CLIC-FFS Tuning Studies
3 TeV Baseline Design

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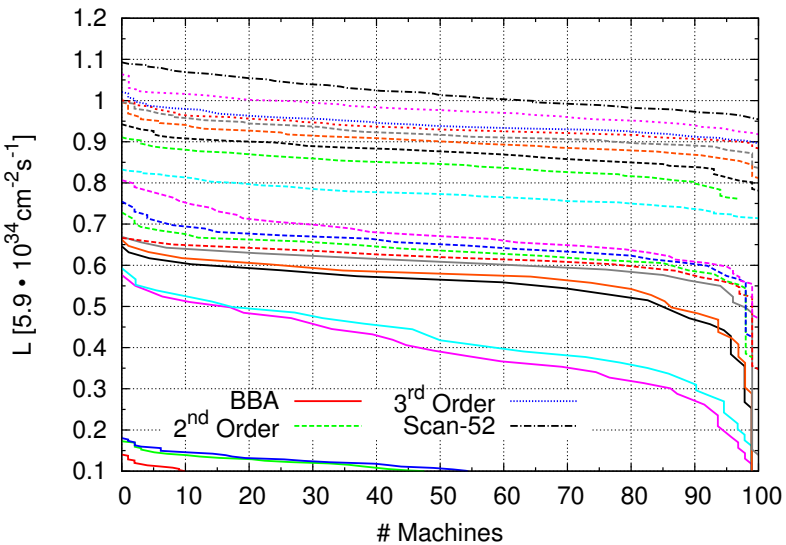
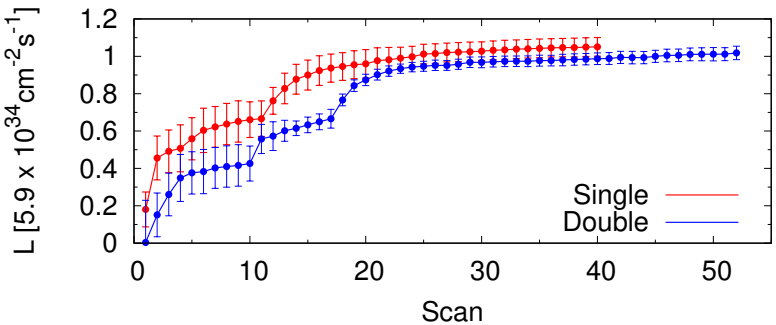
Outline

Tuning Results Static Imperfections

- 2-Beam Tuning results including static imperfections
  - Transverse & rotation alignment imperfections ($10\mu m$,$300\mu m$)
  - BPM reading errors (10 *nm*)
  - Relative strength errors (10^{-4})



CLIC target: 110 %



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

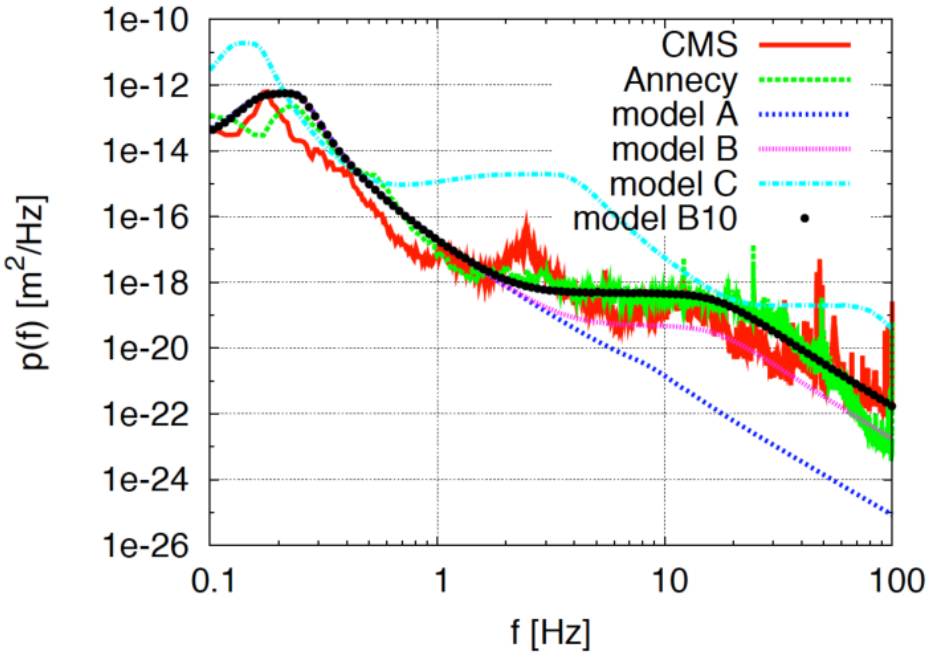
*

*https://journals.aps.org/prab/abstract/10.1103/PhysRevAccelBeams.21.011003

GROUND MOTION

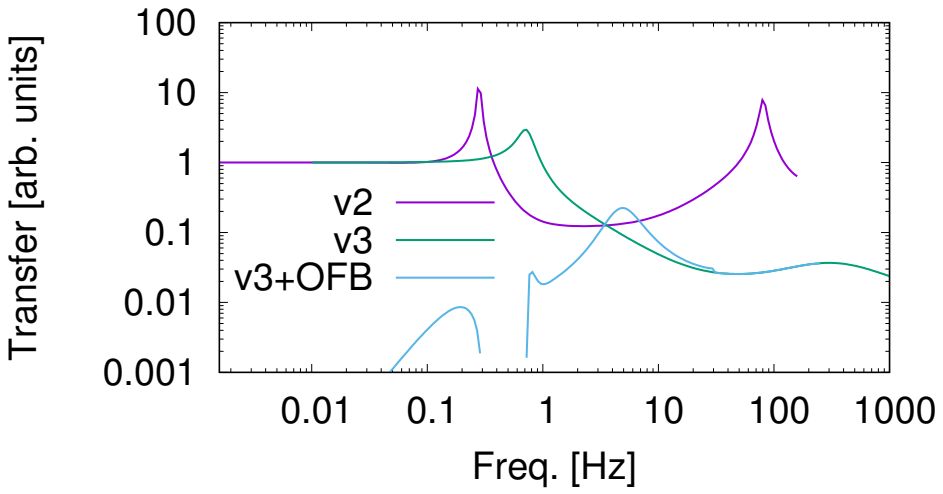
Models

- D (B10) GM model implemented in our simulations

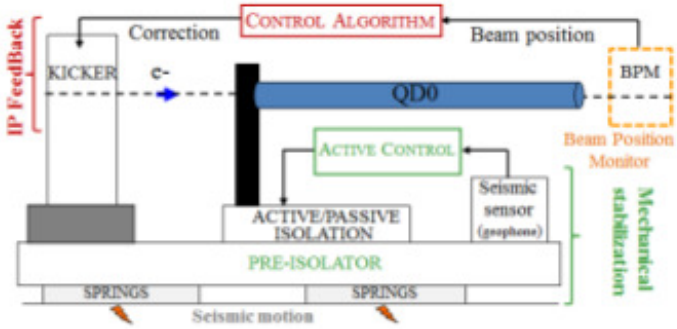


Magnet Stabilization

- Stabilization Filter type
  - v2
  - v3
  - v4 (Orbit Feed-Back)



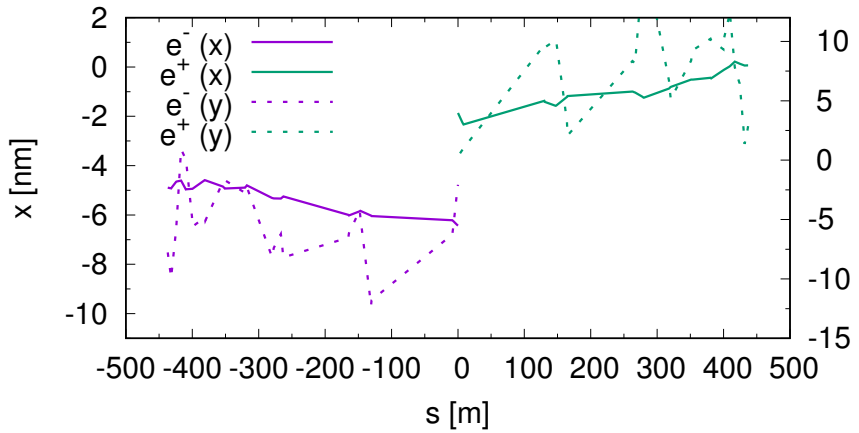
- Pre-isolator:
  - 1: simple version F. Ramos et al.
  - 2: mechanical feedback B. Caron et al.
  - 3: F. Ramos et al. including tilt motion

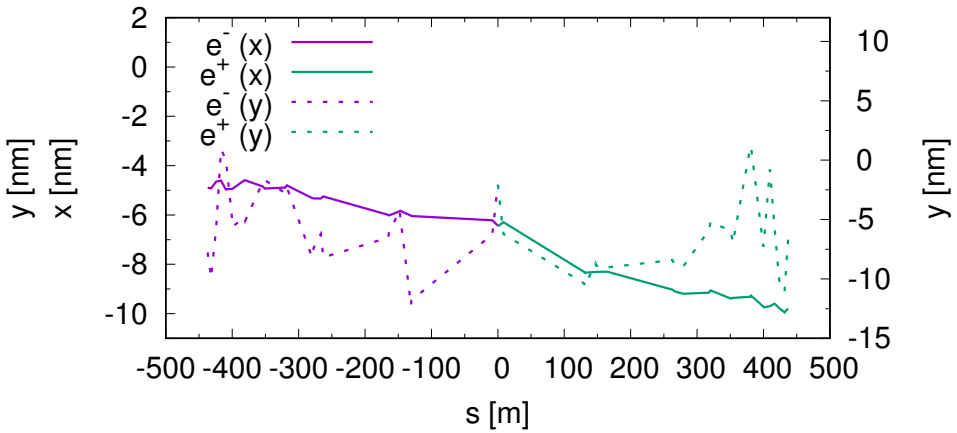


GM Random Generator

- Initial GM seed has to be the same for both e^-, e^+

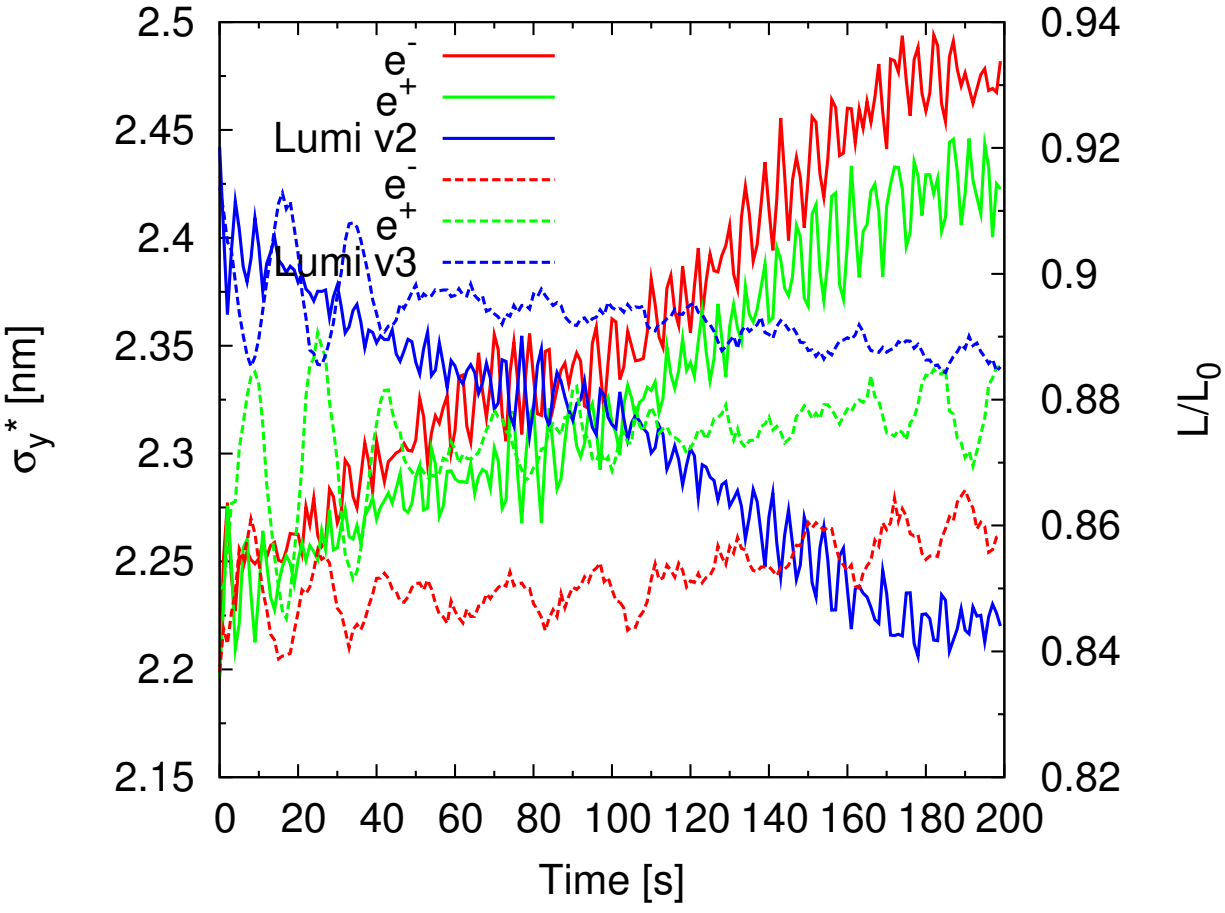
```
Octave{
...
Tcl_Eval("RandomReset -seed $machine -stream Groundmotion ");
Tcl_Eval("ground_motion_init electron $groundmotion(type) $groundmotion(model) 1");
Tcl_Eval("RandomReset -seed $machine -stream Groundmotion ");
Tcl_Eval("ground_motion_init positron $groundmotion(type) $groundmotion(model) -1");
...
}
```





Dynamic Effect

- Effect of Ground Motion on σ^* and $\mathcal{L}$



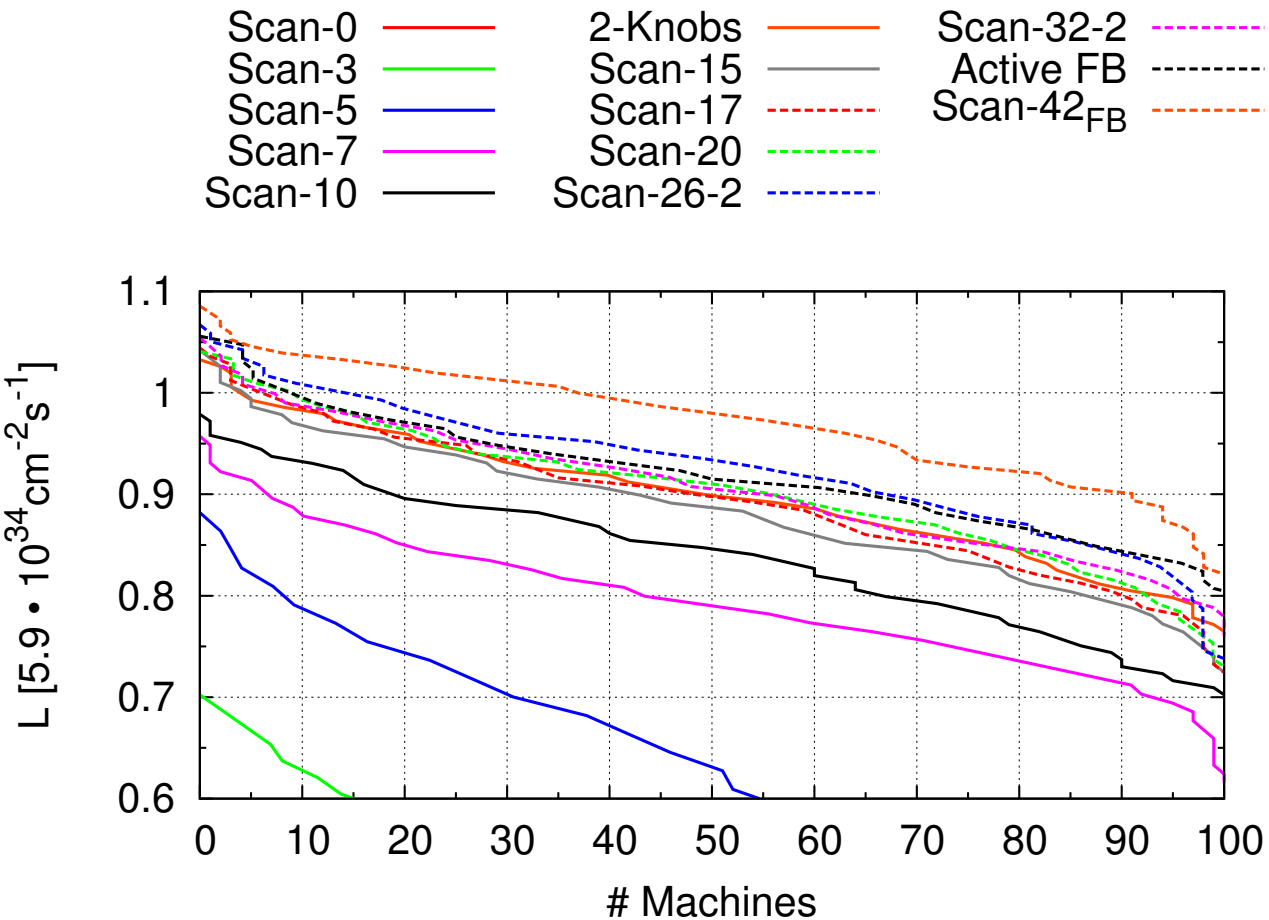
TUNING STUDY

- Same imperfections as static study, but BPM resolution 20 *nm* + GM
- 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 systems: *v3* and *v3+OFB*
- Ground motion acts on both beamlines through the entire tuning procedure
- *t_start* variable keeps track of each machine time
- Procedure based on previous studies: (BBA $\Rightarrow$ Linear $\Rightarrow$ Non-linear Knobs) firstly applied to e^- and secondly to e^+

† required for luminosity precision $\leq 1\%$

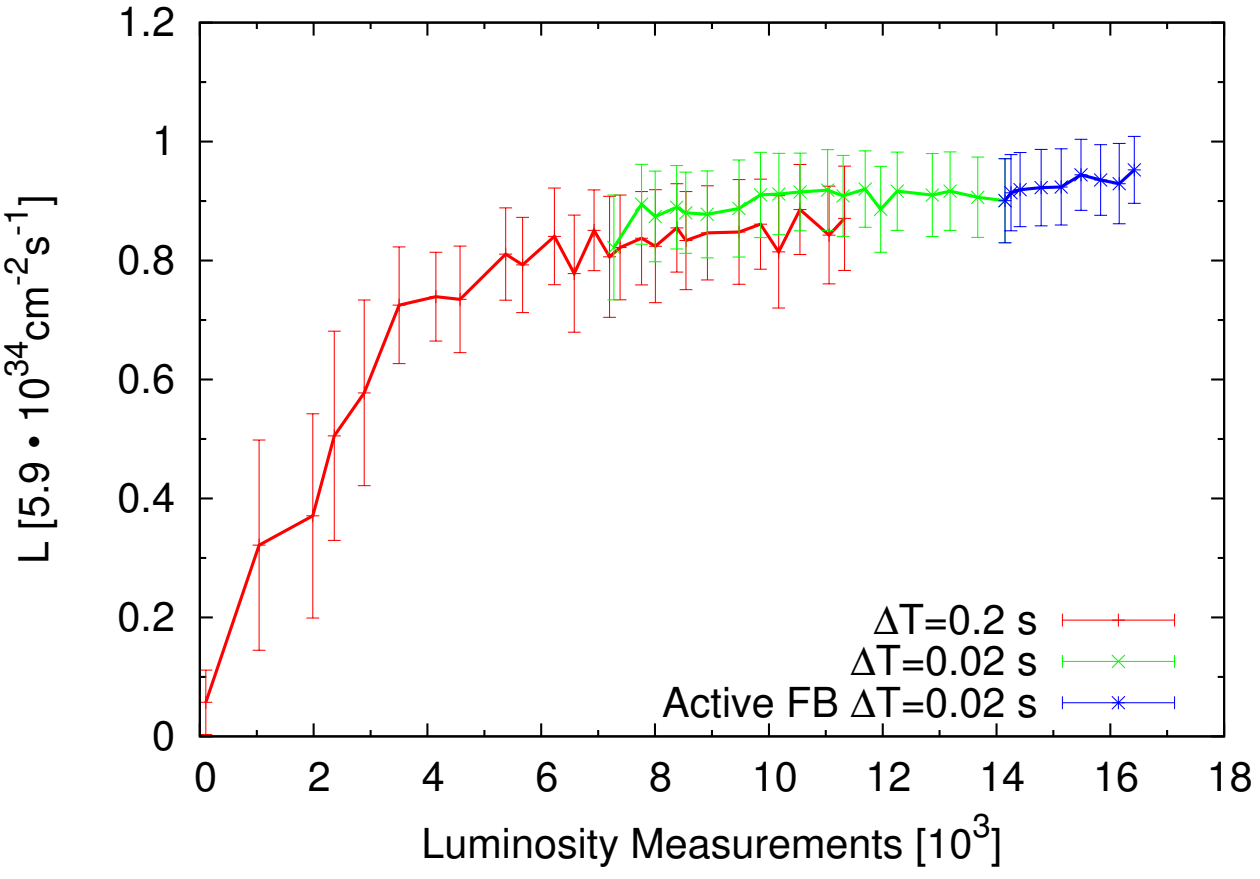
Accumulative Histograms

- Considered interval times (Δt):
  - From Scan 1st to 25th: Δt_1 =0.2 s (5 Hz)
  - From Scan 26st to 32nd: Δt_2 =0.02 s
  - From Scan 32nd to 41st: Δt_2 =0.02 s , *OFB* ON



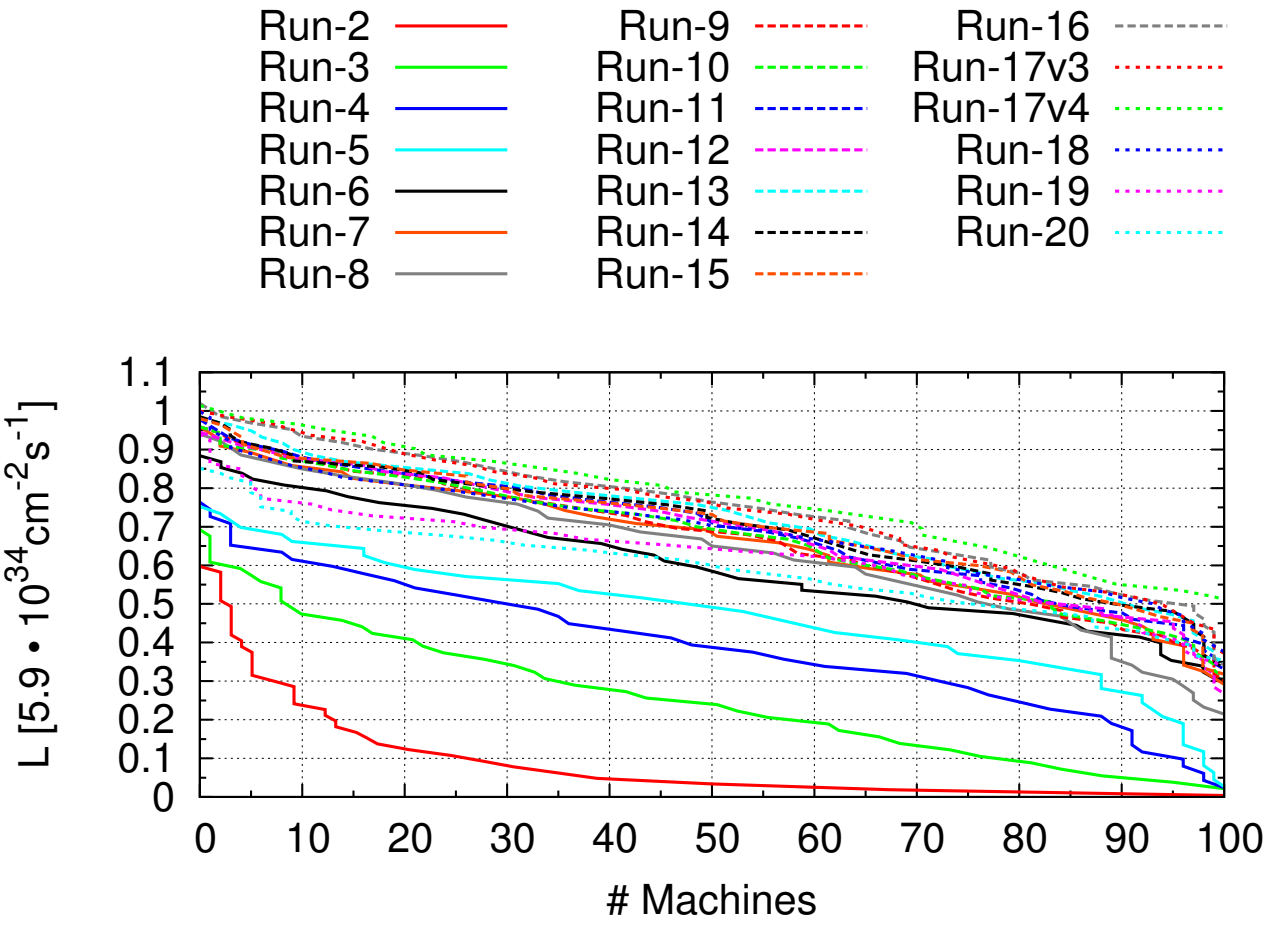
Tuning Time

- Stabilization Filter v3 + *OFB* (blue)
- Interval times (Δt) [s]: 0.2 (red), 0.02 (green and blue)



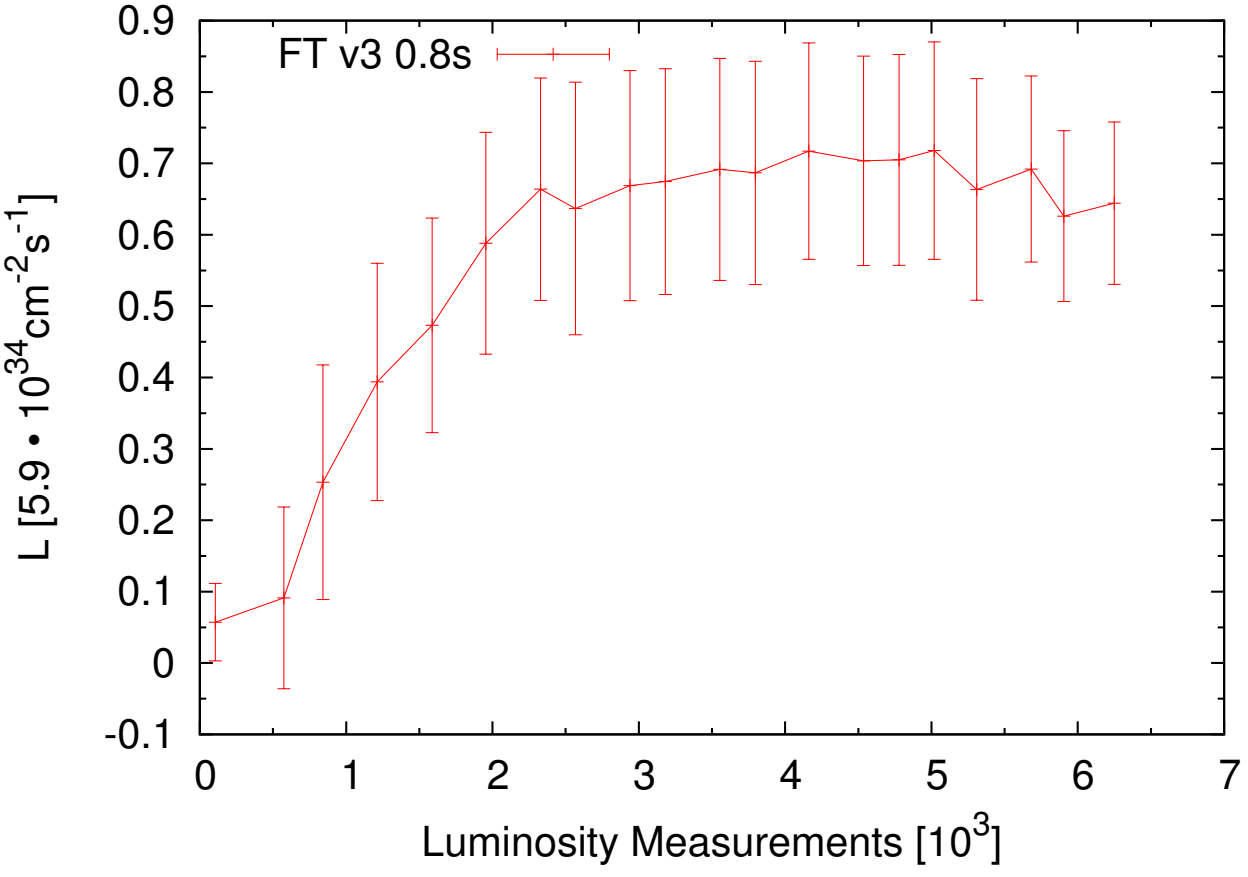
Tuning Results III

- Stabilization Filter *v*3 *OFB*-OFF
- Interval time (Δt) [s]: 0.8 (1.25 Hz)



Tuning Results IV

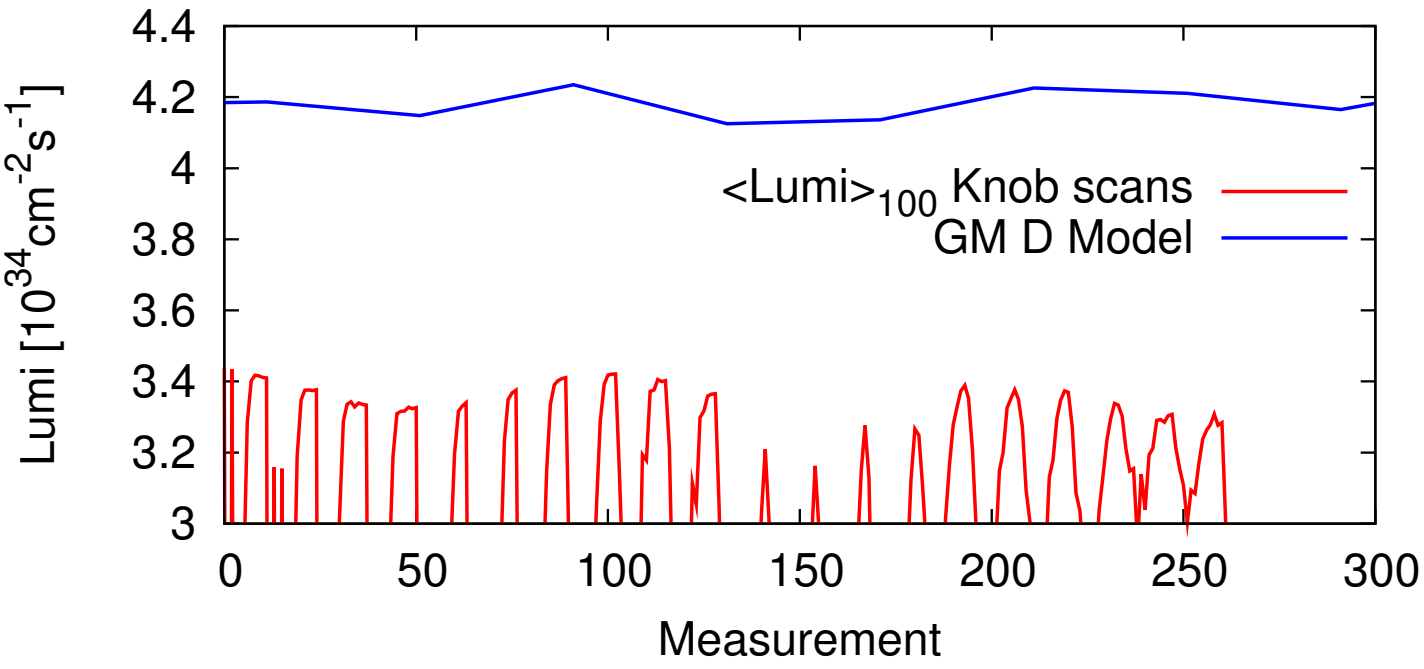
- Stabilization Filter v3
- Interval time (Δt) [s]: 0.8 (1.25 Hz)



ISSUES

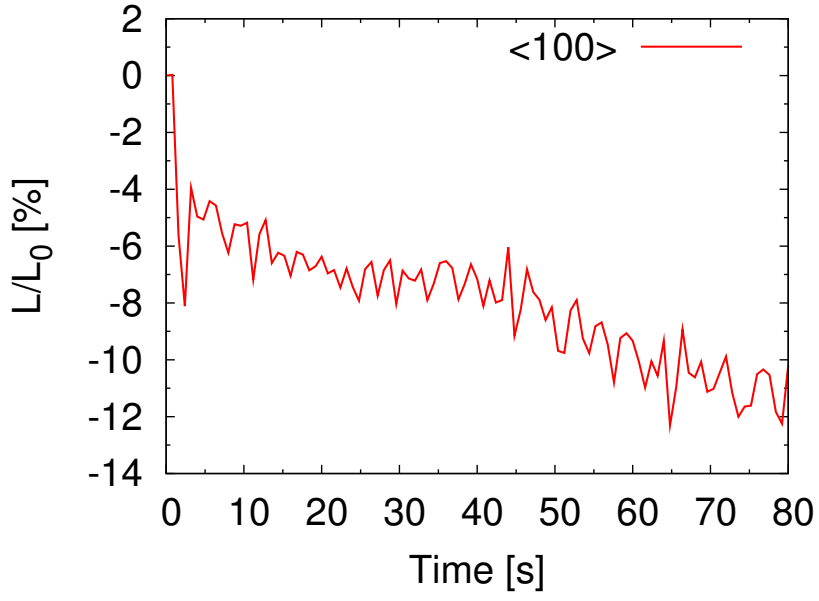
Ground Motion

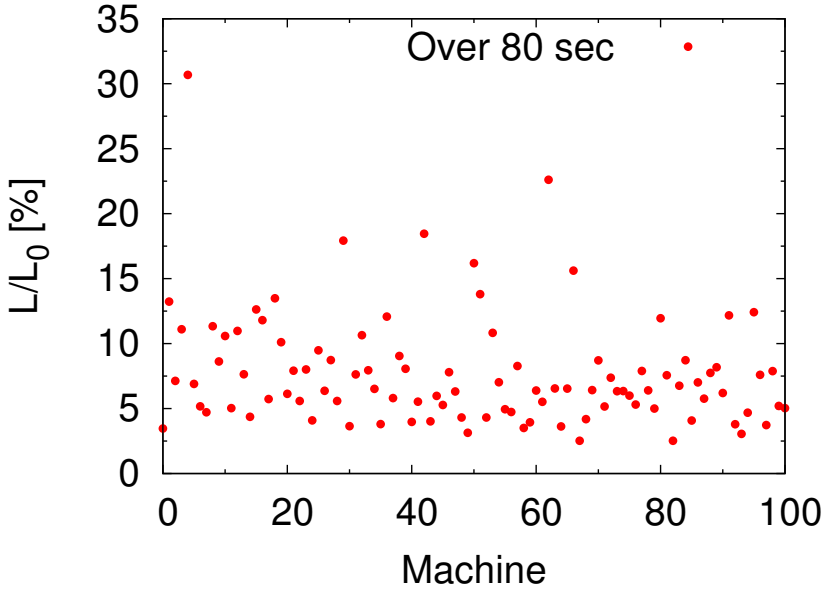
- Average luminosities during typical linear knob scans (250 measurements)



Ground Motion

- Average luminosities (100 machines) over 2 seconds
- Relative $\mathcal{L}$ fluctuation of each machine

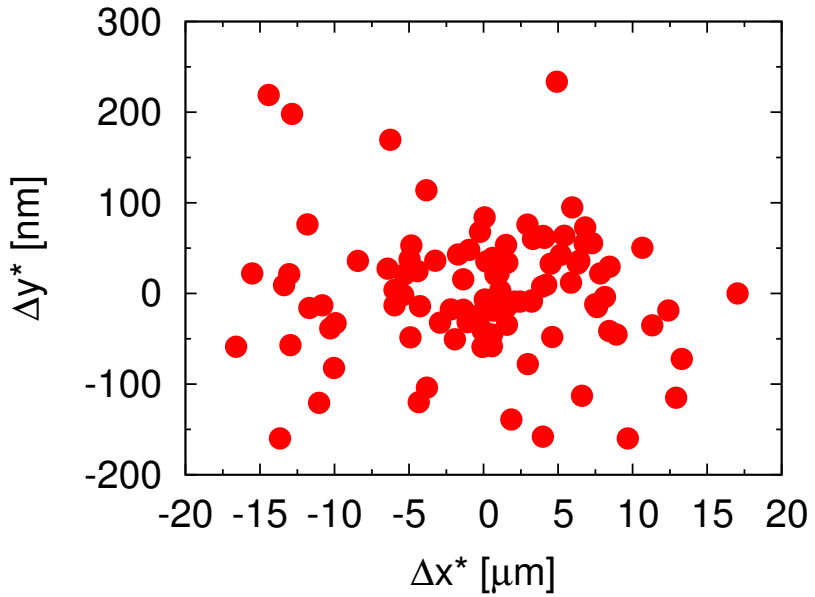




- The behavior of $\frac{\mathcal{L}}{\mathcal{L}_0}$ depends on current value of *t_start*

IP Feed-Back

- Relative offset at the IP



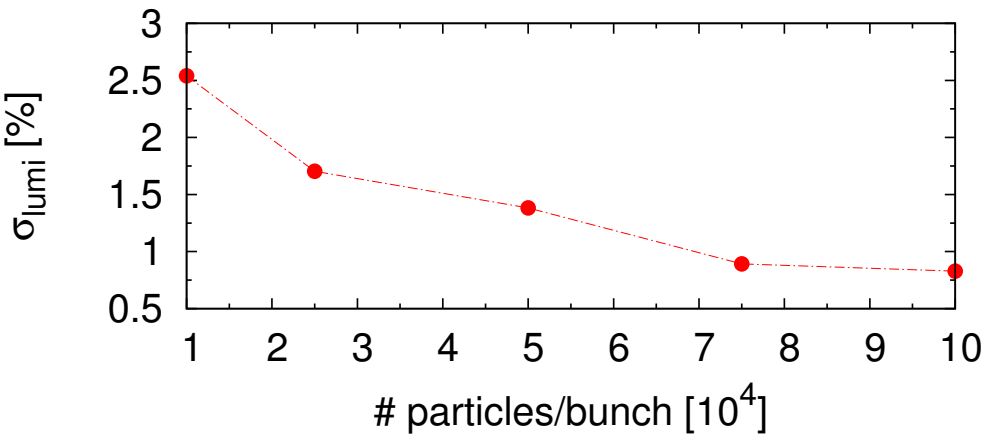
$$< \Delta x^* >= 6 \pm 5 \ \mu m$$
$$< \Delta y^* >= 62 \pm 94 \ nm$$

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

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

Computation Time

- Luminosity is 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 $\mathcal{L} \geq 0.8\mathcal{L}_0$



LUMINOSITY SIGNALS

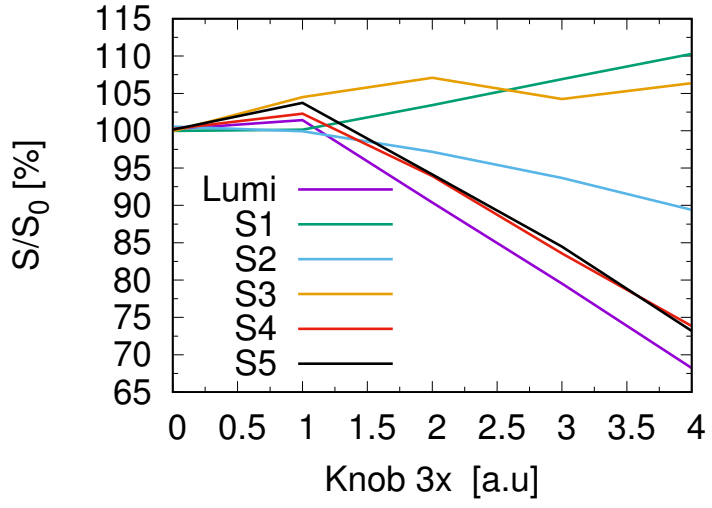
Considered Signals

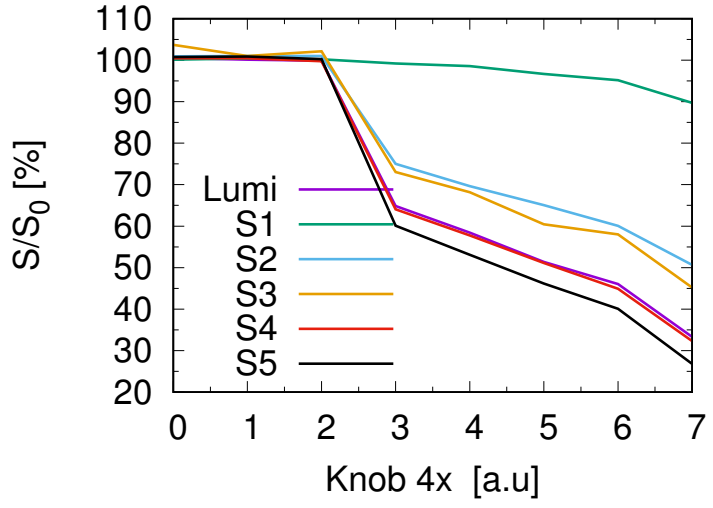
Signals generated by Guinea-Pig through collision of 10^6 particles per beam

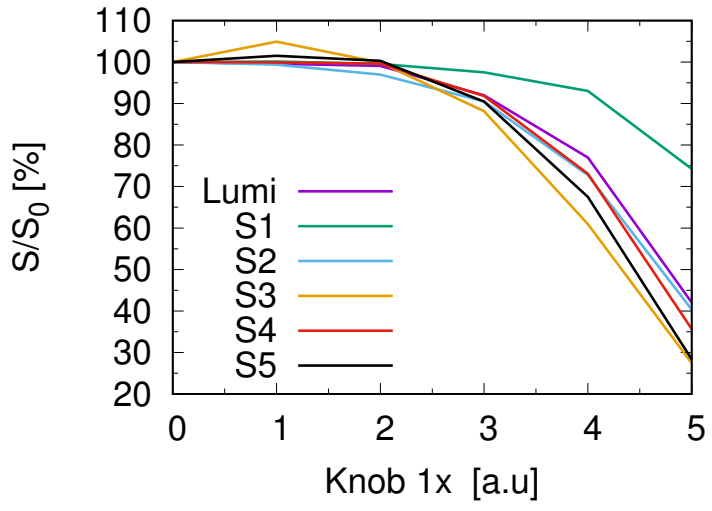
- Luminosity
- Number of Photons (beam1)
- Number of Photons (beam2)
- Number of Coherent
- Number of Pairs
- Number of Hadrons

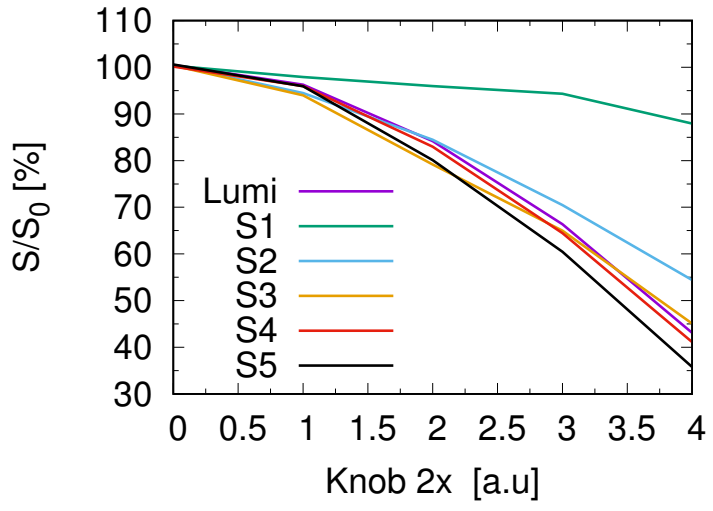
Considered Signals

X - Linear Knobs (Mapclass)



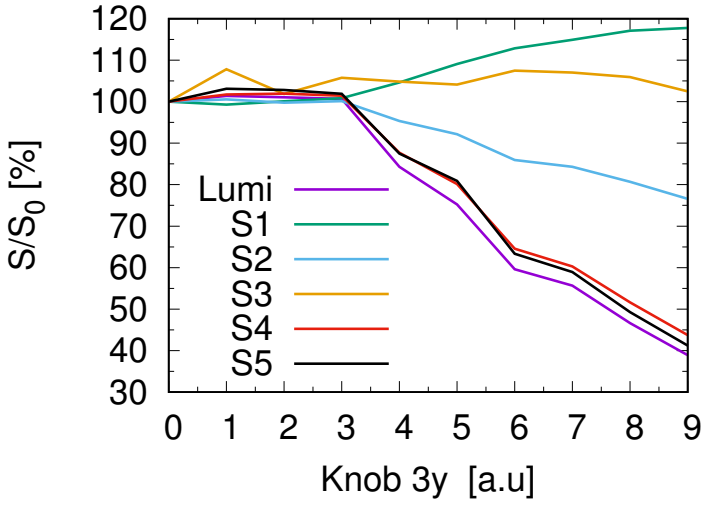


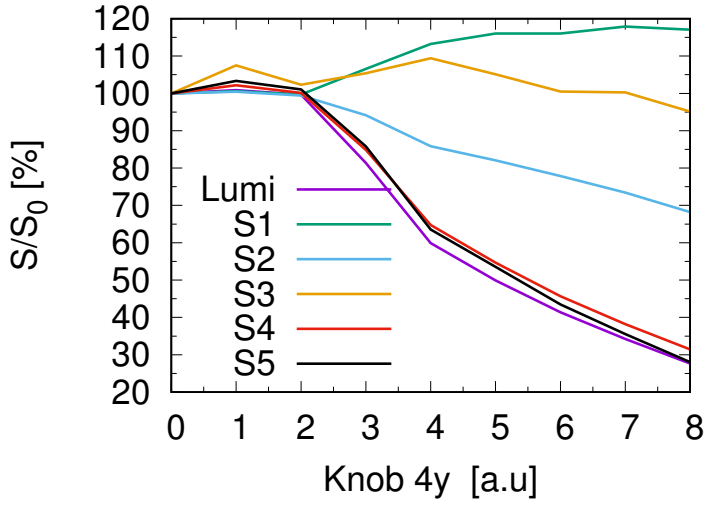


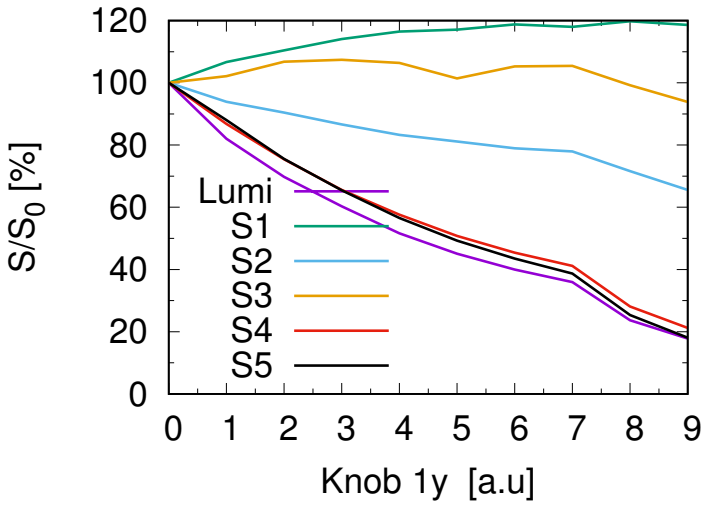


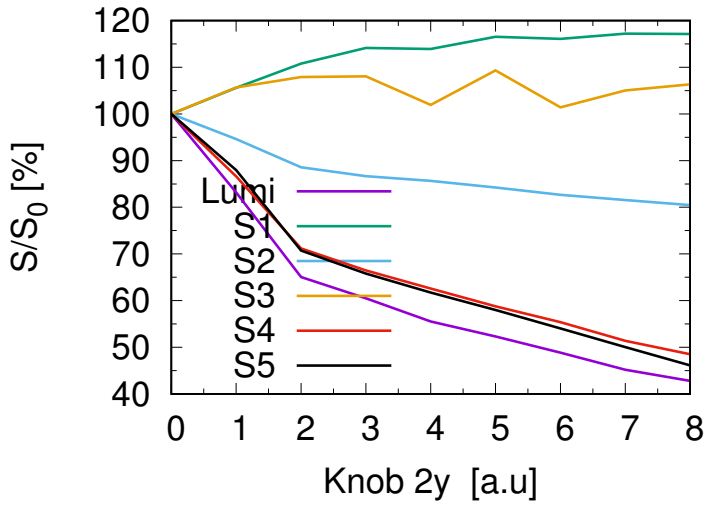
Considered Signals

Y - Linear Knobs (Mapclass)



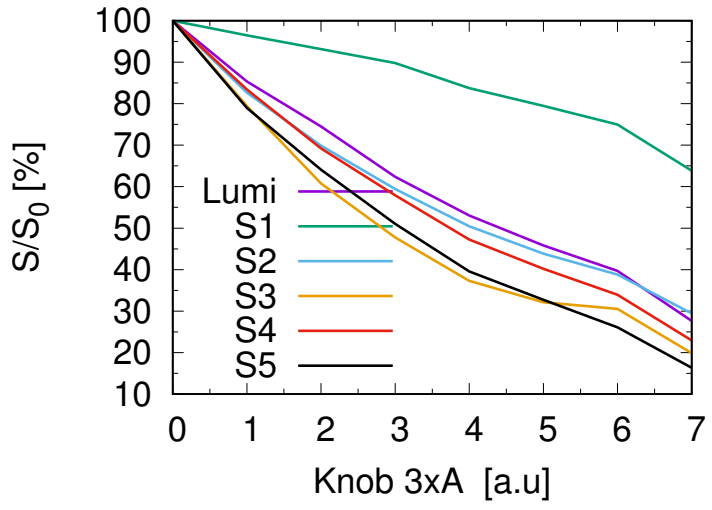


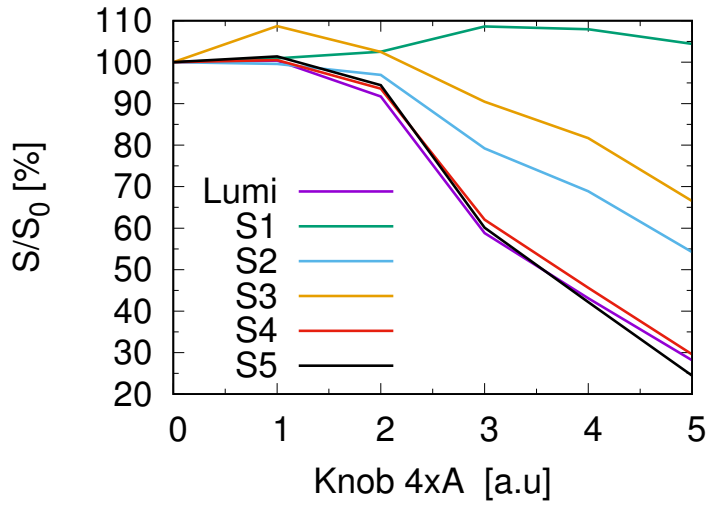


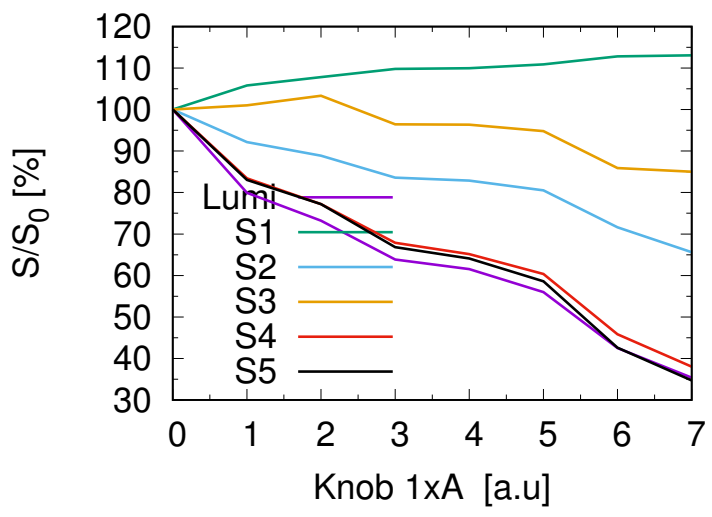


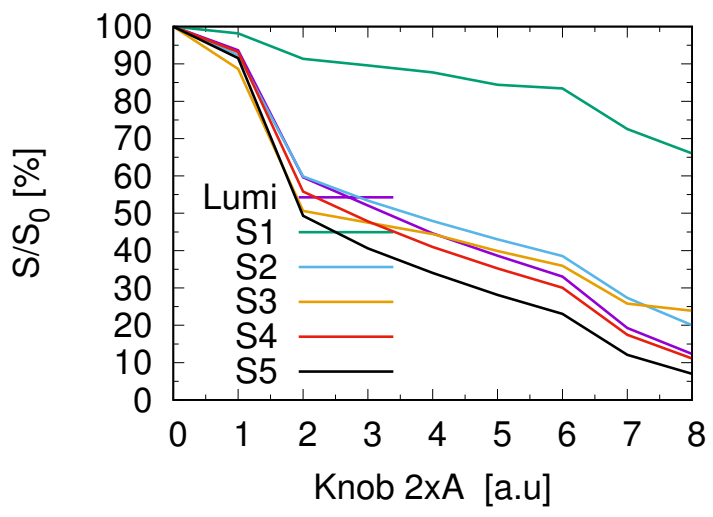
Considered Signals

X - Linear Knobs (Octave)



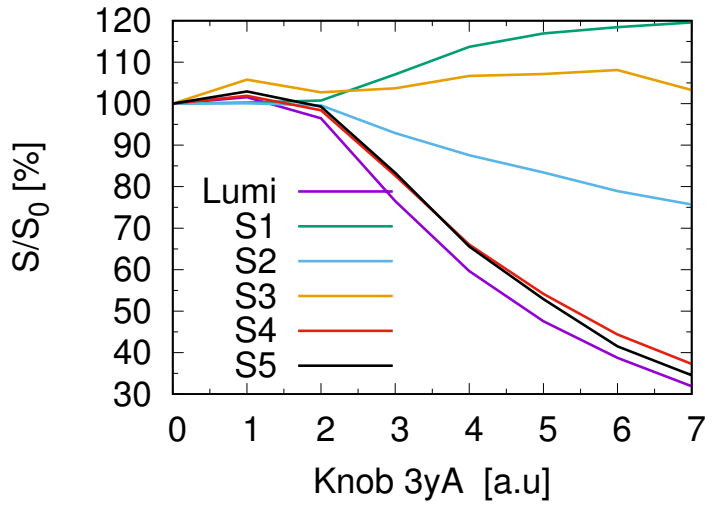


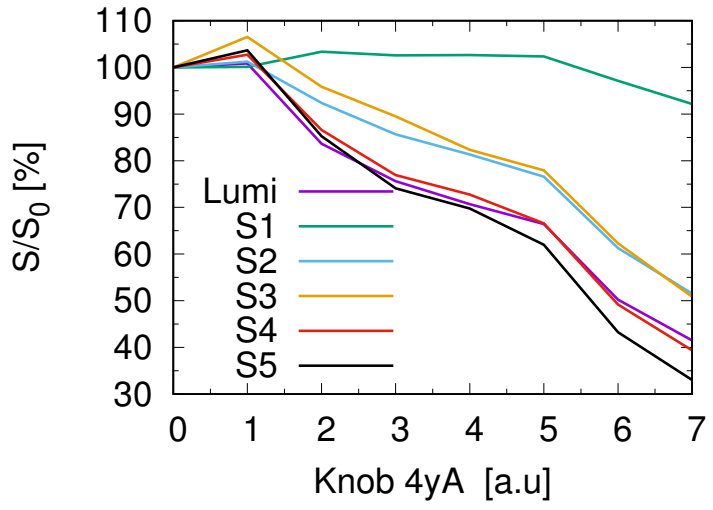


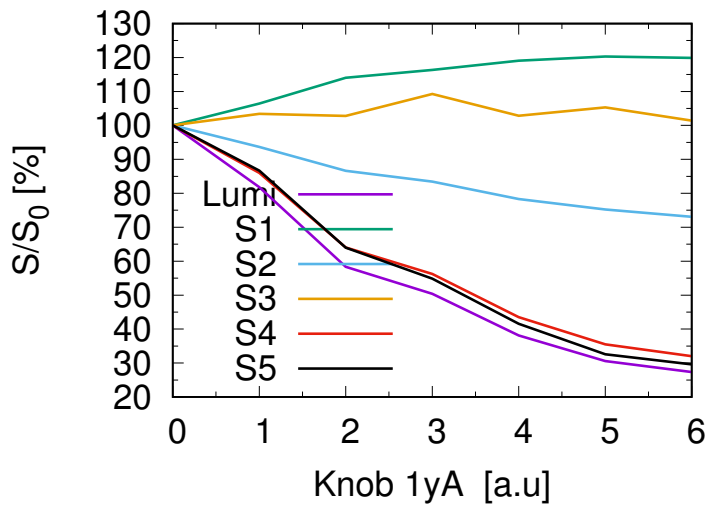


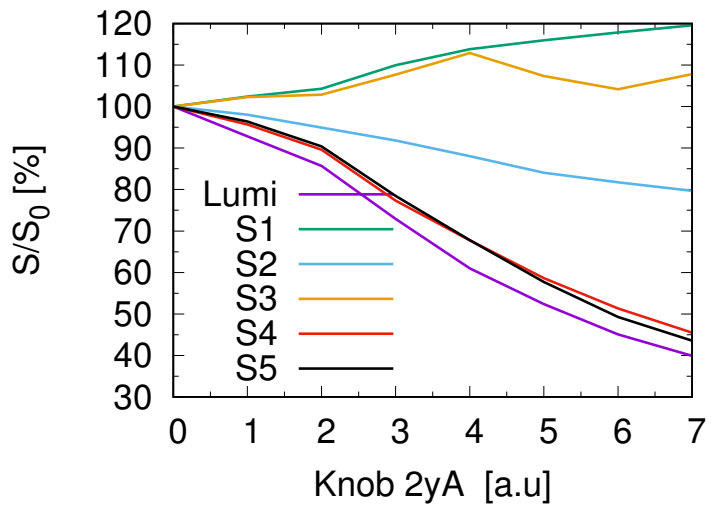
Considered Signals

Y - Linear Knobs (Octave)



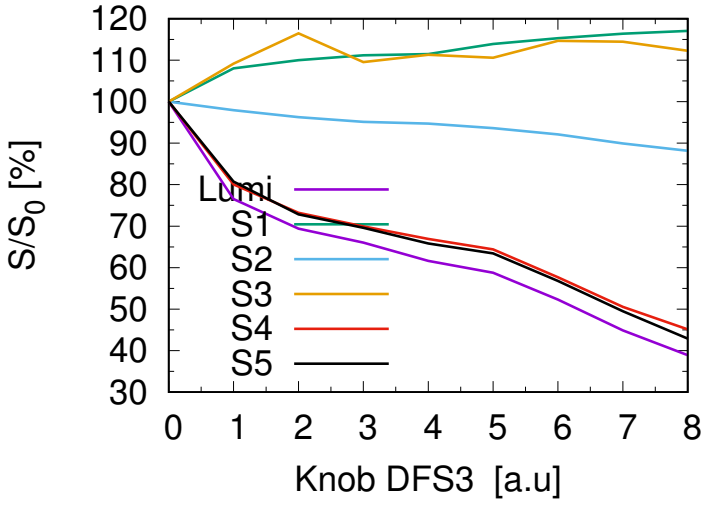


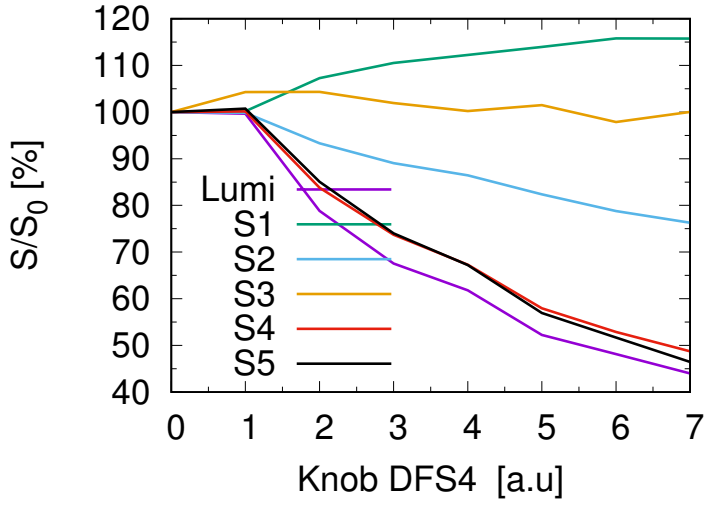


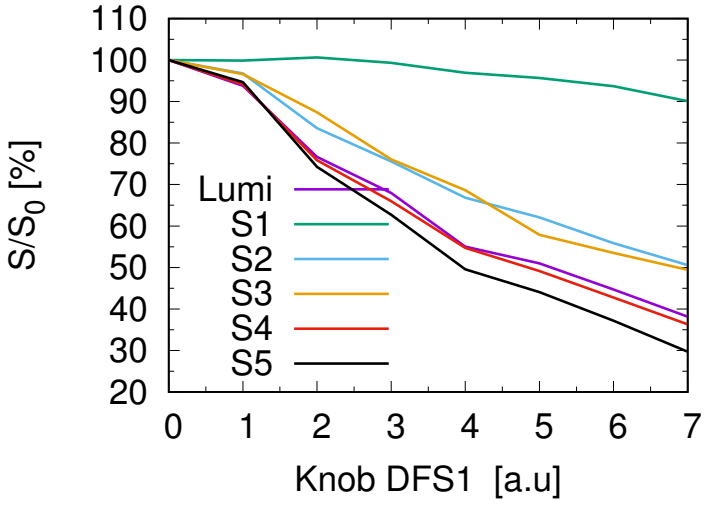


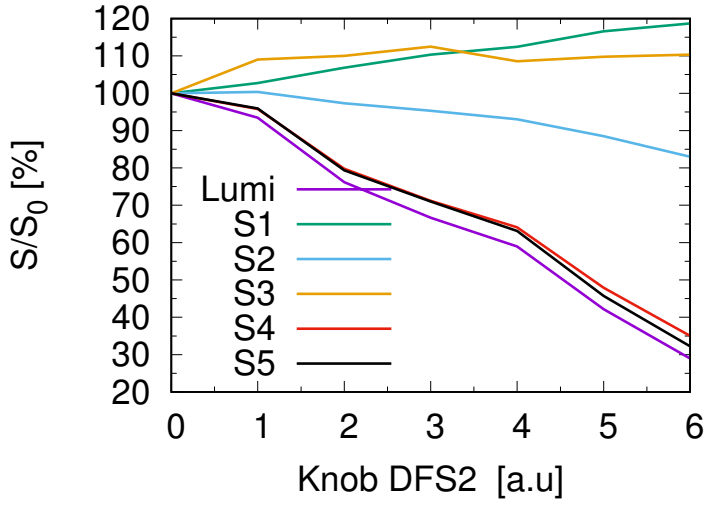
Considered Signals

Dispersion-Free-Steering Knobs - Octave



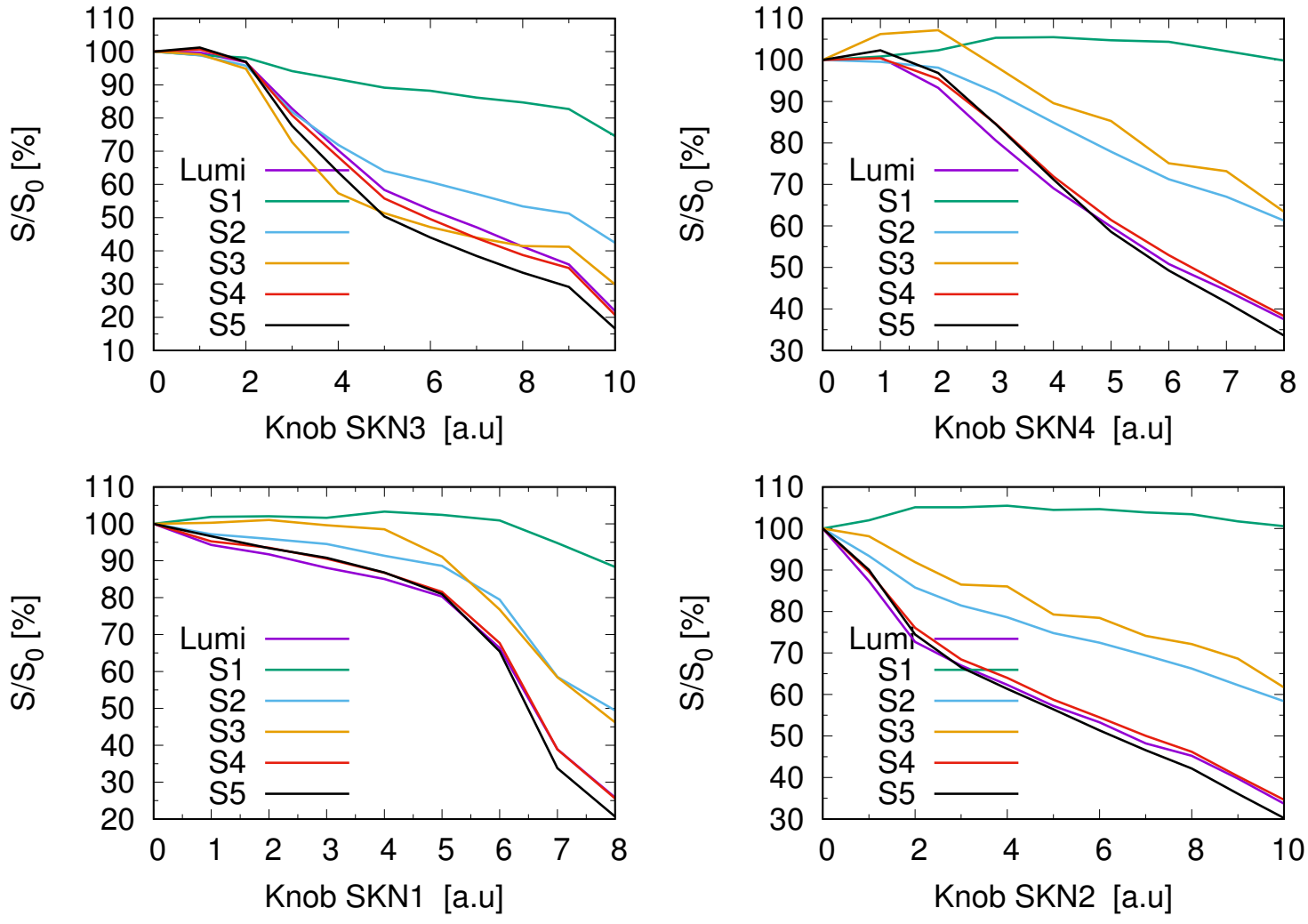






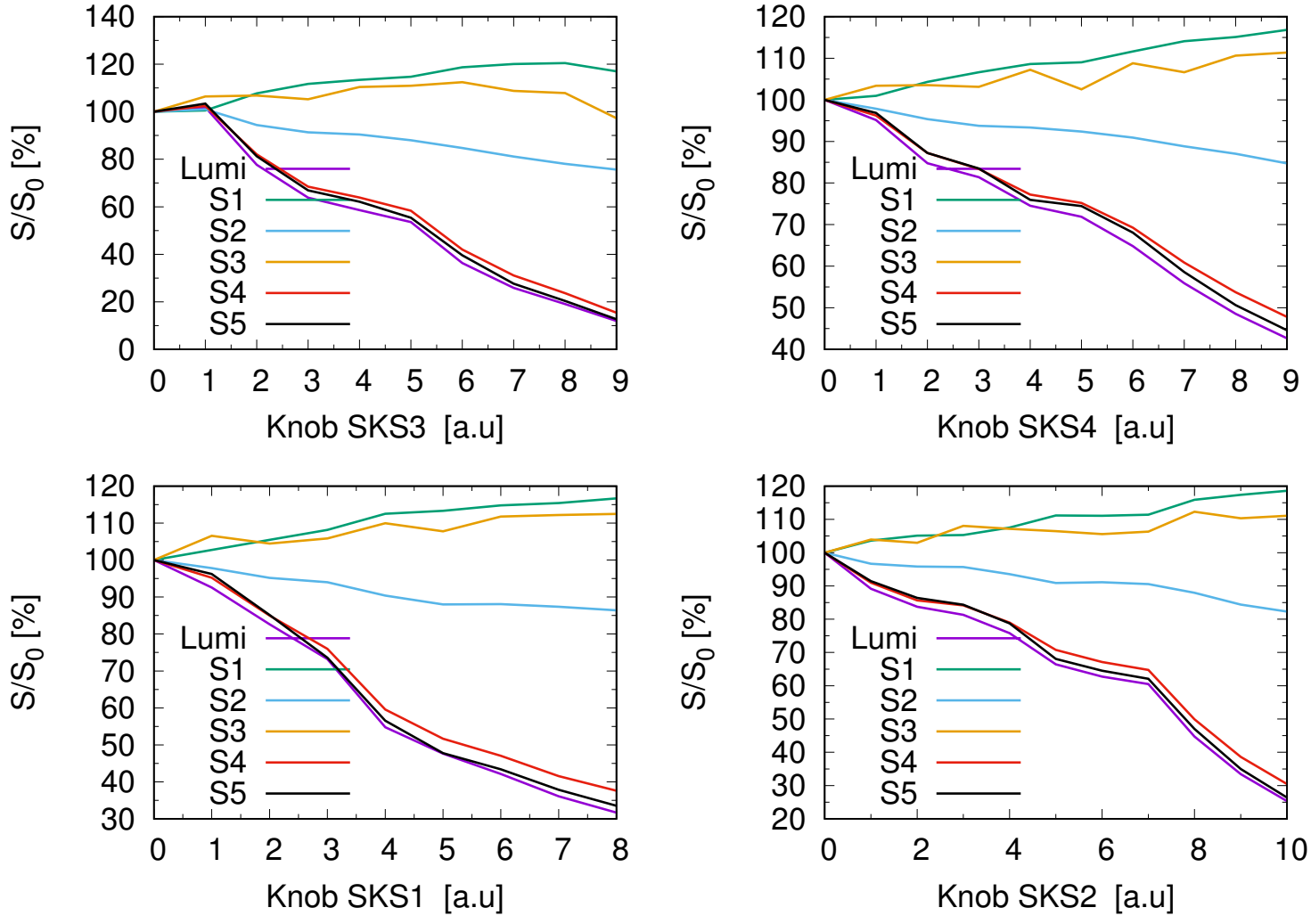
Considered Signals

Normal Sextupoles - Non-Linear Knobs - Mapclass



Considered Signals

Skew Sextupoles - Non-Linear Knobs - Mapclass



CONCLUSIONS

Summary

Conclusions

- GM Δt step impacts significantly the tuning convergence
  - Δt=0.8$\Rightarrow$ 90% machines reach 70%$\mathcal{L}_0$ after 6000 meas.
  - Δt=0.02$\Rightarrow$ 90% machines reach 80%$\mathcal{L}_0$ after 6000 meas.
  - Δt=0.02$\Rightarrow$ 90% machines reach 90%$\mathcal{L}_0$ after 16000 meas.
    - Effect of orbit FB assumed in GM model

Outlook

- Continue study with Δt= 0.02 s, 0.8 s
- # of pairs seems to be an alternative useful signal
- Remove noneffective knobs
- Scan knobs always on the smallest beam
- Perfect IP intra-train feedback (*may not be the best*)

BACK UP

Aberration Content

Δt=0.8s case after Scan-20