The DESY FH Sustainability Forum

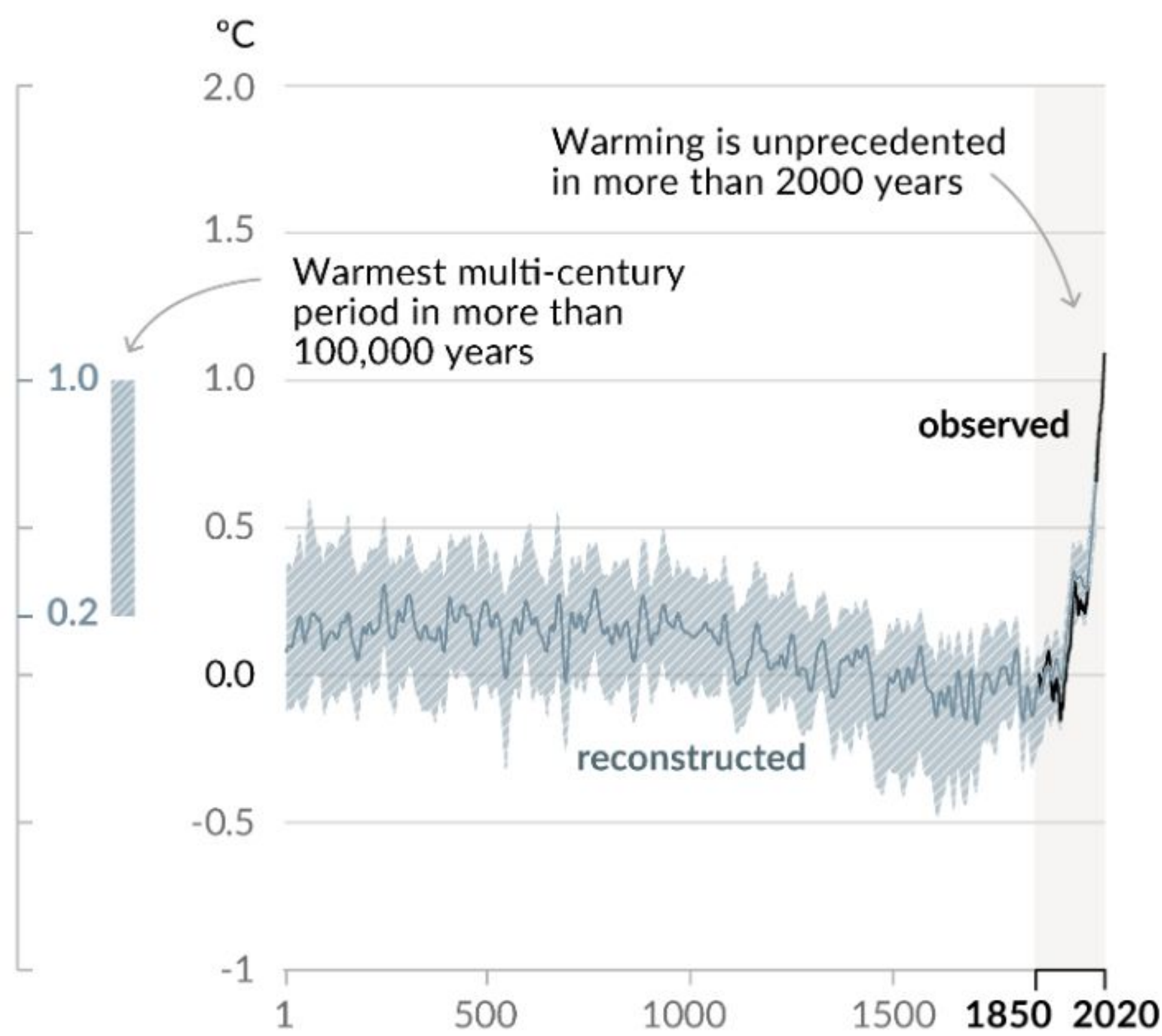## *Climate change will not wait for us to finish our research.*
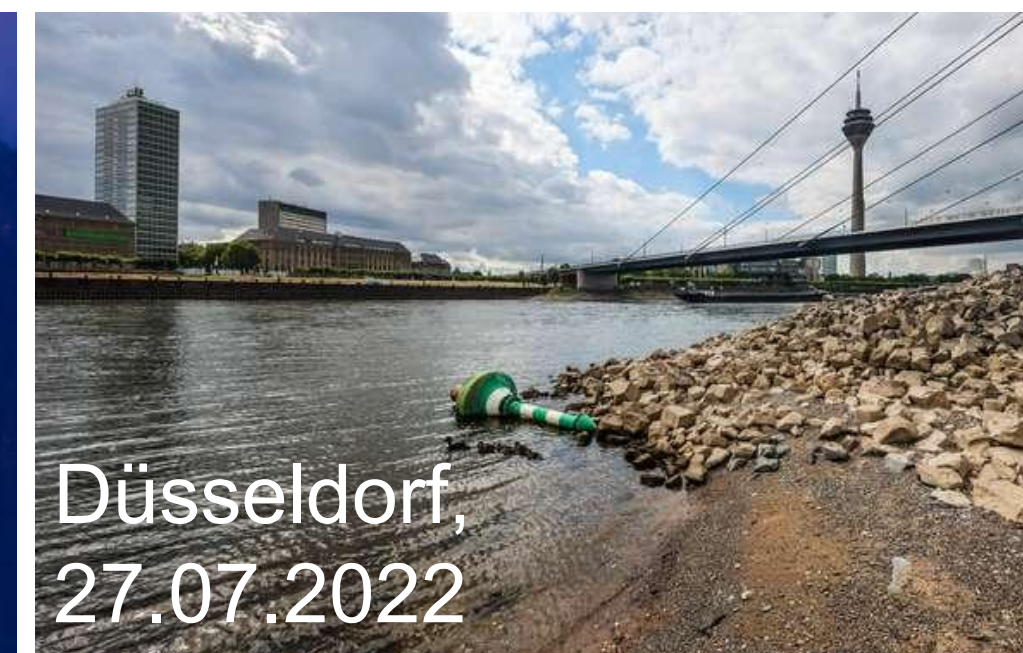
Ben Brüers, Nils Gillwald, Trine Poulsen
ben.brueers@desy.de; nils.gillwald@desy.de; trine.poulsen@desy.de

The climate crises necessitates all parts of society to take action in reducing greenhouse gas emissions and becoming more sustainable. The FH sustainability forum wants to foster the sustainability of HEP by initiating cause studies and providing a platform to discuss methods and results. You can find the mandate here: https://indico.desy.de/event/34510

The climate crisis is here!

Image sources: IPCC 6. AR, dpa/Jan Woitas, dpa/Robert Michael, https://www.24rhein.de/rheinland-nrw/nrw-rhein-ausgetrocknet-niedrigwasser-rheinpegel-fotos-bilder-schiffe-wasserstand-91722637.html

a) Change in global surface temperature (decadal average) as reconstructed (1-2000) and observed (1850-2020)

- Warming is unprecedented in more than 2000 years
- Warmest multi-century period in more than 100,000 years

Brandenburg, Juli 2022
Sächsische Schweiz, Juli 2022
Düsseldorf, 27.07.2022
Bad Honnef, 10.08.2022

"Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years. Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach." – IPCC, 6. AR

Major reasons (IPCC, 6. AR):

1. Fossil fuel consumption (CO_2)
2. Non-CO_2 green house gas emission (FCK(W), …)
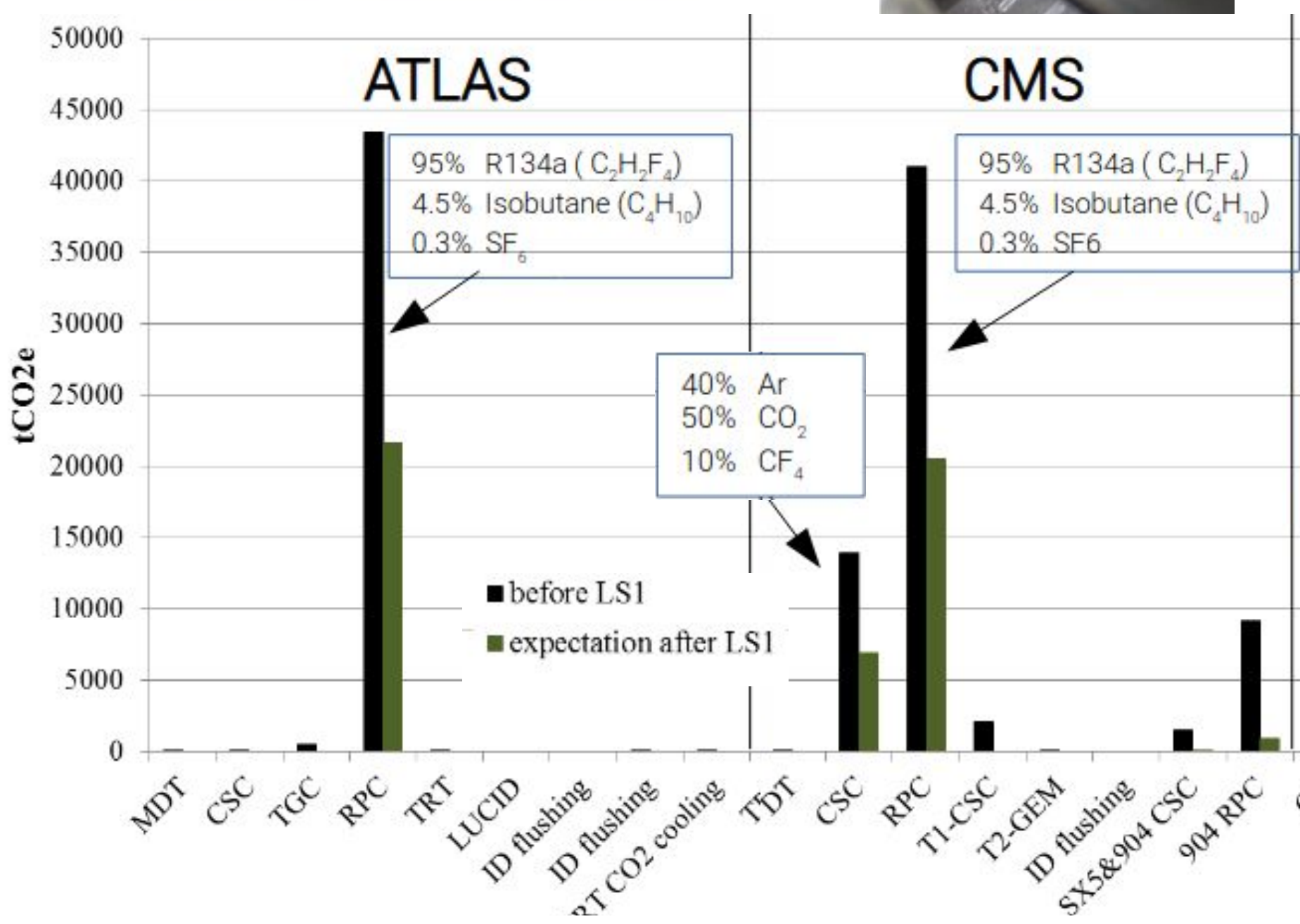3. Other human activities (SLCF, land use albedo, …)

CO_2 ^9F Oth
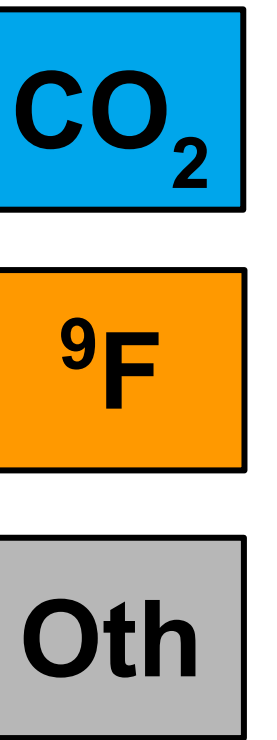
How does HEP contribute? - Example LHC experiments

Many thanks to D. Britzger, K. Lohwasser for their fabulous input!
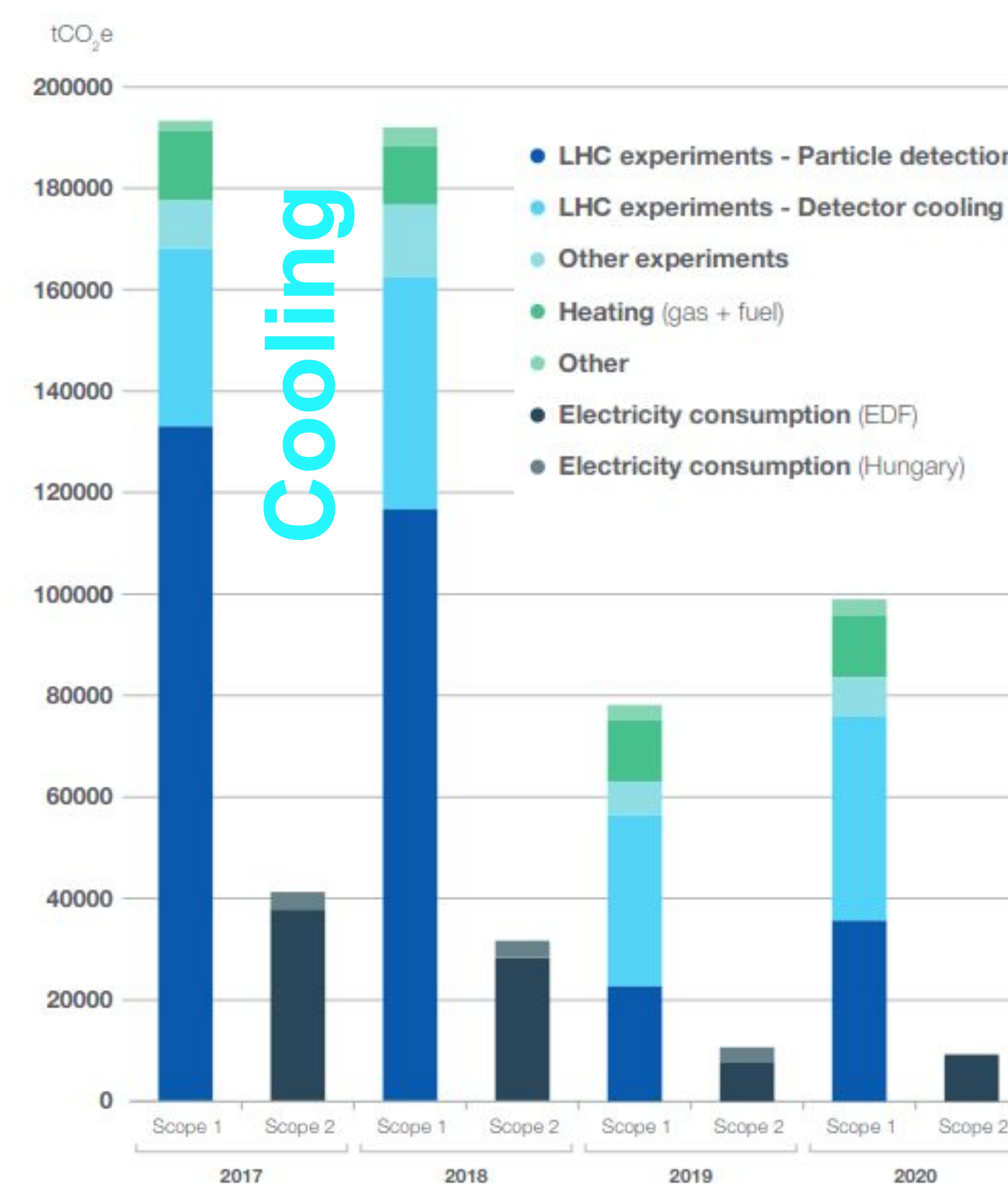
Gaseous detectors ^9F

- One of the largest emission sources of the LHC detectors: leaks in gas detectors
- Large outlet of F-gases → impact per ton O(2500) x 1 ton CO_2

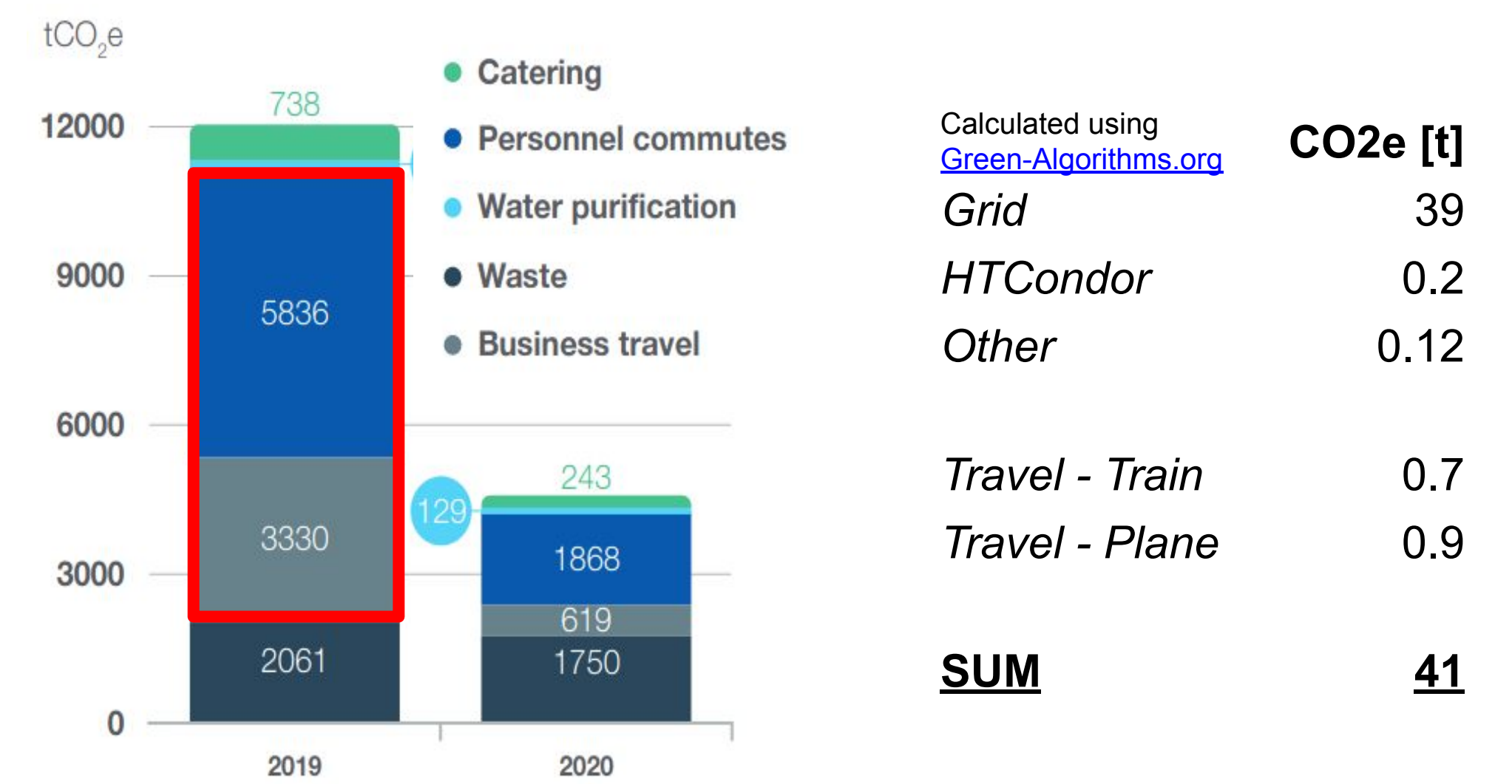https://indico.cern.ch/event/1022051/contributions/4326945/attachments/2231022/3780366/CMS_ATLAS_talk_22_4_21.pdf
https://www.npc.ch/site/assets/uploads/2018/07/WGI_AR5_Chap._8_SM.pdf
Guida et al. The gas systems for the LHC experiments, In proceedings of 2013 IEEE Nuclear Science Symposium and Medical Imaging Conference, 2013

ATLAS — 95% R134a ($C_2H_2F_4$), 4.5% Isobutane (C_4H_{10}), 0.3% SF_6
CMS — 95% R134a ($C_2H_2F_4$), 4.5% Isobutane (C_4H_{10}), 0.3% SF6
40% Ar, 50% CO_2, 10% CF_4

before LS1 / expectation after LS1

Cooling ^9F CO_2

- Second largest CO_2e source at LHC experiments
- Due to cooling with F-gases in all LHC experiments

- LHC experiments - Particle detection
- LHC experiments - Detector cooling
- Other experiments
- Heating (gas + fuel)
- Other
- Electricity consumption (EDF)
- Electricity consumption (Hungary)

https://doi.org/10.25325/CERN-Environment-2021-002

Computing CO_2

- Impact depends a lot on electricity mix
- Inefficient code → large CO_2 emission!
- Example from Ben's time as a PhD
- Hardware purchases

- Catering
- Personnel commutes
- Water purification
- Waste
- Business travel

Calculated using Green-Algorithms.org	CO2e [t]
Grid	39
HTCondor	0.2
Other	0.12
Travel - Train	0.7
Travel - Plane	0.9
SUM	41

Travelling CO_2

- Daily commuting and business travel largest part of "scope 3" emissions at CERN: >9000 t CO_2e
- Strong reduction if reduce travelling & distances

And there is a lot more: one-way electrical components, civil engineering, …

^9F CO_2 Oth

What can we do?

- Make carbon footprint & reusability design parameters: introduce climate budgets similar to monetary budgets
- Develop more energy efficient detectors & accelerators
- Introduce climate panels
- Reduce travelling or use more sustainable transportation
- Carbon footprints for computing jobs:
  - CO_2 monitors – stricter rules on usage (grid retries, ...) – prefer "green" grid sites – CO_2 friendly coding – …
- Check physics: Less systematics? More skimming? …
- Calculate & publish CO_2 consumption of publications
- Make sustainability & impact on global warming part of everyday work!

The FH Sustainability Forum

…a platform to discuss & share ideas & projects for sustainable high energy physics!

- Talks & discussions on different sustainability topics: identify unsustainable practices – discuss, share, and implement sustainable solutions – networking
- Establish innovative and support existing projects working towards a sustainable HEP
- Monthly meetings
- Next meeting September 19 at 4pm on sustainability initiatives in DESY computing with Martin Gasthuber and Yves Kemp
- E-Mail list: fh-forum-sustainability@desy.de