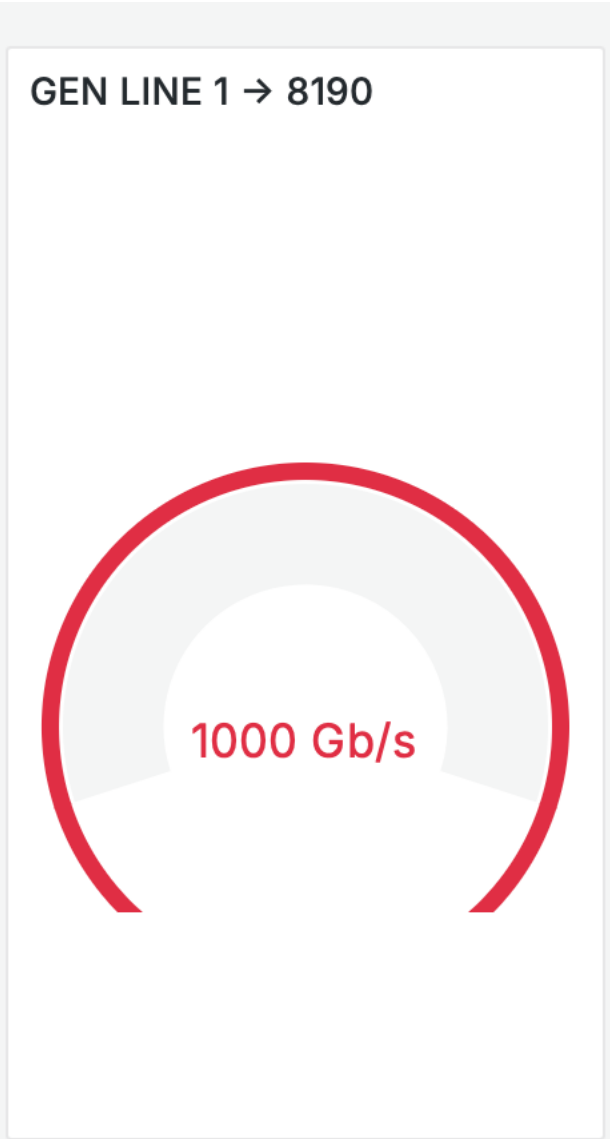
Dutch Cross-Border Trials

-"Harder, Better, Faster, Longer"

Edwin Verheul & Arno Bakker

NORDUnet Conference 2026

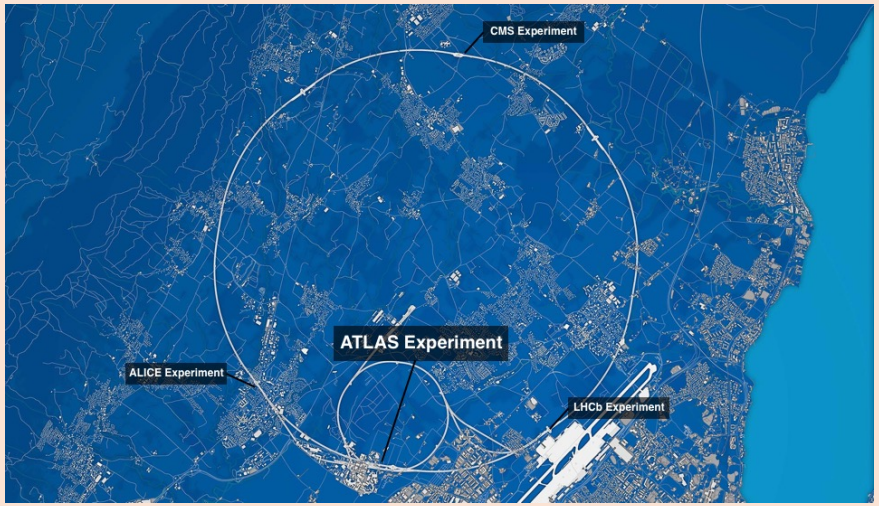


OpenZR+ MULTI-SOURCE AGREEMENT

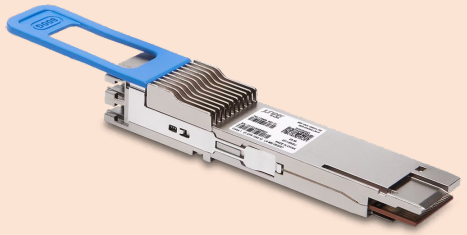
Why Dutch cross-border trails?

LHC
World's largest and highest-energy particle collider.
Located across the border of France and Switzerland.

SURF/Nikhef NL-T1 in Amsterdam
Store and process data from LHC



LUMI
High performance connection from SURF HPC to Finland



800G

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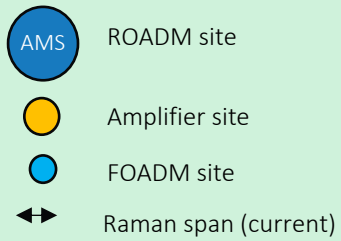
ZR+
Basis for SURF national network upgrade

SURF

Better: 800 Gbps from CERN

Geneva -> Amsterdam, Spring 2024

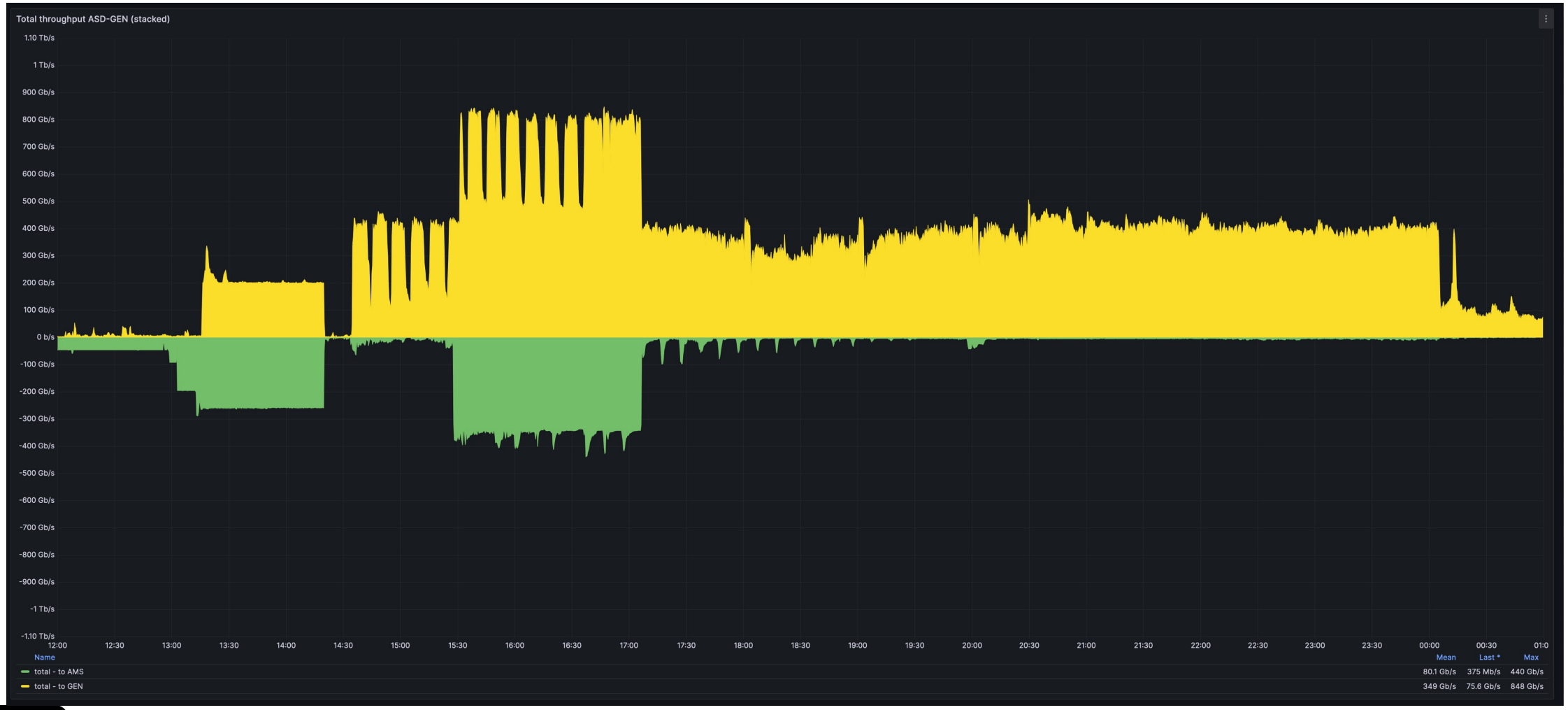
- Total fiber distance (one-way) is 1648 km.
- Not ideal:
- Mostly G.655 fiber
- Asymmetric amplification
- Many small spans
- **800 Gbps in 150 Ghz of spectrum**



Hardware used

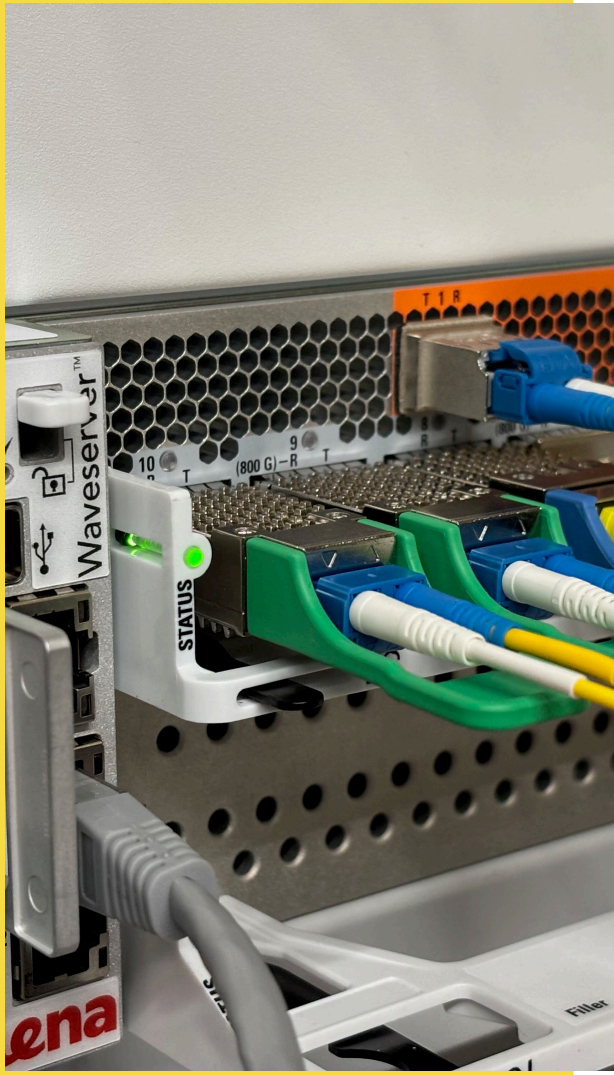
- Nokia PSE-6 based Line cards: 1.2T capable per lambda
- Nokia FP5 based SR-1 routers
- Packet generator 4x dual port Mellanox ConnectX-7
- DPDK pkt-gen

Total throughput Amsterdam <-> Geneva

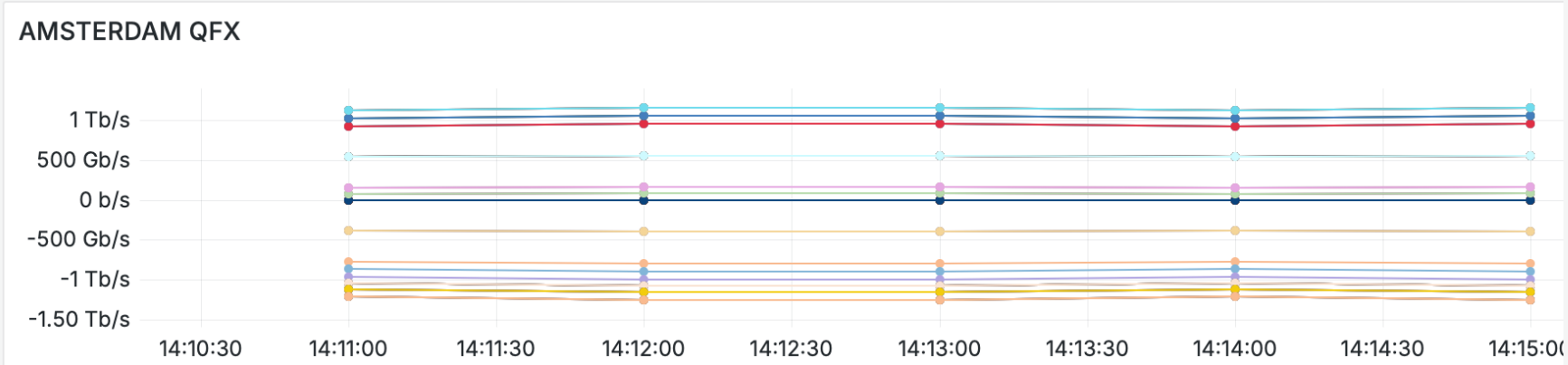


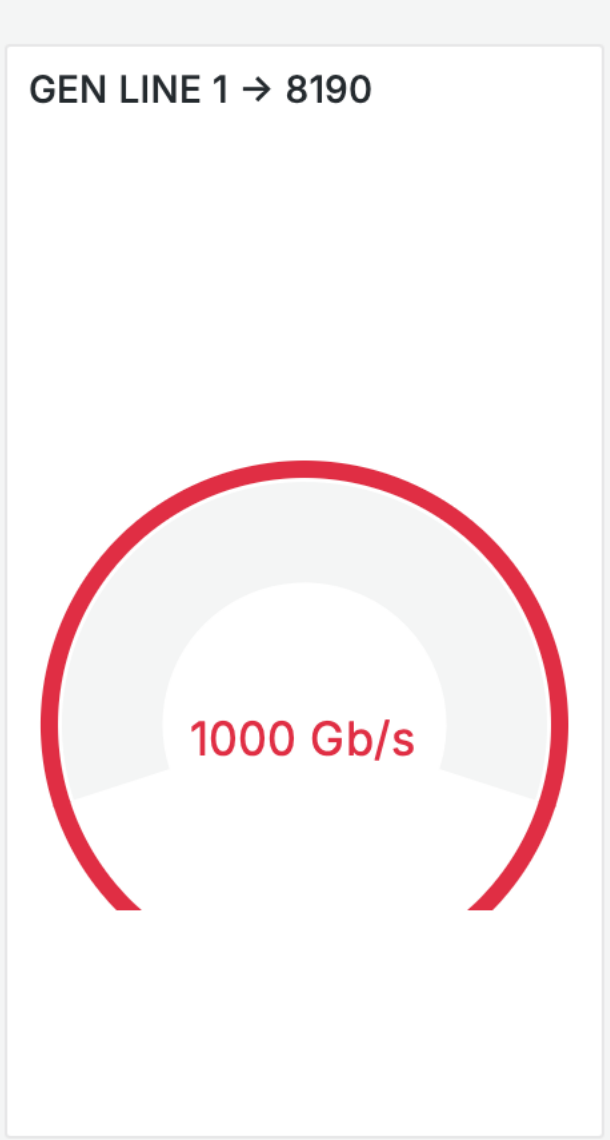
Faster: Terabits/s from Geneva

- Goal: Test multiple 1 Tbit/s or higher connections over brownfield fiber
- Ciena WaveLogic6 Extreme
- “1.6T Transponder Module is a multi-rate, single-carrier coherent transponder capable of transmitting and receiving up to 1,600 Gbit/s of client payload on a single wavelength. ”
- *https://www.ciena.com/insights/infobriefs/wavelogic-6-extreme-1-6t-transponder-module*



Results from Grafana





2x 1.0 Tbps stable in 24h test over 1648 km of brownfield fiber!

Longer: LUMI Trial

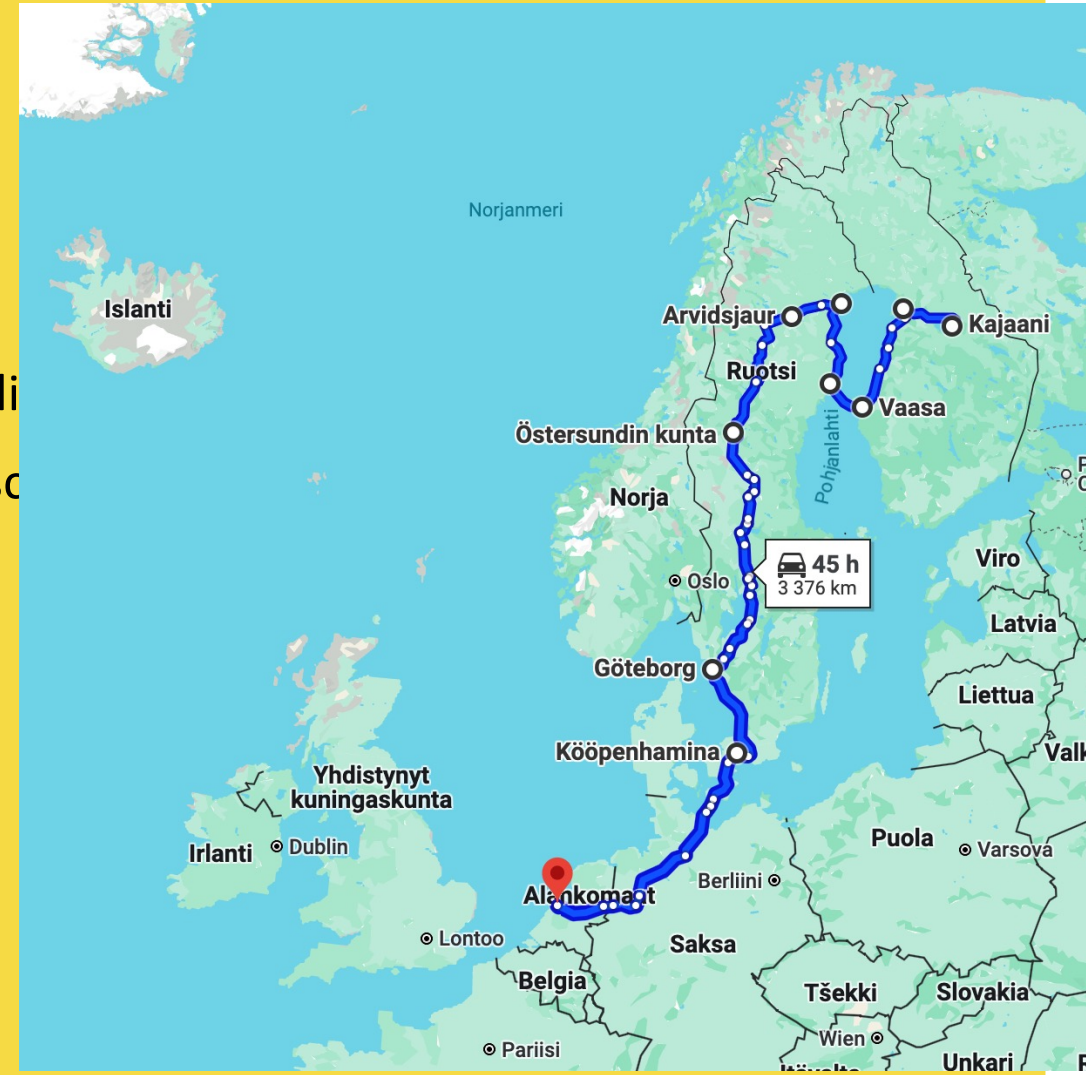
Goal: Test high-speed data transfer between HPC centers

Trajectory: Amsterdam to Kajaani, different routes

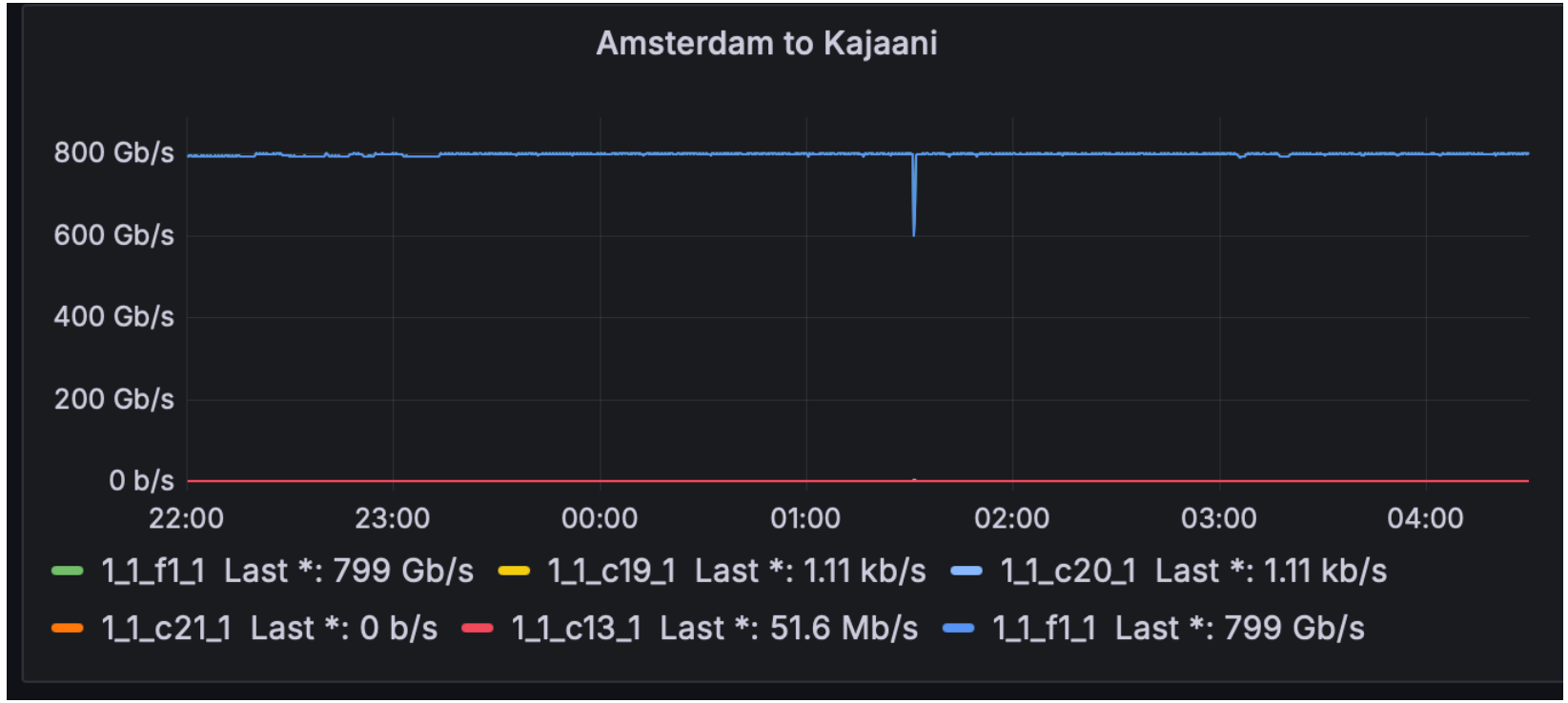
- Amsterdam: home of Dutch National Supercomputer, Snelli
- Kajaani: home of LUMI, one of the pan-European pre-exasc supercomputers by EuroHPC Joint Undertaking

Tests:

- High-speed networking w/ Nokia DMAT-6 and FlexE
- Copying datasets from Snellius to LUMI-O object storage

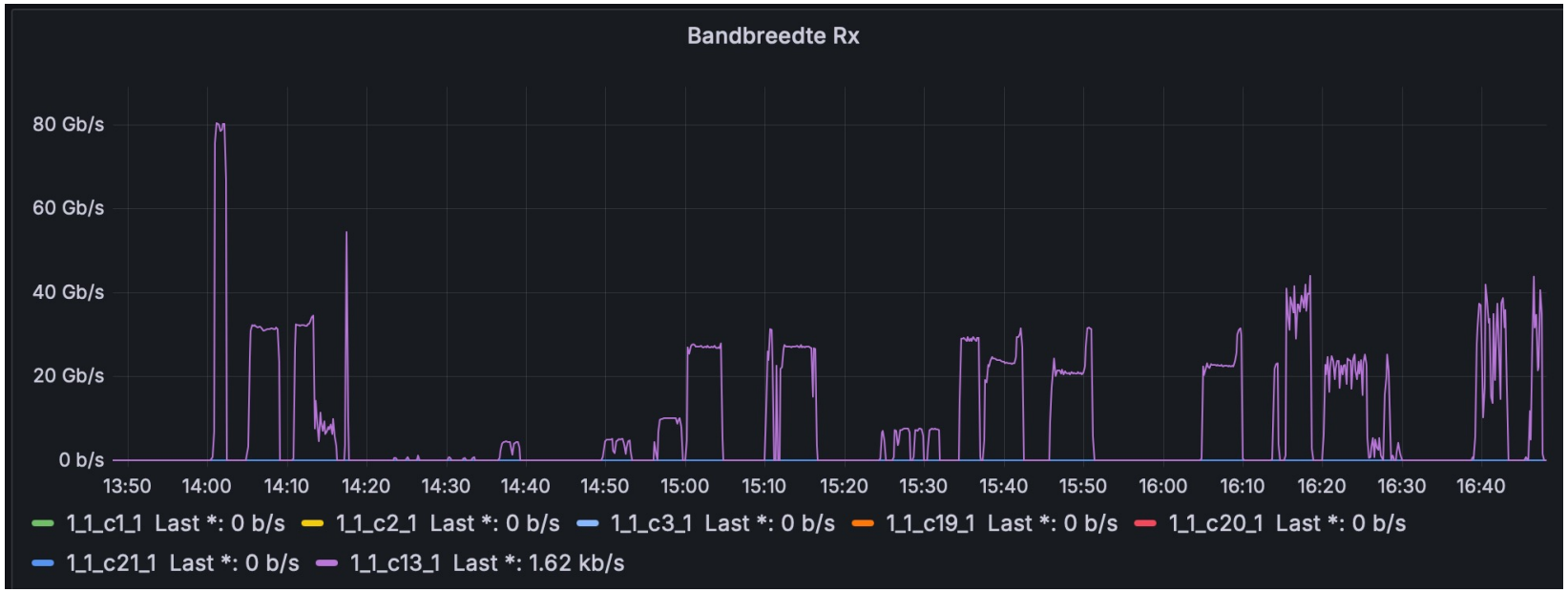


Results from Grafana



- Packet generator filling 800 Gbit/s FlexE (short route)

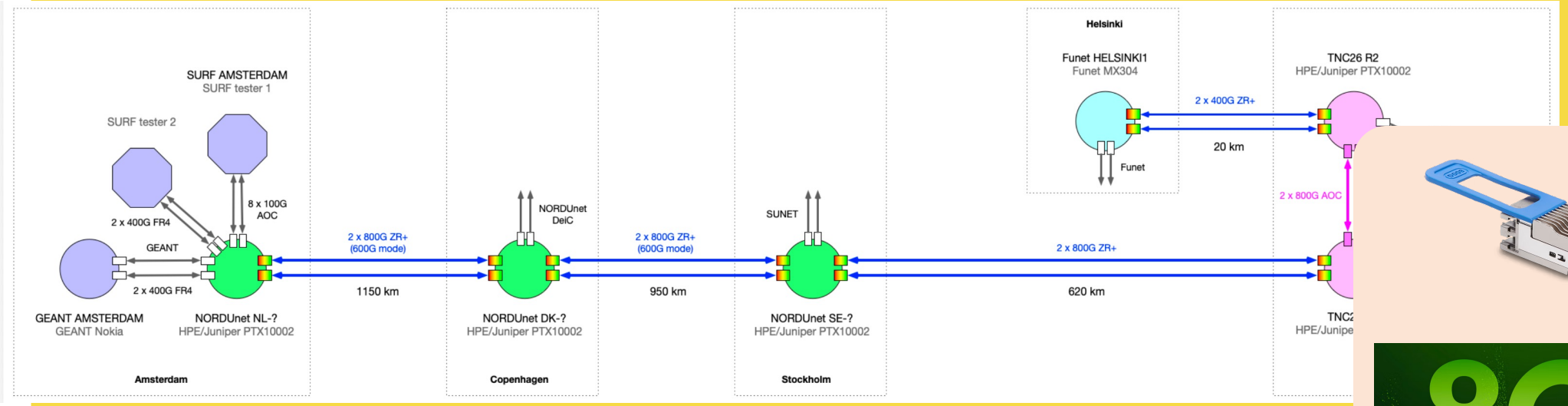
Results from Grafana (cont'd)

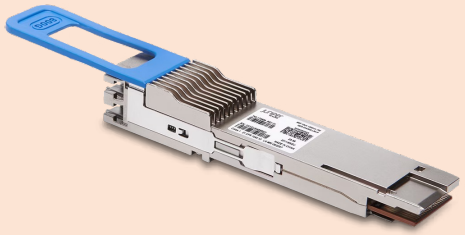


- DTN-to-LUMI storage tests, example 80 Gbit/s peak
- Best result storage test: peak 130 Gbit/s, average 80 Gbit/s
- Limited time for tuning DTN and rclone software, huge Bandwidth-Delay-Product! (~686 Megabyte in-flight at 3500 KM)
- Some tuning to do for S3. Note: Regular LUMI interface is scp + rsync…

Better/Faster/Longer: TNC26 conference, Helsinki 2026

- 2x 800 Gbps OpenZR+ from show floor to Amsterdam





800G

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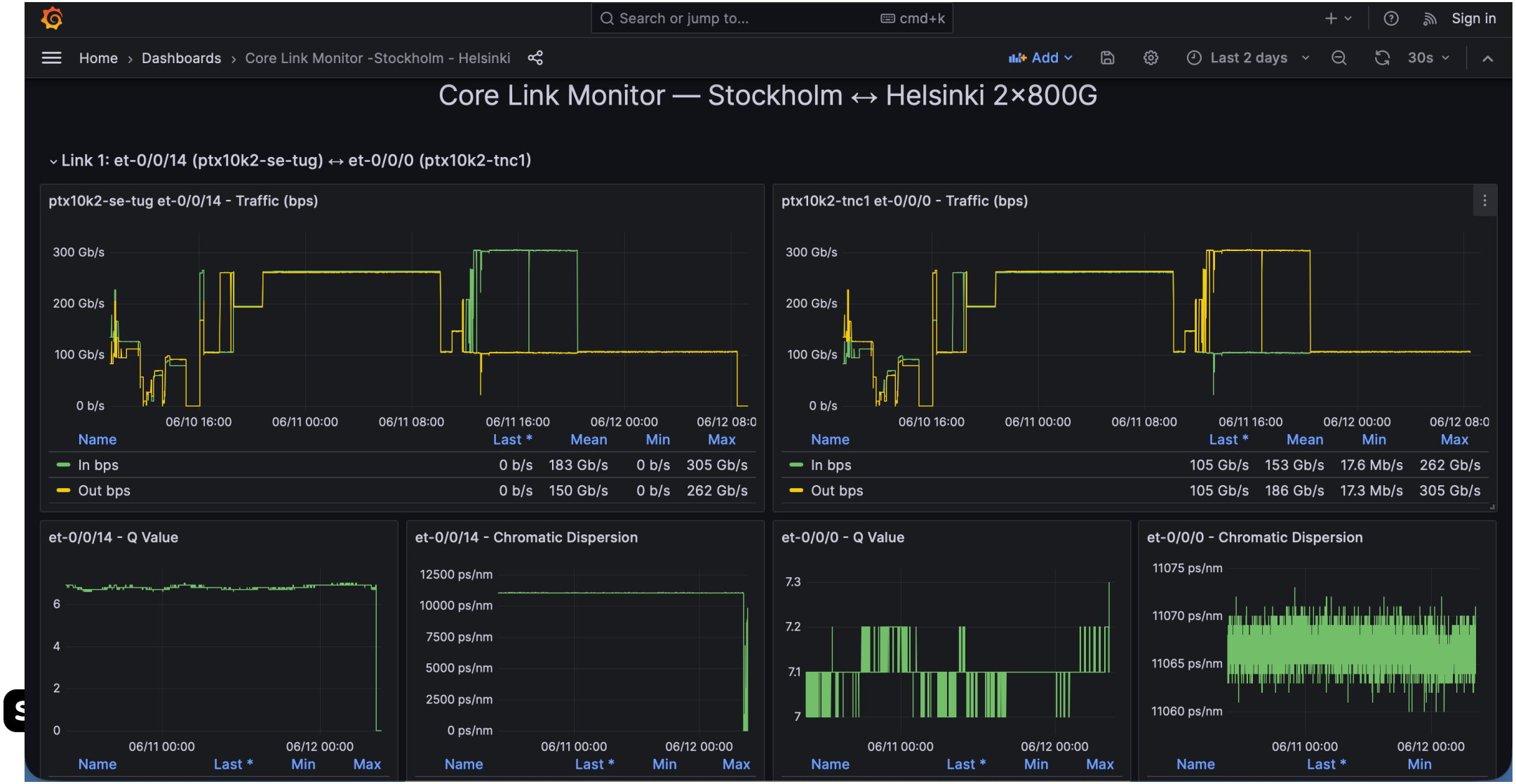
SURF

Packet Generation: EXFO and (broken ☹) Power9 server



Thanks all!

- Nokia
- Ciena
- HPE
- CERN
- LUMI
- NORDUnet
- FUNET
- Sikt
- SUNET
- SURF HPC
- Nikhef

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