Loss maps for crystal-assisted Pb collimation

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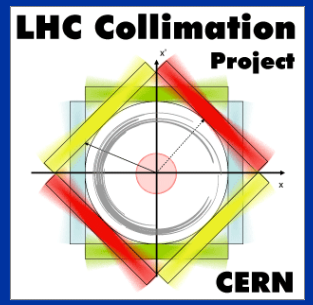
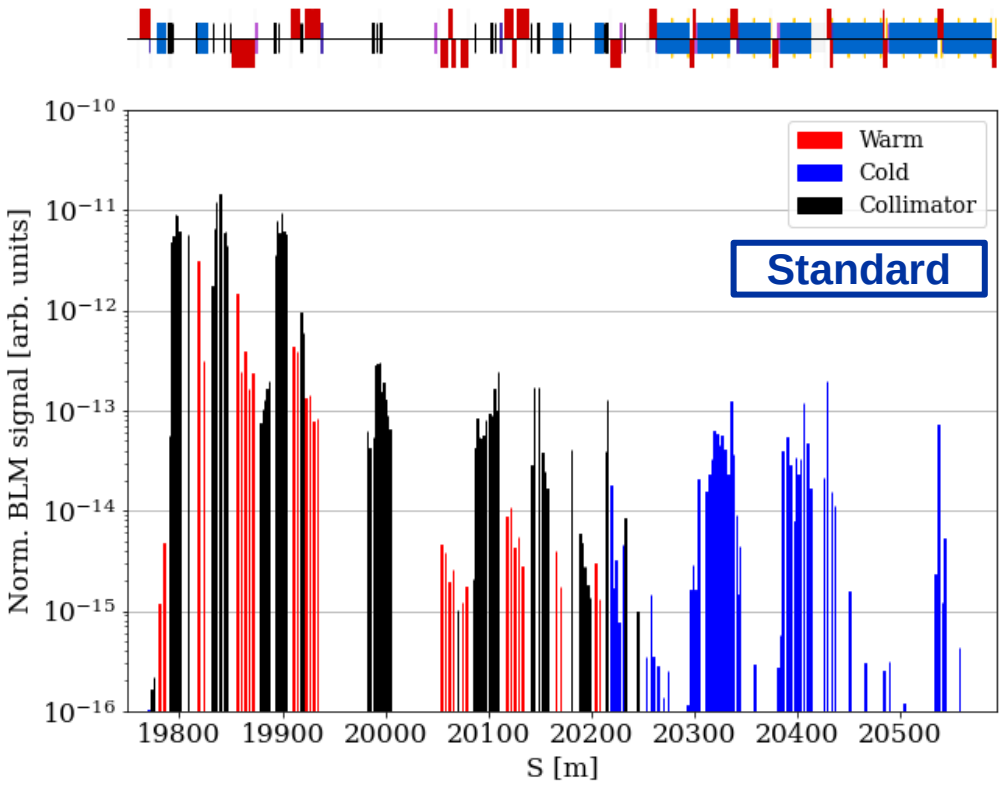
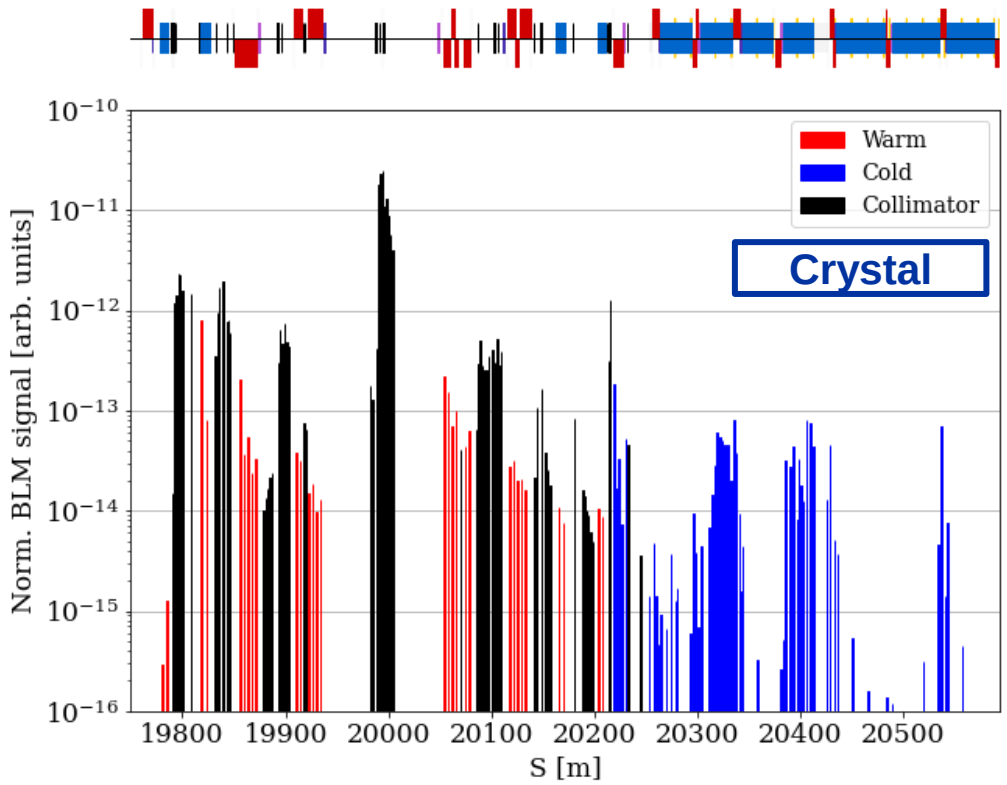


Introduction

- **Crystal collimation** planned to be used operationally during 2023 Pb ion run
- Very different cleaning dynamics with respect to standard collimation: **very different loss pattern**





- **Dedicated set of BLM thresholds needed to respect desired beam loss limits**
- First assessment based on loss maps performed during 2022 Pb ion beam tests

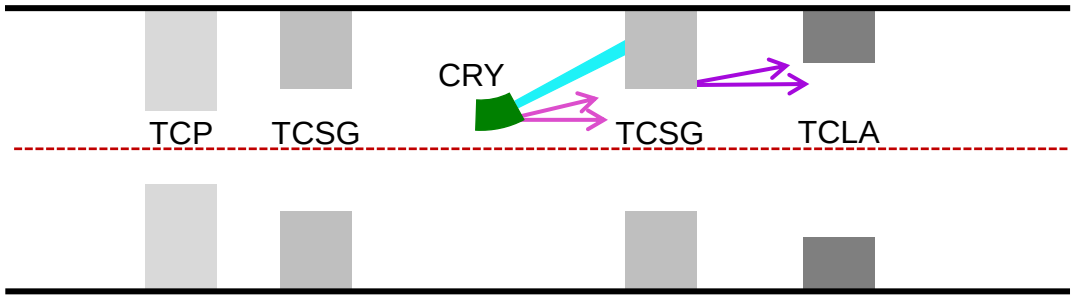
IR7 collimator settings in 2022 loss maps with ions

Configurations tested at 6.8 Z TeV

- **Channeling**: crystals at 4.75 in optimal channeling orientation, everything else at nominal settings
- **Amorphous**: crystals at 4.75 with large angular misalignment, everything else at nominal settings
- **Standard**: nominal settings

Configurations tested at 450 Z TeV

- **Channeling**: crystals at 5.7 in optimal channeling, TCPs and TCSGs upstream of absorber of channeled halo retracted, everything else at nominal settings
- **Standard**: nominal settings



Note: these are not the final operational settings (see previous talk by R. Cai), but loss maps used as starting point to define new BLM thresholds

Loss map analysis

Target power loss

- $P_{max} = 50$ **kW** with crystal collimation in optimal channeling (initial target)
- Crystal collimation in optimal channeling used as primary reference for definition of thresholds

Upscaling of BLM signals

- **Normalization**: BLM signals divided by instantaneous rate of lost charges (calculated from BCT signal derivative)

$$\mathrm{BLM}_i^{\mathrm{norm}}(t_0)\left[\frac{\mathrm{Gy}}{\mathrm{charge}}\right] = \frac{\mathrm{BLM}_i(t_0)\left[\frac{\mathrm{Gy}}{\mathrm{s}}\right] - \mathrm{BKG}_i\left[\frac{\mathrm{Gy}}{\mathrm{s}}\right]}{\left|\frac{dI}{dt}(t_0)\right|\left[\frac{\mathrm{charge}}{\mathrm{s}}\right]}$$

t_0 timestamp of max losses

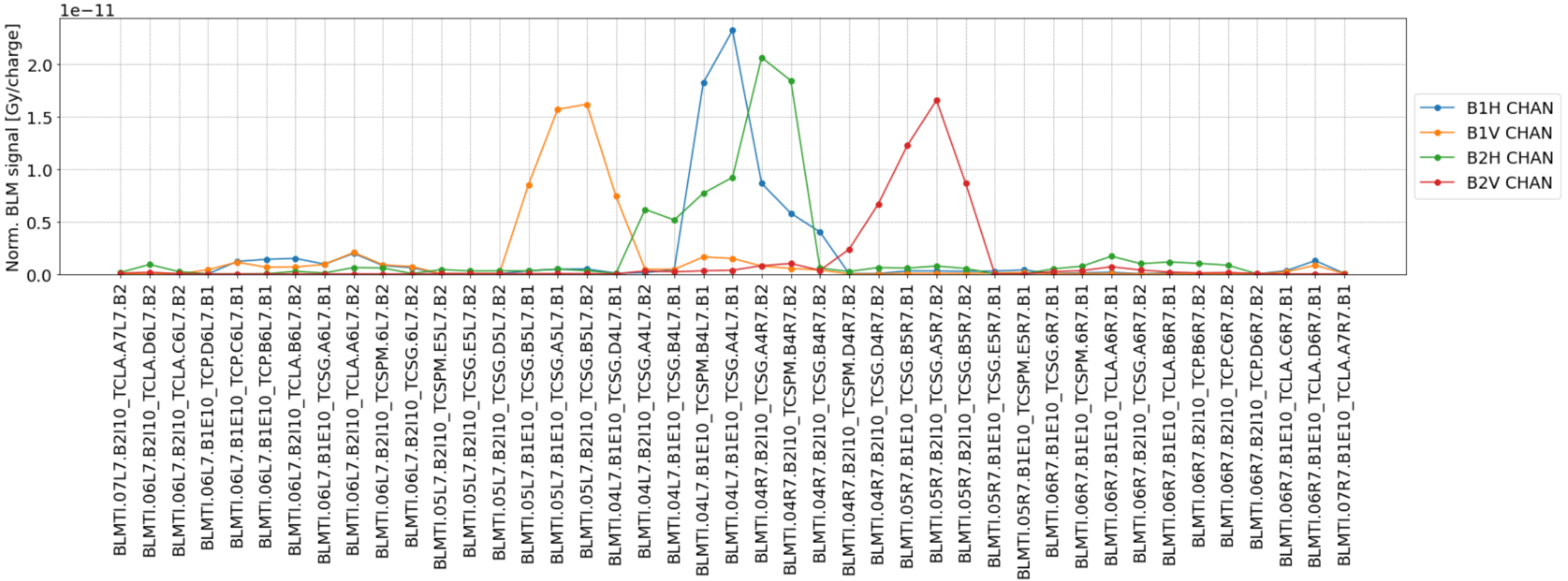
- **Upscaling**: normalized BLM signals multiplied by rate of lost charges corresponding to target power loss

$$\mathrm{Rate}_{max}\left[\frac{\mathrm{charge}}{\mathrm{s}}\right] = \frac{P_{max}[\mathrm{W}]}{E_{beam}\left[\frac{\mathrm{J}}{\mathrm{charge}}\right]} \Rightarrow \mathrm{BLM}_i^{\mathrm{upscaled}}(t_0)\left[\frac{\mathrm{Gy}}{\mathrm{s}}\right] = \mathrm{BLM}_i^{\mathrm{norm}}(t_0)\left[\frac{\mathrm{Gy}}{\mathrm{charge}}\right] \cdot \mathrm{Rate}_{max}\left[\frac{\mathrm{charge}}{\mathrm{s}}\right]$$

- **Comparison**: upscaled BLM signals compared to currently applied thresholds

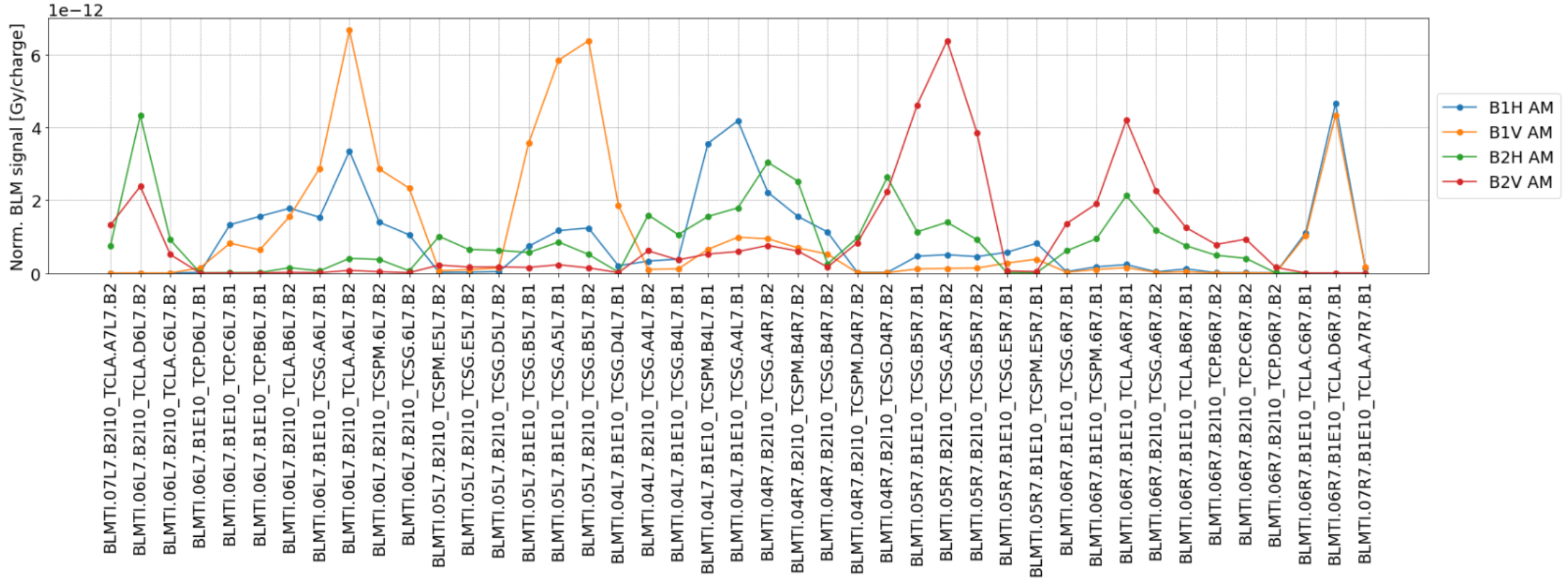
IR7 collimators overview – Crystals in channeling

- **Envelope** can be defined by taking maximum signal across all loss maps for each BLM



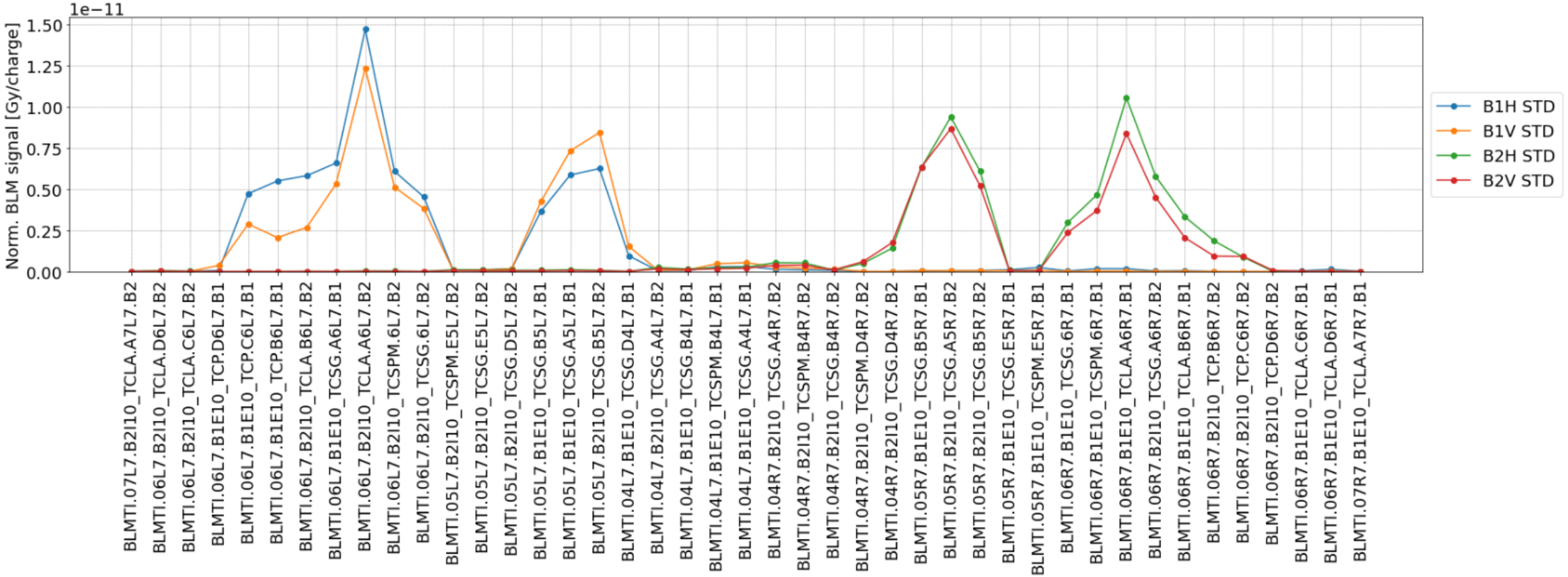
IR7 collimators overview – Crystals in amorphous

- **Envelope** can be defined by taking maximum signal across all loss maps for each BLM

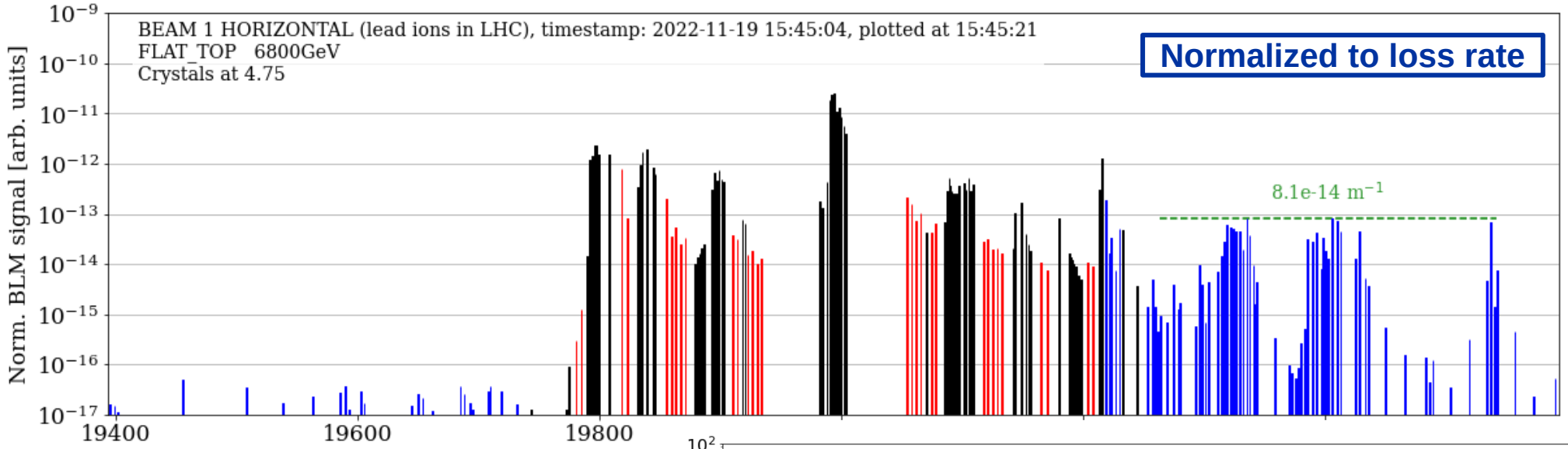


IR7 collimators overview – Standard

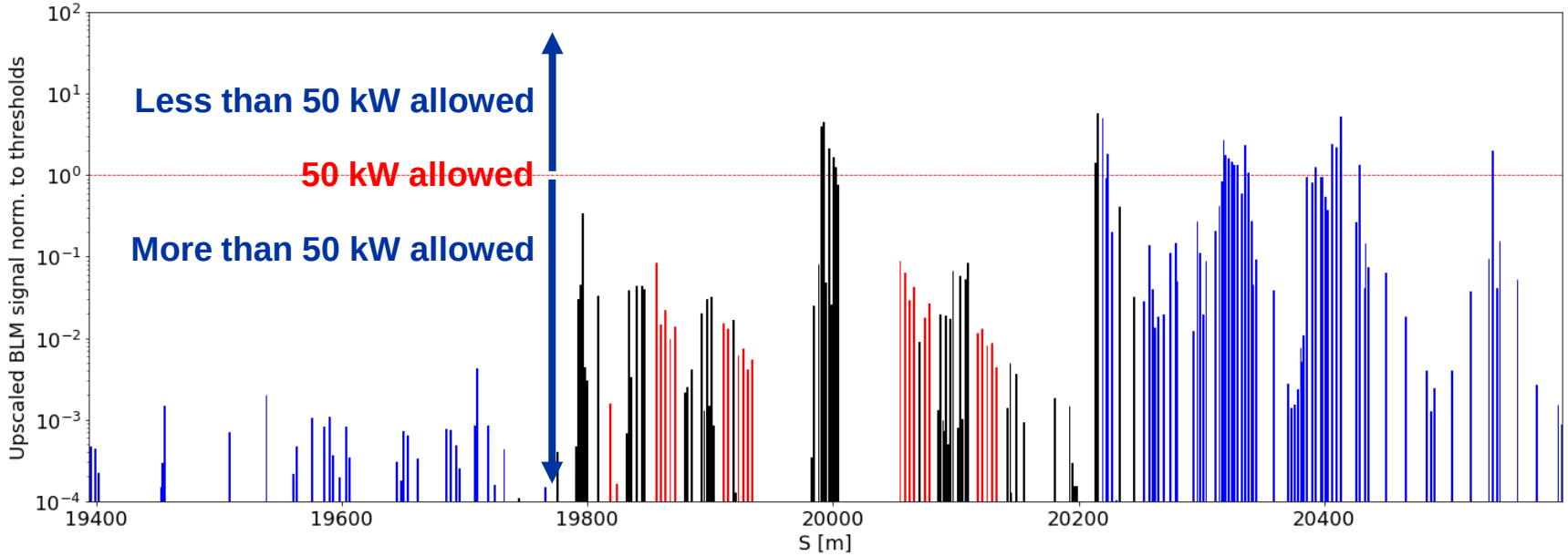
- **Envelope** can be defined by taking maximum signal across all loss maps for each BLM



Example of upscaling – B1H crystal in channeling

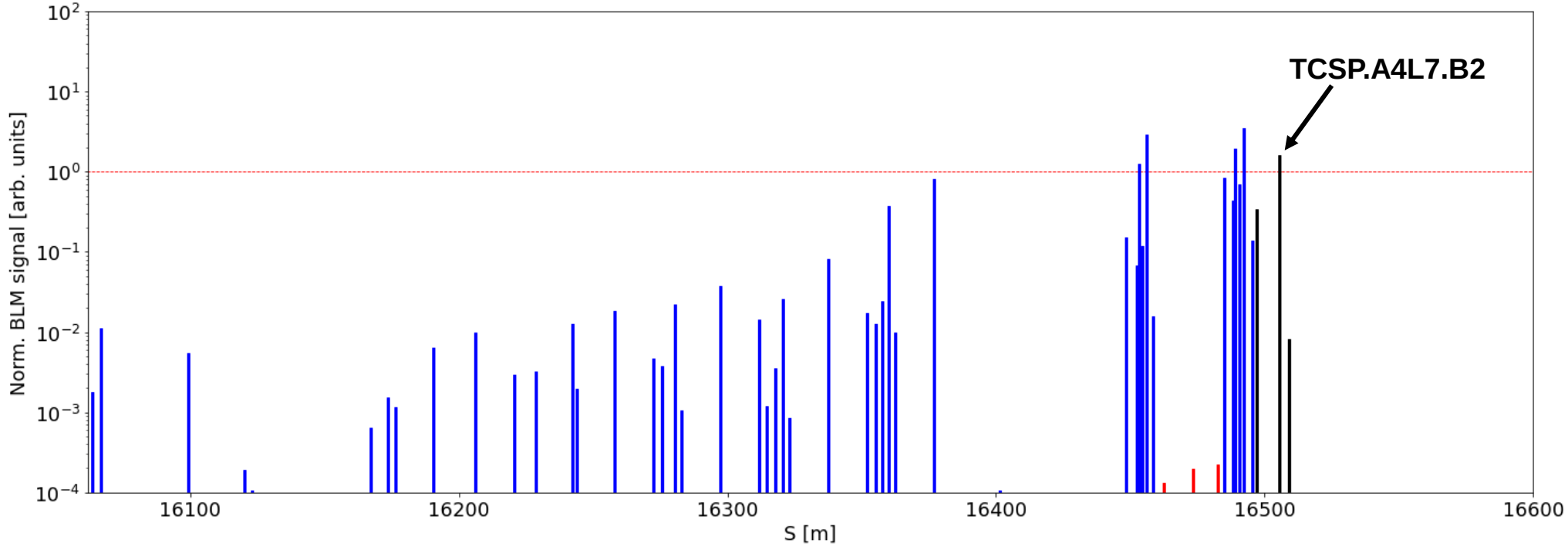


Upscale to 50 kW and divide by current applied thresholds



Other limitations outside of IR7

- Extending the analysis, **limitation found in IR6 due to showers from TCSP collimator** in loss maps for Beam 2 horizontal: option to mitigate losses by adjusting TCSP setting to be investigated in commissioning



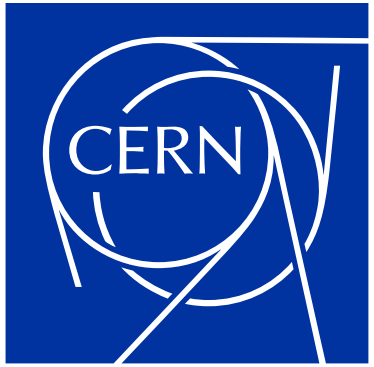
- **A few other single BLMs** show up depending on the beam and plane, **mainly in IR3**
- **Note**: Losses on TCTs could not be checked as they were open during 2022 loss maps

Conclusions

- **Crystal collimation for Pb ions** requires a **dedicated set of BLM thresholds** due to the very different loss pattern from standard collimation
- First analysis of thresholds for IR7 collimators based on BLM signals in **loss maps performed during 2022 Pb ion beam test**, upscaled to target power loss of 50 kW
- **Current strategy**: thresholds based on configuration with crystal in channeling (dump at target power loss), then applied also to other scenarios (dump at lower power loss)
- More **details** on proposed families and BLM thresholds in **next talk by A. Lechner**

Outlook

- 2022 loss maps do not feature the final operational settings: **important to quickly review results after first loss maps with final configuration available**
- Verification and setup of new thresholds would **benefit from a test earlier than the commissioning time**, leaving some time for analysis before the intensity ramp up
- **Limitation in IR6 and other locations** to be checked and potentially addressed by adjusting collimator settings



Thank you for your attention!

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