Beamline Tuning with Reinforcement Learning

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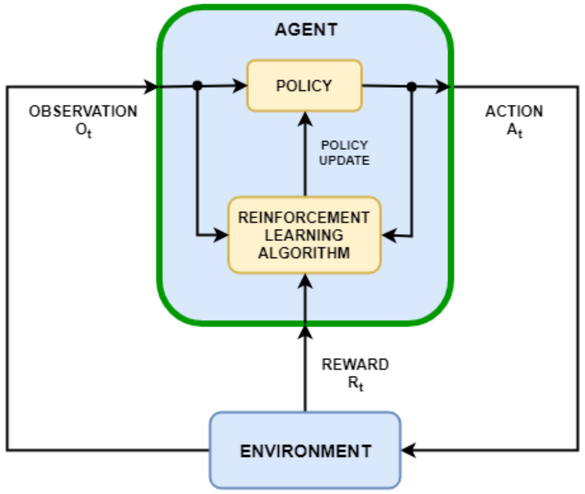
The problem

- 1-2 shifts dedicated to tuning on ISAC I after each intervention / new species
- Based on experience and intuition to achieve optimal parameters (from simulation)
- Want to accelerate this process to provide more physics beamtime

Automation

- Iteratively tune the beamline while obtaining observations of the machine
- Meant to counteract the misalignments in the shift of the real ISAC



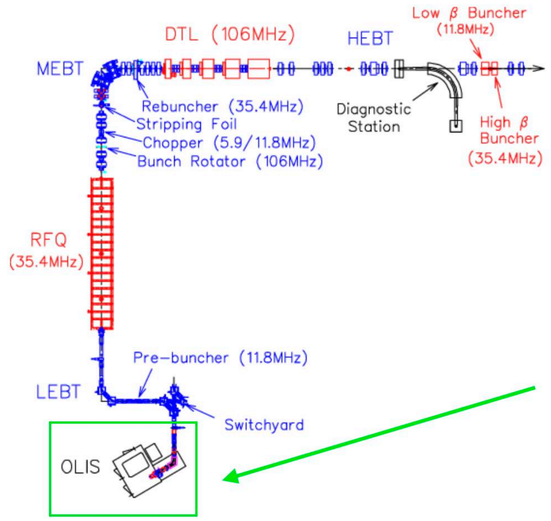
Ideal problem for reinforcement learning

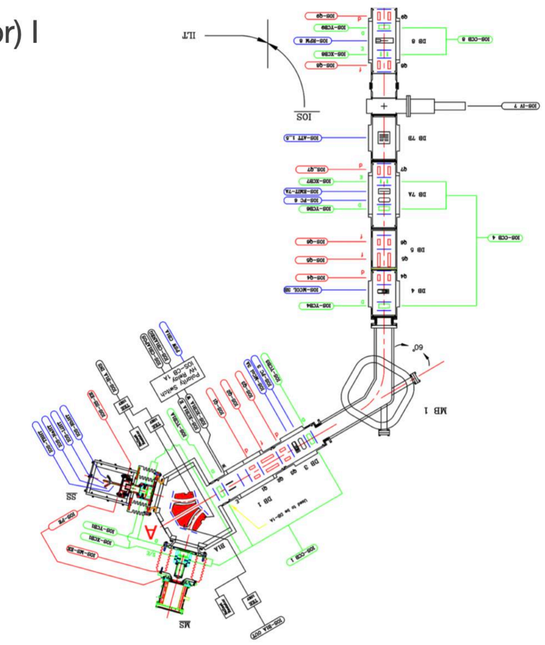
- Complex nature
- Model-free, which relies on real samples of the environment to alter its behaviour
- Continuous action space
- LSTM based actor to retain the history of an episode

OLIS as a sandbox

- Full feature small problem O(10) tunable parameters
- Non-radioactive beam
- Low current - will not damage the machine
- **High availability –** potentially usable during delivery of physics beam

ISAC (Isotope Separator and Accelerator) I and OLIS (Off-Line Ion Source)





Simulation - TRANSOPTR

- Developed a simulated OpenAI Gym environment
- Needed for RL algorithms development and training
- Hope for future transfer learning application
- Leverages TRIUMF expertise in beamline modelling

Current Progress and Future Plans

- Simulation sandbox with tuning parameters developed
- OpenAI gym integration
- RL algorithms with continuous action developed
- Try in simulated environment
- Integrate with control software and try on real machine
- Transfer learning
- Build up to full ISAC I complex

Discovery, accelerated