Dynamic Effects During Tuning in the CLIC FFS at 3 TeV

Edu Marin[1]
emarinla@cern.ch

[1]CERN, Geneva, Switzerland

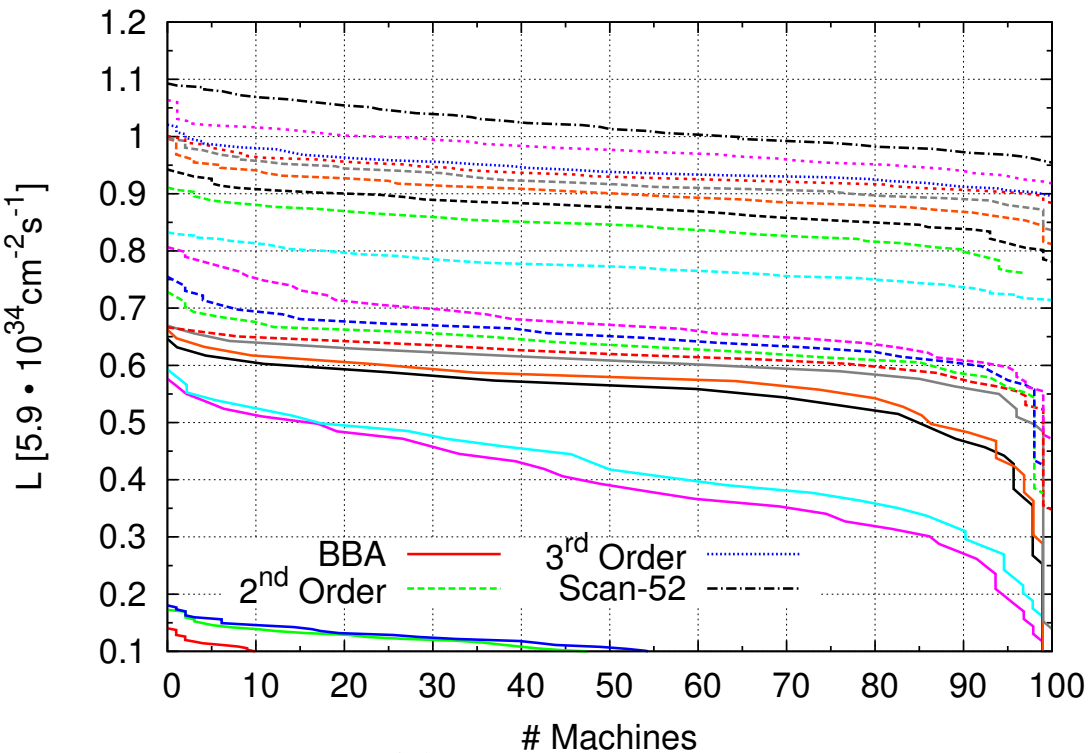
October 26th, 2017
BDS & MDI Session
LCWS 2017, Strasbourg (France)

Acknowledgements: **J. Pfingstner**

Outline

Square One

- 2-Beam Tuning results including static imperfections
  - Transverse & rotation alignment errors
  - BPM reading errors
  - Strength errors



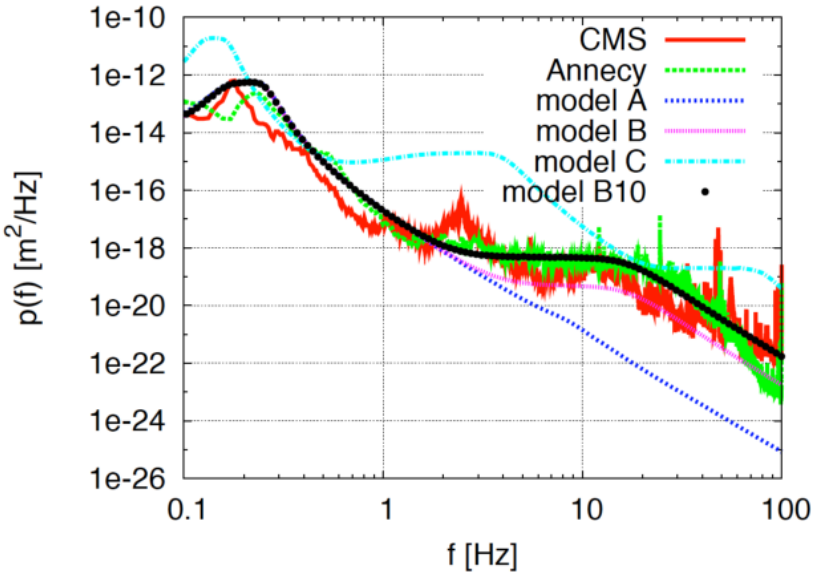
90 % machines reach 97 % of $\mathcal{L}_0$ after 15000 $\mathcal{L}$ measurement

CLIC target: 110 %

GROUND MOTION

Simulation Model

- Ground Motion Model D (B10)
- Stabilization Filter type
  - v2
  - v3
- Pre-isolator:
  - 1: simple version F. Ramos et al.
  - 2: mechanical feedback B. Caron et al.
  - 3: F. Ramos et al. including tilt motion
- Perfect intra-train IP feedback

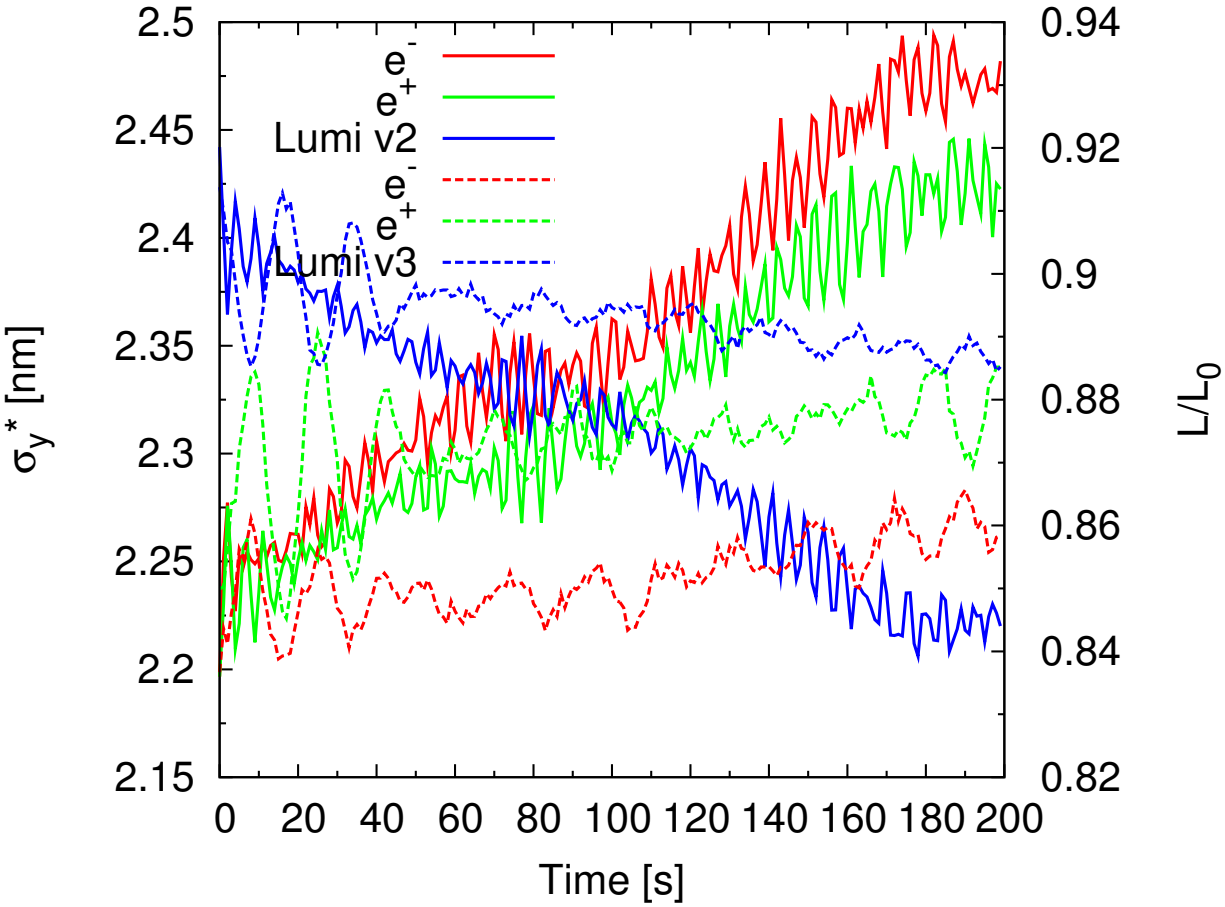


Not included into simulations:

- Orbit feed-back

Stabilization Model

- Impact of only Ground Motion (GM)



TUNING STUDY

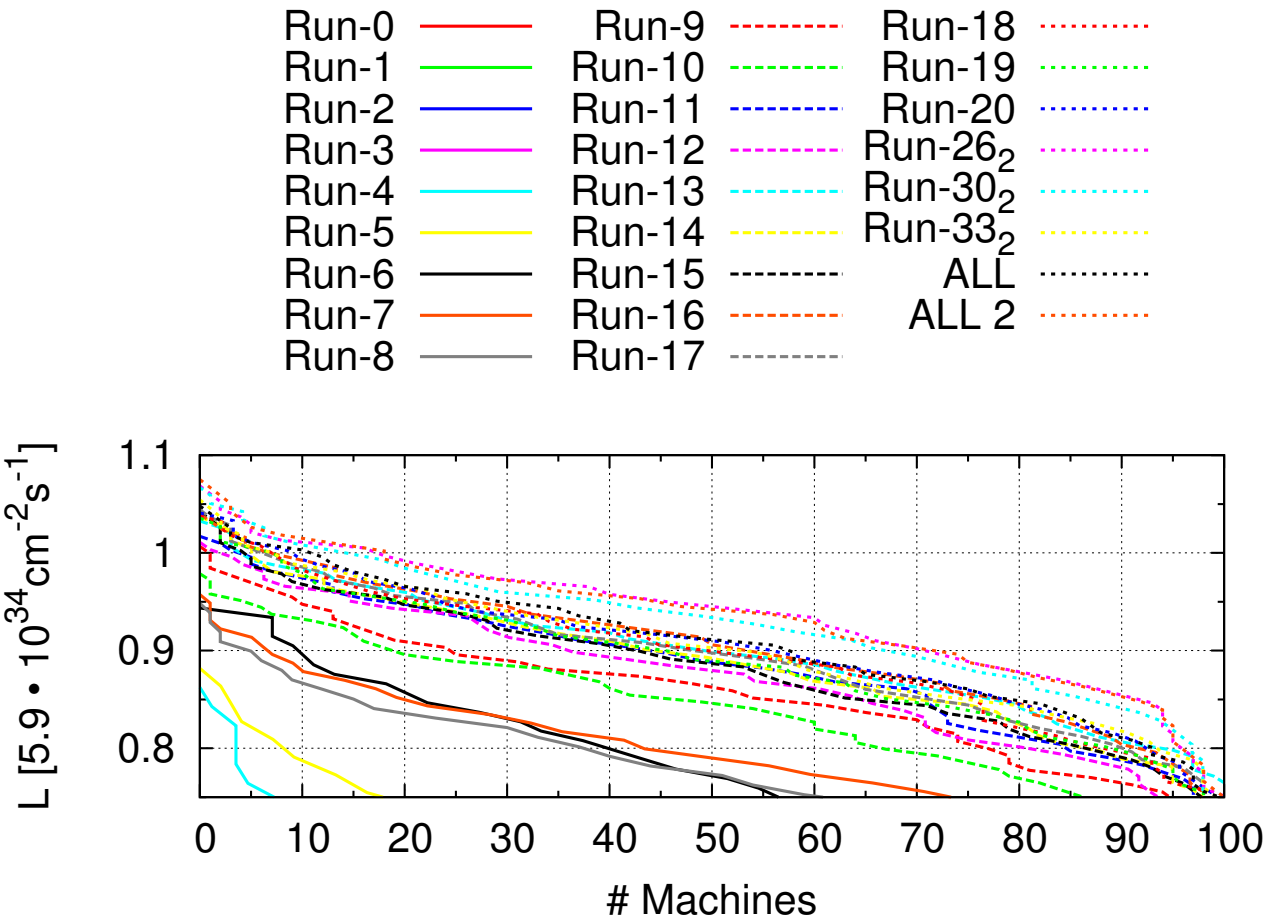
Tuning Algorithm

- Motion of beamlines w.r.t IP
- Considered Interval times (Δt) [s] (steps of 0.02 s):
  - 0.02 (50 Hz)
  - 0.2 (5 Hz)
  - 0.8 (1.25 Hz) *
- $\mathcal{L}$ only evaluated at every Δt
- Considered stabilization versions: *v2* and *v3*
- Ground motion acts on both beamlines through the entire tuning procedure
- Procedure based on previous studies:
  (BBA $\Rightarrow$ Linear $\Rightarrow$ Non-linear Knobs)

*required for luminosity measurement error $\leq 1\%$

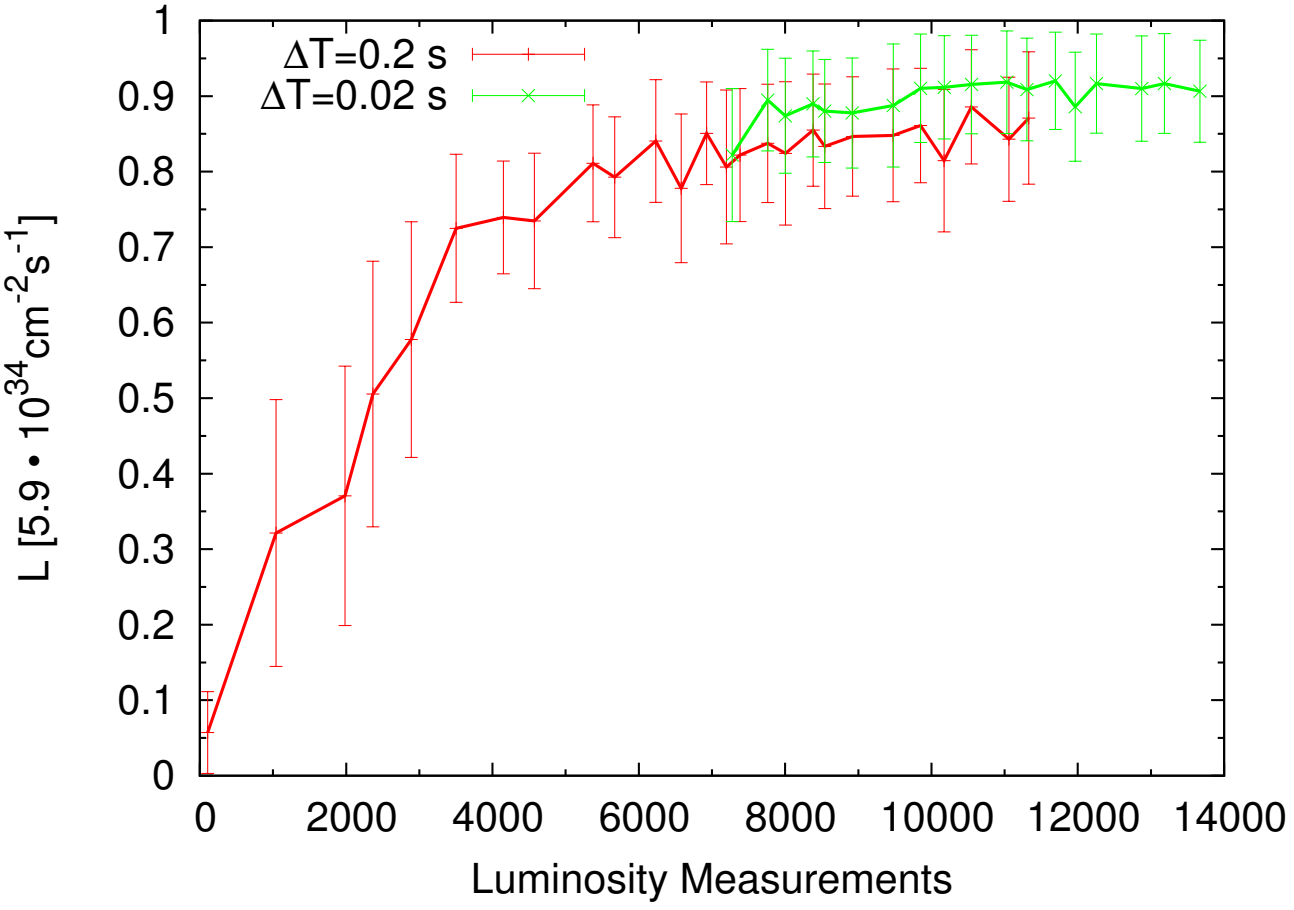
Tuning Results I

- Stabilization Filter v2
- Considered interval times (Δt):
  - From Scan 1st to 25th: 0.2 s (5 Hz)
  - From Scan 26st to 33rd: 0.02 s (5 Hz)



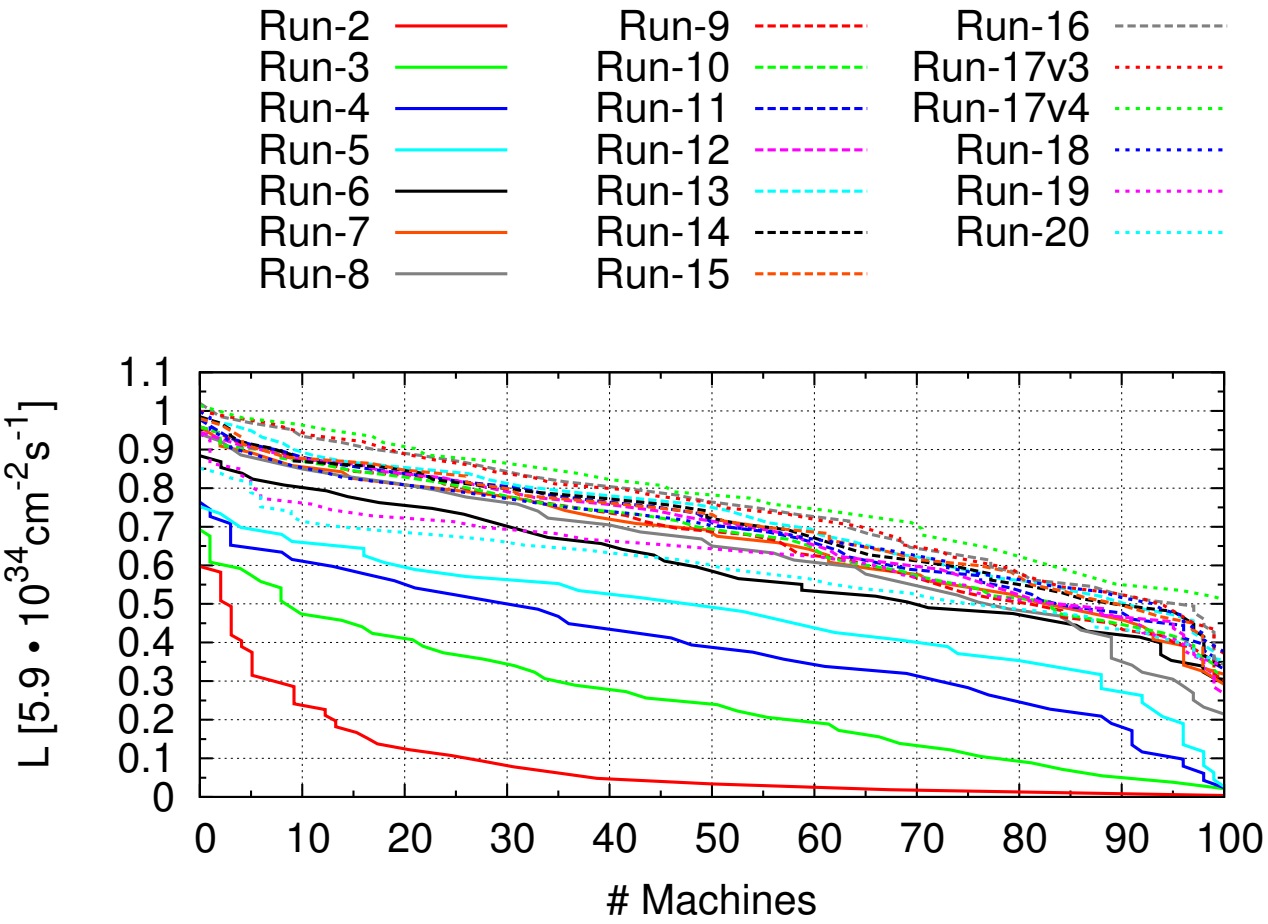
Tuning Results II

- Stabilization Filter v2
- Interval times (Δt) [s]: 0.02 (50 Hz), 0.2 (5 Hz)



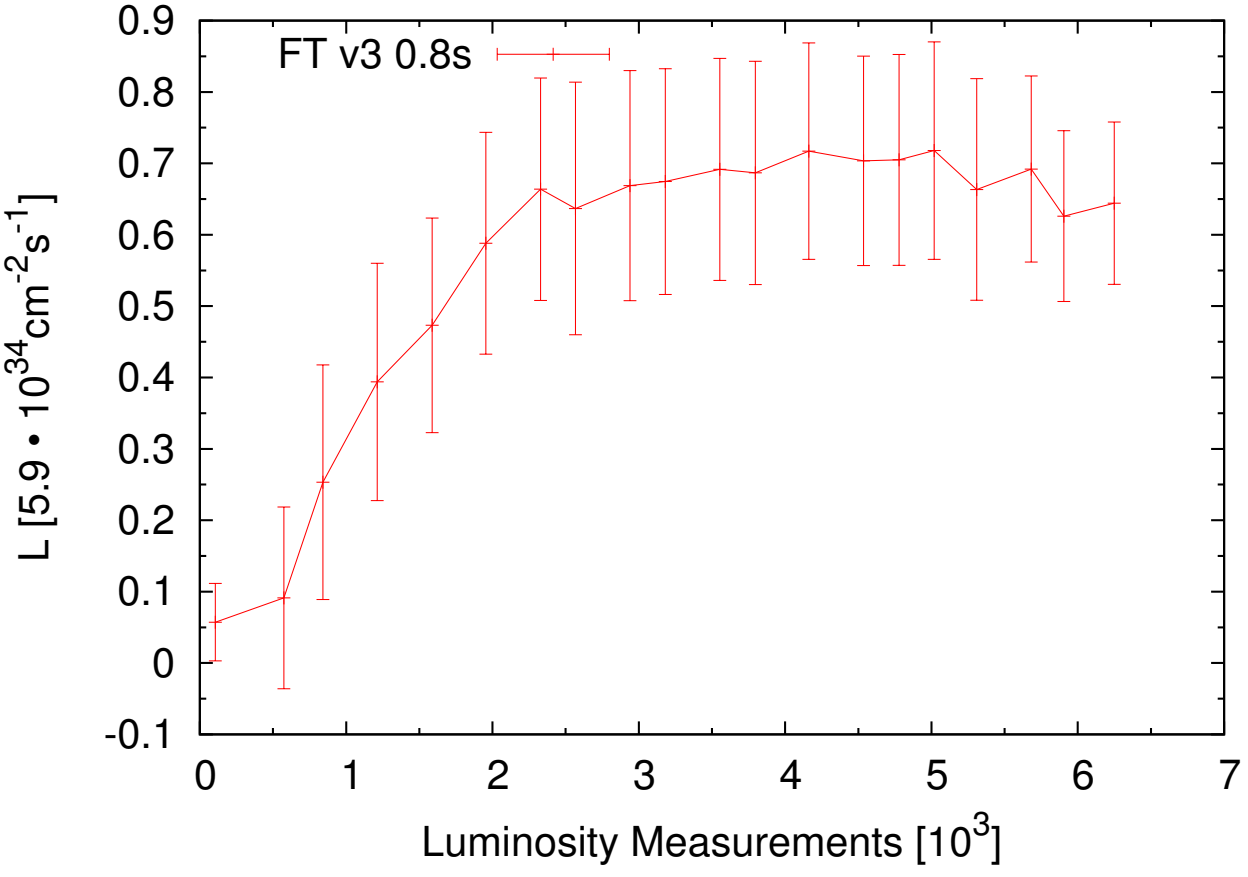
Tuning Results III

- Stabilization Filter v3
- Interval time (Δt) [s]: 0.8 (1.25 Hz)



Tuning Results IV

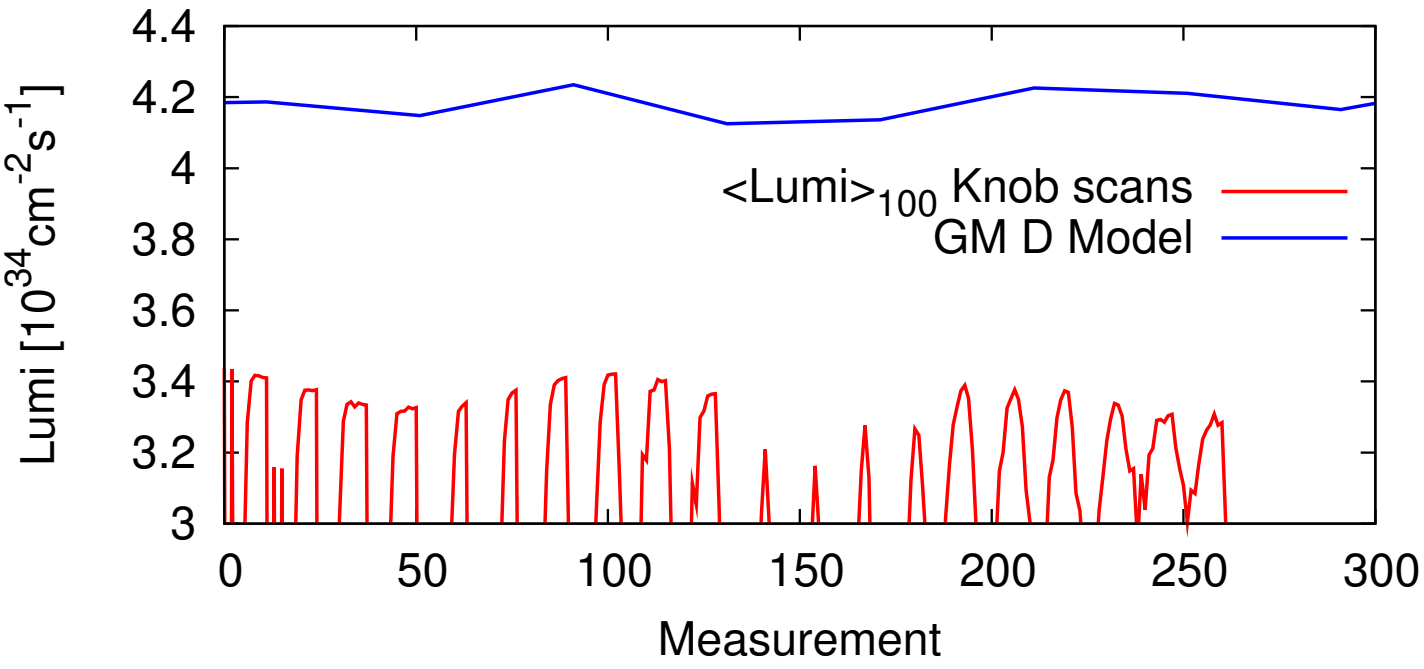
- Stabilization Filter v3
- Interval time (Δt) [s]: 0.8 (1.25 Hz)



ISSUES

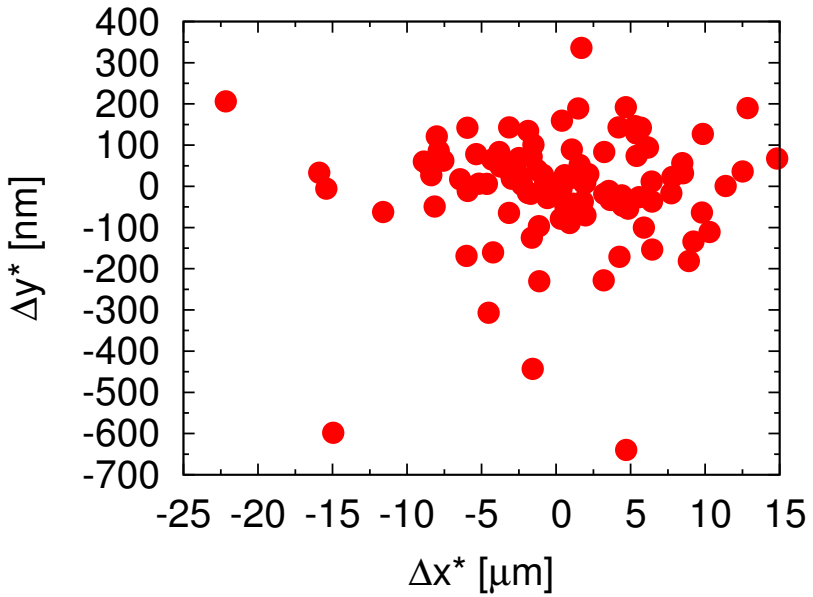
Ground Motion

- Average luminosities during typical linear knob scans (250 measurements)



IP Feed-Back

- Relative offset at the IP



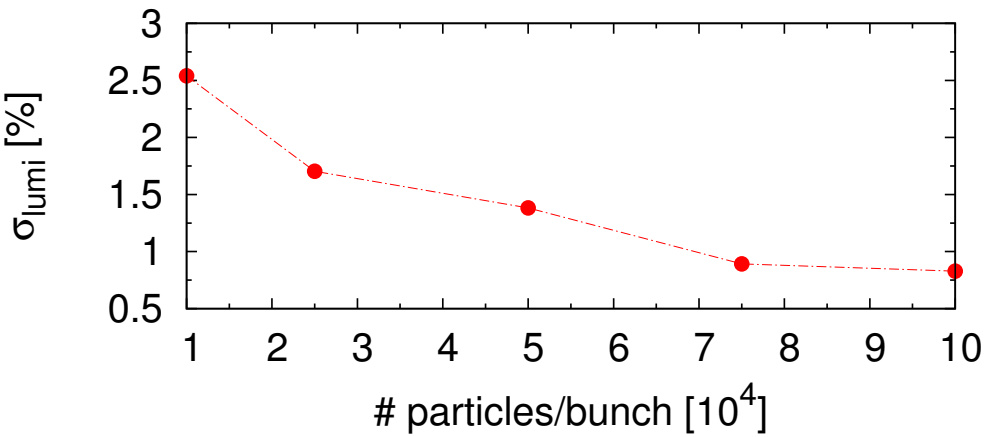
$$< \Delta x^* >= 5 \pm 4\ \mu m$$
$$< \Delta y^* >= 130 \pm 150\ nm$$

IP orbit feedback range [†] in Y-plane is 10 σ_y^*

[†] J Resta-López et al 2010 JINST 5 P09007

Computation Time

- Luminosity computed every 0.8 s
  - Should be computed every 0.02 s $\Rightarrow$ "average" every 0.8 s
- Bunch Population is linked to $\mathcal{L}$ precision
  - 10^5 particles required when $\mathcal{L} \geq 0.8\mathcal{L}_0$



- Orbit Feed-back not included
  - If included it will significantly increase computational time

LUMINOSITY SIGNALS

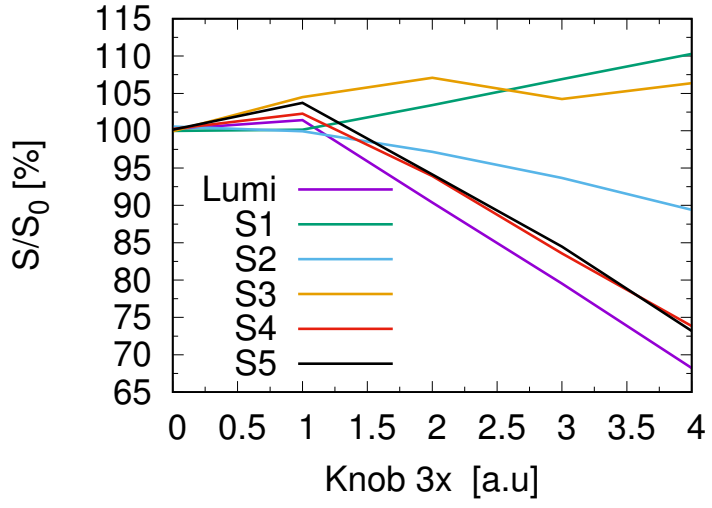
Considered Signals

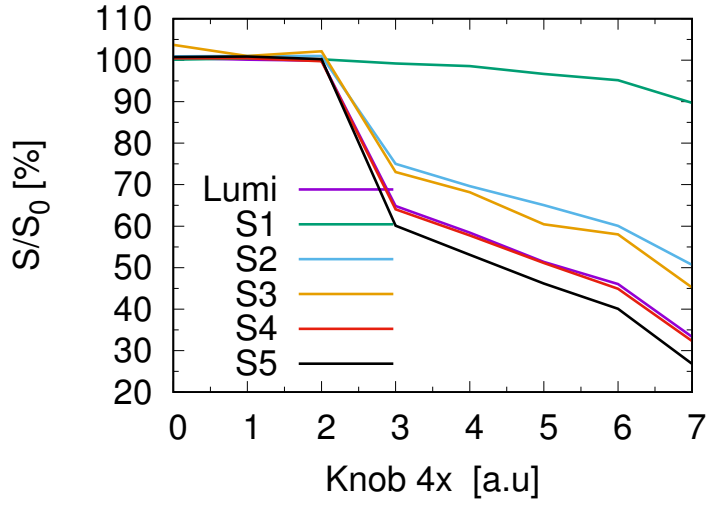
Signals generated by Guinea-Pig through collision of 10^6 particles per beam

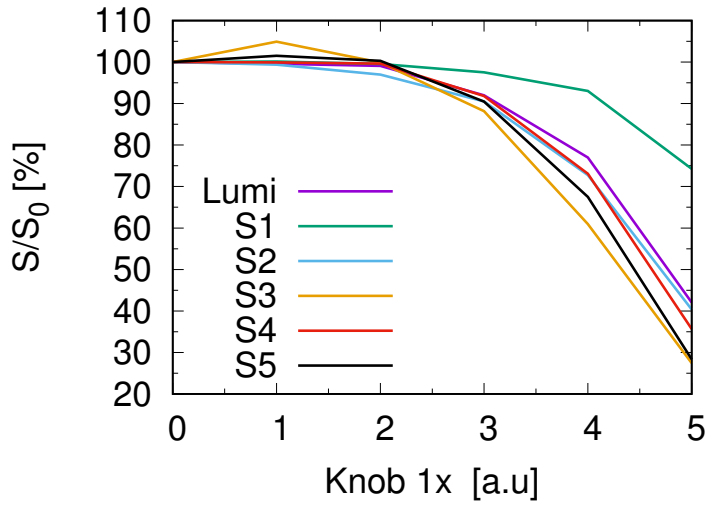
- Luminosity
- Number of Photons (beam1)
- Number of Photons (beam2)
- Number of Coherent
- Number of Pairs
- Number of Hadrons

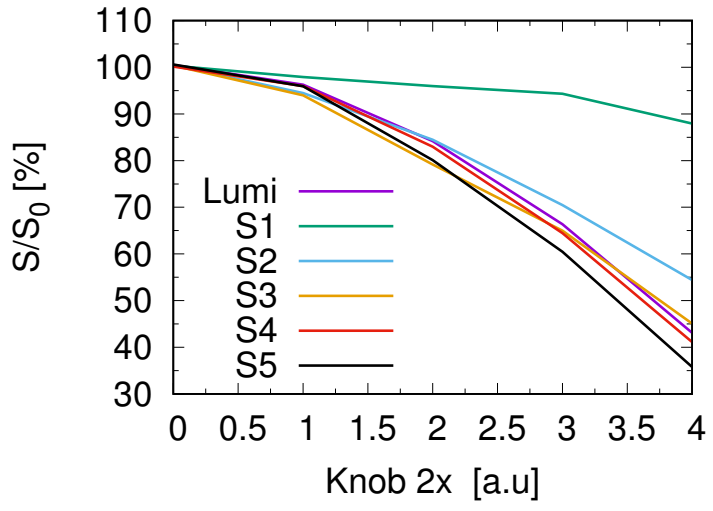
Considered Signals

X - Linear Knobs (Mapclass)



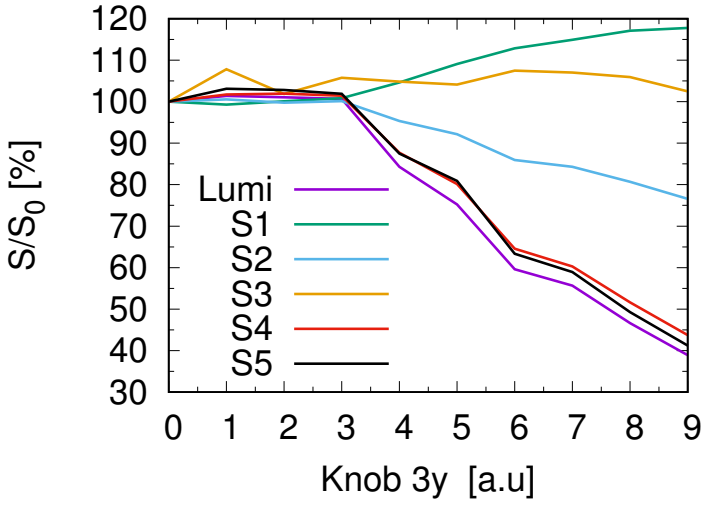


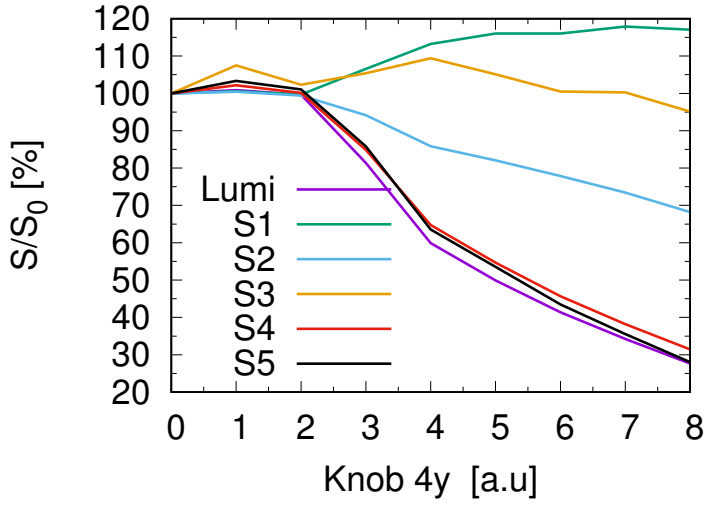


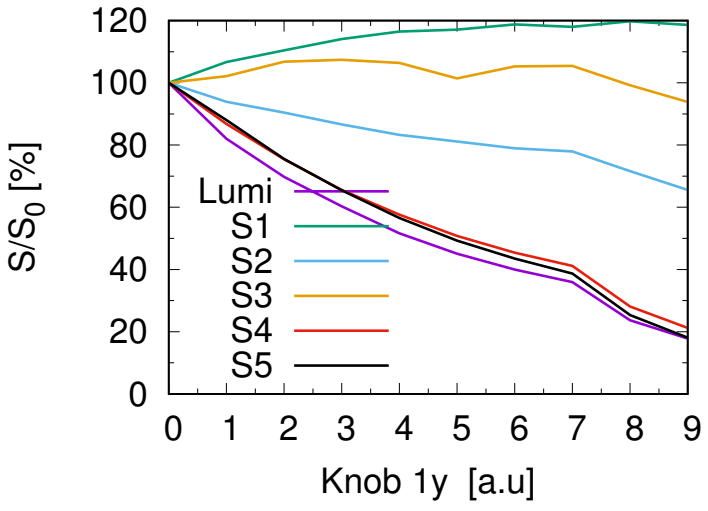


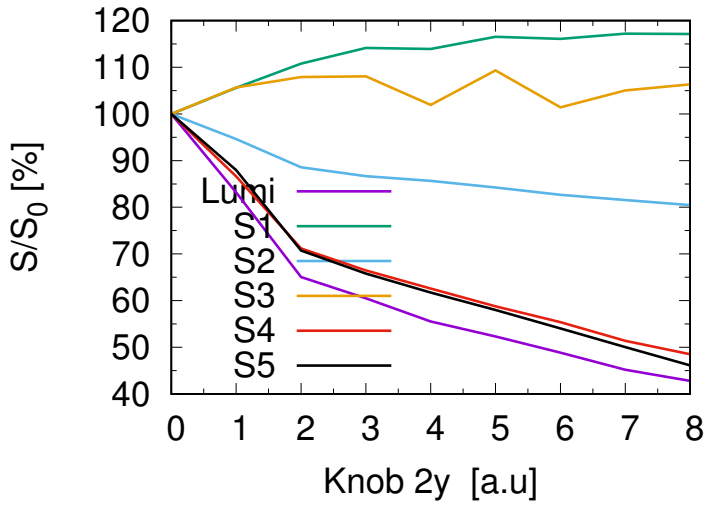
Considered Signals

Y - Linear Knobs (Mapclass)



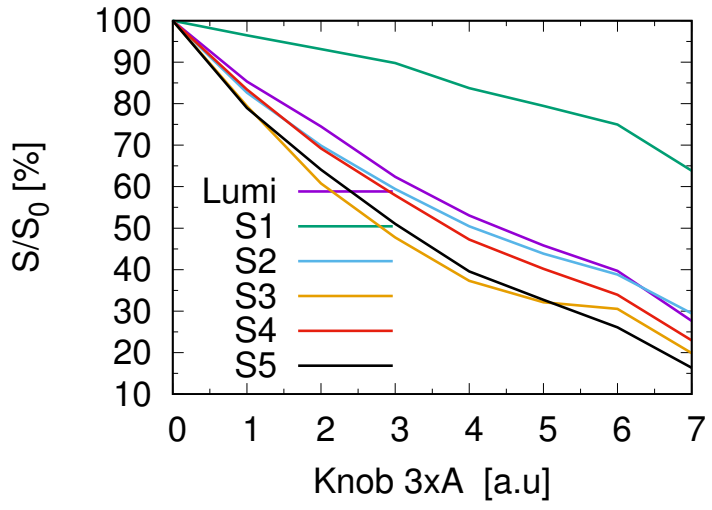


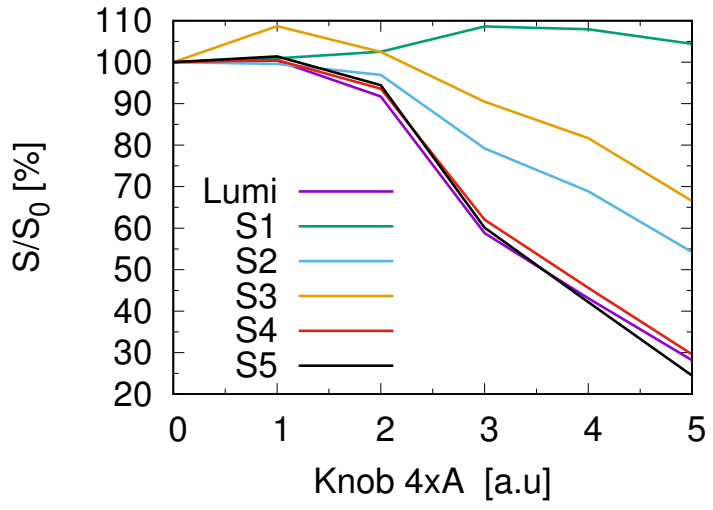


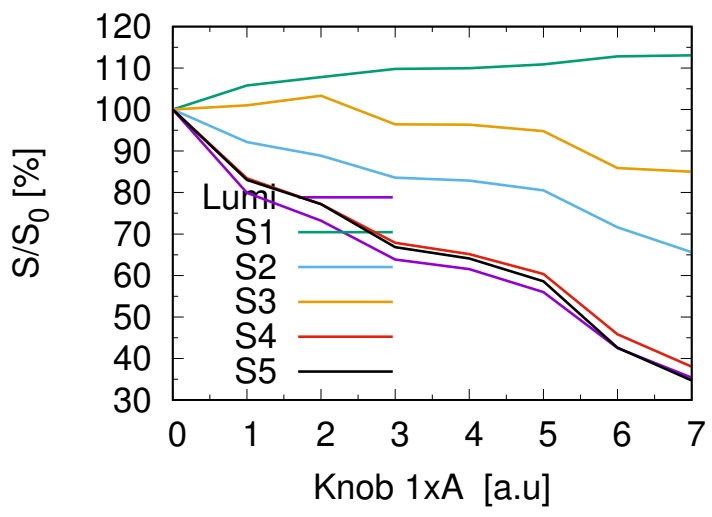


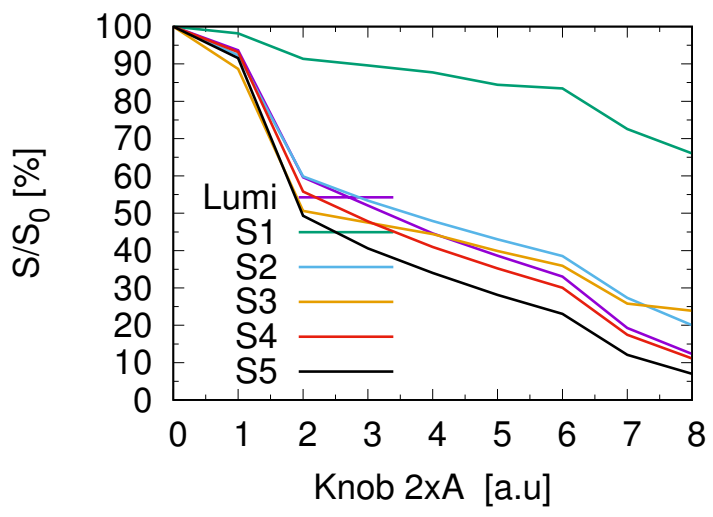
Considered Signals

X - Linear Knobs (Octave)



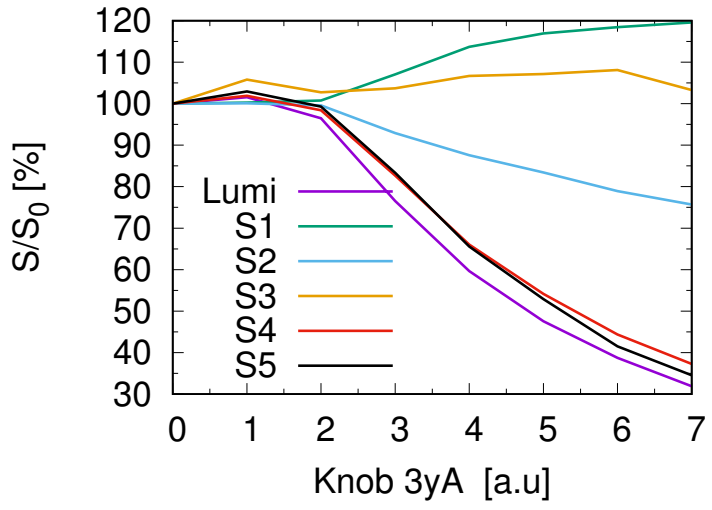


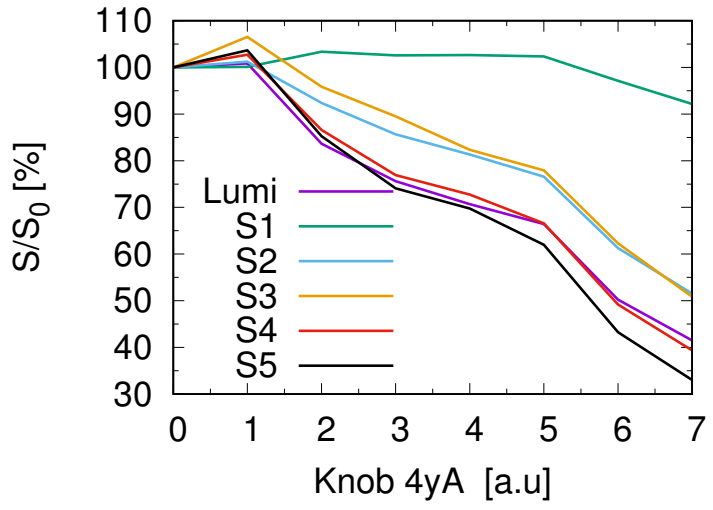


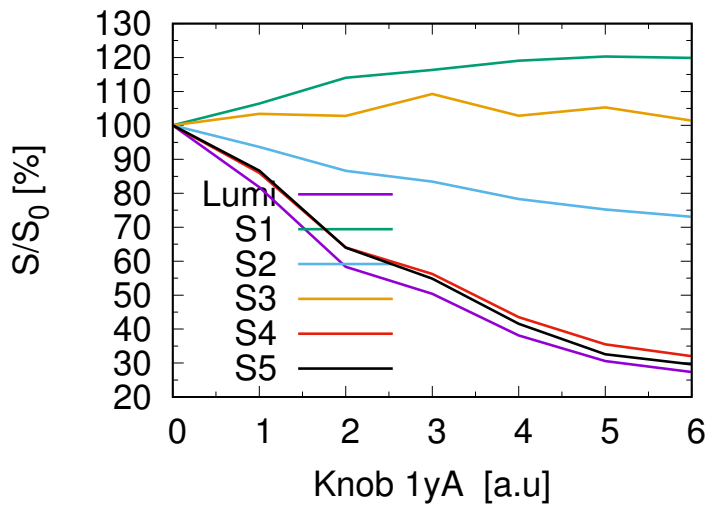


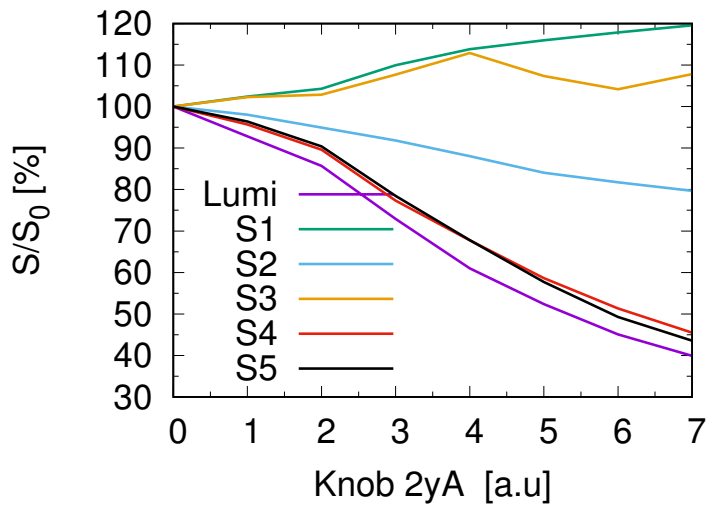
Considered Signals

Y - Linear Knobs (Octave)



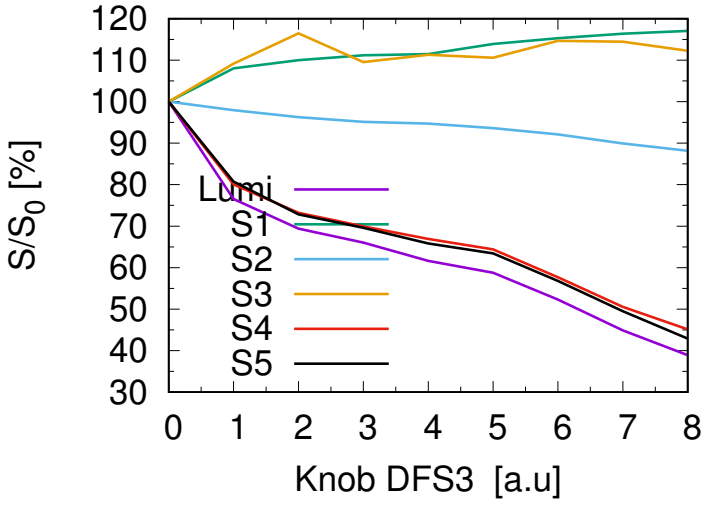


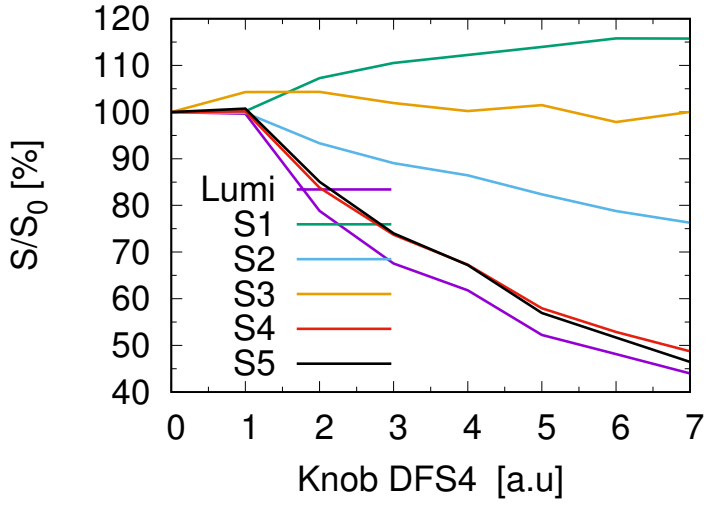


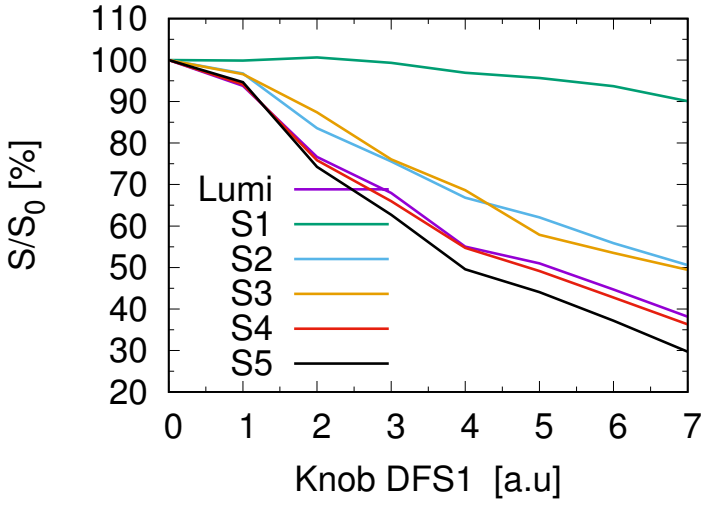


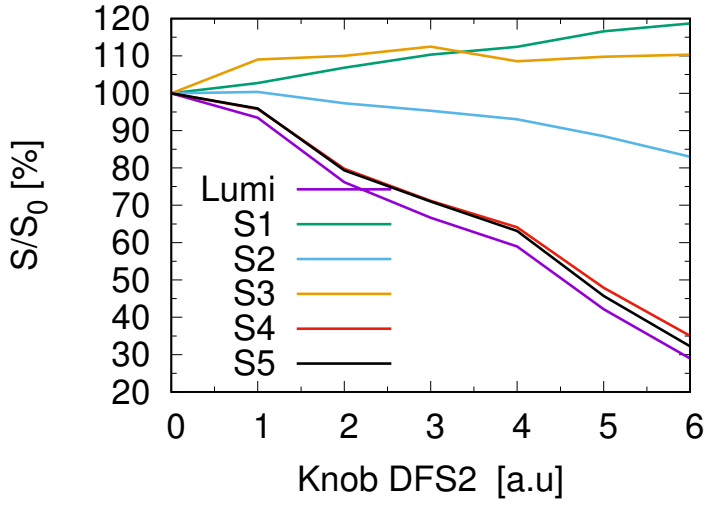
Considered Signals

Dispersion-Free-Steering Knobs - Octave



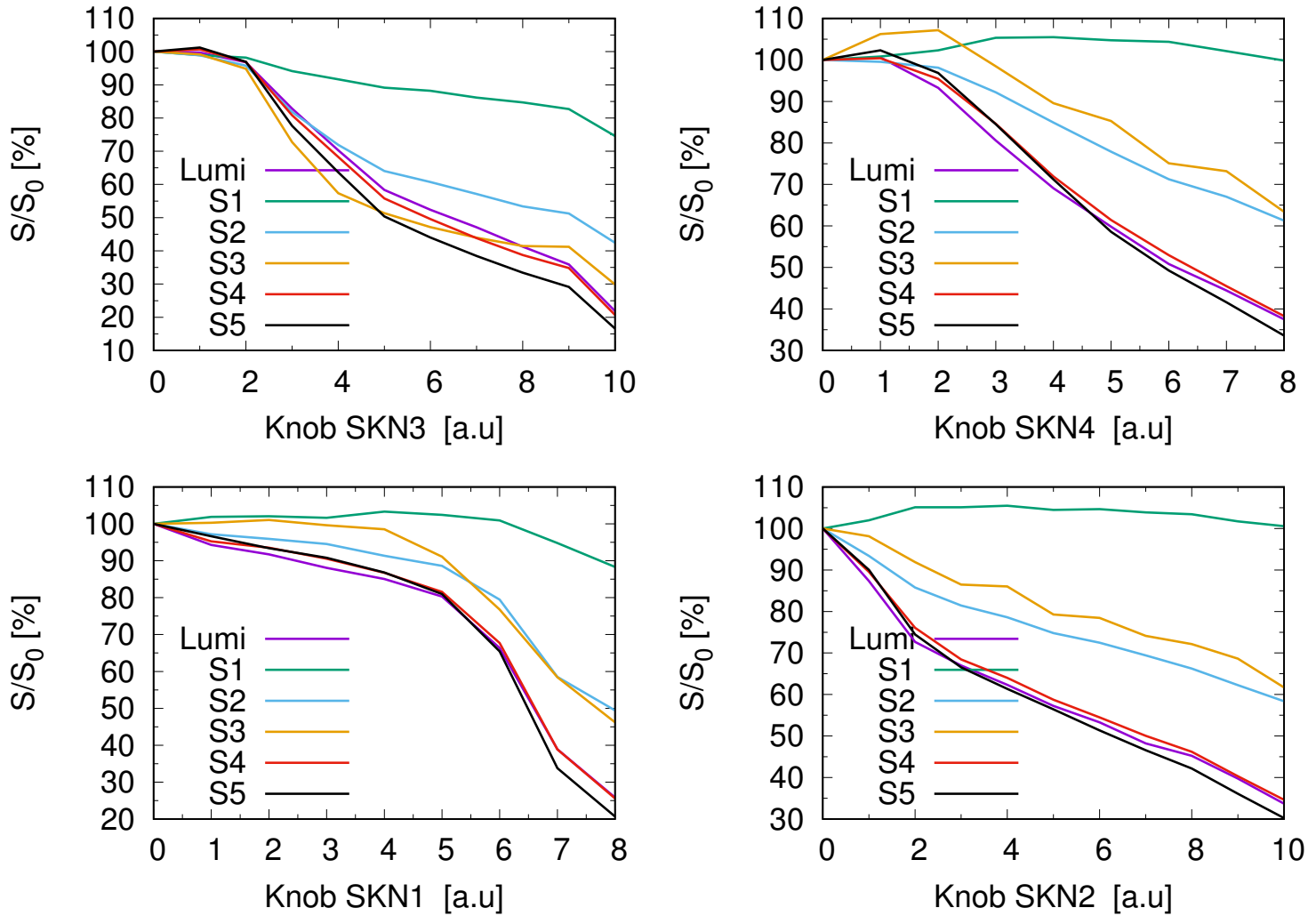






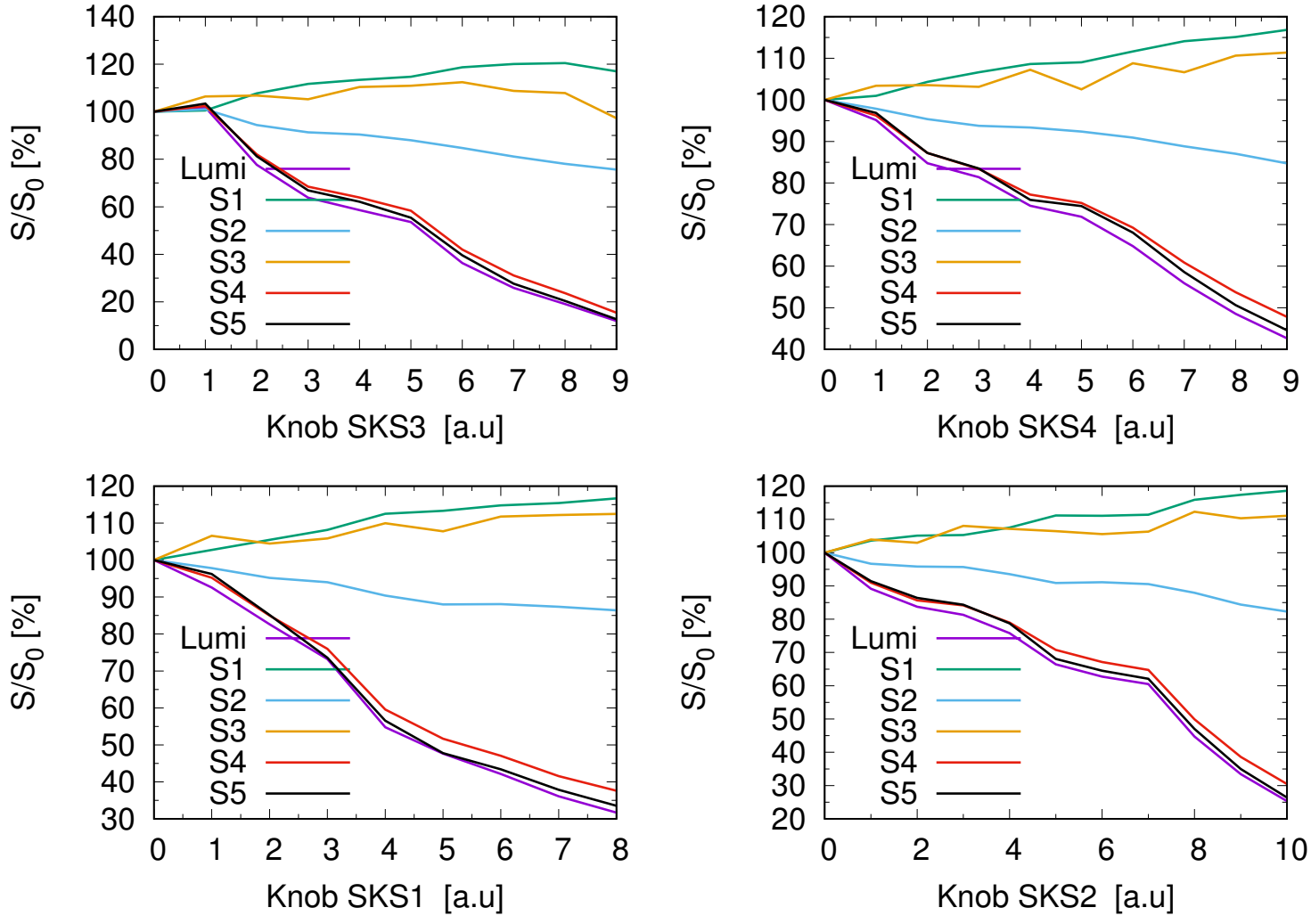
Considered Signals

Normal Sextupoles - Non-Linear Knobs - Mapclass



Considered Signals

Skew Sextupoles - Non-Linear Knobs - Mapclass



CONCLUSIONS

Summary

Conclusions

- Semi-realistic tuning has been implemented
  - Single $\mathcal{L}$ calculation every 0.8 s
  - Ideal IP intra-train feedback
- Realistic tuning is time costly
- # of pairs and Hadrons seems to be alternative useful signals
- Dynamic imperfections seem to impact machine performance by more than 10%

Outlook

- Include orbit feed-back into simulations
- Determine required interval time when using pairs or hadrons signals
- Speed-up calculation by justified assumptions