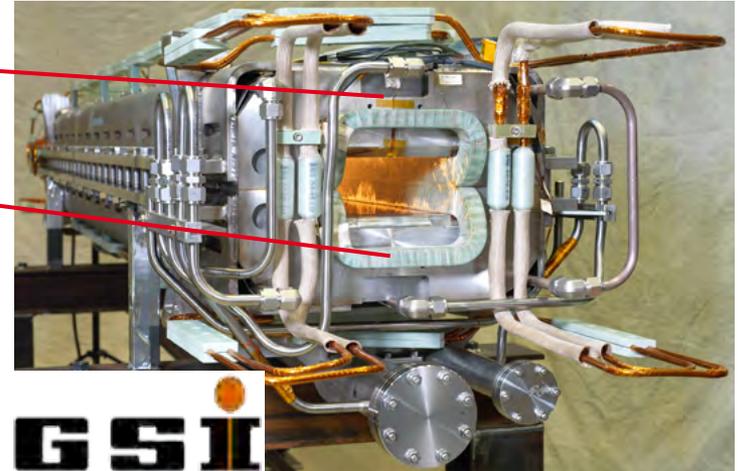


photo: J. Guse, GSI ([www.gsi.de](http://www.gsi.de))

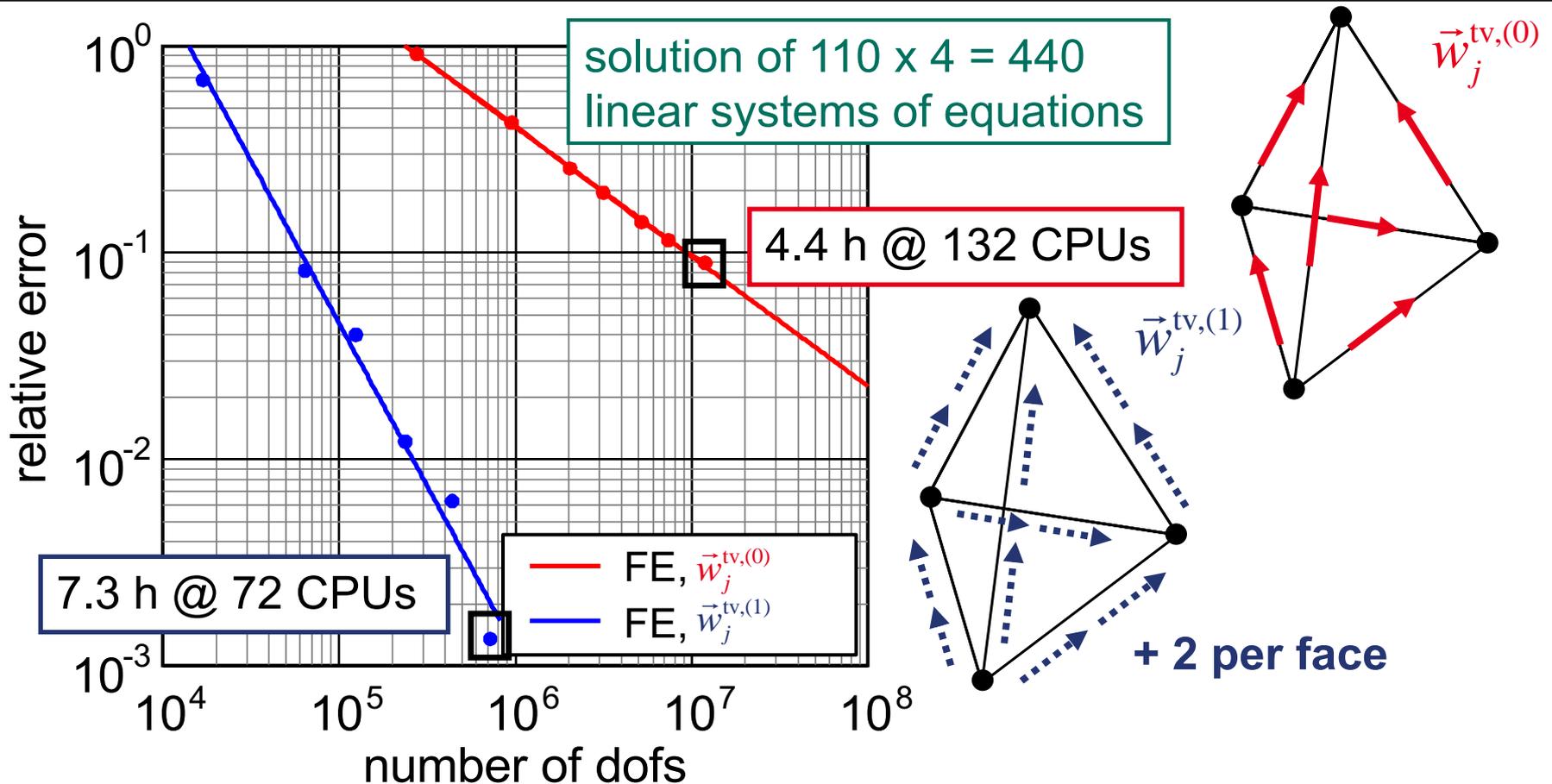
length: 3 m

# Equipment

- Hardware
  - well configured PCs
  - compute cluster (parallelisation)
  - GPU computing
  - access to HPC (inside/outside university)
- Software
  - commercial software (for research purposes!)
  - in-house software (particular applications & state-of-the-art development)
  - state-of-the-art libraries (building blocks)
- Expertise

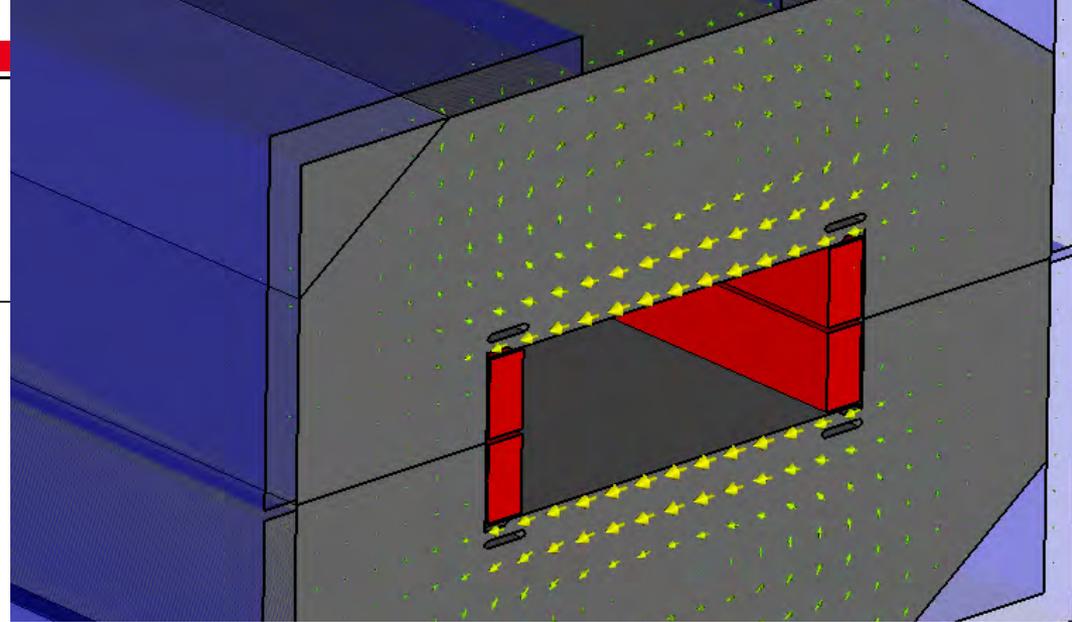


# Example: Computational effort

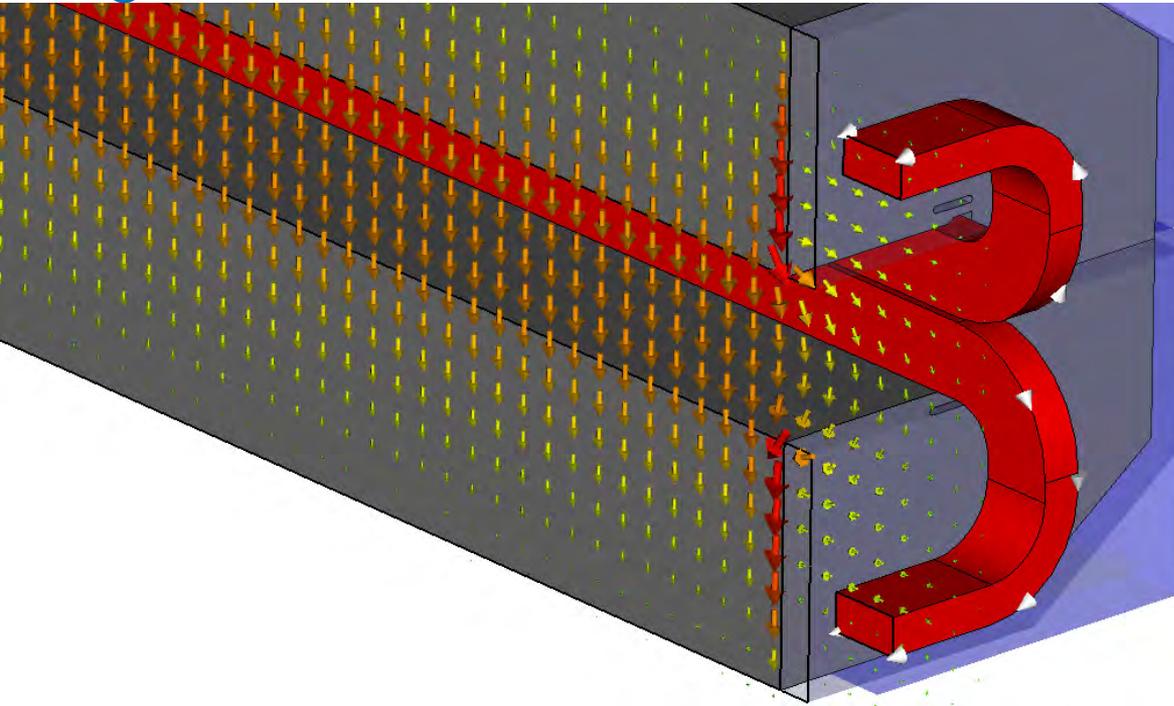


+ S. Koch, J. Trommler

# Example: Results



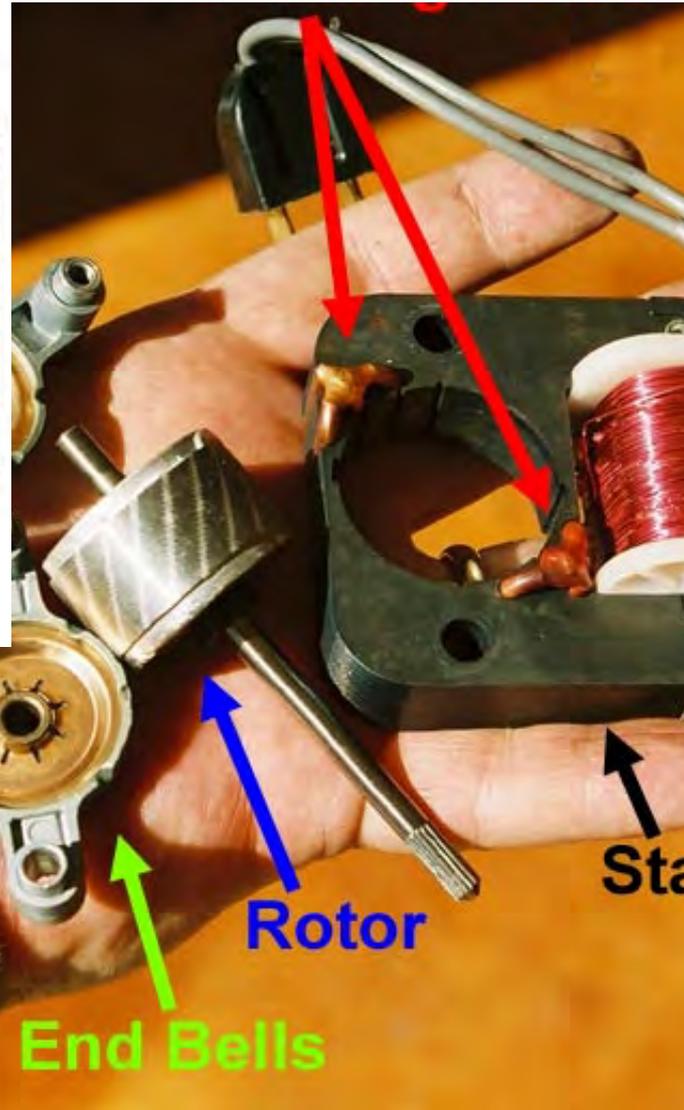
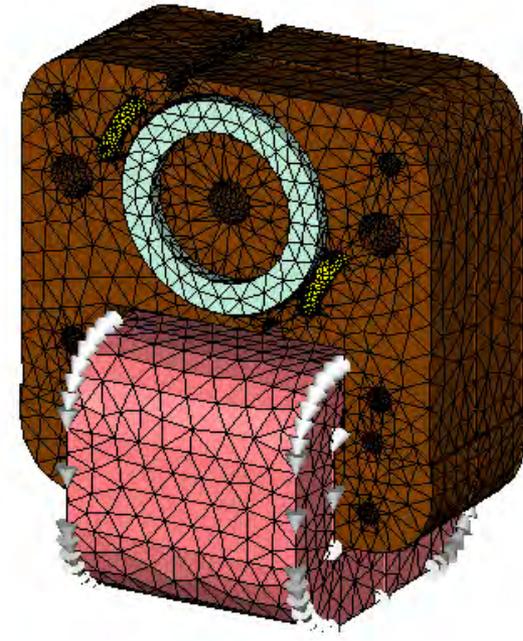
magnetic field



eddy currents  
in the end plane

simulation by  
CST EMStudio®

# Example 2: Shaded-pole motor

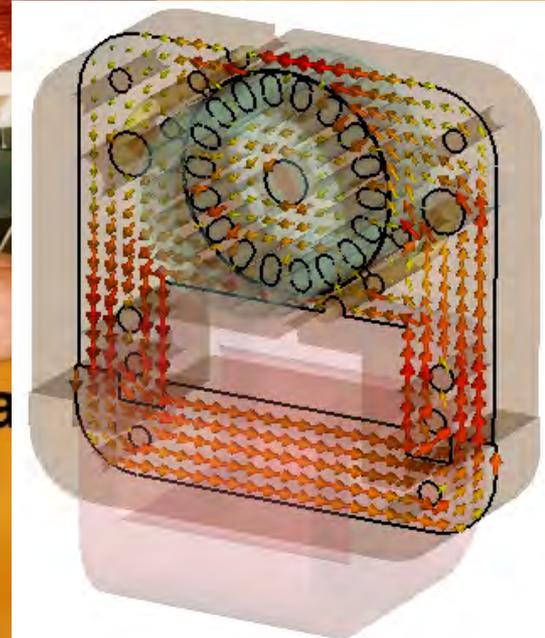


← Stator

Rotor

End Bells

Stator



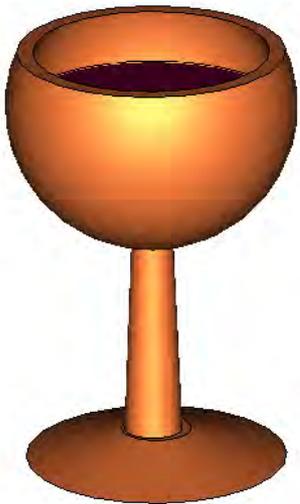
$U_s/m^2$

1.81
1.53
1.09
0.761
0.517
0.336
0.202
0.103
0.0293

$\theta$

# Field Simulation

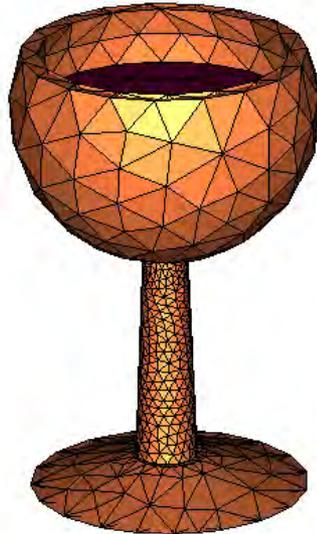
geometry



CAD data  
(small,  
proprietary)

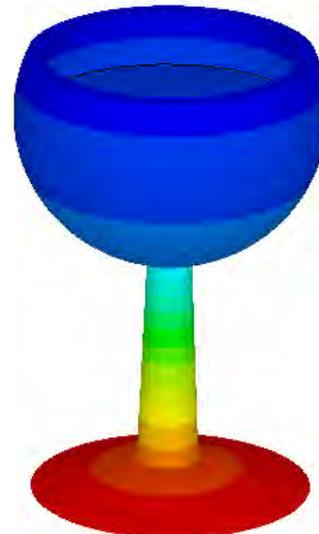
+ simulation software  
(sftw version + hardware)

comput. mesh



mesh data  
(large,  
compressed)

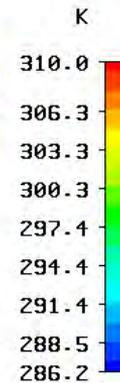
field solution



solution data  
(large,  
compressed)

+ simulation settings (physical  
model, numerical parameters)

post-processing  
results



```
% Column 0: Length, m  
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0.00000000e+00 9.98299967e  
1.67785235e-005 9.60682936e  
3.35570470e-005 9.33737611e-001  
5.03355705e-005 9.10240365e
```

post-proc. data  
(small,  
proprietary)

# Scientific Data Management: Requirements

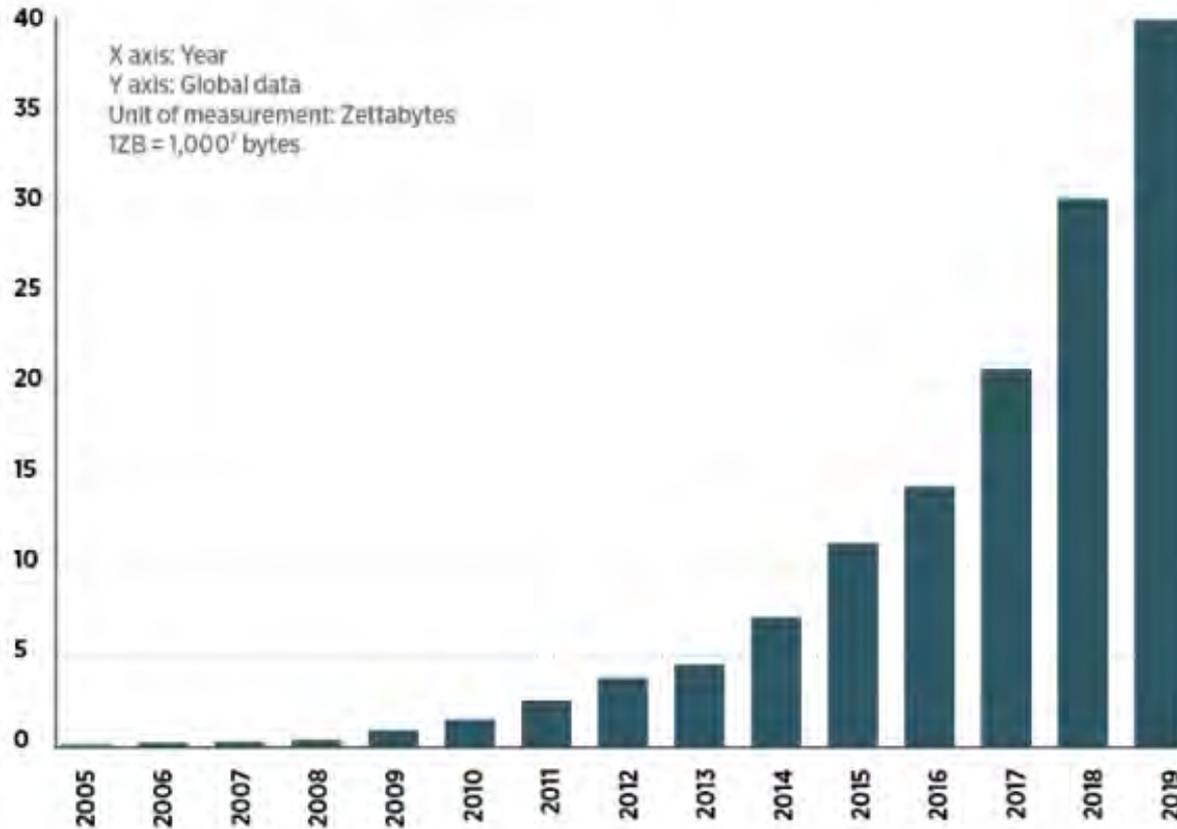
- *access*
- *parallelisation and transport*
- *back-up*
- *reproducibility*

# Scientific Data Management

- *CAD data, post-processing results*
  - small
  - sometimes priority
  - version control
- *mesh data, solution data*
  - large
  - sometimes compressed
  - processed in parallel
- *software*
  - commercial, freeware, in-house code
  - version control (or at least version number)
- *hardware*
  - system, floating point arithmetic
  - fluctuations in load balancing

# Conclusions

## DATA GROWTH



Note: Post-2013 figures are predicted. Source: UNECE

Source:  
United Nations  
Economic Commission  
for Europe (UNECE)