JSC [HPC] SYSTEMS

JUWELS, JURECA-DC and JUSUF

11.11.2024 I D. ALVAREZ

Member of the Helmholtz Association

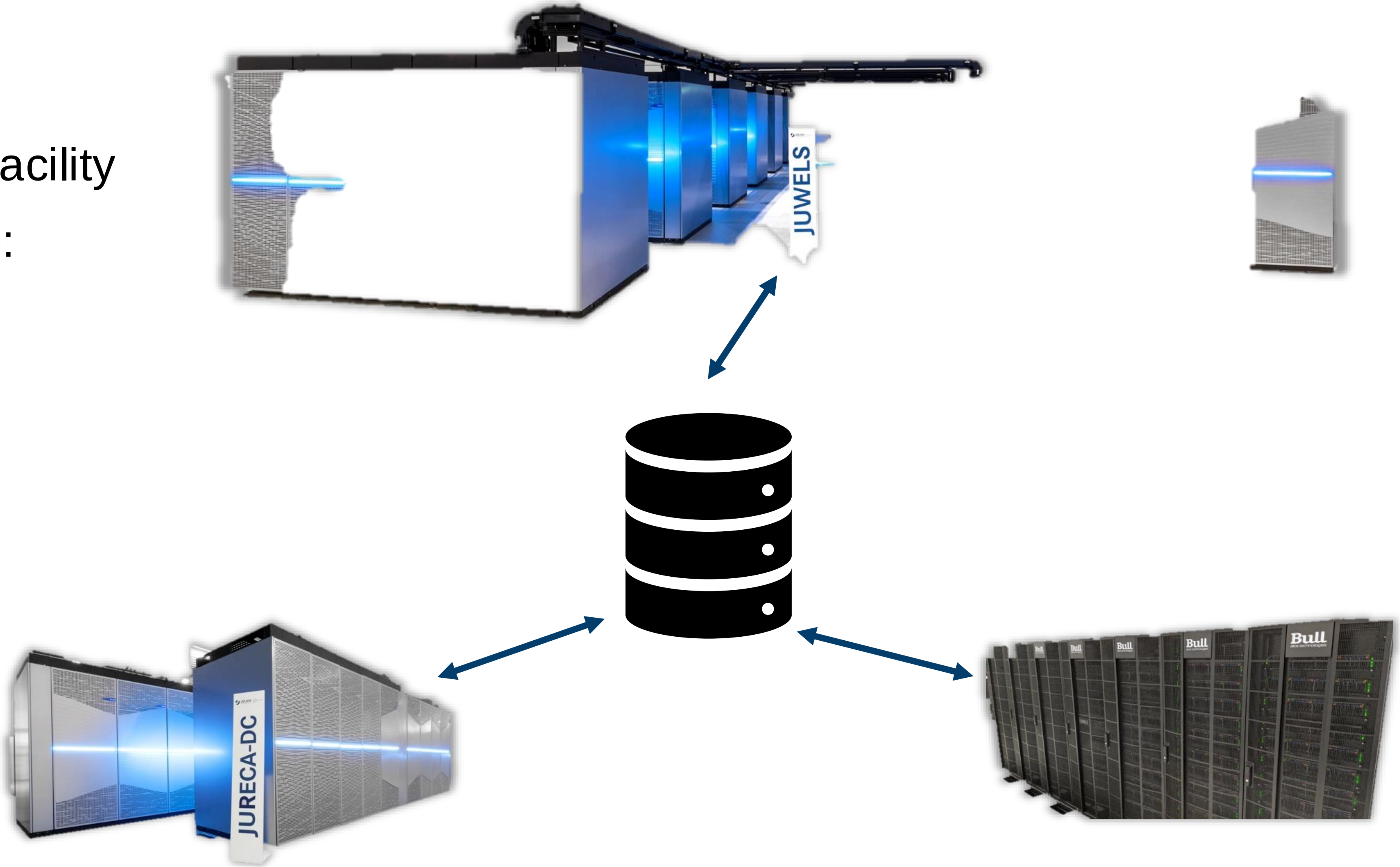
JÜLICH
Forschungszentrum

JSC [HPC] SYSTEMS

- JSC is a multi-system facility

JSC [HPC] SYSTEMS

- JSC is a multi-system facility
- Main HPC systems are:
    - JUWELS
    - JURECA-DC
    - JUSUF
- Shared storage!
    - Different talk



BRIEF JUWELS TIMELINE

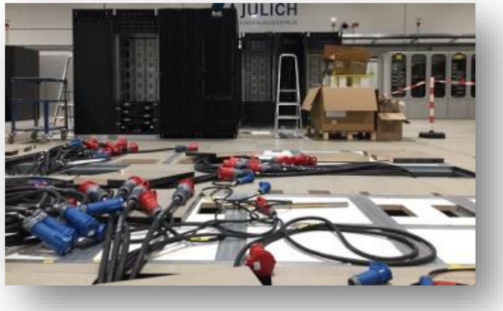
2018

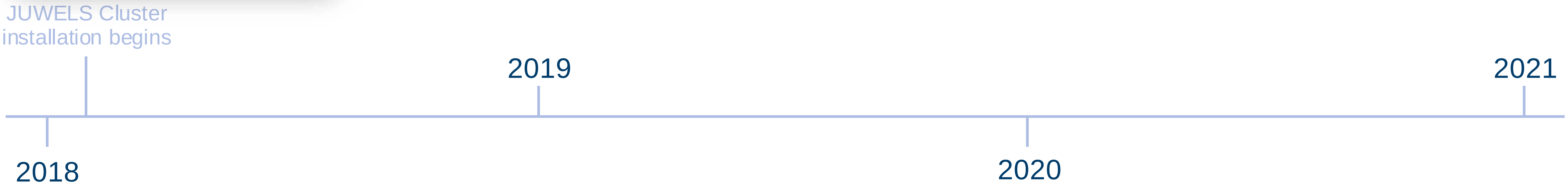
2019

2020

2021

BRIEF JUWELS TIMELINE





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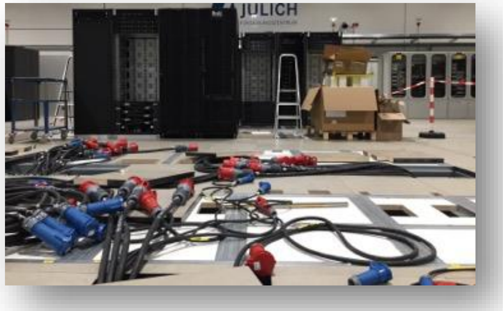
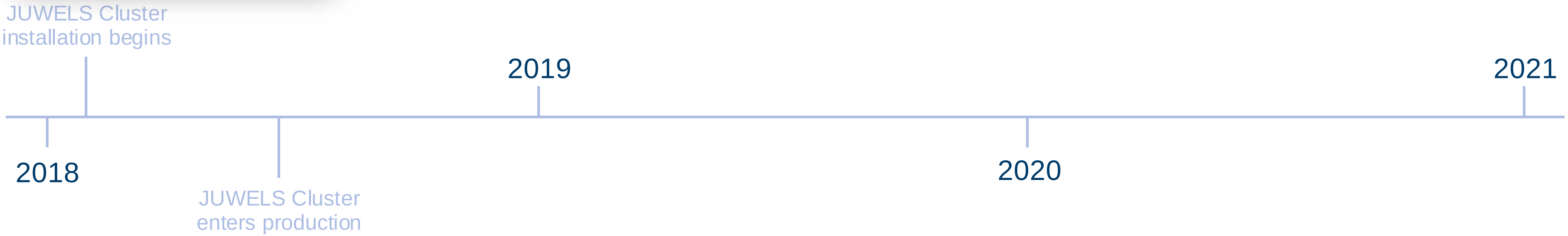




2018

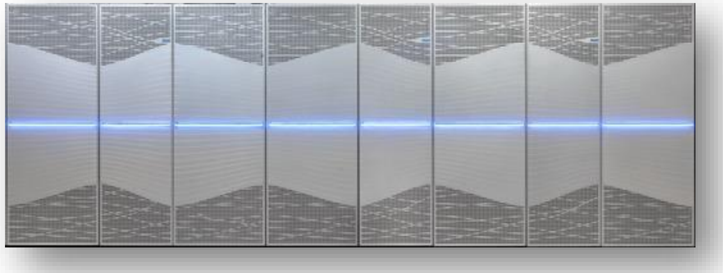
JUWELS Cluster installation begins

JUWELS Cluster enters production

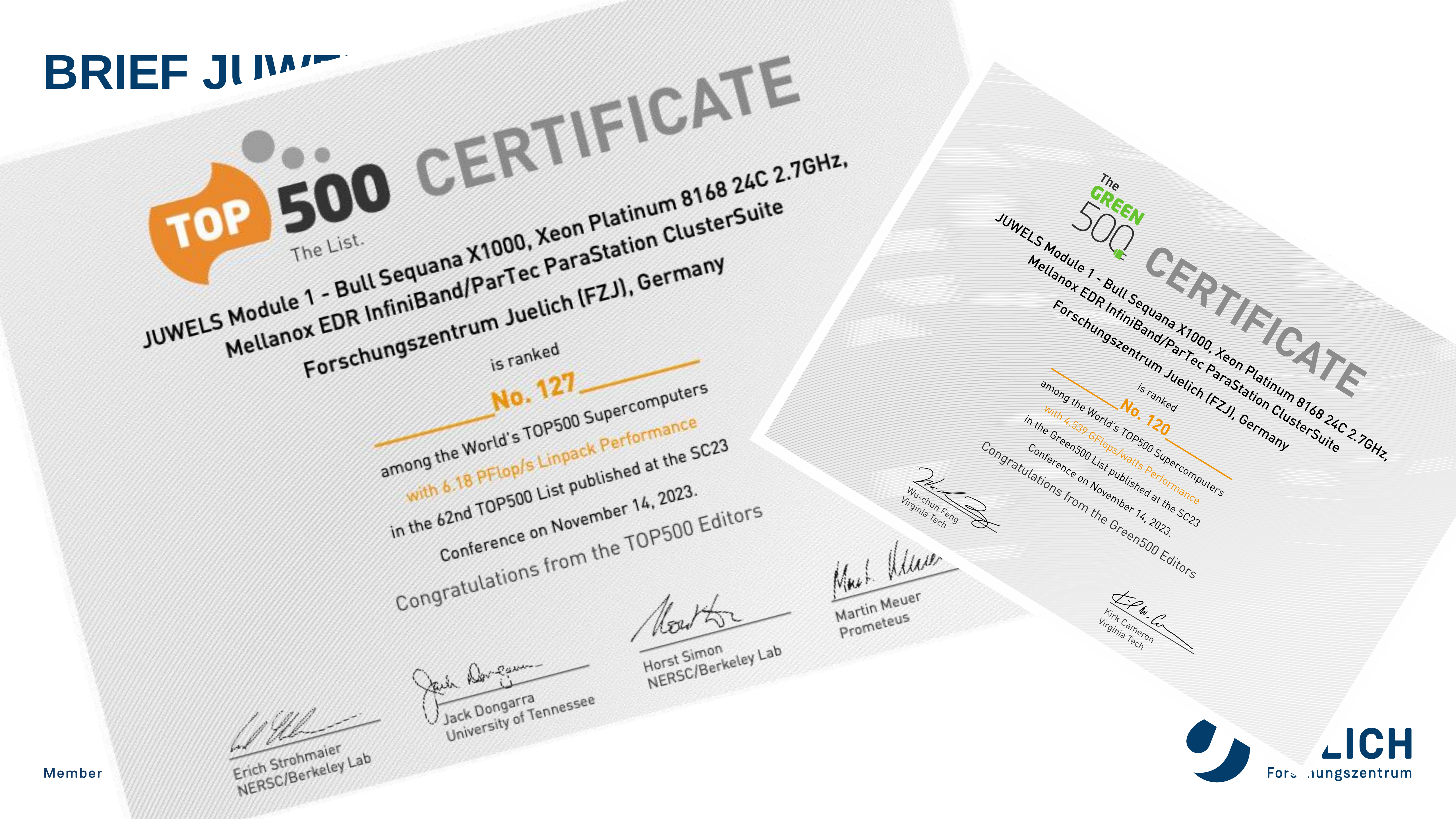
2019

2020

2021



BRIEF JUWE



TOP 500 The List. CERTIFICATE

JUWELS Module 1 - Bull Sequana X1000, Xeon Platinum 8168 24C 2.7GHz, Mellanox EDR InfiniBand/ParTec ParaStation ClusterSuite
Forschungszentrum Juelich (FZJ), Germany

is ranked

No. 127

among the World's TOP500 Supercomputers
with 6.18 PFlop/s Linpack Performance
in the 62nd TOP500 List published at the SC23
Conference on November 14, 2023.

Congratulations from the TOP500 Editors

Erich Strohmaier
NERSC/Berkeley Lab

Jack Dongarra
University of Tennessee

Horst Simon
NERSC/Berkeley Lab

Martin Meuer
Prometeus

The GREEN 500 CERTIFICATE

JUWELS Module 1 - Bull Sequana X1000, Xeon Platinum 8168 24C 2.7GHz,
Mellanox EDR InfiniBand/ParTec ParaStation ClusterSuite
Forschungszentrum Juelich (FZJ), Germany

is ranked

No. 120

among the World's TOP500 Supercomputers
with 4.539 GFlops/watts Performance
in the Green500 List published at the SC23
Conference on November 14, 2023.

Congratulations from the Green500 Editors

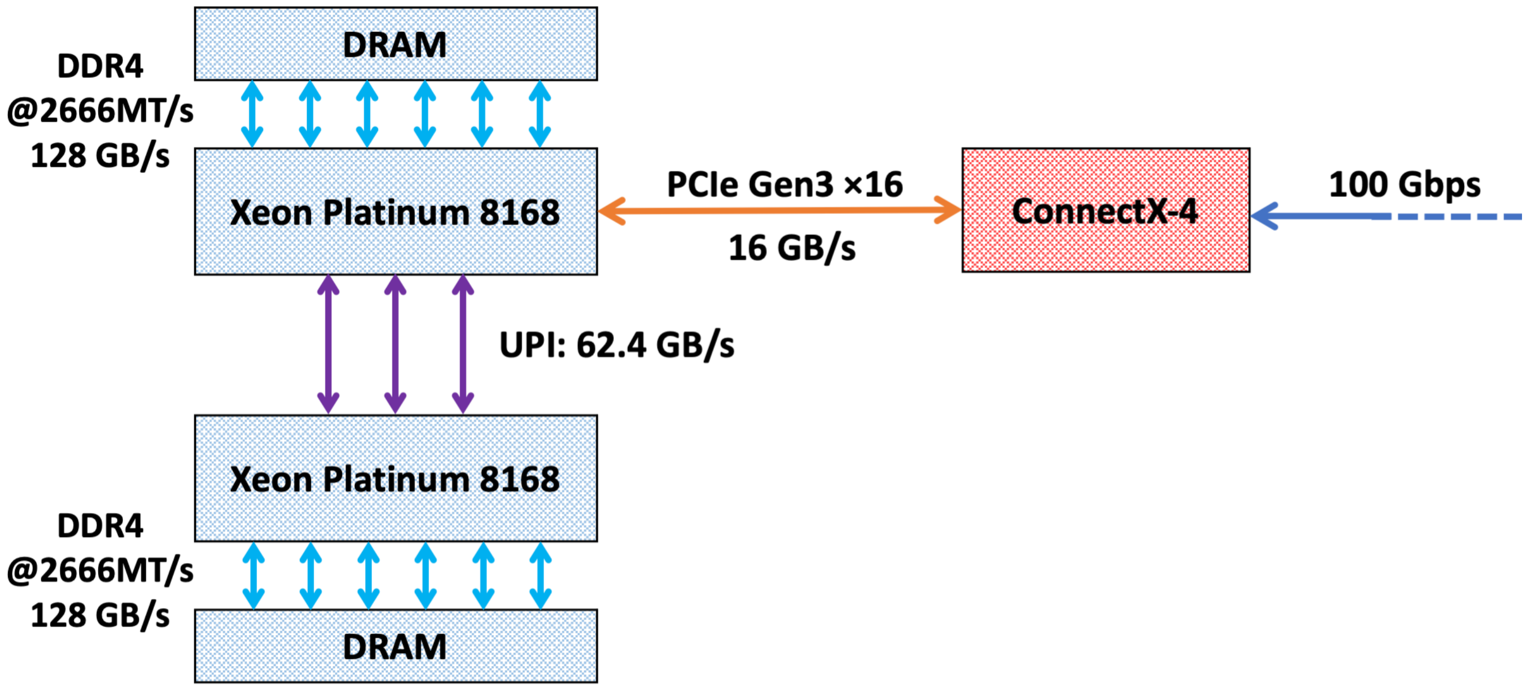
Wu-chun Feng
Virginia Tech

Kirk Cameron
Virginia Tech

JUWELS CLUSTER NODES

- 2511 compute nodes Atos
  - 2× 24-core Intel Xeon Platinum 8168 intel
    - 2x 6 memory channels
    - 2x 48 GB DDR4 @ 2.666 GHz
      - 240 nodes with 2x 96 GB DDR4 @ 2.666 GHz
    - PCIe Gen3
  - 1x EDR InfiniBand adapter (100Gbps)

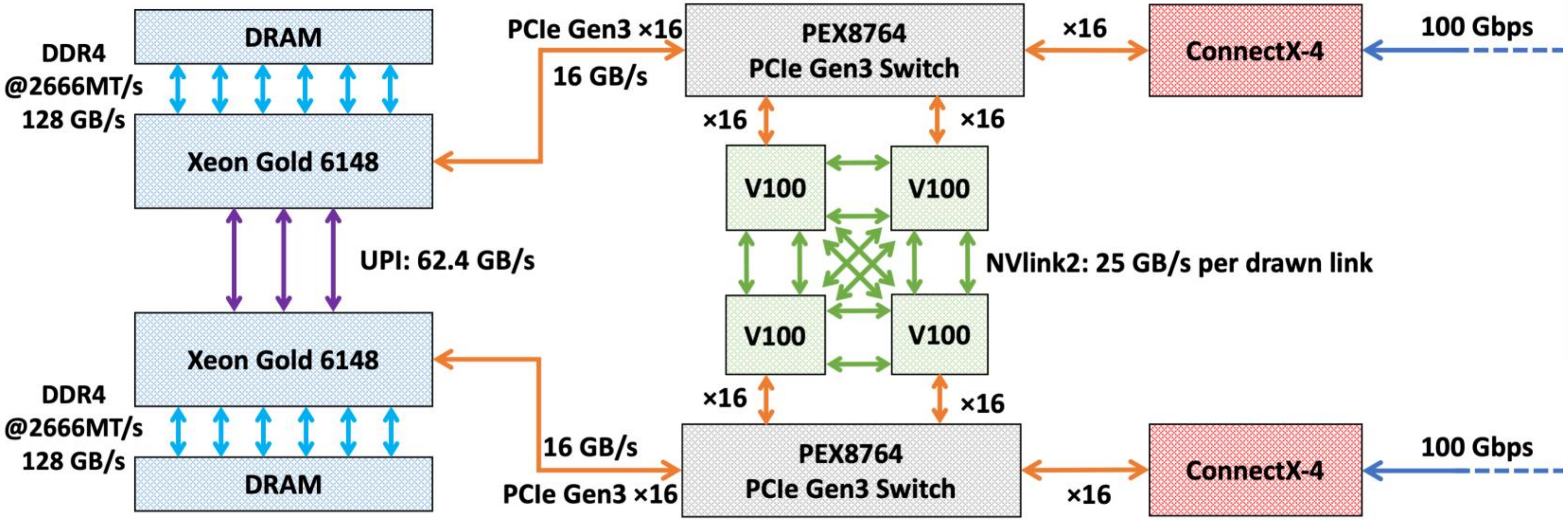
JUWELS CLUSTER NODES



JUWELS CLUSTER GPU NODES

- 56 compute nodes
  - 2× 20-core Intel Xeon Gold 6148
    - 2x 6 memory channels
    - 2x 96 GB DDR4 @ 2.666 GHz
    - PCIe Gen3
  - PCIe Switch
  - 4× Nvidia V100 GPUs
    - 7.8 TF/s peak
    - 16 GB HBM2
    - 900 GB/s memory performance
    - NVLink2 full mesh
      - 2 links (100GB/s bidir) between GPU pairs
    - PCIe Gen3 x16 (32 GB/s bidir)
  - 2x EDR InfiniBand adapter (100 Gbps)

JUWELS CLUSTER GPU NODES



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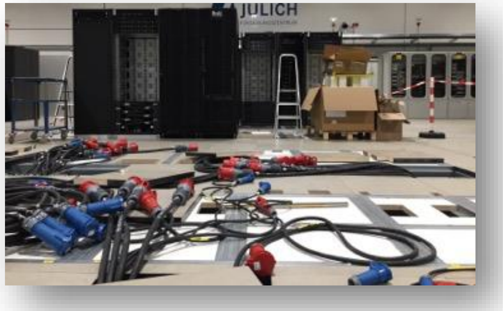
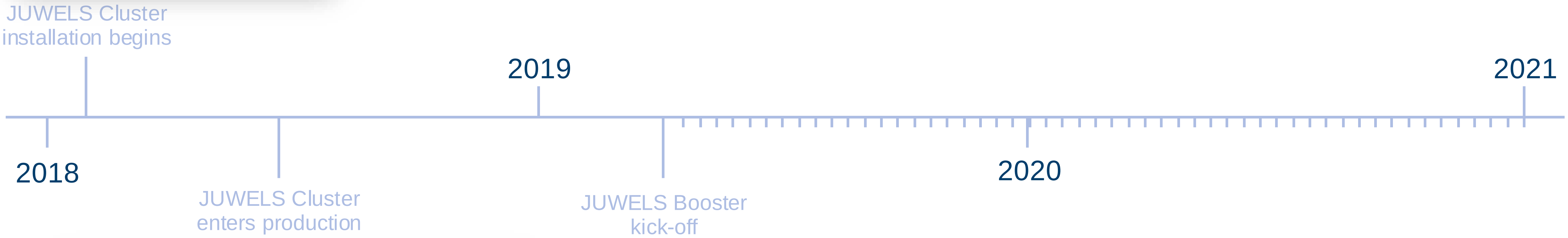
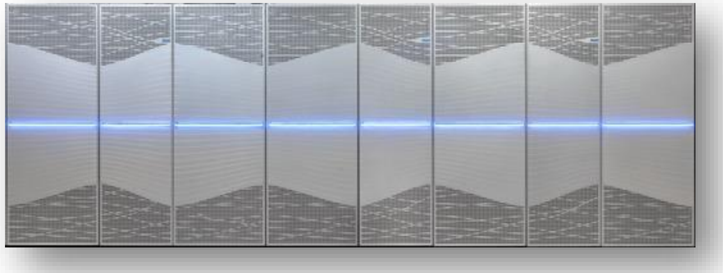



JUWELS Cluster installation begins
2019
2021
2018
JUWELS Cluster enters production
JUWELS Booster kick-off
2020



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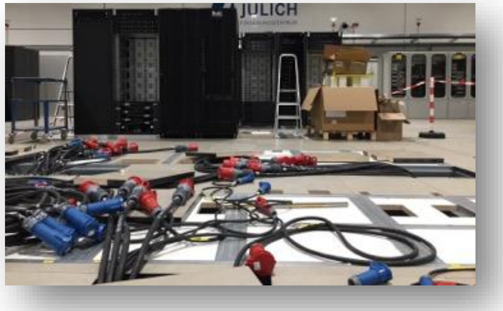

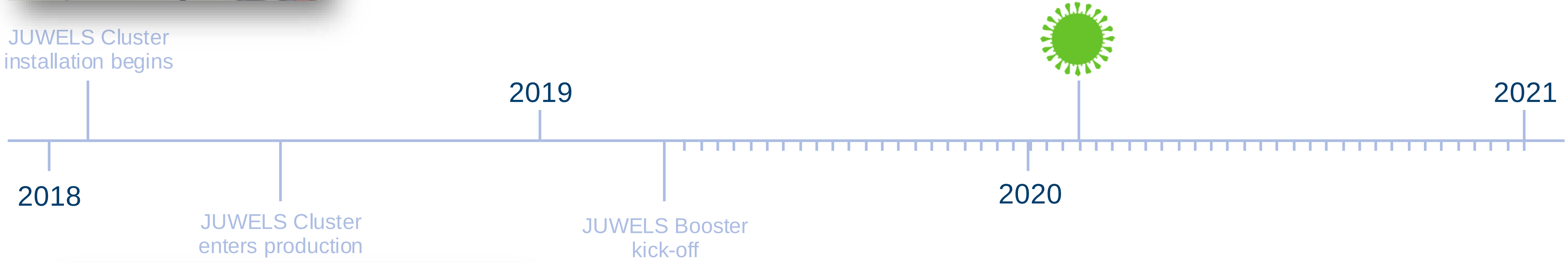

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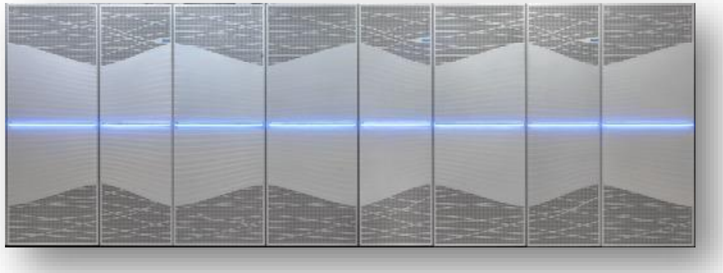

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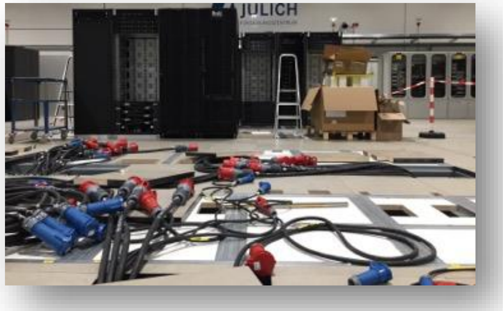

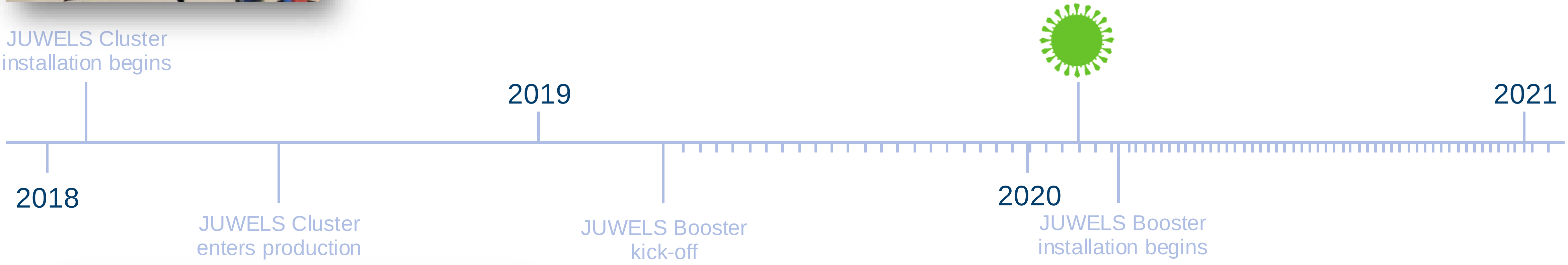

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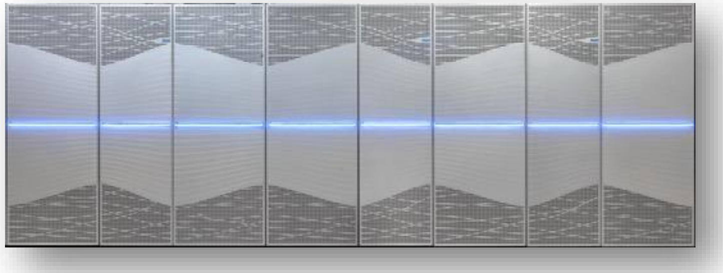

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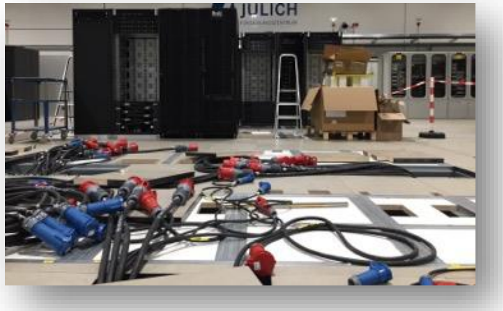

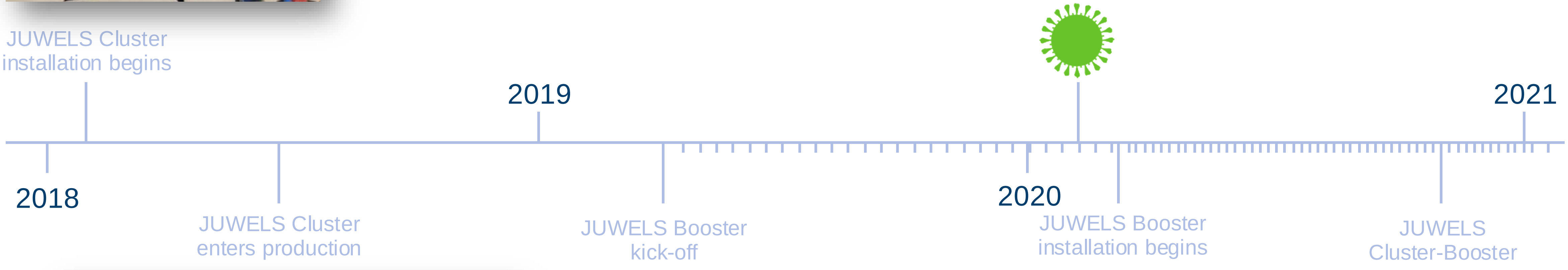

JUWELS Cluster installation begins

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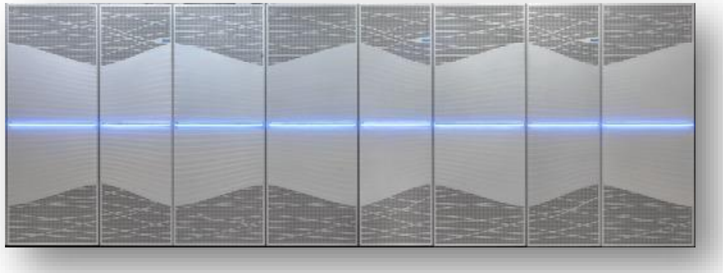
JUWELS Booster installation begins

2021

JUWELS Cluster-Booster merge



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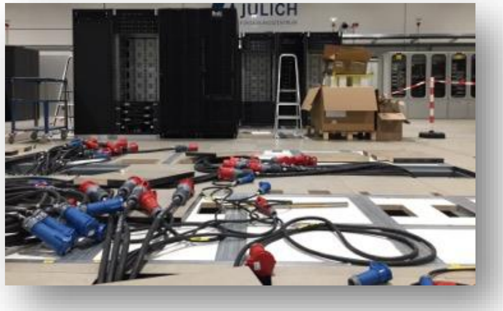

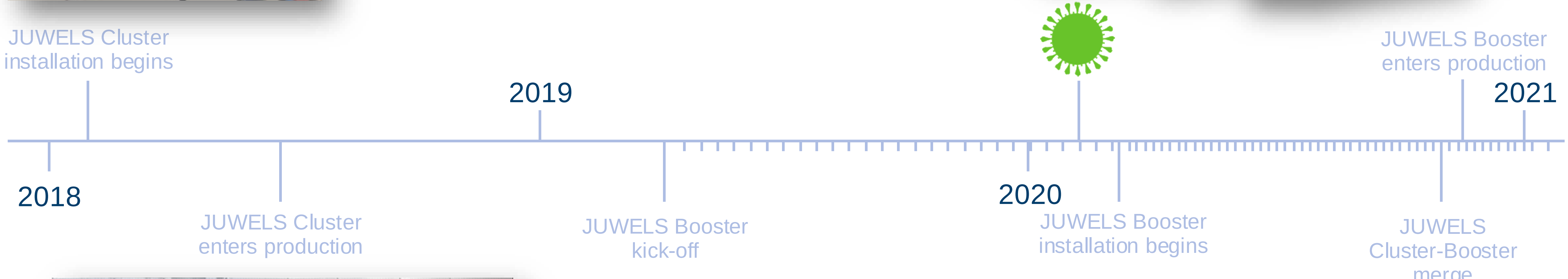

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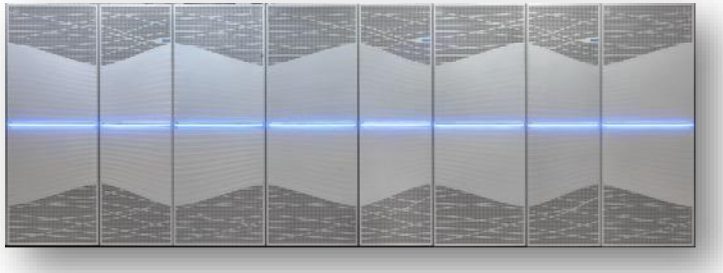
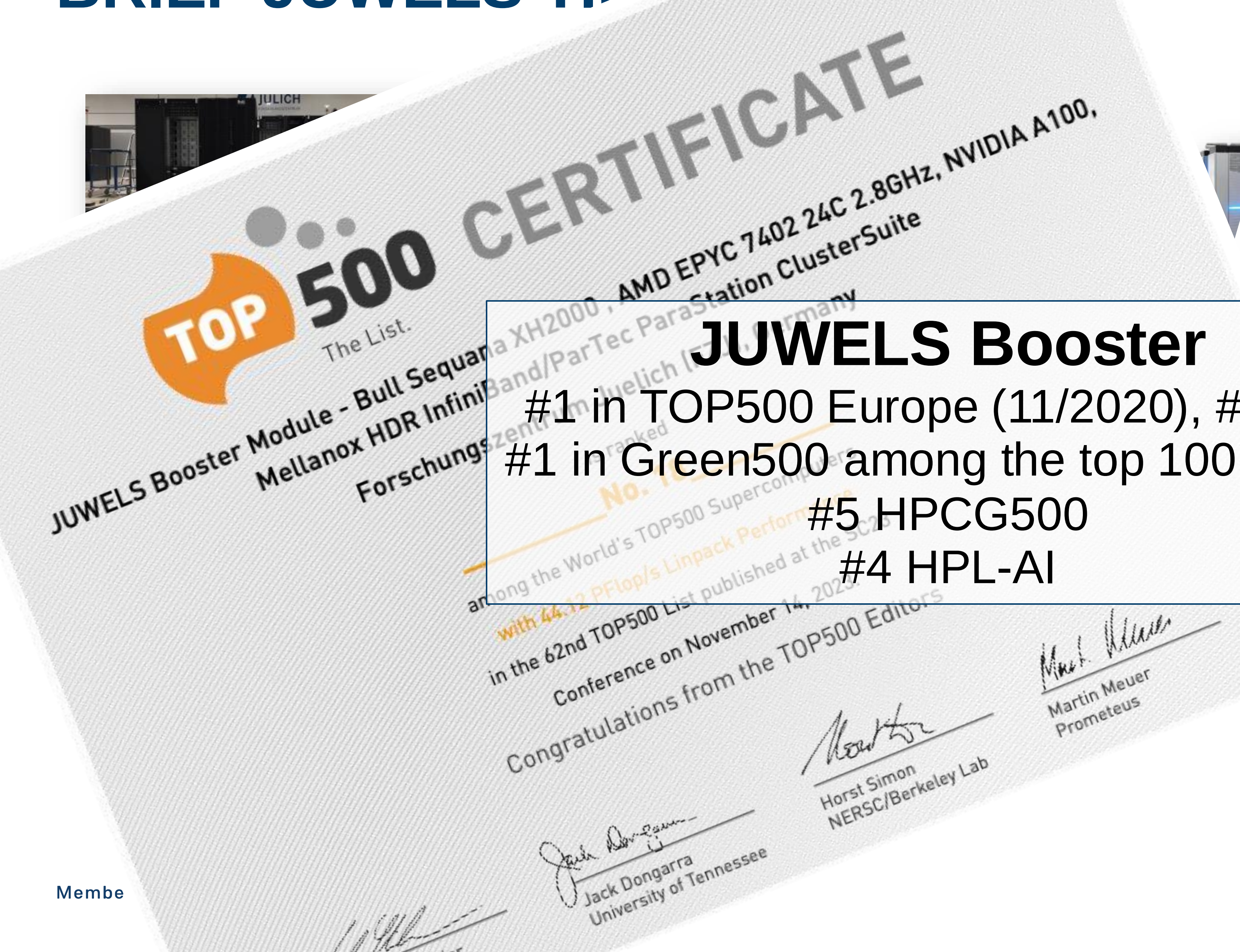


BRIEF JUWELS TIM

JUWELS Booster

#1 in TOP500 Europe (11/2020), #7 WW
#1 in Green500 among the top 100 in HPL
#5 HPCG500
#4 HPL-AI



TOP 500 The List. CERTIFICATE

JUWELS Booster Module - Bull Sequana XH2000 , AMD EPYC 7402 24C 2.8GHz, NVIDIA A100,
Mellanox HDR InfiniBand/ParTec ParaStation ClusterSuite
Forschungszentrum Juelich (FZJ), Germany
is ranked
No. 1
among the World's TOP500 Supercomputers
with 44.12 PFlop/s Linpack Performance
in the 62nd TOP500 List published at the SC23
Conference on November 14, 2023.
Congratulations from the TOP500 Editors

Jack Dongarra
University of Tennessee

Horst Simon
NERSC/Berkeley Lab

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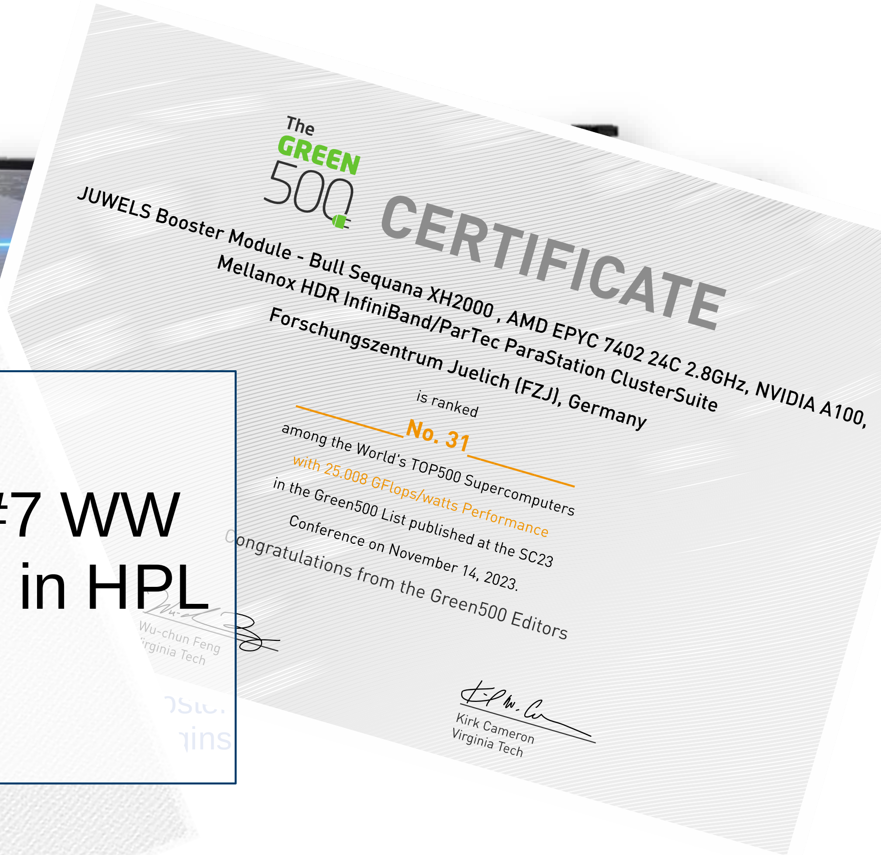

The GREEN 500 CERTIFICATE

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Forschungszentrum Juelich (FZJ), Germany
is ranked
No. 31
among the World's TOP500 Supercomputers
with 25.008 GFlops/watts Performance
in the Green500 List published at the SC23
Conference on November 14, 2023.
Congratulations from the Green500 Editors

Wu-chun Feng
Virginia Tech

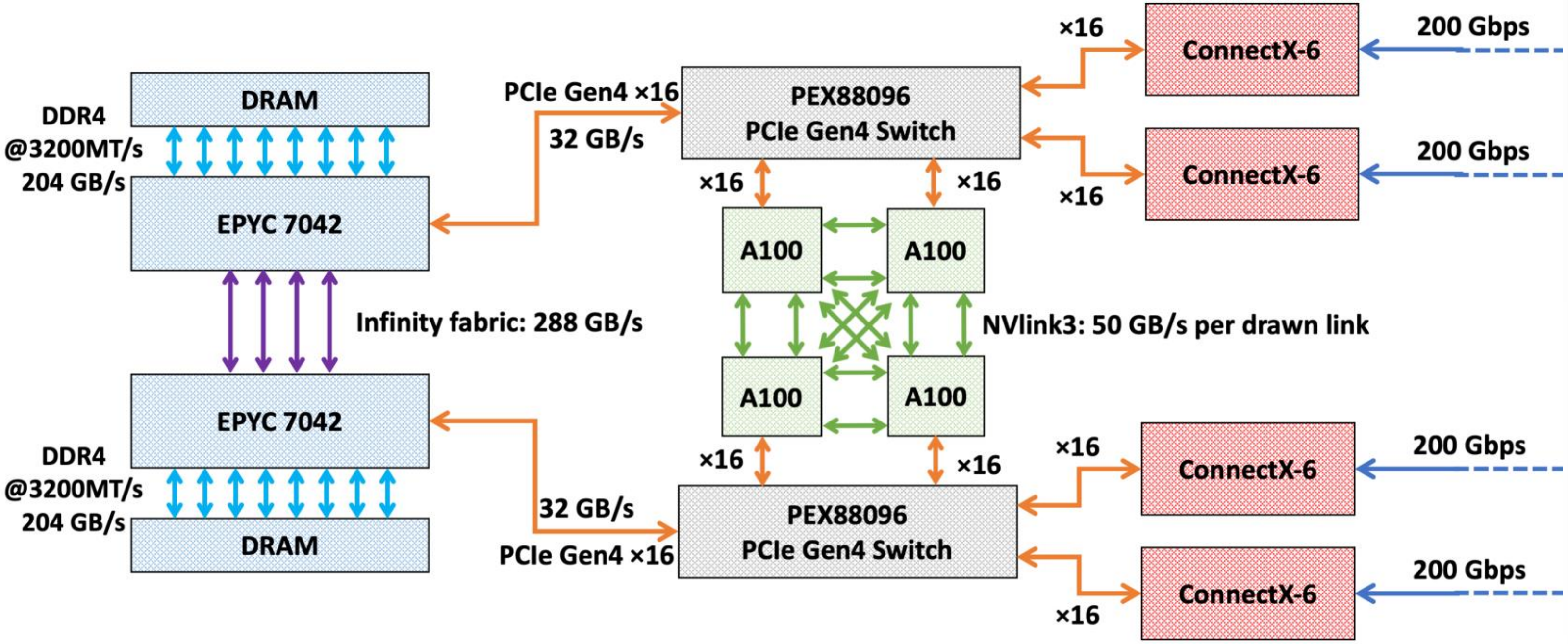
Kirk Cameron
Virginia Tech

JÜLICH Forschungszentrum

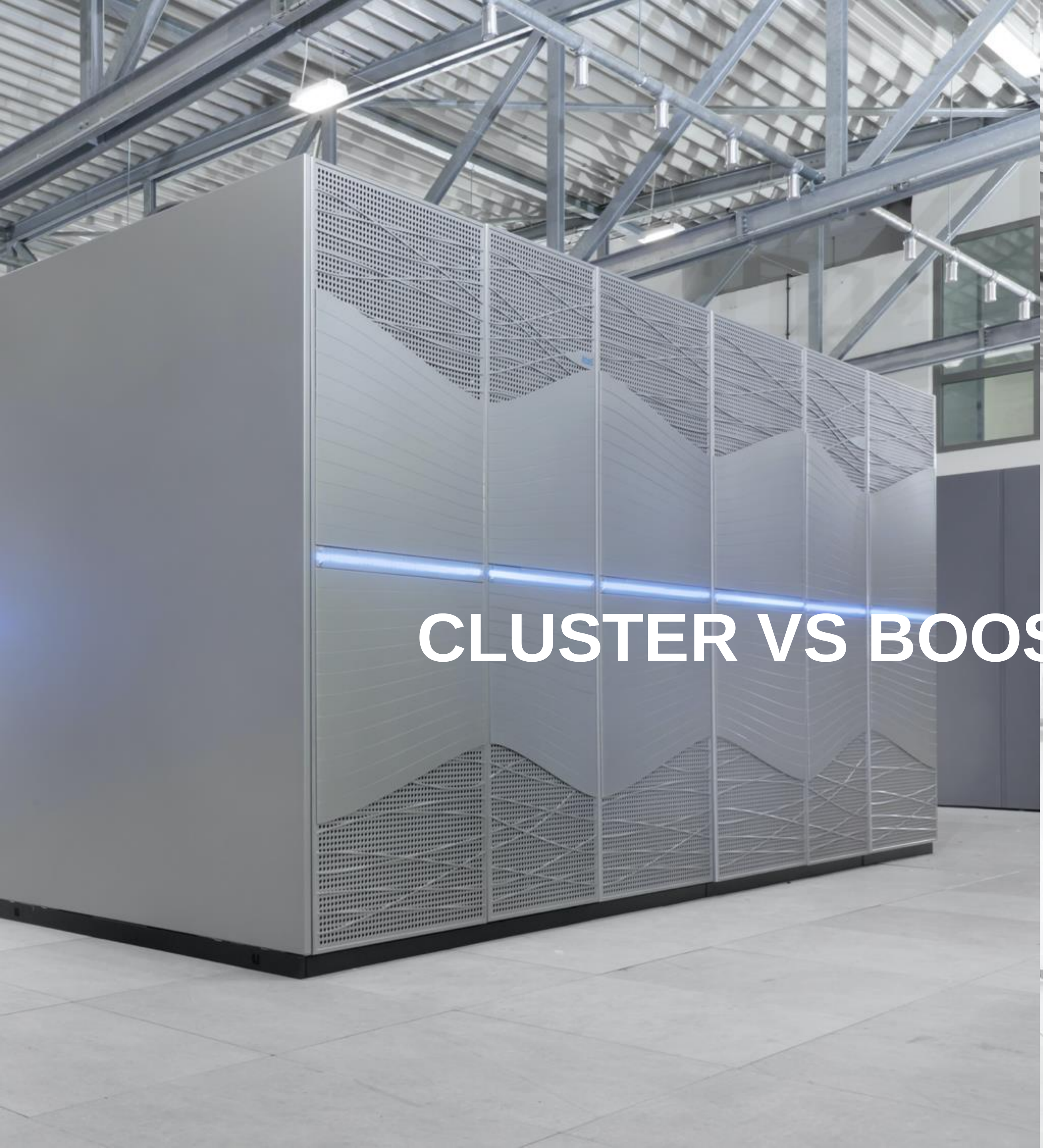
JUWELS BOOSTER NODES

- 936 compute nodes
  - 2× 24-core AMD Epyc 7402 Rome CPUs
    - 2x 8 memory channels
    - 2x 256 GB DDR4 @ 3.2GHz
    - 2x 4 NUMA domains
    - 96 PCIe Gen4 lanes
  - 512 GB DDR memory
  - 4× Nvidia A100 GPUs
    - 9.7 / 19.5 TF/s peak
    - 40 GB HBM2
    - 1.5 TB/s memory performance
    - NVLink3 full mesh
      - 4 links (200GB/s) between GPU pairs
    - PCIe Gen4 x32 (64 GB/s)
  - 4x HDR200 InfiniBand adapter (1 per GPU)

JUWELS BOOSTER NODES



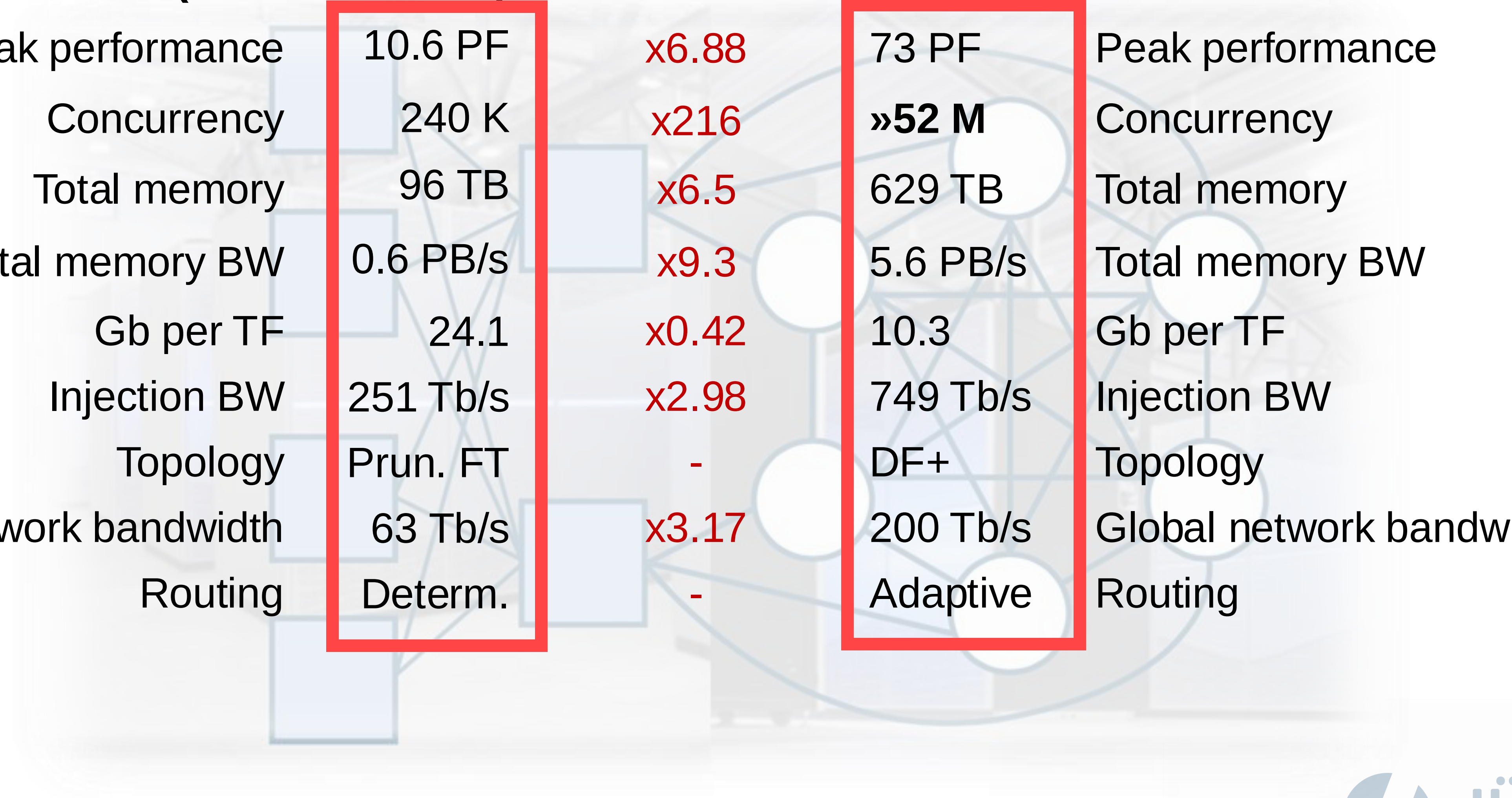
CLUSTER VS BOOSTER: KEY FACTS



CLUSTER VS BOOSTER –NODE VIEW– (1/2)

JUWELS Cluster (w/o GPU nodes)			JUWELS Booster	
Processors	Intel	-	AMD	Processors
Cores	48	x1	48	Cores
Vector width (CPU)	512	x0.5	256	Vector width (CPU)
Memory (main)	96/192 GB	x5.33/2.66	512 GB	Memory (main)
Memory BW (main)	256 GB/s	x1.59	408 GB/s	Memory BW (main)
GPUs	0	xNaN	4	GPUs
Memory (GPU)	0	xNaN	160 GB	Memory (GPU)
Memory BW (GPU)	0	xNaN	6 TB/s	Memory BW (GPU)
HCAs	1	x4	4	HCAs
Link BW	100 Gbps	x2	200 Gbps	Link BW
Network BW	100 Gbps	x8	800 Gbps	Network BW
TFLOPs	4.15	x18.8	78	TFLOPs (GPUs)

CLUSTER VS BOOSTER –GLOBAL VIEW– (2/2)



JUWELS Cluster (w/o GPU nodes)			JUWELS Booster	
Peak performance	10.6 PF	x6.88	73 PF	Peak performance
Concurrency	240 K	x216	**»52 M**	Concurrency
Total memory	96 TB	x6.5	629 TB	Total memory
Total memory BW	0.6 PB/s	x9.3	5.6 PB/s	Total memory BW
Gb per TF	24.1	x0.42	10.3	Gb per TF
Injection BW	251 Tb/s	x2.98	749 Tb/s	Injection BW
Topology	Prun. FT	-	DF+	Topology
Global network bandwidth	63 Tb/s	x3.17	200 Tb/s	Global network bandwidth
Routing	Determ.	-	Adaptive	Routing

JUWELS CLUSTER LOGIN NODES

- 9 + 2 standard login nodes
  - 2× 20-core Intel Xeon Gold 6148
  - 756 GB DDR4 @ 2.666 GHz
  - 100 GigE external network
- 4 visualization nodes
  - 2× 20-core Intel Xeon Gold 6148
  - 756 GB DDR4 @ 2.666 GHz
  - 100 GigE external network
  - 1x Nvidia P100 GPU
    - Different compute capabilities than in compute nodes!
- Used for:
  - Compile/submit jobs
    - Careful with `make -j`!
  - Small pre- and post-processing/visualization
- Shared nodes!

JUWELS BOOSTER LOGIN NODES

- 4 login nodes
  - 2× 24-core AMD Epyc 7402 Rome CPUs
  - 512 GB DDR4 @ 3.2 GHz
  - 100 GigE external network
  - No GPUs!
- Used for:
  - Compile/submit jobs
    - Careful with `make -j` !
  - Small pre- and post-processing/visualization
- Shared nodes!

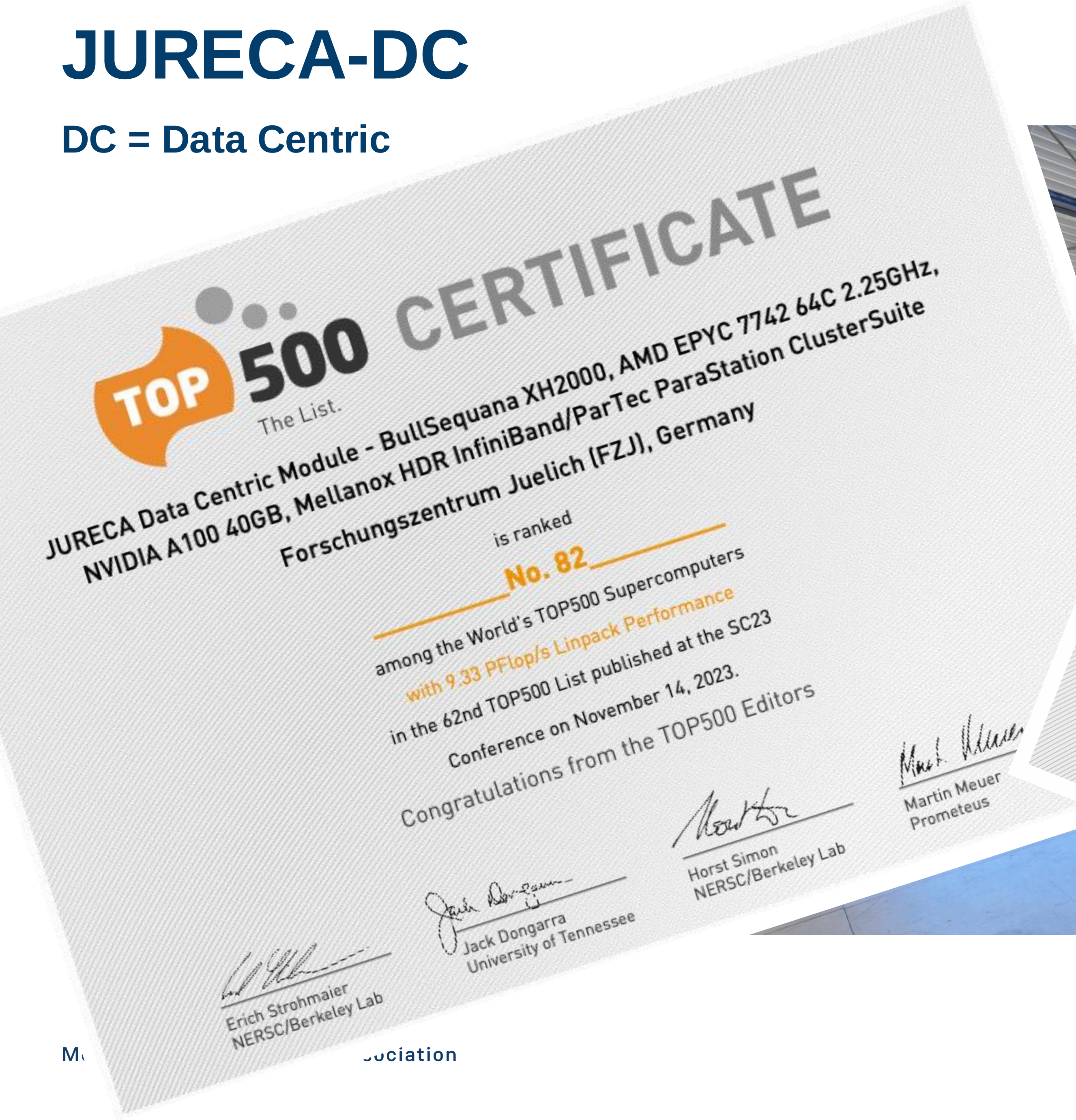
JURECA-DC

DC = Data Centric

- Intended for mixed capacity and capability workloads
  - Designed with big-data science needs in mind

JURECA-DC

DC = Data Centric



TOP 500 The List. CERTIFICATE

JURECA Data Centric Module - BullSequana XH2000, AMD EPYC 7742 64C 2.25GHz,
NVIDIA A100 40GB, Mellanox HDR InfiniBand/ParTec ParaStation ClusterSuite
Forschungszentrum Juelich (FZJ), Germany

is ranked

No. 82

among the World's TOP500 Supercomputers
with 9.33 PFlop/s Linpack Performance
in the 62nd TOP500 List published at the SC23
Conference on November 14, 2023.

Congratulations from the TOP500 Editors

Erich Strohmaier
NERSC/Berkeley Lab

Jack Dongarra
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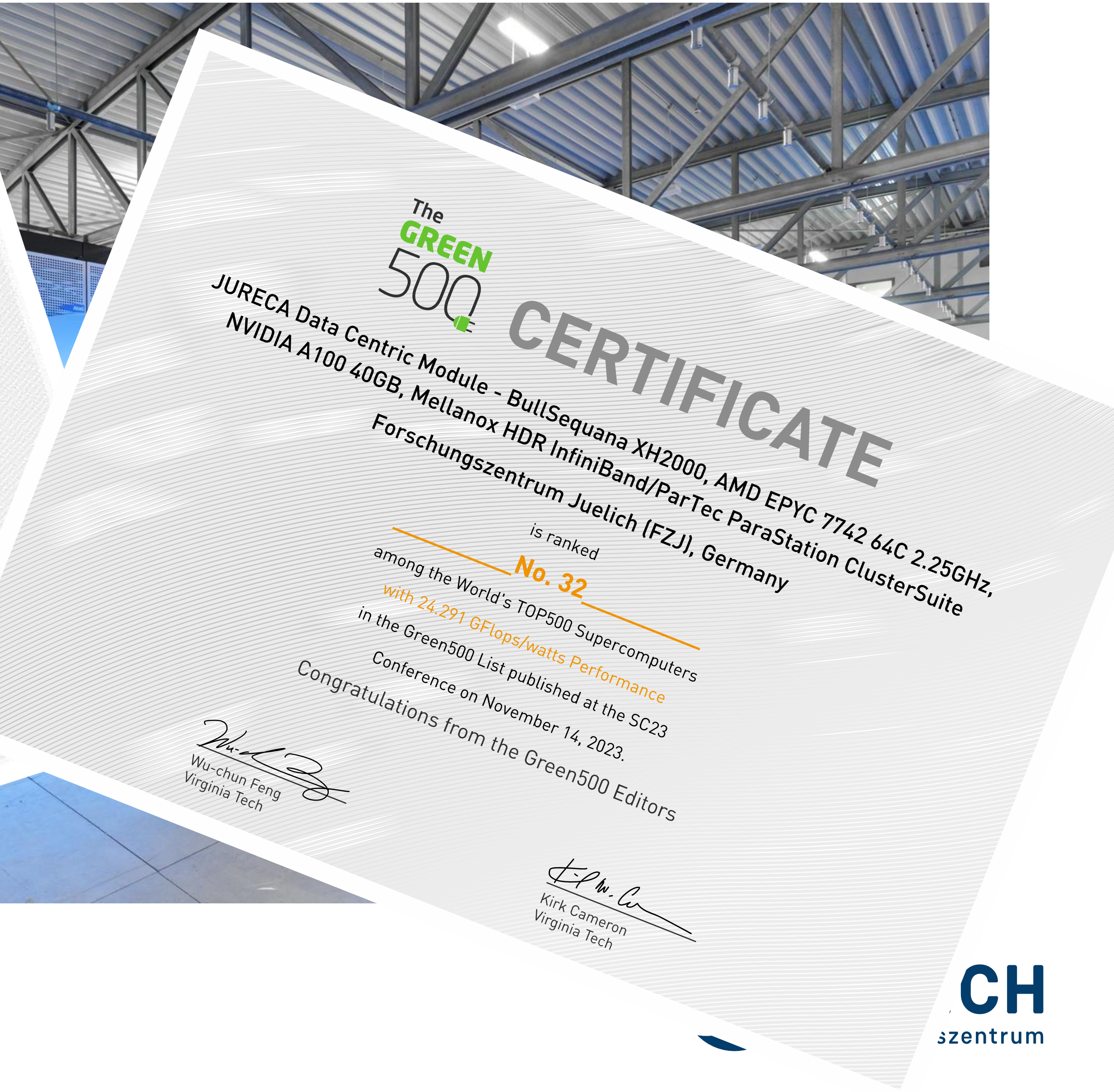


The GREEN 500 CERTIFICATE

JURECA Data Centric Module - BullSequana XH2000, AMD EPYC 7742 64C 2.25GHz,
NVIDIA A100 40GB, Mellanox HDR InfiniBand/ParTec ParaStation ClusterSuite
Forschungszentrum Juelich (FZJ), Germany

is ranked

No. 32

among the World's TOP500 Supercomputers
with 24.291 GFlops/watts Performance
in the Green500 List published at the SC23
Conference on November 14, 2023.

Congratulations from the Green500 Editors

Wu-chun Feng
Virginia Tech

Kirk Cameron
Virginia Tech

JURECA-DC CPU NODES

- 576 compute nodes
  - 2× 64-core AMD Epyc 7742 Rome CPUs
    - 2x 8 memory channels
    - 2x 256 GB DDR4 @ 3.2 GHz
      - 96 nodes with 2x 512 GB DDR4 @ 3.2 GHz
    - 2x 4 NUMA domains
    - PCIe Gen4
  - 1x HDR100 InfiniBand adapter (100Gbps)

JURECA-DC GPU NODES

- 192 compute nodes
  - 2× 64-core AMD Epyc 7742 Rome CPUs
    - 2x 8 memory channels
    - 2x 256 GB DDR4 @ 3.2GHz
    - 96 PCIe Gen4 lanes
  - 512 GB DDR memory
  - 4× Nvidia A100 GPUs
    - 9.7 / 19.5 TF/s peak
    - 40 GB HBM2
    - 1.5 TB/s memory performance
    - NVLink3 full mesh
      - 4 links (200GB/s) between GPU pairs
    - PCIe Gen4 x32 (64 GB/s)
  - 2x HDR200 InfiniBand adapter (1 per GPU)

JURECA-DC LOGIN NODES

- 12 login nodes
  - 2× 64-core AMD Epyc 7742 Rome CPUs
  - 1024 GB DDR4 @ 3.2 GHz
  - 100 GigE external network
  - 2x Nvidia RTX8000 GPUs
    - Different compute capabilities than in compute nodes!
- Used for:
  - Compile/submit jobs
    - Careful with `make -j` !
  - Small pre- and post-processing/visualization
- Shared nodes!

JURECA-DC PROTOTYPE/TEST/NEW NODES

- 2x MI250X nodes
  - 2× 24-core AMD Epyc 7443 Milan CPUs
  - 512 GB DDR4 @ 3.2 GHz
  - 2x HDR200 InfiniBand adapter
  - 4x AMD MI250X GPUs
- 2x NVIDIA ARM HPC DevKit nodes
  - 1x Ampere Altra Q80-30
  - 512 GB DDR4 @ 3.2 GHz
  - 2x HDR200 InfiniBand adapter
  - 2x NVIDIA A100 GPUs

- 1x Graphcore IPU-M2000 node
  - 4x GC200 IPUs

JURECA-DC PROTOTYPE/TEST/NEW NODES

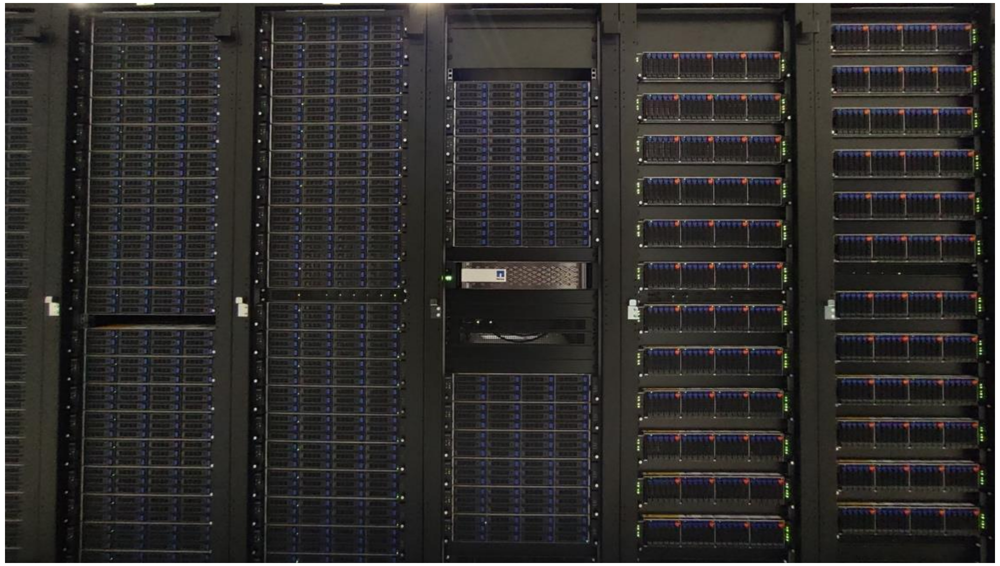
- 1x Sapphire Rapids + NVIDIA H100 node
  - 2× 36-core Intel Xeon Platinum 8452Y CPUs
  - 512 GB DDR5 @ 4.8 GHz
  - 4x NVIDIA H100 GPUs (PCIe/350W/80GB)
  - 1x BlueField-2 InfiniBand adapter

- 2x Grace-Hopper nodes
  - 1x Grace-Hopper Superchip
    - 72 ARM Neoverse V2 cores
    - 480 GB LPDDR5X (Grace)
    - 90 GB HBM3 (H100)
  - 1x HDR200 InfiniBand adapter

- 16x Sapphire Rapids + NVIDIA 4xH100 nodes
  - 2× 32-core Intel Xeon Platinum 8462Y CPUs
  - 512 GB DDR5 @ 4.8 GHz
  - 4x NVIDIA H100 GPUs (SXM5/700W/90 GB)
  - 2x NDR400 InfiniBand adapters

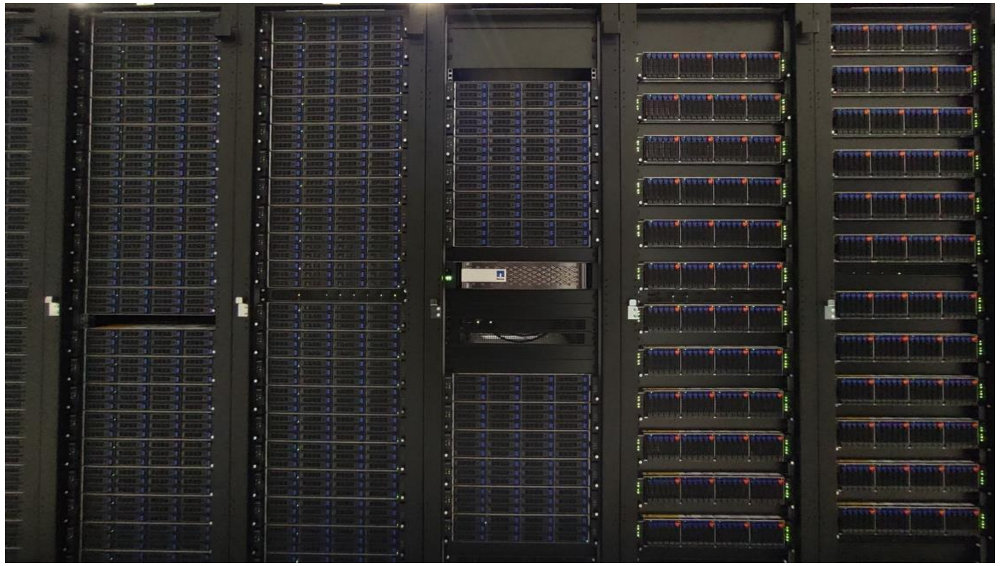
JUSUF

- Serves the ICEI project (Interactive Computing E-Infrastructure for the Human Brain Project)
- Contains 2 partitions
  - HPC
  - Cloud
- Air-cooled, less dense than other systems



JUSUF HPC PARTITION

- 124 compute nodes
  - 2× 64-core AMD Epyc 7742 Rome CPUs
    - 2x 8 memory channels
    - 2x 128 GB DDR4 @ 3.2 GHz
    - 2x 4 NUMA domains
    - PCIe Gen4
  - 1x HDR100 InfiniBand adapter (100Gbps)
  - 1x 40 GbE adapter (for storage)
  - 1TB NVMe local scratch
- 49 GPU nodes
  - Same config as CPU nodes. Additionally:
  - 1× Nvidia V100 GPUs
    - 7.8 TF/s peak
    - 16 GB HBM2
    - 900 GB/s memory performance
    - PCIe Gen3 x16 (32 GB/s bidir)



FURTHER INFORMATION

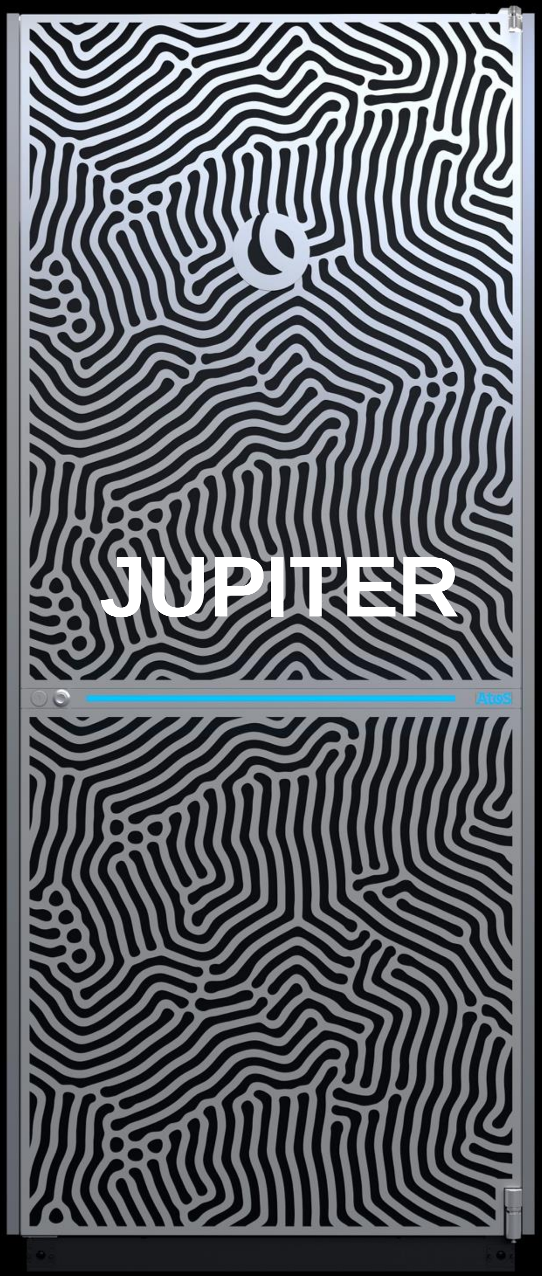
MAINTENANCE HANDLING

- JSC systems go on maintenance for any of the following reasons:
  - JUST (storage cluster) needs maintenance
  - Compute node updates (OS and/or FW and/or configuration changes)
  - Admin node updates (OS and/or FW and/or configuration changes)
  - Emergencies
- Frequency
  - Depends on pending issues
  - Typically decreases as system ages
- Days and duration
  - Typically on Tuesdays
  - Whole working day
  - Announced with at least 1 week in advance
- Communicated through MOTD and status page

IMPORTANT LINKS

- Status page:
  - https://status.jsc.fz-juelich.de/
- General system information
  - https://go.fzj.de/JUWELS
  - https://go.fzj.de/juwels-known-issues
  - https://go.fzj.de/JURECA
  - https://go.fzj.de/jureca-known-issues
  - https://go.fzj.de/JUSUF
  - https://go.fzj.de/jusuf-known-issues
- User documentation:
  - https://apps.fz-juelich.de/jsc/hps/juwels/index.html
  - https://apps.fz-juelich.de/jsc/hps/jureca/index.html
  - https://apps.fz-juelich.de/jsc/hps/jusuf/index.html
- Job reporting:
  - https://go.fzj.de/llview-juwels
  - https://go.fzj.de/llview-juwelsbooster
  - https://go.fzj.de/llview-jureca
- User support at FZJ
  - sc@fz-juelich.de
  - Phone: 02461 61-2828

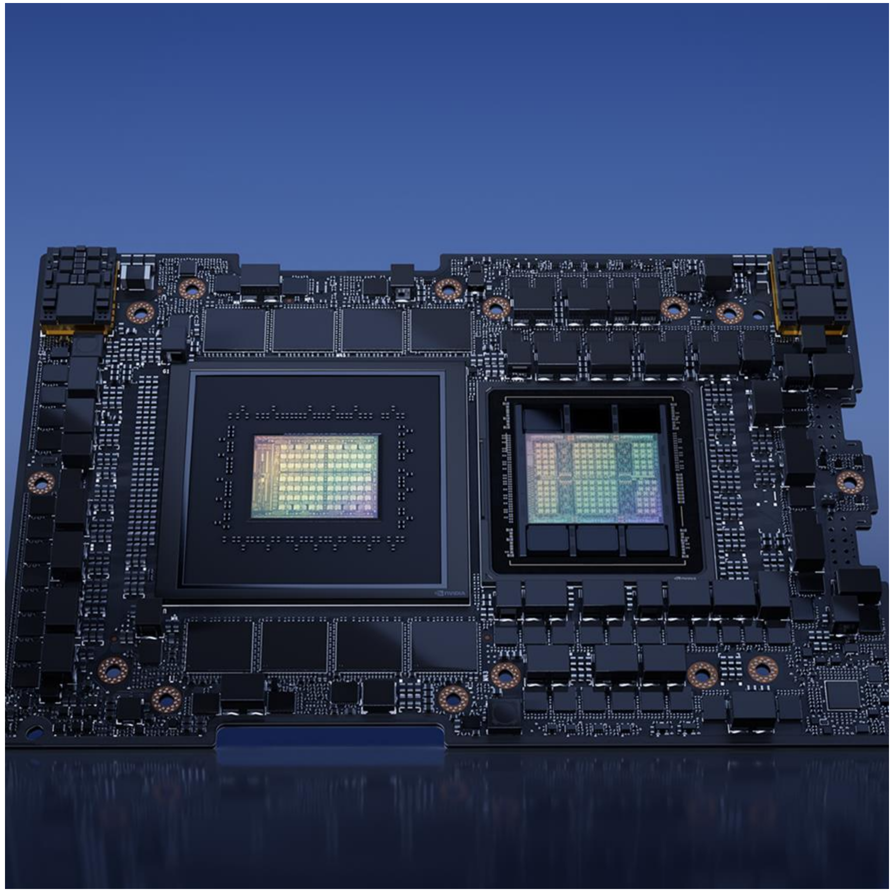
1 MORE THING


JUPITER
Atos

JUPITER – THE BOOSTER

Highly-Scalable Module for HPC and AI workloads

- 1 ExaFLOP/s (FP64, HPL)
- NVIDIA Grace-Hopper CG1
  - ~5900 compute nodes
  - 4× CG1 chips per compute node
- NVIDIA Mellanox NDR
  - 4 NDR200 NICs per compute node
- BullSequana XH3000
  - Direct Liquid Cooled blades
  - 2 compute node per blade



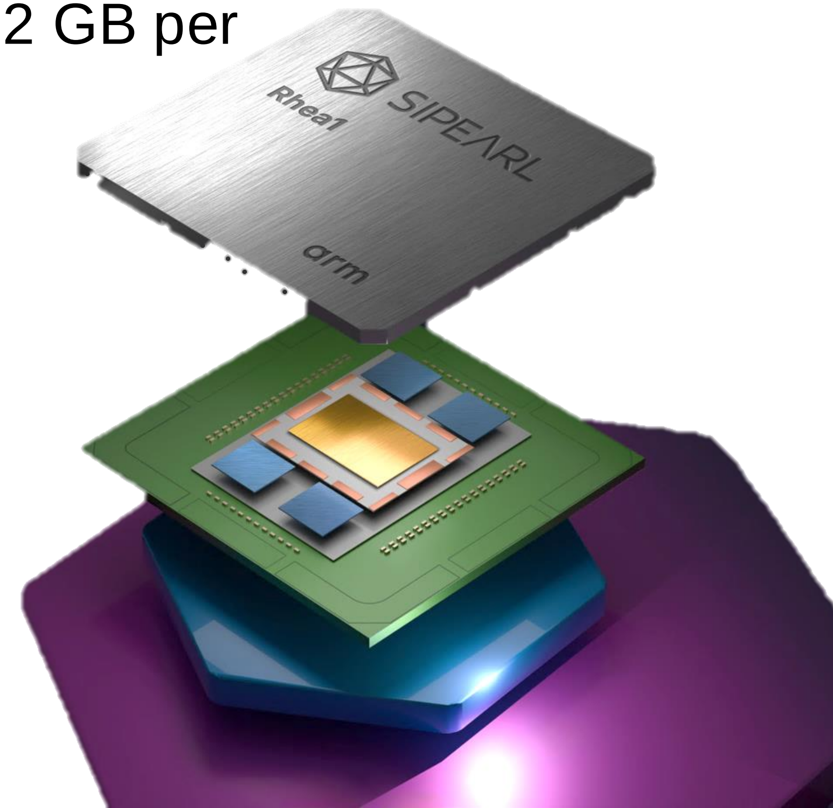
Preliminary numbers, might change during installation

JUPITER – THE CLUSTER

General-Purpose Module for Mixed Workloads

- >5 PetaFLOP/s (FP64, HPL)
- SiPearl Rhea1
  - ~1340 compute nodes
  - 2× CPUs per node
- NVIDIA Mellanox NDR
  - 1× NDR200 NICs per compute node
- BullSequana XH3000
  - Direct Liquid Cooled blades
  - 3× compute nodes per blade

- 80 Neoverse V1 cores
  - 2× 256 SVE each
- 64 GB HBM (128 GB per node)
- 256 GB DDR5 (512 GB per node)



Preliminary numbers, might change during installation

JUWELS VS. JUPITER

	JUWELS	JUPITER
Cluster	**CPU:** Intel Xeon Platinum 8168 **GPU:** NVIDIA V100 **Peak:** 10 PFlop/s	**CPU:** SiPearl Rhea1 **GPU:** none **Mem. Bandwidth:** 0,51 Byte/Flop
Booster	**CPU:** 2* AMD Epyc Rome **GPU:** 4× NVIDIA A100 GPUs **Peak:** 73 PFlop/s	**CPU:** 4* NVIDIA Grace **GPU:** 4* NVIDIA Hopper **Peak:** **>1 EFlop/s**
Network topology	Fat tree and DragonFly+	DragonFly+
System access	GCS or PRACE proposals	GCS and EuroHPC JU proposals
User support	HLST, SDL, ATML, training courses, targeted early access program	**same**

FIRST PUBLIC ACHIEVEMENTS

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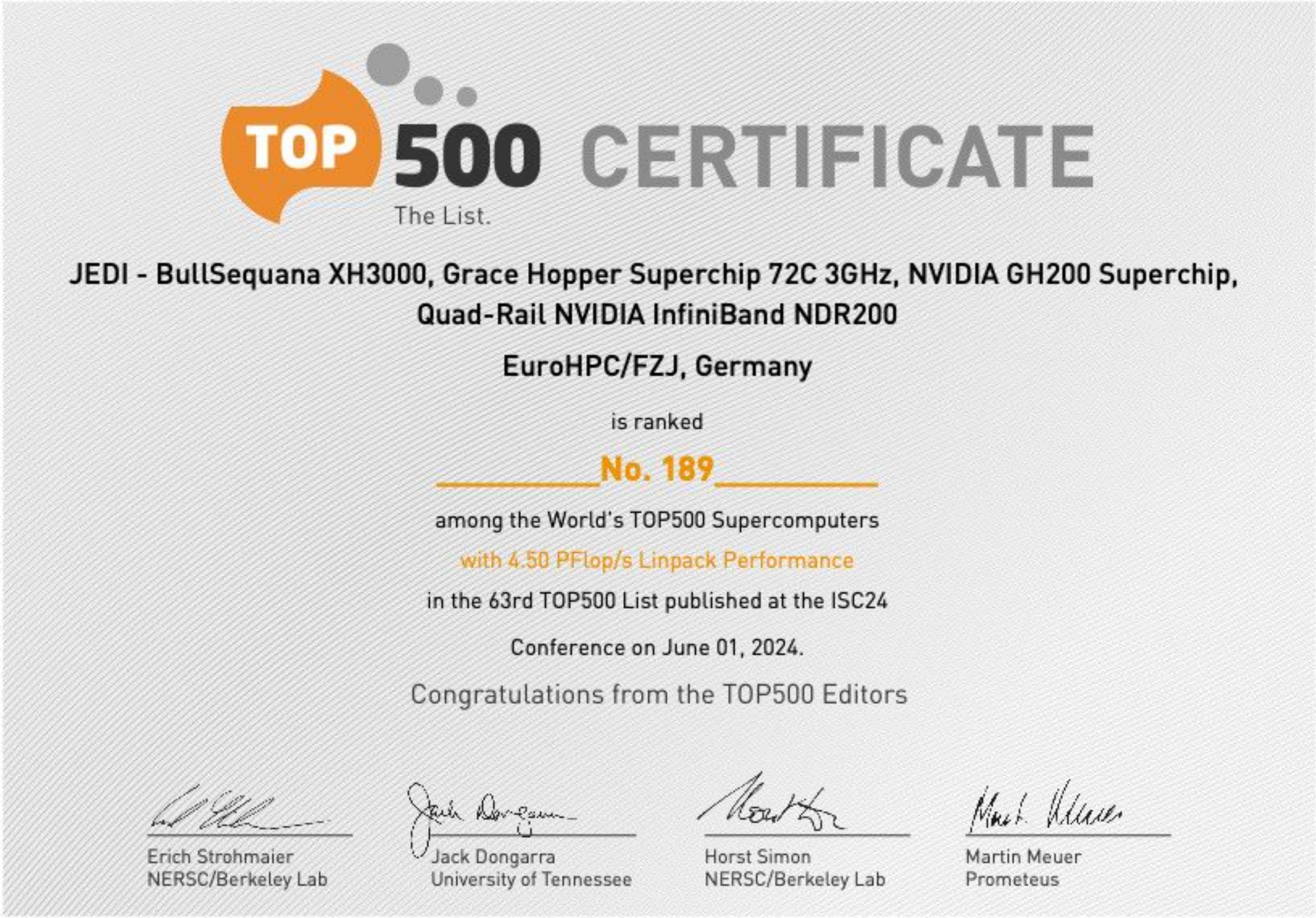


TOP500 CERTIFICATE

The List.

JEDI - BullSequana XH3000, Grace Hopper Superchip 72C 3GHz, NVIDIA GH200 Superchip, Quad-Rail NVIDIA InfiniBand NDR200

EuroHPC/FZJ, Germany

is ranked

No. 189

among the World's TOP500 Supercomputers

with 4.50 PFlop/s Linpack Performance

in the 63rd TOP500 List published at the ISC24

Conference on June 01, 2024.

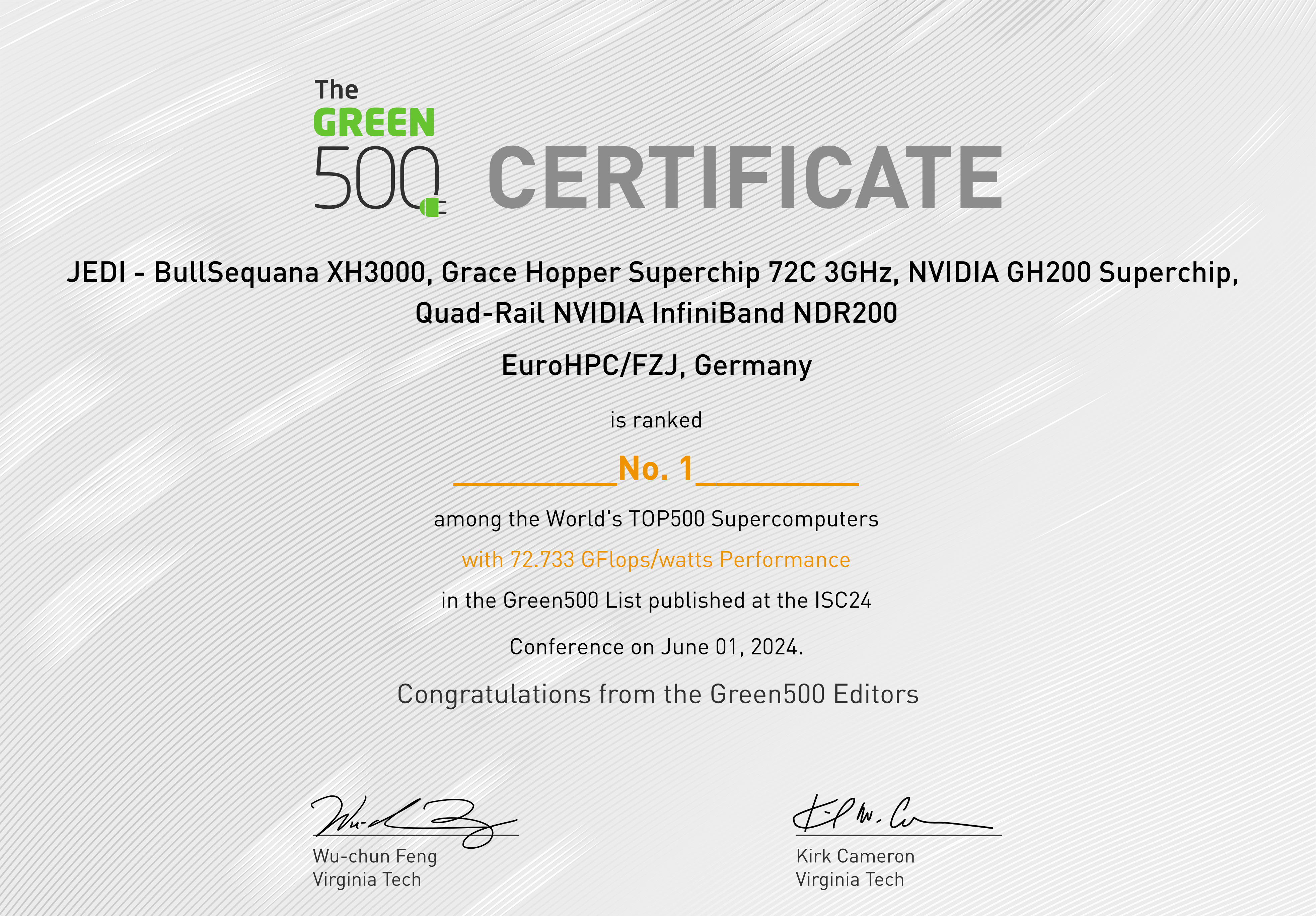
Congratulations from the TOP500 Editors

Erich Strohmaier
NERSC/Berkeley Lab

Jack Dongarra
University of Tennessee

Horst Simon
NERSC/Berkeley Lab

Martin Meuer
Prometeus



The GREEN 500 CERTIFICATE

JEDI - BullSequana XH3000, Grace Hopper Superchip 72C 3GHz, NVIDIA GH200 Superchip, Quad-Rail NVIDIA InfiniBand NDR200

EuroHPC/FZJ, Germany

is ranked

__________No. 1__________

among the World's TOP500 Supercomputers

with 72.733 GFlops/watts Performance

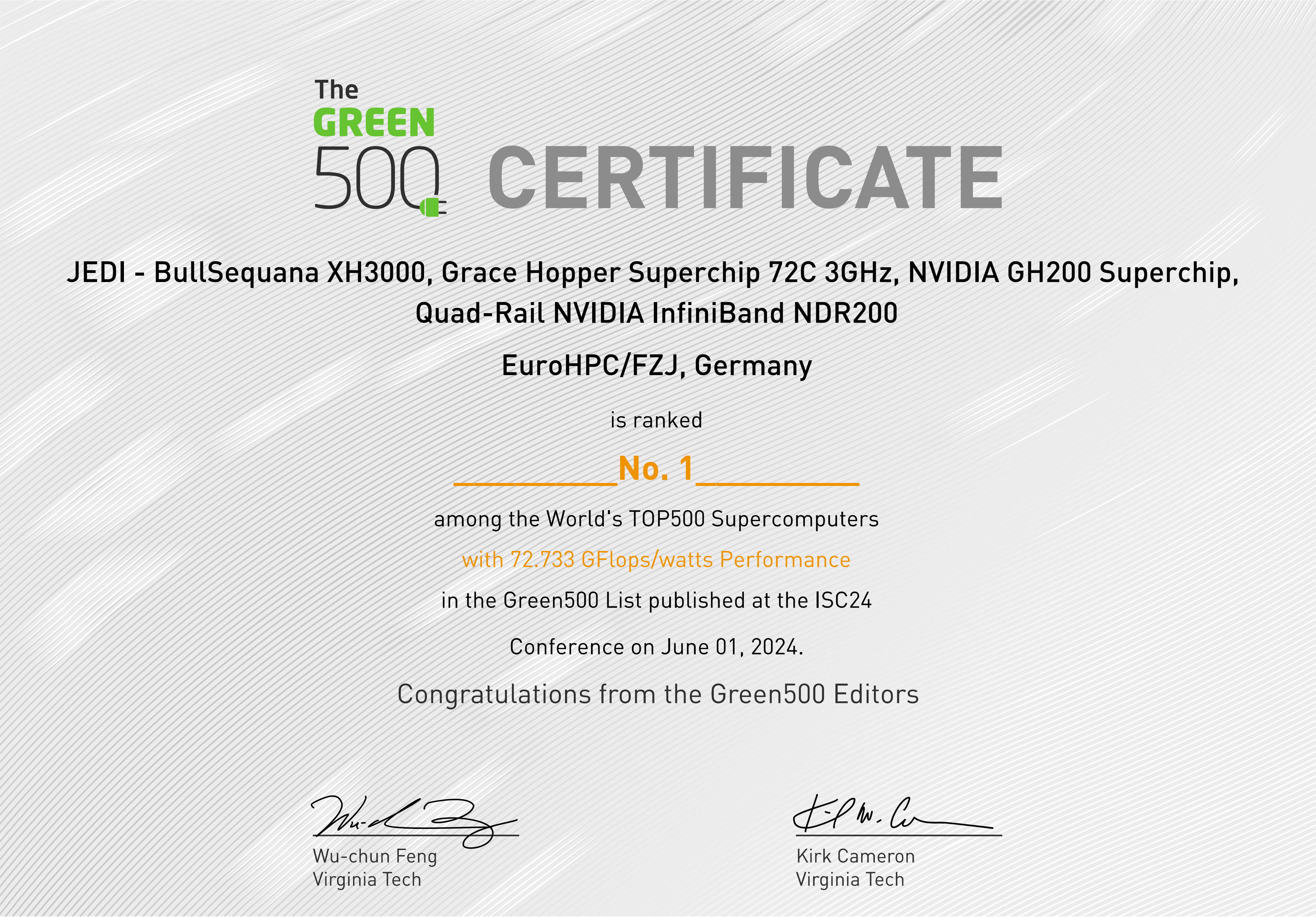
in the Green500 List published at the ISC24

Conference on June 01, 2024.

Congratulations from the Green500 Editors

Wu-chun Feng
Virginia Tech

Kirk Cameron
Virginia Tech



The GREEN 500 CERTIFICATE

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Congratulations from the Green500 Editors

Wu-chun Feng
Virginia Tech

Kirk Cameron
Virginia Tech

- 1 Rack 50% populated
  - 12 Blades
  - 24 Nodes

More details on the Green500 BoF

JUPITER

The Arrival of Exascale in Europe

fz-juelich.de/jupiter | #exa_jupiter

Funding Agencies:

EuroHPC Joint Undertaking

Federal Ministry of Education and Research

Ministry of Culture and Science of the State of North Rhine-Westphalia