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PACMAN – HIPA studies and organisational

Outline

- Organisational
- Status research goals

Organisational

- Replacement Asya
  - Ekaterina EPFL
  - Fernando PSI (until replacement found)
    - need to find working model
- Yearly reporting SDSC
  - Asked multiple times for guidelines, but haven't received anything
- (Bi?)-monthly Skype meetings
  - exchange ideas / tools
  - first meeting in December
  - good to continue and dedicate to a specific topic?
- ML particle accelerator workshop Korea was postponed (perhaps indefinitely?)
  - Feb -> June -> July
  - look for alternative
- Sichen and Jaime exchange with SNS:
  - originally May – June
  - to be decided soon
- HIPA now in shutdown mode (Jan – May)

PACMAN
Particle Accelerators & Machine Learning

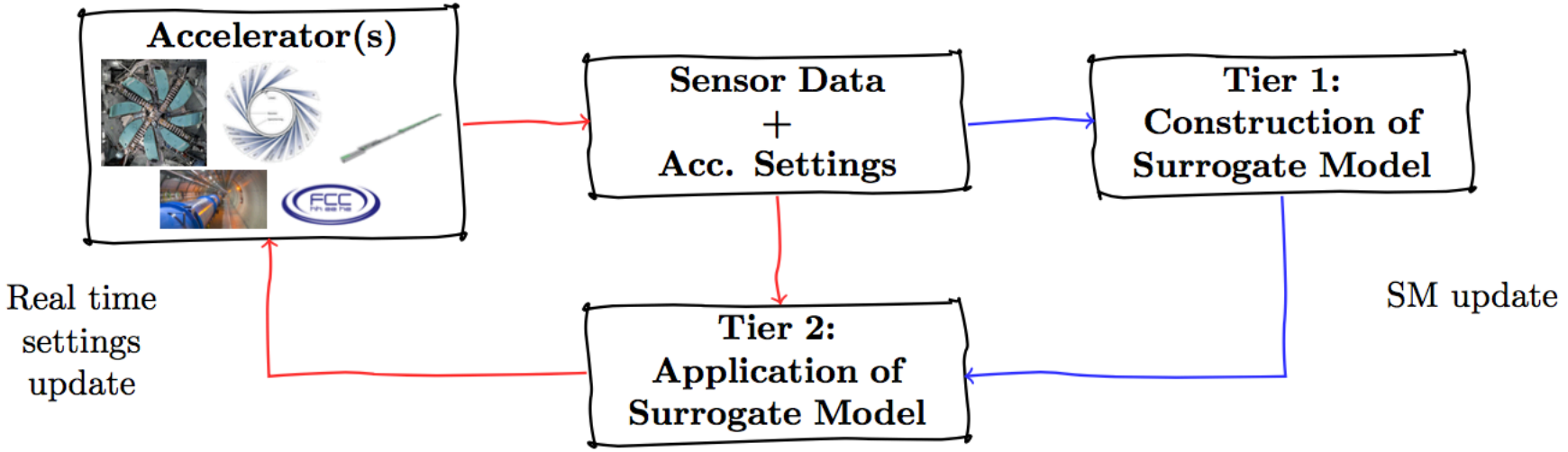

Figure 1: Sketch of the application of a Surrogate Model (SM) for particle accelerators. Red lines indicate real time data transfer.

- Research goals:

1. Minimise beam losses (HIPA and LHC)
2. Better control of accelerator parameters (HIPA and LHC)
3. Prevent unnecessary machine interruptions (HIPA)
4. Neural networks instead of particle tracking (LHC)

People PSI

- Andreas Adelmann — PhD supervision Sichen Li working on surr. models (Tier 1)
- Johannes Kirschner — Research goal 1: Beam losses (Tier 1 + 2)
- Sichen Li — Research goal 3: Prevent Machine Interruption (Tier 1+2)
- *Mélissa Zacharias* — Research goal 3: Prevent Machine Interruption (Tier 1+2)
- ~~Anastasia Pentina~~ — Surrogate model construction (Tier 1)
- Jochem Snuverink — PI, data access, transfer surr. models to operation (Tier 2)
- Davide Reggiani — Research goal 2: Parameter Control (Tier 2)
- Markus Janousch — Connection operation (Tier 2), adaptation to future acc.
- Jaime Coello — Transfer surrogate models to operation (Tier 2)
- Marco Schippers — Postdoc supervision, general HIPA coordinator

Tier /

WP	Partner (short name)				Year and Quarter							
	SDSC	PSI-Accel EPFL-Accel	PSI-LSM	PSI-Control	2019			2020				2021
					2	3	4	1	2	3	4	1
1	L	P	P				M1.1		M1.2		M1.3	M1.4
2	P	L		P	M2.1					M2.2		M2.3
3	P	P	P	L		M3.1			M3.2		M3.3	

- Work packages and first milestones: see proposal
  - WP 1: Surrogate Model construction
  - WP 2: Accelerator Implementation
  - WP 3: Adaptation to Future Accelerators
  - M1.2: Surrogate models implemented
  - M2.2: Models for semi automatic operation implemented
  - M3.2: Connectivity to the control system

Research goal 1: Minimise beam losses

- HIPA beam intensity limited (to some extent) to the beam losses
  - Reduce damage and activation
- Optimisation is now mostly done empirically
- Large potential for automated optimisation and surrogate model construction
  - No accurate and fast physics model available
  - Needs to be *safe*
- HIPA status: tests done on HIPA with safe Bayesian optimisation with Johannes Kirschner and Nicole Hiller developed originally for SwissFEL
  - Tests and data taking will restart after startup
- Details and GUI development: **see talk Jaime**
- Open question: implementation in OCELOT?
  - an optimisation framework with several algorithms used mainly at other FELs
  - Main developer (Sergey Tomin from DESY, Hamburg) will visit in March
    - Night shift for testing Ocelot and our GUI

Research goal 2: Parameter Control

- Stable and safe operation very important
  - Beam parameters and beam collisions need to be controlled to a high level

1. Construct surrogate models of beam parameters from diagnostics data
2. Some safety systems can be slower than other diagnostics data
   - Use surrogate models for prediction to enhance safety systems

- HIPA use case and status: target spot size control
  - Direct measurement (VIMOS camera) rel. slow (~30 ms) and in precarious state
  - VIMOS data now stored in consistent way
  - Not in operation 2019, will be in 2020
  - GUI and model ready for online use
    - Same GUI as for interlock prediction
    - Flexible enough for any type of real time model prediction
    - Possibility to “replay” archived data
      - Archiver API not fast enough (yet), so needs to be stored on disk first

Research goal 3: Prevent machine interruption

- Data
  - 2018: 2 weeks
  - 2019: 3 months: September – December
    - July – August: interlock data not properly recorded
      - Recoverable but with additional effort
      - Lesson: need to check data as early as possible!
    - ~ 2300 interlocks
    - 450 channels recorded in 1 file / day
      - about 100 channels with only NaNs in some files
        - value not changed: need to correct those files
- Baseline model made
  - Linear regression with LASSO (see presentation June)
- Survival model (see presentation Sichen)
- Alternative models (master student project Mélissa)
  - Random forest
  - Time series classification to image classification (see pres. Mélissa)
- December: first model live!

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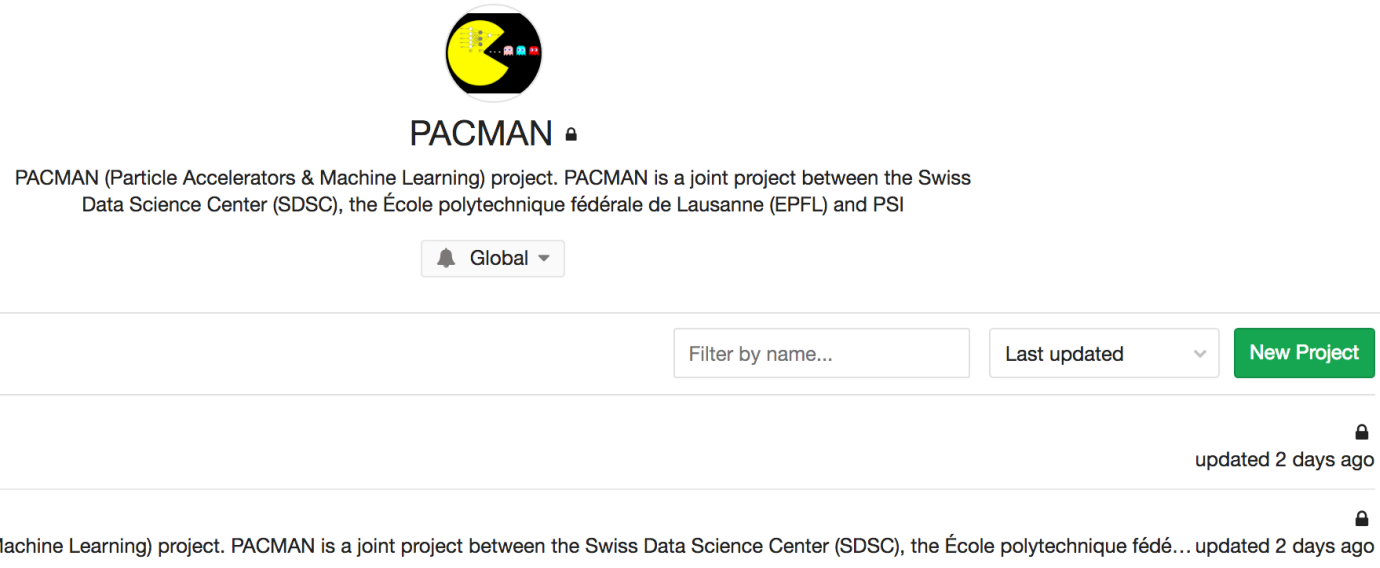
Backup

Practicalities

- email list: pacman@lists.psi.ch
- homepage: https://gitlab.psi.ch/PACMAN



Data archive

- Online viewer
  - https://hipa-data-ui.psi.ch/
- Python API
  - https://github.com/paulscherrerinstitute/data_api_python
  - The library accesses the data via the DataAPI REST service and (by default) loads it into a Pandas data frame.

Example:

```
import data_api as api
import datetime
now = datetime.datetime.now()
end = now-datetime.timedelta(minutes=10)
data = api.get_data(channels=['ABK1:IST:2'], start='2018-12-10
        00:00:00.000', end=now, base_url='https://data-api.psi.ch/hipa')
```

Research goal 2: Parameter Control

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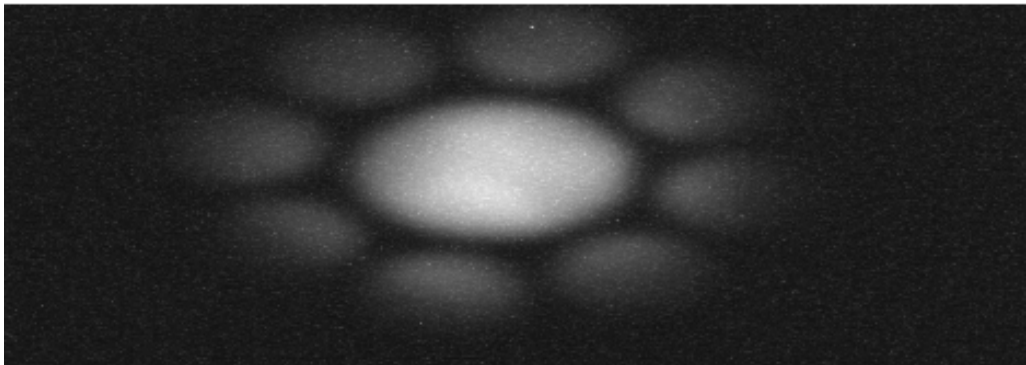
- HIPA use case and status: target spot size control
  - Direct measurement (VIMOS camera) rel. slow (~30 ms) and in precarious state
  - VIMOS data now stored in consistent way
  - Challenges
    - Critical area
    - Few data with bad measurements; no good image at small currents
    - Data not well synchronised



Target spot size

- First look at data by Jaime
  - Temperature sensors in the target
  - VIMOS camera data
- Goal: try to predict temperature and VIMOS from accelerator data
  - Current
  - Loss monitors
  - Position monitors
  - etc.

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VIMOS

VIMOS beim Einbau 2006

Längsdraht (Kettfaden) 0.3mm
Querdraht (Schussfaden) 0.1mm

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SINQ: Target-13

Alternative? TBPS (Target Beam Positioning System)