Time spent on interventions from equipment experts/piquet

Kostas Papastergiou *with thanks to EPA team for feedback*

Pulsed Power Engineering, Accelerator Beam Transfer Group

Efficient Particle Accelerators Project

Joint Accelerator Performance Workshop

Montreux, 12 December 2024

Outline

- Why analyse stand-by service data
- Description of the dataset
- Anatomy of an intervention
- Statistics and trends of interventions at CERN
- Automation in the service of Teams
- Take away messages

Why analyse stand-by data

Interventions a key element of technical People's job

- They happen out-of-hours/night
- They are unpredictable (time, duration)
- They are performed under pressure
- Lonely, exposed to risks

Interventions drive safety and availability (machine time)

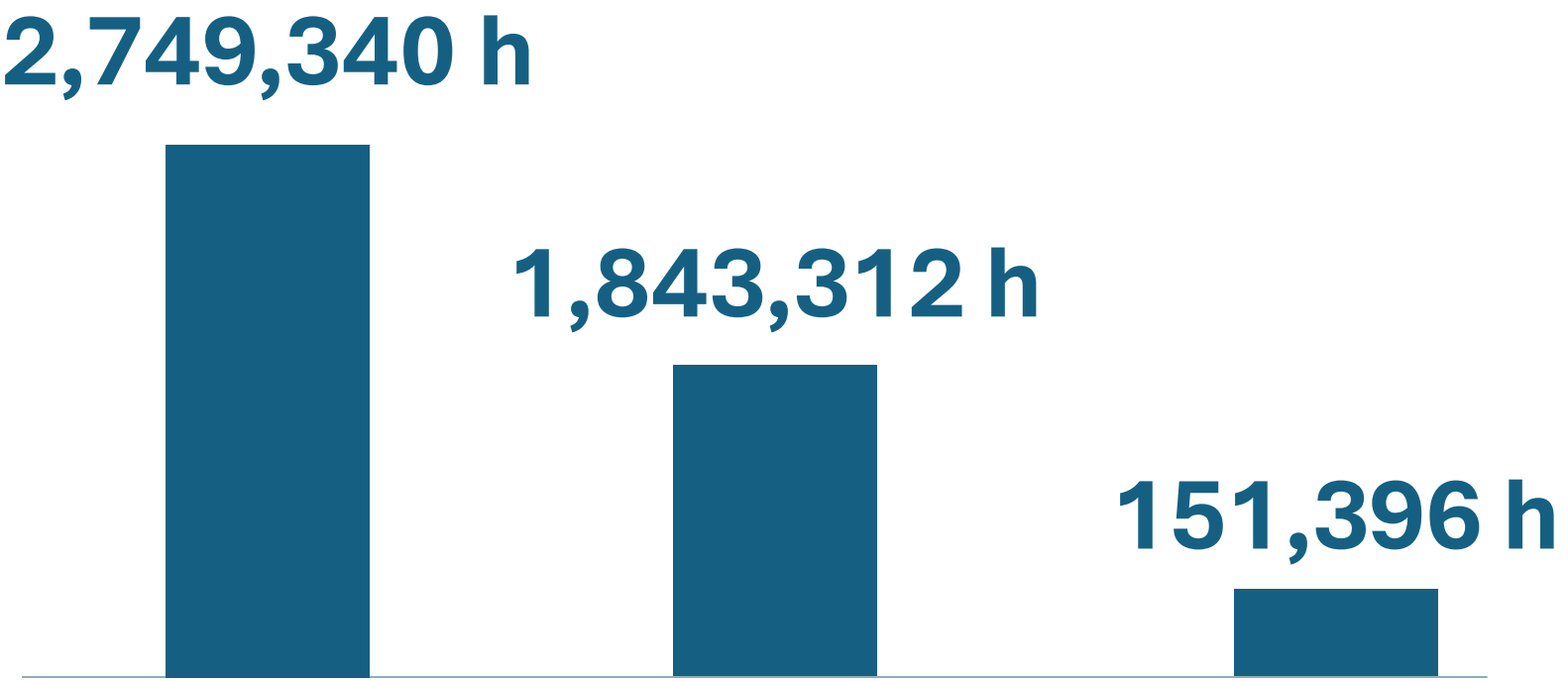
- More intervention time tends to mean less availability
- Consume resources that could be used for other reasons
- Impact general wellbeing

Dataset & Thanks

The dataset comprises **200,000** rows of **anonymised** overtime (out-of-hours) and shift work data from HRT from the year 1st Jan 2011 to 4th Nov 2024. The following results are focused on ATS departments and HSE. Shift hours of BE-OP are excluded.

Sincere thanks to **Nicole Polivka** (HR-CBS) and **Matthias Braeger** (FAP-BC) for the effort of modifying HRT to allow extracting useful data about remote/local interventions.

Thanks to **Rodolphe Maillet** for extracting data from the OP logbook too.
Thanks to ABT and EPA colleagues for their feedback.



1431 personnel-years

102 person/year

960 personnel-years

69 person/year

~ 79 personnel-years since 2011

~5.6 person/year

On-site

42,629

Hours

Remote

15,398

Hours

1.6% of stand-by time spent in interventions not counting daytime and travel

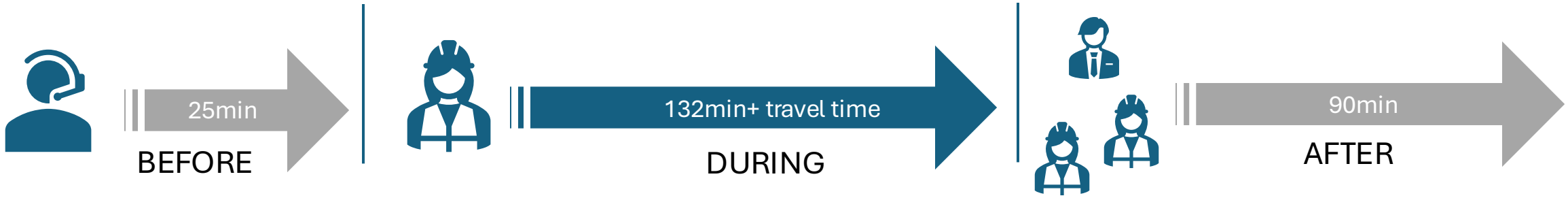
out-of-hours intervention since 2011

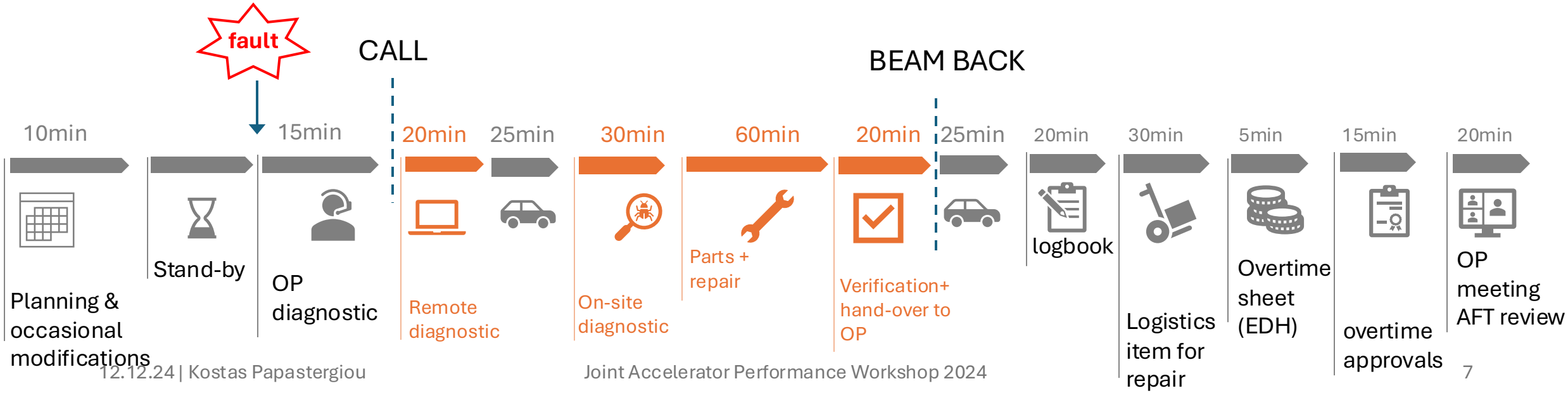
total 30.2 person-years

*14 years of data, 1 person=240 working days/year. Including travel time. Not including adjustment for weekends and holidays

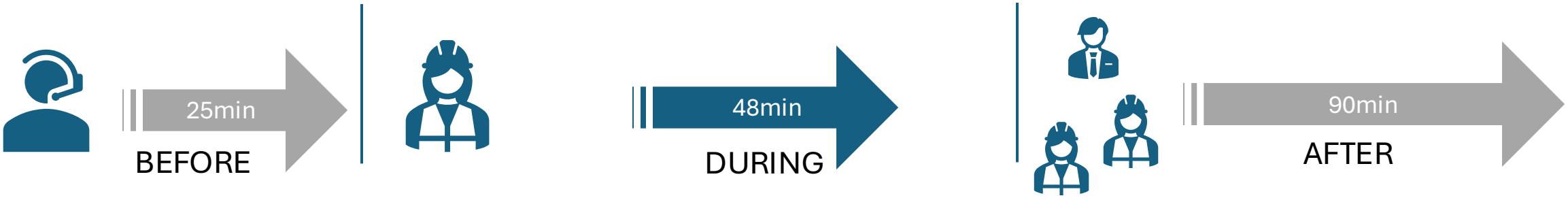
Anatomy of an on-site intervention

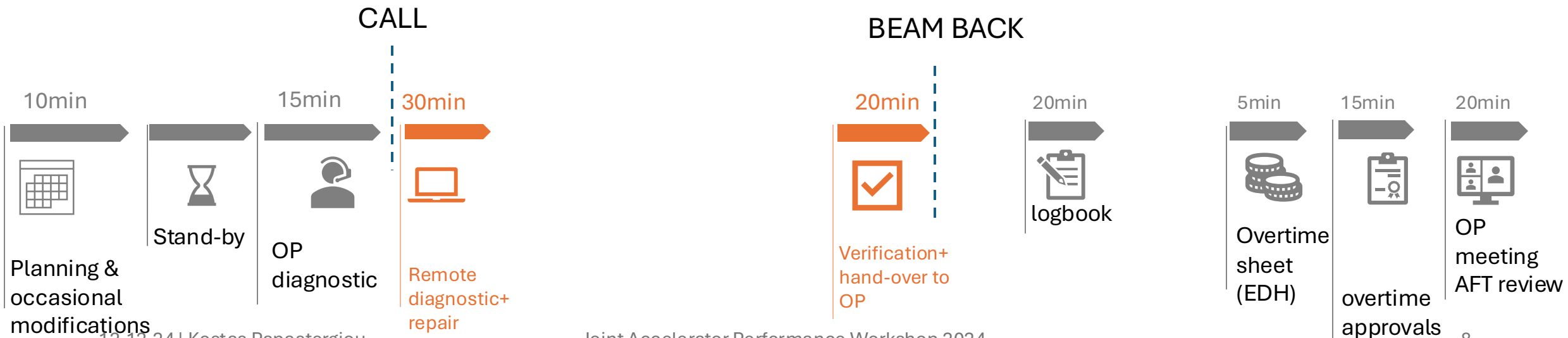
One Intervention = 295min





Anatomy of a remote intervention

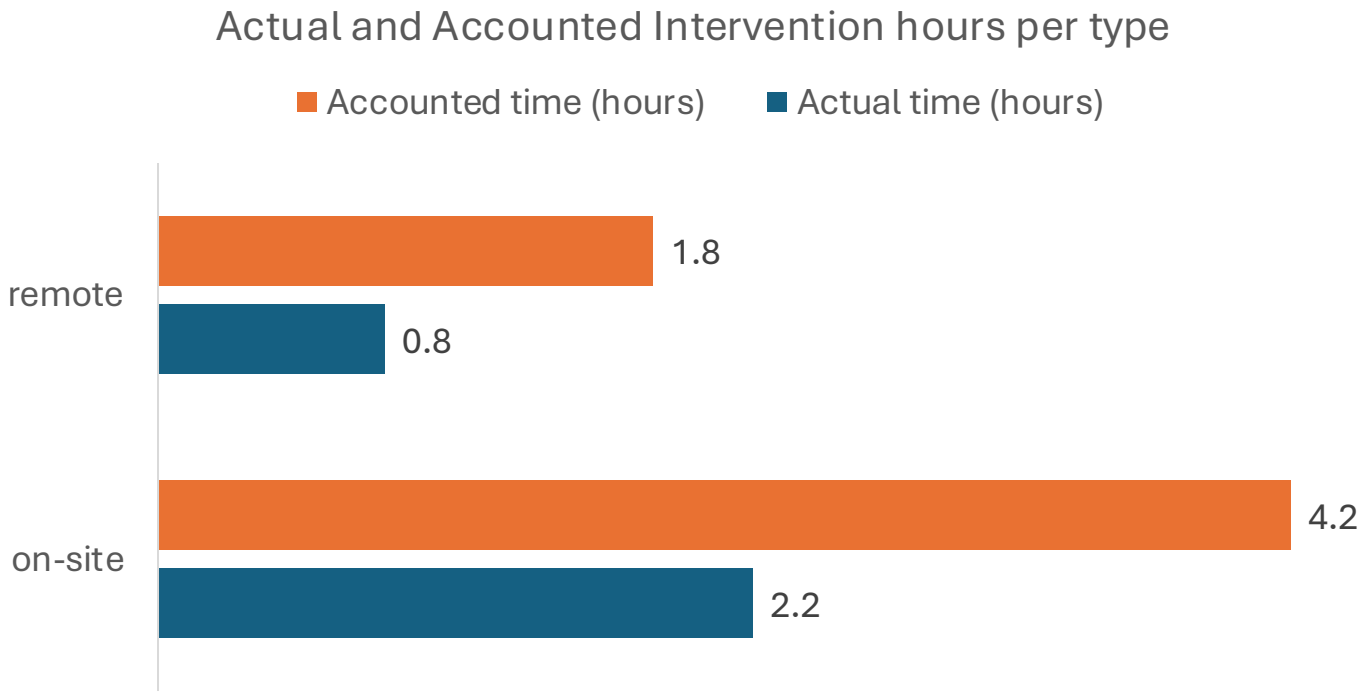




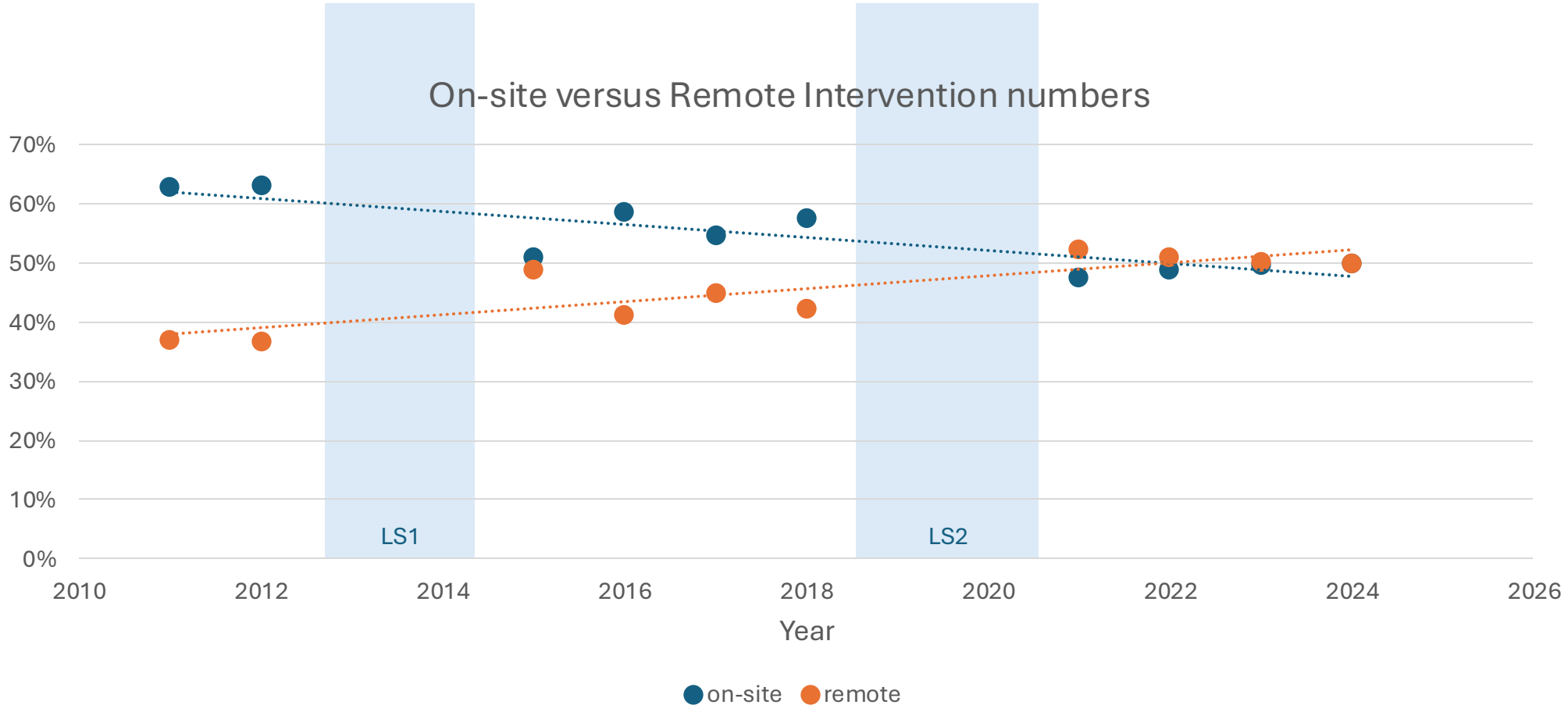
Do remote interventions cut time/cost

Actual time refers to the time spent by the person carrying out the intervention. This corresponds to the actual “machine down time”.

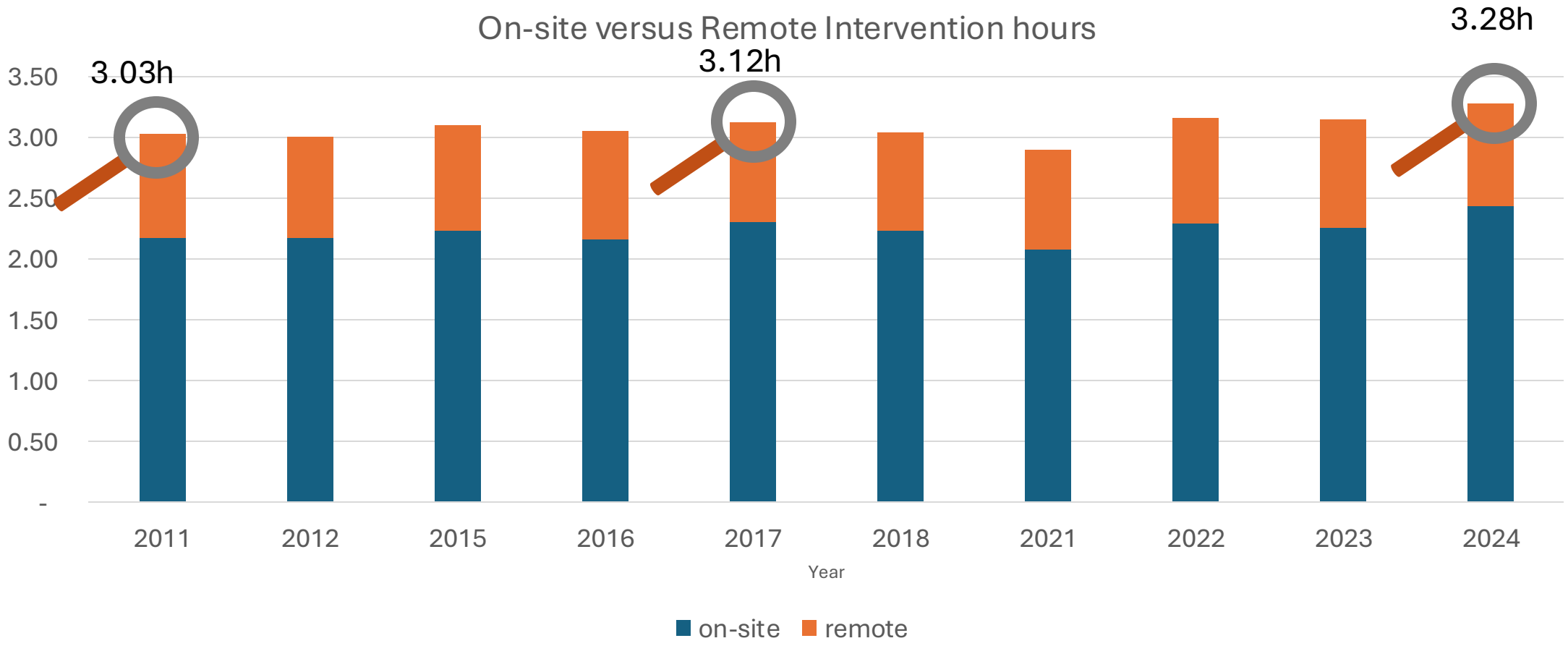
Accounted time refers to the intervention time including travel time. This reflects better the actual overtime paid out cost.



What is the trend of remote interventions



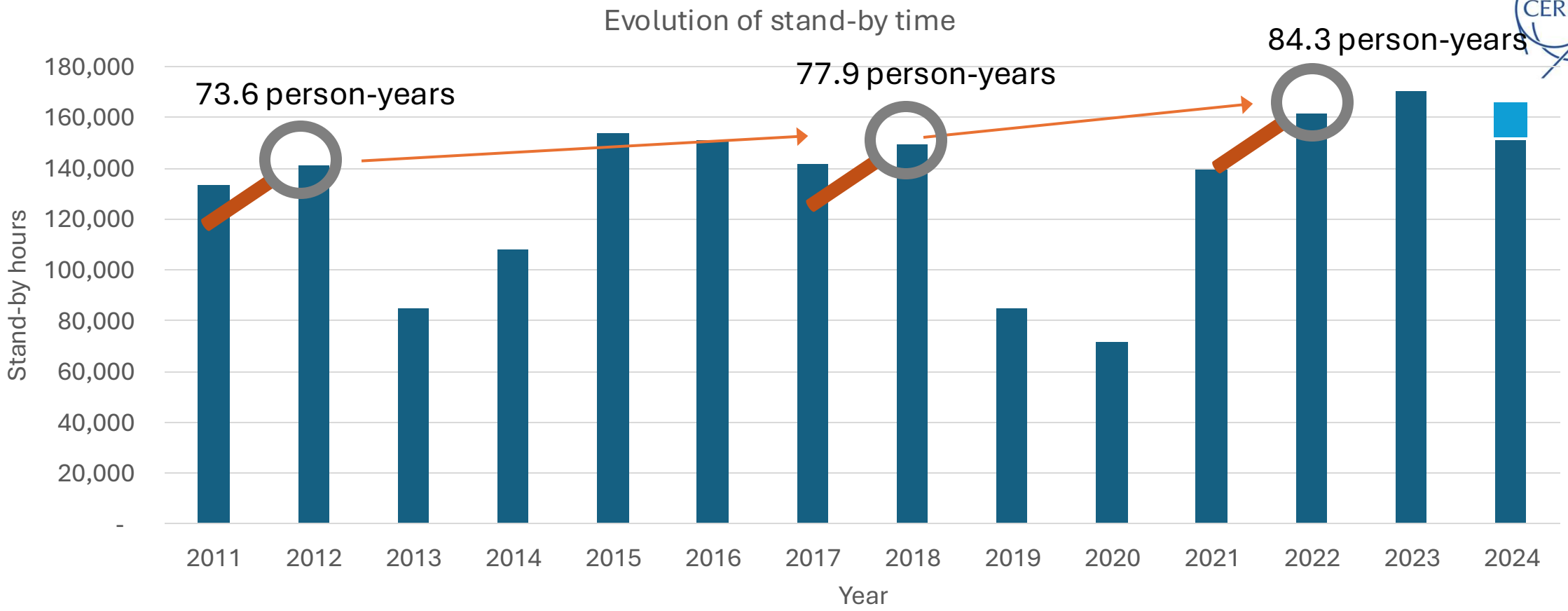
What is the trend of interventions duration



*actual intervention time, not including travel time and adjustments

Machines run with 99% availability

What can be improved?



*actual time, not including travel time and adjustments

What is the cost of machine availability

What is the cost of machine availability

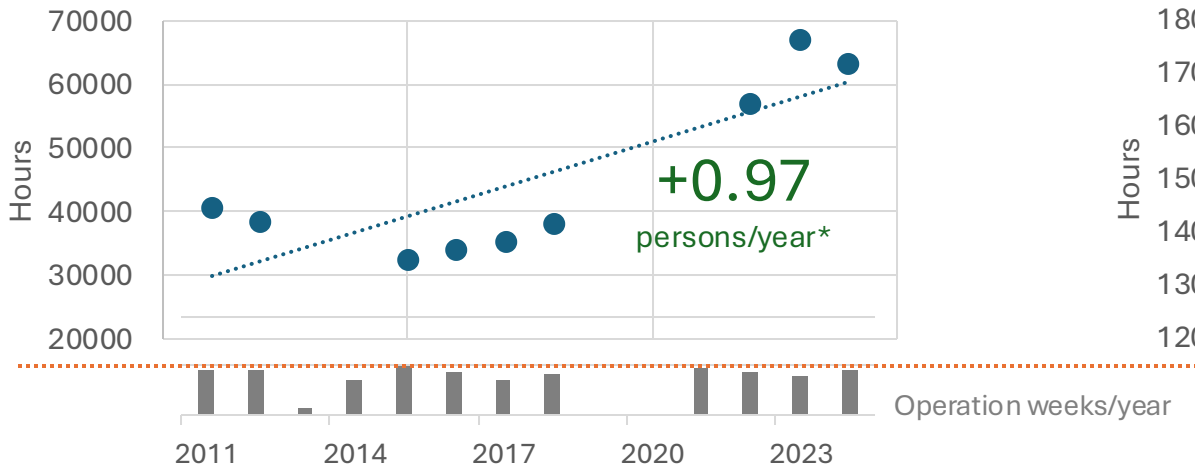
Shift hours

20.4

persons/year*

*one person working 1920 hours per year.
Calculation excludes years of machine stop.

Trend of Shift effort over time

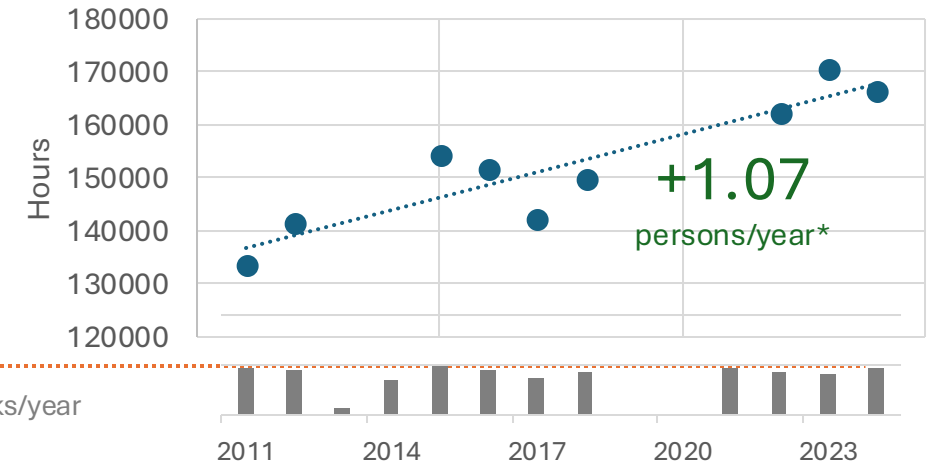


Stand-by hours

68.6

persons/year*

Trend of Stand-by effort over time



What is the potential benefit from automation?

On-site

- Interventions: 730/year
- Actual intervention time: 1880h/year
- Travel time: 1460h

Max* gain of machine time with automation of 10%

8days
per year
192 hours

Remote

- Interventions: 730/year
- Actual intervention time: 750h/year
- Travel time: 730h

Max* potential gain of machine time

31days
Per year
744 hours

Max* potential gain of intervention time

1330h
Per year

* Cumulative time across all machines. Only refers to accounted intervention time (no travel, preparation, logbook writing etc). Out-of-hours interventions tend to be blocking Operation, however. Interventions on services (EL, CV) are not always beam blocking. Interventions can take place simultaneously and therefore the final figures might be lower.

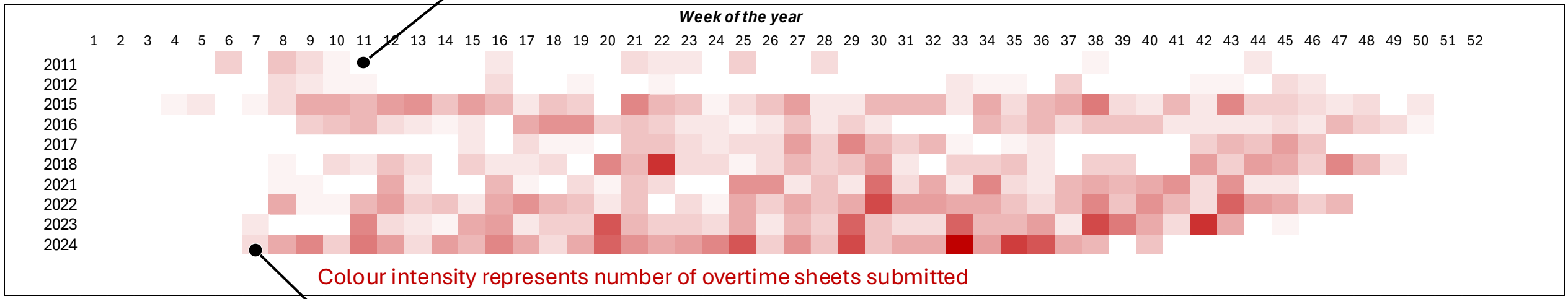
Complex Interventions

How do they evolve?

Number of overtime claims per week

Example of a single technology Group at CERN

2011 baseline: If only stand-by team intervened this would be the colour every week of 2011



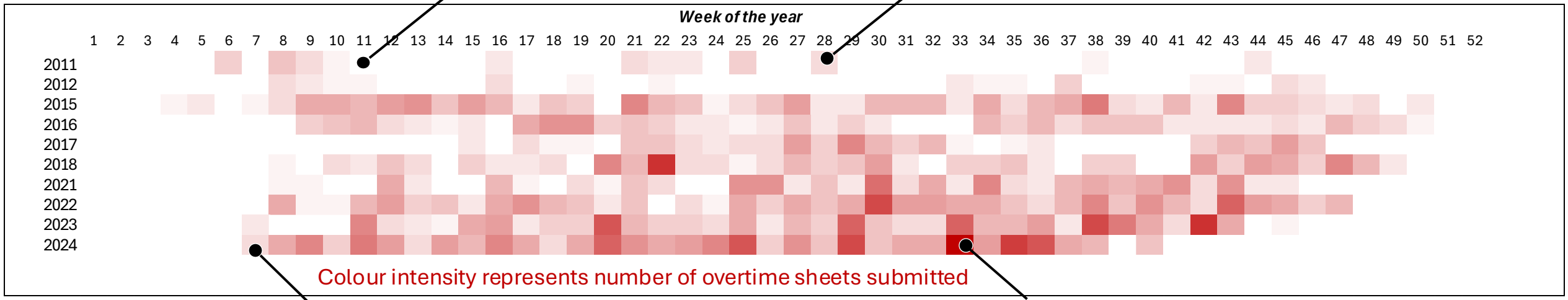
2024 baseline: If only stand-by team intervened this would be the colour every week of 2024

Number of overtime claims per week

Example of a single technology Group at CERN

2011 baseline: If only stand-by team intervened this would be the colour every week of 2011

Baseline+9 overtime sheets in this week



2024 baseline: If only stand-by team intervened this would be the colour every week of 2024

Baseline+12 overtime sheets in this week

Number of overtime claims per week

Example of a single technology Group at CERN

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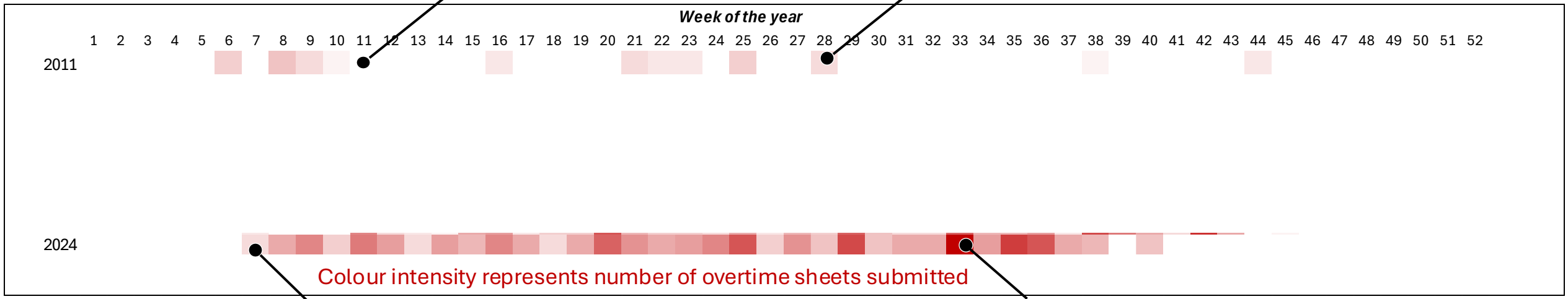

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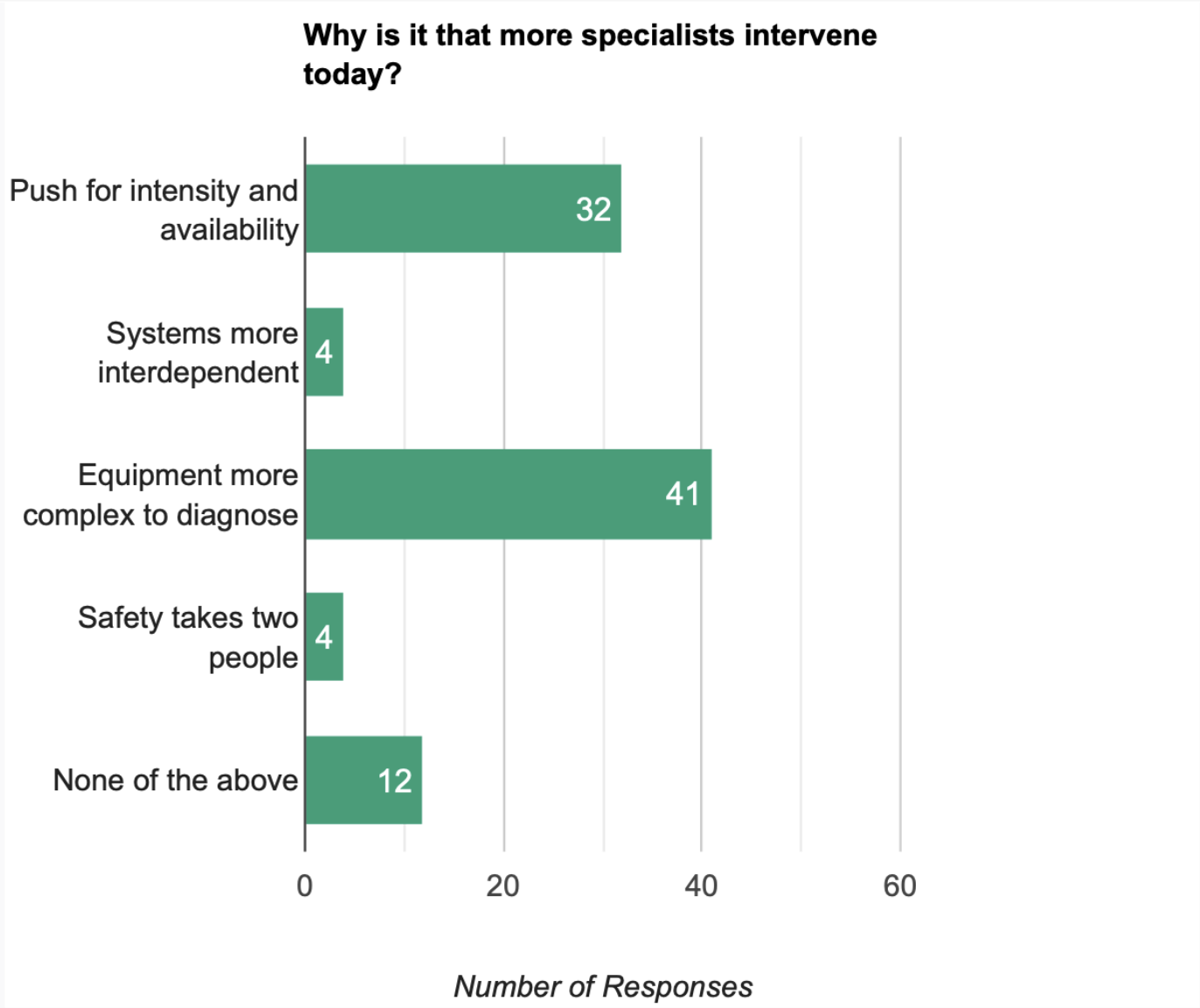

Source:

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Anatomy of an on-site intervention

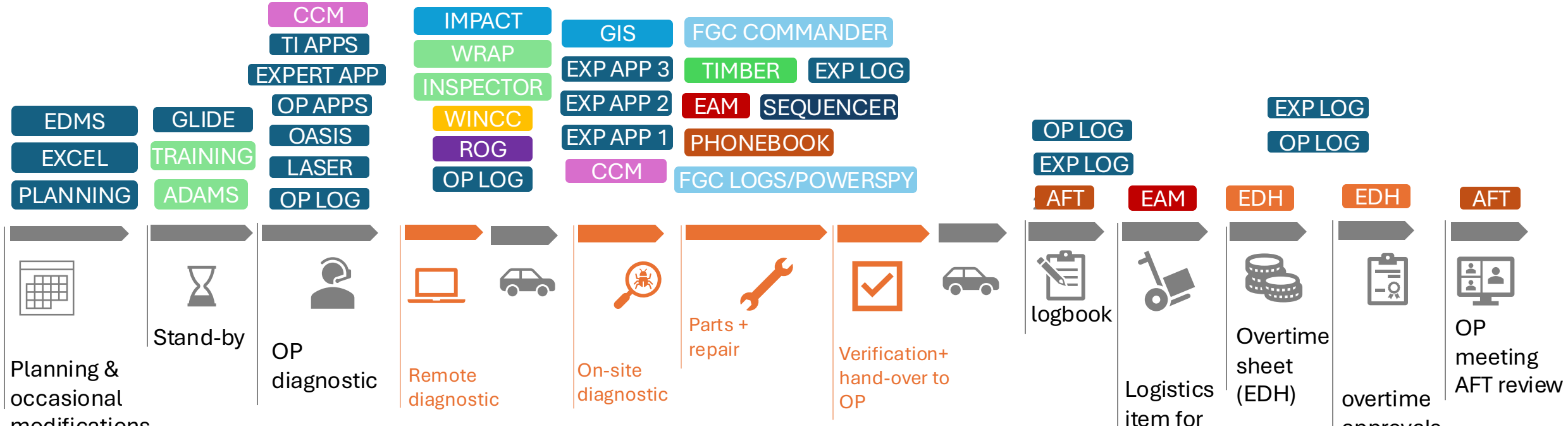
> 3 persons
> 12 steps
> 25 applications

One Intervention = 295min

BEFORE

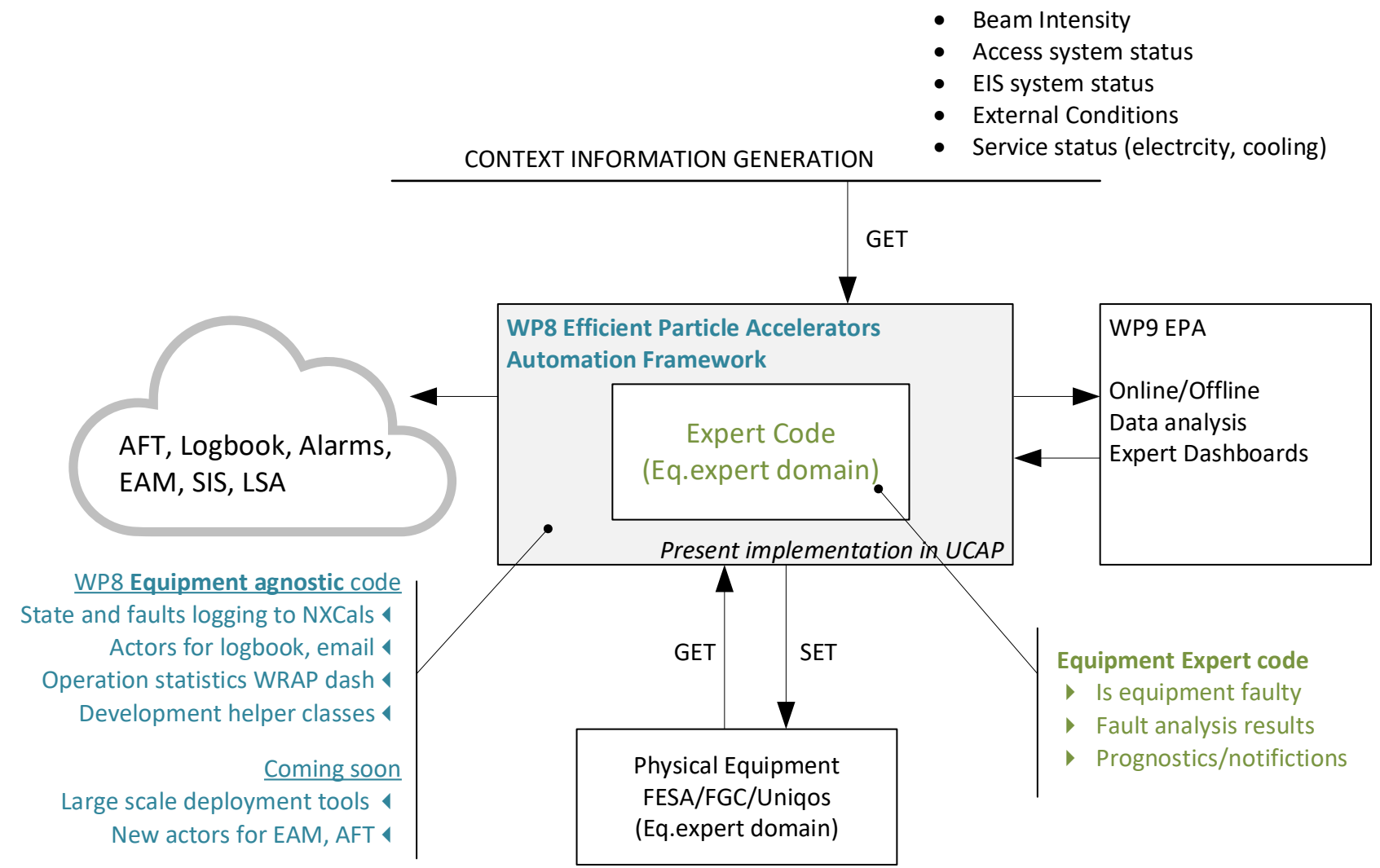
DURING

AFTER



Efficient Particle Accelerators

TO SEEK CCTB ENDORSEMENT



Tune in to Raul Murillo's Talk for applications of this

Conclusions

Intervention Trends Highlight Automation Potential

The data highlights a significant amount of time and resources allocated to out-of-hours interventions. With 30.2 person-years spent on interventions since 2011 and a notable portion of stand-by hours dedicated to these tasks, automation can play a critical role in reducing this load.

Potential Efficiency Gains

Automation has the potential to significantly cut intervention times, especially in repetitive tasks. With 730 on-site and 730 remote interventions annually, automation could save more than 1 month of machine time.

By automating at least 10% of interventions, up to 8 days of machine availability could be gained annually across all systems.

Safety and Well-Being

Night interventions are inconvenient, stressful, and potentially risky. By automating routine diagnostics and repair processes, technical personnel can focus on complex tasks, reducing stress and exposure to night work hazards.

Proposals

Key Areas for Automation

Low hanging fruit – 1 to 3 year
Automation, AI,

- **Preparation and Diagnostics:** Automation can assist in fault diagnosis and intervention planning before an on-site visit, reducing preparation time.
- **Reporting and Logging:** Standardizing and automating logbook entries and overtime claims can save administrative overheads.
- **Guided Interventions:** Integrating expert systems with real-time suggestions can guide personnel during interventions, enhancing efficiency and accuracy.

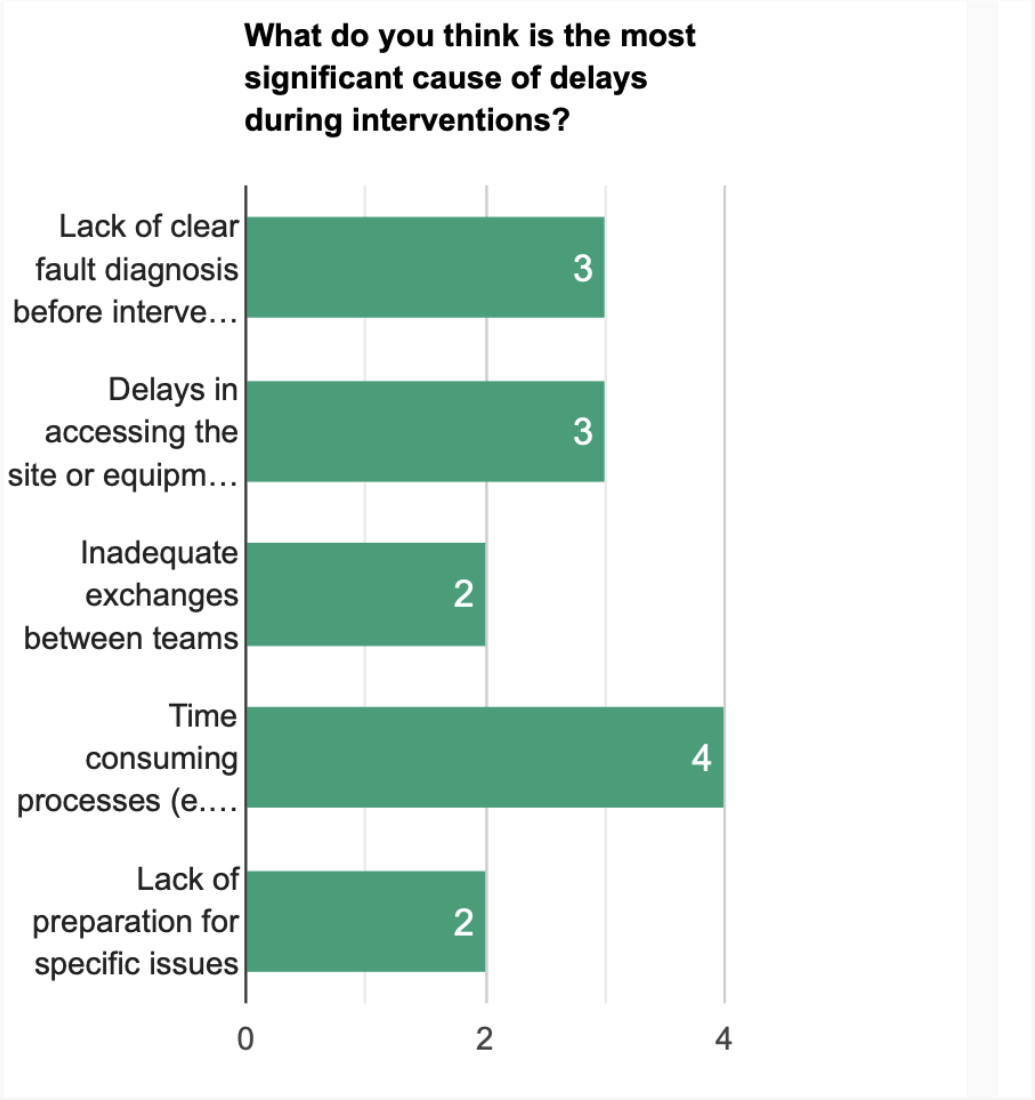
Interoperability of systems for more efficient interventions

Medium term 1 to 5 year
Forums, projects

- Common fault tracking (AFT), Logbook intervention & overtime reporting across the teams
- Produce AI-ready data/applications
- Asset management

Promote-encourage trend for remote interventions

Long term effort
requires R&D, new skills etc



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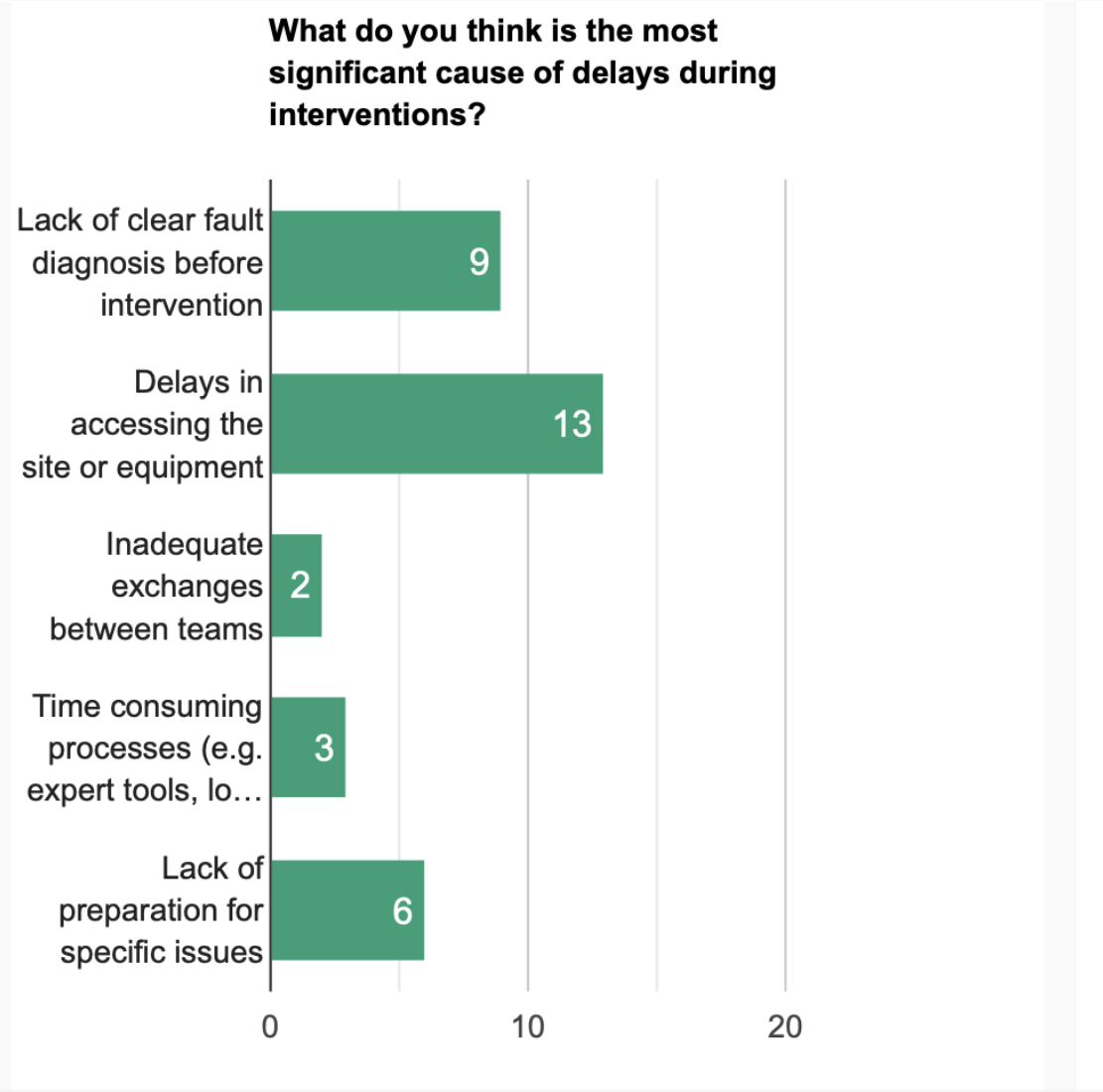

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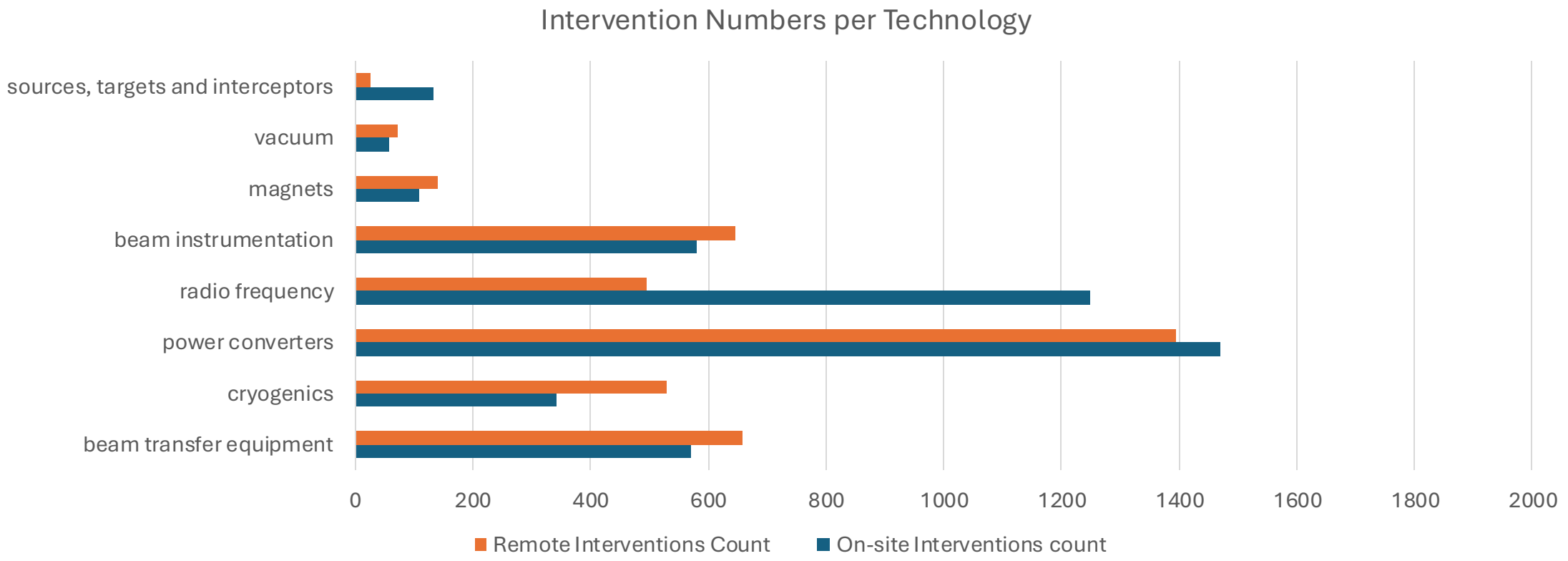
Equipment Experts

Operation-Physics Experts

Annex

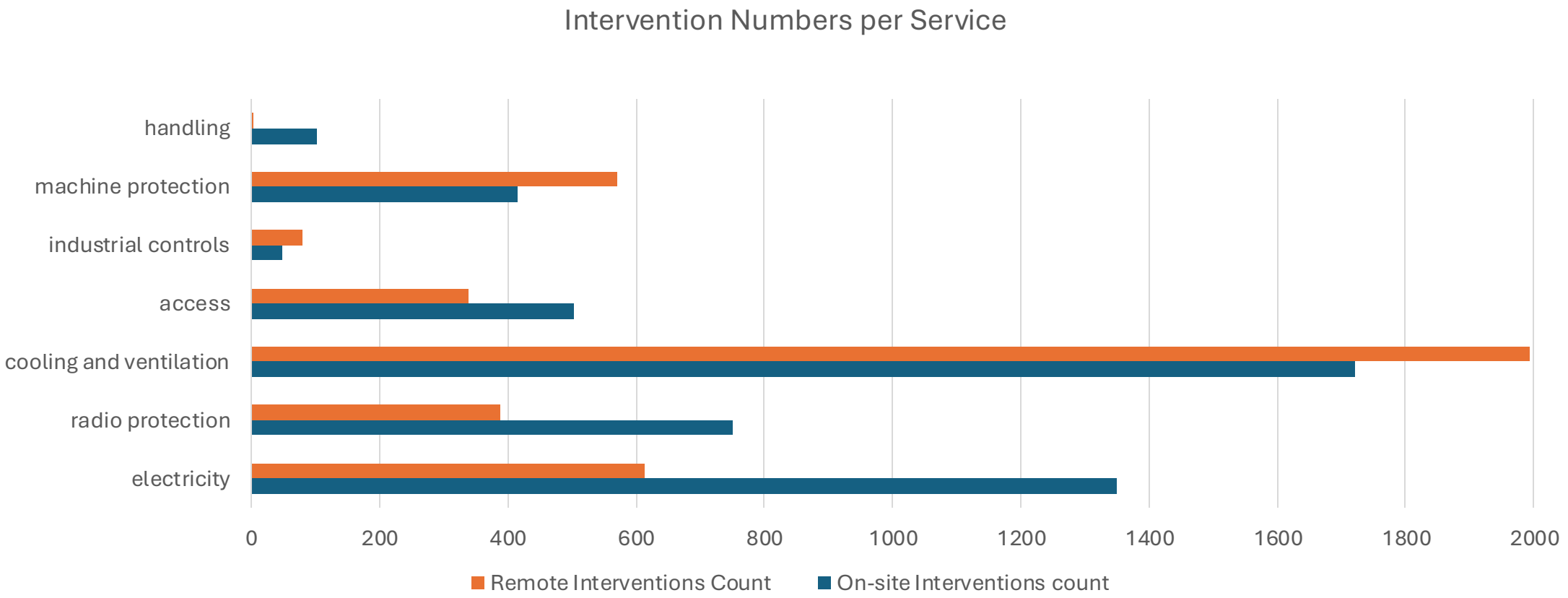
On-site vs remote interventions per technology

as an indicator of readiness for automation



On-site vs remote interventions per service

as an indicator of readiness for automation



Example of standby hours evolution

Week of the year

	Jan				Feb				Mar				Apr				May				Jun				Jul
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
2011	0	0	0	0	63	128	0	202	512	507	385	128	508	256	513	512	480	224	128	384	640	384	577	273	295	256
2012	0	0	0	0	0	0	0	128	128	336	384	254	256	480	224	384	384	272	385	424	129	359	256	384	128	384
2013	0	384	256	255	256	384	209	199	239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112	0	64	256	256	272	288	264	256	128
2015	0	0	63	225	176	192	256	432	366	536	480	449	381	640	448	640	256	561	496	410	656	584	384	385	384	512
2016	0	0	0	0	0	0	0	0	384	304	607	385	462	449	512	258	511	640	687	505	416	512	512	512	256	384
2017	0	0	0	0	0	0	0	0	0	0	0	0	128	0	681	225	608	472	769	256	408	727	288	256	256	512
2018	0	0	0	0	0	0	0	128	0	399	496	461	640	272	384	384	512	408	409	584	264	672	384	223	320	400
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	239	471	199	286	128	480	70	400	389	534	197	522	327	202	512	449	217	408	310	472	434	377	1151	442
2022	0	0	0	0	0	512	479	657	256	384	550	666	604	688	280	554	624	384	513	478	410	433	760	312	506	319
2023	0	0	0	0	0	0	384	384	248	608	433	499	640	800	328	400	760	528	398	629	608	192	512	608	552	512
2024	0	0	0	0	440	239	393	520	648	596	683	799	620	520	400	408	703	680	639	784	584	640	640	601	680	640

				Aug				Sep				Oct				Nov					Dec					
	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
2011	240	336	128	450	192	256	384	256	384	256	272	384	256	192	320	256	384	258	384	384	352	360	0	128	0	0
2012	384	257	384	128	384	128	384	385	208	392	320	256	128	384	393	384	258	193	302	382	383	128	384	384	6.5	17
2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	240	257	248	256	384	258	128	128	336	128	272	288	224	128	257	337	193	304	384	128	384	128	272	319	65.5	0
2015	512	384	480	512	448	575	304	448	384	512	545	624	512	256	512	512	620	496	256	513	272	512	273	513	65.5	0
2016	512	400	562	576	256	384	386	512	384	472	272	508	640	640	304	514	544	387	480	697	553	512	399	575	295	33.5
2017	719	368	528	736	400	384	256	256	256	273	512	256	232	128	513	384	532	480	512	705	400	128	128	256	0	8.5
2018	222	496	384	736	193	232	277	632	465	512	384	512	527	128	400	609	258	416	512	512	760	768	736	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	211	0
2021	448	496	488	284	256	640	432	569	352	360	631	769	384	570	512	273	657	387	384	359	409	256	193	0	0	0
2022	704	576	478	542	639	532	544	418	480	393	646	666	383	639	320	527	418	516	640	487	609	329	0	0	0	0
2023	531	462	682	400	577	359	658	512	640	679	598	930	639	583	634	809	645	384	359	25.5	0	0	0	0	0	0
2024	640	598	546	640	640	598	674	384	592	712	567	657	384	486	480	0	0	0	0	0	0	0	0	0	0	0

* Single Technology group in ATS. Highlighted hours are reported weekly and are the sum of all hours declared by piquet personnel. Deeper colour corresponds to more hours

Example of total interventions evolution

Week of the year

	Jan				Feb				Mar				Apr				May				Jun				Jul
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
2011	0	0	0	0	0	4	4.75	17.5	15.3	8	11	0.5	27.3	16.3	20.5	13.3	2.25	2.5	1.5	7	13.3	10.5	9.25	11.5	9.75	4
2012	0	0	0	0	0	0	0	0.5	10.8	9.25	19.3	5.25	5.5	1.75	11.5	12.5	25.5	18	25	6	0.5	15.5	5.5	7.25	0.75	20.3
2013	0	18	7.25	13.8	13.3	2	8.5	12.8	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.75	2	0	0	2.75	7	1.5
2015	0	0	4.25	0	6.5	11.5	0.5	16.5	19.3	9	15	18.5	16.5	4.75	12	17.3	0.25	8.5	14.8	1.25	10	9.75	14.8	1.75	26.3	3.25
2016	0	0	0	0	0	0	0	0	0	12	27.3	8.5	2.5	28.3	3	0.75	2.75	4.75	23.5	9.25	0	8.75	4.5	10.5	5.25	3.75
2017	0	0	0	0	0	0	0	0	0	0	3	0	0	0	9.25	5	6.5	15.3	9.25	15.8	17.5	10.8	3.25	27	6.5	4.5
2018	0	0	0	0	0	2	0	5.5	1.25	11.8	1.5	3.25	6	10.3	2.25	5.75	4.5	17.8	2	10.3	5	17.3	6.5	4.5	3.5	8
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	5	5	1.25	4.5	2.5	11.8	6.25	1	5.25	3	6.5	13.8	29.3	22.3	4	8.75	21.8	4.75	7.75	0.75	2.5	8	12.8
2022	0.5	0	0	0	0	2.25	1.5	15.8	4	4	15.3	5.5	1.75	6.5	18.3	18	8.5	9	16.3	5.25	18.3	6.25	7	33.5	15.3	3.75
2023	0	0	0	0	0	0	0	0	0.5	1	12.5	6.25	19.8	16.3	3.5	1	19.5	9.25	2.5	21.3	1.5	12.8	10.5	13.5	23.3	11.3
2024	0	0	0	0	0	0	1.5	12.3	36.5	11.3	3	12.8	3.5	26.8	0	2.25	3.75	3	10.3	3.25	4	1	13	29.8	31.3	10.5

				Aug				Sep				Oct				Nov					Dec					
	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
2011	13.8	50.8	6.5	4.5	0	1.25	8.25	13.5	7.25	13.5	6	14.8	8.75	2	2.75	5.75	18.3	10.3	2.5	8.25	8.75	7.5	0	3	0	0
2012	3.25	0.75	2.5	2.5	25.8	4.75	5.5	20.3	13	0.25	11.5	9.25	4.5	5.25	7.5	14.3	19.8	2.25	24	10.8	1	2.25	3	12.8	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	9.25	5	9.5	0.5	4.75	1.5	5	0.75	4	1.75	6	1	0	8	7	14	0	8	11.3	0	0	1.75	6.25	5.25	0.25	0
2015	11.3	7.5	25	12.8	1	10	2.25	2.25	1.5	16.8	19	8	16.8	1.25	16.5	6	10.3	0	9	29	15.5	12.3	3	3.25	0	0
2016	17	5.75	14	0.75	6.5	1	8	17.8	2.75	3.5	7	40	10.8	5	9.5	14.3	6.25	8.5	20.5	6.75	10.3	6.25	0	6.25	0	0
2017	4.25	8.25	48	3	3.75	0	0	3	0	3.5	6	2.5	0	0	11.8	3	14.5	5	16.8	7.25	0.5	2.25	0	2	0	0
2018	18	9	0.75	69.5	16.5	2	4.75	15.5	7	8.25	2.5	27.3	3.5	4.75	2	11.3	0	8.5	6	1.75	6	4	16.3	0.75	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	1.75	0
2021	2.75	18	10.8	6.75	0.25	21.3	5.5	5.75	7.25	0	8.5	12	6.5	7.25	24.8	1.25	16.5	2.25	6.25	19.8	2.75	0	0	0	0	0.5
2022	27.5	16.3	43	39	4.75	14	9	12.3	16	1.25	0.5	16.8	17.5	19	59	16	15.5	19.5	10.8	1.25	15.5	15.3	0	0	0	0
2023	7	11.5	0.75	2.75	4.75	0.5	4	4.5	23	2.75	14	33	15.3	4.5	12.3	8.75	0.25	0	4	0	0	0	0	0	0	0
2024	23.5	7	8.5	9	1.75	7	15	5.25	15.8	14.8	3.5	2.75	8.5	23	0.75	0	0	0	0	0	0	0	0	0	0	0

* Single Technology group in ATS. Highlighted hours are reported weekly and are the sum of all hours declared by piquet personnel. Deeper colour corresponds to more hours

Definitions

- **Overtime sheet** – an EDH document submitted for each accounting period by persons involved in :
  - Shift work
  - Stand-by service
  - Out of hours interventions
- **Compensation hours** – the hours of overtime adjusted for travel time and night, weekend, sundays and holidays. This corresponds to the actual paid sum.
- **Overtime** – are hours of regular overtime in addition to the following:
  - **On-site intervention** – requires the personnel to come on site. The person declares their actual intervention time and two hours (one in advance, one after) are added for travel time
  - **Remote Intervention** – one that can be performed from home. This type of intervention also includes interventions of a second person that gave advice remotely.

Read more on admin guide:
Heures de travail
https://admin-eguide.web.cern.ch/procedure/heures-de-travail?check_logged_in=1

Rétribution des heures de travail spéciales
https://admin-eguide.web.cern.ch/content/retribution-des-heures-de-travail-speciales