Towards Natural Language-driven Autonomous Particle Accelerator Tuning

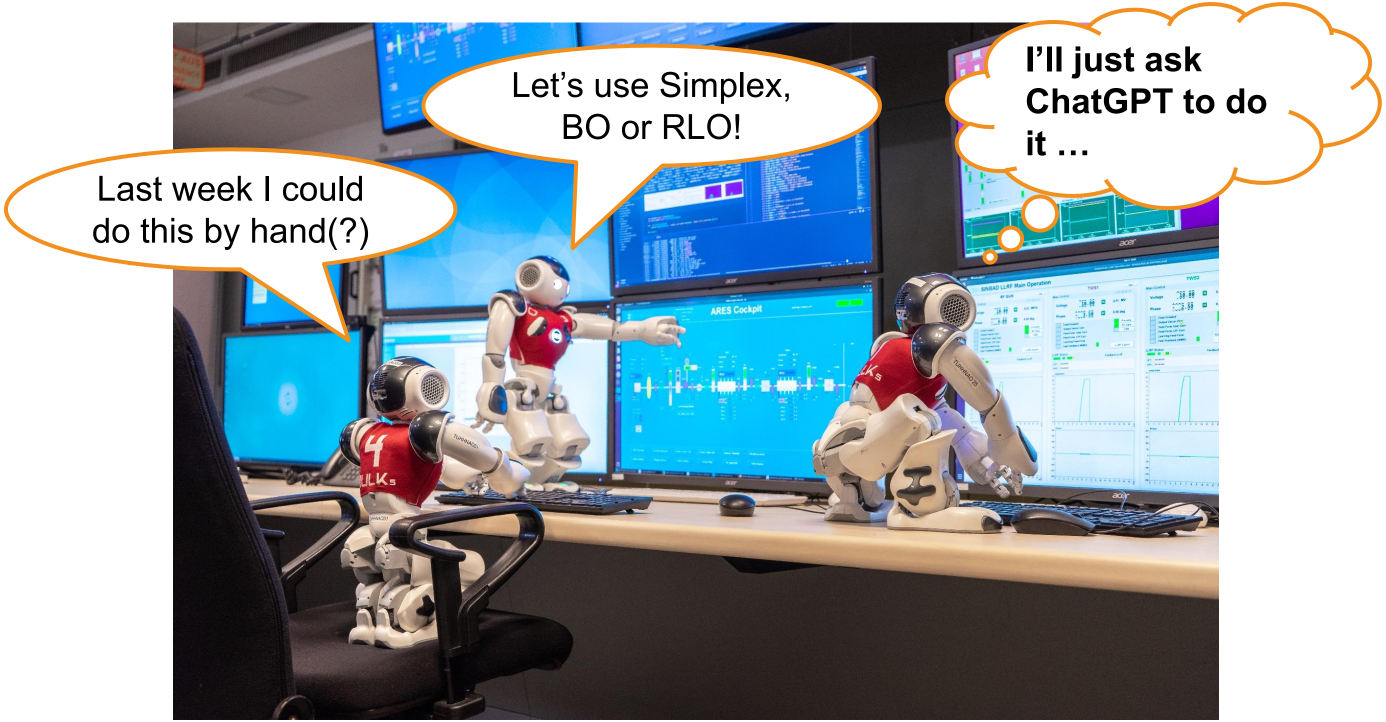
MT ARD ST3 Meeting

Jan Kaiser, Annika Eichler and Anne Lauscher

Darmstadt, 5 July 2024

An Oversimplified History of Autonomous Accelerator Tuning

From human intelligence over optimisation to artificial intelligence



Let’s Ask ChatGPT to Do It …

Questions

large language models (LLMs)

Can ~~ChatGPT~~ tune a particle accelerator?

How would that be implemented?

Teaser

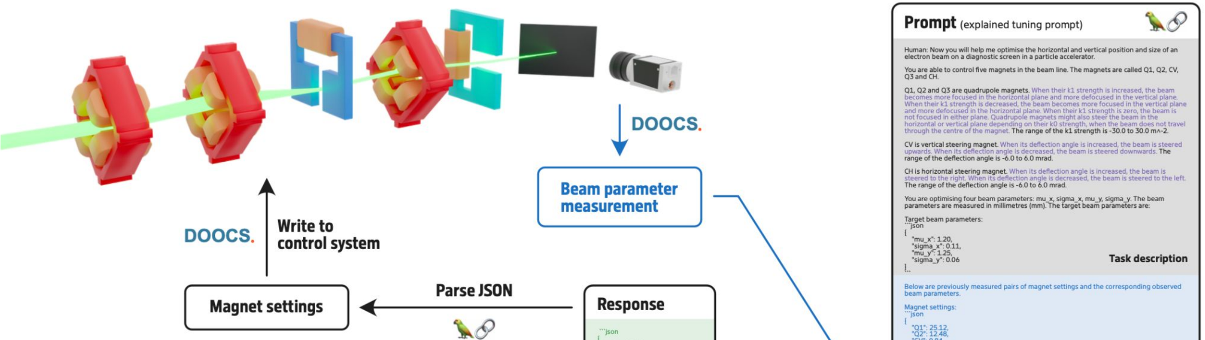
Yes and no …

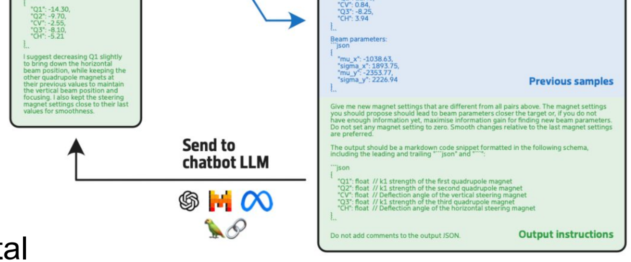
(a) Successful episodes

	Tuning	Explained	CoT	Optimisation
Gemma 2B	7	5	6	5
Gemma 7B	-	8	-	2
GPT 3.5 Turbo	-	2	-	9
GPT 4	-	4	-	9
GPT 4 Turbo	2	5	6	9
Llama 2 7B	-	4	-	1
Llama 2 13B	-	1	-	8
Llama 2 70B	-	3	-	8
Orca 2 7B	-	3	-	6
Orca 2 13B	-	2	-	2
Vicuna 7B 16K	-	2	-	3
Mistral 7B	-	1	-	0
Mixtral 8x7B	8	7	3	5
Starling LM 7B	-	6	-	1

Reinforcement learning	9
Bayesian optimisation	9
Extremum seeking	9
Random search	0
Do nothing	0

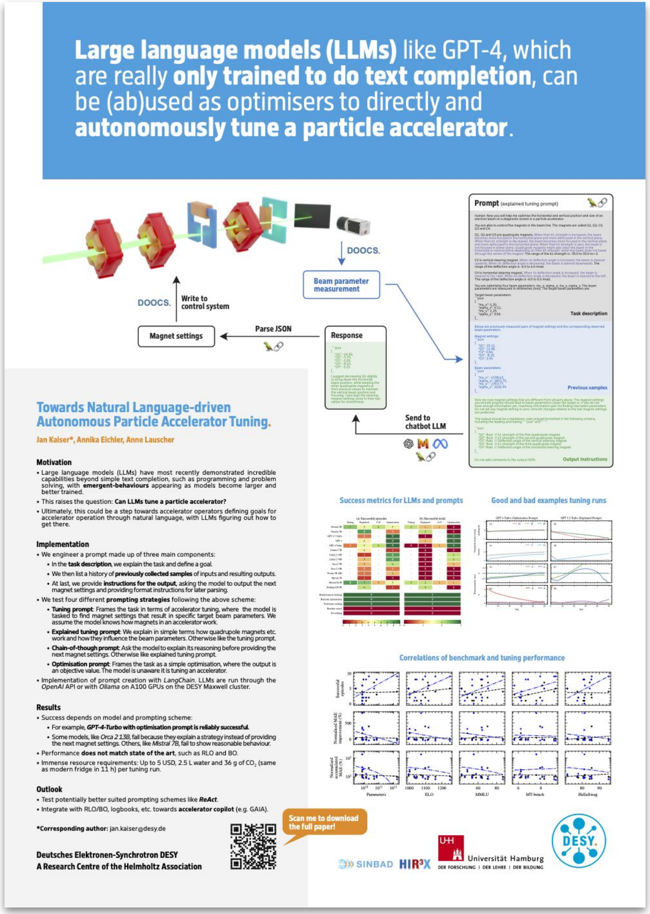
0 1 2 3 4 5 6 7 8 9





- **Prompting and optimisation scheme** developed.
- Tested on **transverse beam parameter tuning** in the Experimental Area section at **ARES accelerator**.
- **Yes!** It works, if you choose the right model and prompt. **A neural network trained for text completion can tune an accelerator and perform optimisation.**

Come to the poster!



Contact

DESY. Deutsches Elektronen-Synchrotron

www.desy.de

Jan Kaiser
Machine Beam Controls (MSK)
jan.kaiser@desy.de