



## Executive Summary - HPC Activities in Iceland

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16<sup>TH</sup> APRIL, RECTOR PREPARATION MEETING, ONLINE



@ProfDrMorrisRiedel



@Morris Riedel



@MorrisRiedel



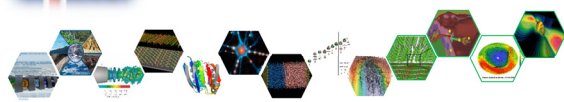
@MorrisRiedel



<https://www.youtube.com/channel/UCWC4VKHmL4NZgFfKoHtANKg>



IHPC National Competence Center  
for HPC & AI in Iceland



EuroHPC  
Joint Undertaking

EOSC  
NORDIC

RAISE  
Center of Excellence

ADMIRE



UNIVERSITY OF ICELAND  
SCHOOL OF ENGINEERING AND NATURAL SCIENCES  
FACULTY OF INDUSTRIAL ENGINEERING,  
MECHANICAL ENGINEERING AND COMPUTER SCIENCE

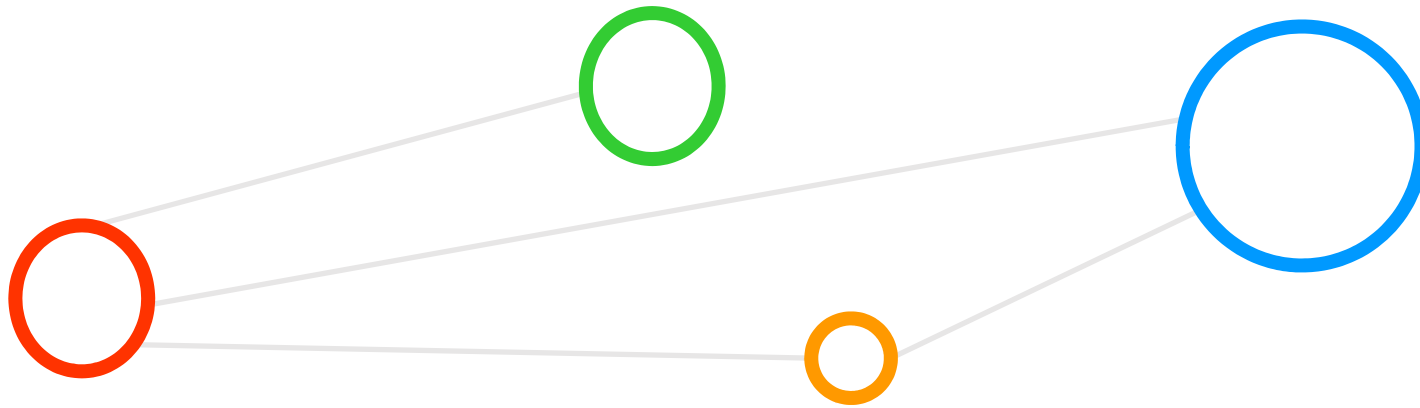
HELMHOLTZAI | ARTIFICIAL INTELLIGENCE  
COOPERATION UNIT

DEEP  
Projects



JÜLICH  
Forschungszentrum | JÜLICH  
SUPERCOMPUTING  
CENTRE

## Executive Summary – Major Icelandic HPC Activities



# Executive Summary – Major Icelandic HPC Activities



## **rannís Icelandic National Infrastructure for HPC**

- ❖ HPC hardware funds by RANNIS; now via roadmap IReiP
- ❖ Proposals yearly required to obtain funds still
- ❖ Joint proposal from IHPC community

## **EuroHPC LUMI Supercomputer in Finland**

- ❖ Supercomputer funded by Finland, Belgium, Czech Republic, Denmark, Estonia, Iceland, Norway, Poland, Sweden, Switzerland
- ❖ Co-Funds by EC and Iceland participation funds from: UoIceland, UoReykjavik, and Hannes Jonsson & Egill Skulason

## **EuroHPC EuroCC National Competence Center for HPC & AI**

- ❖ EU Project (09/2019-08/2021), 2 years
- ❖ Building **Simulation and Data Labs (SDLs)** of the IHPC Community of Users
- ❖ Supports industry engagement in HPC

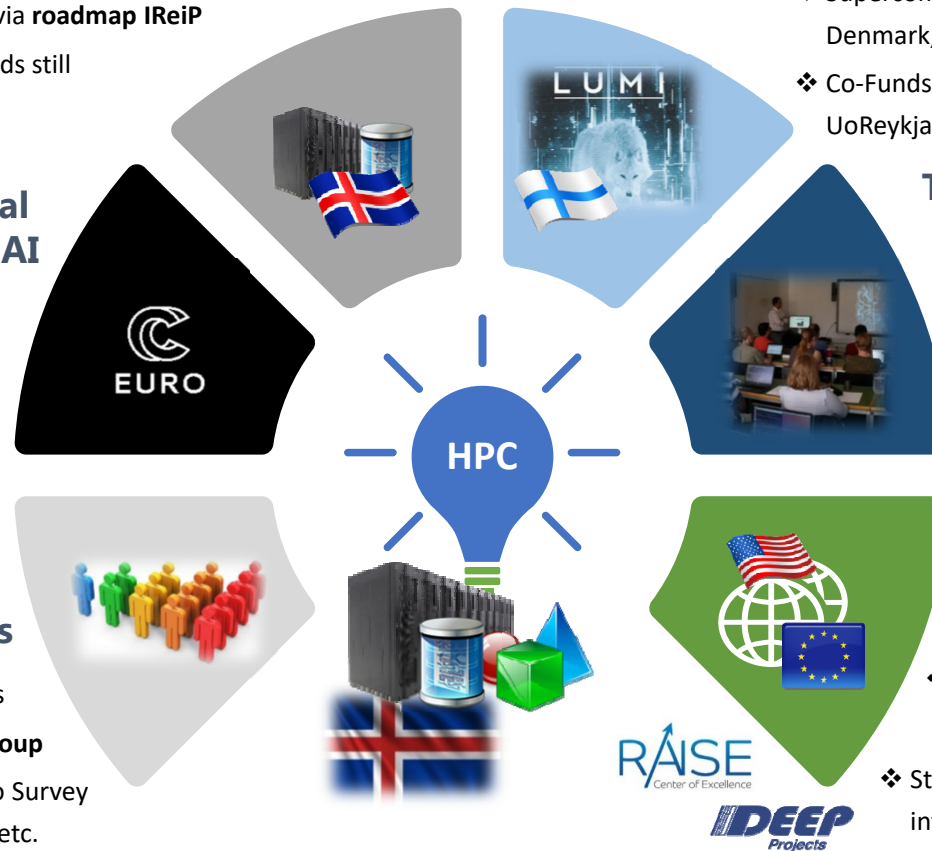
## **Teaching & Education in HPC & AI**

- ❖ University of Reykjavik
- ❖ University of Iceland
- ❖ Arctic Webinar Series (with US partners)
- ❖ Digital/Horizon Europe MSc in HPC



## **IHPC Community of Users**

- ❖ Organized around RANNIS proposals
- ❖ ~53 scientific experts & research group
- ❖ UoIceland/UoReykjavik, Iceland Geo Survey ÍSOR, Met Office & industry: Matis, etc.

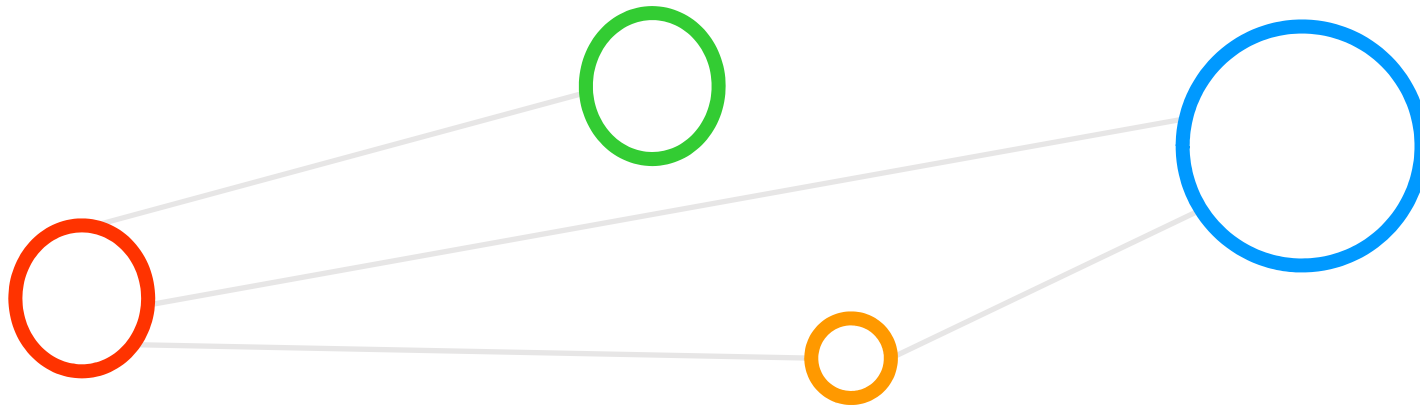


## **International Cooperations**

- ❖ Tactical: ~4 Joint PhDs with Juelich Supercomputing Centre in Germany (#1 HPC System in Europe)
- ❖ Tactical: **EC Projects** like DEEP-EST, EOSC-Nordic, RAISE Center of Excellence (CoE)
- ❖ Strategic: Building an **Icelandic National Lab** with international cooperation together with Industry (e.g. Kaiser Global, other investors)



# IHPC Community of Users





# IHPC Community of Users (1)



Háskóli Íslands - VON	6001692039	Hafsteinn Einarsson	0804923599	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Ebba Þóra Hvannberg	1608574559	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Ivan Shelykh	1803762919	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Egill Skúlason	1003794229	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Lotta María Ellingsen	1301785969	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Haraldur Ólafsson	0912654279	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Jesus Zavala Franco	1901802989	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Jón Tómas Guðmundsson	0306655629	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Pedro Simoes Costa	1506895979	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Helmut Wolfram Neukirchen	2108712689	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Morris Riedel	0	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Freysteinn Sigmundsson	2207664549	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Bryndís Eva Birgisdóttir	2602723499	Vikulega	Doktorsgráða / eða sambærilegt
Háskólinn í Reykjavík - Tölvunarfræðideild	5101054190	Eliahu August	1212743379	Mánaðarlega	Doktorsgráða / eða sambærilegt

Háskólinn í Reykjavík - Verkfræðideild	5101054190	Yonatan Afework Tesfahunegn	1105782619	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskólinn í Reykjavík - Verkfræðideild	5101054190	Erna Sif Arnardóttir	3108813769	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskólinn í Reykjavík - Verkfræðideild	5101054190	Jón Guðnason	0808754449	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskólinn í Reykjavík - Verkfræðideild	5101054190	Kristinn Torfason	3108842199	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskólinn í Reykjavík - Tölvunarfræðideild	5101054190	María Óskarsdóttir	1209862449	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskólinn í Reykjavík - Verkfræðideild	5101054190	Andrei Manolescu	2403582209	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskólinn í Reykjavík - Tölvunarfræðideild	5101054190	Henning Arnór Úlfarsson	2111815679	Vikulega	Doktorsgráða / eða sambærilegt
Háskólinn í Reykjavík - Verkfræðideild	5101054190	Anna Maria Sitek	2706822359	Mánaðarlega	Doktorsgráða / eða sambærilegt
Veðurstofa Íslands	6309080350	Angel Ruiz Angulo	2511772609	Mánaðarlega	Doktorsgráða / eða sambærilegt
Veðurstofa Íslands	6309080350	Jórunn Harðardóttir ktal 0512683509	0	Mánaðarlega	Doktorsgráða / eða sambærilegt
Veðurstofa Íslands	6309080350	Matthew James Roberts	1211762629	Mánaðarlega	Doktorsgráða / eða sambærilegt
Veðurstofa Íslands	6309080350	Jón Elvar Wallevik ktal 1710684799	0	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Sigurður M Garðarsson	0305674479	Mánaðarlega	Doktorsgráða / eða sambærilegt
Matis	6709060190	Viggó Þór Marteinsson	0609614099	Mánaðarlega	Doktorsgráða / eða sambærilegt

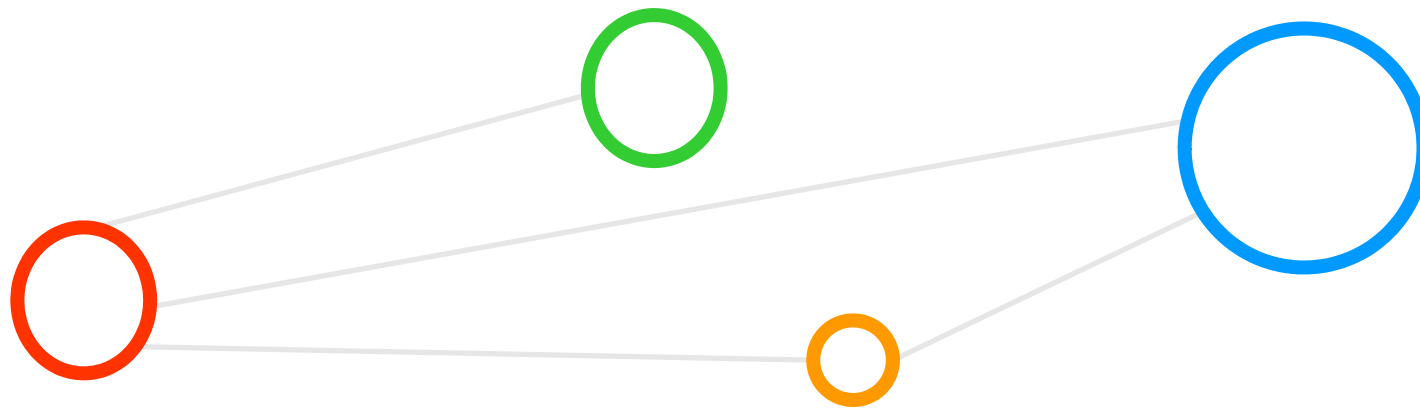
# IHPC Community of Users (2)



Matis	6709060190	Sæmundur Sveinsson	2908842179	Mánaðarlega	Doktorsgráða / eða sambærilegt
Matis	6709060190	Guðmundur Óli Hreggviðsson	1204543749	Mánaðarlega	Doktorsgráða / eða sambærilegt
Matis	6709060190	Ólafur Héðinn Friðjónsson	0402643459	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Thor Aspelund	0401695209	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Jóhanna Jakobsdóttir	0401815209	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Unnur Anna Valdimarsdóttir	3009725359	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - VON	6001692039	Viðar Guðmundsson	2804554669	Daglega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Inga Þórsdóttir	2512554239	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Hugvísindasvið	6001692039	Guðmundur Hálfðánarson	0102560039	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Elín Soffía Ólafsdóttir	3110577319	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Heiða María Sigurðardóttir	0311827199	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Þórhallur Ingi Halldórsson	0601764429	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Sigríður Klara Böðvarsdóttir	0906715379	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Einar Árnason	2606482849	Mánaðarlega	Doktorsgráða / eða sambærilegt

Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Arnar Pálsson	2111705229	Daglega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Birkir Þór Bragason	1002724909	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Guðmundur H Guðmundsson	0204592559	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Kalina Hristova Kapralova	3007802459	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Kristinn Pétur Magnússon	1411574349	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Ólafur Eysteinn Sigurjónsson	2708743399	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Oddur Þór Vilhelmsson	1505683319	Vikulega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Snæbjörn Pálsson	0710632409	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Vilmundur G Guðnason	1501545029	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Þórarinn Guðjónsson	2705675419	Mánaðarlega	Doktorsgráða / eða sambærilegt
Háskóli Íslands - Heilbrigðisvísindasvið	6001692039	Margrét Þorsteinsdóttir	1210624619	Mánaðarlega	Doktorsgráða / eða sambærilegt

## IHPC Community – Simulation and Data Labs (SDLs)



# **NEW** EuroCC EU Project: Building National Competence Centers for HPC & AI



- EuroHPC Joint Undertaking Project
- 33 Countries as Partners
- 50% funding only for University of Iceland (in-kind funding by person Prof. Dr. – Ing. Morris Riedel & Prof. Dr. Ebba Hvanberg)
- Goal: Establish National Competence Centers (NCCs) in the area of HPC & AI to bring national activities together

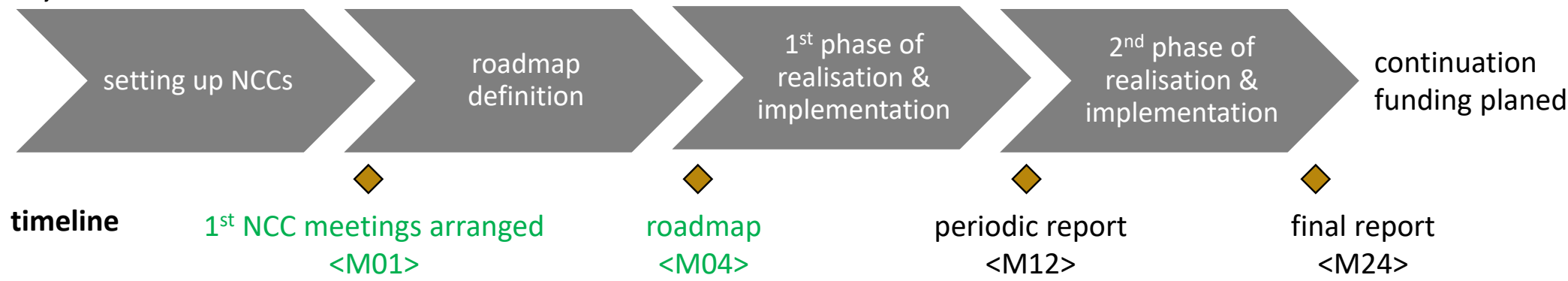


**EuroCC funds two research activities for the University of Iceland in the area of neuroscience & computational fluid dynamics**

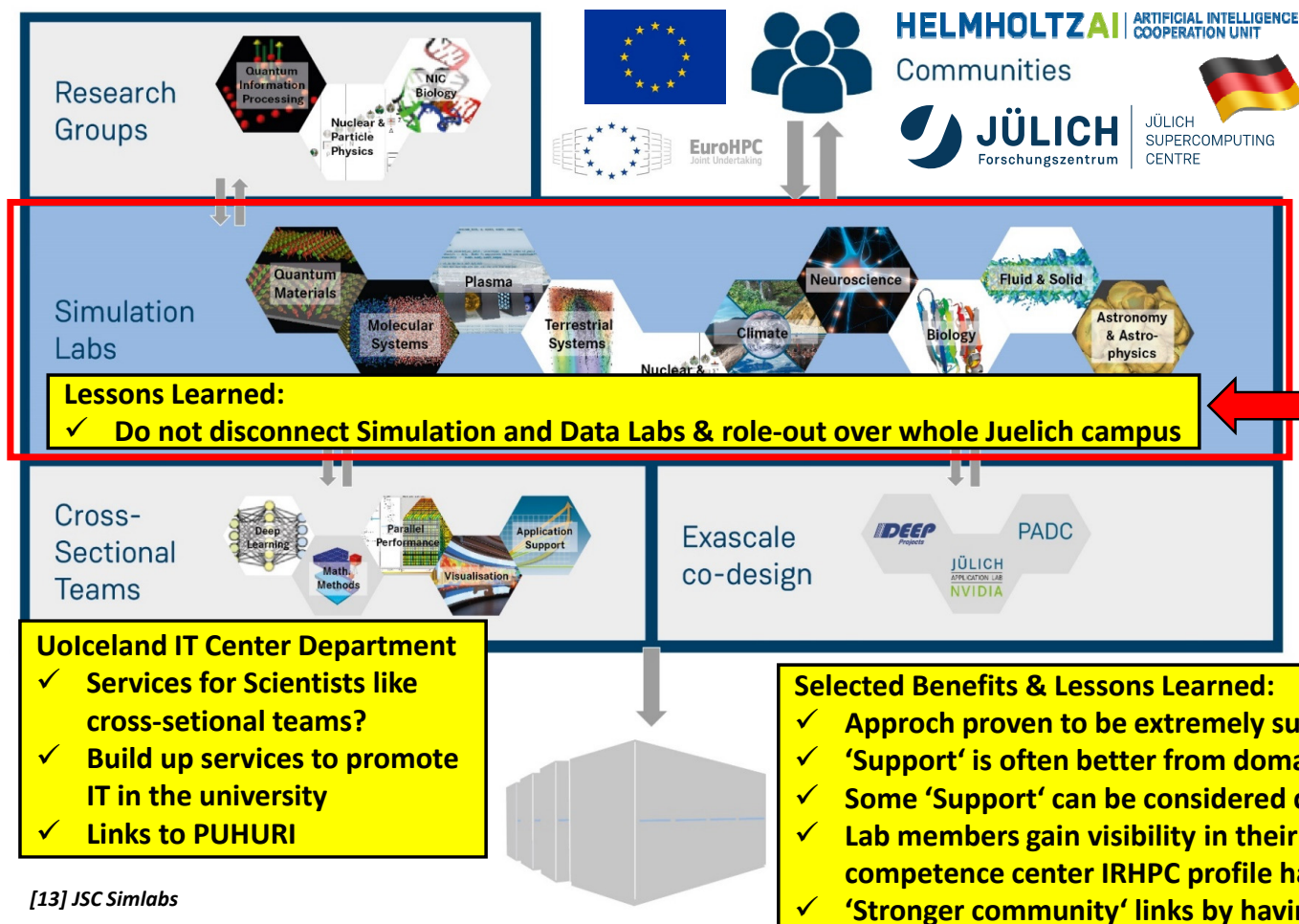
**The National Competence Center (NCC) for Iceland of the EuroCC project represents our already established IHPC & IRHPC activities is fully complementary to those activities**



- Major activities: Community building (including industry)



# Community-building with Simulation & Data Labs (SDLs) – Lessons Learned

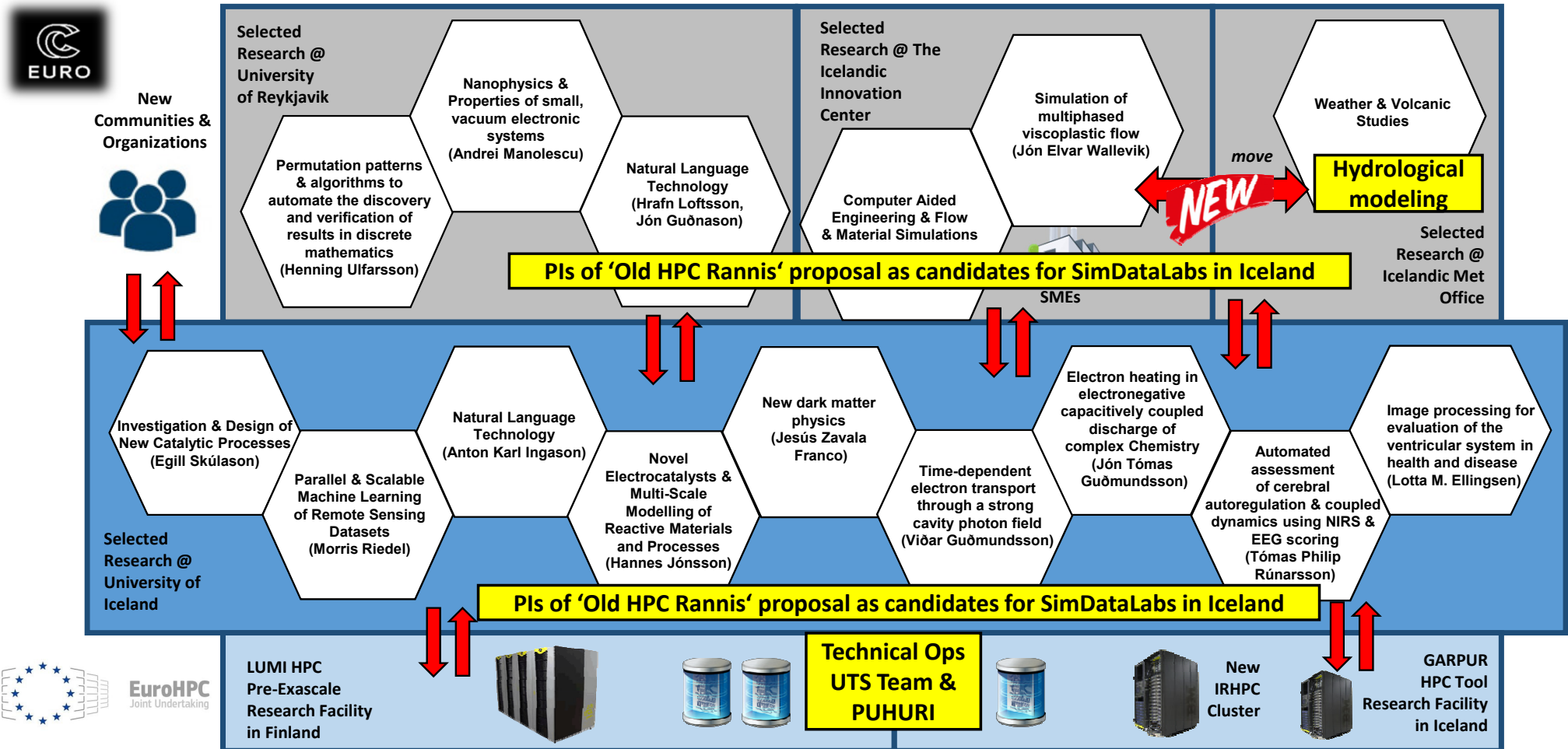


*'For some years now there has been a growing realisation that application software is lagging behind HPC hardware developments. While several Petaflop-scale supercomputers are now available worldwide, it is becoming increasingly difficult to exploit these machines with single applications. Substantial efforts are needed in order to enable computational science communities to solve problems with high scientific impact through efficient use of high-end supercomputing resources. To help meet this challenge the Juelich Supercomputing Centre (JSC) has proposed a new type of domain-specific research and support structure: the Simulation Laboratory.'*

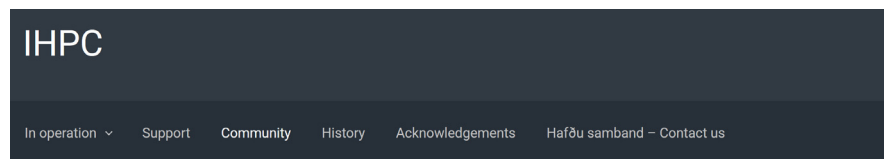
[13] JSC Simlabs



# First Steps towards Potential Simulation and Data Labs in Iceland



# SimDataLabs in Iceland – Confirmed Participation (Work-in-Progress)

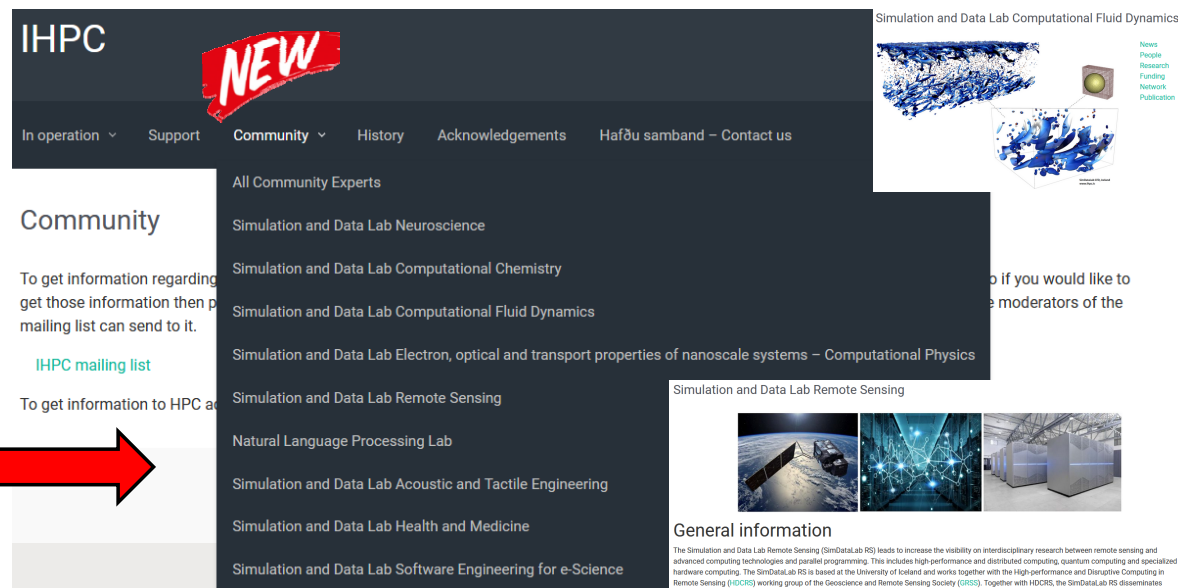


## Community

To get information regarding upgrades, downtime or some other important issues then we will send those information to users with email. If you would like to get those information then please sign up. This is not used very regularly so don't worry about getting spammed through this list and our mailing list can send to it.

[IHPC mailing list](#)

To get information to HPC admins, then please send an email to [help@hi.is](mailto:help@hi.is) and include HPC in the subject.



## [14] IHPC Community

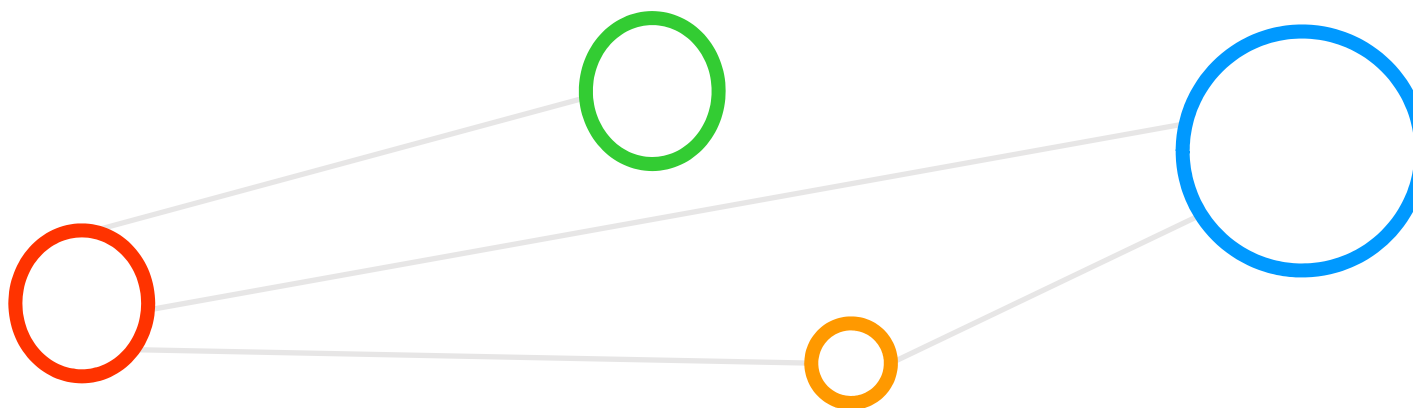


Jointly engage in future funding together, e.g. EuroHPC Master of Science in HPC program and many other activities planned in Horizon Europe

## Selected Discussion Topics:

- ✓ Governance of Labs: Bottom-Up by PI, but optional Executive Advisory Board (EAB) members could be used to guide & 'review' labs on a yearly basis (could be useful): labs of Juelich are 'friendly' reviewed on a 1-2 years basis as part of funding program
- ✓ Engagement with Industry: ISOR, MATIS, MAREL, DECODE (work-in-progress), etc.
- ✓ Including Start-Ups: Nordverse (medical NLP, done), Treble (Acoustic, done), others?
- ✓ Relationship to our new IRHPC & steering board activities → Logo for IRHPC/NCC?!
- ✓ Teaching better topics of relevance in HPC Course for Iceland, other activities?

# Icelandic National Infrastructure for HPC



# Icelandic National Infrastructure for HPC – Hardware Procurement



## 3.1 Innviðir infrastructure

Raðnr.	Innviður	Fjöldi	Erl. einingaverð	Gjaldmiðill	Annar gjaldmiðill	Gengi	ISK einingaverð	ISK heildarkostnaður
1	CPU-nodes	1	0 ISK			1	80.000.000	80.000.000
2	GPU notes	1	0 ISK			1	76.000.000	76.000.000
3	CPU-GPU-nodes	1	0 ISK			1	29.000.000	29.000.000
4	IO-heavy CPU-nodes	1	0 ISK			1	48.000.000	48.000.000
5	Cloud-component	1	0 ISK			1	35.000.000	35.000.000
6	E-infrastr. Provider / EuroHPC	1	0 ISK			1	18.000.000	18.000.000
7	Renewal/Replacement	1	0 ISK			1	113.000.000	113.000.000
8	New Storage System Core	1	0 ISK			1	45.000.000	45.000.000
9	Additional storage solutions	1	0 ISK			1	80.000.000	80.000.000
10	Datacenter network	1	0 ISK			1	60.000.000	60.000.000
11	Software solutions	1	0 ISK			1	30.000.000	30.000.000
12	Installation and implementation	1	0 ISK			1	30.000.000	30.000.000
13	Additional servers	1	0 ISK			1	30.000.000	30.000.000

## 3.2 Mótframlög net contribution

Stofnun/Fyrirtæki	Kt. stofnunar/fyrirtækis	Upphæð	Skýring	Yfirlýsing
Háskóli Íslands	6001692039	168.500.000	Mótframlag til 5 ára í þús kr	
Háskólinn í Reykjavík ehf.	5101054190	17.500.000	Mótframlag til 5 ára í þús kr	
Veðurstofa Íslands	6309080350	500.000	Mótframlag til 5 ára í þús kr	
Matís	6709060190	10.000.000	Mótframlag til 5 ára í þús kr	
ÍSÖR	6005034050	10.000.000	Mótframlag til 5 ára í þús kr	

X 1000 over 5 years

## Icelandic Research e-Infrastructure Project (IREIP) Pis of RANNIS proposal



IHPC Icelandic National Competence Center for High Performance Computing and Artificial Intelligence



200401-901

Innviðasjóður

75 % funding infrastructure fund

### 2.1 Innviðir

### 4. Skoða og skila inn

#### Heiti umsóknar\*

Icelandic Research e-Infrastructure Project (IREIP)

#### Heildarkostnaður

Innviðir samtals	674.000.000 kr.
Hlutfall sótt til Innviðasjóðs	75%
Umsótt upphæð	505.500.000 kr.
Mótframlög	206.500.000 kr.
Eftirstöðvar	-38.000.000 kr.

#### Meginfagsvið\*

Heilbrigðis- og lífvísindi

health & life sciences

#### Lykilorð 1

E-infrastructure

#### Lykilorð 2

Data processing, storage and sharing

#### Lykilorð 3

HPC

#### Kostnaður eftir innviðategundum

Innviður	Upphæð
Tækjakaup	644.000.000 kr.
Uppbygging rafræns innviðar	30.000.000 kr.

#### Hlutfall heildarkostnaðar sem sótt er um (án VSK)\*

75

hardware & electronic equipments

#### Stutt lýsing til opinberrar birtingar\*

Verkefnið snýst um uppbyggingu á öflugum innviðakjarna upplýsingatækni sem er sérsníðinn fyrir íslenskt vísindastarf. Þörf fyrir upplýsingatækni í flestum rannsóknaverkefnum hefur farið hratt vaxandi en verkefnið eru oft dreifð og megna ekki að höndla öflugan upplýsingatækni ein og sjálf. Það væri veruleg lyftistöng fyrir íslenskt vísindasamfélag ef það hefði aðgang að öflugum og jafnframt hagkvæmum innviðakjarna sem rekinn væri á faglegan hátt

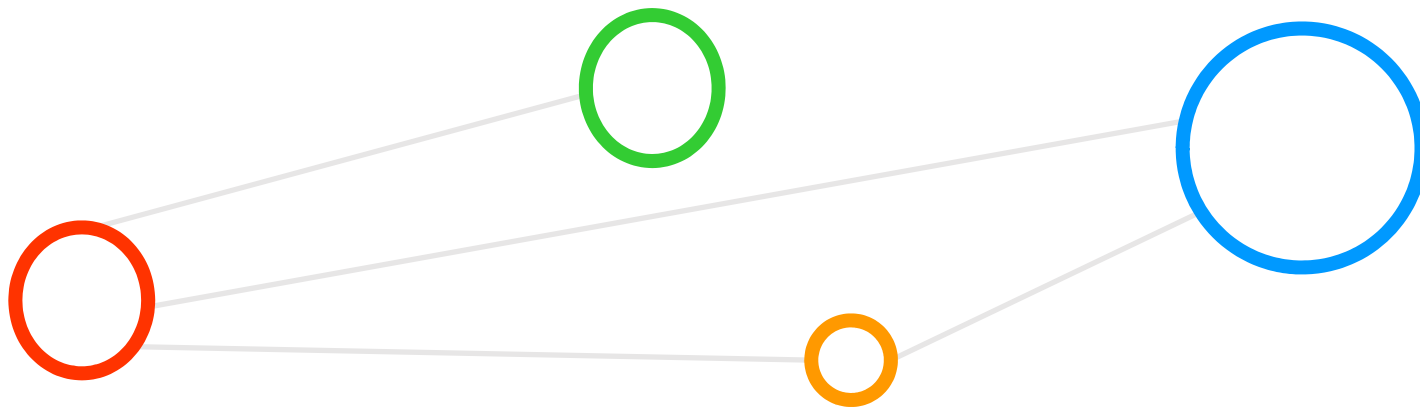
#### Lýsing á innviðum\*

Innviðalýsing\_vegvisir\_vidarGHKfinal.pdf

### 2.2 Umsjónaraðilar

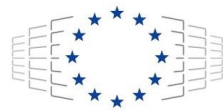
Hlutf.	Stofnun/Fyrirtæki	Kennitala	Tengiliður	Kennitala	Tölvupóstfang	Símanr.
Bókhaldsumsjá innviðar:	Háskóli Íslands	6001692039	Jenný Bára Jensdóttir	2612675439	jbj@hi.is	5254094
Staðsetning innviðar:	Háskóli Íslands	6001692039	Guðmundur H Kjærnestad	1108647449	ghkjaerne@hi.is	8969681

## EuroHPC – LUMI Supercomputer in Finland





# EuroHPC – LUMI Supercomputer in Finland



**EuroHPC**  
Joint Undertaking

**LUMI**

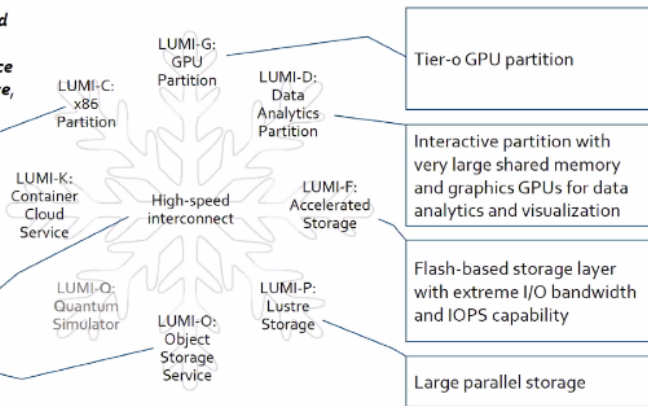
## LUMI system architecture

LUMI is a Tier-0 GPU-accelerated supercomputer that enables the convergence of **high-performance computing, artificial intelligence, and high-performance data analytics.**

- Supplementary "Tier-1" CPU partition
- M, L and XL memory nodes

Possibility for combining different resources within a single run

Encrypted object storage (Ceph) for storing, sharing and staging data



**1 SYSTEM**  
**550+ Pflop/s**  
PEAK PERFORMANCE

LUMI's computing power will be over 550 petaflops.

COMPUTING POWER EQUALS  
**1.5 MILLION**  
MODERN LAPTOP'S  
CAPACITY

LUMI's computing power is equivalent to the combined performance of 1.5 million of the latest laptop computers. These would form over 23-kilometer high tower.

**117 PB**  
STORAGE

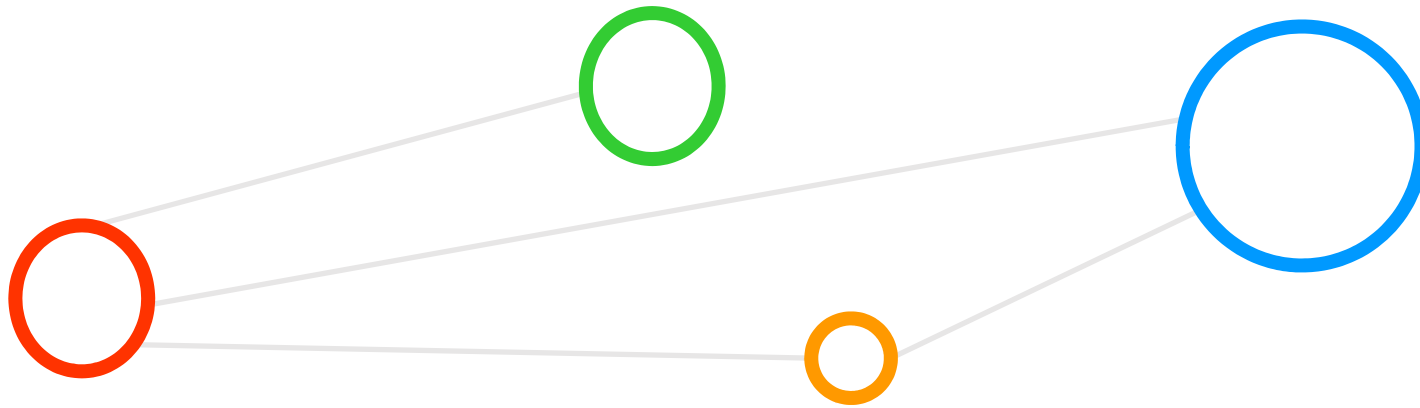
In total, LUMI will have astounding storage of 117 petabytes and an impressive aggregated I/O bandwidth of 2 terabytes per second.

**100%**  
HYDROPOWERED  
ENERGY UP TO  
**200MW**

LUMI is using 100% hydropowered energy. Up to 200MWs are available. The **waste heat** of LUMI will produce 20 percent of the district heat of the area.

[6] LUMI Supercomputer

# Teaching & Education in HPC & AI



# Teaching & Education in HPC & AI



## Masterworks Webinar Series

Advanced Computing driven research in Health Sciences, Energy, and the Environment

Arctic Master Works Webinar and Panel Session 2 Master Works Webinar and Panel Session 1

As part of an effort to promote and foster new scientific collaboration among Arctic nations, we are initiating a Master Works webinar series to highlight the impact of advanced computing in health sciences, energy, and environmental research. This webinar series brings together scientists from the U.S., Iceland and the Nordic countries to discuss compelling scientific challenges of common interest being addressed through advanced computing and to explore opportunities for collaboration. These Master Works events will feature two 30 minute presentations followed by a 30 minute panel session, total 90 min.

- Date: Wednesday December 9, 2020
- Time: 4pm GMT 10am CDT 9am MDT
- Zoom Link: [MasterWorks webinar link](#)

**Presenter**

**Henrik Madsen** - Professor, Head of Section, Dept. of Applied Mathematics and Computer Science (DTU COMPUTE), Technical University of Denmark.

**Title:** Digitalization for the future weather-driven low-carbon energy system

**Abstract:** Today energy systems are operated and planned such that the production follows the demand. However, a future low-carbon society calls for systems where demand follows the weather-driven energy production. This highlights a need for a disruption of the whole spectrum of methods ranging energy systems operation to planning. Most importantly we need methods for enabling energy flexibility at all levels of the society; examples being buildings, supermarkets, wastewater treatment plants, districts and cities. We describe a framework called the Smart-Energy Operating-System (SE-OS) for controlling the electricity load in integrated energy systems using big data analytics, AI, edge-to-cloud computing and IoT solutions. The framework can also provide ancillary services (like congestion management, voltage and frequency control) for systems with a large penetration of wind and solar power.

**Ben Kroposki** - Director of the Power Systems Engineering Center at the National Renewable Energy Laboratory and IEEE Fellow, where he leads strategic research in the design, planning and operations of electrical power systems.

**Title:** Understanding the Challenges with Integrating Very High Levels of Wind and Solar in Electric Power Systems

## Webinar Series Organizing Committee

- Morris Riedel, Associate Professor, University of Iceland
- David Martin, Industry Partnerships and Outreach Manager, Argonne National Laboratory
- Henning Úlfarsson, Assistant Professor, Reykjavik University
- Steve Hammond, Senior Research Advisor, National Renewable Energy Laboratory



HÁSKÓLI ÍSLANDS



HÁSKÓLINN Í REYKJAVÍK  
REYKJAVÍK UNIVERSITY

Teaching HPC & AI university courses at two universities



EuroHPC  
Joint Undertaking

emerging education activities



long-term center of excellence in HPC, e.g. RAISE

European Commission Funding & tender opportunities  
Single Electronic Data Interchange Area (SEIDIA)

SEARCH FUNDING & TENDERS HOW TO PARTICIPATE PROJECTS & RESULTS WORK AS AN EXPERT SUPPORT

Training and Education on High Performance Computing

TOPIC ID: EuroHPC-2020-03

[Grant](#)

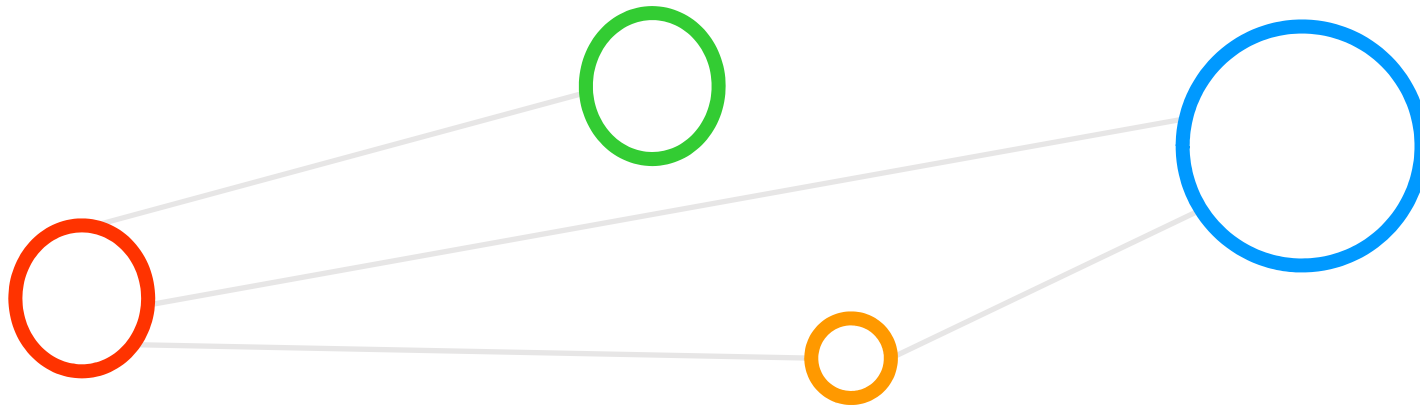
General information	General information	
Topic description	Programme	
Conditions and documents	Horizon 2020 Framework Programme	
Partner search	Call	
Submission service	Training and Education on High Performance Computing (H2020-JTI-EuroHPC-2020-03)	
Topic related FAQ	Type of action	
Get support	EuroHPC-CSA EuroHPC-CSA	
Call updates	Deadline model	Opening date
	single-stage	17 March 2021
		Deadline date
		01 July 2021 17:00:00 Brussels time

## INDICATIVE Pillar 5: Investment Plan for 2021-27 Digital Europe Programme Funding

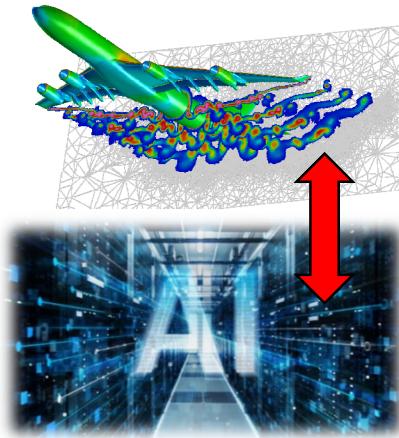
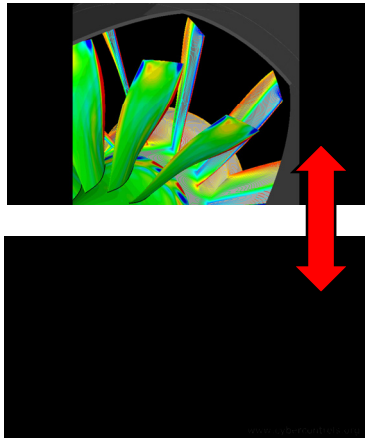
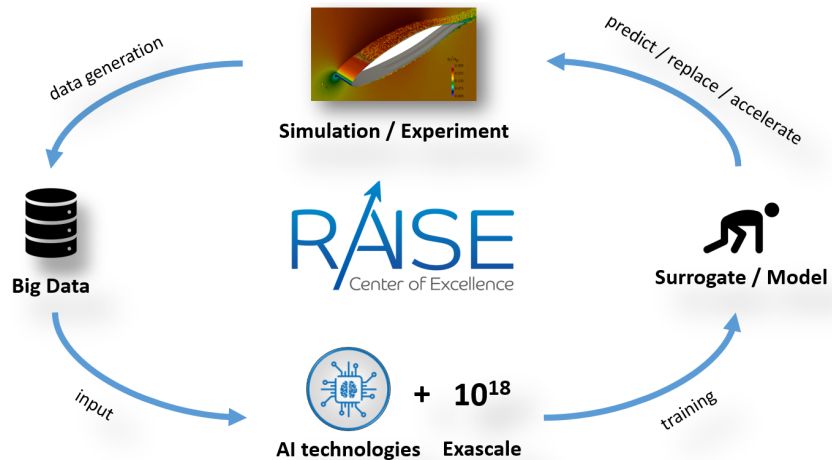
PILLAR	ACTION	Total EU (21 - 27)
Usage & Skills	Supporting Networking National Centres of Competence (CoC) on HPC (Actions to strengthen the wide application of HPC and increasing the innovation potential of SMEs using advanced HPC services)	€100M
Usage & Skills	Education (Curricula development) - Short Term trainings/Traineeships	€30M
Usage & Skills	M.Sc. HPC	€20M



## International Cooperations – EU Projects in the HPC Field



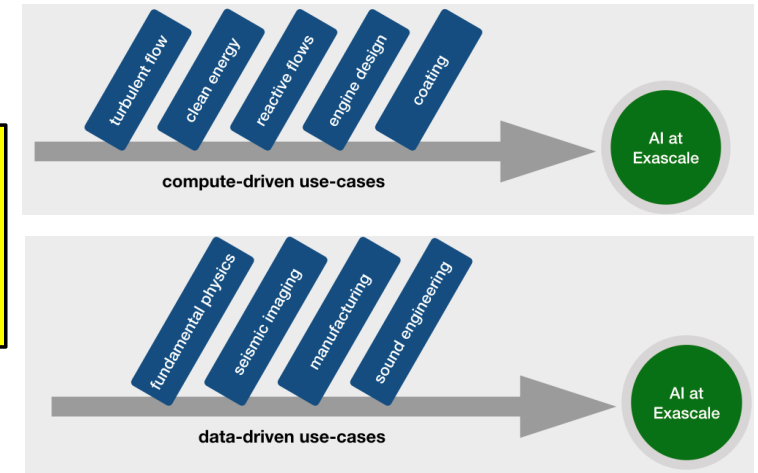
# NEW RAISE Center of Excellence (CoE) EU Project – HPC Intertwined with AI



[4] CoE RAISE Web Page

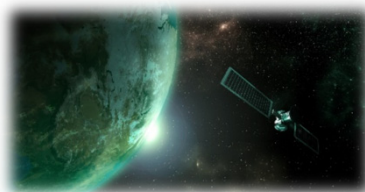
[3] Simulation Figure

RAISE funds three use cases for the University of Iceland in the area of AI-enabled remote sensing, sound engineering, and links with our computational fluid dynamics activities





# DEEP Series of HPC Projects – Modular Supercomputing Architecture Research



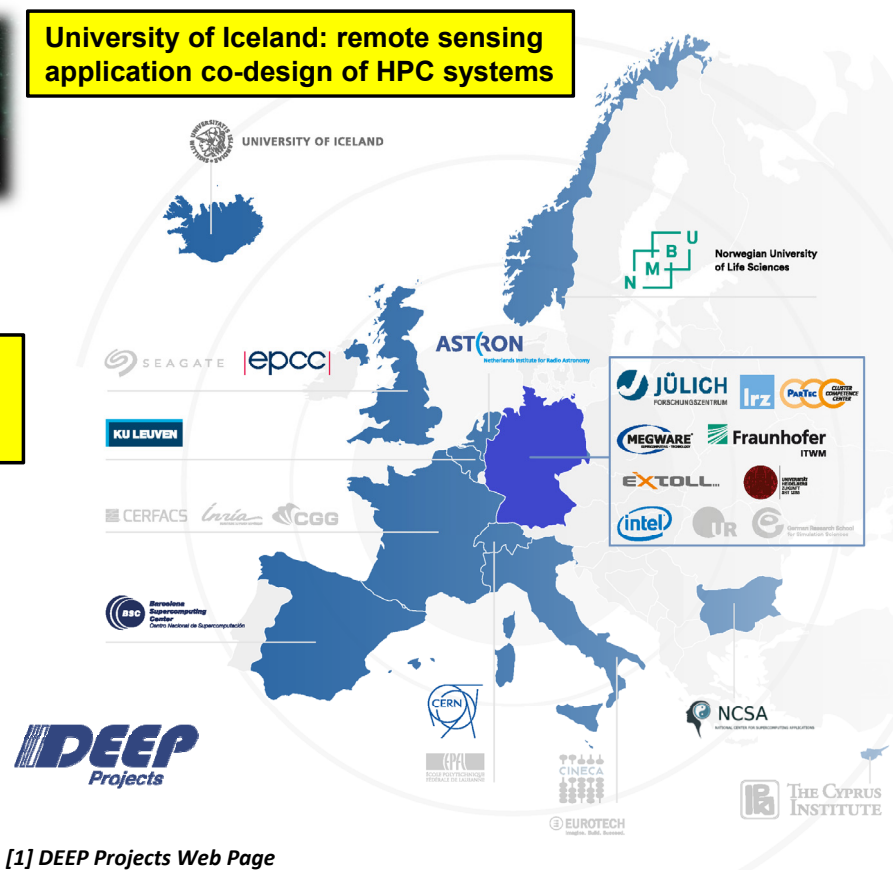
**University of Iceland: remote sensing application co-design of HPC systems**

**Strong collaboration with our industry partners Intel, Extoll & Megware**

**Strong collaboration with industry partners Intel, Extoll & Megware**

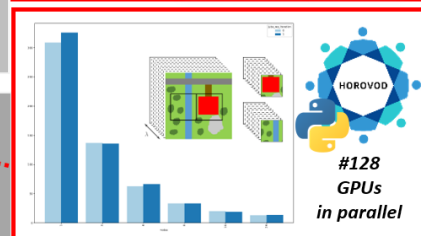
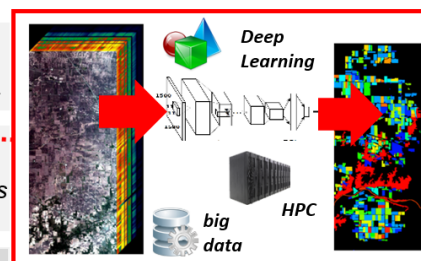
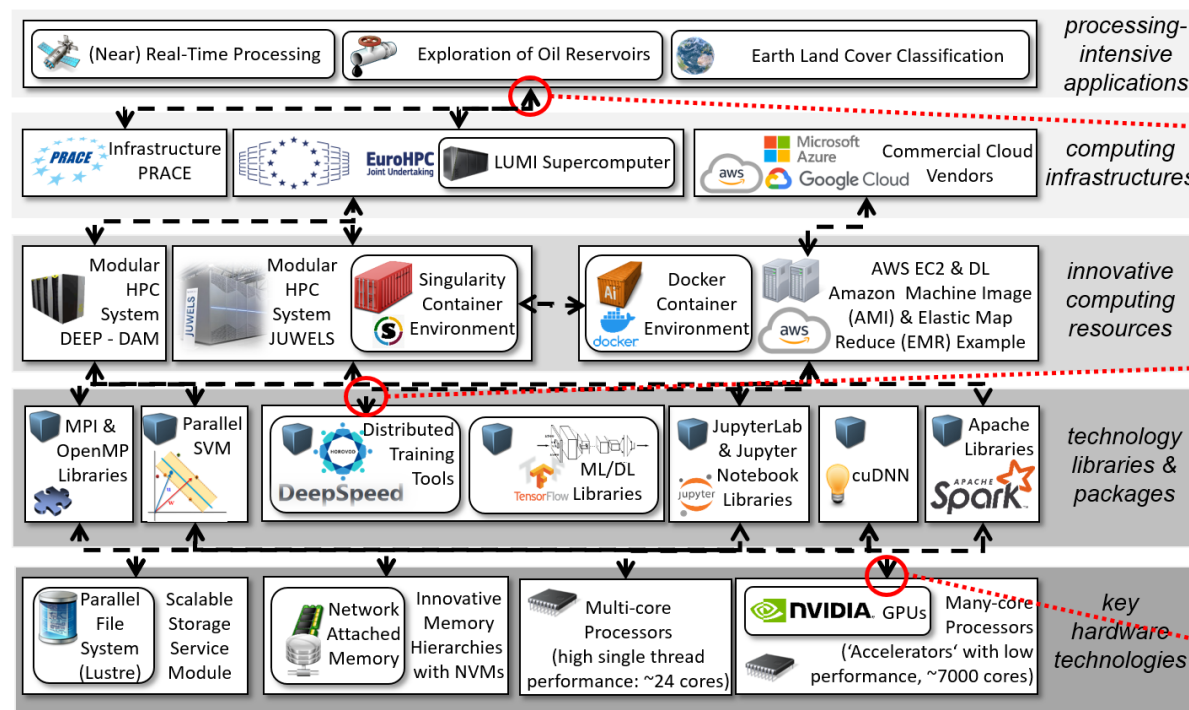
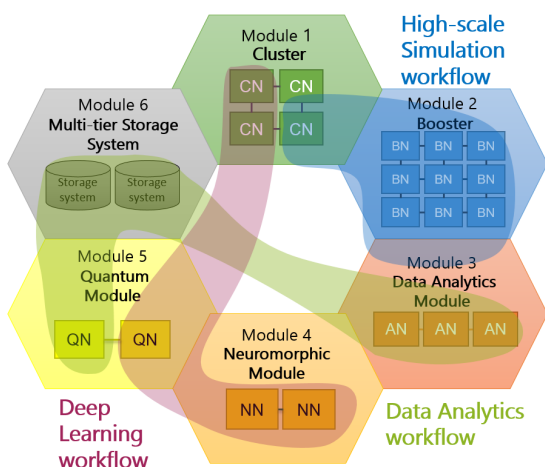
**Juelich Supercomputing Centre implements the DEEP projects designs in its HPC infrastructure**

- 3 EU Exascale projects  
DEEP, DEEP-ER, DEEP-EST
- 27 partners  
Coordinated by JSC
- EU-funding: 30 M€  
JSC-part > 5,3 M€
- Nov 2011 – Mar 2021



[1] DEEP Projects Web Page

# DEEP Series of Projects – Research Examples & Need for Academic HPC Centres

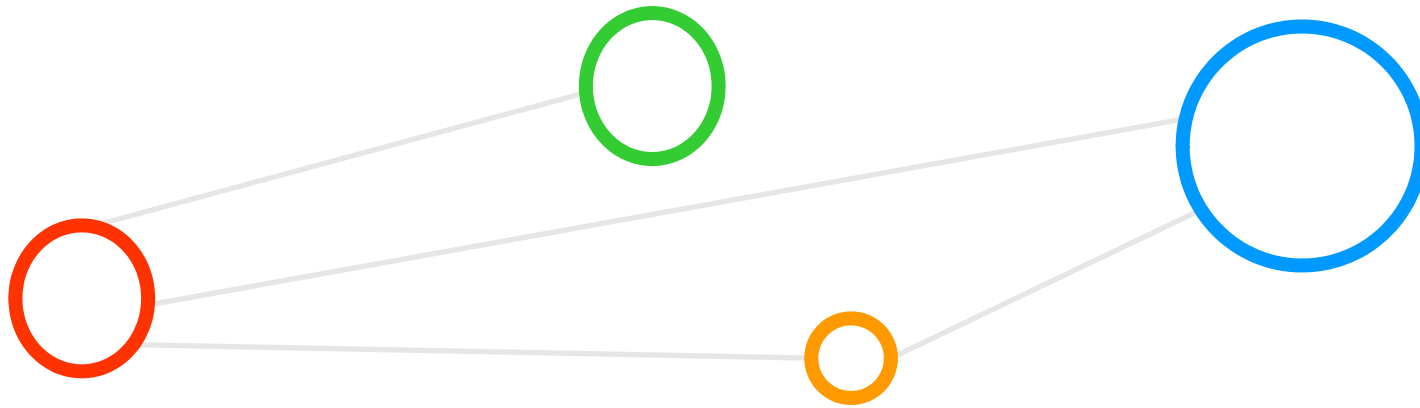


The modular supercomputing architecture (MSA) enables a flexible HPC system design co-designed by the need of diverse research application workloads

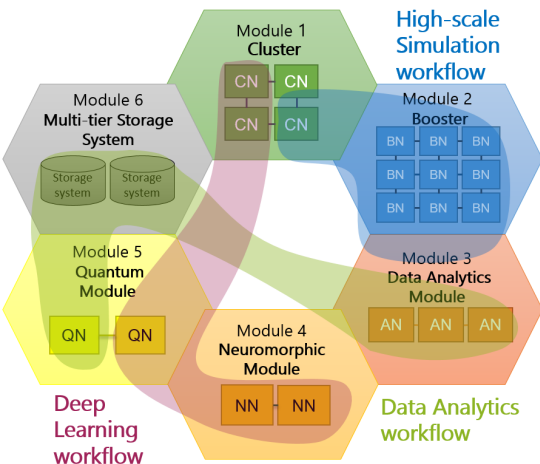
Commercial cloud computing is no option to be used here instead (e.g., Amazon Web Services charge 24\$/hour GPU)

[11] R. Sedona & M. Riedel et al., MDPI, Journal of Remote Sensing

## International Cooperations – Juelich Supercomputing Centre – Germany



# International Collaboration Partners: Juelich Supercomputing Centre & LUMI

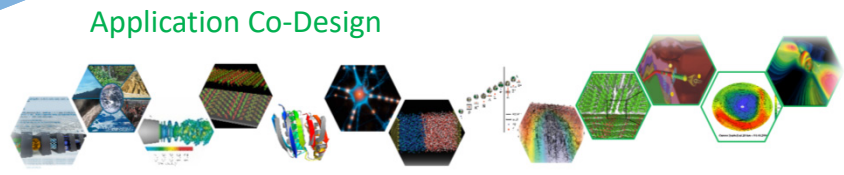


**DEEP Projects** [1] DEEP Series of Projects Web Page

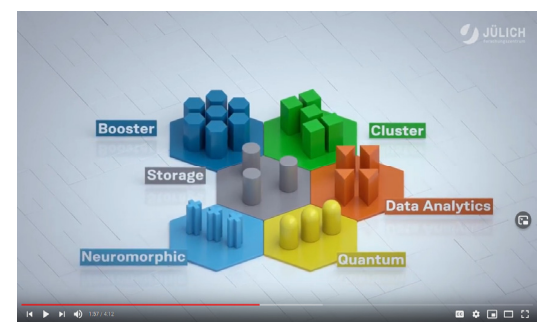
**Despite the strong collaborations, it is important to have local HPC resources in Iceland for education & research (!)**



2018

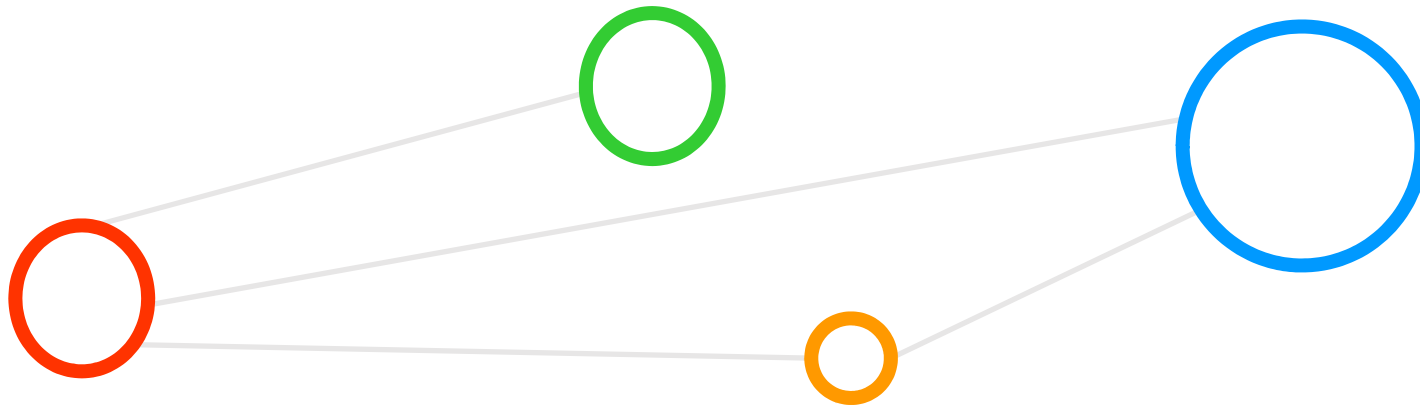


2020



[2] YouTube, 'flexible and energy-efficient supercomputer: JUWELS is faster than 300 000 modern PCs'

# Lecture Bibliography





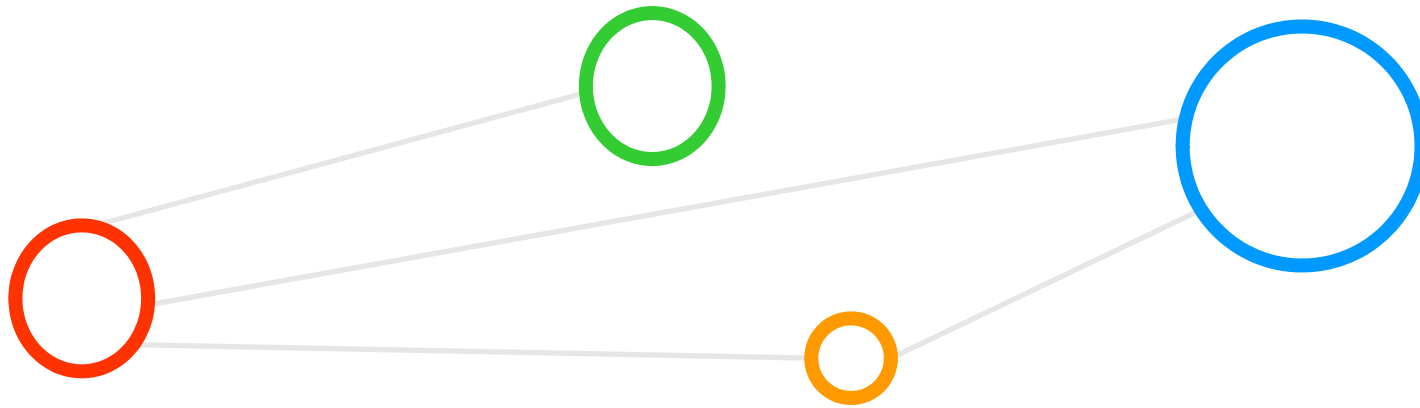
# Selected References (1)

- [1] DEEP Series of Projects Web page, Online:  
<http://www.deep-projects.eu/>
- [2] YouTube Video, 'flexible and energy-efficient supercomputer: JUWELS is faster than 300 000 modern PCs' Online:  
<https://www.youtube.com/watch?v=t5kNxPT5rSY&list=PLCer2BlxxQ2zToC6SRVlfwj0MO1-xli6I>
- [3] Copyright Institute of Aerodynamics and Chair of Fluid Mechanics, RWTH Aachen University, Online:  
<https://www.aia.rwth-aachen.de>
- [4] CoE RAISE Web page, Online:  
<http://www.coe-raise.eu>
- [5] EuroHPC Joint Undertaking Web page, Online:  
<https://eurohpc-ju.europa.eu/>
- [6] LUMI EuroHPC Supercomputer hosted at CSC Finland, Online:  
<https://www.lumi-supercomputer.eu/>
- [7] YouTube, Morris Riedel, UTmessan 2020 - Demystifying Quantum Computing, Online:  
<https://www.youtube.com/watch?v=EQGshhspn9A>
- [8] D. Willsch, M. Willsch, H. De Raedt, K. Michielsen, 'Support Vector Machines on the D-Wave Quantum Annealer', Online:  
<https://www.sciencedirect.com/science/article/pii/S001046551930342X951733>
- [9] Cavallaro, G., Willsch, D., Willsch, M., Michielsen, K., Riedel, M.: APPROACHING REMOTE SENSING IMAGE CLASSIFICATION WITH ENSEMBLES OF SUPPORT VECTOR MACHINES ON THE D-WAVE QUANTUM ANNEALER, in conference proceedings of the IEEE International Geoscience and Remote Sensing Symposium (IGARSS 2020), September 26 – October 2nd, 2020, Virtual Conference, Hawaii, USA, to appear, Online:  
<https://igarss2020.org/Papers/ViewPapers.asp?PaperNum=1416>
- [10] Open PhD Position for the RAISE EU project @ Iceland, Online:  
<https://www.gabriele-cavallaro.com/news/fully-funded-phd-position>

## Selected References (2)

- [11] R. Sedona, G. Cavallaro, J. Jitsev, A. Strube, M. Riedel, J.A. Benediktsson, 'Remote Sensing Big Data Classification with High Performance Distributed Deep Learning', MDPI Journal of Remote Sensing, Online:  
[https://www.researchgate.net/publication/338077024\\_Remote\\_Sensing\\_Big\\_Data\\_Classification\\_with\\_High\\_Performance\\_Distributed\\_Deep\\_Learning](https://www.researchgate.net/publication/338077024_Remote_Sensing_Big_Data_Classification_with_High_Performance_Distributed_Deep_Learning)
- [12] EuroCC Project, Online:  
<http://www.eurocc-project.eu>
- [13] Juelich Supercomputing Centre – SimLabs Blueprint, Online:  
[https://www.fz-juelich.de/ias/jsc/EN/Expertise/SimLab/simlab\\_node.html](https://www.fz-juelich.de/ias/jsc/EN/Expertise/SimLab/simlab_node.html)
- [14] Icelandic HPC Community Page, Online:  
<https://ihpc.is/>

# ACKNOWLEDGEMENTS



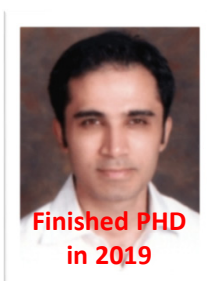
# Acknowledgements – High Productivity Data Processing Research Group



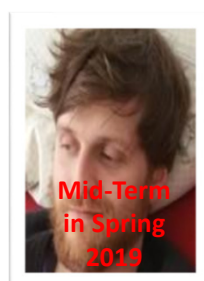
PD Dr.  
G. Cavallaro



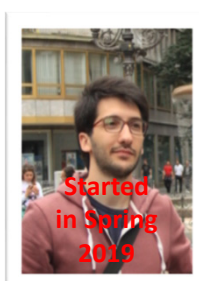
Senior PhD  
Student  
A.S. Memon



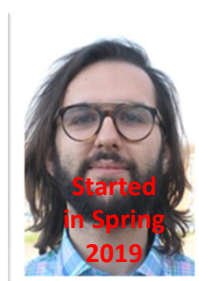
PD Dr.  
M.S. Memon



PhD Student  
E. Erlingsson



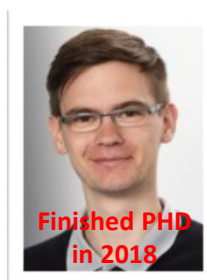
PhD Student  
S. Bakarat



PhD Student  
R. Sedona



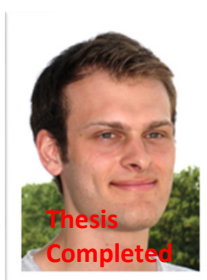
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P. H. Einarsson



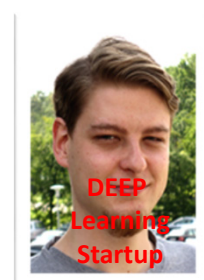
Dr. M. Goetz  
(now KIT)



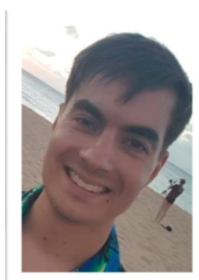
MSc M.  
Richerzhagen  
(now other division)



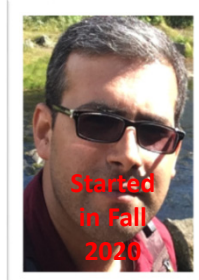
MSc  
P. Glock  
(now INM-1)



MSc  
C. Bodenstein  
(now Soccerwatch.tv)



MSc G.S.  
Guðmundsson  
(Landsverkjun)



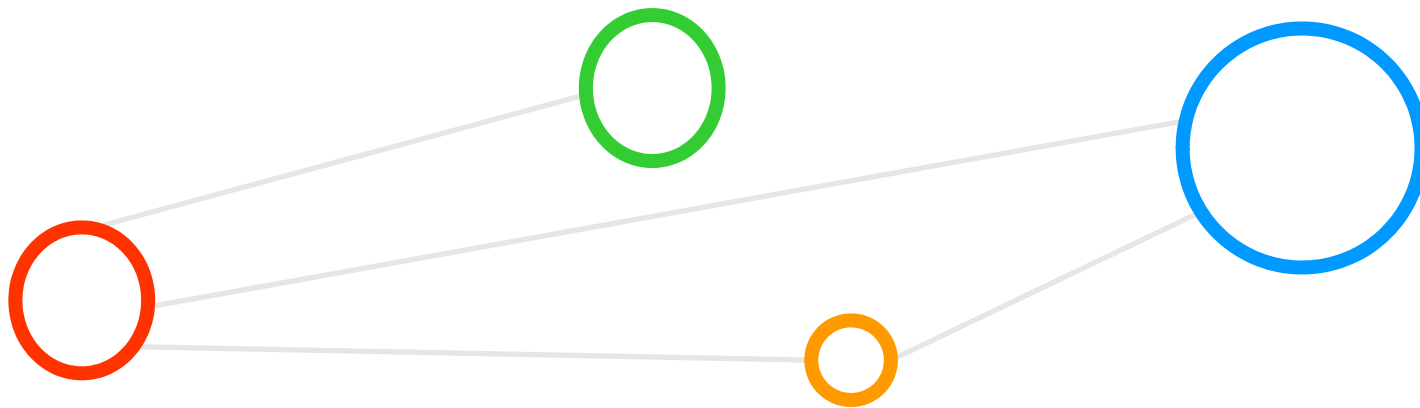
PhD Student  
Reza



This research group has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 763558 (DEEP-EST EU Project) and grant agreement No 951740 (EuroCC EU Project) & 951733 (RAISE EU Project)

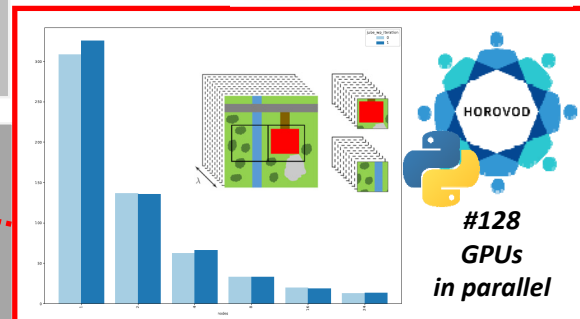
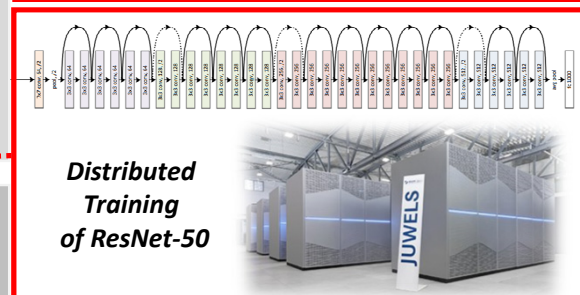
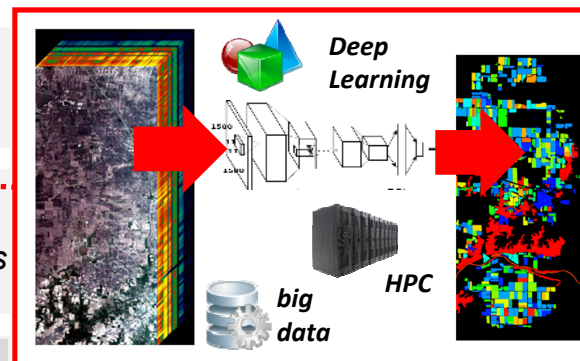
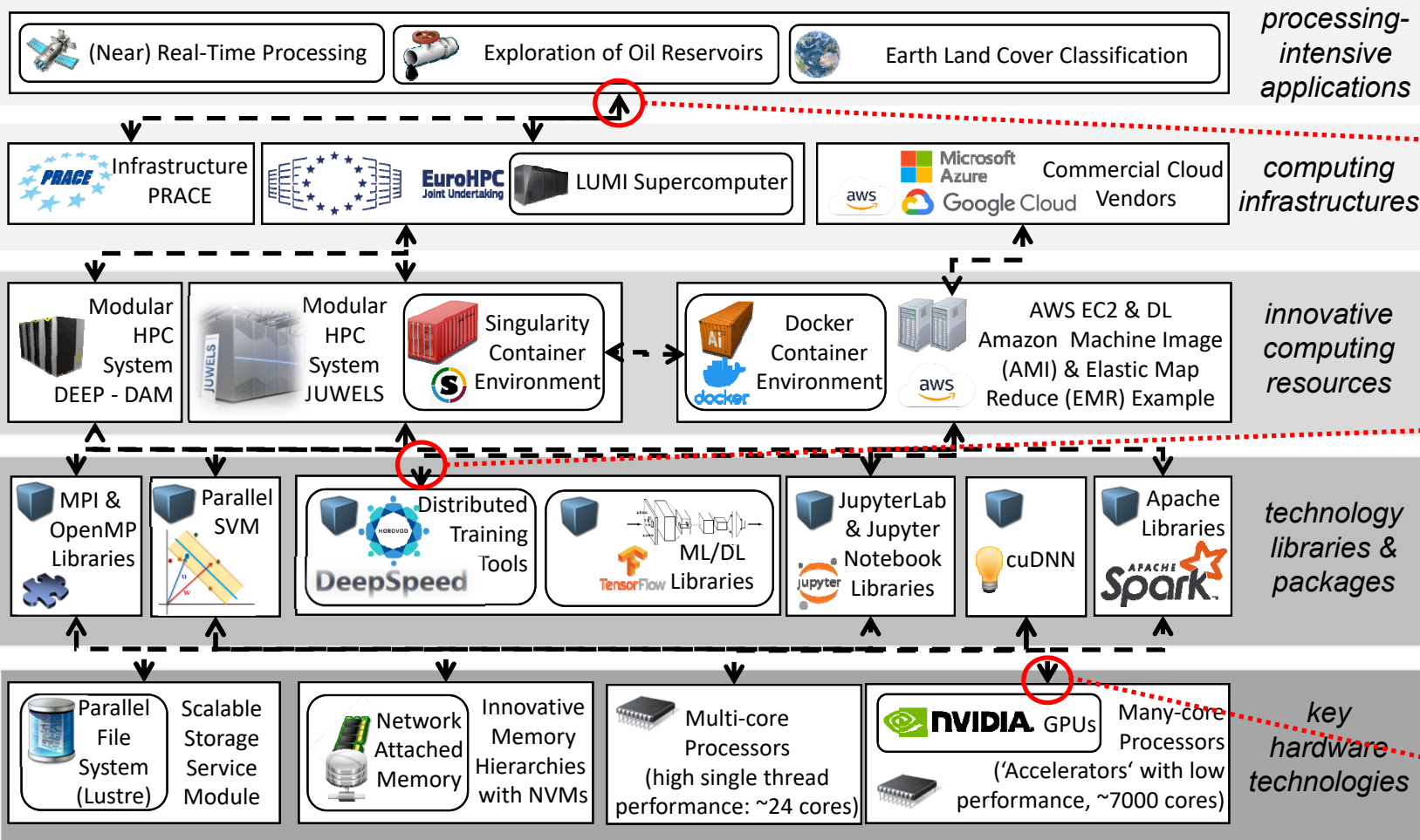


# Appendix

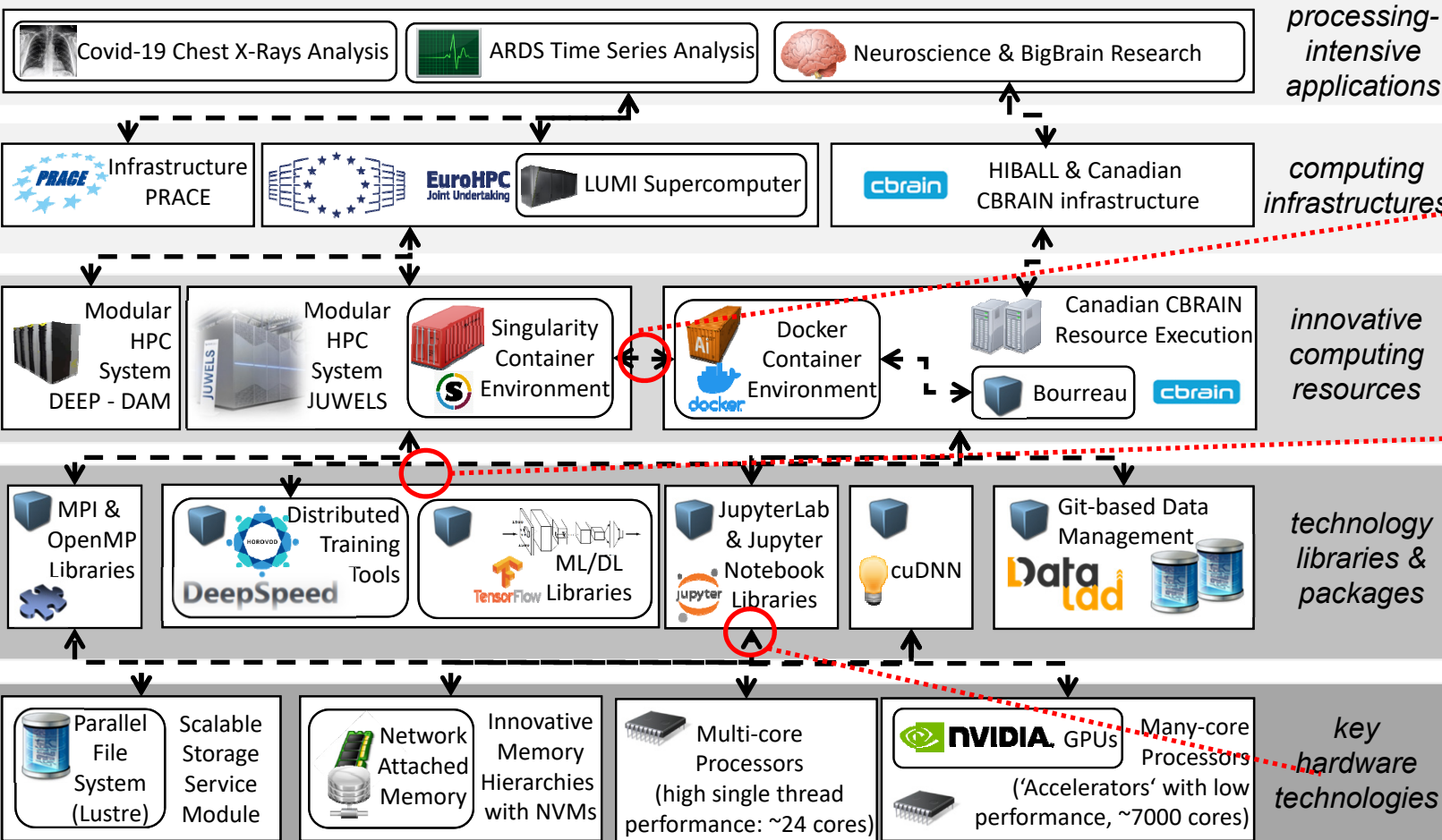




# Research Examples – Remote Sensing AI & HPC Applications



# Research Examples – Health & Medical AI & HPC Applications



Some preparation

```
$ mkdir winterschool_winterschool_cache winterschool_tmp
$ chmod +w winterschool_cache
$ export SINGULARITY_CACHEDIR=$(mktemp -d -p "$(pwd)/winterschool_cache")
$ export SINGULARITY_TMPDIR=$(mktemp -d -p "$(pwd)/winterschool_tmp")
```

Pull the docker image:

```
$ cd winterschool
$ singularity pull hws.sif docker://glatard/hws
```

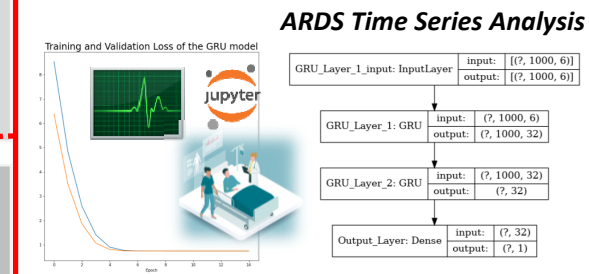
Step into the container

```
$ singularity shell ./hws.sif
(the prompt changes to `Singularity`)
```

download a dataset:

```
$ git config --global user.name "Your name"
$ git config --global user.email "peturhelgi@gmail.com"
```

Singularity> datalad install https://github.com/CONP-PCNO/conp-dataset.git



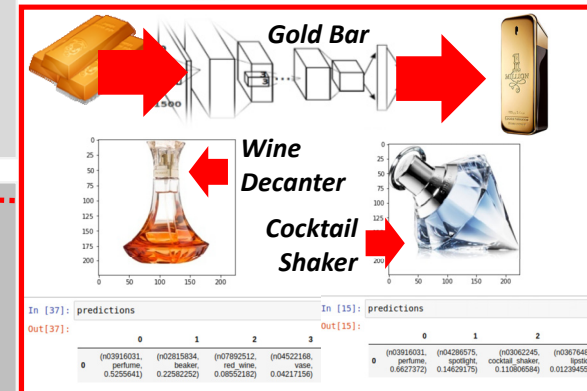
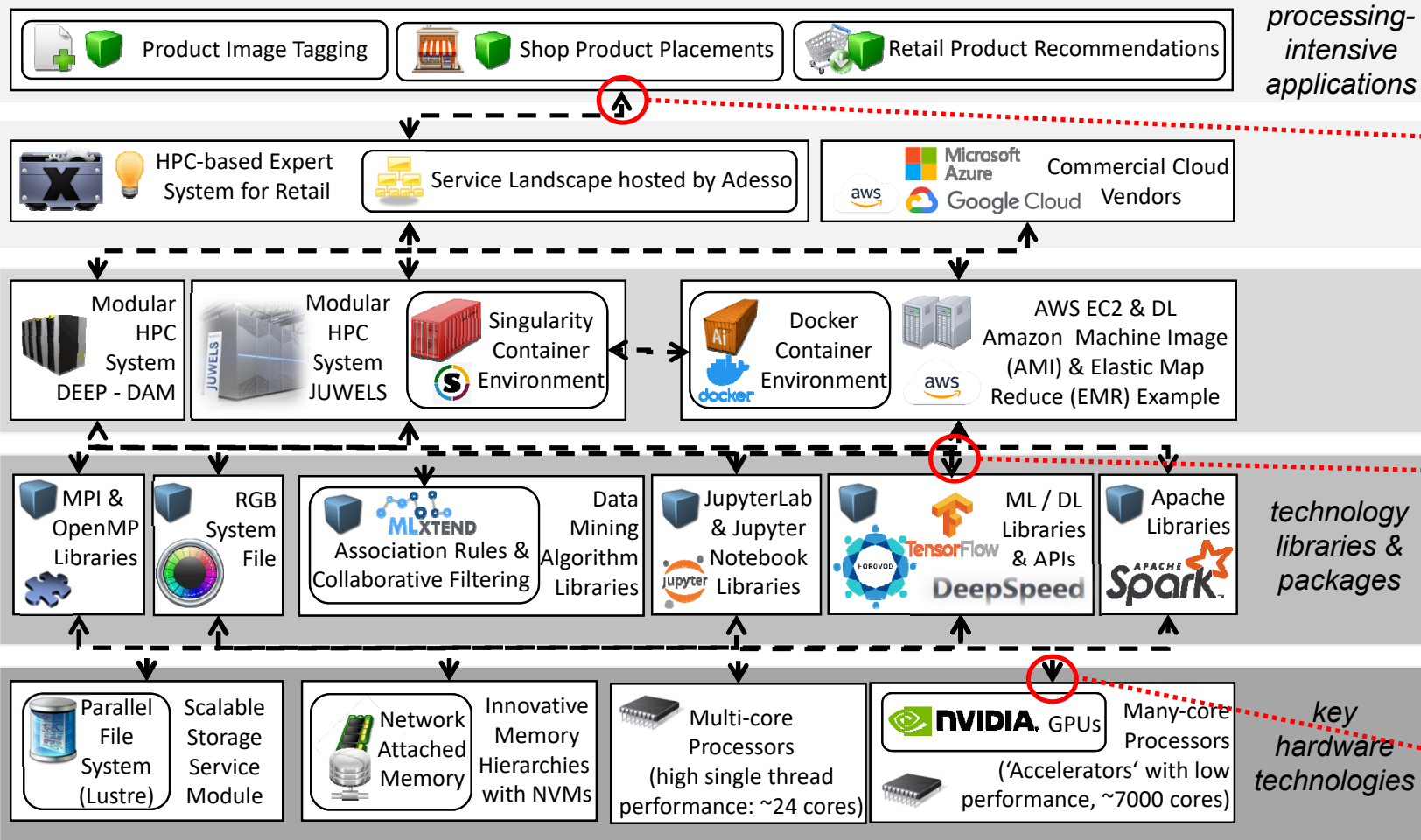
### Covid-19 Chest X-Ray Analysis

**Covid-Net**

```
#!/bin/bash
# Load required modules
module purge
module use $OTHERSTAGES
module load Stages/2020
module load GCCcore/9.3.0
module load Python/3.8.5
module load TensorFlow/2.3.1-Python-3.8.5
module load OpenCV/4.5.0-Python-3.8.5
# Activate Python virtual environment
source /p/project/training2104/ingolfsson1/jupyter/kernels/ingolfsson1_kernel/bin/activate
# Ensure python packages installed in the virtual environment are always preferred
export PYTHONPATH=/p/project/training2104/ingolfsson1/jupyter/kernels/ingolfsson1_kernel/lib
exec python -m ipynbkernel $@
```

**Covid-X Dataset**

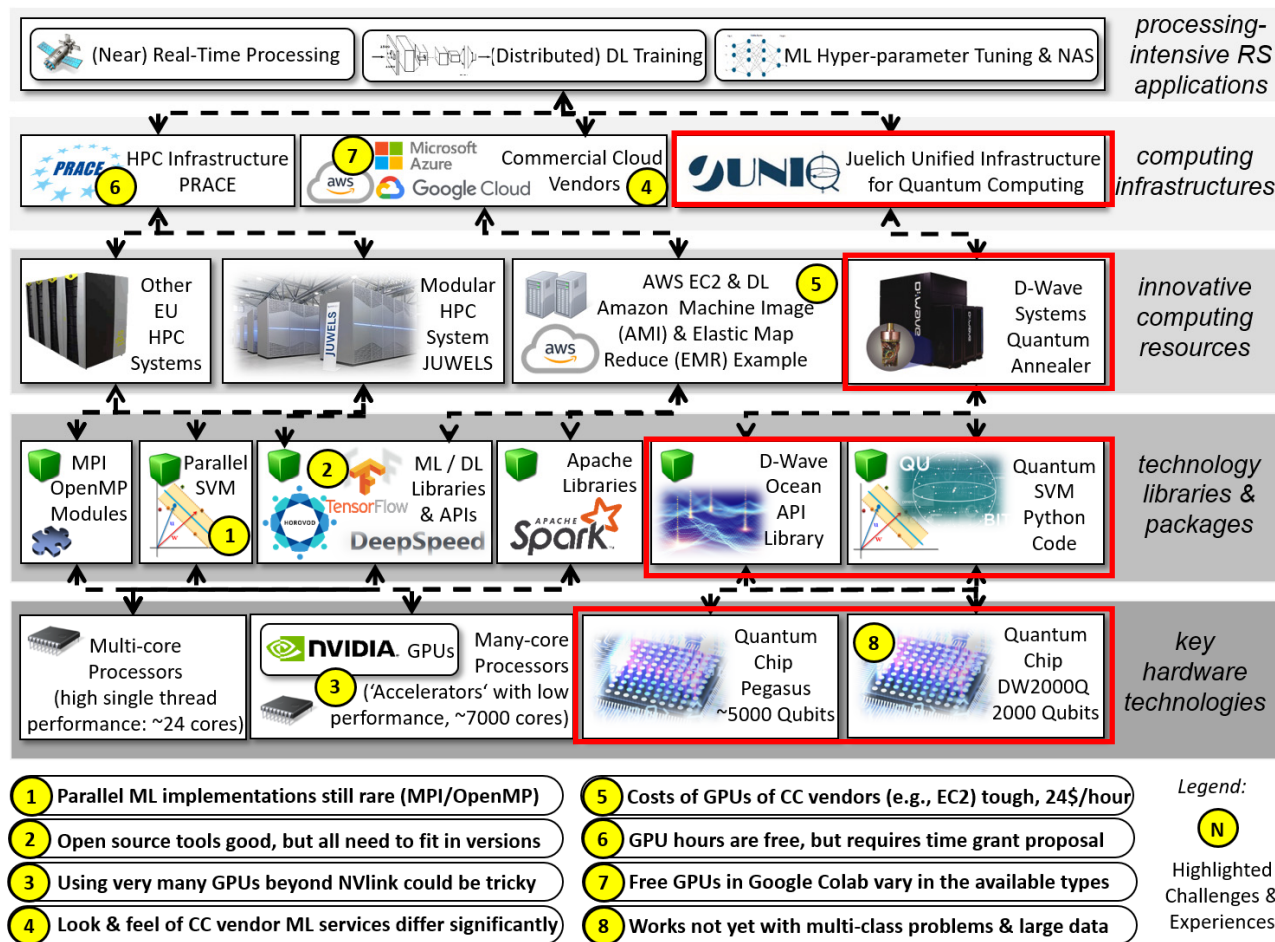
## Research Examples – Retail AI & HPC Applications



#GPUs	images/s	speedup	Performance per GPU [images/s]
1	55	1.0	55
4	178	3.2	44.5
8	357	6.5	<b>#128</b> 44.63
16	689	12.5	<b>GPUs</b> 43.06
32	1230	22.4	<b>in parallel</b> 38.44
64	2276	41.4	35.56
128	5562	101.1	43.45



# Research Examples – Quantum Module with D-Wave Systems Quantum Annealer



```
In [ ]: from quantum_SVM import *
import numpy as np
from utils import *
from sklearn.model_selection import KFold
from sklearn import preprocessing

# Write the data
experimental =
slices = # Number of samples to use for the training
fold = int(len(X_train)/40)

print(fold)

for i in range(0, experiments):
    cv = KFold(n_splits=fold, random_state=i, shuffle=True)
    count = 0
    for test_index, train_index in cv.split(X_train):
        #print("Train index: ", len(train_index), "\n")
        X_train_slice = X_train[train_index], Y_train[train_index]
        X_train_slice = preprocessing.scale(X_train_slice)

        X_test_slice = X_train[test_index], Y_train[test_index]
        X_test_slice = preprocessing.scale(X_test_slice)
```

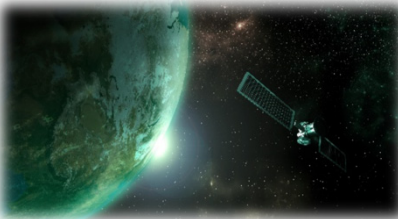
(a) cSVM (b) qSVM#1 (c) qSVM#6 (d) qSVM#16

[9] Approaching Remote Sensing Image Classification with Ensembles of SVMs on the D-Wave Quantum Annealer, G. Cavallaro & M. Riedel et al.

Morris Riedel  
Juelich Super-computing Centre  
Demystifying Quantum Computing

[8] Quantum SVM, D. Willsch et al. [7] M. Riedel, UTMessan 2020 YouTube Video

# Open PhD Position Available in EU Project RAISE @ Iceland



## Information

The PhD position is funded by the EU project Center of Excellence "Research on AI- and Simulation-Based Engineering at Exascale" (CoE RAISE). This project will be the excellent enabler for the advancement of European multi-physics and/or multi-scale applications on industrial and academic level and a driver for novel intertwined AI and HPC technologies.

👤 **Supervisor:** Prof. Morris Riedel (University of Iceland)

👥 **Co-Supervisors:** Dr. Gabriele Cavallaro (Jülich Supercomputing Centre) and Prof. Magnús Örn Úlfarsson (University of Iceland)

📅 **Starting date:** January 2021

⚠️ (Due to the current corona pandemic, the first work period can be conducted remotely)

📍 **Location:** Reykjavík (Iceland). You will be employed at the University of Iceland. A research stay at the Jülich Supercomputing Centre (Forschungszentrum Jülich, Germany) is envisaged for a minimum period of time of 6 months. To obtain your PhD degree at the University of Iceland you will have to acquire 30 ECTS from courses and seminars. Your working hours will be not monitored and working from home will be largely permitted.

🎯 **Goal:** pioneer the research of advanced deep transfer learning methods in the context of complex learning scenarios in applications from remote sensing. The priority will be put on the investigation of the transferability capacity of Deep Learning (DL) models with meta-learning and Neural Architecture Search methods.

🧑‍🔬 **Research Group:** be part of our joint research group "High Productivity Data Processing" at University of Iceland and Jülich Supercomputing Centre. The group is highly active in developing parallel and scalable machine (deep) learning algorithms for remote sensing data processing and many other types of applications (i.e., medical research and retail sectors).

⚙️ **Working Environment:** Direct access to high performance multi-GPU systems equipped with the state-of-the-art of DL frameworks (TensorFlow, pyTorch, Chainer, Horovod, DeepSpeed). There is also the possibility to access innovative quantum computing systems.

📖 **Other information:** You will have the possibility to participate in international top conferences in the field of machine learning, HPC and remote sensing. You will be put in contact with several international partners for initiating research collaborations that match the topic of the PhD.

🎓 **Background education:** MSc degree in computer science or computer engineering. Level of English  $\geq$  B2.

🧠 **Required knowledge and experience:** deep learning (Convolutional Neural Networks and/or Transformers) and Python programming (TensorFlow and/or pyTorch). Experience with parallel programming (OpenMP and MPI), High Performance Computing (HPC) and remote sensing data processing are a substantial plus.

✉️ **Apply:** Send your CV, a cover letter and the transcripts of records of your bachelor and master to Gabriele Cavallaro: g.cavallaro@fz-juelich.de.

[Apply now](#)

A screenshot of a Facebook post. At the top, it shows the profile of Morris Riedel, Professor &amp; Head of Research Group High Productivity Data Processing Juelich. Below that, it shows a post by Dr. -Ing. Gabriele Cavallaro, 1st Machine Learning | HPC | Remote Sensing, Deputy Head of a research group @ Jülich. The post text says: "Fully-funded PhD position in our 'High Productivity Data Processing' research group at the University of Iceland - Háskóli Íslands". Below the text is a large image of a landscape with a mountain and a waterfall. At the bottom of the image, the text "PHD POSITION IN ICELAND" is written in large, bold, white letters.

[10] Open PhD Position, RAISE EC Project @ Iceland