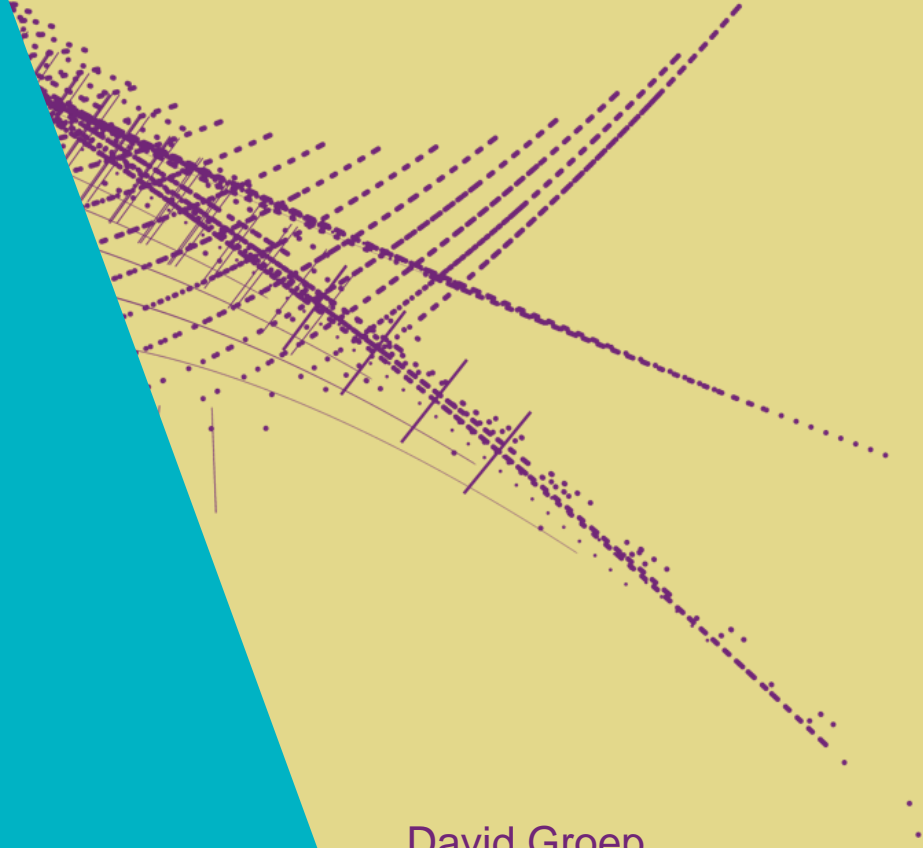# Nikhef

Maastricht University

Introduction to Nikhef and
the NikhefHousing Data Centre

Welcome to Nikhef

David Groep
May 2024

Our world, made of particles and fields

- **Accelerator-based particle physics**
  Experiments studying interactions in particle collision processes at particle accelerators, in particular at CERN;
- **Astroparticle physics**
  Experiments studying interactions of particles and radiation emanating from the Universe.

COLLIDER PHYSICS

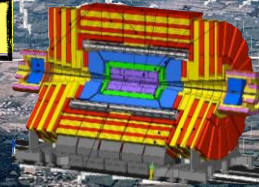ASTROPARTICLE PHYSICS

PHENOMENOLOGY

TECHNOLOGY R&D
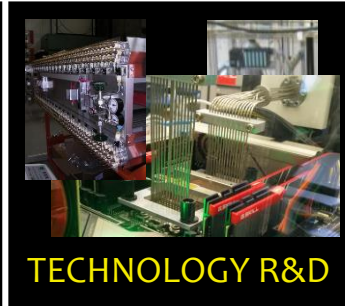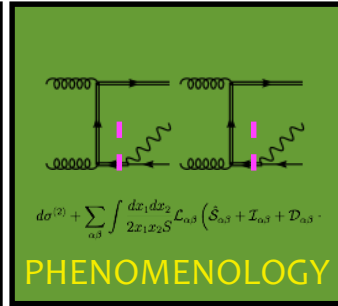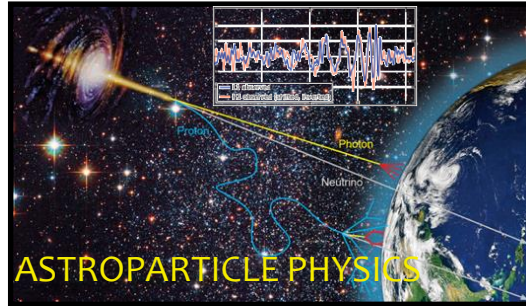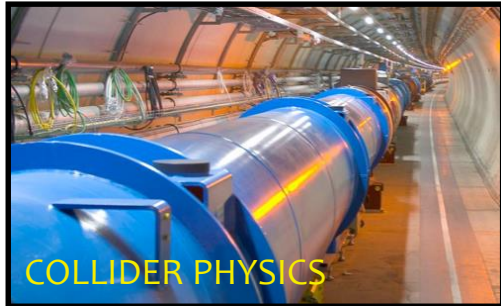
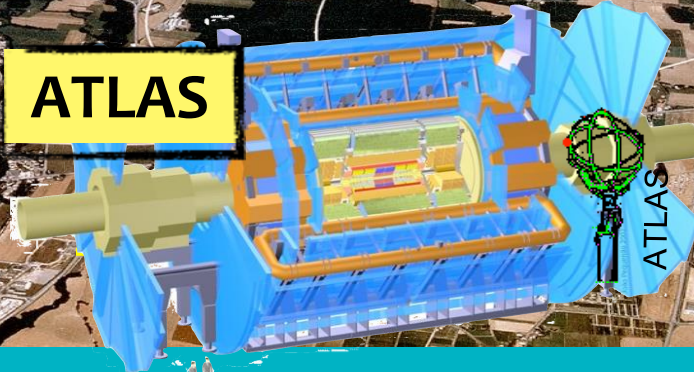# CERN – Europe's laboratory for high-energy physics

Large Hadron Collider

CMS

LHCB

ALICE

ATLAS

ATLAS

Imagery: CERN, European Organisation for Nuclear Research
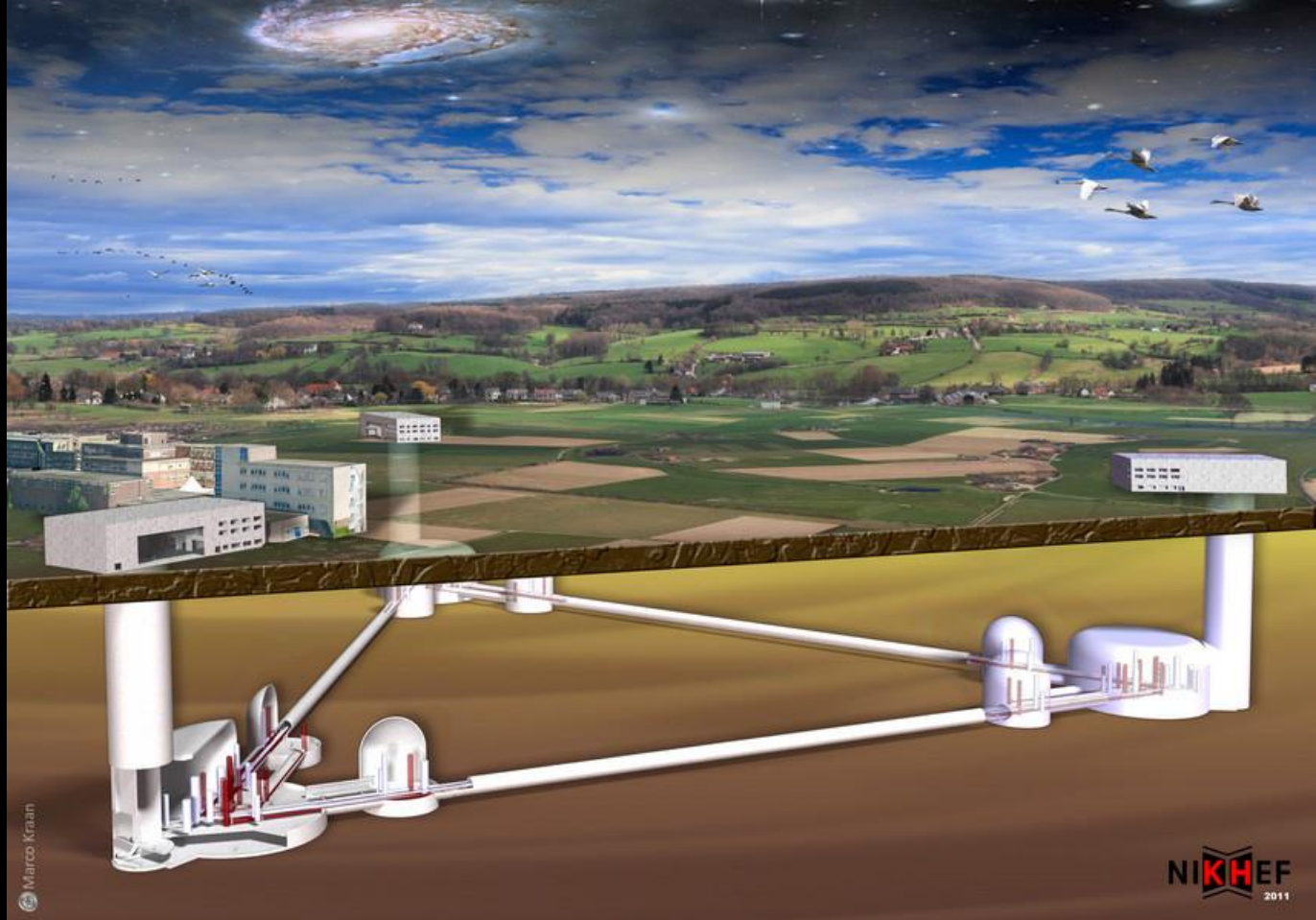
Introduction to Nikhef and the NikhefHousing Data Centre

www.et-emr.eu!
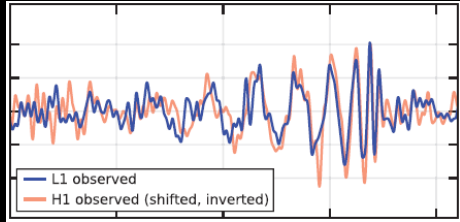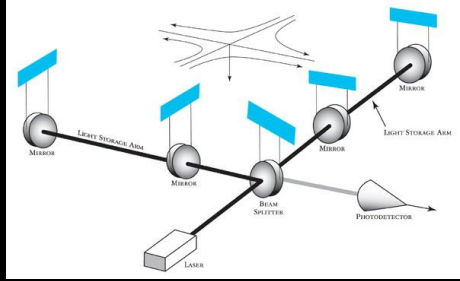
Einstein Telescope projected in the EMR region, image: Marco Kraan
GW150914 event:
gw-astronomy collaborations, LIGO

Data at the Large Hadron Collider at CERN

1964

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

~ 50 PiB/year primary data

Nikhef

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
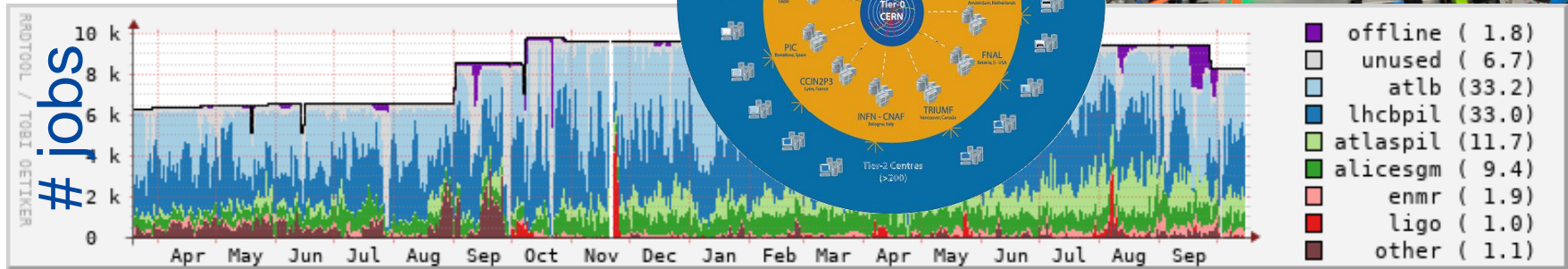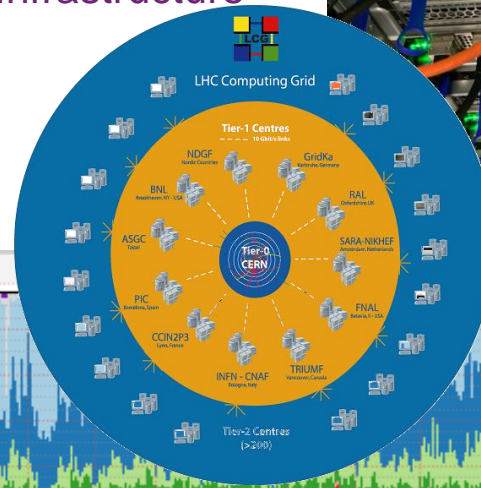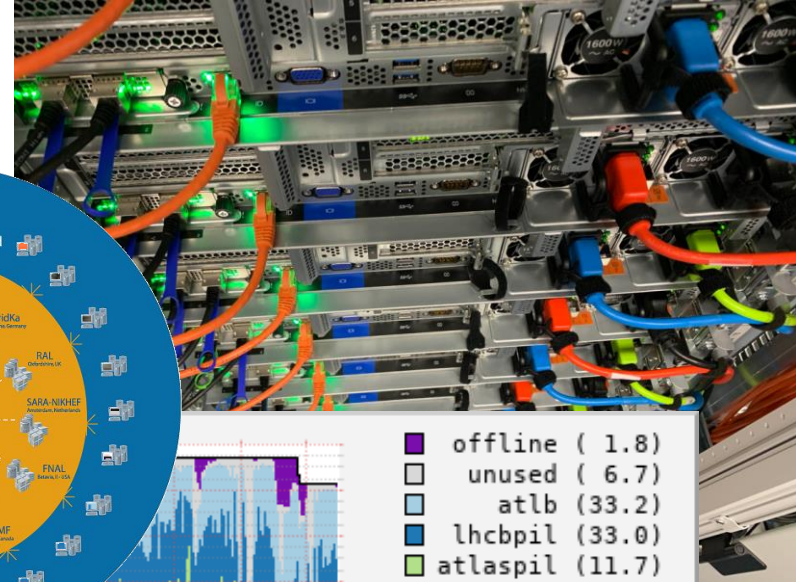
offline	(1.8)
unused	(6.7)
atlb	(33.2)
lhcbpil	(33.0)
atlaspil	(11.7)
alicesgm	(9.4)
enmr	(1.9)
ligo	(1.0)
other	(1.1)

Globally distributed computing: federated services

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

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

From a simple federation: eduroam global WiFi …

Service-specific "WiFi" federation
trust between organisations, globally

local organization grants access
based on your home credentials

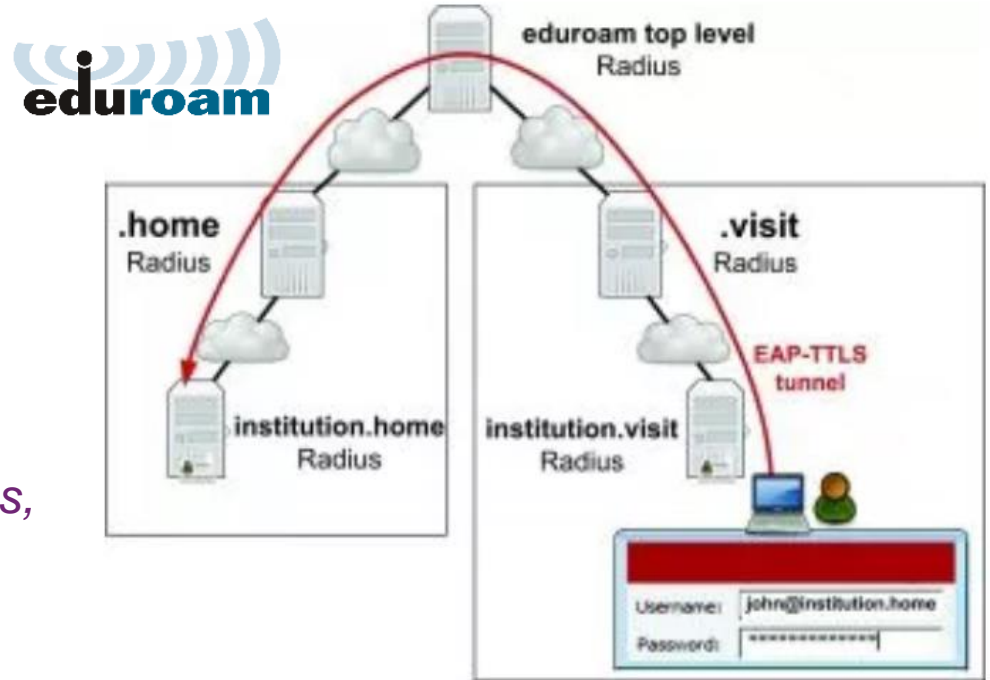*There are now multiple such federations,
such as govroam*

eduroam: Klaas Wieringa et al., image from https://eduroam.org/how/, GEANT ; RADIUS: RC2865 https://www.rfc-editor.org/rfc/rfc2865; see also freeradius.org

… to a global service federation for research and education

Images: SURFconext IdP dashboard by SURF, showing some services tagged with REFEDS R&S; eduGAIN map: GEANT, https://technical.edugain.org/status

eduGAIN without edupain, please

When something happens to it: federated incident response

Default Fed as proxy
Fed-1
No direct Coordinating team - Participant Communication

Support request situation
Fed-2
Direct Coordinating team - end entity Communication
Fed is always in CC
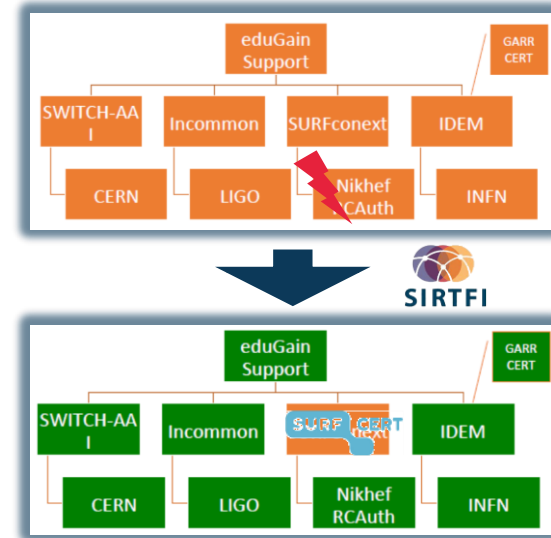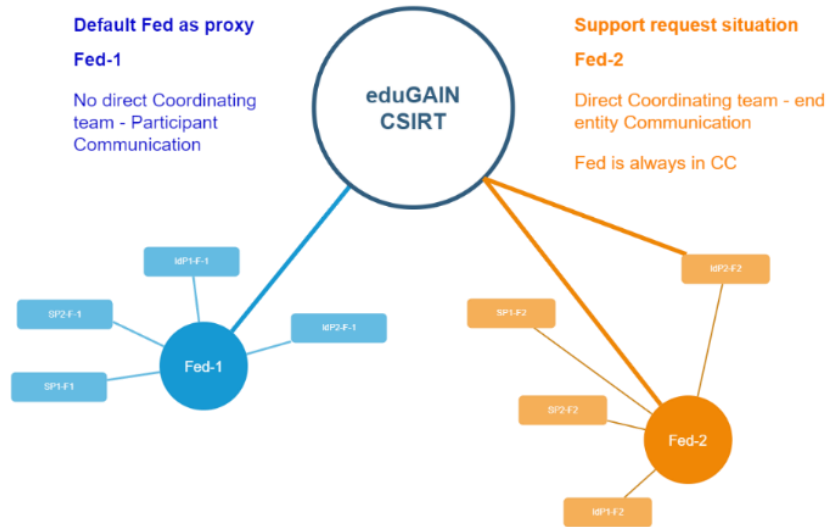
eduGAIN CSIRT

- *Joint **operational trust baseline** for the global R&E federations*
- *Supplemented by **sectoral policy guidance***
- *focus on infrastructure and data integrity, confidentiality, availability*

images: AARC Sirtfi v1 exercise (Hannah Short), eduGAIN security TTX (Sven Gabriel, eduGAIN CSIRT); joint with GN5-1 EnCo

Security Service Challenges: exercise finding & removing malware and spyware in global collaboration

Screenshots: Oscar Koeroo *et al.*, Nikhef, for EGI SSC5

Data Centres – housing and connectivity

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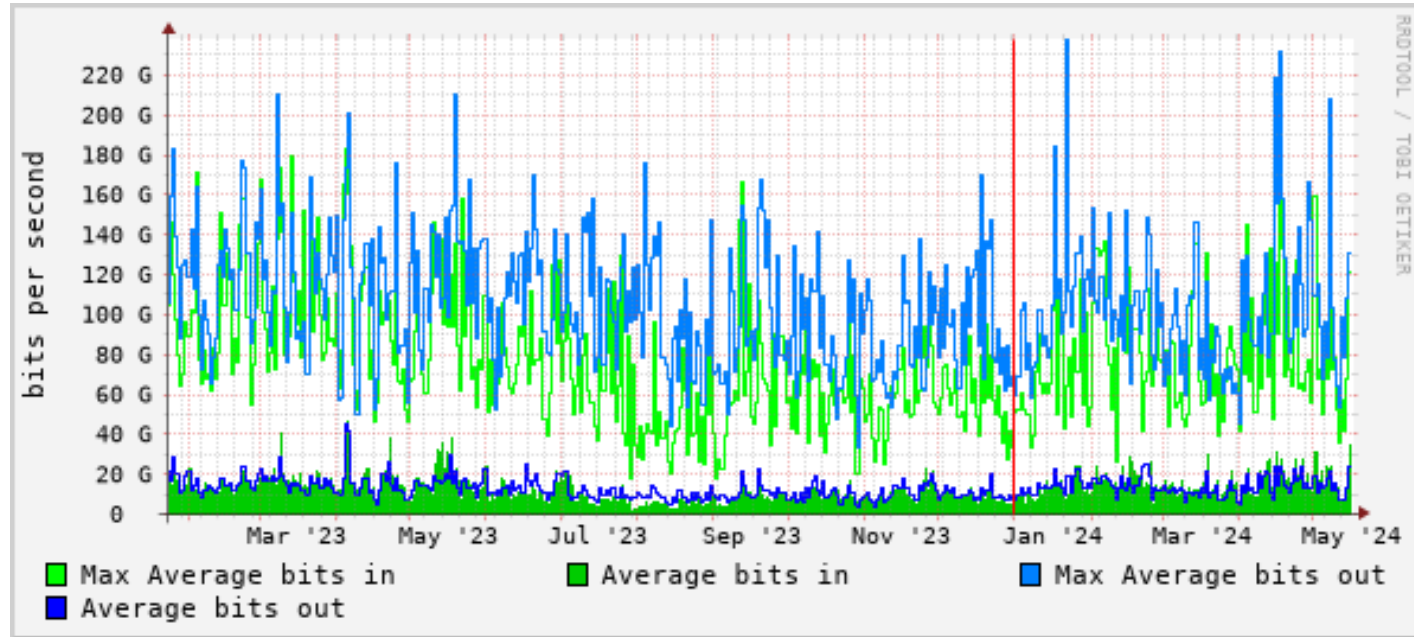
Source: Nikhef cricket graphs period January 2023 – May 2024 – aggregated (research) traffic to external peers from deelqfx – https://cricket.nikhef.nl/

Introduction to Nikhef and the NikhefHousing Data Centre

Getting to CERN from the Netherlands

ANSNET/NSFNET T3 Topology as of 11/18/91
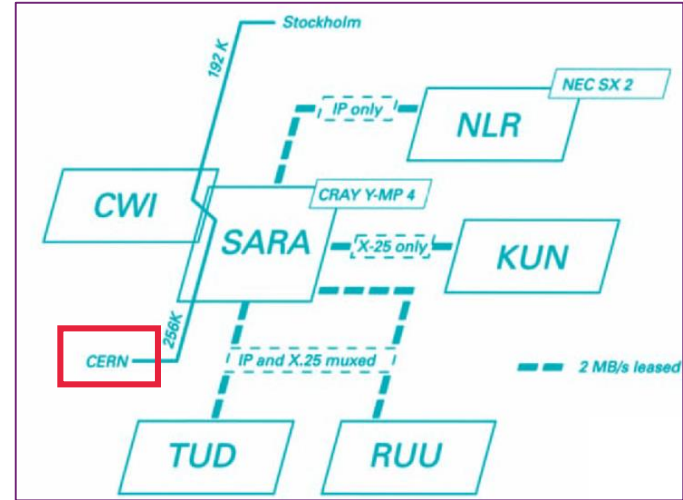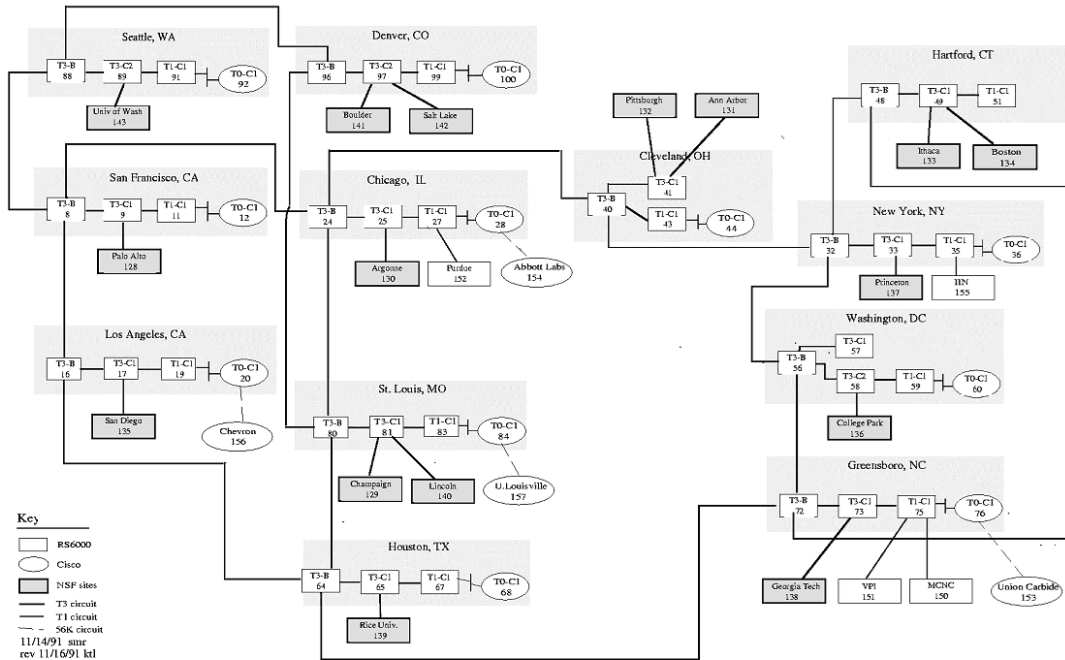
See https://personalpages.manchester.ac.uk/staff/m.dodge/cybergeography/atlas/historical.html for more historic maps ; right-hand image: SURFnet2, 1990

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

Nikhef room H1.37 – terminal station 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

Nikhef
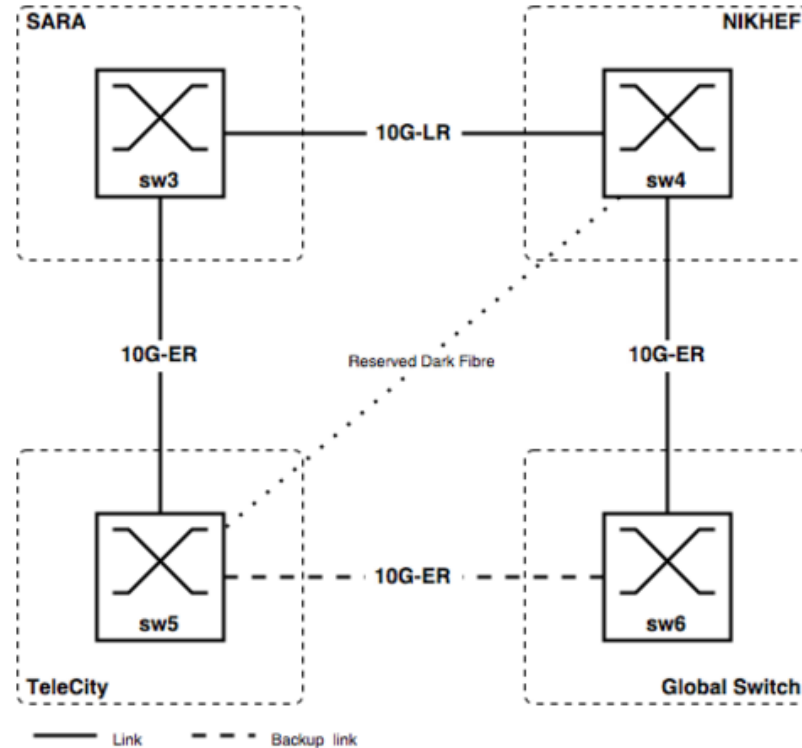
IBR-LAN at Nikhef

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
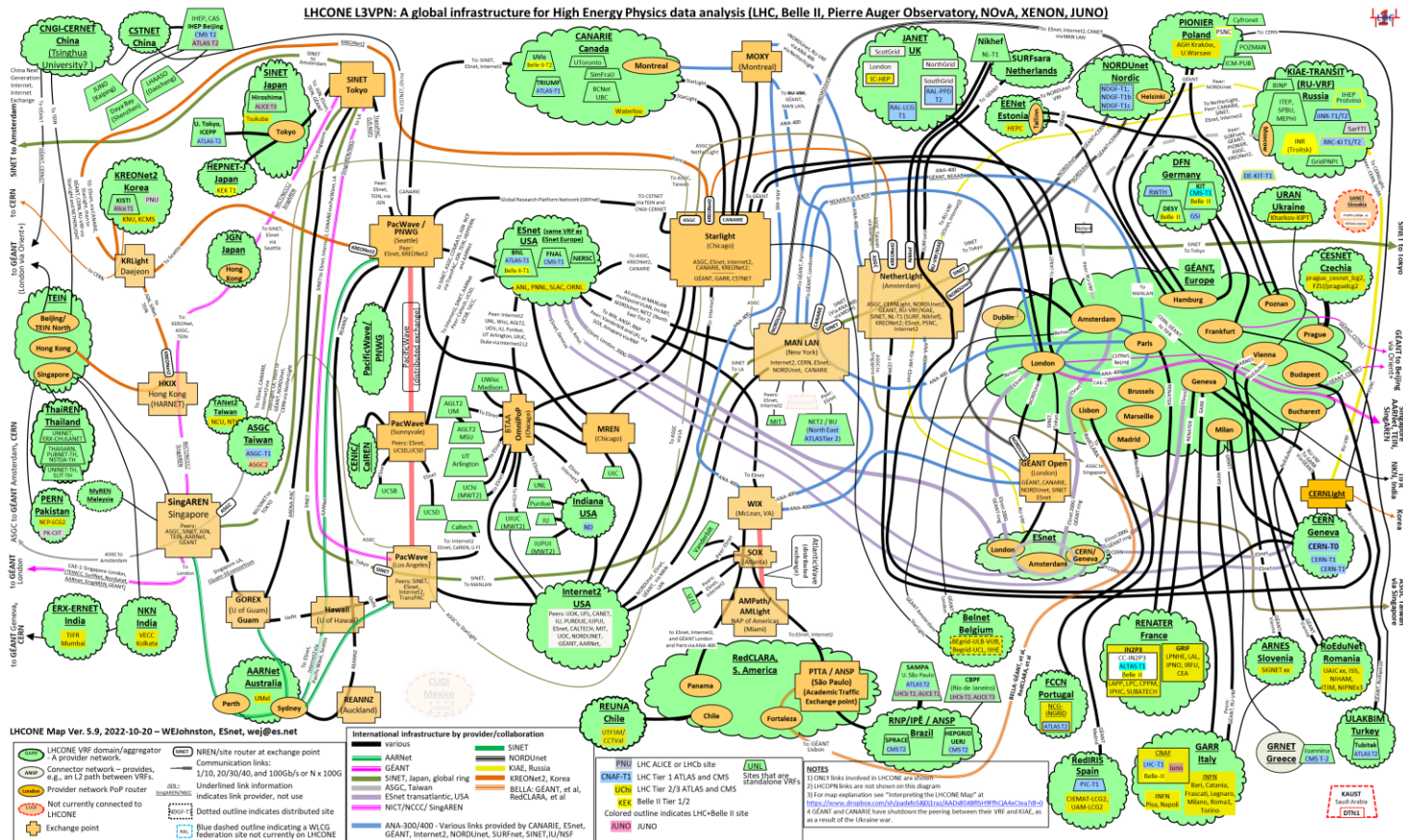
A growing internet!

AMS-IX topology, 2002

LHCone

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

Today's data centre at Nikhef

Nikhef 'science' data centre H234b
- 47 racks and ~350 kW
- hosts Nikhef, CERN, GW, 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
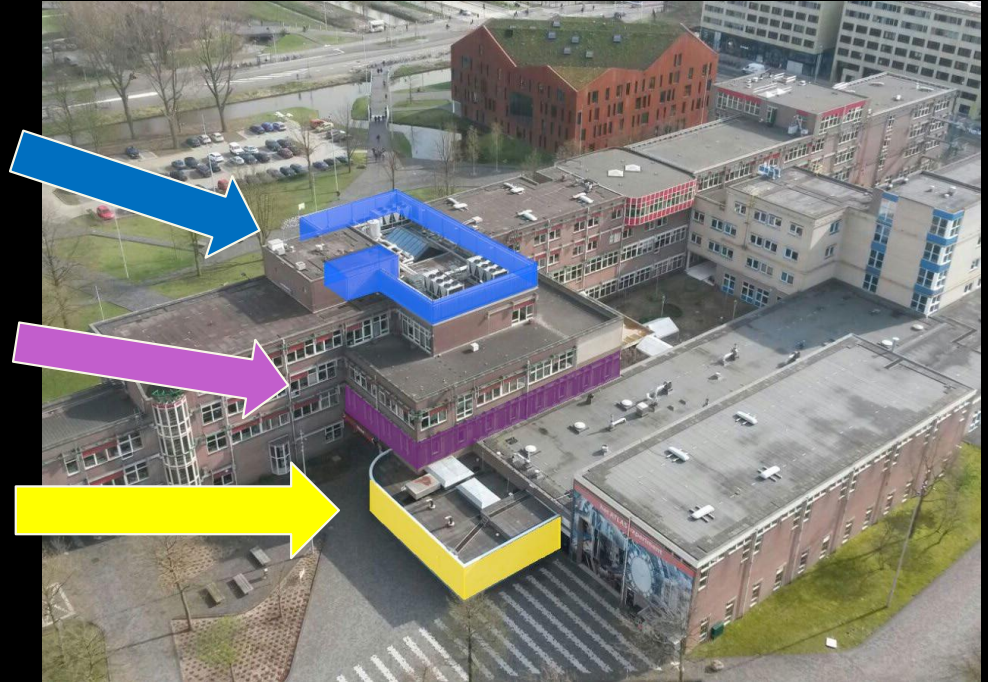- Aquifer Thermal Energy Storage (ATES) system in 2010

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

What happens inside a data centre …

Yet 'connectivity' housing and 'hosting' are also quite different

- NikhefHousing (H140) has connectivity parties only, and does not host any content
- what you will be seeing on tour is *network* equipment, shipping data, but not keeping anything

(H234b has our science data, only)

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

But some are faster than …
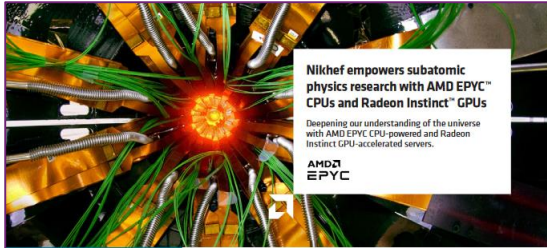
Nikhef empowers subatomic physics research with AMD EPYC™ CPUs and Radeon Instinct™ GPUs

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

798.49 Gb/s

FUNGIBLE

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

Companies Double Current Performance Record, Set the New Bar at 6.55 Million Read IOPS
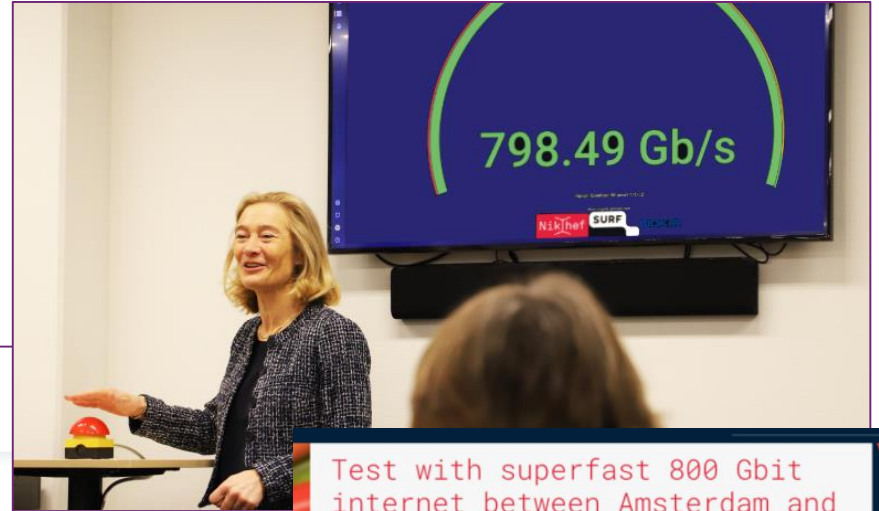
Test with superfast 800 Gbit internet between Amsterdam and CERN successful

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.

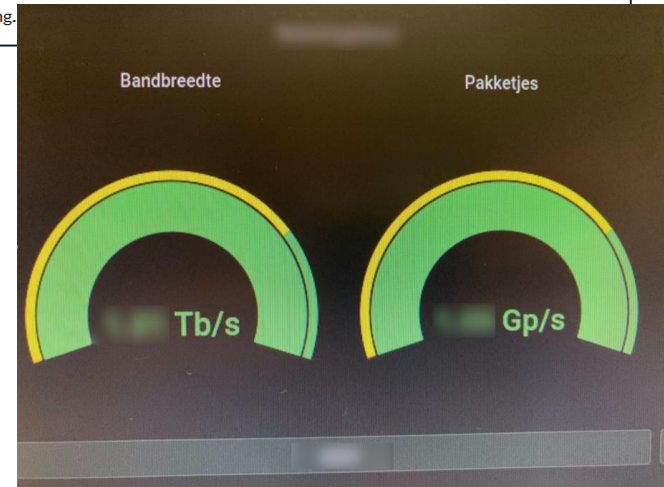**Data hub**

Our science data flows are somebody else's DDoS attack

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

Thanks, and enjoy Nikhef

David Groep
davidg@nikhef.nl
https://www.nikhef.nl/~davidg/presentations/
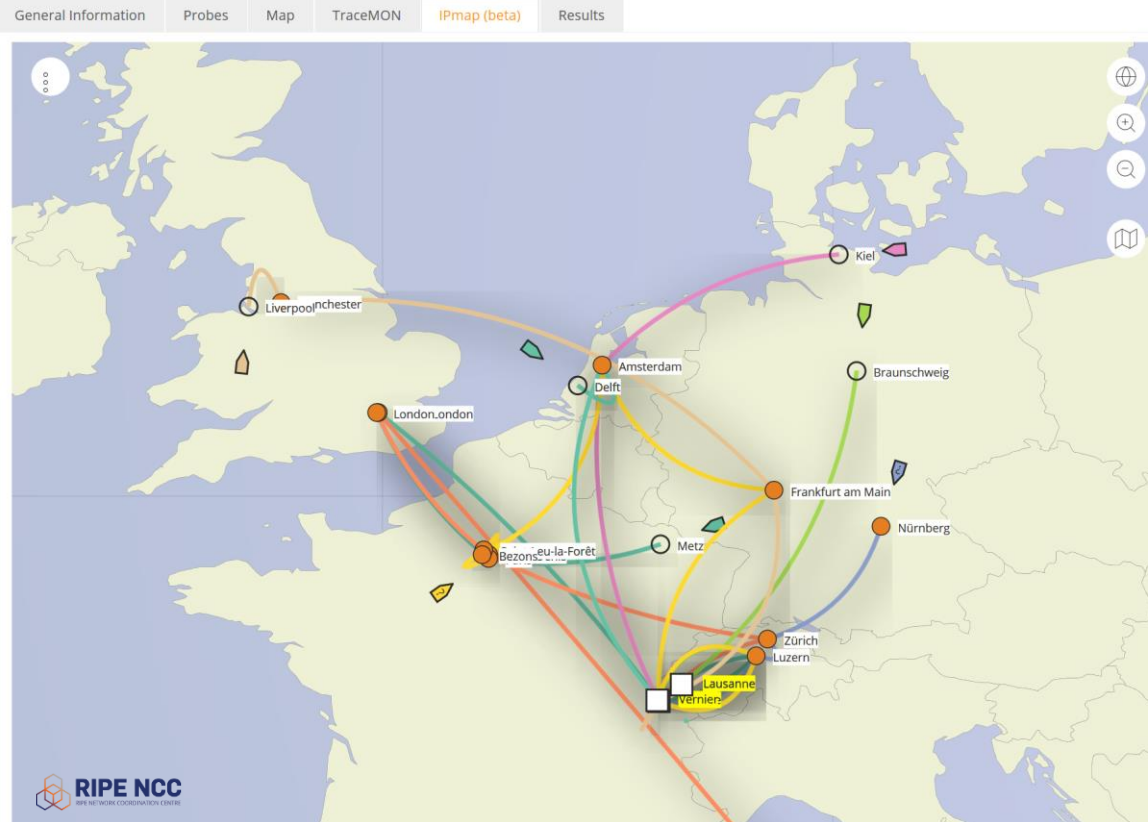https://orcid.org/0000-0003-1026-6606

Maastricht University

Nikhef

Getting to CERN

Traceroute measurement to linuxsoft.cern.ch (multihomed)

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