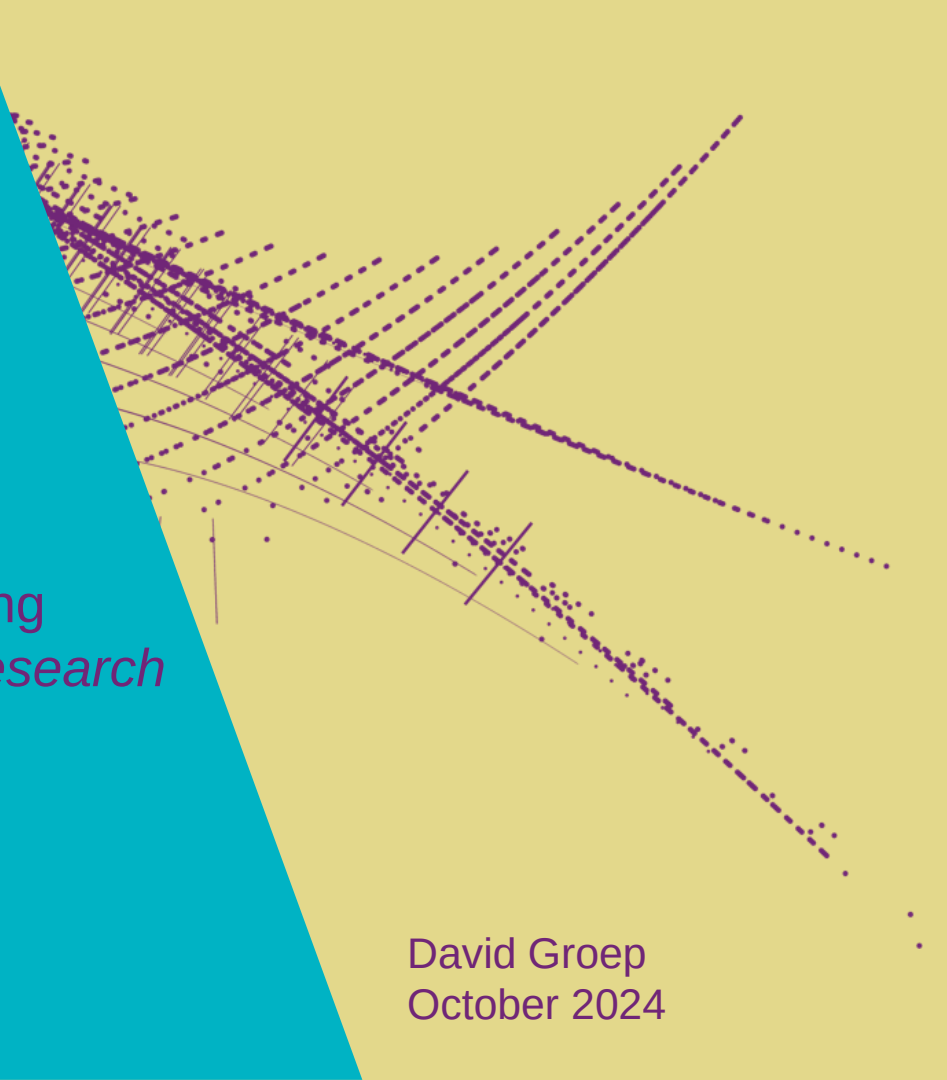
Nikhef

Maastricht University



Introduction to Nikhef and NikhefHousing

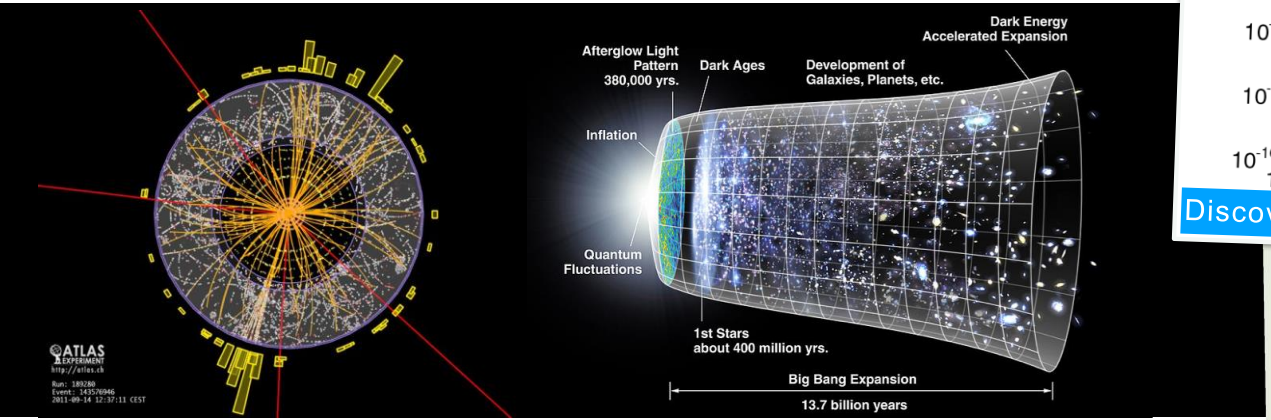
Connectivity and e-Infrastructure for Research

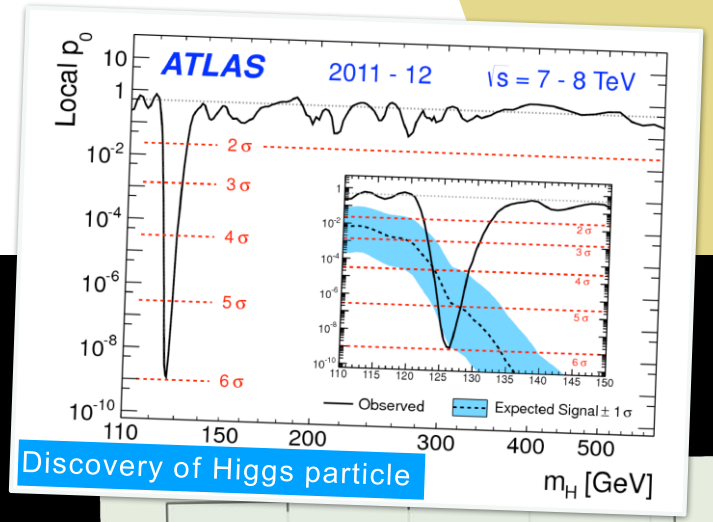
Welcome to Nikhef

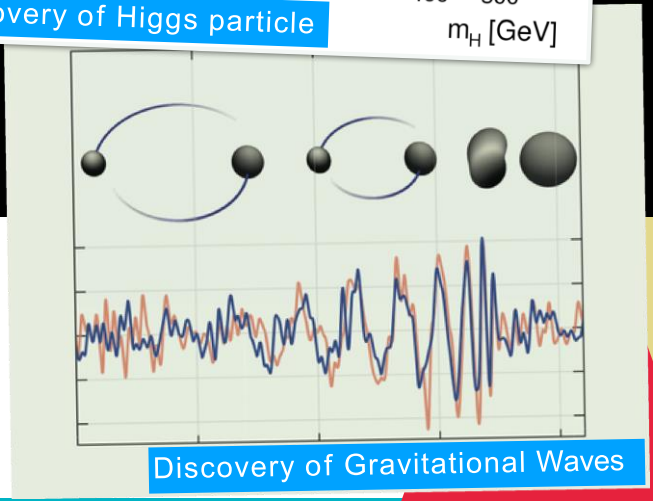
David Groep

October 2024

Nikhef - National Institute for Sub-atomic Physics







Our world, made of particles and fields, we probe

- with collider physics, at CERN
- astroparticle physics:
  particles, radiation, and ripples coming from the universe

images: atlas.cern.ch, CERN, LIGO-Virgo Collaboration

Nikhef Partnership

NWO institute & University partners

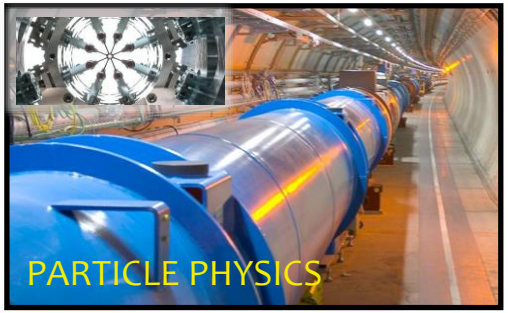
- University partners co-lead (most) research programmes
- align with Nikhef National Strategy

Nikhef Institute infrastructure adds

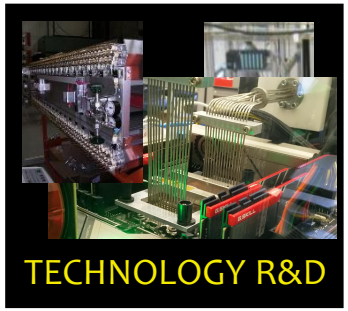
- Technical competence and support
- Large computing infrastructure
- Long term strategy & commitment

Permanent Staff	96
PhD candidates	125
Postdocs	43
Technical/engineer	88
Support	33

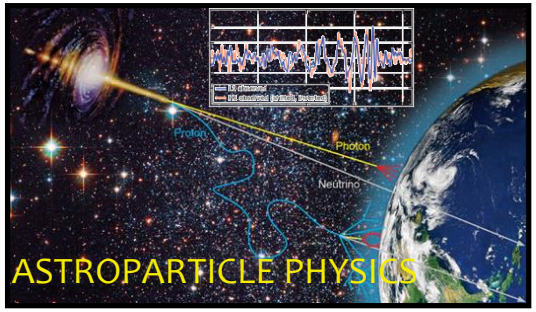
Nikhef Scientific Programmes



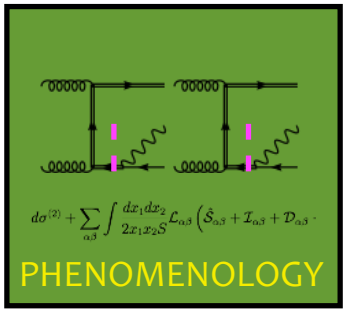
- Atlas
- LHCb
- Alice
- eEDM



- Detector R&D
- Physics Data Processing



- Neutrinos
- Gravitational waves
- Cosmic Rays
- Dark Matter

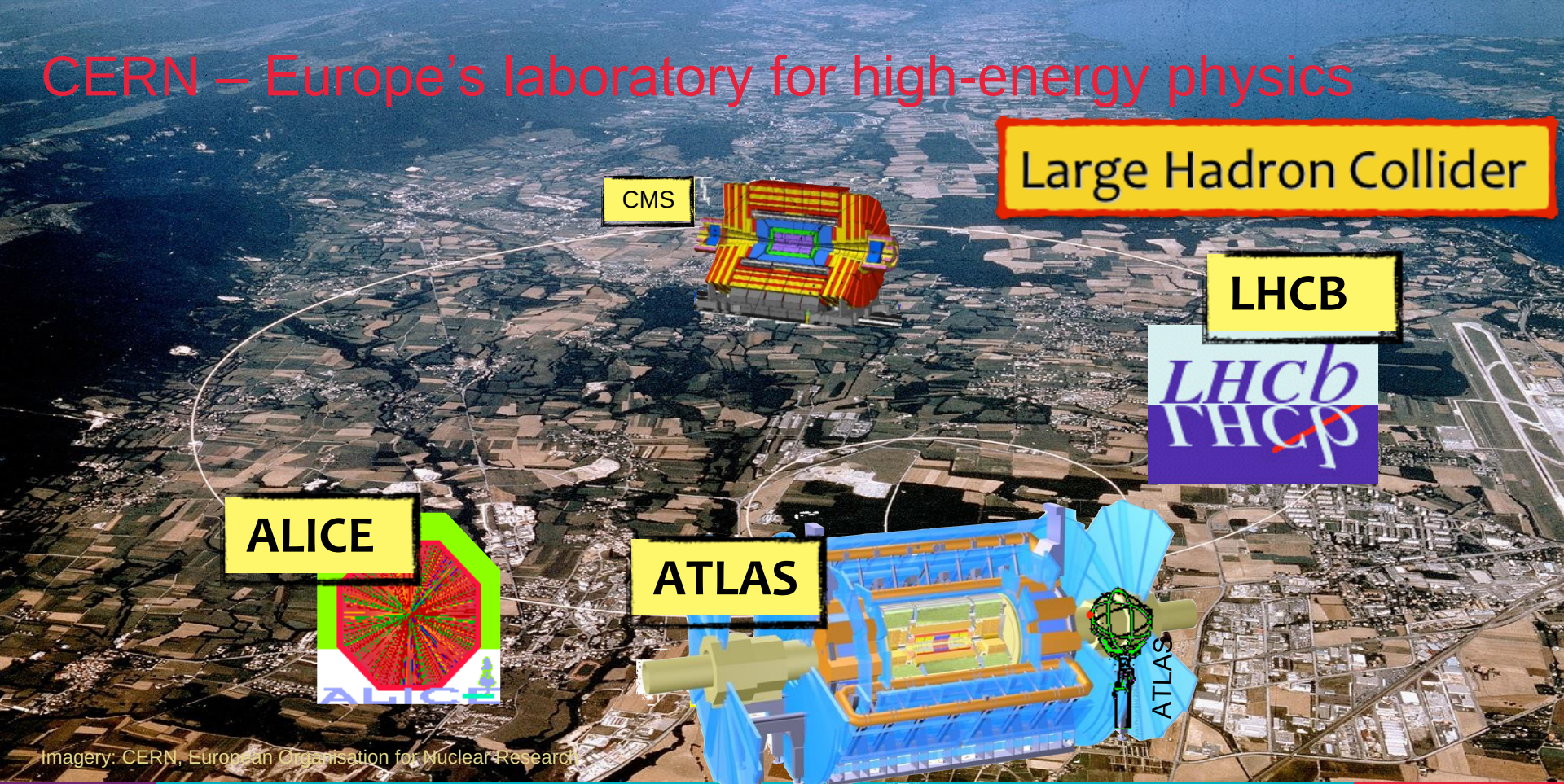


- Theoretical Physics

Technical and Engineering expertise

pictures from Nikhef's 'Dimensions' magazine and Computing Office Hours

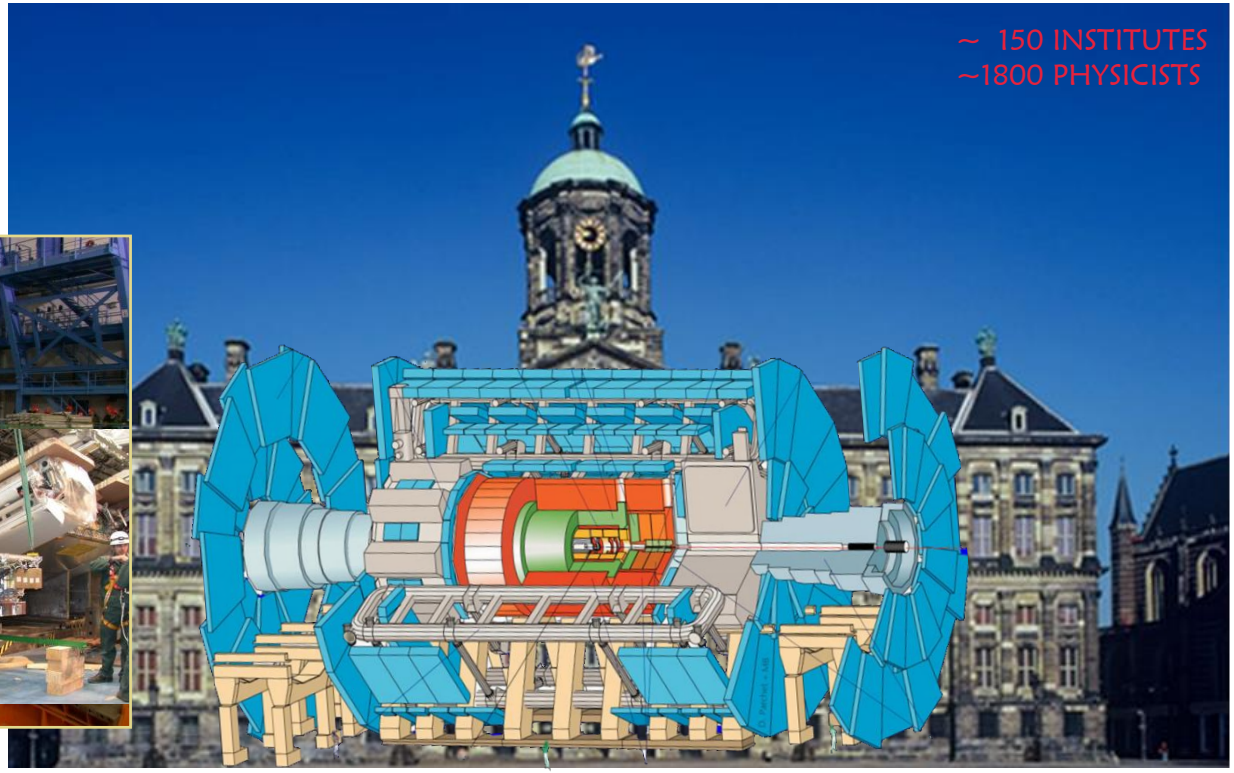
CERN – Europe's laboratory for high-energy physics



Imagery: CERN, European Organisation for Nuclear Research

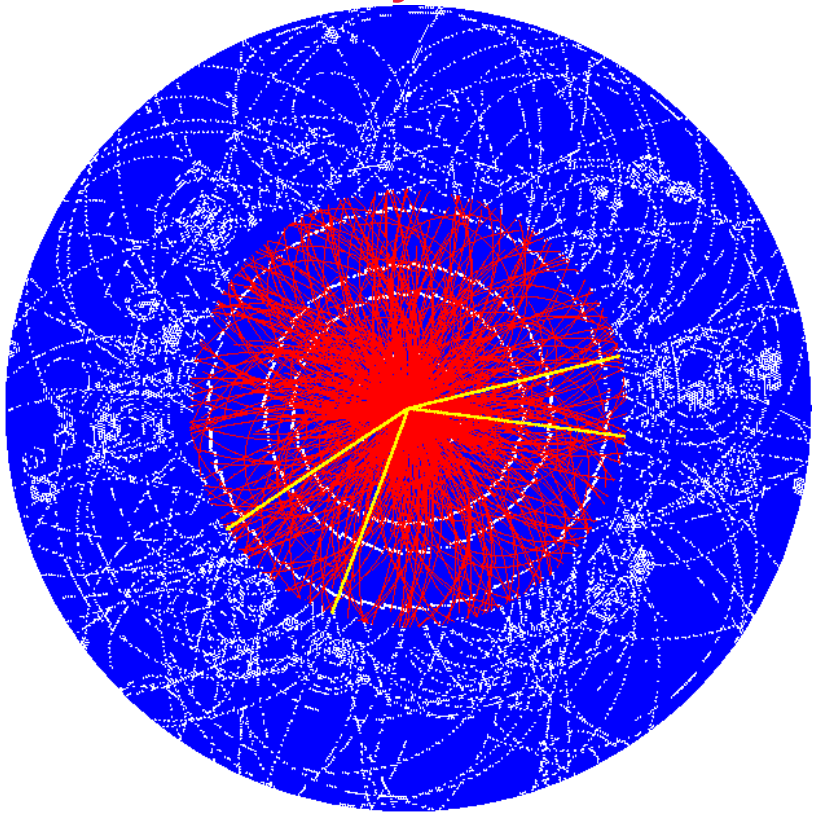
Example: the ATLAS experiment

LENGTH	44 M
DIAMETER	22 M
MASS	~7000 TON
READ-OUT CHANNELS	10^8



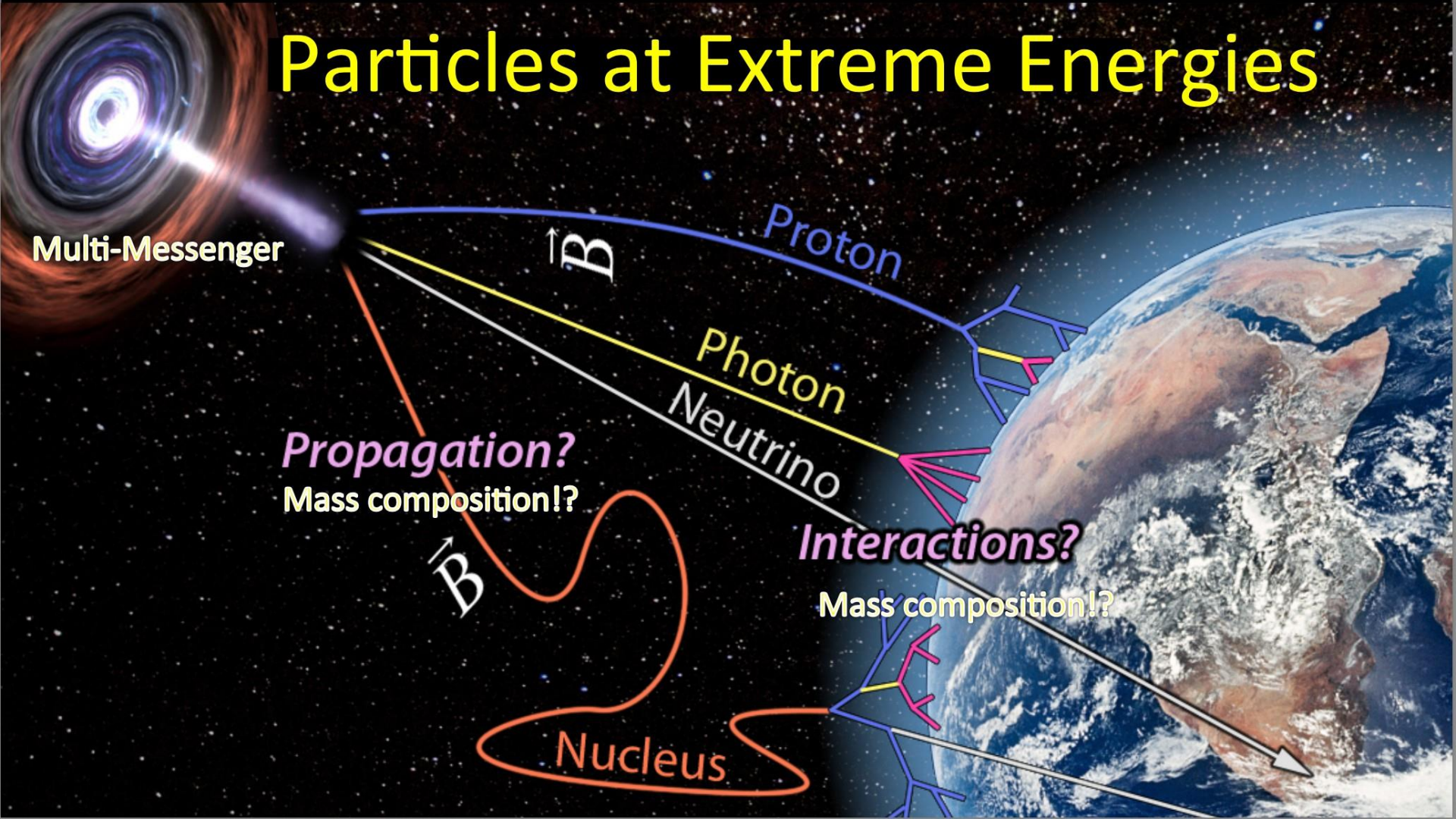
Slide materials from: Stan Bentvelsen, Open Day 2016

Needle in a haystack



PRODUCED PER SECOND IN LHC RUN 2	
WEAK COLLISIONS	10^8
$W^{\pm} \rightarrow E^{\pm}\nu$	15
$Z^0 \rightarrow E^+E^-$	1
TOP-ANTI-TOP QUARK PAIRS	1
$BB \rightarrow \mu + X$	10^3
QCD JETS, P_T>150 GEV	10^2
HIGGS PARTICLES	~1/DAY

Slide materials from: Stan Bentvelsen, Open Day 2016


Particles at Extreme Energies
Multi-Messenger
B
Proton
Photon
Neutrino
Propagation?
Mass composition!?
B
Interactions?
Mass composition!?
Nucleus

ASTROPARTICLE PORTFOLIO @ NIKHEF

PIERRE AUGER - UHECR

XENONNT - DARK MATTER

KM3NET - NEUTRINO TELESCOPE

GRAVITATIONAL WAVES

Slide: Stan Bentvelsen, Nikhef SEP 2023

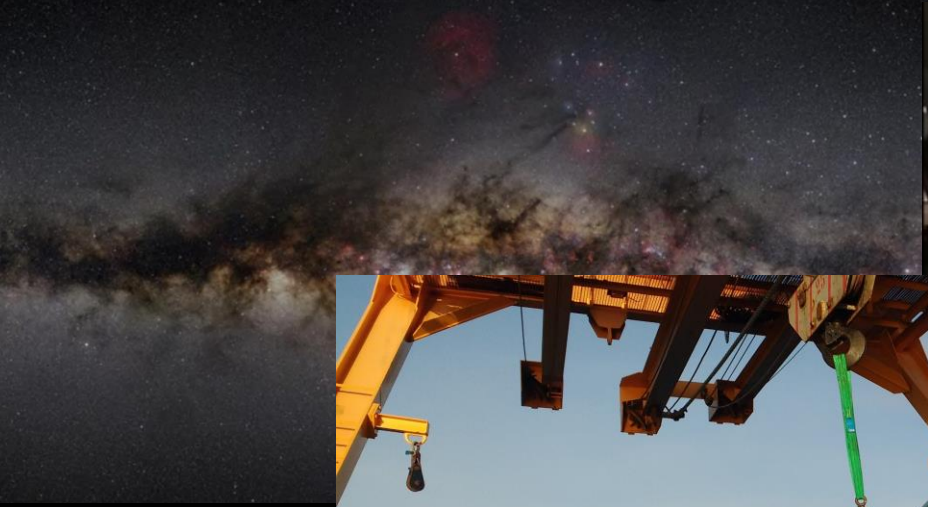
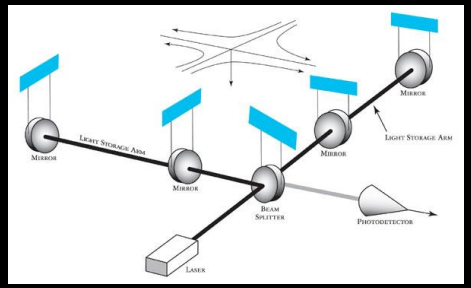
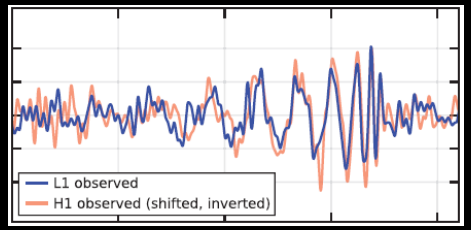


Image sources:
Nikhef, NIOZ,
KM3NET collaboration,
NRC Handelsblad

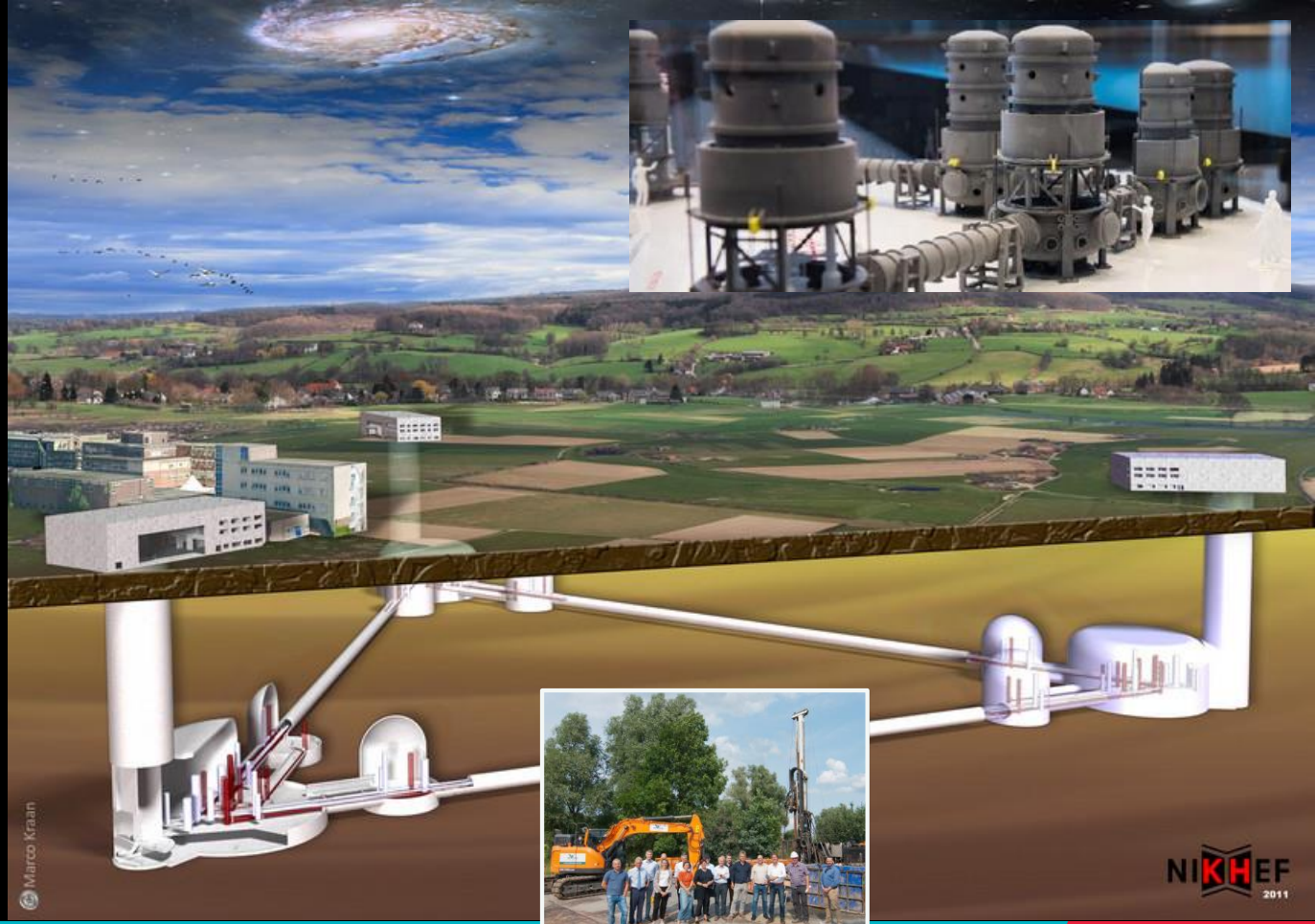
www.et-emr.eu!





LSC LIGO Scientific Collaboration VIRGO

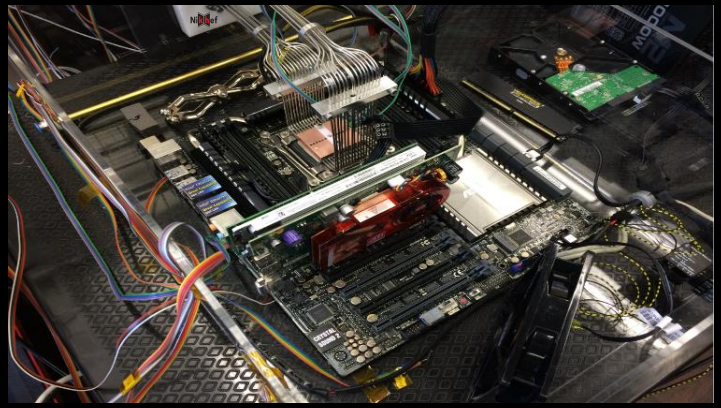
Einstein Telescope projected in the EMR region, image: Marco Kraan
GW150914 event:
gw-astronomy collaborations, LIGO



Enabling Research Programmes

Detector R&D

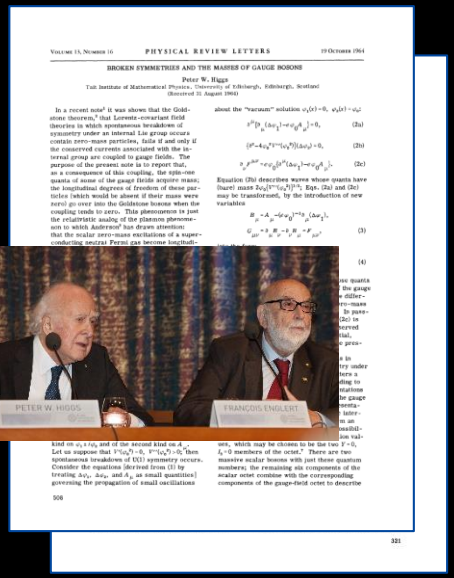
Theoretical Physics



Physics Data Processing

Data at the Large Hadron Collider at CERN

1964



VOLUME 13, NUMBER 16 PHYSICAL REVIEW LETTERS 19 OCTOBER 1964

BROKEN SYMMETRIES AND THE MASSES OF GAUGE BOSONS

Peter W. Higgs

Tait Institute of Mathematical Physics, University of Edinburgh, Edinburgh, Scotland

(Received 31 August 1964)

In a recent note[1] it was shown that the Goldstone theorem,[2] that Lorentz-covariant field theories in which spontaneous breakdown of symmetry under an internal Lie group occurs contain zero-mass particles, fails if and only if the conserved currents associated with the internal group are coupled to gauge fields. The purpose of the present note is to report that, as a consequence of this coupling, the spin-one quanta of some of the gauge fields acquire mass; the longitudinal degrees of freedom of these particles (which would be absent if their mass were zero) go over into the Goldstone bosons when the coupling tends to zero. This phenomenon is just the relativistic analog of the plasmon phenomenon to which Anderson[3] has drawn attention: that the scalar zero-mass excitations of a superconducting neutral Fermi gas become longitudi-

about the "vacuum" solution $\varphi_1(x) = 0$, $\varphi_2(x) = \varphi_0$:

$$\partial^\mu[\partial_\mu\{\delta\varphi_2\} + e\varphi_0 A_\mu] = 0, \quad (2a)$$

$$(\partial^\mu - 4a_2{}^2 k^{\mu\nu})(e\varphi_0{}^2)(\delta\varphi_1) = 0, \quad (2b)$$

$$\partial_\mu \partial^\mu \cdot e\varphi_0 A^\nu(\delta\varphi_2) - e\varphi_0 A_\mu. \quad (2c)$$

Equation (2b) describes waves whose quanta have (bare) mass $2a_2(k^{\mu\nu}(a_\mu)(a_\nu))^{1/2}$. Eqs. (2a) and (2c) may be transformed, by the introduction of new variables

$$B_\mu = A_\mu - e\varphi_0{}^{-1}\partial_\mu(\delta\varphi_2), \quad (3)$$

$$G_{\mu\nu} = \partial_\mu B_\nu - \partial_\nu B_\mu = F_{\mu\nu}, \quad (4)$$

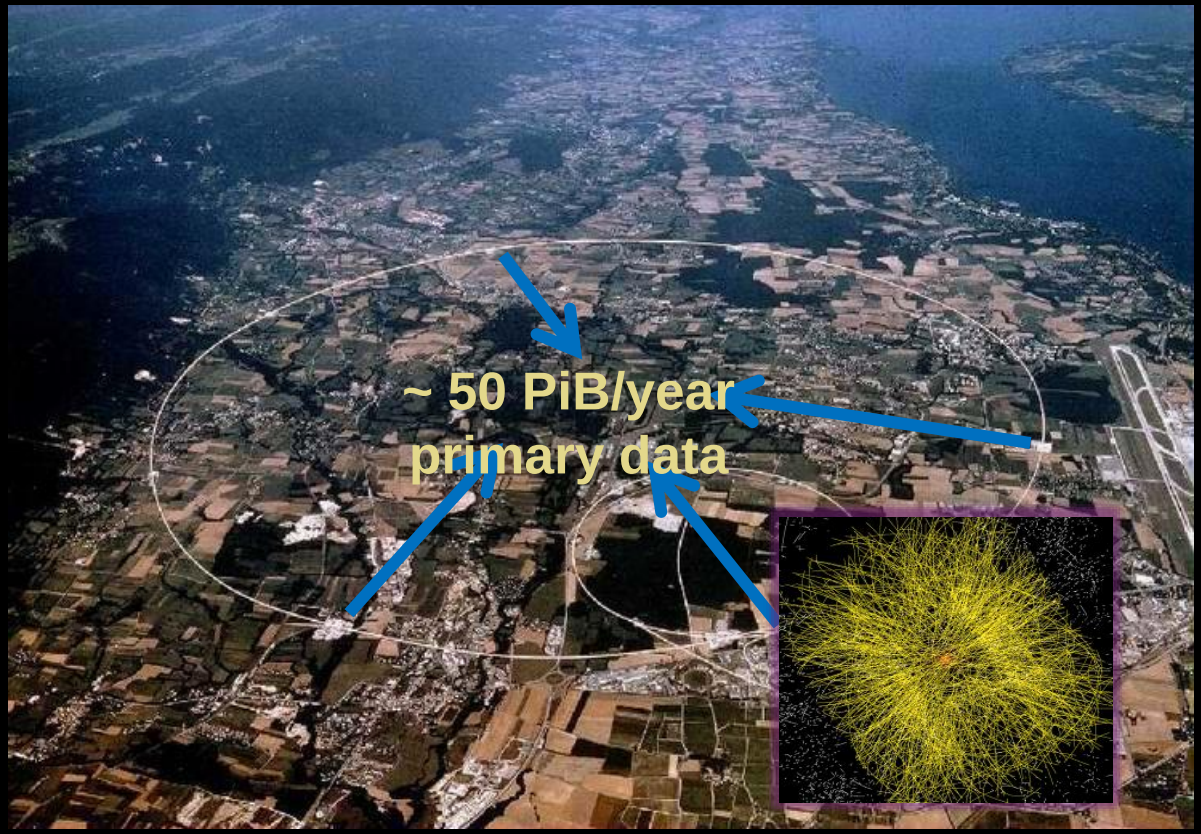
kind on φ_1 axis and of the second kind on A_μ. Let us suppose that $V'(\varphi_1^2) = 0$, $V''(\varphi_1^2) > 0$; then spontaneous breakdown of U(1) symmetry occurs. Consider the equations [derived from (3) by treating $\delta\varphi_1$, $\delta\varphi_2$, and A_μ as small quantities] governing the propagation of small oscillations

sets, which may be chosen to be the two $Y = 0$, $I_3 = 0$ members of the octet.[7] There are two massive scalar bosons with just these quantum numbers; the remaining six components of the scalar octet combine with the corresponding components of the gauge-field octet to describe

508

321

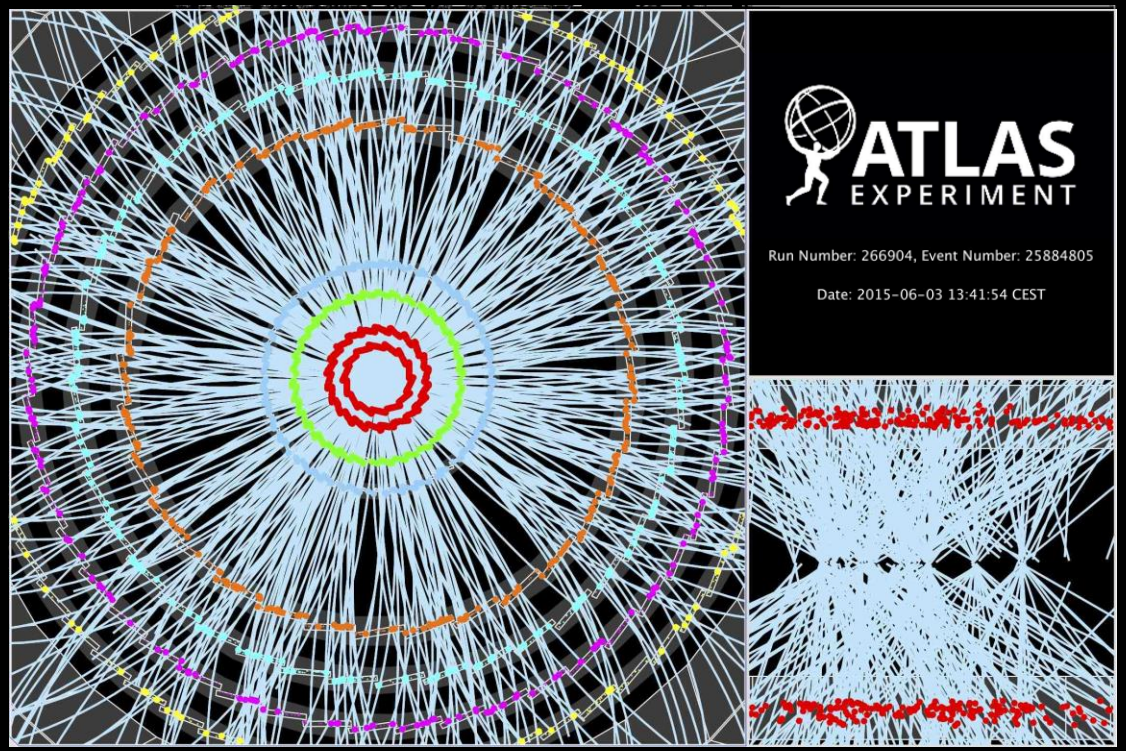
P. Higgs, Phys. Rev. Lett. 13, 508
16823 characters, 165kByte PDF



Peter Higgs and Francois Englert at the 2013 Nobel prize press conference, Stockholm. Photo: Bengt Nyman, https://www.flickr.com/photos/97469566@N00

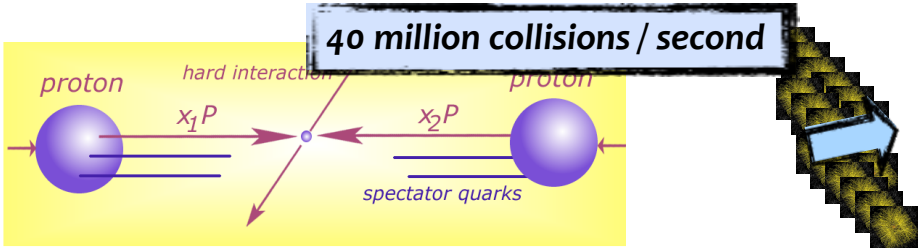
Computing on lots of data – 40 Mevents/sec

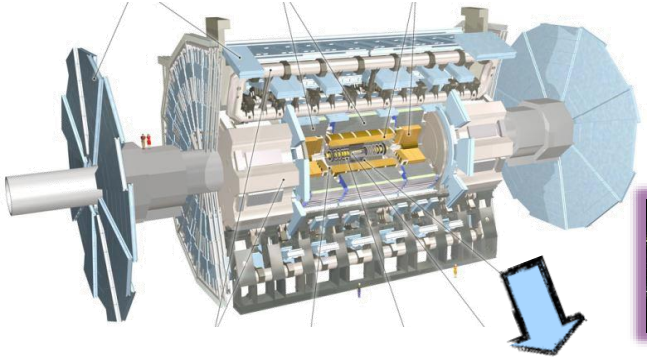
~ 10 seconds to compute a single event at ATLAS for ‘jets’ containing ~30 collisions



Display of a proton-proton collision event recorded by ATLAS on 3 June 2015, with the first LHC stable beams at a collision energy of 13 TeV; Event processing time: v19.0.1.1 as per Jovan Mitrevski and 2015 J. Phys.: Conf. Ser. 664 072034 (CHEP2015)

Detector to doctor workflow





Trigger system selects 600 Hz ~ 1 GB/s data

Classify particles in collision and their physics properties:
- *electrons*
- *muons*
- *jets consisting of hadrons*
- *...*

Physics analysis by (PhD) students, in papers & analysis notes

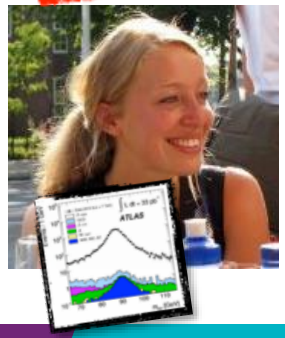
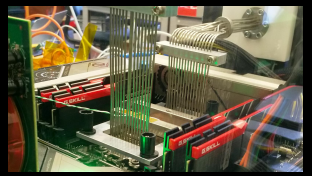


diagram adapted from Frank Linde; images: ATLAS collaboration, Nikhef. … and thanks to Rosemarie Aben

Nikhef's Physics Data Processing (PDP) Programme

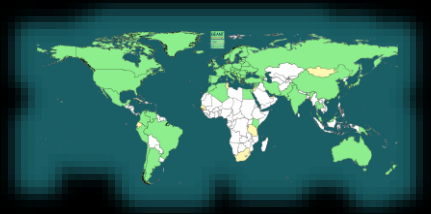
Algorithmic design patterns and software

- designing software for (GPU) accelerators, new algorithms, high-performance processors
- software design patterns for workflow & data orchestration



Infrastructure for trusted collaboration

- trust and identity for enabling communities
- managing complexity of collaboration mechanisms
- securing the infrastructure of our open science cloud



Infrastructure, network & systems co-design R&D

- building 'research IT facilities'
- co-design & development
- big data science innovation
- research *on* IT infrastructure

people: 3.6 FTE (2.6 staff + 1 postdoc)
+ ~ 7.5 FTE DevOps and research engineers from the Nikhef Computing Technology group
(plus Housing and electrical engineering)

Efficient computing and ‘accelerated results’

- FASTER: computing for HL-LHC & ‘4D’ reco
- LHCb’s Allen full-GPU trigger for HLT1
  - now adding HLT2 and CPU NN implementations
- NLeSC GPU acceleration in LHCb
  and parallel inference with ONNX+tensor ML libraries

- R&D roadmap for hybrid computing
  - link to infrastructure innovation & engineering with vendors
    alternative architectures: non-x86 (ARM “Ampere”), watercooling, GPU+FPGA, hybrid dies
  - ‘scaling and validation’, collaboration with computer science (SLICES-RI) & ML algorithms (@UM + RU)

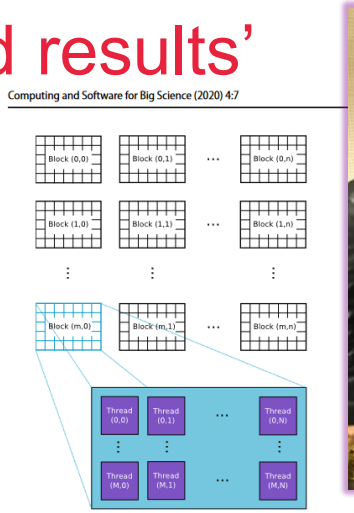


Fig. 2 Threads are grouped into blocks, forming a grid that executes one kernel on the GPU


Fig. 3 In the GPU-enhanced proposal for the … data acquisition system x86 event building units rec… sub-detectors and build events by sending and rece… gments over a 100G Infiniband (IB) network. The same x… also host GPUs which process HLT1. Only events selected b… nt to the x86 servers processing HLT2. The data … server farms is, therefore, reduced by a fa…

For the long term: Quantum Computing algorithms exploration
- in collaboration with our experiments (notably LHCb and GW), SURF, QuSoft, and Maastricht University
- personal expectation: ‘production’ use far away (>2035?), but work on algorithms, even if ultimately not QC, is very interesting

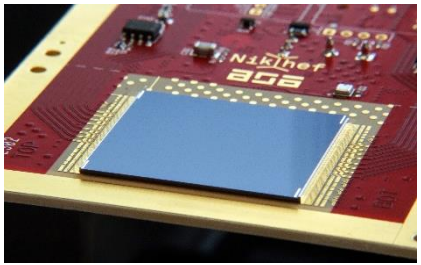
Image: LHCb’s *Allen* team: Daniel Campora (Nikhef & UM), Roel Aaij (Nikhef), Dorothea vom Bruch (LPNHE) (source: LPNHE). Graphs: Allen inference event rate vs batch size (NLeSC) https://github.com/LHC-NLeSC/run-allen-run
Paper: Aaij et al. https://doi.org/10.1007/s41781-020-00039-7

Algorithms and detectors go hand in hand

Reducing complexity is both in hardware and algorithms

If we ‘do nothing’, the HL-LHC intensity will result in hundreds of overlapping ‘images’ that are impossible to disentangle:

- improve timing resolution to 10-50ps (more ‘frames’ per collision)
- accelerated algorithms and dedicated GPU kernels, also ‘off-line’



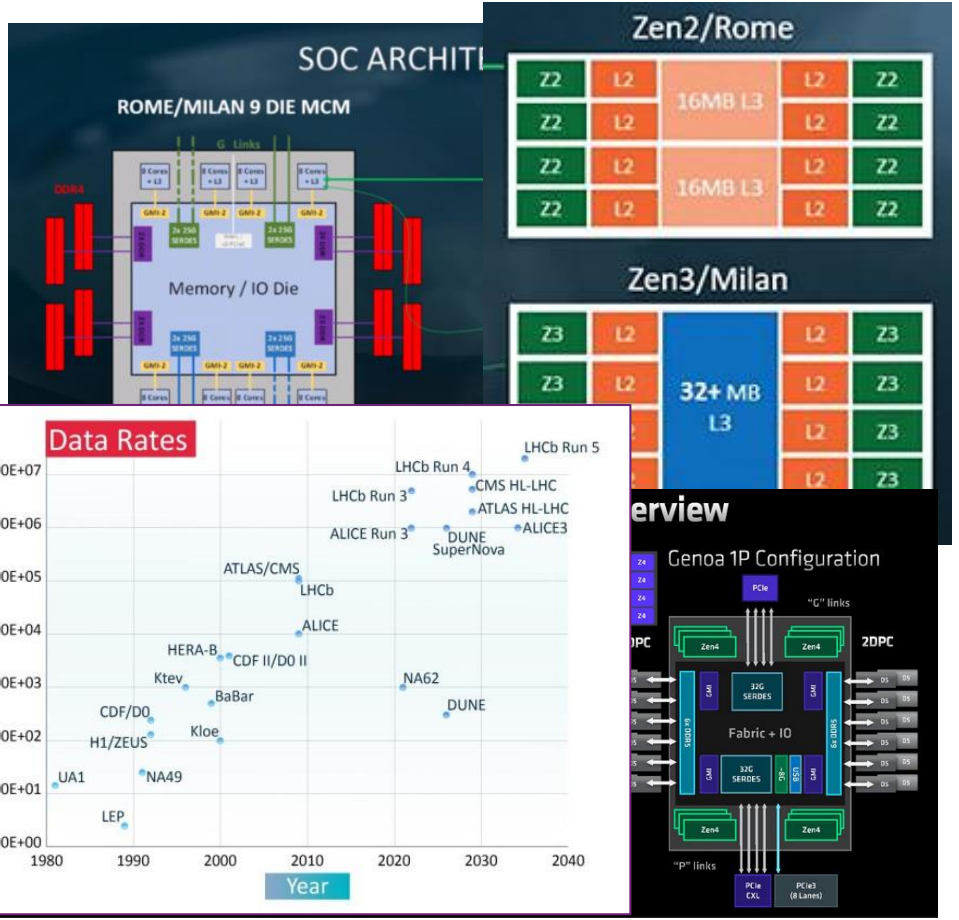
From: FASTER (LHCb images) and R.Geertsema LHCP2022; right: TimePIX4 (also used at e.g. M4i)

PDP & accelerated systems

Combining GPUs and improved algorithms

but e.g. not all die are created equal

- Naples → Rome added shared memory die, linking all cores directly to memory
- Rome → Milan adds shared L3 cache that benefits tightly coupled HPC, but not HTC
- Genoa adds memory bandwidth again



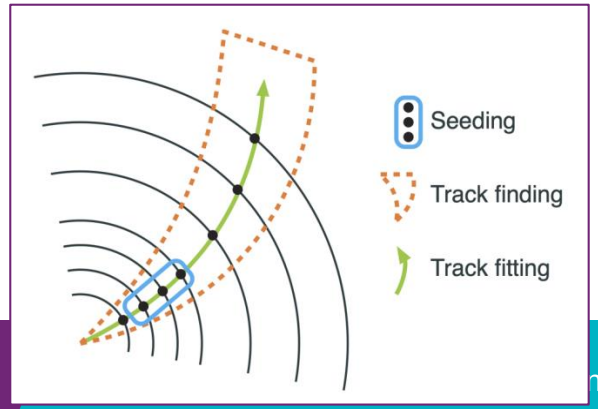


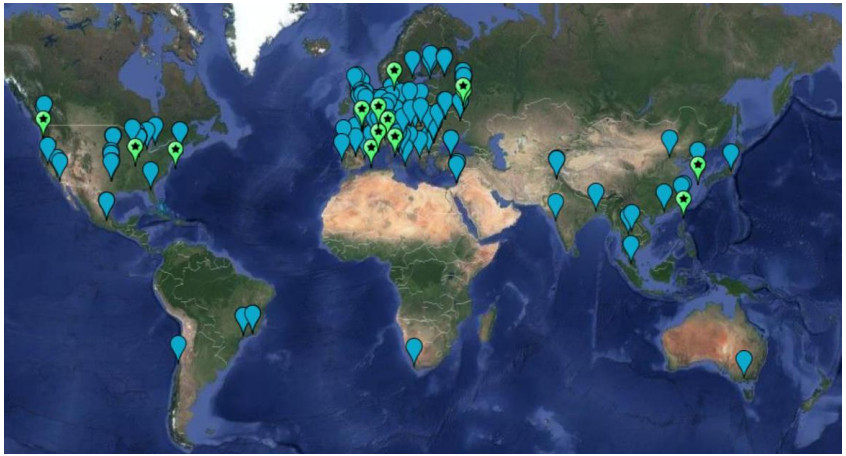
Image sources: FASTTRACK, and A. Cerri – Univ. of Sussex; AMD, retrieved from https://m.hexus.net/tech/news/cpu/135479-amd-shares-details-zen-3-zen-4-architectures/ and https://www.semianalysis.com/p/amd-genoa-detailed-architecture-makes

Infrastructure for Collaboration

When WLCG met a global trust scaling issue

- approx. 170 sites
- over 42 countries & regions
- over 20000 users

so *how* many interactions ?



people photo: a small part of the CMS collaboration in 2017, Credit: CMS-PHO-PUBLIC-2017-004-3; site map: WLCG sites from Maarten Litmaath (CERN) 2021

Scaling issues – credentials at each site *does not work*

state of EDG and the HEP LHC computing in 2000

NIKHEF
NATIONAAL INSTITUUT VOOR KERNFYSICA EN HOGE-ENERGIEFYSICA

Guest / students form (pleas

1. This form is completed in connection with: ☐ work experien ☐ otherwise, vis

CERN/User Registration

CERN COMPUTER CENTRE - US

http://cern.ch/it/documents/ComputerUsage/Comp.A

To be returned to the User Registration box at the en
completed by a user who requires a computer accou
Department, and is not yet registered in another grou

To be completed by the User :

It is **MANDATORY** to provide the following infor
treated confidentially and only be used for ensuring
Supply name as registered by the Users' Off
FAMILY NAME(S): .....
FIRST NAME(S) : .....
SEX [M] [F] BIRTHDATE: Day ..... Month ..... Year .....
HOME INSTITUTE/FIRM: .....
NATIONALITY: .....*CERN SUPERVISOR.....
*CERN DEPARTMENT: . . . . . *CERN ID NUMBER (as on CERN card).....

To be completed by the Group Administrator:

Fermilab

For Office Use Only

ID:	Action:	ID Exp:	
Insurance:	Medical:	Safety:	
Computer:	Stkrm:	Family:	
NON-473:	Sensitive:	Verifier:	Date:

Name:

Last	First	Middle
SWIETZER	JOHN	JAMES

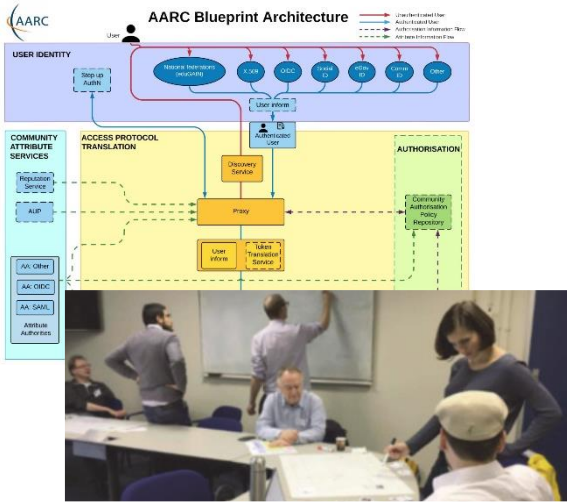
University or Institution Name: Telephone:

FLORIDA STATE UNIVERSITY	850-644-XXXX

Experiment/Department:

Exp. / Dept.	Spokesperson	Home Institution Contact	Contact Telephone
D0	WOMERSLEY/WEERTS	SHARON HAGOPIAN	850-644-4777

Infrastructure for Collaboration



Target specific ‘high-impact’ areas for research collaboration

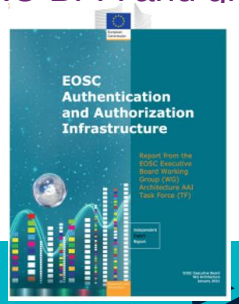
- trust and identity,
- technical architecture,
- operational security and risk management

Authentication & Authorization for Research Collaboration

- **AARC TREE project & community**,
  GEANT GN5, REFEDS & eduGAIN, TCS & RCauth.eu, …
- **policy for interoperability** for data protection, seamless service access, single-click acceptable use
- continuous **technical evolution** driving IGWN, WLCG in line with the AARC BPA and global RIs

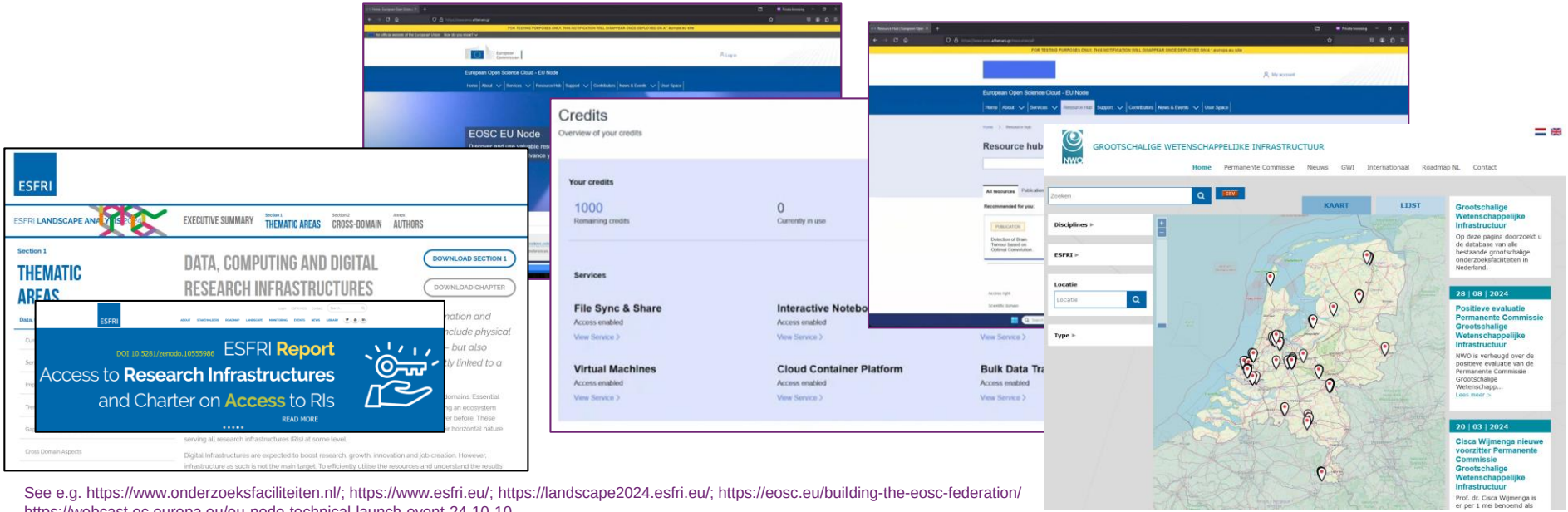
Data processing needs of research in the (EOSC) landscape

- **EOSC** Interoperability Framework, EOSC Federation, Tripartite
- EOSC-A (AAI-TF), **EGI, GEANT community,** EOSC EU Node



R&E services are all around you, *especially* outside

Nationally: SURF, ‘managed’ via the NWO Rekentijdcall
Research Infrastructures: Dutch GWIs and ESFRIs, like ODISSEI, LCG, ELIXIR, …
Data Spaces, European Open Science Cloud (EOSC): EU Node, DistinE, ESS, Copernicus, …



See e.g. https://www.onderzoeksfaciliteiten.nl/; https://www.esfri.eu/; https://landscape2024.esfri.eu/; https://eosc.eu/building-the-eosc-federation/
https://webcast.ec.europa.eu/eu-node-technical-launch-event-24-10-10

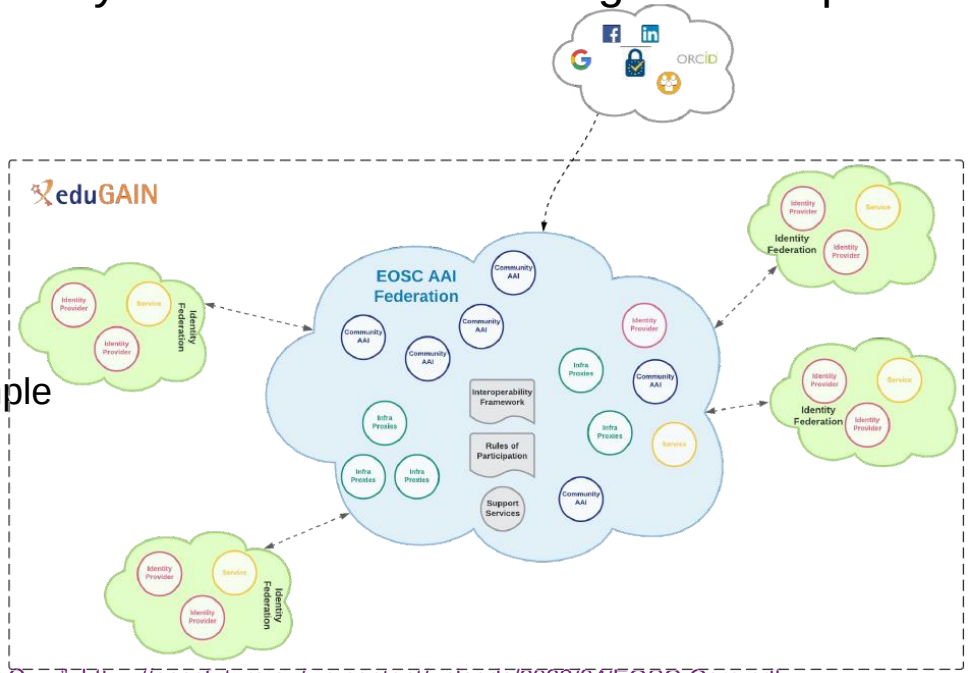
European Open Science Cloud AAI federation

Collaborations span domains (or an industry sector with lots of mergers and spin-offs)

- proxies with each group
- inter-federate SP/IdP interfaces
- each federation can add own policy and entity filtering

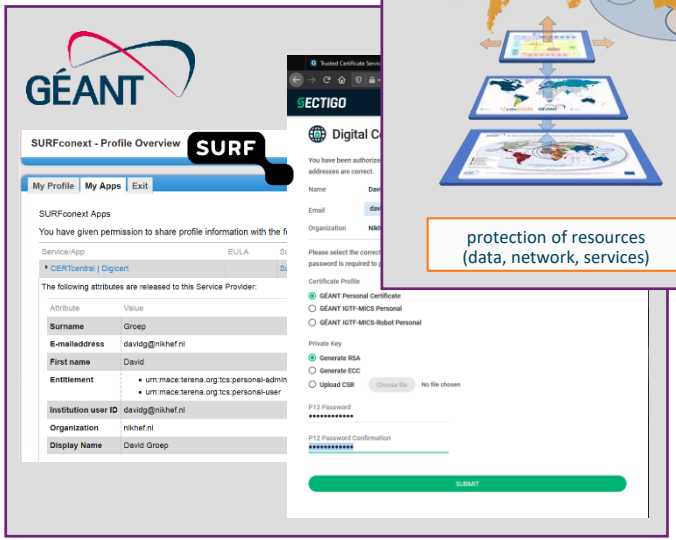
European Open Science Cloud (EOSC)
AAI based on federations and proxies as an example

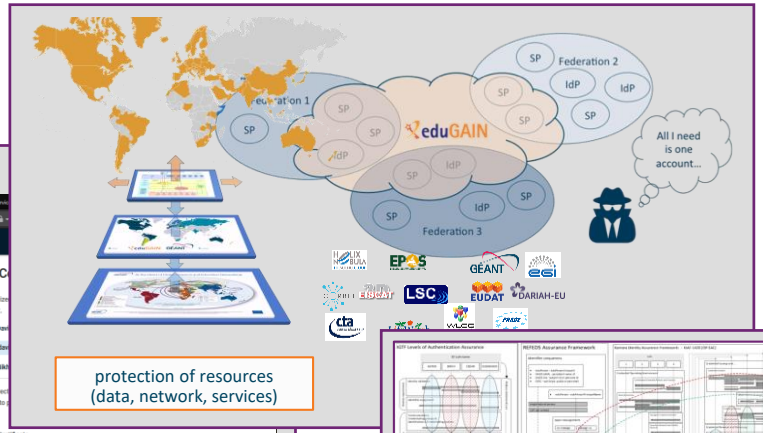
Access policy federation and rules of participation go alongside the trust and identity federation
but the supporting AAI is foundational to the rest

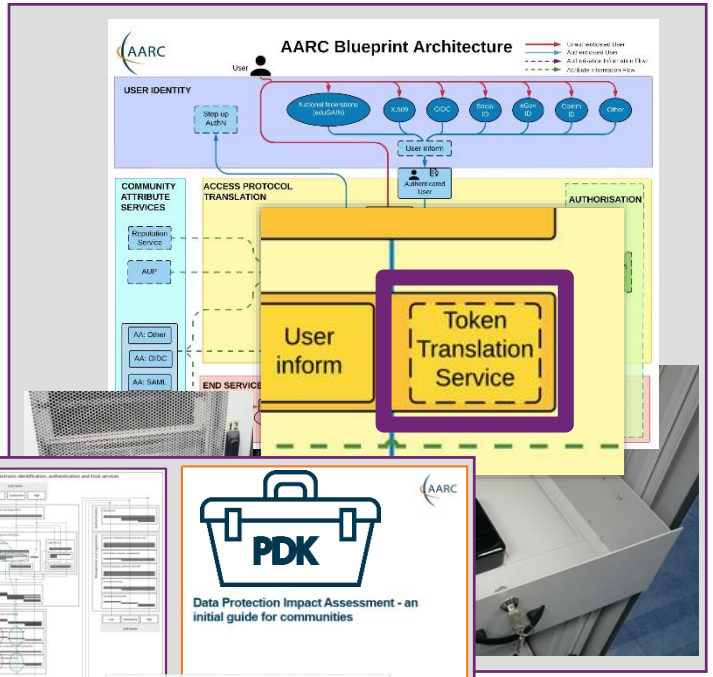


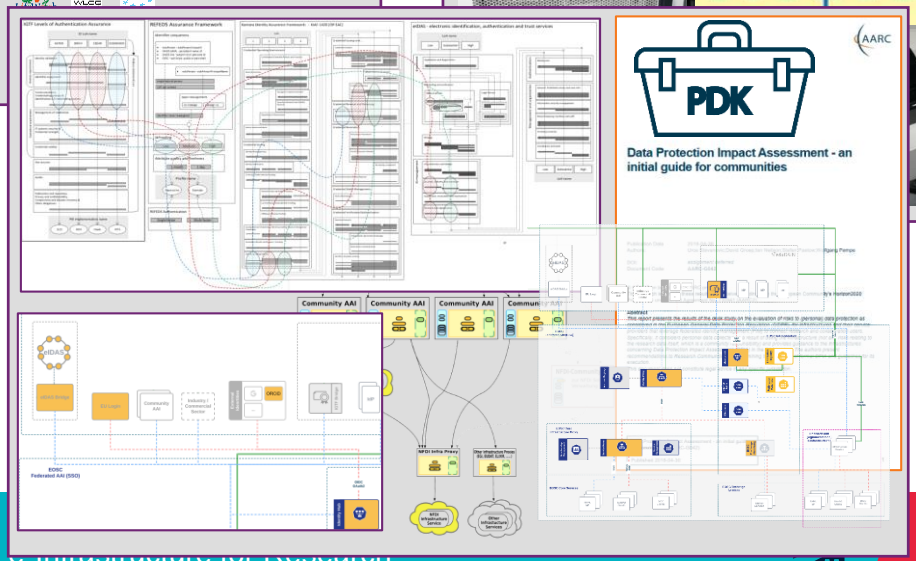
Christos Kanellopoulos (GEANT) for the EOSC AAI Federation in “The EOSC Core”, https://eoscfuture.eu/wp-content/uploads/2022/04/EOSC-Core.pdf

PDP: Applied trust, identity, security



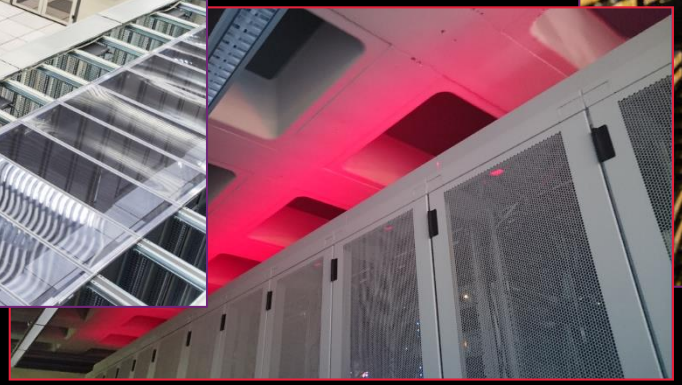






GEANT Trusted Certificate Service; RCauth; Sirtfi eduGAIN Security;
REFEDS Assurance Framework; AARC-I050;
Privacy and WISE AUP (AARC-G083); EOSC AAI; AAOPS (AARC-G071)

PDP: Infrastructure for Data Processing

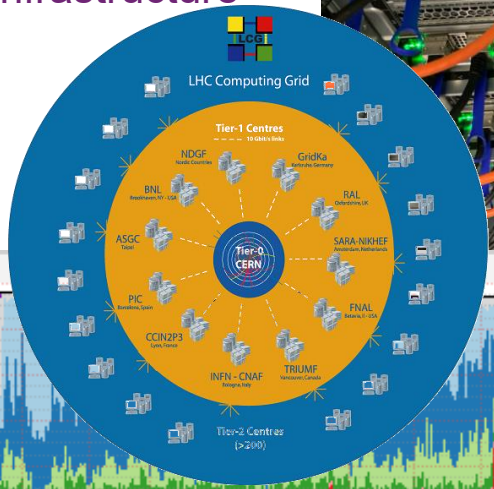


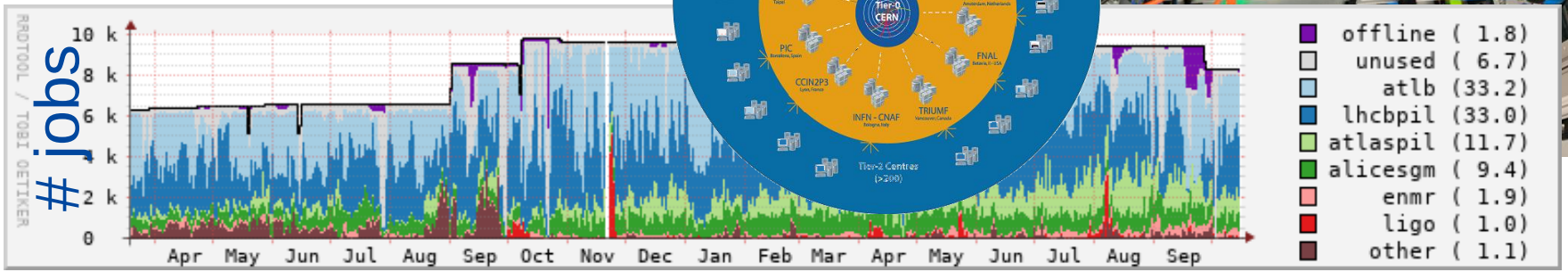
CERN CC B513, image: https://cds.cern.ch/record/2127440; tape library: CC-IN2P3 with LHC and LSST data; cabinets: Nikhef H234b

WLCG and Dutch National Infrastructure

11 global Tier-1 centres for CERN's LHC

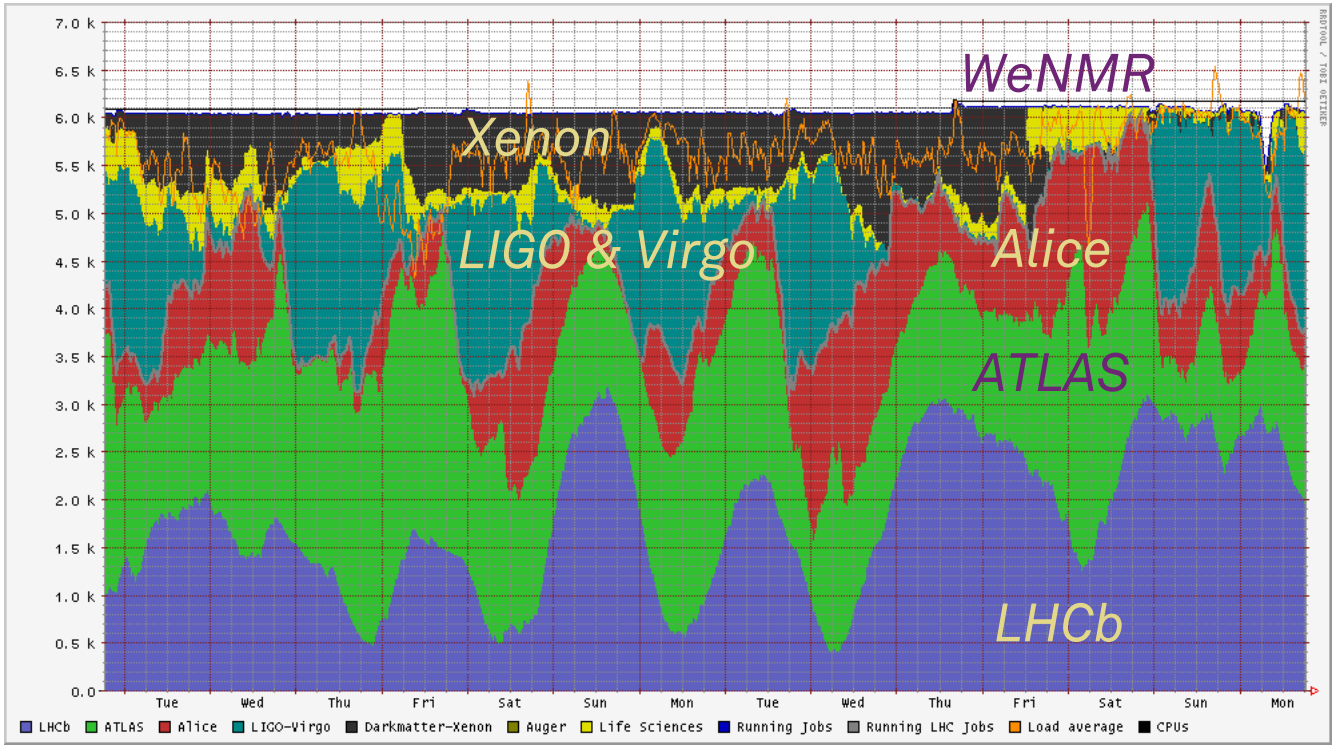
- 'NL-T1' part of the Dutch National Infrastructure **coordinated by SURF**
- located at SURF and Nikhef
- **shared** across research domains: GWIs, WIs, and other instruments



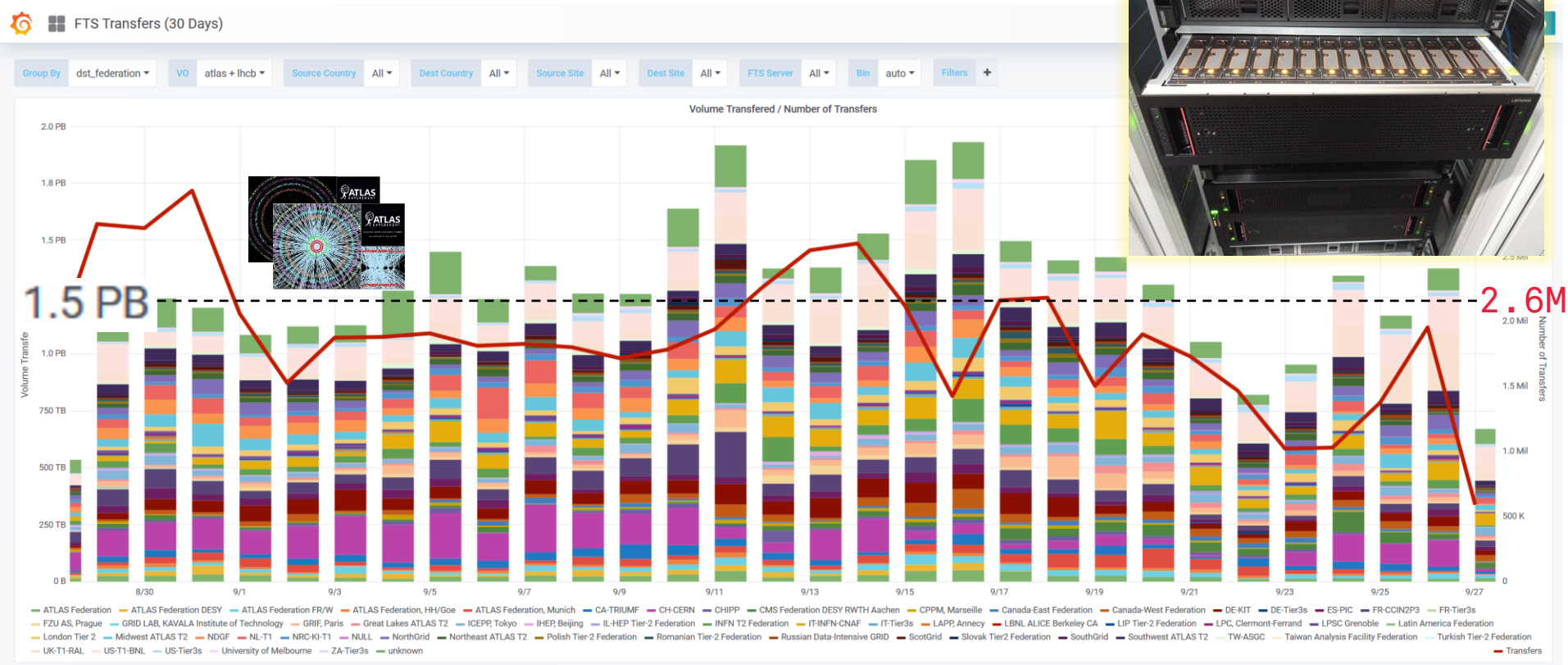


Source: NDPF Statistics overview, https://www.nikhef.nl/pdp/doc/stats/ GRISview images: Jeff Templon period: March 2021 .. October 2022; cluster nodes: 'Lotenfeest'

Shared High Throughput computing

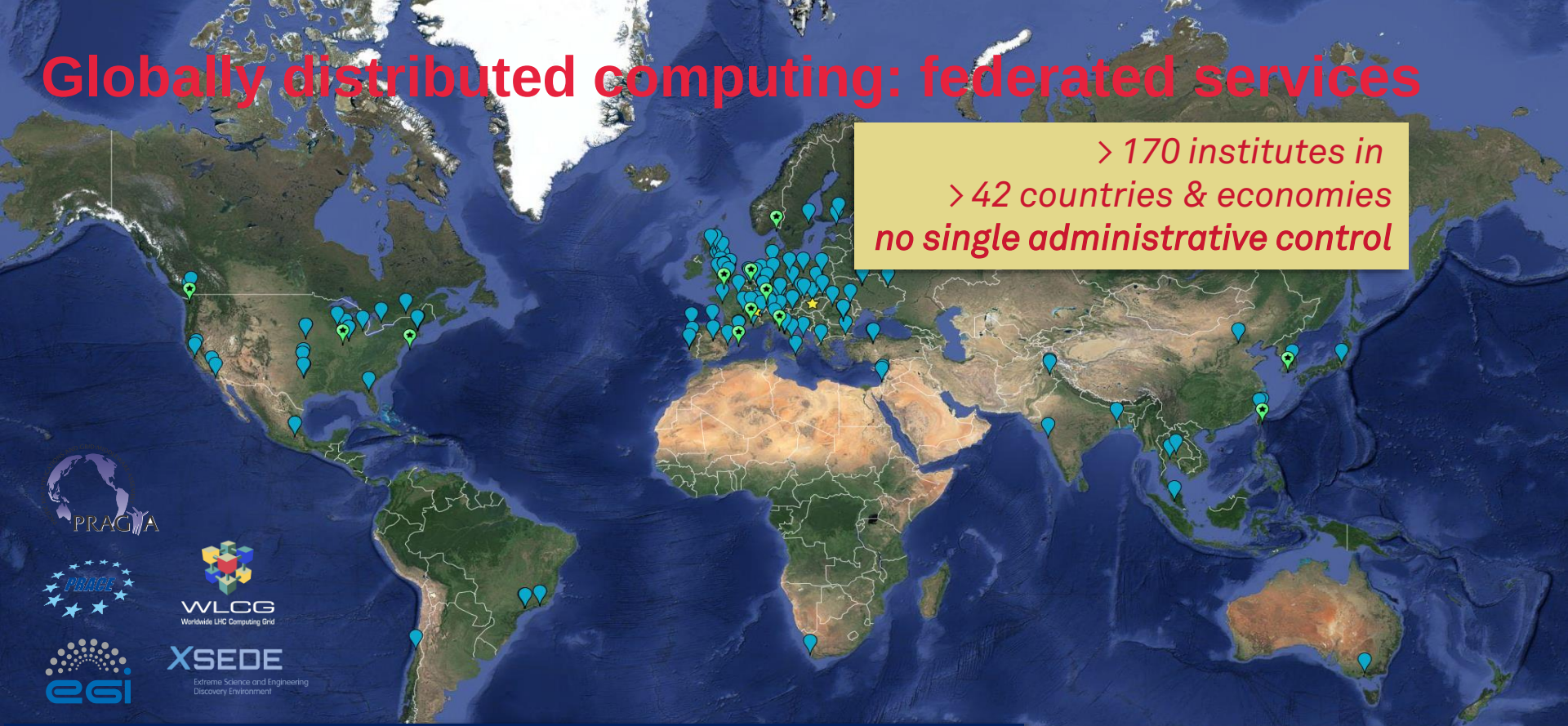


NDPF voview short 1 October 2018



source: https://monit-grafana.cern.ch/d/000000420/fts-transfers-30-day

Globally distributed computing: federated services



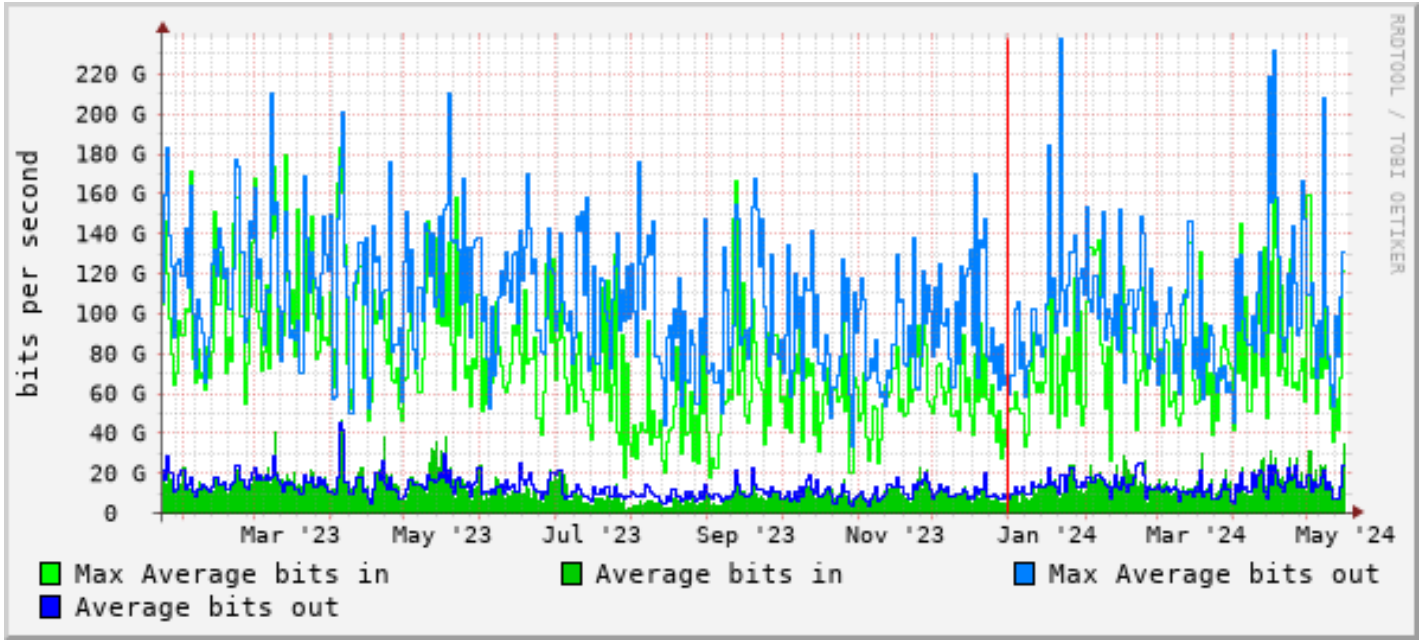
> 170 institutes in
> 42 countries & economies
no single administrative control

PRACE
WLCG Worldwide LHC Computing Grid
XSEDE Extreme Science and Engineering Discovery Environment
EGI

COMPUTING	~ 2,000,000 CORES
ON-LINE DISKS	> 400 PB
ARCHIVAL	> 600 PB

Nikhef

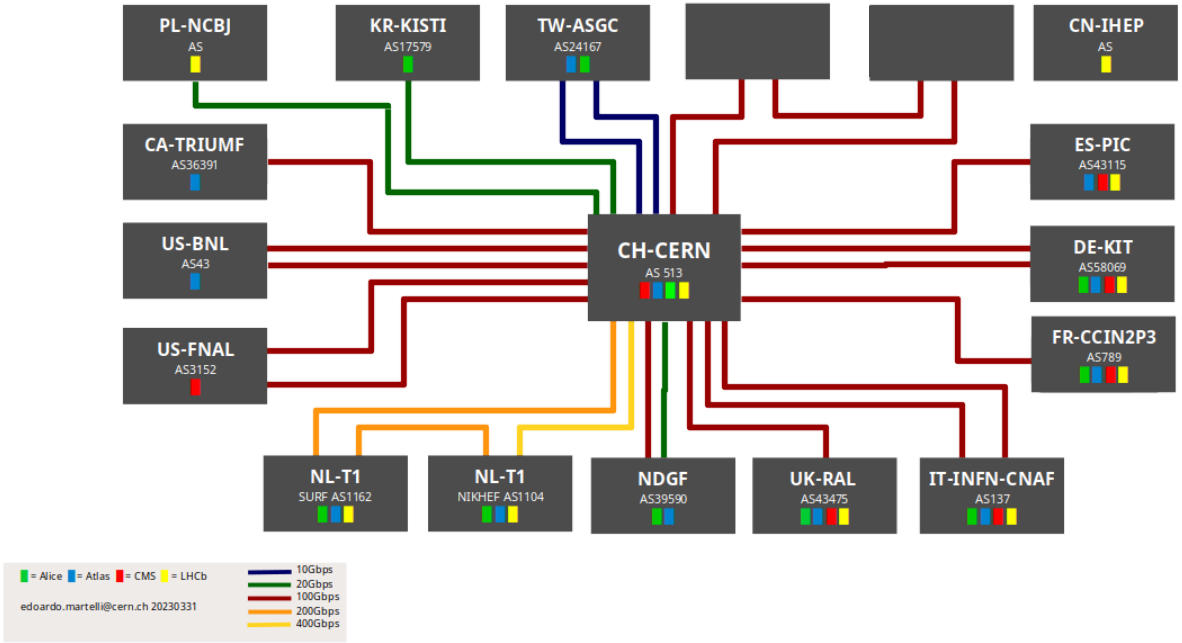
Typical data traffic to and from our processing cluster



Source: Nikhef cricket graphs period January 2023 – May 2024 – aggregated (research) traffic to external peers from deelqfx – https://cricket.nikhef.nl/

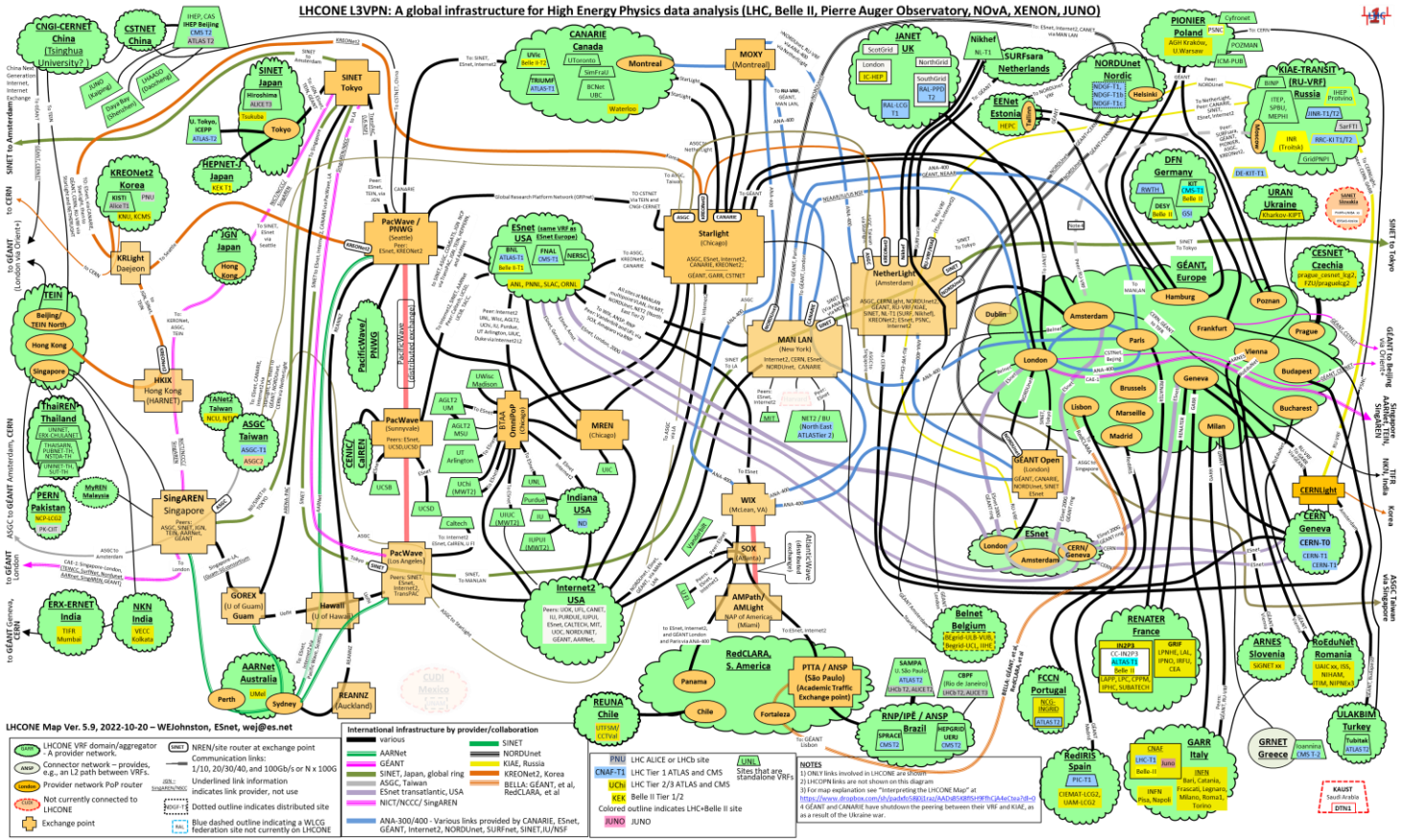
LHC Optical Private Network

LHCOPN



Edoardo Martelli, CERN (https://twiki.cern.ch/twiki/bin/view/LHCOPN/OverallNetworkMaps)

LHCone



LHCone ("LHC Open Network Environment") – visualization by Bill Johnston, ESnet version: October 2022 – updated with new AS1104 links

Research networks with office enclaves: the ScienceDMZ

Predicable performance and data access for research

‘where research services, data, and researchers meet’

- latency hiding through caching
- security zoning/segmentation protects specific data sets
- **outside any enterprise perimeter**

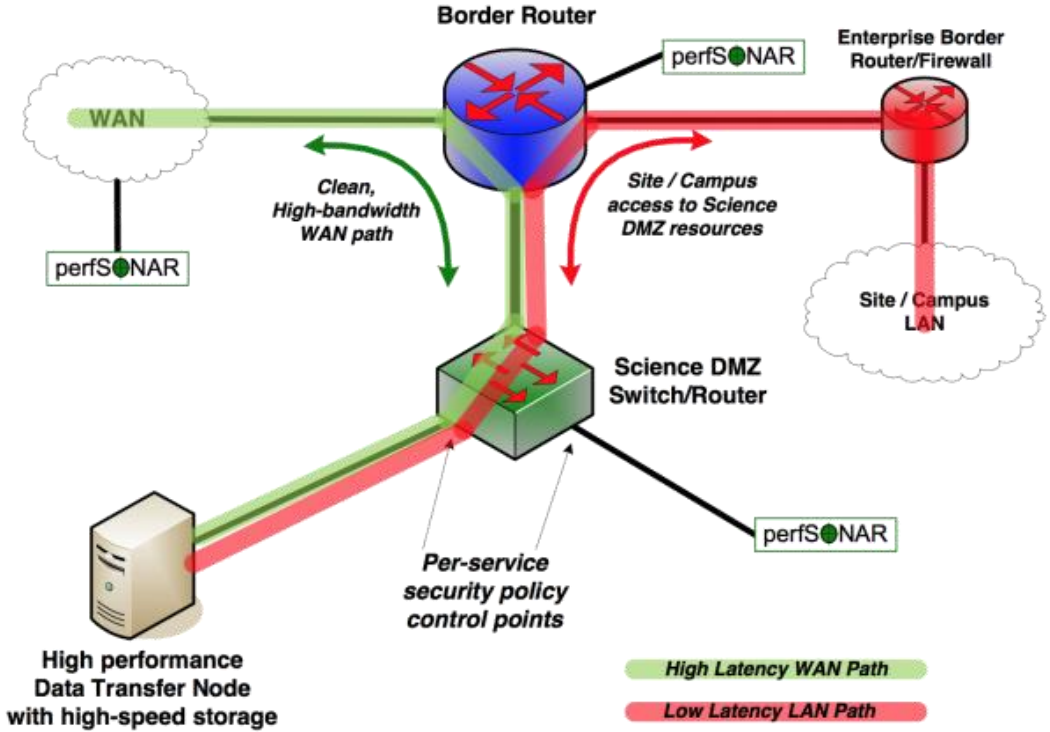
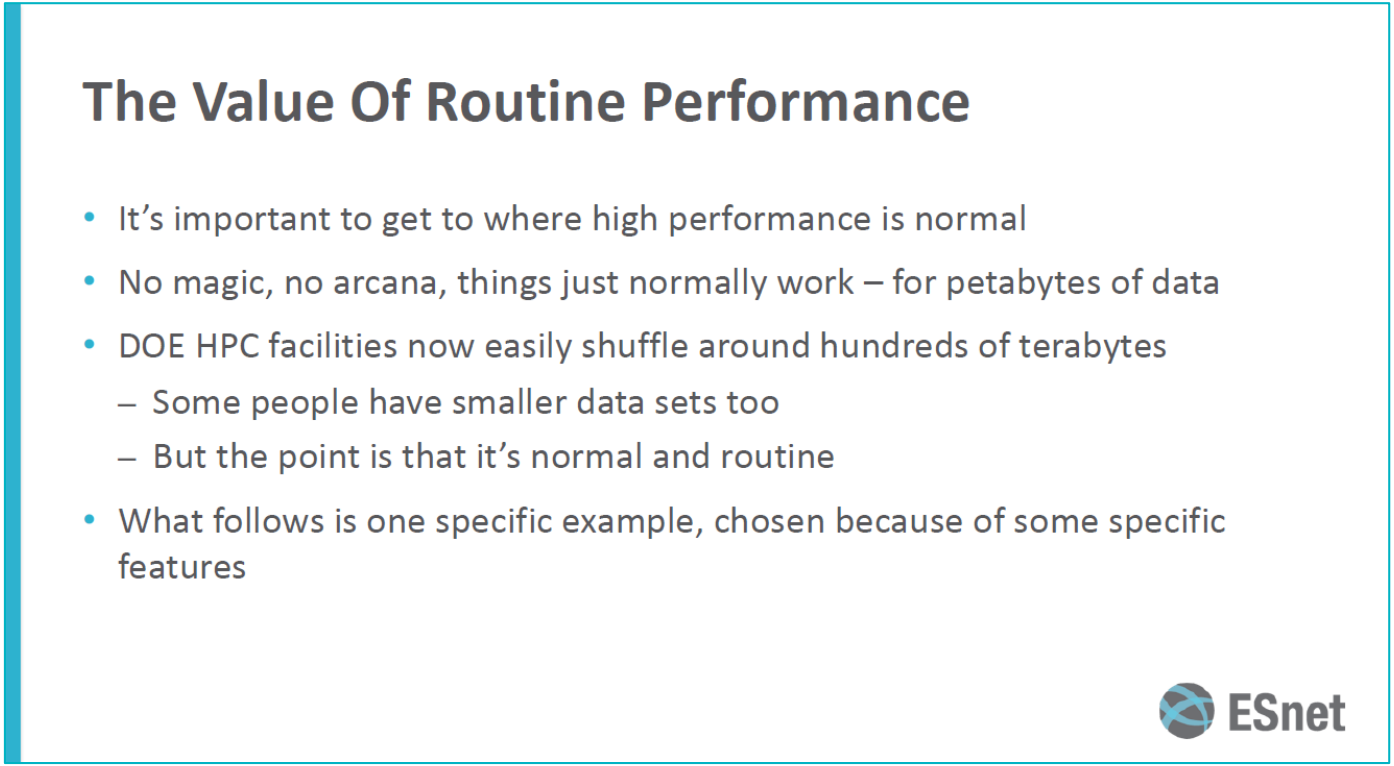


Image and ‘ScienceDMZ’ concept promulgated by ESnet (see fasterdata.es.net)

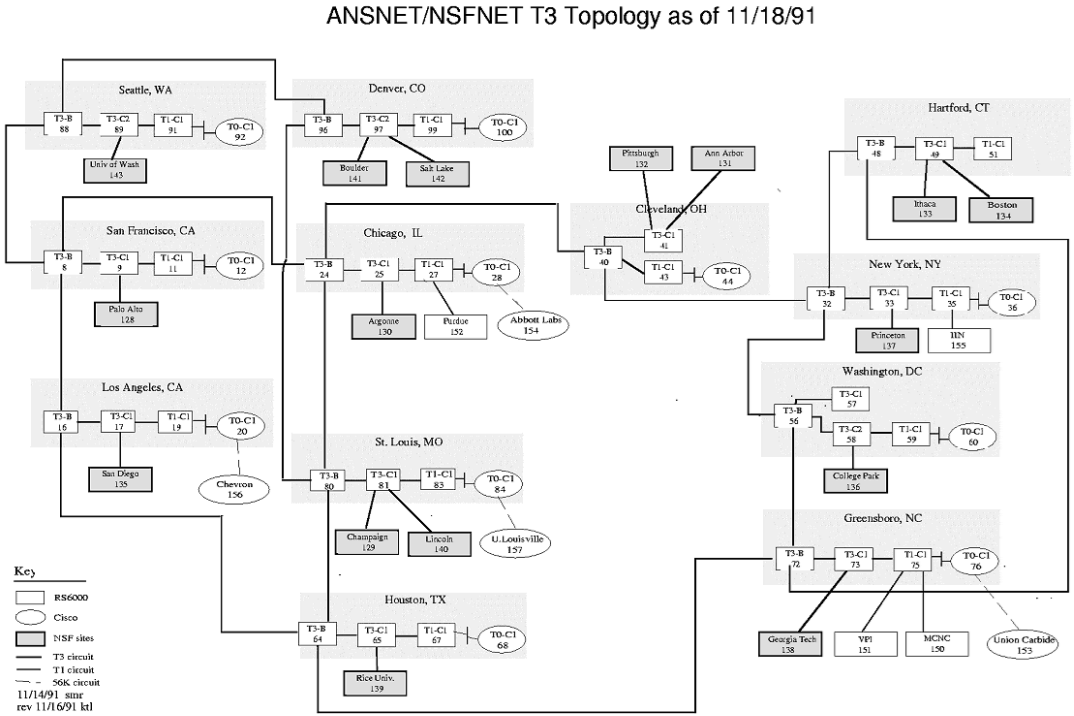
Can hardly state it better than Eli Dart (again at TNC23)

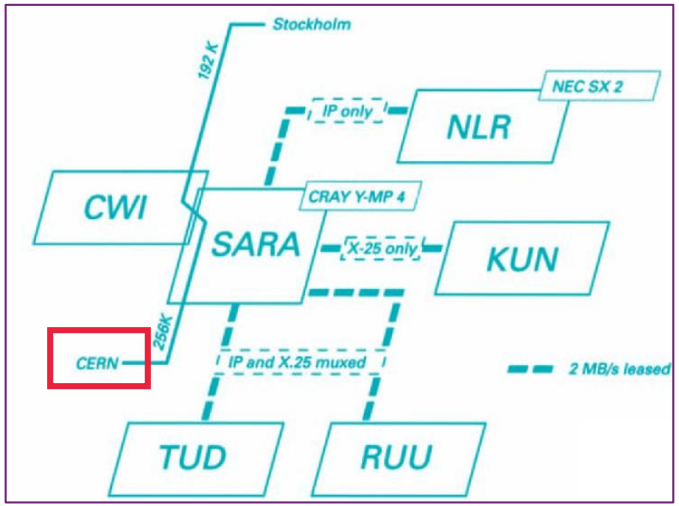


From Eli Dart (ESnet), "The Strategic Future of the Science DMZ", TNC23, https://indico.geant.org/event/2/contributions/186/attachments/168/

Data Centre: Housing, Connectivity, Compute, Data

Getting to CERN from the Netherlands





See https://personalpages.manchester.ac.uk/staff/m.dodge/cybergeography/atlas/historical.html for more historic maps ; right-hand image: SURFnet2, 1990

The Nikhef data centre – at the end of the 1980s

Nikhef room H1.37 – terminal stations on the raised data floor of the computer room (H1.40, behind the glass-panel walls)

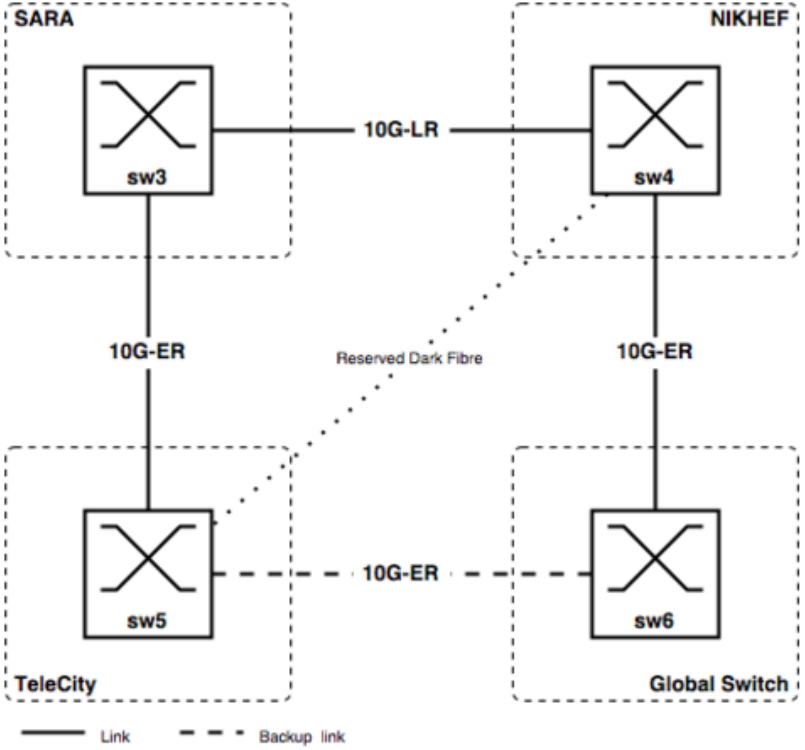
Gould, Sun, and DEC systems, taking several racks each

- 500 m2 floor area
- Raised floor: +60cm
- walls are ‘movable’ to accommodate expansion

IBR-LAN at Nikhef

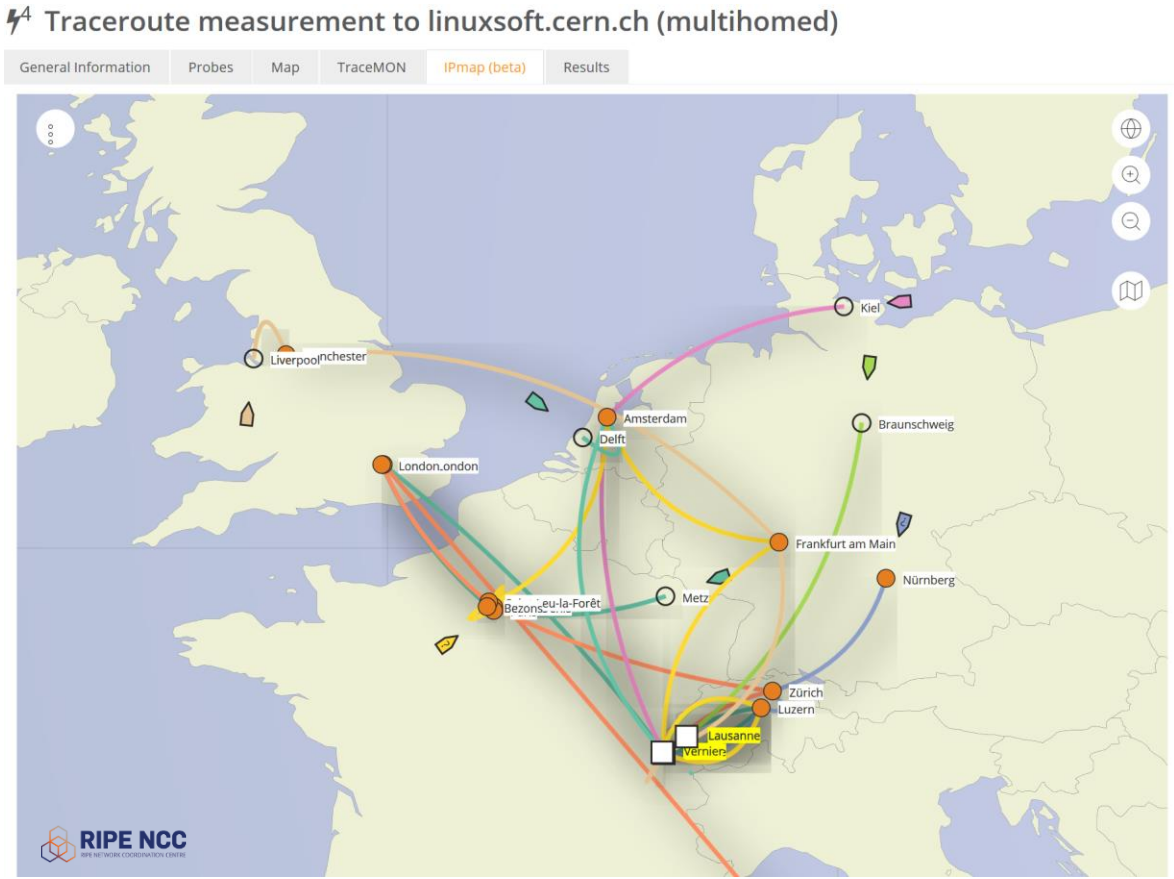
International Backbone Router Local Area Network “IBR-LAN” at Nikhef, room H1.40 as seen in 1996. Right: H1.39 with nikhefh.nikhef.nl racks and early DAS-2 system

A growing internet!



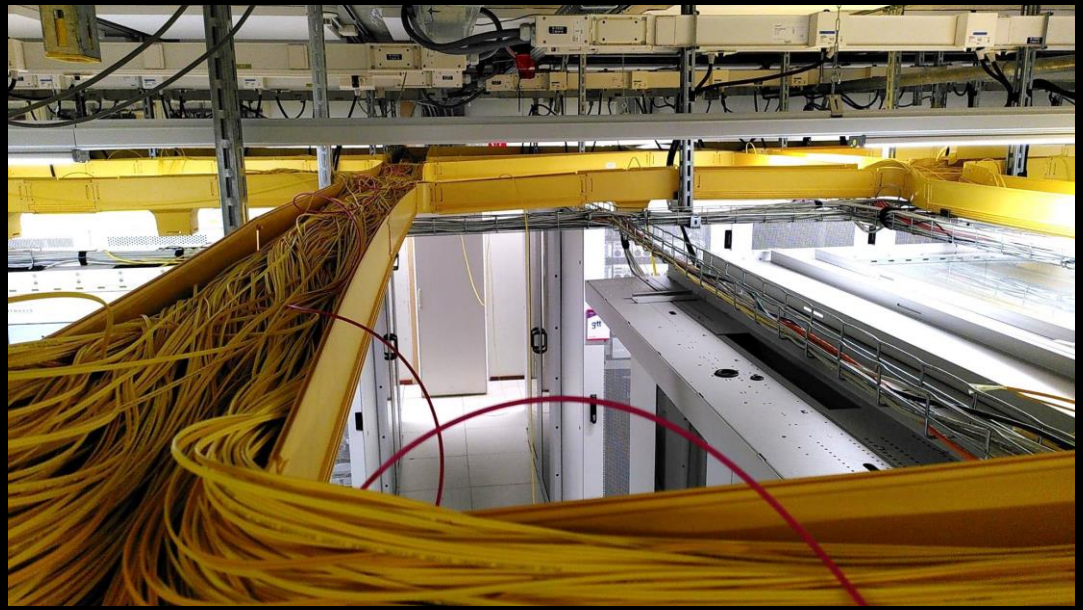
AMS-IX topology, 2002

Getting to CERN



Data: TraceMON IPmap from RIPE NCC Atlas atlas.ripe.net measurement 9249079

What happens inside a data centre …



‘Connectivity’ housing and ‘hosting’ are different things:

- NikhefHousing (H140) has connectivity parties only, and does not host any content
- what you see on the 1st floor tour is *network* equipment: shipping data, but not keeping anything

2nd floor has our science data centre

And no single connectivity data centre is a single point of failure:
Internet protocols are engineered to re-route traffic

Today’s data centre at Nikhef

Nikhef ‘science’ data centre H234b

- 47 racks and ~350 kW
- hosts Nikhef, CERN, gravitational waves, and SURF *research* data
- strengthens connectivity at NikhefHousing

‘NikhefHousing’ data centre

- from once just 2 racks in a spare space
- to now > ~400 racks
- many different connectivity parties
- connectivity only, but not hosting

Data centre installation management

- three 400kW active/free cooling chillers installed in 2009
- data floor: grown to ~400 racks
- additional electricity generator set added in 2009
- Aquifer Thermal Energy Storage (ATES) system in 2010

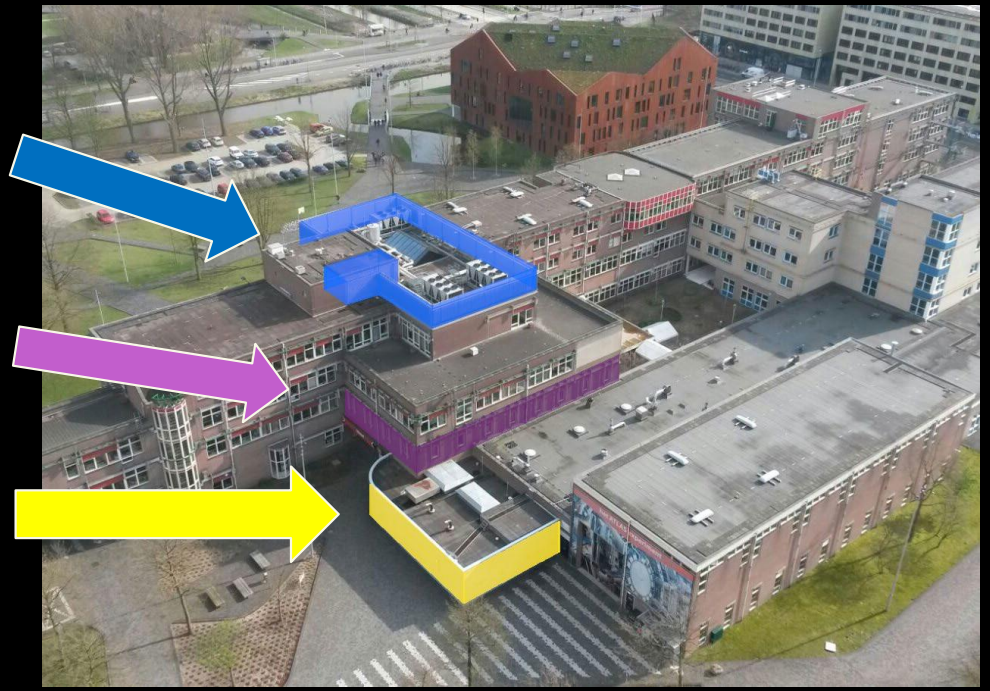
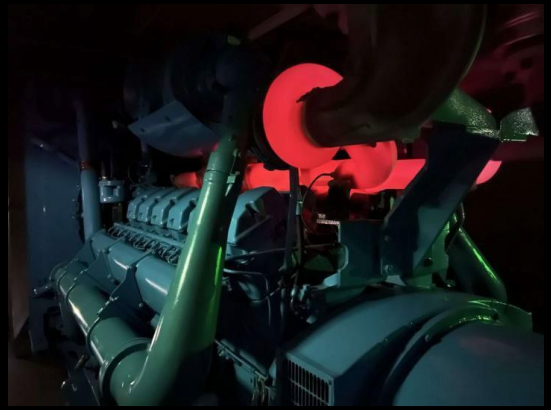


Image: Floris Bieshaar, Nikhef

Power in … and energy out …



Three generators

- A-Feed 1250 kVA (pictured under load while testing)
- B-Feed 1700 kVA
- C-Feed 1250 KVA added with the current expansion

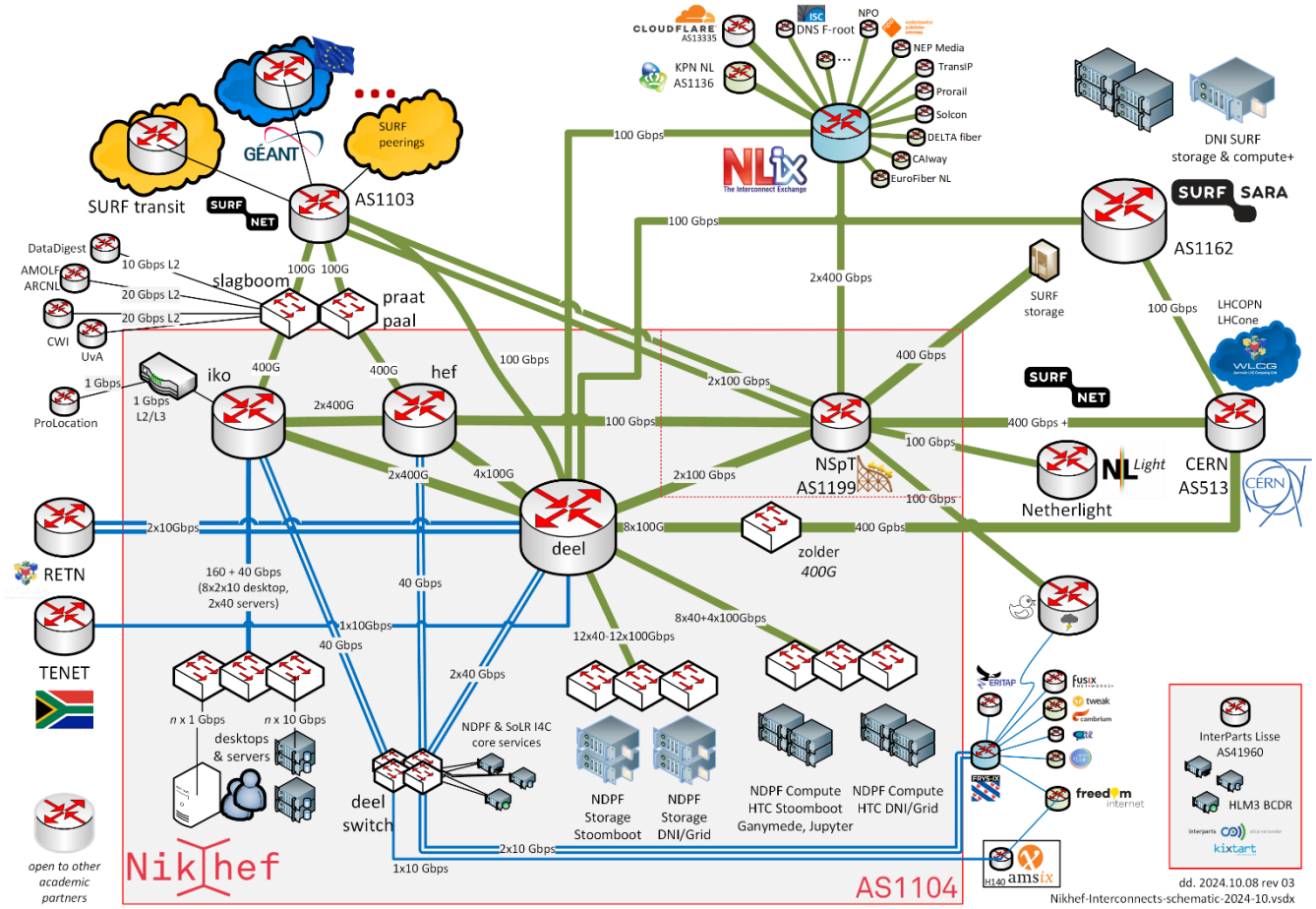
Separate redundant UPS for each

Heat re-use: aquifer thermal energy storage

re-use heat to warm our building (pretty warm) AND feed more heat to student housing opposite
nominal 'PUE' ~ 1.21

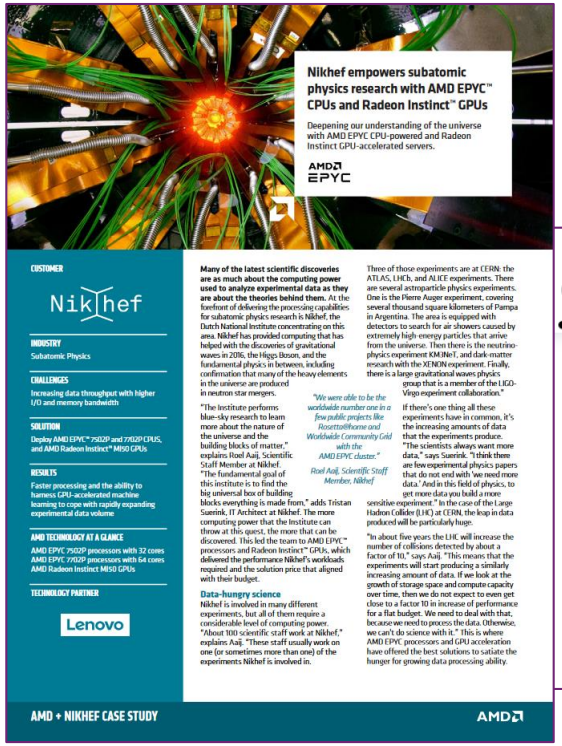
Generator image source: Floris Bieshaar. MacGillevrylaan sketch: Science Park Amsterdam

Just one of the many autonomous systems ...



AS1104

Some are faster than …



Nikhef empowers subatomic physics research with AMD EPYC™ CPUs and Radeon Instinct™ GPUs

Deepening our understanding of the universe with AMD EPYC CPU-powered and Radeon Instinct GPU-accelerated servers.

AMD EPYC

CUSTOMER

Nikhef

INDUSTRY

Subatomic Physics

CHALLENGES

Increasing data throughput with higher I/O and memory bandwidth

SOLUTION

Deploy AMD EPYC™ 7502P and 7702P CPUs, and AMD Radeon Instinct™ MI50 GPUs

RESULTS

Faster processing and the ability to harness GPU-accelerated machine learning to cope with rapidly expanding experimental data volume

AMD TECHNOLOGY AT A GLANCE

AMD EPYC 7502P processors with 32 cores
AMD EPYC 7702P processors with 64 cores
AMD Radeon Instinct MI50 GPUs

TECHNOLOGY PARTNER

Lenovo

Many of the latest scientific discoveries are as much about the computing power used to analyze experimental data as they are about the theories behind them. At the forefront of delivering the processing capabilities for subatomic physics research is Nikhef, the Dutch National Institute concentrating on this area. Nikhef has provided computing that has helped with the discoveries of gravitational waves in 2016, the Higgs Boson, and the fundamental physics in between, including confirmation that many of the heavy elements in the universe are produced in neutron star mergers.

"The Institute performs blue-sky research to learn more about the nature of the universe and the building blocks of matter," explains Roel Aaij, Scientific Staff Member at Nikhef. "The fundamental goal of this institute is to find the big universal box of building blocks everything is made from," adds Tristan Suerink, IT Architect at Nikhef. The more computing power that the Institute can throw at this quest, the more that can be discovered. This led the team to AMD EPYC™ processors and Radeon Instinct™ GPUs, which delivered the performance Nikhef's workloads required and the solution price that aligned with their budget.

"We were able to be the worldwide number one in a few public projects like Rosetta@home and Worldwide Community Grid with the AMD EPYC cluster."

Roel Aaij, Scientific Staff Member, Nikhef

Data-hungry science

Nikhef is involved in many different experiments, but all of them require a considerable level of computing power. "About 100 scientific staff work at Nikhef," explains Aaij. "These staff usually work on one (or sometimes more than one) of the experiments Nikhef is involved in.

Three of those experiments are at CERN: the ATLAS, LHCb, and ALICE experiments. There are several astroparticle physics experiments. One is the Pierre Auger experiment, covering several thousand square kilometers of Pampa in Argentina. The area is equipped with detectors to search for air showers caused by extremely high-energy particles that arrive from the universe. Then there is the neutrino-physics experiment KM3NeT, and dark-matter research with the XENON experiment. Finally, there is a large gravitational waves physics group that is a member of the LIGO-Virgo experiment collaboration."

If there's one thing all these experiments have in common, it's the increasing amounts of data that the experiments produce. "The scientists always want more data," says Suerink. "I think there are few experimental physics papers that do not end with 'we need more data.' And in this field of physics, to get more data you build a more sensitive experiment." In the case of the Large Hadron Collider (LHC) at CERN, the leap in data produced will be particularly huge.

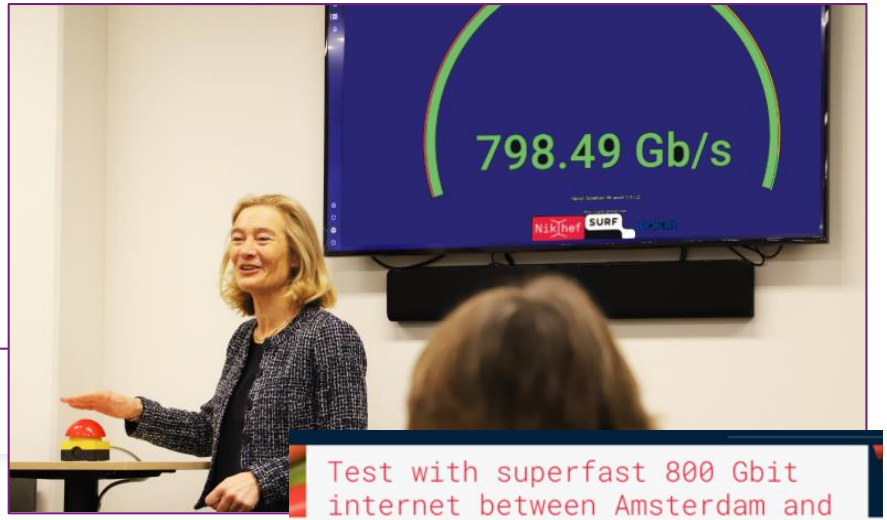
"In about five years the LHC will increase the number of collisions detected by about a factor of 10," says Aaij. "This means that the experiments will start producing a similarly increasing amount of data. If we look at the growth of storage space and compute capacity over time, then we do not expect to even get close to a factor 10 in increase of performance for a flat budget. We need to deal with that, because we need to process the data. Otherwise, we can't do science with it." This is where AMD EPYC processors and GPU acceleration have offered the best solutions to satiate the hunger for growing data processing ability.

AMD + NIKHEF CASE STUDY AMD

FUNGIBLE

NIKHEF, SURF AND FUNGIBLE SET NEW BENCHMARK FOR THE WORLD'S FASTES STORAGE PERFORMANCE

Companies Double Current Performance Record, Set the New Bar at 6.55 Million Read IOPS



Test with superfast 800 Gbit internet between Amsterdam and CERN successful

15 April 2024

Nokia and SURF have successfully tested an 800 Gbit/s data connection between Nikhef in Amsterdam and CERN in Geneva. Such a connection is needed to transmit data from the upcoming high-luminosity LHC accelerator.

The test used existing fiber-optic connections through Belgium and France toward Geneva in Switzerland over a total distance of 1,648 kilometers. An 800 Gbit/s connection is about a thousand times faster than the Internet connection in an average household.

Nokia's latest photonic technology, the sixth-generation super-coherent Photonic Service Engine (SPE-6s), was deployed in the tests, along with 16QUM-shaped modulation. The results of the tests will be announced in more detail next week at a Nokia expert conference in Athens.

Data hub

Image: Minister of Economic Affairs M. Adriaansens launched the Innovation Hub with Nikhef, SURF, Nokia and NL-ix, January 2023. Composite image from https://www.surf.nl/nieuws/minister-adriaansens-lanceert-testomgeving-voor-supersnelle-netwerktechnologie

Exercising the network – sensor data and events

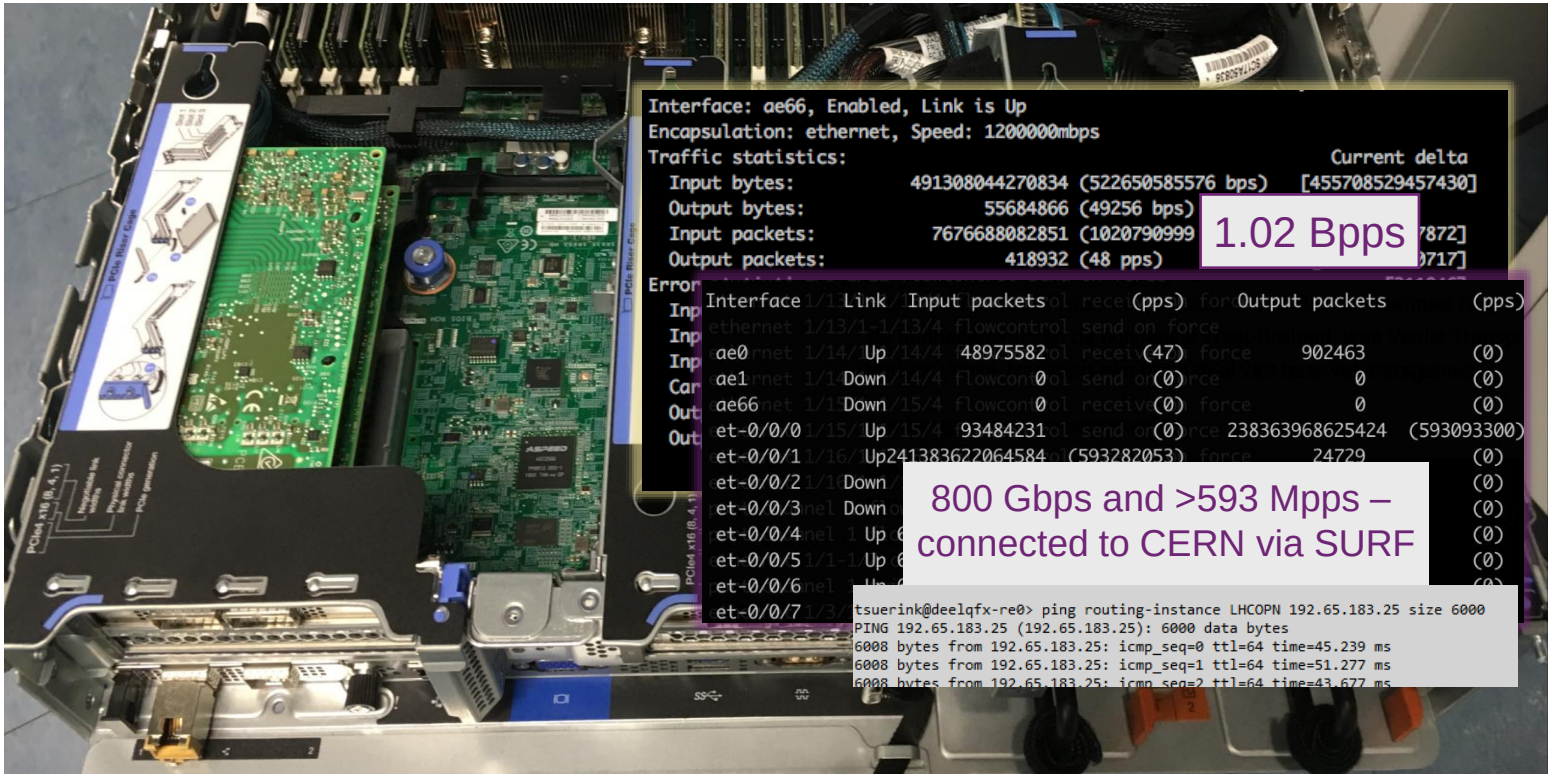
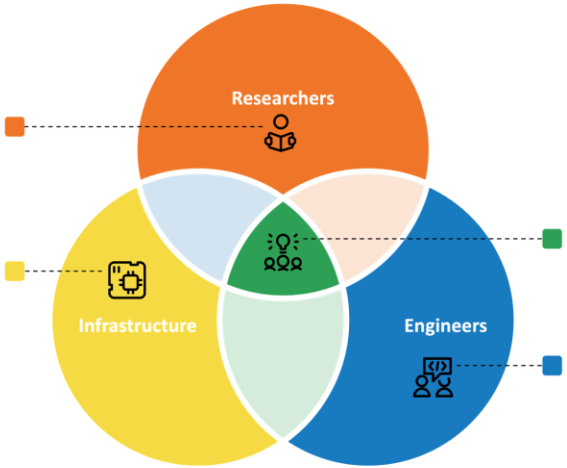


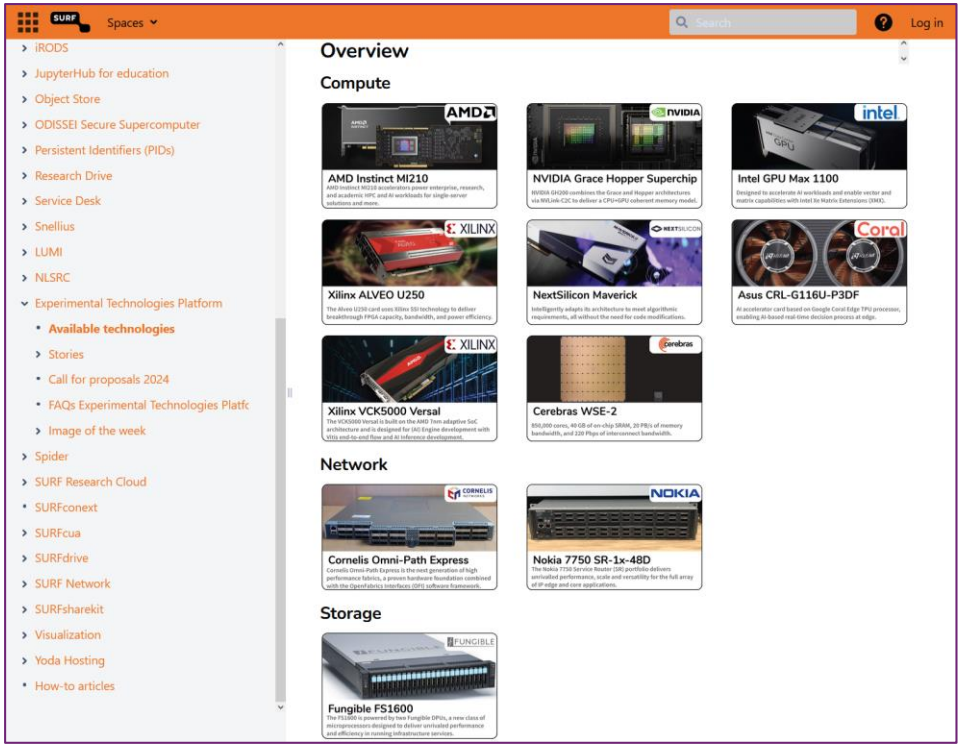
Image: ballenbak.nikhef.nl, Tristan Suerink

SURF Experimental Technologies Platform



SURF–ETP
Open and collaborative environment to foster the assessment of cutting-edge technologies and methodologies.

Engineers
Leverage their technical skills and motivation to surf the state-of-the-art.



https://servicedesk.surf.nl/wiki/display/WIKI/Experimental+Technologies+Platform and https://www.surf.nl/en/etp - contact Raymond Oonk at SURF for more info

Our science data flows are somebody else's DDoS attack

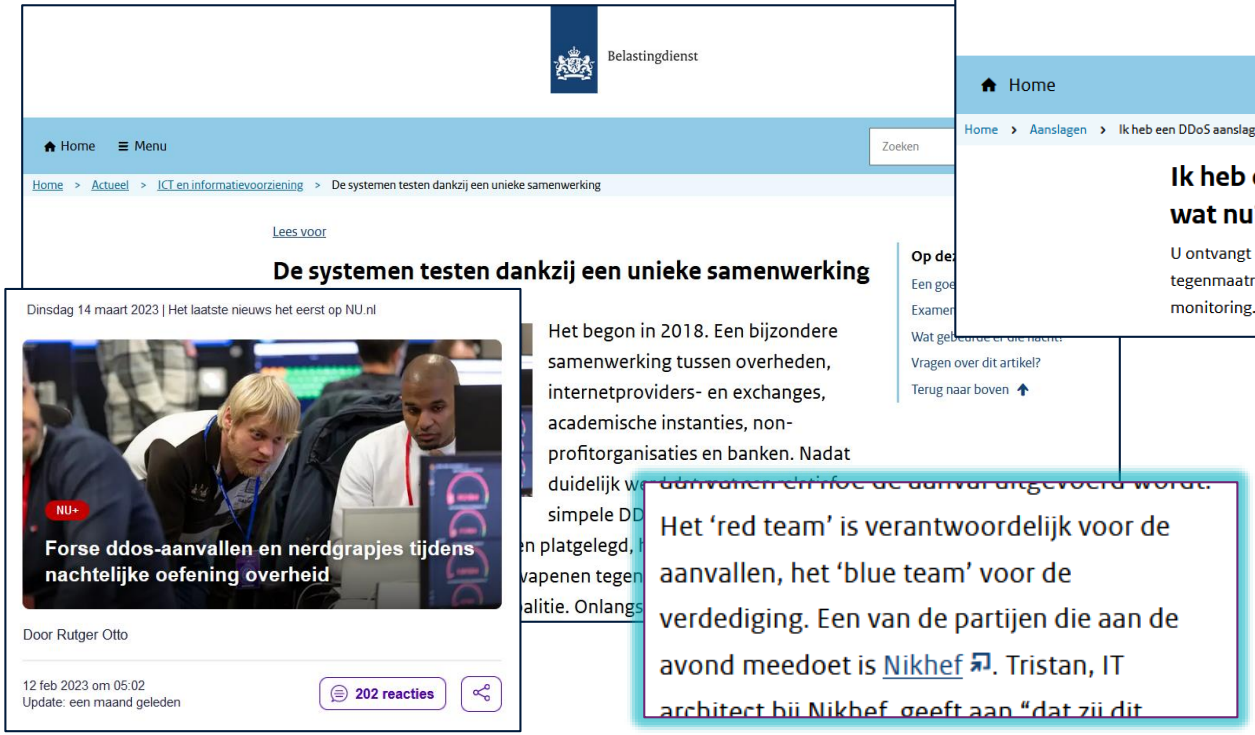
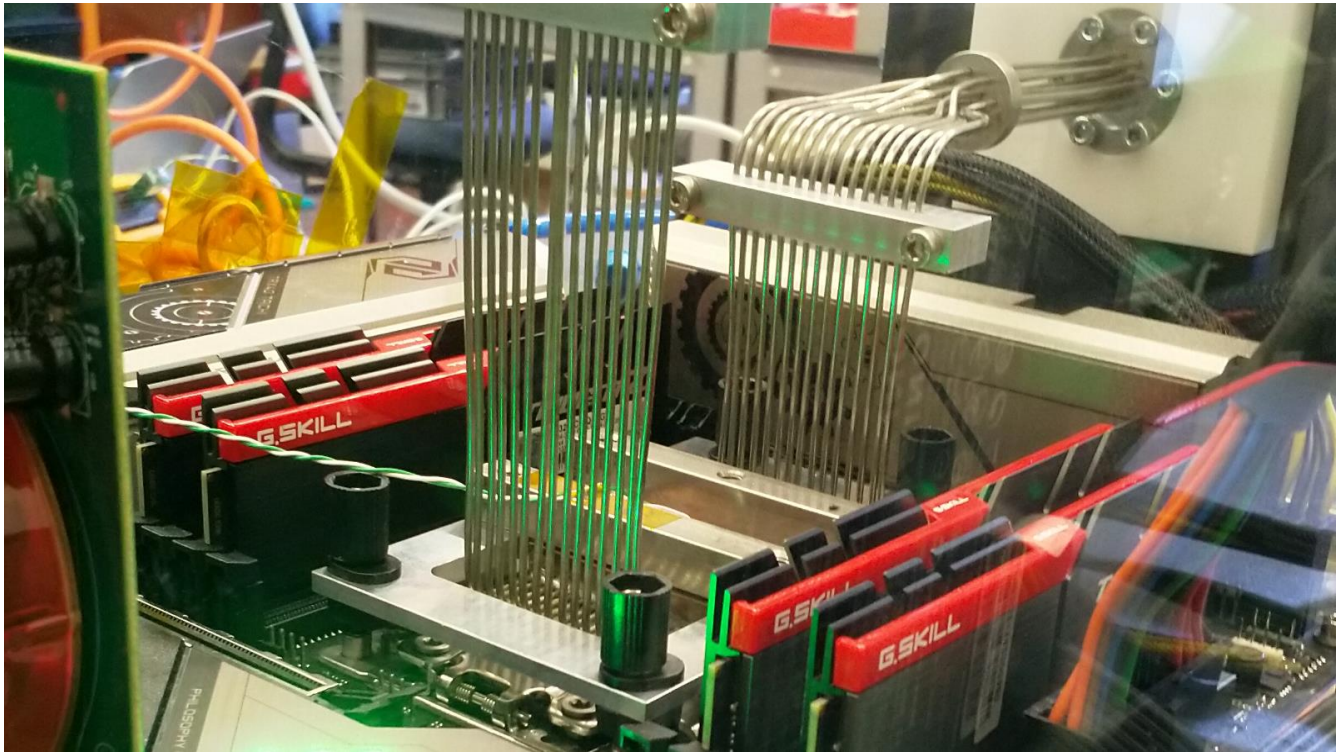


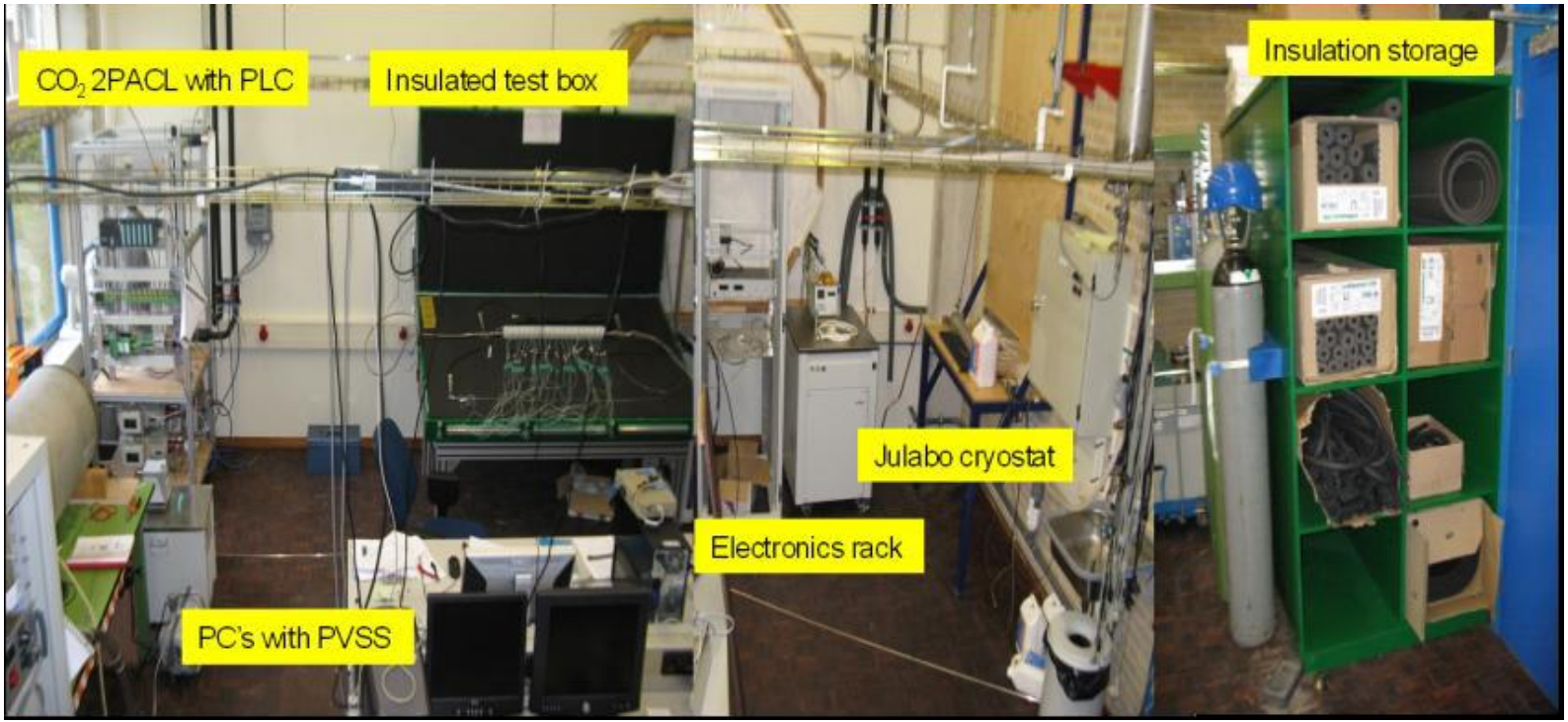
Image sources: belastingdienst.nl, rws.nl, nu.nl, werkentegennederland.nl

Because, even if we can …

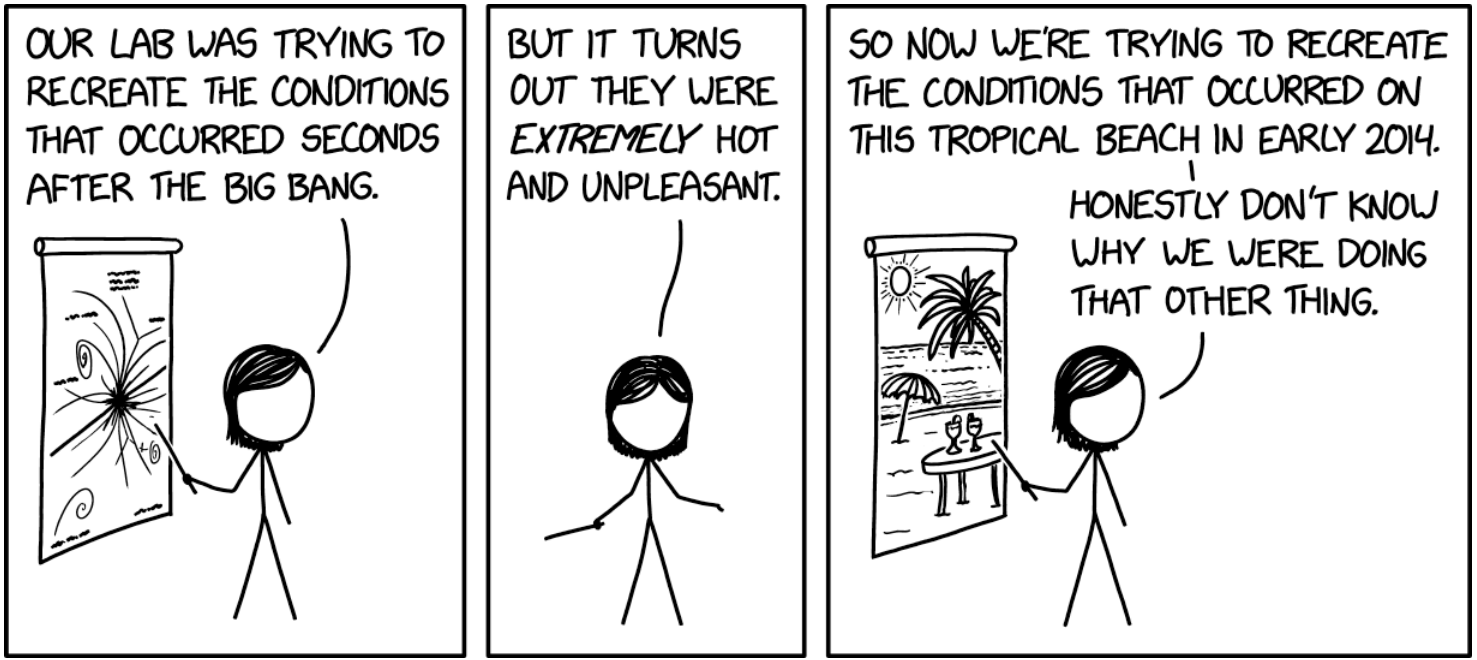


LCO2 cooling of an AMD Ryzen Threadripper 3970X [56.38 °C] at 4600.1MHz processor (~1.25x nominal speed) sustained over all cores simultaneously, using the Nikhef LCO2 test bench system (https://hwbot.org/submission/4539341) - (Krista de Roo en Tristan Suerink)

… it is not always the most scalable solution!



Nikhef 2PA LCO2 cooling setup. Image from Bart Verlaat, Auke-Pieter Colijn *CO2 Cooling Developments for HEP Detectors* https://doi.org/10.22323/1.095.0031



https://xkcd.com/2511/

Thanks, and enjoy Nikhef

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https://orcid.org/0000-0003-1026-6606

Maastricht University

Nikhef