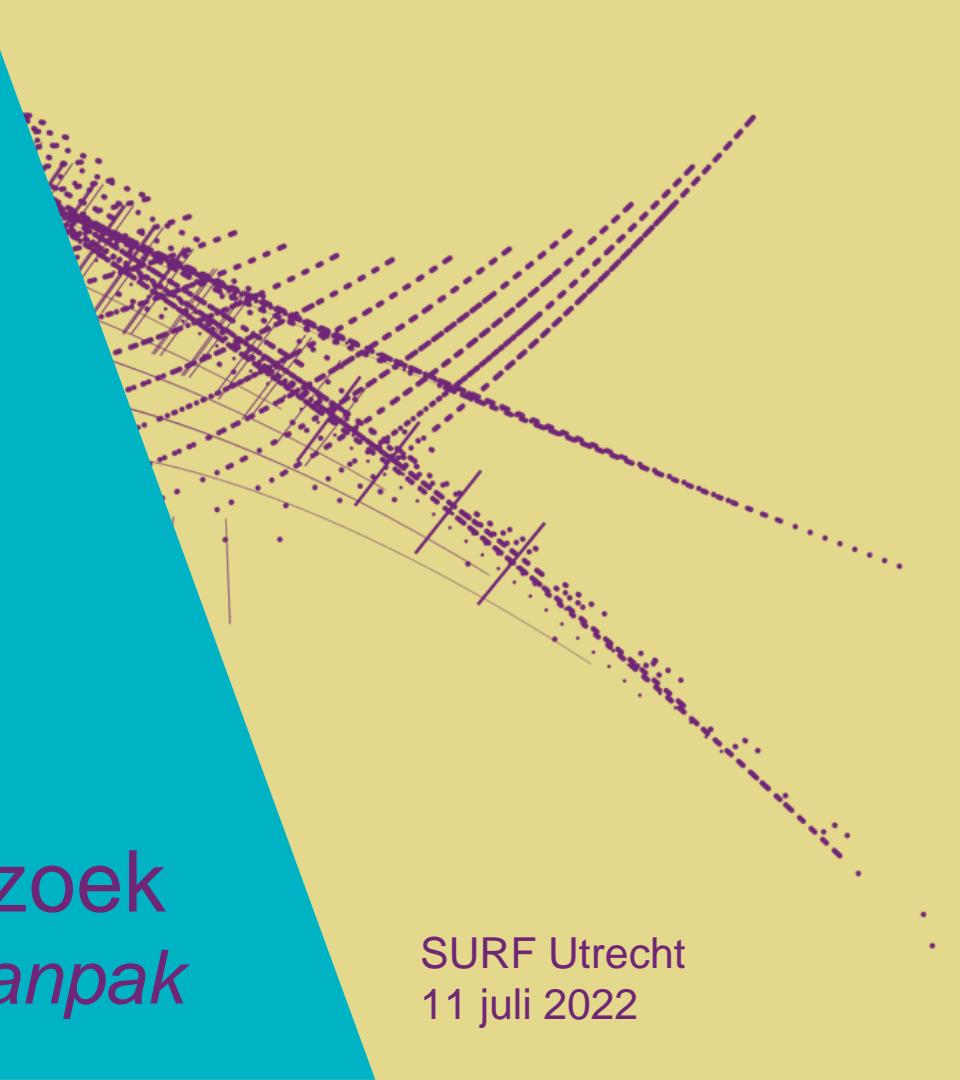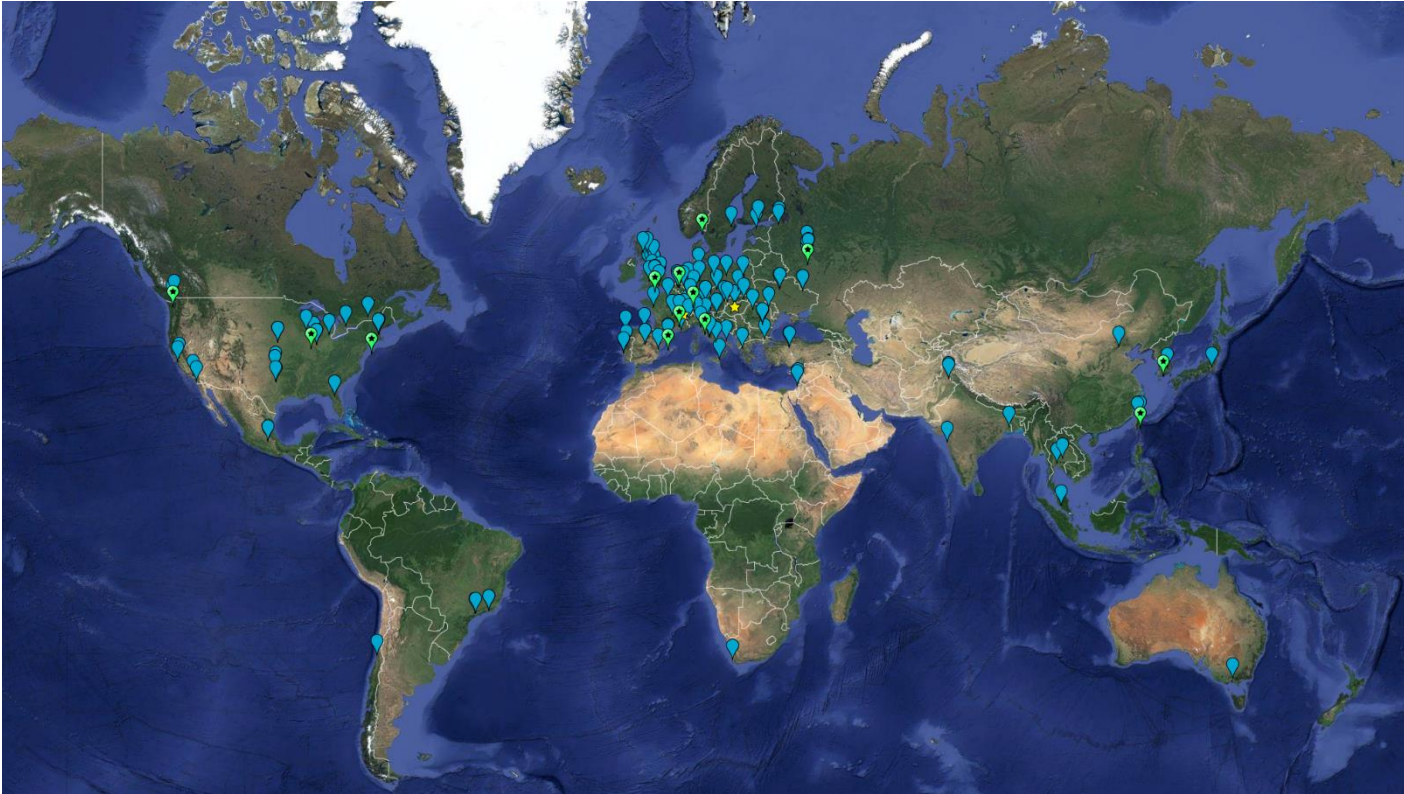# Nikhef

Maastricht University

David Groep

Samenwerken in onderzoek
een Nederlandse e-Infra aanpak

SURF Utrecht
11 juli 2022

An example - computing & data collaboration for the LHC
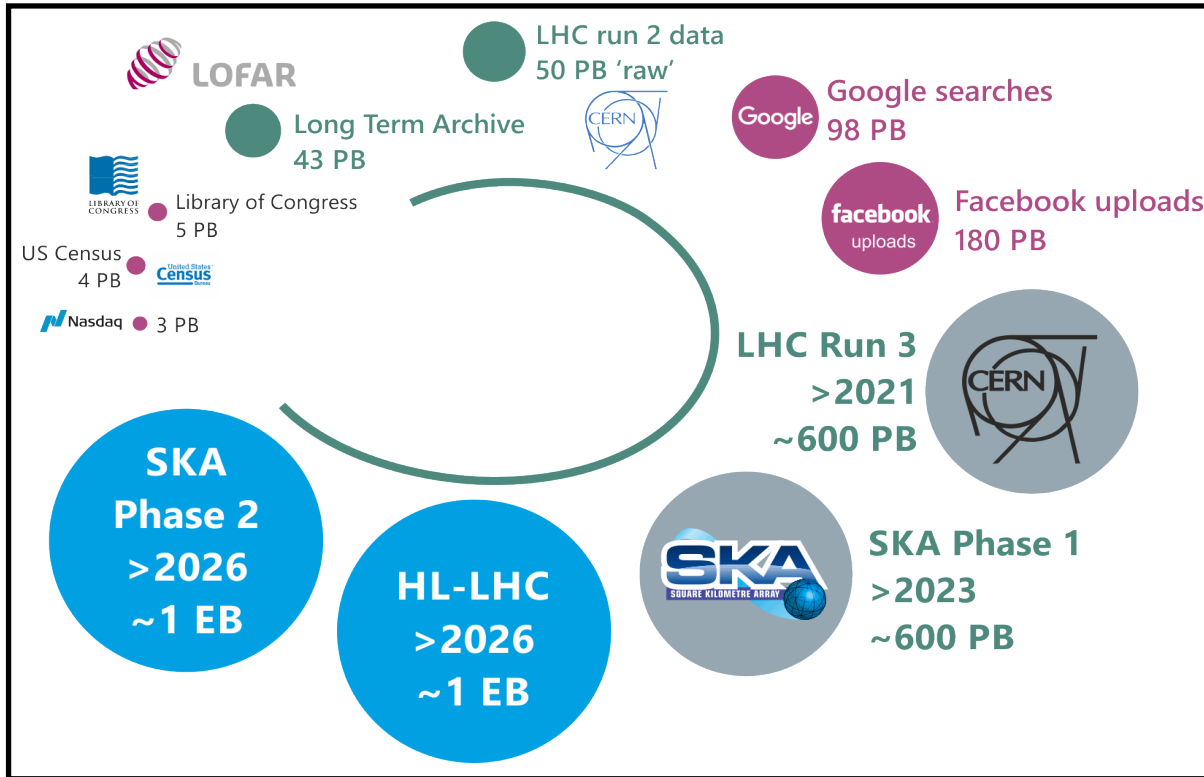

~ 1.4 million CPU cores
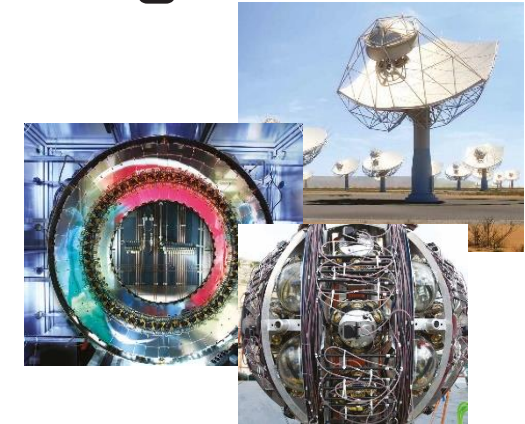~ 1500 Petabyte
    disk + archival

170+ institutes
 40+ countries
 13 'Tier-1 sites'
  1 **NL-T1:**
     SURF & Nikhef

e-Infrastructures
EGI
PRACE-RI
EuroHPC
OpenScienceGrid
XSEDE (ACCESS)

Samenwerken in onderzoek - een Nederlandse e-Infra aanpak

Earth background: Google Earth
Data and compute animation: STFC RAL for WLCG and EGI.eu
Data: https://home.cern/science/computing/grid

Data in the Dutch National e-Infrastructure

FuSE

Fundamental **S**ciences **E**-infrastructure

LHC run 2 data
50 PB 'raw'

Google searches
98 PB

LOFAR

Long Term Archive
43 PB

Library of Congress
5 PB

US Census
4 PB

Nasdaq 3 PB

Facebook uploads
180 PB

LHC Run 3
>2021
~600 PB

SKA
Phase 2
>2026
~1 EB

HL-LHC
>2026
~1 EB

SKA Phase 1
>2023
~600 PB
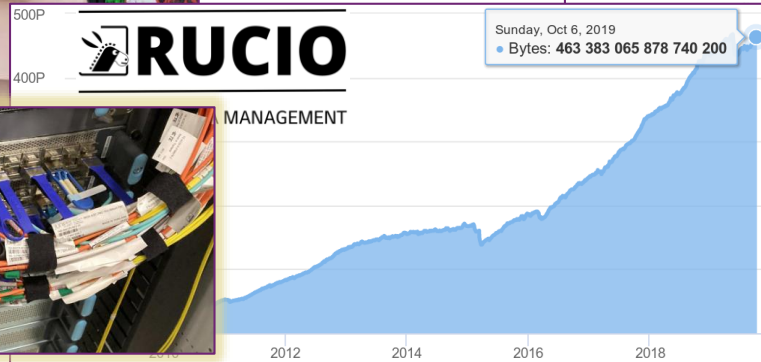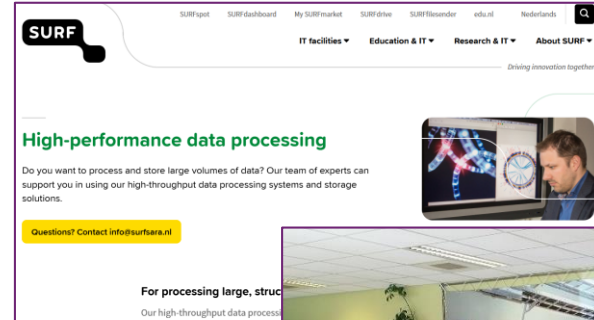
approximate volumes for LoC, Google searches and FB uploads from ~ 2018. Source: WLCG publicity presentations
Imagery: SKA mid (South Africa) courtesy SKAO. Silicon tracker composite photo Nikhef, KM3NeT DOM deployment module: Nikhef and NIOZ
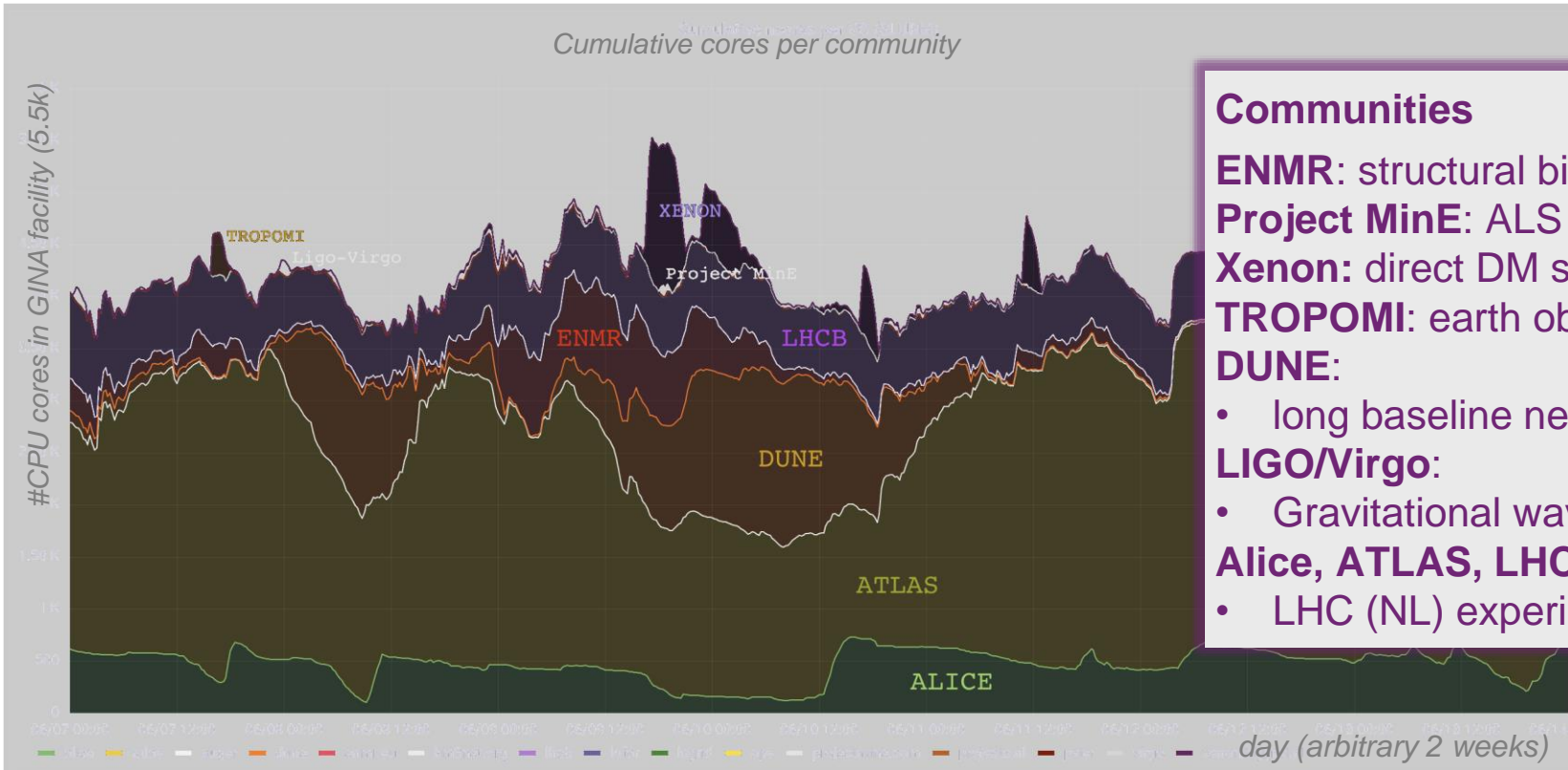
Infrastructure for research is an ecosystem: hardware, software, services, and … people

Images: ATLAS Rucio volume, (from rucio.cern.ch); optical network: NDPF 'deel'; User meeting Stoomboot Office Hours (both Nikhef)); Snellius opening visit; HPDC service page (both SURF)

Samenwerken in onderzoek - een Nederlandse e-Infra aanpak

Connected globally via LHCone and Netherlight

LHCONE L3VPN: A global infrastructure for High Energy Physics data analysis (LHC, Belle II, Pierre Auger Observatory)

Graphic: Bill Johnston, ESnet, for LHCone

Collaboration in the data processing coordinated by SURF

Cumulative cores per community

Communities

ENMR: structural biochemistry
Project MinE: ALS (health)
Xenon: direct DM searches
TROPOMI: earth observation
DUNE:
- long baseline neutrinos

LIGO/Virgo:
- Gravitational waves

Alice, ATLAS, LHCb
- LHC (NL) experiments

day (arbitrary 2 weeks)

Samenwerken in onderzoek - een Nederlandse e-Infra aanpak

Graphic: GINA DNI compute service coordinated by SURF

Scalable HPC strategy: from local "T2" to European "T0"

Nikhef "Stoomboot"
Analysis Facility

. . .

SURF National Infrastructure
solid foundation *and* essential stepping stone

**How to exploit
these unique systems?**
*access, expertise, and …
a long-term vision
on how research scales up*

Samenwerken in onderzoek - een Nederlandse e-Infra aanpak

SURF als 'linking pin' tussen instellingen – en de wereld

Gezamenlijk optrekken werkt
- 'DNI' federative computing service
- Data repositories DANS & 4TU.RD
- HPC 'Tier-2' network (SURF & 8 instellingen)
- data management - zoals 'yoda' met UU
- 'digital competences': data levend houden

Maar dit werkt alleen als ook *instellingen* infrastructuur als 'asset' zien, *en* durven investeren

en dan is dit een effectieve oplossing die misschien eens *niet* aan vendor lock-in ten prooit valt zoals public cloud … of zoals PURE & Mendelay, of Figshare (van die andere uitgever)
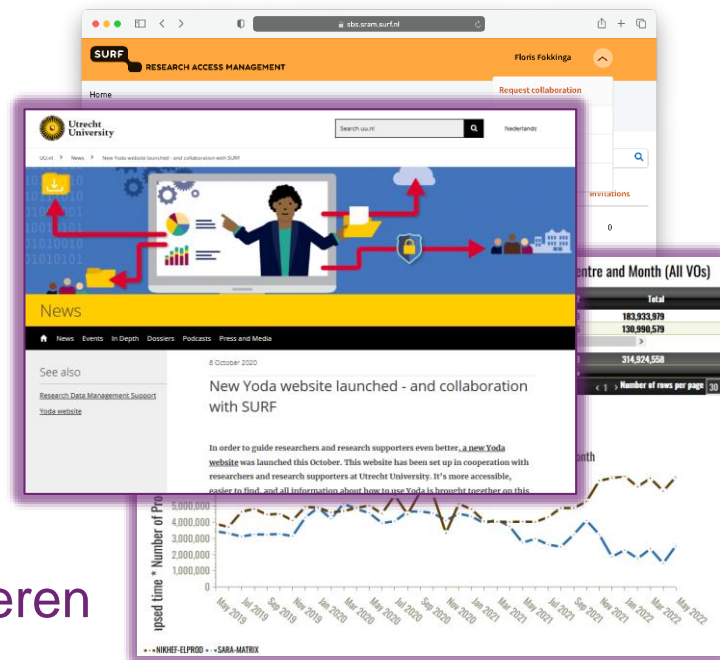
Sharing more than resources: from data to software & expertise

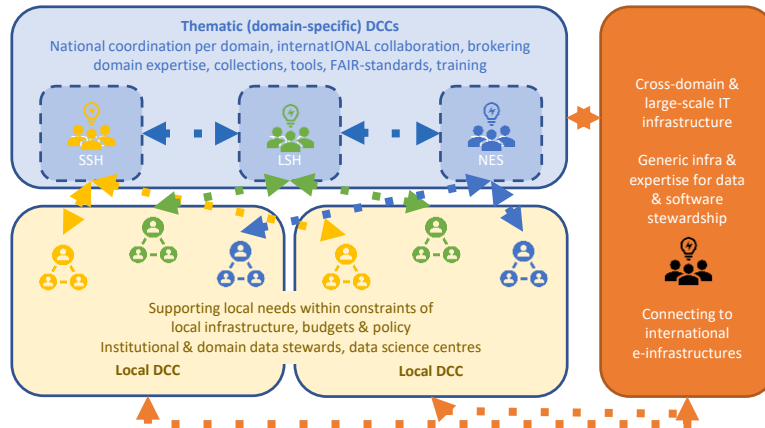Beyond the 'F & A' of FAIR – *infrastructure for reproducible research with re-usable software*


Image by: Ruben Kok, LSH TDCC and DTL

Software and infrastructure essential to bring 'dead' data to life!

Samenwerken in onderzoek - een Nederlandse e-Infra aanpak
TDCC Roadmaps: https://www.nwo.nl/en/roadmaps-three-thematic-dccs-digital-competence-centres

Sharing expertise across domains – the 'NES' example

Case study: Einstein Telescope seismic studies in EUregio Meuse-Rhine in *E-TEST*
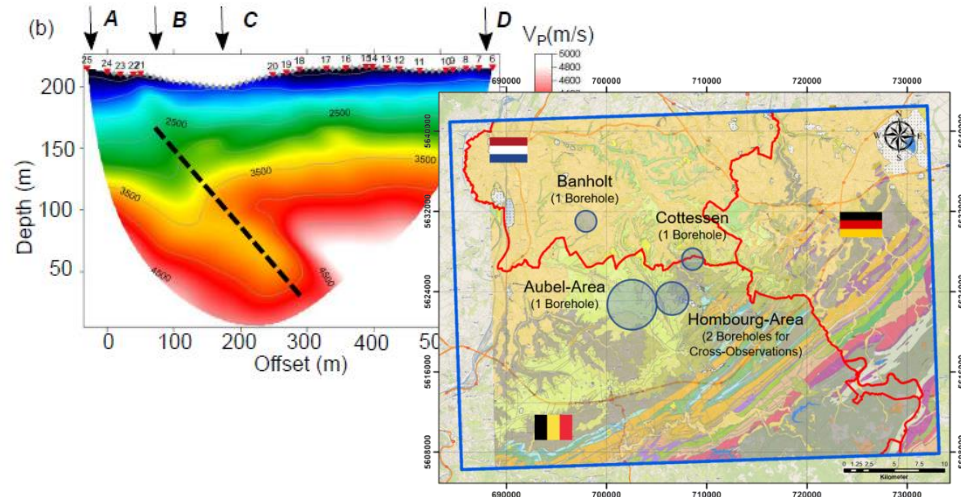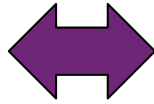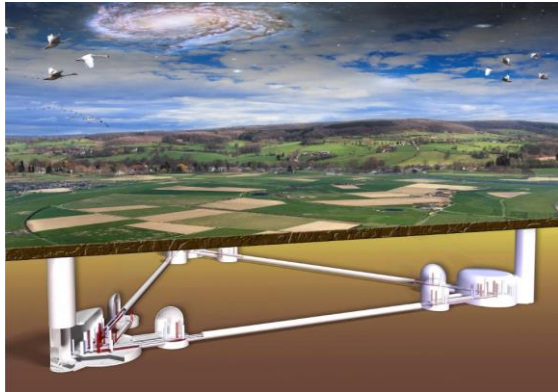
Data collected here is also useful for many others - outside of the ET planning …
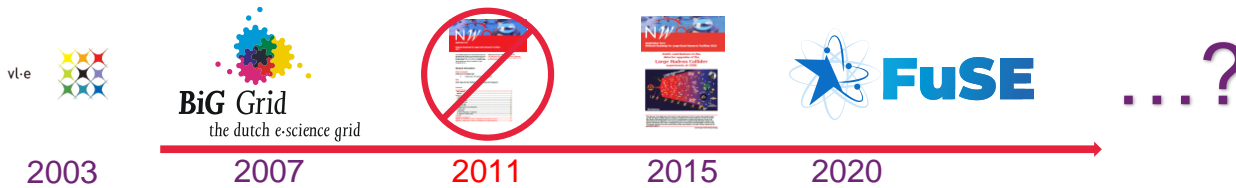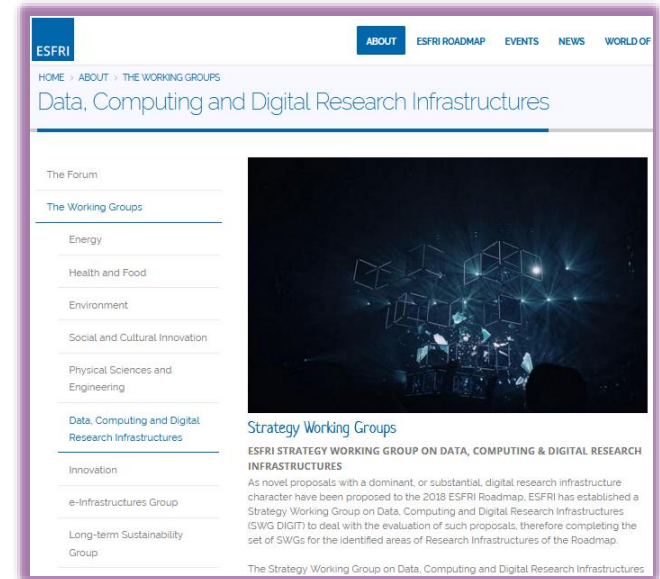that span many 'local' organisations (UM/Nikhef, KNMI, Liege, Aachen,…)

ICT als onderzoeks*instrument*

'ICT infrastructuur voor onderzoek is geen office IT'

- research data is 'born digital' – research domein clusters steeds beter in bepalen volume en inschatten behoeftes
- 'digitale paragraaf' in ESFRI RIs is strategische resource

- open science, open data? groeiend beslag infrastructuur!
- research software idem: maintenance 'eet' in innovatie

Computing vraag blijft: open science is geen project
en 'de instellingen' gaan dit nu nooit alleen redden!

ESFRI
Data, Computing and Digital Research Infrastructures

Strategy Working Groups
ESFRI STRATEGY WORKING GROUP ON DATA, COMPUTING & DIGITAL RESEARCH INFRASTRUCTURES
As novel proposals with a dominant, or substantial, digital research infrastructure character have been proposed to the 2018 ESFRI Roadmap, ESFRI has established a Strategy Working Group on Data, Computing and Digital Research Infrastructures (SWG DIGIT) to deal with the evaluation of such proposals, therefore completing the set of SWGs for the identified areas of Research Infrastructures of the Roadmap.

The Strategy Working Group on Data, Computing and Digital Research Infrastructures

2003   2007   2011   2015   2020   …?

Image sources: https://www.esfri.eu/working-groups/data-computing-and-digital-research-infrastructures; vl-e.nl; biggrid.nl; fuse-infra.nl

Infrastructure research for research infrastructures

Improving infrastructure

SURF DNI, Dutch data centres, joint tenders, systems innovation

Accessing infrastructure

Workflow engines, access, Rucio data lakes, eduGAIN, SRAM, …

Improving use & efficiency

```
Matrix d_C;
d_C.width = d_C.stride = C.width; d_C.height = C.height;
size = C.width * C.height * sizeof(float);
cudaMalloc(&d_C.elements, size);

// Invoke kernel
dim3 dimBlock(BLOCK_SIZE, BLOCK_SIZE);
dim3 dimGrid(B.width / dimBlock.x, A.height / dimBlock.y);
MatMulKernel<<<dimGrid, dimBlock>>>(d_A, d_B, d_C);

// Read C from device memory
```

Pipelines, machine learning, GPU's, Quantum Computing

Structure: fuse-infra.nl, images: Nikhef (nationalespeeltuin.nl), AARC Community, LHCb

Riding the Infrastructure Innovation Chain together

Computing Sciences Research

Operational Research (near-term, NextGen storage, 800G+ network, QC simulators)

Operational innovation (procurement, systems vendor co-engineering)

involving non-CS research domains

Samenwerken in onderzoek - een Nederlandse e-Infra aanpak

Images: SLICES-RI, CompSysNL, UM & SURF QC, SURF SOIL BDRI, NationaleSpeeltuin.nl @Nikhef
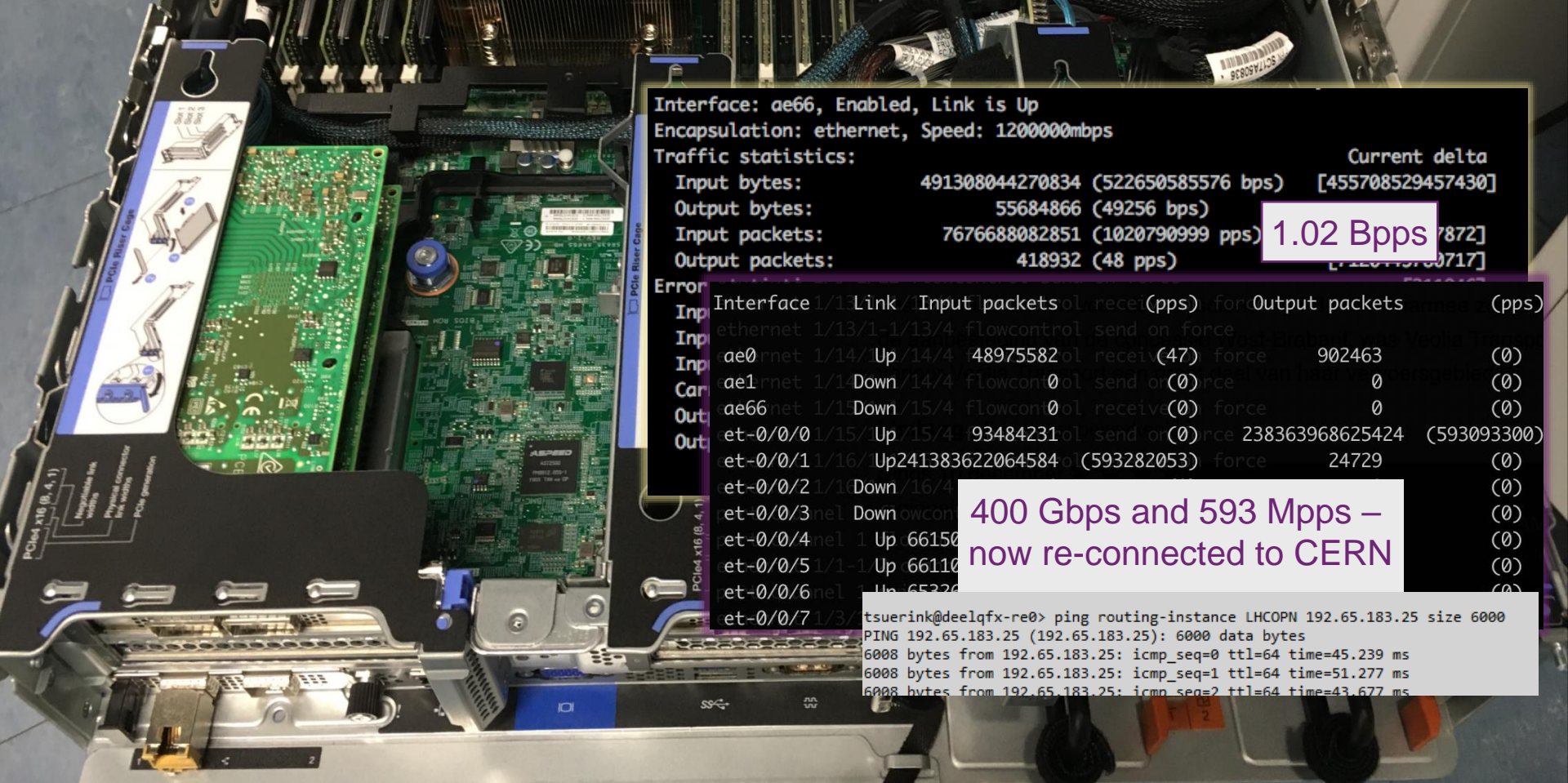
Interface: ae66, Enabled, Link is Up
Encapsulation: ethernet, Speed: 1200000mbps
Traffic statistics: Current delta
  Input bytes: 491308044270834 (522650585576 bps)   [455708529457430]
  Output bytes: 55684866 (49256 bps)
  Input packets: 7676688082851 (1020790999 pps)   ...7872]
  Output packets: 418932 (48 pps)   [...0717]
Error ...
  Inp...
  Inp...
  Inp...
  Car...
  Out...
  Out...

1.02 Bpps

Interface	Link	Input packets	(pps)	Output packets	(pps)
ae0	Up	48975582	(47)	902463	(0)
ae1	Down	0	(0)	0	(0)
ae66	Down	0	(0)	0	(0)
et-0/0/0	Up	93484231	(0)	238363968625424	(593093300)
et-0/0/1	Up	241383622064584	(593282053)	24729	(0)
et-0/0/2	Down				(0)
et-0/0/3	Down				(0)
et-0/0/4	Up	66150			(0)
et-0/0/5	Up	66110			(0)
et-0/0/6	Up	65320			(0)
et-0/0/7					

400 Gbps and 593 Mpps –
now re-connected to CERN

```
tsuerink@deelqfx-re0> ping routing-instance LHCOPN 192.65.183.25 size 6000
PING 192.65.183.25 (192.65.183.25): 6000 data bytes
6008 bytes from 192.65.183.25: icmp_seq=0 ttl=64 time=45.239 ms
6008 bytes from 192.65.183.25: icmp_seq=1 ttl=64 time=51.277 ms
6008 bytes from 192.65.183.25: icmp_seq=2 ttl=64 time=43.677 ms
```
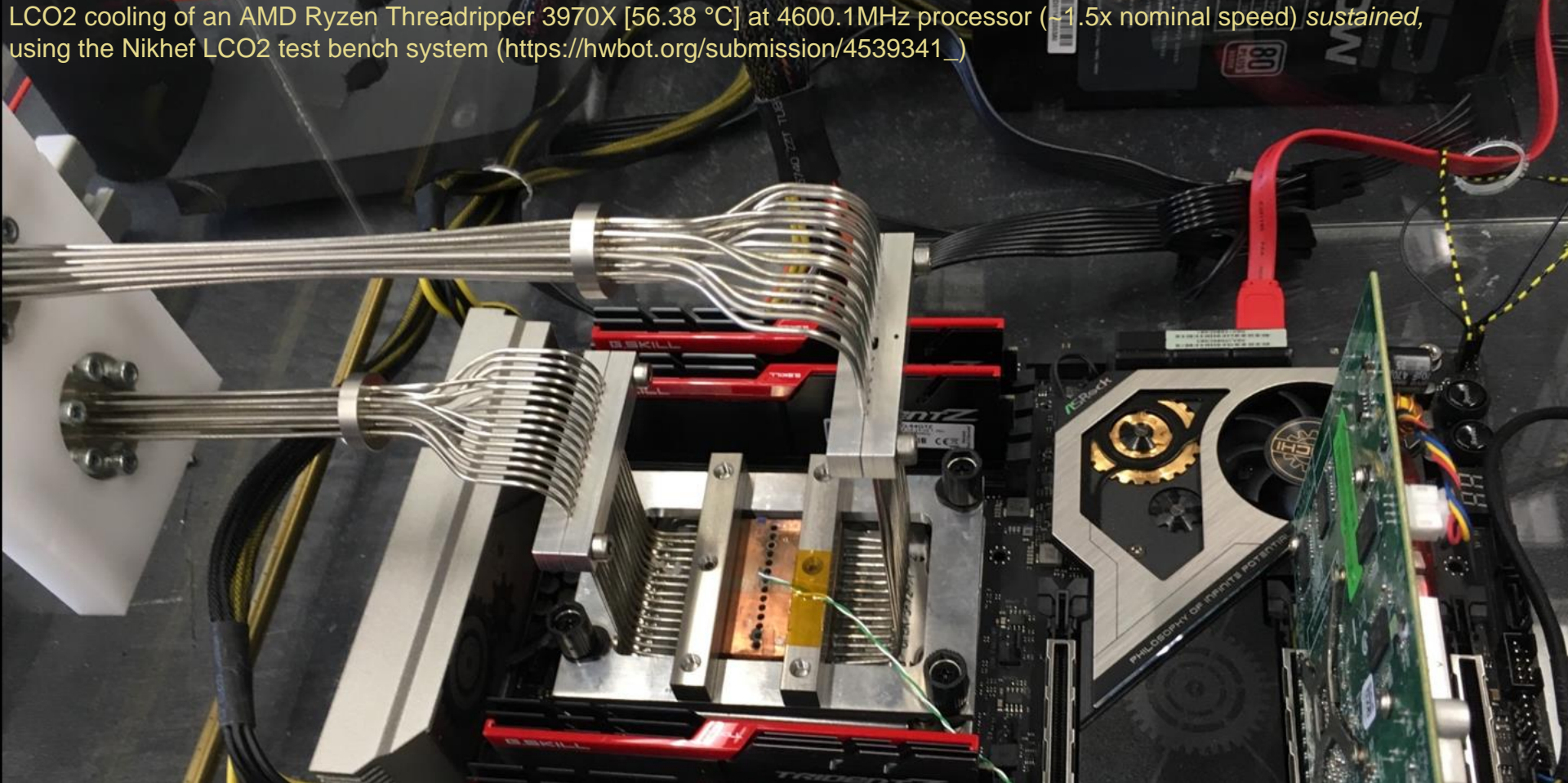
ballenbak.nikhef.nl
Image: Tristan Suerink

Nikhef

Our science data looks akin to a DoS … hence …

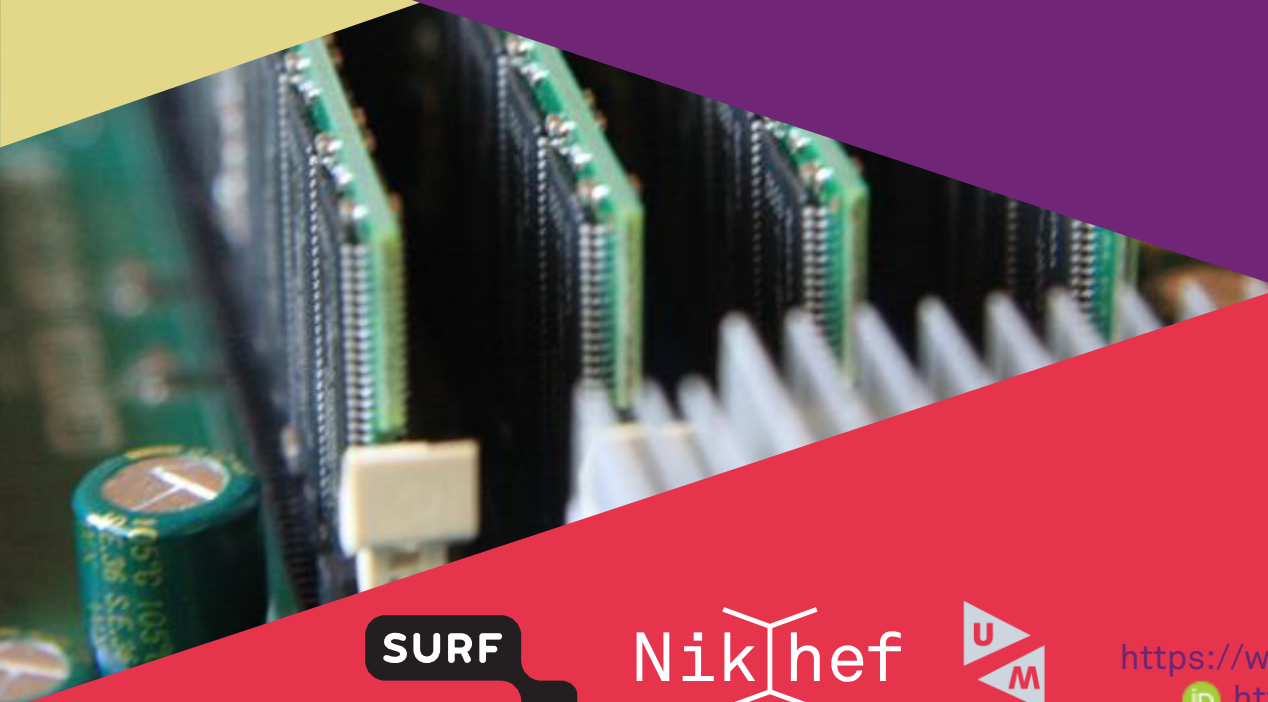
shown: testing against SURFnet7
other targets cannot be disclosed publicly
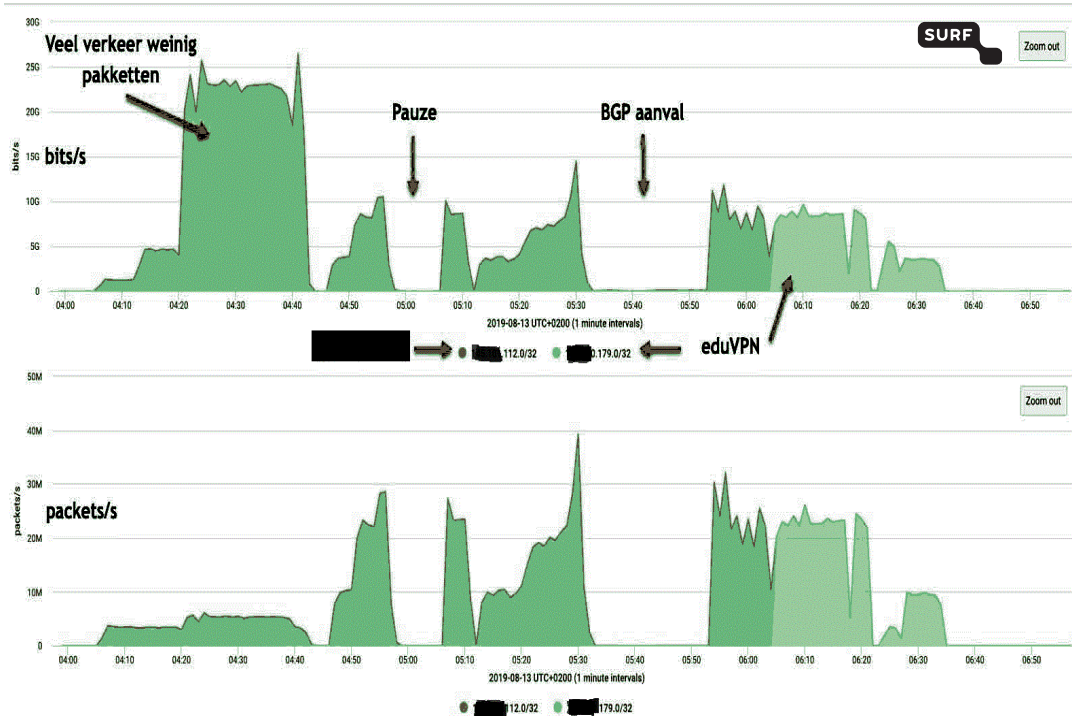
evaluating resilience to cyberattack - *in a cooperative way*

Images: SURFcert and the red team

LCO2 cooling of an AMD Ryzen Threadripper 3970X [56.38 °C] at 4600.1MHz processor (~1.5x nominal speed) *sustained,* using the Nikhef LCO2 test bench system (https://hwbot.org/submission/4539341_)

Samenwerken in onderzoek - een Nederlandse e-Infra aanpak

David Groep

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