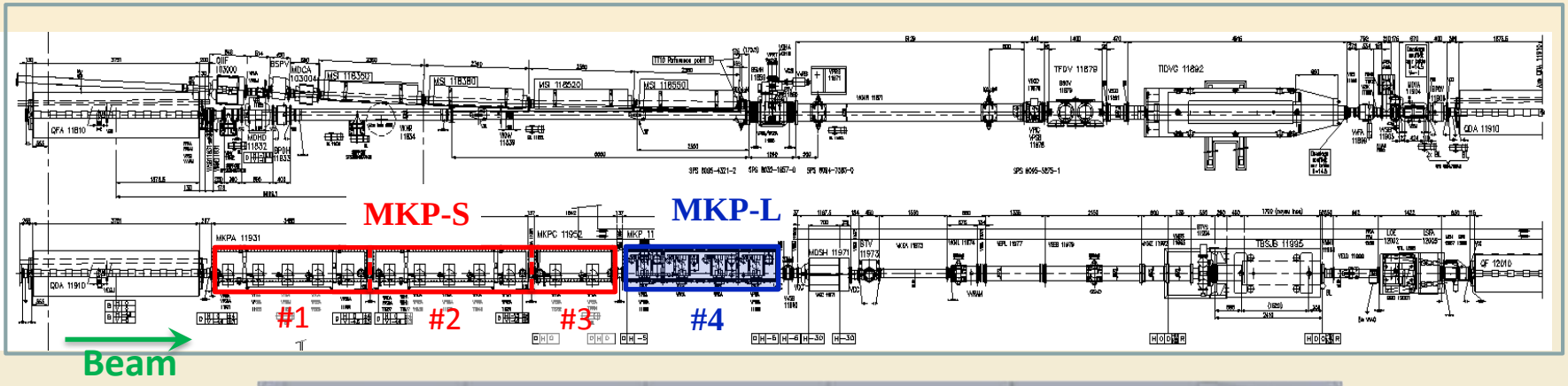
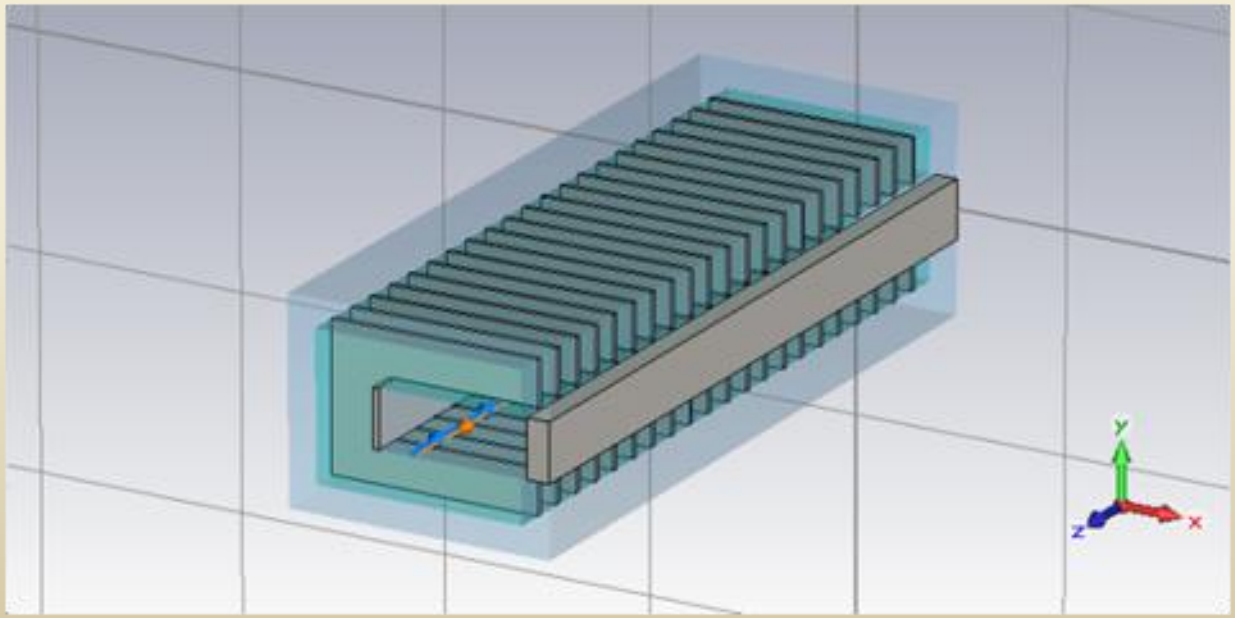
MKPL impedance measurements with and without serigraphy

M. Barnes, O. Bjorkqvist, C. Zannini

Ack.: P. Blaise, L. Ducimetiere, Y. Sillanoli

MKP configuration

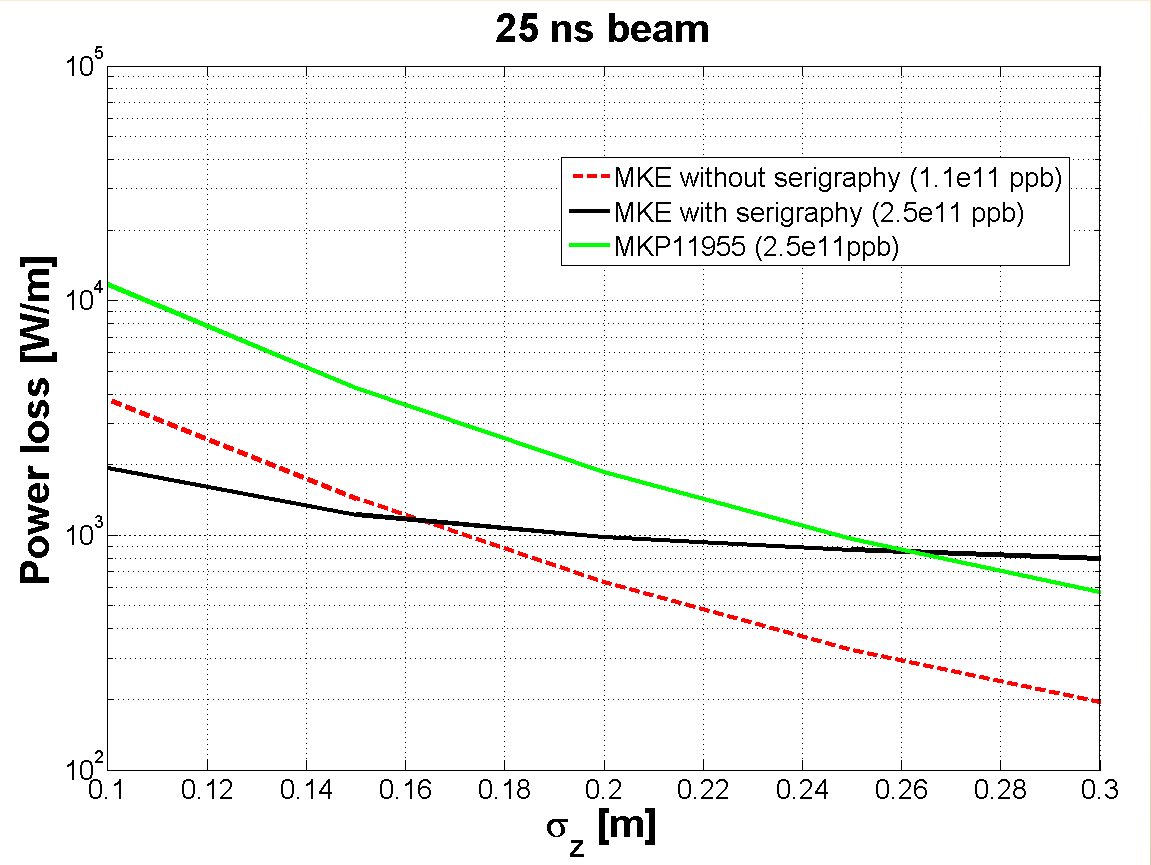




Beam induced power loss

$$\Delta W = (f_0 e N_{\text{beam}})^2 \sum_{p=-\infty}^{p=\infty} \left(\left| \bar{\Lambda}(p\omega_0) \right|^2 \text{Re}\left[Z_{\parallel}(p\omega_0) \right] \right)$$

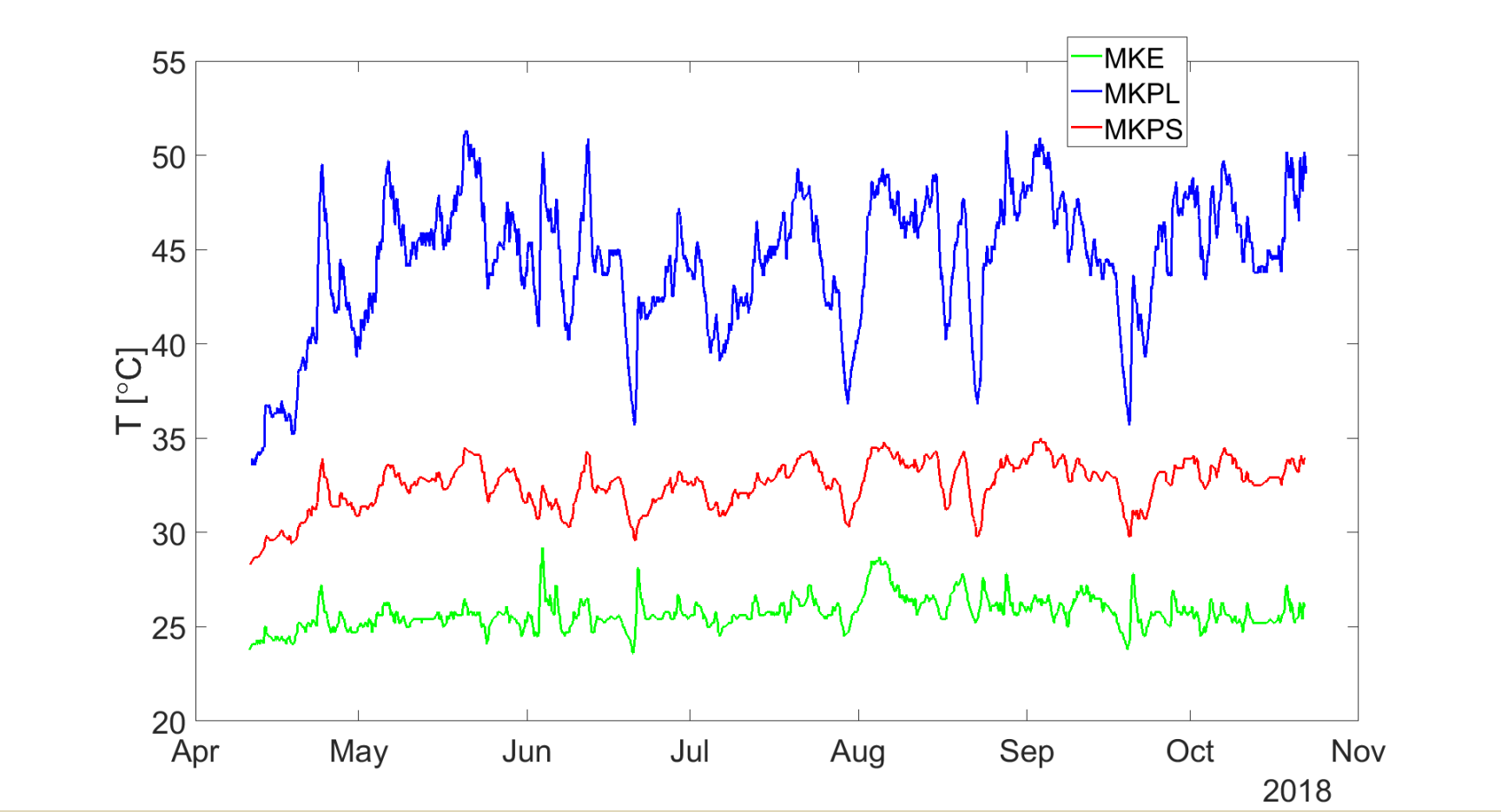
Beam induced heating



MKP-I: Impedance considerations, C. Zannini et al., LIU-SPS 50 ns Injection System for Pb Ions Review, 4 October 2013 (slides).

Present MKPs could strongly suffer of beam induced heating with high intensity beam

2018 thermal behavior of MKPL,MKPS and MKE



Reached high temperatures even without dedicated scrubbing, just from nominal operation and high intensity studies on Thursdays

M. Barnes

Operational Scenarios for SPS

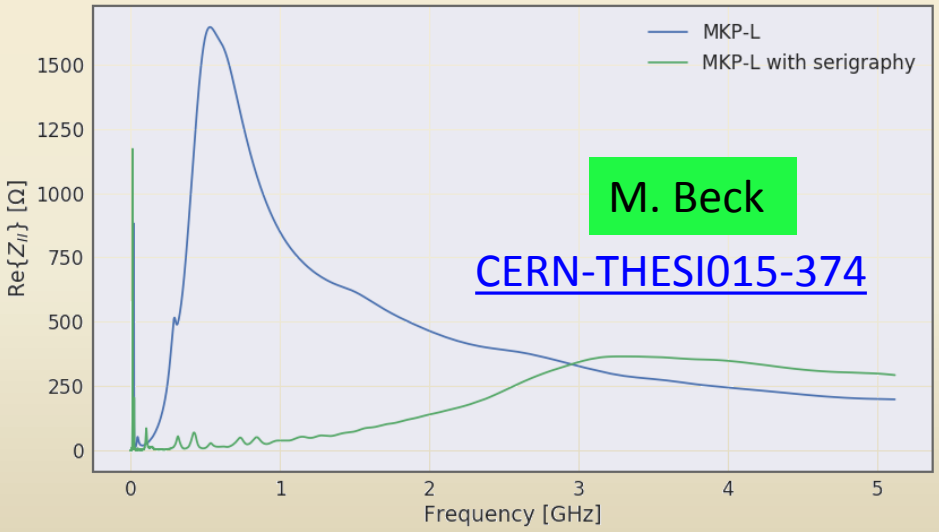
Confident: Below Tc (Curie Temp.)
Could exceed Tc: risk of mis-kicking beam
Risk of mechanical damage
Very low risk of damage
Not OK (> Tc)

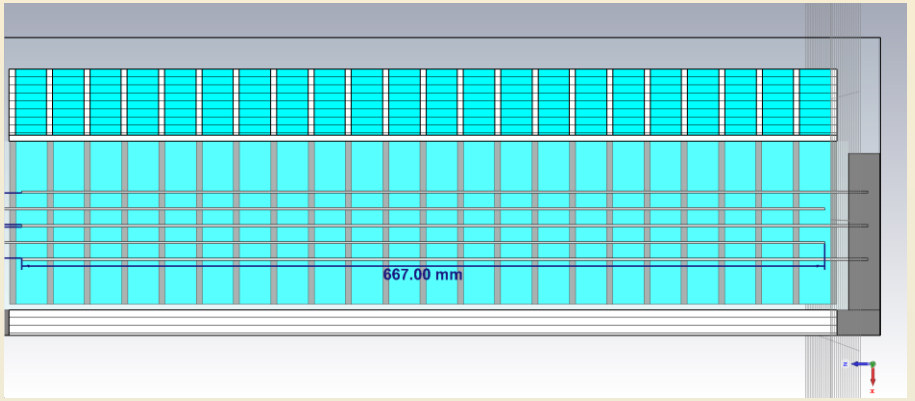
Basic table courtesy Hannes Bartosik, Giovanni Rumolo & Carlo Zannini

enario		trains	Injected p/b	Exrtracted p/b	duty cycle	cycle type	module length [m]	resulting average power loss [W/m]	resulting average power loss per module [W/module]	duration (hours)	repetition	Ferrite Temperature
	2018 operation	3x48	1.33E+11	1.20E+11	50%	acceleration	0.7	149	104	1.5	every 12 hours	OK
	2018 MD	4x48	1.80E+11	1.80E+11	50%	flat bottom	0.7	164	115	10	once per week	OK
scrubbing week	2021 scrubbing	4x72	1.50E+11	1.50E+11	70%	flat bottom	0.7	239	167	continuous	continuous	OK
typical week	2021 operation	4x48	1.44E+11	1.30E+11	50%	acceleration	0.7	220	154	1.5	every 12 hours	OK
	2021 MD	4x72	1.67E+11	1.50E+11	50%	acceleration	0.7	443	310	10	once per week	OK
scrubbing week	2022 scrubbing	4x72	2.00E+11	2.00E+11	70%	flat bottom	0.7	424	297	continuous	continuous	Exceeds TC
typical week	2022 operation	4x48	1.67E+11	1.50E+11	50%	acceleration	0.7	296	207	1.5	every 12 hours	OK
	2022 MD	4x72	2.22E+11	2.00E+11	50%	acceleration	0.7	783	548	10	once per week	Close to TC
scrubbing week	2023 scrubbing	4x72	2.60E+11	2.60E+11	70%	flat bottom	0.7	717	502	continuous	continuous	Not OK
typical week	2023 operation	4x48	2.00E+11	1.80E+11	50%	acceleration	0.7	424	297	1.5	every 12 hours	Exceeds TC
	2023 MD	4x72	2.56E+11	2.30E+11	50%	acceleration	0.7	1074	752	10	once per week	Not OK
typical week	2024 operation	4x48	2.00E+11	1.80E+11	50%	acceleration	0.7	424	297	1.5	every 12 hours	Exceeds TC
	2024 MD	4x72	2.56E+11	2.30E+11	50%	acceleration	0.7	1074	752	10	once per week	Not OK

MKP impedance reduction

Concept with longitudinal serigraphy exists (4, 5 and 6 stripes)



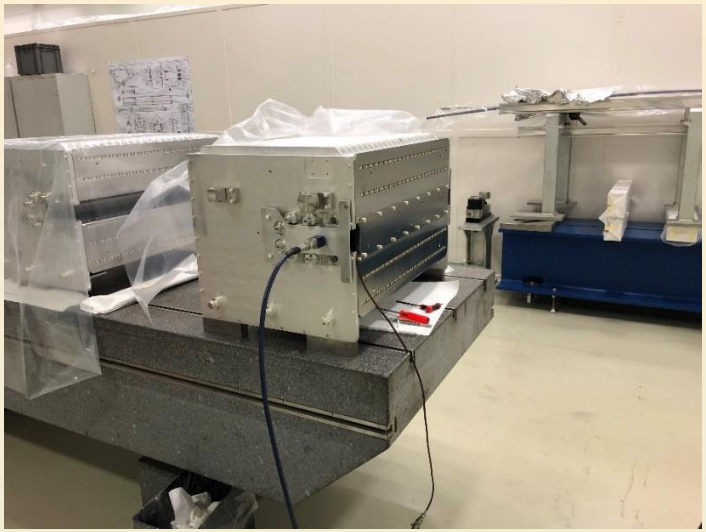


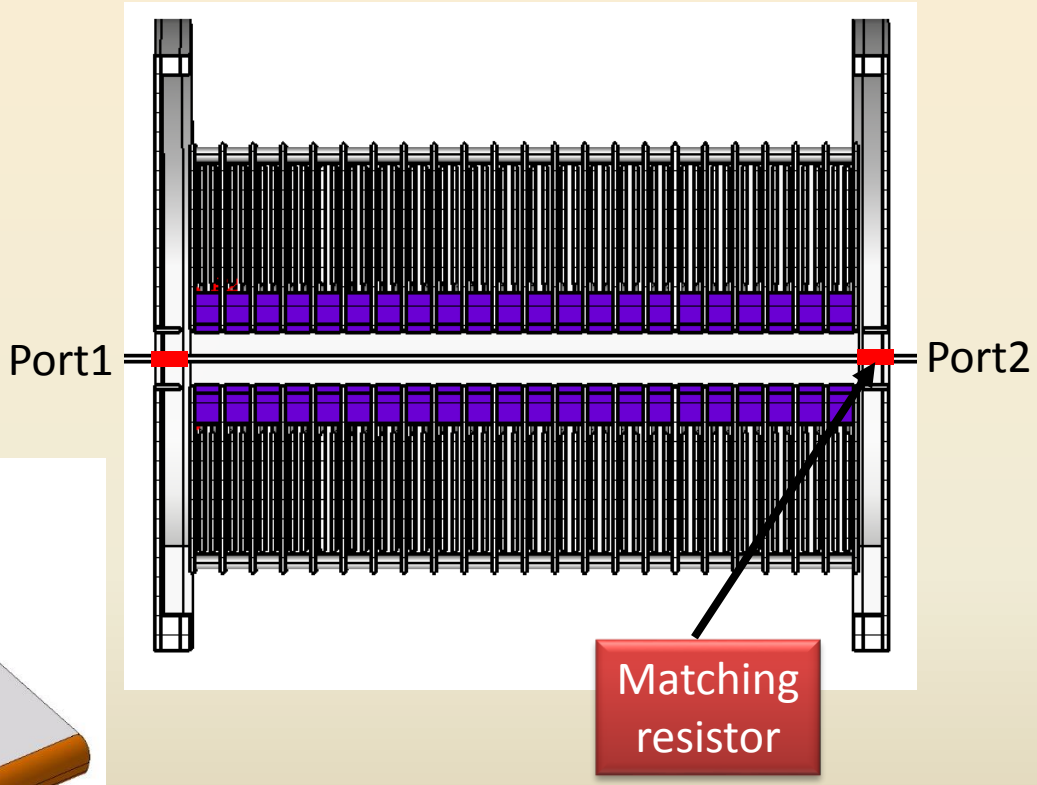
Q20	PL per LHC fill cycle
MKP-L	874 W
MKP-S	234 W
MKP-L ser. (6 stripes)	28 W
MKP-L ser. (4 stripes)	99 W

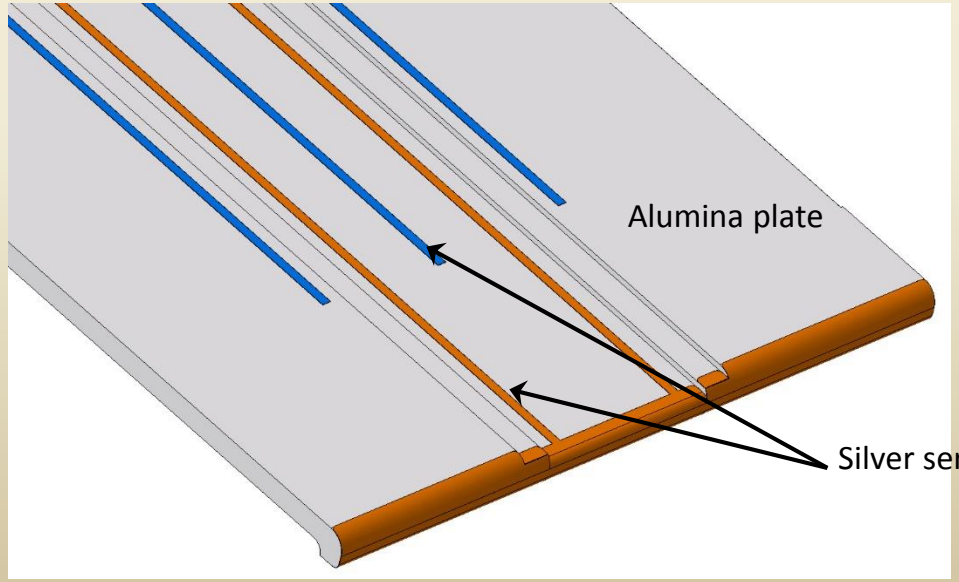
Impact on beam stability has been studied and estimated to be negligible

C. Zannini, I. Karpov, Impact of new MKP-L serigraphy, summary from BD analysis. Presented at the LIU-SPS coordination meeting, March 2020.

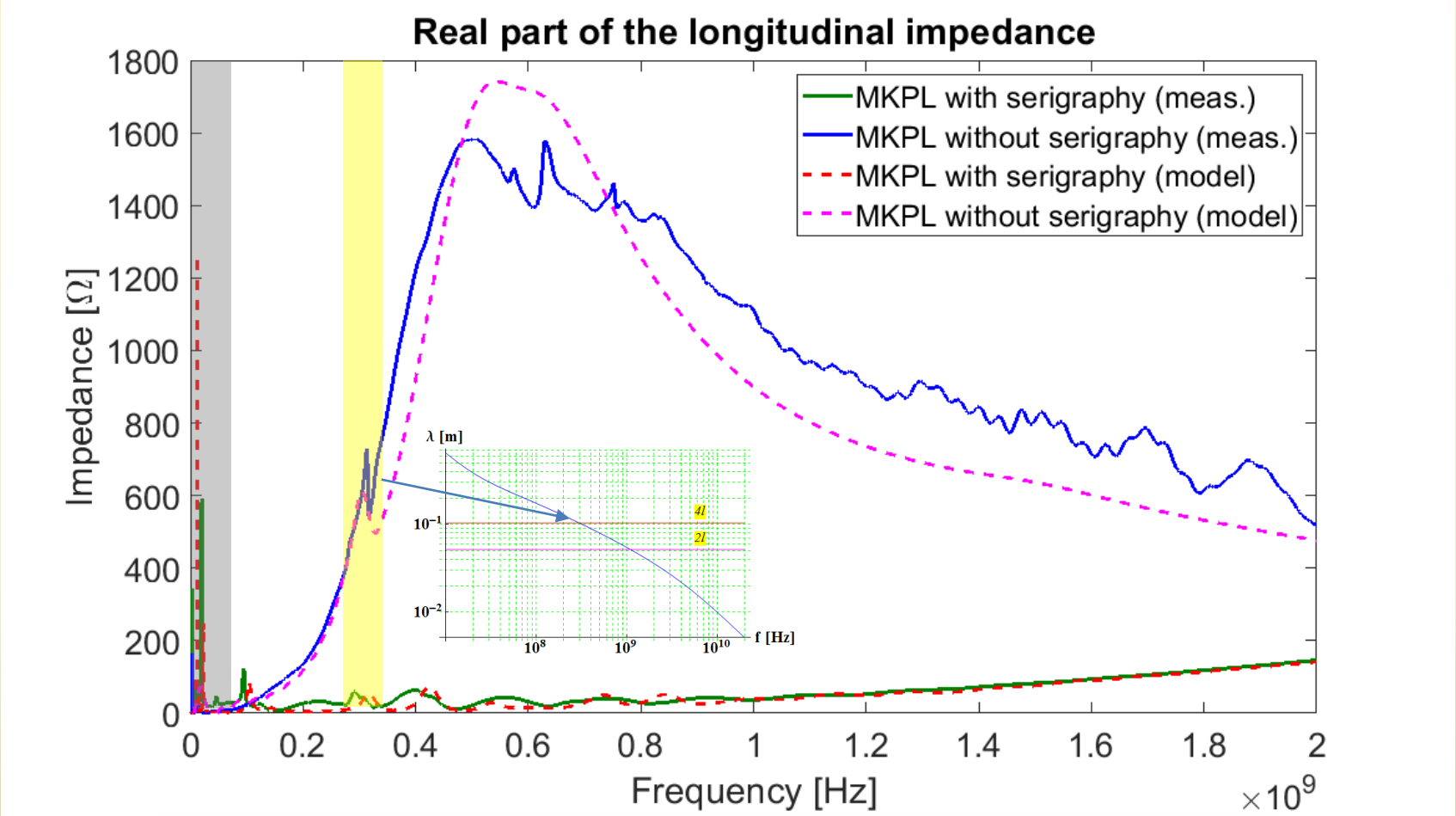
MKP impedance measurements







MKP impedance measurements



Good agreement between simulation models and measurements

Frequency shift of the peak due to serigraphy probably due to the effect of wire and terminations

Summary

- The MKPL was predicted to suffer of beam induced heating with LIU beam already in 2013
  - 2018 temperature data confirm the criticality of the kicker
- The MKPL is expected to limit operation and scrubbing during run III
- Impedance mitigation solution is available and validated with impedance measurements
  - Ongoing: simulation of the measurement setup (C. Antuono)

Thank you very much for your attention