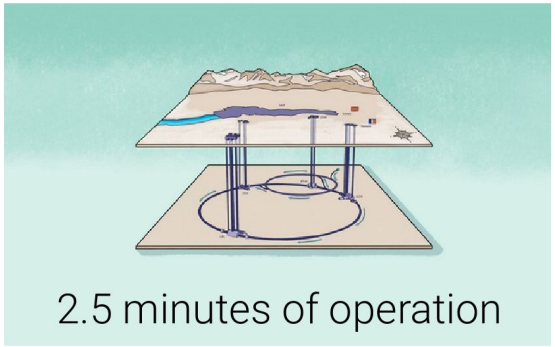
The DESY FH Sustainability Forum

1 Ton of CO_2 is…



https://www.sueddeutsche.de/projekte/artikel/wissen/kohlendioxid-e412457/
pictures from a presentation by Kristin Lohwasser, Daniel Britzger

Ben Brüers, Nils Gillwald,
Eleanor Jones, (Trine Poulsen)

DESY Hamburg and Zeuthen

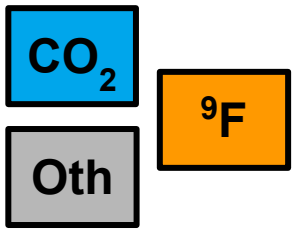
December 14th, 2022
DESY FH Retreat Follow-up

The climate crisis is caused by greenhouse gas emissions - also in HEP.

"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

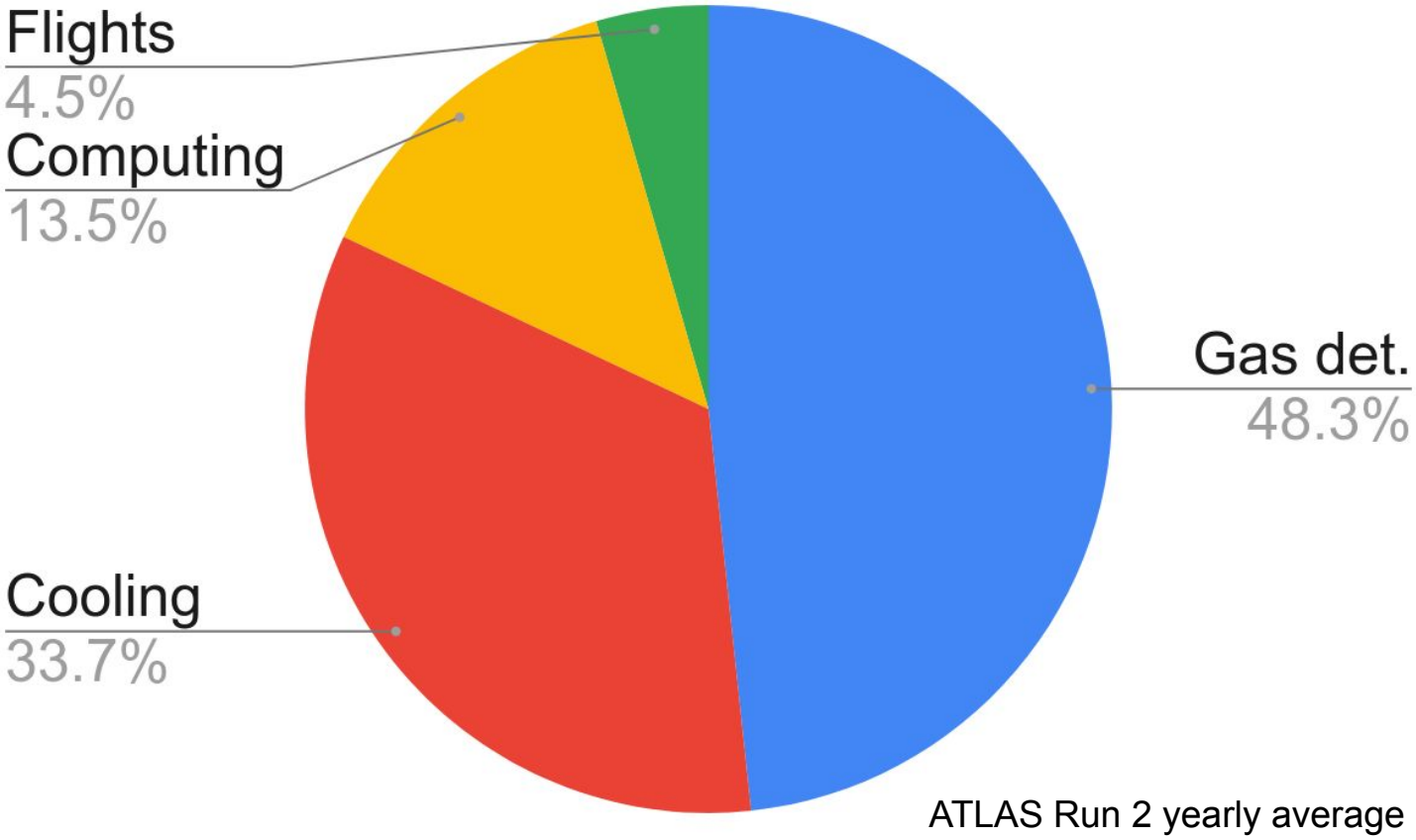
Major reasons:

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



- DESY consumes energy of ~150,000 German households/year (0.5 TWh), CERN of ~420,000 households (1.3 TWh)
- On top: contributions from
  - Detector building, cooling, and maintenance, computing, building and maintenance of other infrastructure, heating, travelling, …

Impacts of HEP - Emissions from ATLAS.

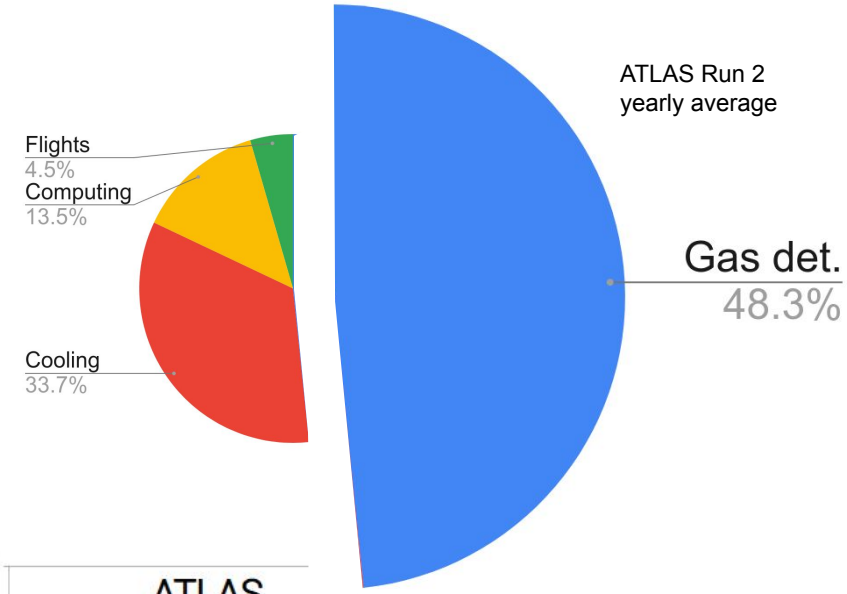


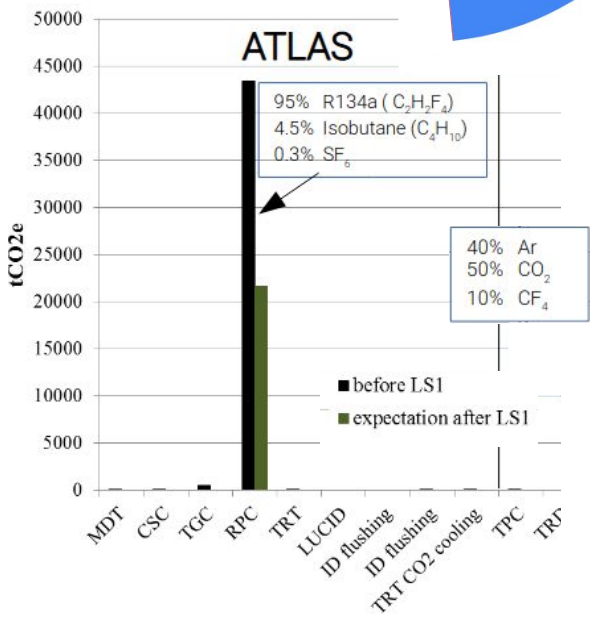
ATLAS Run 2 yearly average

Impacts of HEP - Gaseous detectors.

^{9}F

- Largest CO_2 emission source of LHC detectors: gas detector leaks
- Mostly F-gases: impact ~2500x CO_2e* & longer in atmosphere
- Need to fix leaks, consider using alternative gases
- Talk in Sustainability Forum



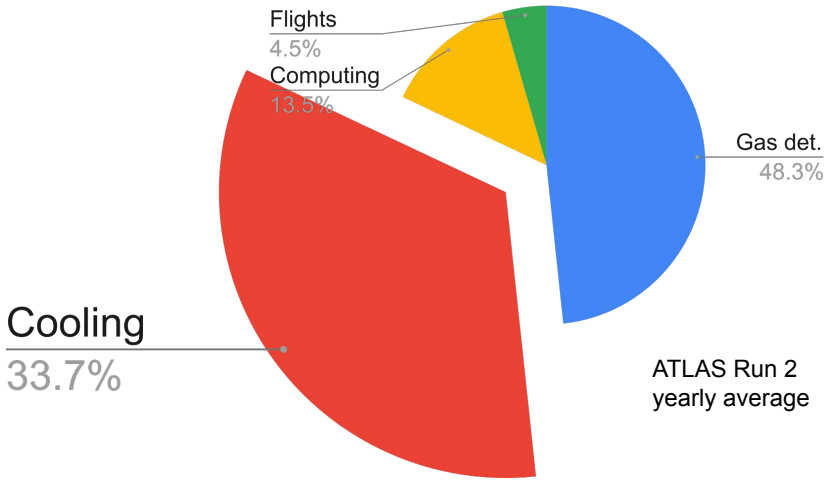


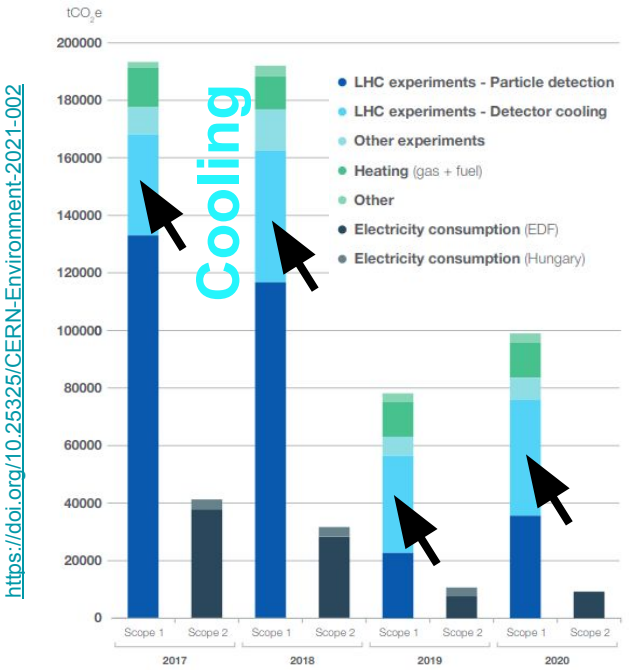
Many thanks to D. Britzger, K. Lohwasser for their fabulous input! Sources: https://indico.cern.ch/event/1022051/contributions/4325945/attachments/2231022/3780366/CMS_ATLAS_talk_22_4_21.pdf; https://www.ipcc.ch/site/assets/uploads/2018/07/WGI_AR5.Chap_.8_SM.pdf; Guida et al, The gas systems for the LHC experiments, in proceedings of 2013 IEEE Nuclear Science Symposium and Medical Imaging Conference, 2013

Impacts of HEP - Detector cooling.

^{9}F CO_2

- Cooling needed for all detector systems
- Based on water, CO_2 and F-gases
- Leaks of F-gases → very large CO_2e source
- E.g. CMS: 14 kt CO_2e/a
- “Considered to be sustainable for the current foreseen long run”





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

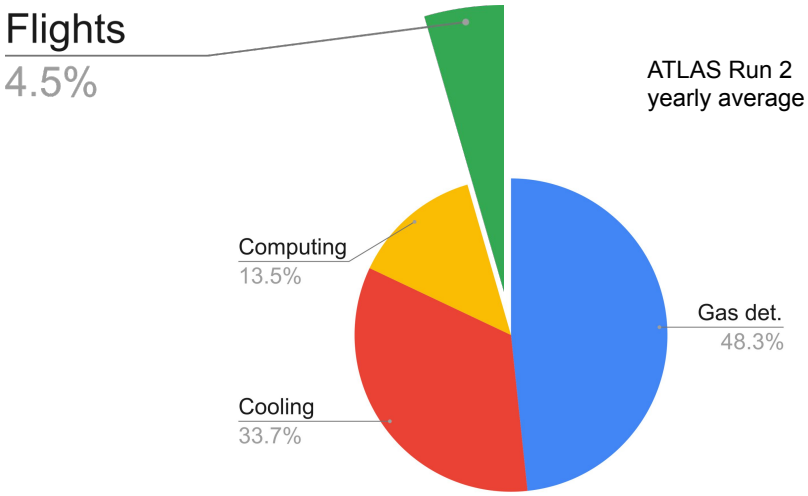
Impacts of HEP - Travelling.

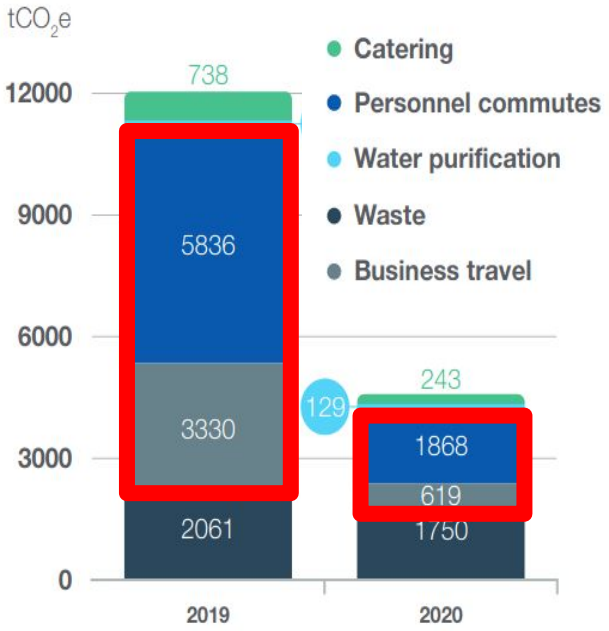
CO_2

- Daily commuting and business travel largest part of indirect (scope 3) emissions at CERN: >9000 t CO_2e
- Strong reduction if reduce travelling & distances
- Visible e.g. in 2020, where travelling at CERN decreased substantially due to Covid

…and there are a lot more one-way electrical components, civil engineering, ...

CO_2 | ^9F | Oth





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Considerations regarding DESY Strategy

Sustainability must be a central part of the long-term DESY and DESY FH strategy and made into a project with appropriate funding and job lengths.

The environmental and social impact must become a mandatory and major consideration in every decision-making process, both on a managerial side and in TDRs.

DESY as a science and tech institute should not be contributing to the climate crisis and sixth mass extinction, but be part of the solution!

Proposals for immediate measures

Mid-term measures:

- Reuse waste heat (IT, cooling)
- Convection cooling for big rooms
- Solar panels on all possible roofs
- Flexible computing resource usage
- Flexible energy use: Store in green energy peaks, use storage when no green energy available
- Encourage bike & public transport w.r.t. car use at DESY
  - Better JobTicket
  - Dienstfahrrad
- Increase funding: D6 / us / …

Long-term measures:

- Use waste heat for heating: DESY buildings, but maybe also in Lurup/Bahrenfeld?
- Take climate impact into account in building construction, renovation, …
- Extra funding for projects pushing sustainability in HEP

Current focus: Awareness

- Aim: point to consequences of our actions, start self-reflection & discussions
- So far mostly talks on different topics:
  - Snowmass climate impact, sustainable computing, sustainable research infrastructure (KITTEN), sustainable gaseous detectors

In the future…

- Interconnect FH sub-departments on questions of sustainability
- Connect FH departments with relevant outside partners for sustainability
- Create a web presence: DESY website? Social media? …?
- Provide information on DESY CO_2(e) & resource usage more publicly
- Give a feeling for orders of magnitude of DESY resource usage
  - How much energy do PETRA / IT / … use in terms of e.g. car km?
- Go to individual group meetings to advertise the Forum

Long-term ideas: Workshop and paper

FH Sustainability Workshop(s)

- Identify unsustainable practises and/or educate people (e.g. computing)
- **Have a workshop, open to all FH members for 2 days in Hamburg**
- Very interactive with lots of discussion and expert inputs

Paper/report on sustainability in FH

- Create CO_2e emission profile for FH
- Categories of emissions, e.g. computing, gas detectors, cooling, etc.
- Quantify CO_2e emissions & mitigation
- **Need contributors from subgroups!**

Personpower

Bottleneck for a sustainable sustainability forum

- Currently: one (unemployed) PhD student and two (temporary) post-docs
- **Need permanent personpower**
- Ideas:
  - ≥1 permanent joins organisation team
  - ≥1 senior with post-docs / students agrees to (repeatedly) oblige one person to join the organisation team
  - Another idea?
- Diversification: **currently all organisers from ATLAS group** → would appreciate people from CMS / Belle / IT / Electronics / FTX / TH / …
- Necessary to make DESY (not just ATLAS) involved in sustainability
- Going to group meetings to introduce ourselves, also encouraging people to join organisation team

Conclusions

- Gas detectors, cooling and computing are the three largest sources of CO2e emission at ATLAS
- We have to get active at DESY!
  - Multiple short-/mid-/long-term actions proposed
  - Need to increase awareness about the issue across the division
- Permanent personpower required for forum organisation
- Workshop(s) to get more people involved and active
- Write paper documenting sources of CO2e emissions in our groups

Talks/ideas in the next months:

- 19.12.: Frauke Poblotzki, “The HECAP initiative”
- 30.01.: Andreas Mussgiller, “Energy-saving clean-rooms”
- tbd: Frauke Poblotzki, “CO_2e friendly CO_2 cooling systems”
- tbd: “The Green IT Cube in Darmstadt”

CLIMATE CHANGE WILL NOT WAIT FOR US TO FINISH OUR RESEARCH.

LET'S TAKE ACTION NOW!

Mentimeter:

47334949

Sign up to our E-Mail list!

fh-forum-sustainability@desy.de

The DESY FH Sustainability Forum is organised by

Ben Brüers,
Nils Gillwald, and
Eleanor Jones.

ben.brueers@desy.de
nils.gillwald@desy.de
eleanor.jones@desy.de

Backup

Impacts of HEP - Gaseous detectors.

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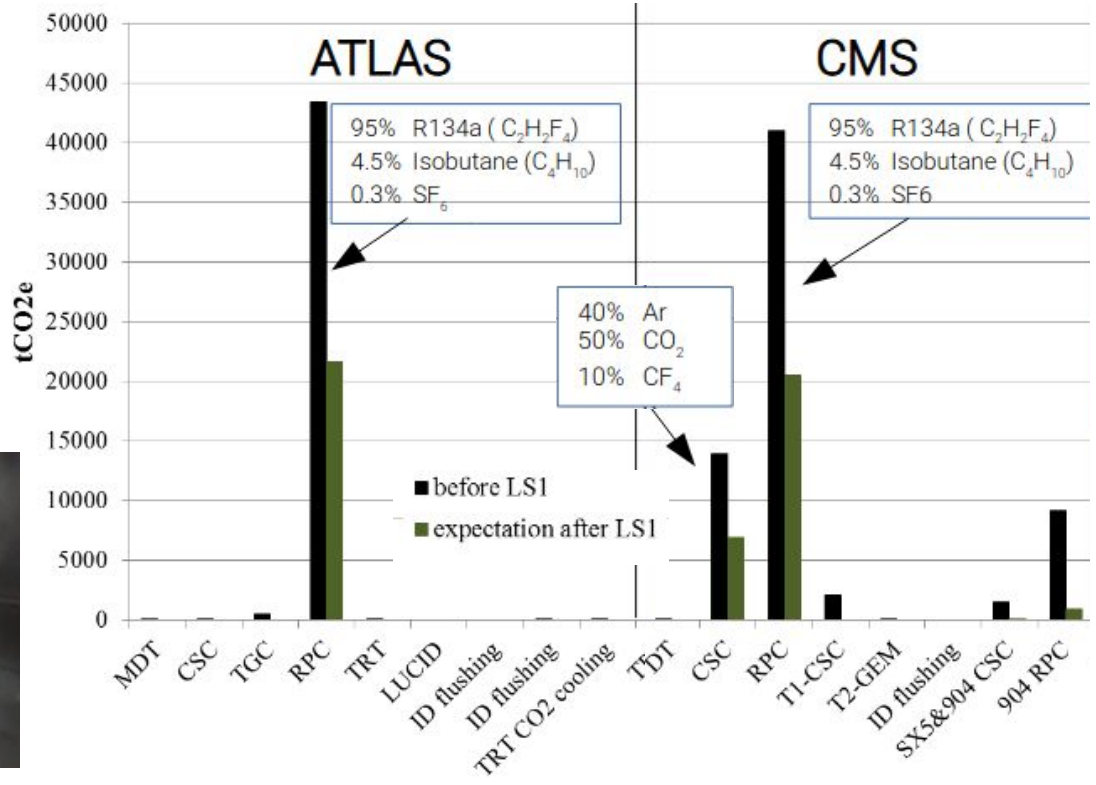

* CO_2e = CO_2 equivalent

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Impacts of HEP - Computing.

CO_2

- Impact depends a lot on electricity mix
- Inefficient code → large CO_2e mission!
- Example from Ben's PhD time
- Minimise new hardware purchases!

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

13-inch MacBook Pro life cycle carbon emissions

73%	Production
7%	Transport
19%	Use
<1%	End-of-life processing

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https://www.apple.com/environment/pdf/products/notebooks/13-inch_MacBookPro_PER_Nov2020.pdf

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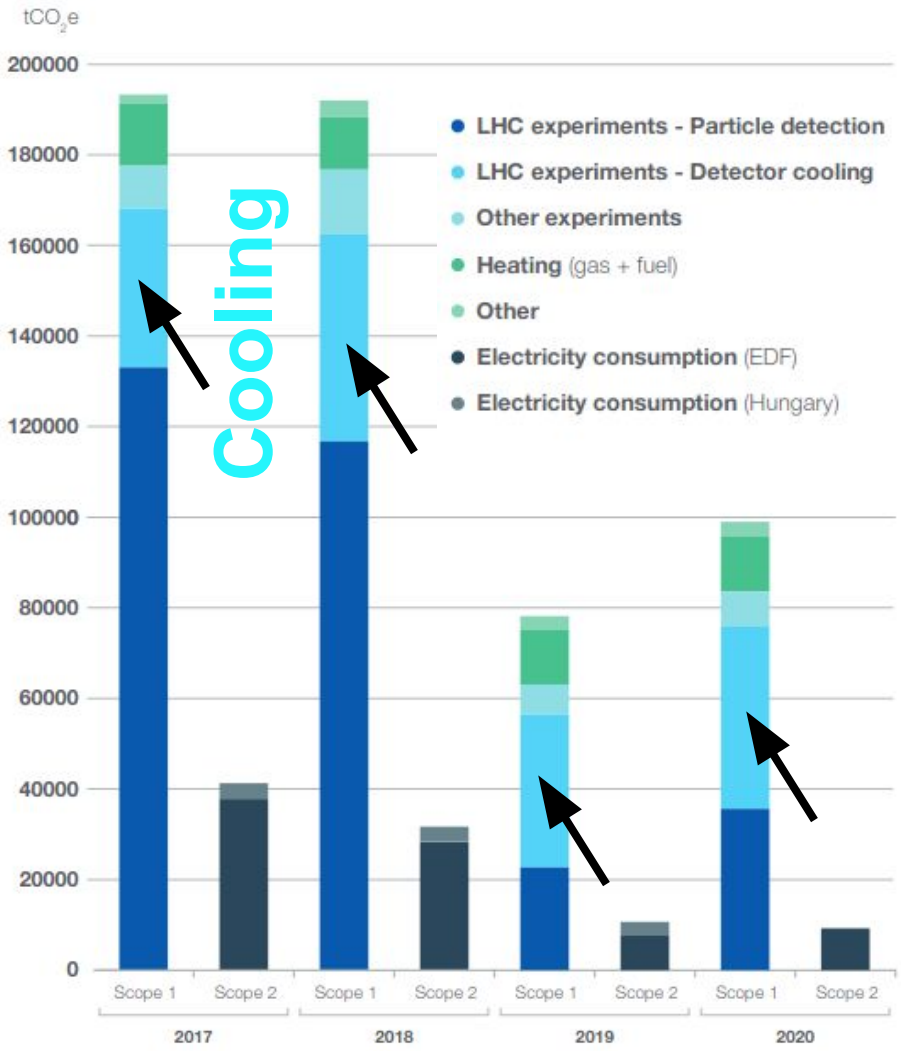

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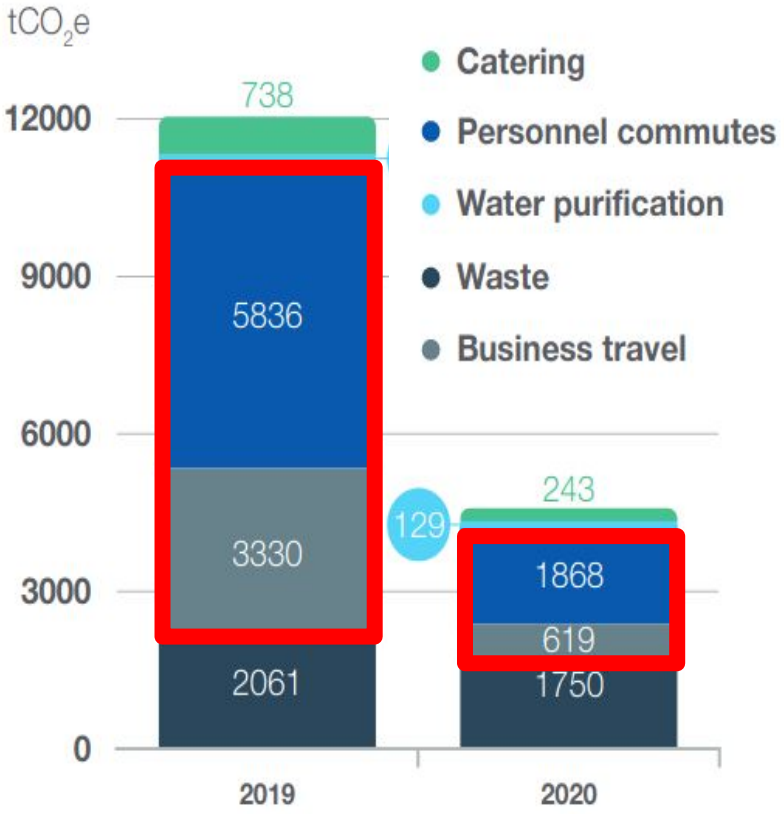

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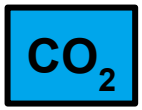
CO_2 ^9F Oth

The DESY-FH Sustainability Forum.

A platform to discuss and share ideas and projects for sustainable HEP

- Talks and discussions on different sustainability topics
  - Identification of unsustainable practices
  - Discussion of more sustainable solutions
  - Sharing of working, implemented solutions
  - Networking with other initiatives
- Establish innovative and support existing projects working towards a sustainable HEP
- Discuss funding opportunities
- Monthly meetings
- E-Mail list

How we started



- nTuple production on the grid → tremendous CPU hours in PANDA
- Reason: memory leaks, grid retried jobs on machines with more RAM until they succeeded
- Calculated CO_2e using PANDA outputs
  https://atlas-kibana.mwt2.org/app/dashboards#/view/00a4a6d0-24f9-11ec-bc4b-6bc59948c109
- Found more than 1200 years of single-core CPU hours or 39t of CO_2e!!
- Largest source of CO_2e emission for the entire PhD time
- It would be useful to have a CO_2e monitor in PANDA to show consumption
- Beate Heinemann founded DESY HEP department (FH) sustainability forum

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What can we do to make HEP sustainable?

If we want to tackle global warming, we must look for solutions everywhere:

- Make carbon footprint & reusability a design parameter
- Develop more energy efficient detectors & accelerators
- Reduce travelling – or use more sustainable transportation
- Introduce climate panels
- Introduce climate / CO_2 budgets – similar to monetary budgets
- Calculate & publish CO_2 consumption of publications
- Carbon footprints for computing jobs:
  - show CO_2 monitor
  - stricter rules on usage (grid retries, ...)
  - Prefer “green” grid sites
- CO_2 friendly coding: Profiling & (compiler) optimization, …
  - faster code’s nicer anyway!
- Check physics: Less systematics? More skimming? …
- …

But most importantly:

Make sustainability and the impact on global warming part of everyday work!

Long-term idea: FH sustainability workshop

Identify unsustainable practises and discuss mitigation techniques

- Need to identify unsustainable practises at DESY and mitigation
- **Have a workshop, open to all FH members for 2 days in Hamburg**
  → In our ideal world group leaders would encourage employees to join
- Very interactive
  - Input on why climate change is happening
  - Input on how HEP produces CO2e emissions
  - Brainstorming sessions
    - How we produce CO2e
    - What we can do to reduce it
    - (Structural) changes needed
    - Discussion / summary
- **Need experts to give inputs**
  → D6, CERN/MPI people, perhaps professional coaches

Long-term idea: Paper sustainability in FH

A first report on sustainability in DESY FH

- Create CO_2e emission profile for FH
  - **How to assess this?**
- Categories of emissions, e.g.
  - Computing
  - Gaseous detectors / cooling
  - Waste material
  - Travelling / transport
  - …
- Discuss how sub-groups contribute
  - Quantify the (largest) CO_2e emissions
  - Discuss mitigation
- This paper would
  - Be a nice first step to assess the CO_2e emissions at DESY FH
  - **Need contributors from all FH subgroups!**