Impact des grandes infrastructures

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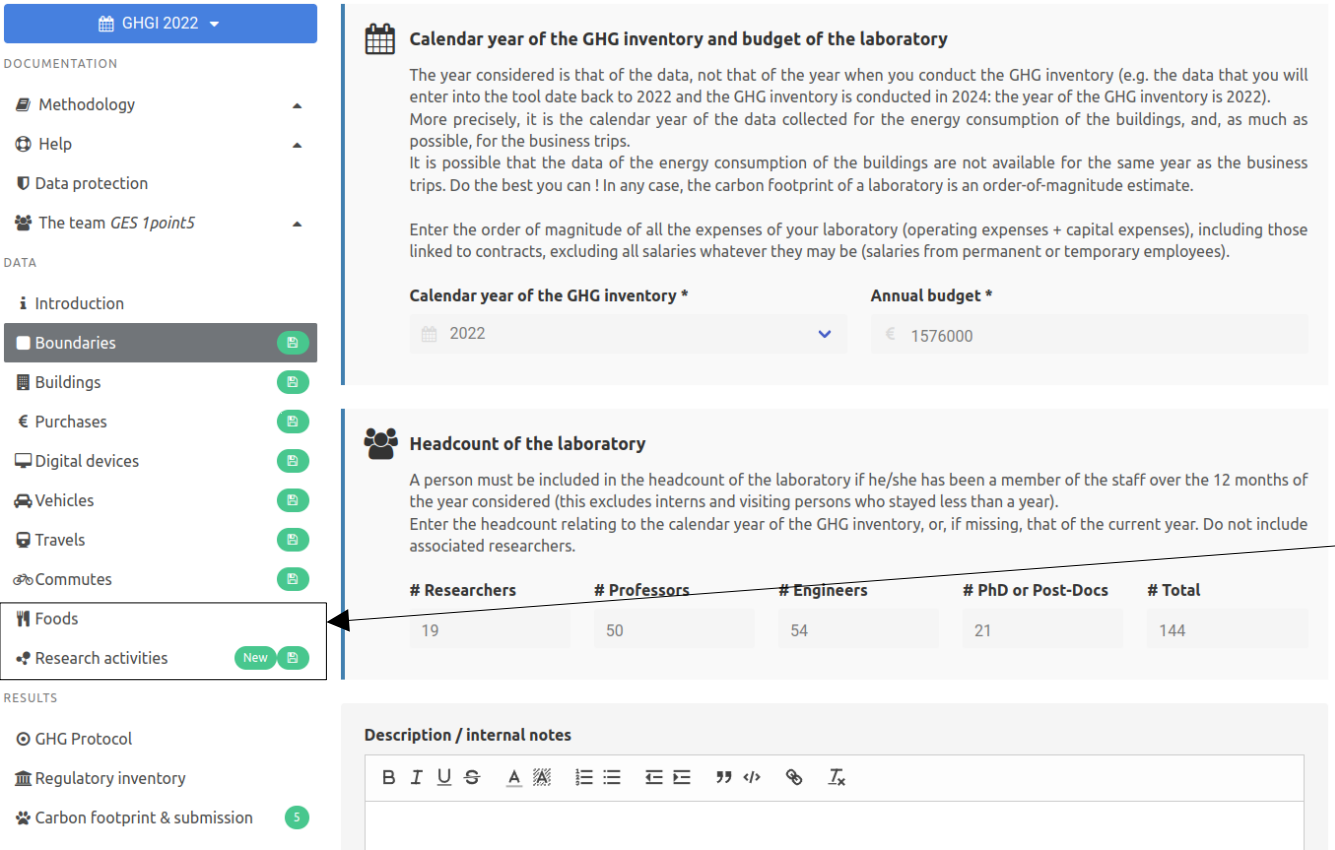
on behalf of members of Labos 1point5

Réunion référents DD IN2P3
26 mars 2024

Labos 1.5

- Groupement de Recherche
  - Understand and reduce the C footprint of research
  - CNRS, INRIA (computing), INRAE (agriculture), ADEME (environment agency)

- Develop tools to estimate C footprint for labs https://apps.labos1point5.org/ges-1point5



Récentes additions à GES 1point5

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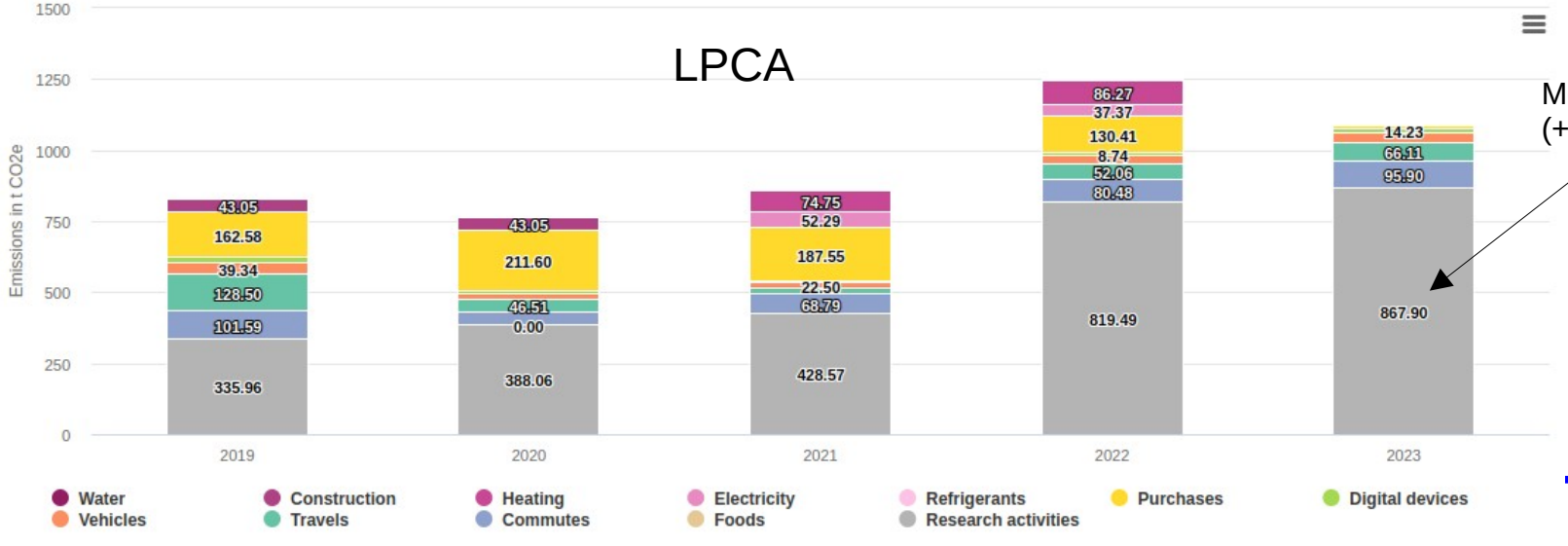
Include plane contrails in GES 1point5 calculations.

For air travel, the French regulation advocates to take into account the emissions linked to fuel combustion and upstream, with the option of including or excluding emissions from **condensation trails**.
The **radiative forcing** of these contrails is **significant** even if its **magnitude is still uncertain**. Therefore, GES 1point5 allows to take these contrails into acccount or not in the calculation.



Mostly CERN usage (+telescopes)

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  … evaluate policies to reduce it

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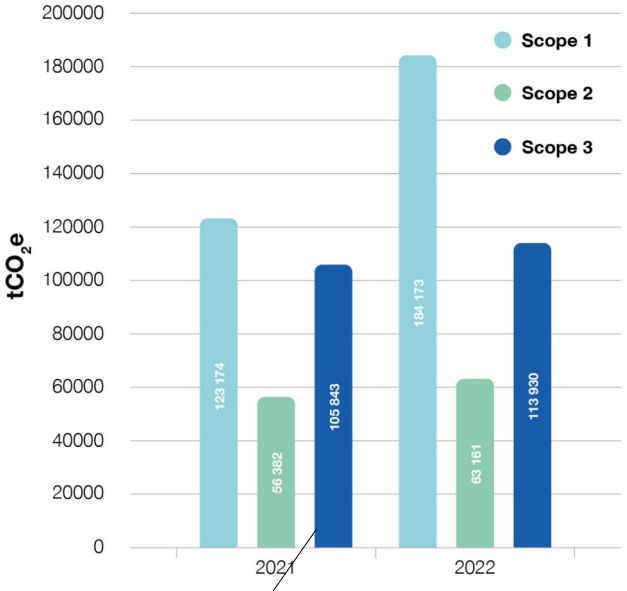
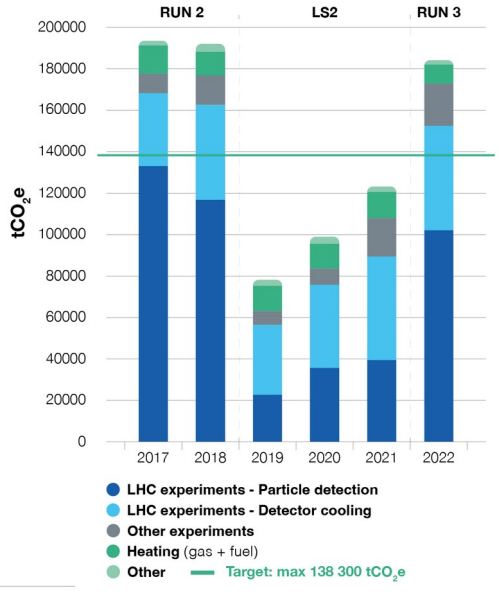
- On going task force to include the impact of infrastructures
  - Crucial task
    - Better awareness of the impacts by physicists → actions
    - Fairer discussion in the labs if everything is properly accounted for
  - CERN, telescopes and national computing center impacts released in 1st version of the module

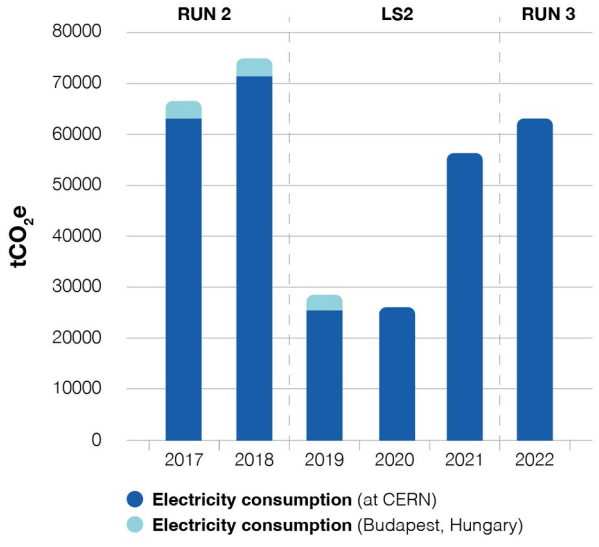
    - More to come: biological and medical analysis platforms, animal facilities, ...
- Possibility to use outside of French research institutes (open source)
  - Discussions ongoing

Inputs, last CERN environmental report

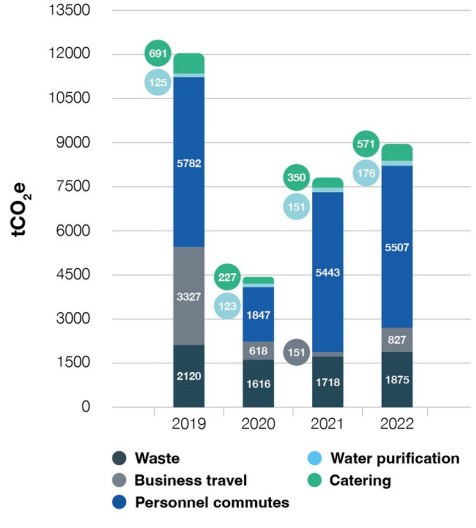
- https://hse.cern/environment-report-2021-2022/emissions







Scope 3 includes procurement for 2 last years



Scope 1

Scope 2
(previous years recomputed)

Scope 3
(excluding procurement)

Strategy & Inputs (2)

- How to distribute the footprint?
  - Share it among the physicists using CERN
    - CERN's goal is to provide them data
    - Well known numbers, by CERN and labs

      PhD student, post-doc, staff at Dec 31st
  - https://cds.cern.ch/collection/CERN%20Annual%20Personnel%20Statistics

		2017	2018	2019	2020	2021	2022
2	**Runs**	Run 2	Run 2	LS2	LS2	LS2	Run 3
3	**Users CERN (31-déc.)**	**12236**	**12569**	**12428**	**11399**	**11175**	**11860**
4	Atlas	3912	3971	3983	3699	3517	3580
5	CMS	3076	3092	3055	2862	2749	2940
6	Alice	1314	1320	1329	1180	1159	1208
7	LHCb	870	913	946	887	910	959
8	**->Exp LHC**	**9172**	**9296**	**9313**	**8628**	**8335**	**8687**
9		74,96%	73,96%	74,94%	75,69%	74,59%	73,25%
10	LHC	78					
11	SPS	733	745	718	676	695	711
12	PS	219	229	204	179	177	221
13	**-> Acc**	1030	974	922	855	872	932
14		8,42%	7,75%	7,42%	7,50%	7,80%	7,86%
15	**--> Autres Expe**	**2034**	**2299**	**2193**	**1916**	**1968**	**2241**

LHC experiment users

Accelerator sector
→ not used for the sharing

Other-experiment users

Scope 1

		2017	2018	2019	2020	2021	2022	2023			
1											
2	**Runs**	Run 2	Run 2	LS2	LS2	LS2	Run 3	Run 3			
18	**Emissions (tCO2eq)**	374 119	380 943	220 270	231 057	285399	361264				
19	scope 1	193600	192100	78169	98997	123174	184173				
20	*Exp-Detec LHC*	*133029*	*116690*	*22597*	*35537*	39355	101850				LHC
21	*Exp-Refr LHC*	*35312*	*46122*	*33665*	*40383*	50171	50475				LHC
22	*Autres Exp*	*9132*	*14068*	*6918*	*7846*	18325	20430				horsLHC
23	*Chauffage*	*13700*	*11300*	*12221*	*12000*	12618	9012				any
24	*autres*	*2130*	*3921*	*2768*	*3231*	2704	2403				any
25	->LHC	168341	162812	56262	75920	89526	152325				
26	-> hors LHC	9132	14068	6918	7846	18325	20430				
27	-> anyexp	15830	15221	14989	15231	15322	11415				

18.35t/phys (for LHC experiment users)

38	scope 1 LHC/user	18,35	17,51	6,04	8,80	10,74	17,53
39	scope 1 horsLHC/user	4,49	6,12	3,15	4,09	9,31	9,12
40	scope 1 any	1,29	1,21	1,21	1,34	1,37	0,96

4.49t/phys (for non-LHC experiment users)

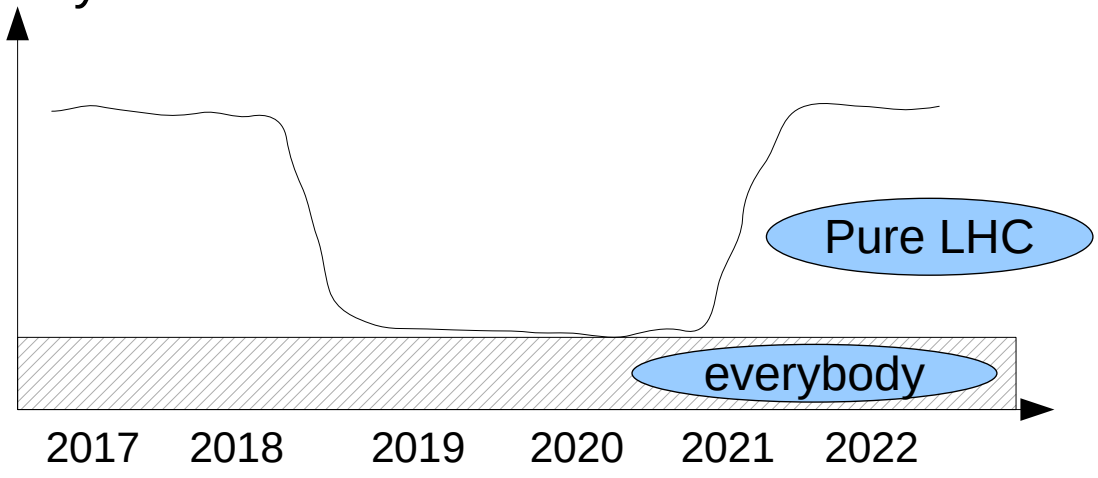
+ 1.29t/phys (LHC or non-LHC)

Actuellement dans l'outil GES1point5 (pre-rapport environnemental 2021-2022) :

37	scope 1 LHC/user	18,22	17,51	6,04	8,80	7,93	18,74
38	scope 1 horsLHC/user	4,61	6,12	3,15	4,09	3,75	6,28
39	scope 1 any	1,12	1,21	1,21	1,34	1,32	1,25

Scope 2 (mostly electricity)

- Global tendency:



Chiffres revus à la hausse rétroactivement (2017-2020) dans le nouveau rapport 2021-2022

Hypothèse: durant le shutdown la conso électrique/physicien pour une expérience hors LHC est similaire à celle du LHC/physicien

Cooling!
→ LS with high consumption

1		2017	2018	2019	2020	2021	2022	2023	
2	**Runs**	Run 2	Run 2	LS2	LS2	LS2	Run 3	Run 3	
30	scope 2	66589	74913	28554	26127	56382	63161		
31	scope 2 (any)	27340,5	27340,5	28554	26127	27340,5	27340,5	Ave (19',20	27340,5
32	scope 2 (LHC)	39248,5	47572,5	0	0	29041,5	35820,5		

Scope 2 (mostly electricity) - **Uncertainties**

- Evaluate with another sharing:
  - LHC data production: largest part of scope 2 → give it to LHC users

1		2017	2018	2019	2020	2021	2022
2	**Runs**	Run 2	Run 2	LS2	LS2	LS2	Run 3
41	scope 2 pour LHC	7,26	8,06	3,07	3,03	6,76	7,27
42	scope 2 (any)	2,23	2,18	2,30	2,29	2,45	2,31
43	scope 2 (LHC)	4,28	5,12	0,00	0,00	3,48	4,12

  - Comparaison des 2 méthodes :
    - LHC: [15, 27%] → 30%
    - Non-LHC : [10,16%] → 20%

Actuellement dans l'outil GES1point5 (pre-rapport environnemental 2021-2022) :

40	scope 2 pour LHC	4,91	3,41	1,15	1,07	1,19	4,41
41	scope 2 (any)	0,81	0,79	0,86	0,81	0,89	0,84
42	scope 2 (LHC)	3,82	2,34	0,00	0,00	0,00	3,27

Scope 3

Some assumptions for early periods

	Run 2	Run 2	LS2	LS2	LS2	Run 3		
	2017	2018	2019	2020	2021	2022		
Waste	1875	1875	2120	1616	1718	1875	2017/8: use running condition (2022)	
Business travel	3327	3327	3327	618	151	827	2017/8: use pre-covid condition (2019)	
Commute	5782	5782	5782	1847	5443	5507	2017/8: use pre-covid condition (2019)	
Water	176	176	125	123	151	176	2017/8: use running condition (2022)	
Catering	691	691	691	227	350	571	2017/8: use pre-covid condition (2019)	
Sub-total	11851	11851	12045	4431	7813	8956		
procurement	101502	101502	101502	101502	98030	104974	<2021: Average(21', 22')	101502
Total	113353	113353	113547	105933	105843	113930		

Adding **procurement**, from recent years
(not available in reports before 2021)

Construction of LHC

- Not clear how to handle it
  - Tunnel already existing (LEP)
  - Amortisation period (how long?) or single shot at construction time?
  - How to take into account the upgrades ?

- Order of magnitude

	A	B	C	D	E	F
1	cout:	4,50E+09	euros	LHC+4 experiences (CHF=euros)		
2	annees:	2008	2040	32	ans	
3				1,41E+08	euros/an	
4	FE:	0,3	kg/euros			
5	Co2eq:	4,22E+04	tonnes			
6	physiciens:	8600				
7		4,91	t/phys			

→ Much smaller than yearly usage → choice to **ignore** it

Results & Uncertainties

- Uncertainties
  - Methodology:

    Comparaison btw 2 methods

    LHC: [15, 27%] → 30%

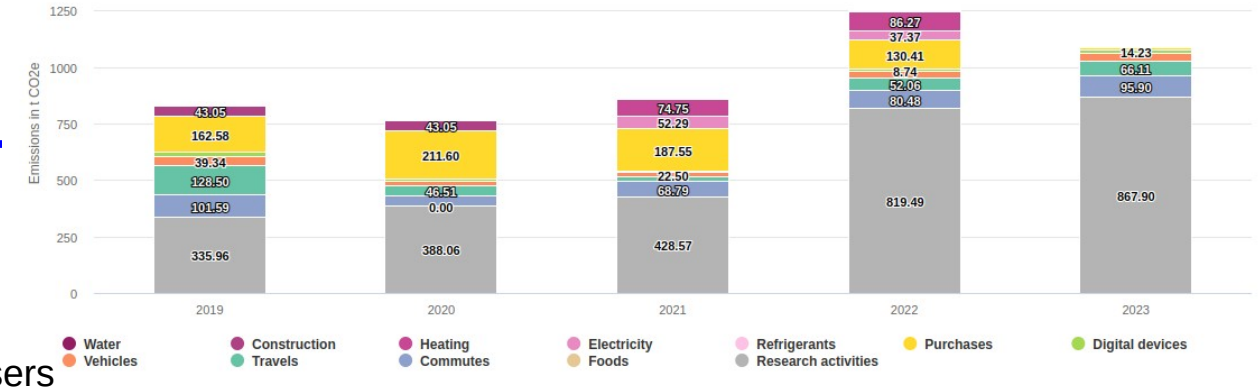
    non-LHC : [10,16] → 20%

		2017	2018	2019	2020	2021	2022	2023
2	Runs	Run 2	Run 2	LS2	LS2	LS2	Run 3	Run 3
52	FE t/user (LHC)	-0,15	-0,17	-0,27	-0,23	-0,24	-0,20	-> 30%
53	FE t/user (CERNuser)	0,16	0,15	0,09	0,10	0,10	0,14	->20%

  - Emission factors: (from GES1.5)
    - Gaz : 30%
    - Electricity (Fr): 10%
- Results: (computing still to be included...)

			2017	2018	2019	2020	2021	2022	
56			Run 2	Run 2	LS2	LS2	LS2	Run 3	
57	**FE t/user (LHC)**		**35,43**	**35,04**	**18,68**	**21,72**	**27,51**	**34,53**	divise les 3 scopes
58		30%	10,63	10,51	5,60	6,52	8,25	10,36	methodologie
59		30%	5,51	5,25	1,81	2,64	3,22	5,26	gaz
60		10%	0,65	0,73	0,23	0,23	0,59	0,64	electricite
61	**incertitude totale**		**11,99**	**11,77**	**5,89**	**7,03**	**8,88**	**11,64**	
62									
63	**FE t/user (exp non-LHC)**		**17,28**	**18,52**	**15,79**	**17,02**	**22,60**	**21,99**	
64		20%	3,46	3,70	3,16	3,40	4,52	4,40	methodologie
65		10%	0,22	0,22	0,23	0,23	0,24	0,23	electricite
66	**incertitude totale**		**3,46**	**3,71**	**3,17**	**3,41**	**4,53**	**4,40**	

Results for LPCA



Just a single number to be provided by the users

Category	Type	Sub-type	Amount	Unit
Research facilities	CERN	LHC experiment	32	User(s)
Research facilities	Astronomy	STEREO, TESS, GAIA, GALEX, WISE...		Utilisation
Research facilities	Astronomy	STEREO	0.1	% facility usage
Research facilities	Astronomy	TESS	0.01	% facility usage
Research facilities	Astronomy	GAIA	0.01	% facility usage
Research facilities	Astronomy	GALEX	0.02	% facility usage
Research facilities	Astronomy	WISE	0.01	% facility usage
Research facilities	Astronomy	HST	0.01	% facility usage
Research facilities	Astronomy	SWIFT	0.01	% facility usage
Research facilities	Astronomy	Fermi	0.04	% facility usage
Research facilities	Astronomy	Pic-du-Midi Observatory	2.74	% facility usage
Research facilities	Astronomy	Anglo-Australian Telescope	0.06	% facility usage
Research facilities	Astronomy	VLT (Paranal)	0.01	% facility usage
Research facilities	Astronomy	GTC	0.09	% facility usage
Research facilities	Astronomy	TAROT	2	% facility usage
Research facilities	Astronomy	VLA	0.01	% facility usage

10 persons

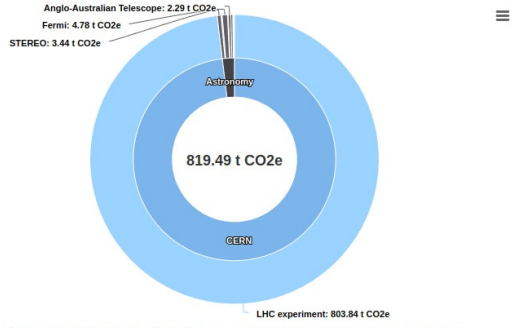


Figure : *Carbon footprint of laboratory research activities separated by their types.*

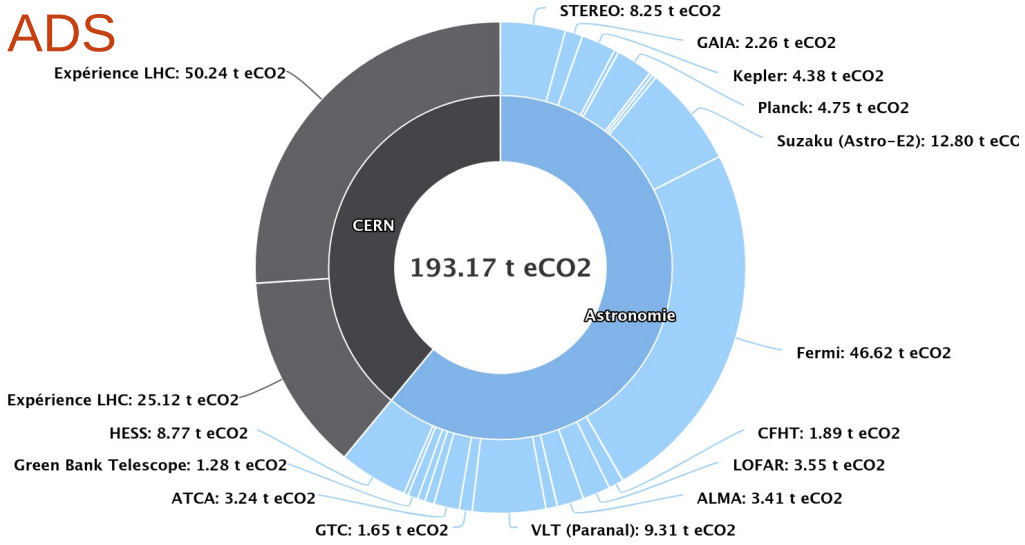
Type of research activity	Emissions (t CO2e)	Share of the research activity footprint
CERN	803.84 ± 297.42	98 %
Astronomy	15.64 ± 12.52	2 %

Astronomie

- Prend en compte les téléscopes (spatiaux et terrestres) utilisés dans les publications du laboratoire
- Facile à utiliser : juste fournir le nom du labo
- Emissions attribuées au rapport entre *auteurs du labo ayant publié des articles citant l'infrastructure* et *ensemble des auteurs à l'échelle mondiale ayant également publié des articles citant cette même infrastructure*
- Amortissement : 38 ans pour les télescopes et 18 ans pour les satellites
- Données bibliométriques extraites de ADS
- N'inclut pas encore les infra récentes (Euclid, CTA, LSST, etc.)
- Ref : arXiv: 2201.08748 [astro-ph.IM]

$$EC_{\text{infra}} = \frac{GES_{\text{construction}}}{\text{amortissement}} + GES_{\text{opérations}}$$

$$EC_{\text{labo}} = \sum_i \left(EC_{\text{infra}_i} \times \%\text{utilisation}^{\text{labo}}_{\text{infra}_i} \right)$$



CPPM (fake LHC pour voir l'astro)

Implementing CERN reduction in Scenario1.5

- That will ...
  - Answer to
    “our biggest GHG emission source is CERN,
    and they're going to cut back on gas,
    so we don't have much left to do for our 50% reduction?”
  - Raise awareness of the long-term consequences
    of our technological choices
    (especially as the FCC proto-collab will be launched next year).

- So … What will the CERN footprint be in 2030 ?
  - CERN plans to reduce Scope 1 by 28%
    (wrt/ 2018) by 2025
    → Scope 1(2018) *28% / nb of phys = -5.8t
  - To be applied only if the reference year is not a LS

Conclusion

- All French research areas involved in the labos1.5
  - Tools, methods, webinars, papers, …
  - Encouraged by funding agencies

- Developed a tool to handle C-footprint of CERN and telescopes (and GENCI)
  - Rising awareness, decision-making support