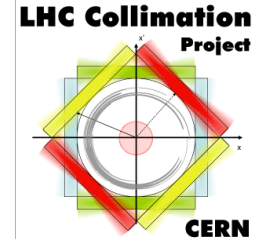




# MD4168 - Crystal Collimation Tests with Pb Ion Beams

**M. D'Andrea**, E. Belli, A. Fomin, D. Mirarchi, S. Redaelli, R. Rossi, W. Scandale

Acknowledgements: UA9 Collaboration, BE-ABP, BE-OP, EN-SMM, EN-STI



# Overview of measurements

27<sup>th</sup> November 2018 – 12 hours

## Goal of the MD

Complete characterization of crystal devices and evaluation of crystal collimation performance with Pb ion beams

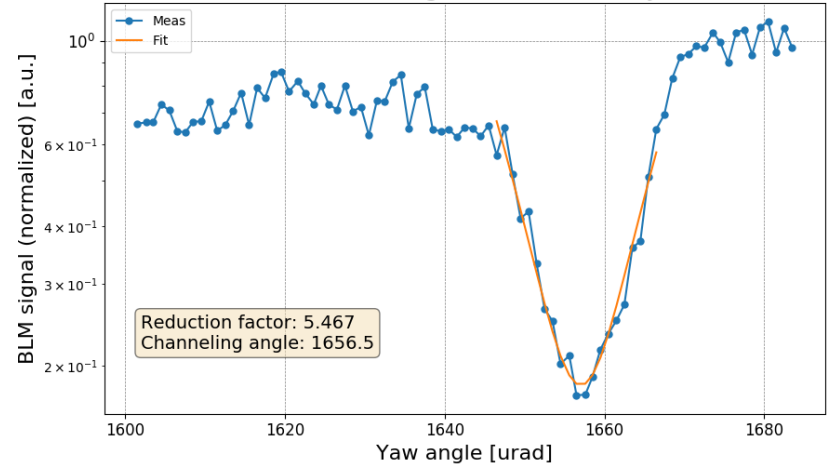
## Program completed

- Angular and linear scans at injection and flat top
- Loss maps at flat top with different collimator settings
- Crystals kept in channeling during squeeze
- Crystals left in with sustained losses on all four planes at the same time

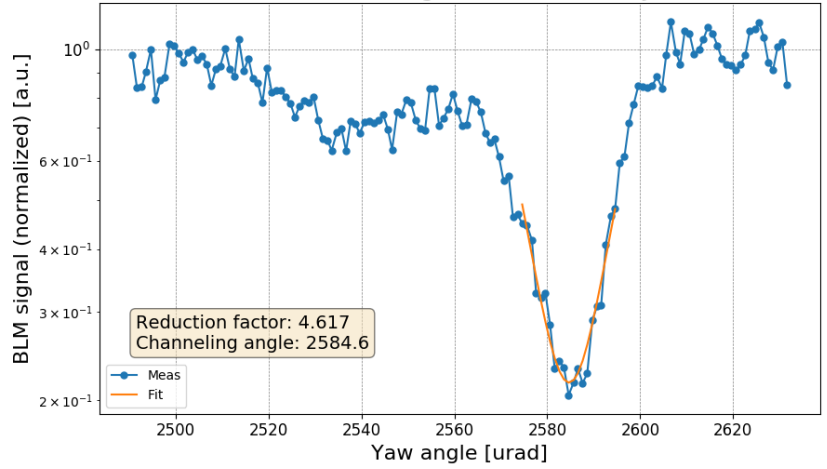
High intensity fill originally planned but not performed in favor of more measurements at top energy in the first fill

# Angular scans at injection

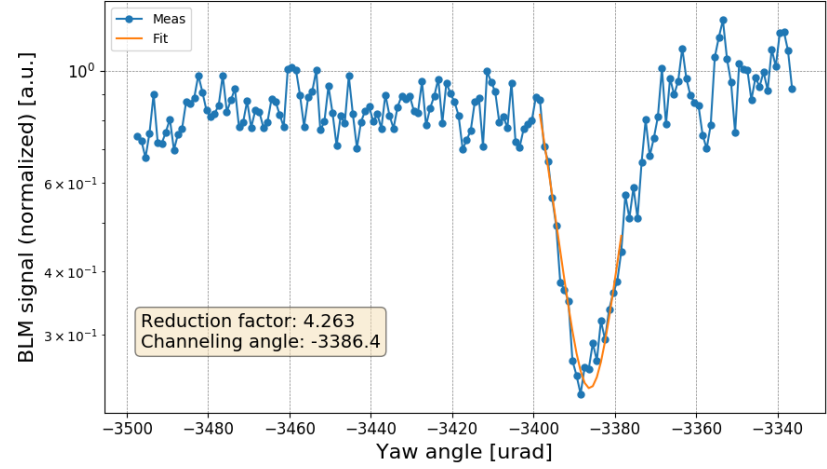
Measured angular scan - B1H INJ



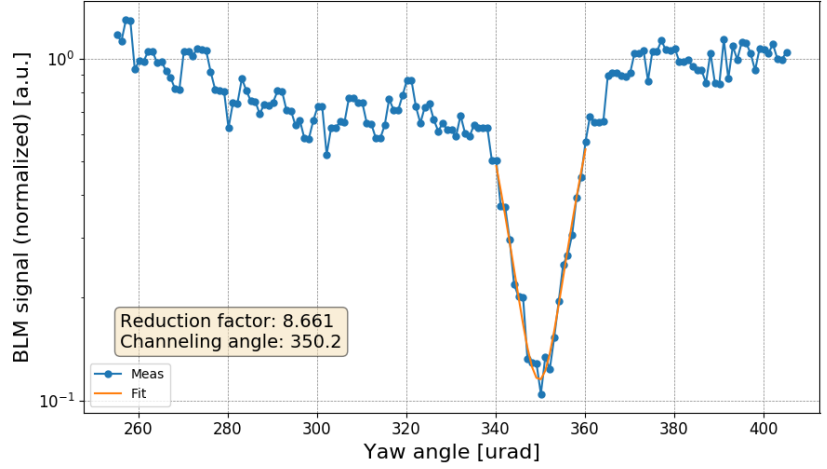
Measured angular scan - B1V INJ



Measured angular scan - B2H INJ

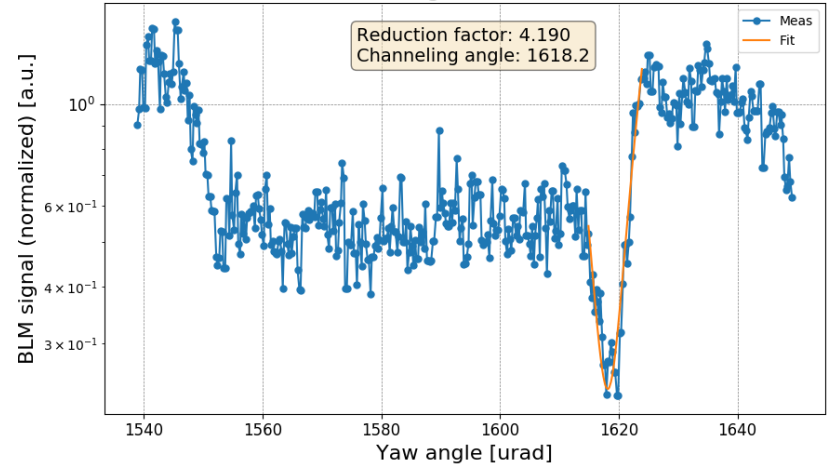


Measured angular scan - B2V INJ

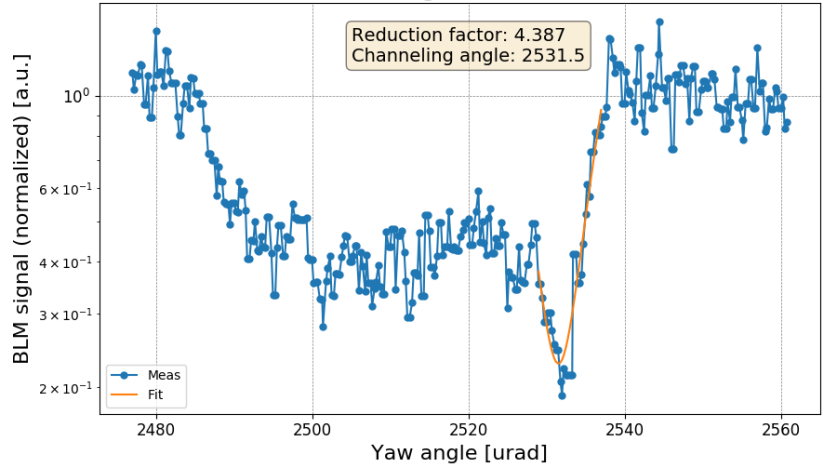


# Angular scans at flat top

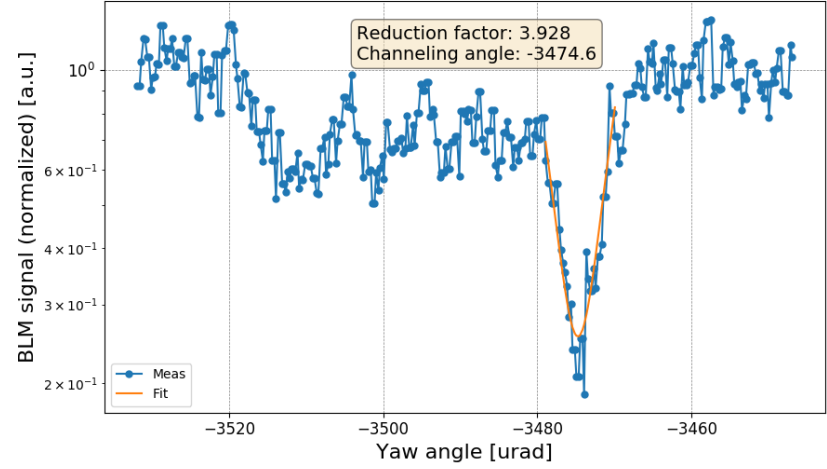
Measured angular scan - B1H FT



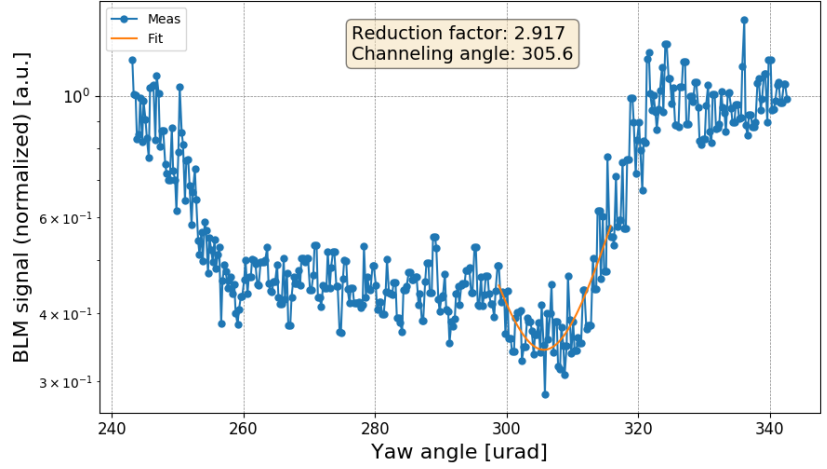
Measured angular scan - B1V FT



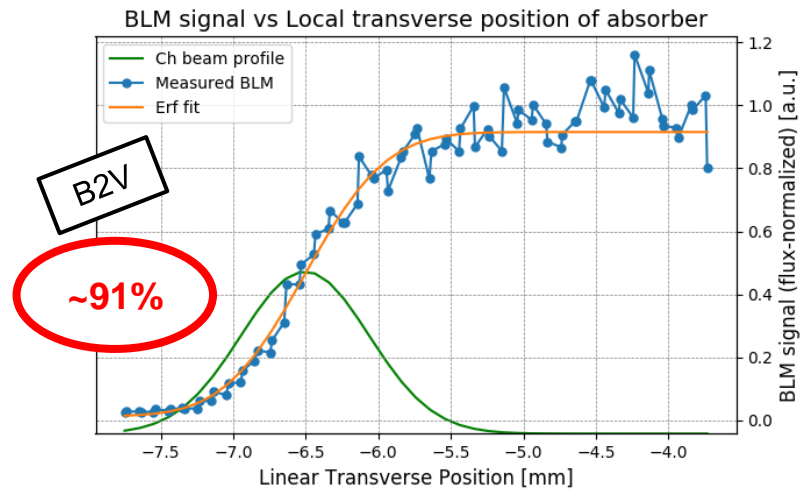
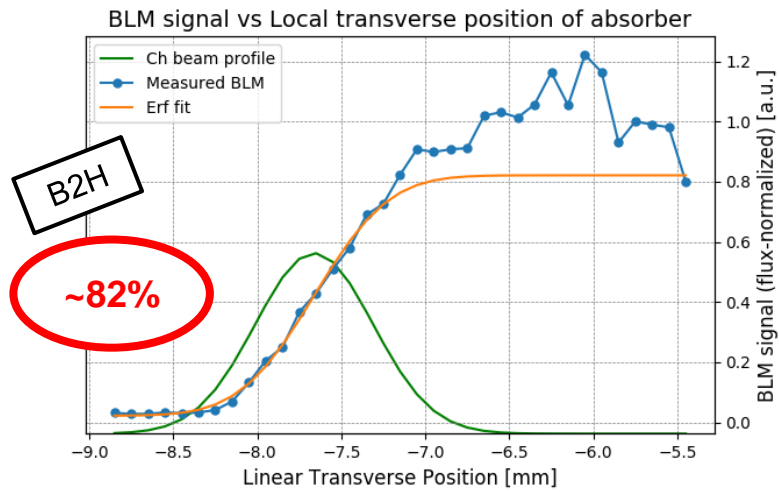
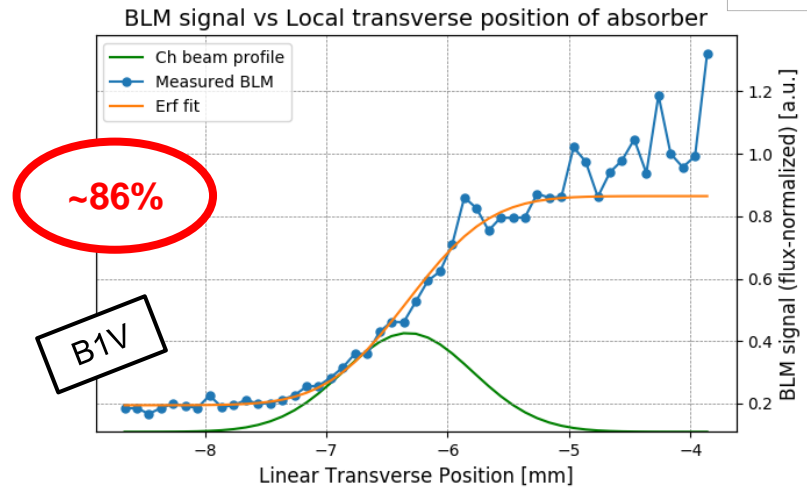
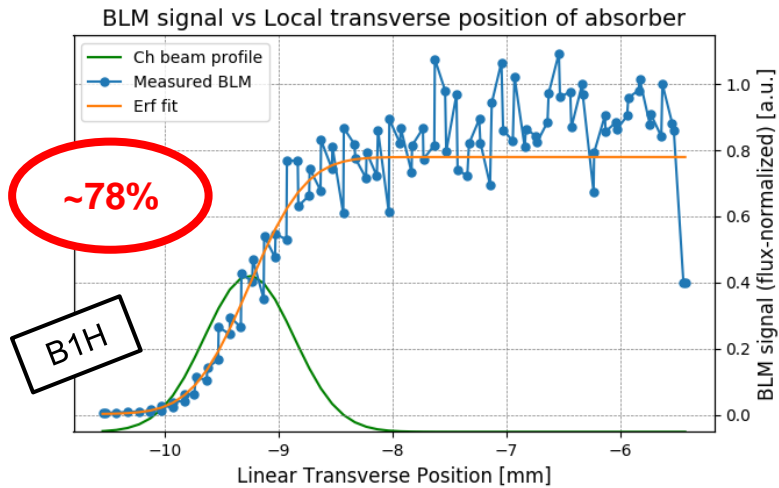
Measured angular scan - B2H FT



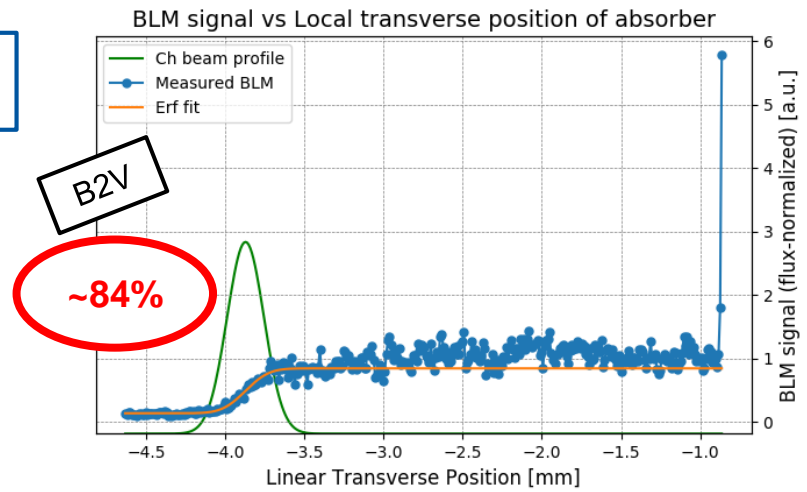
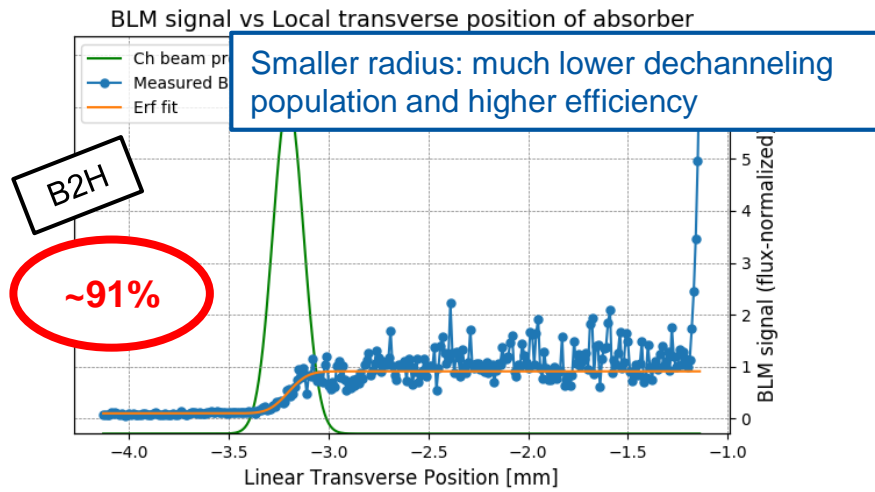
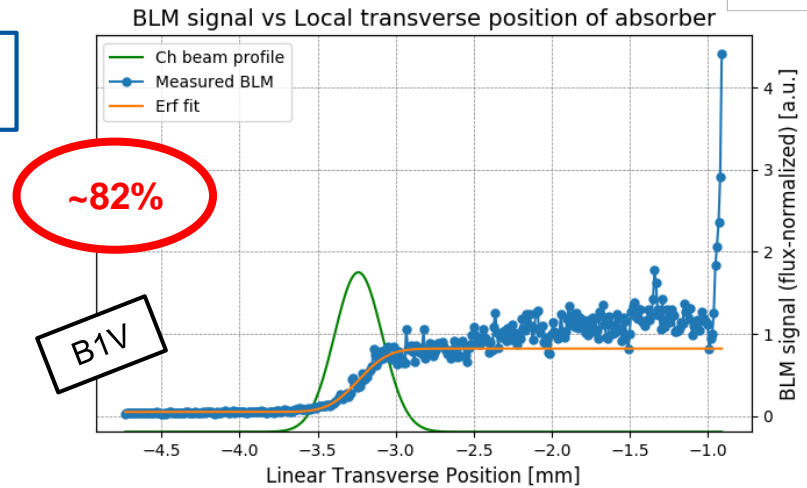
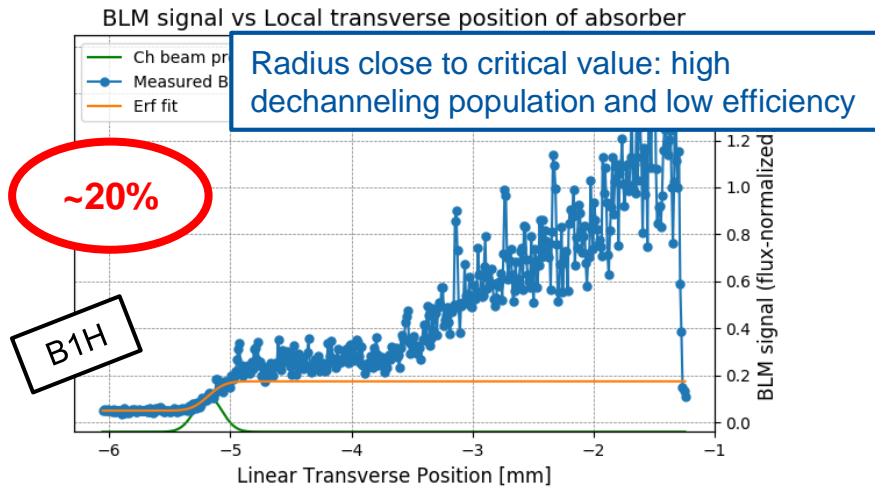
Measured angular scan - B2V FT



# Linear scans at injection



# Linear scans at flat top



# Loss maps at flat top

Extensive loss map campaign (~ 90 in total) with many different configurations to be compared with the standard collimation system

Crystals kept at  $5.0 \sigma$

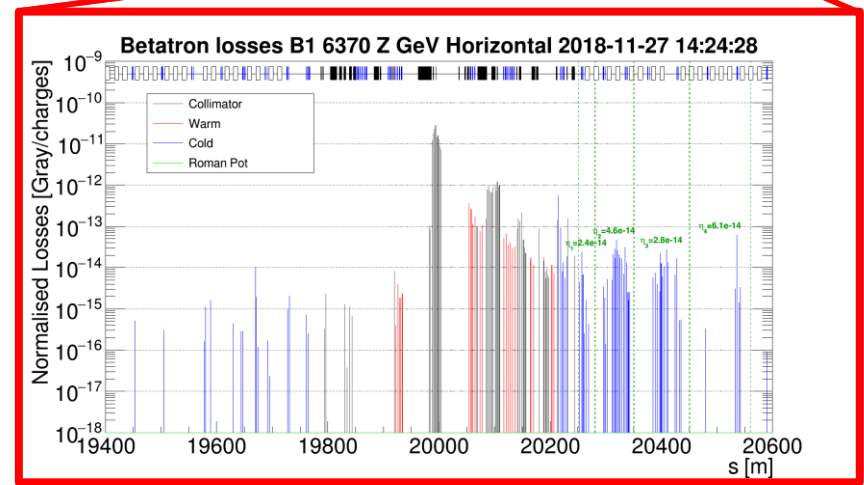
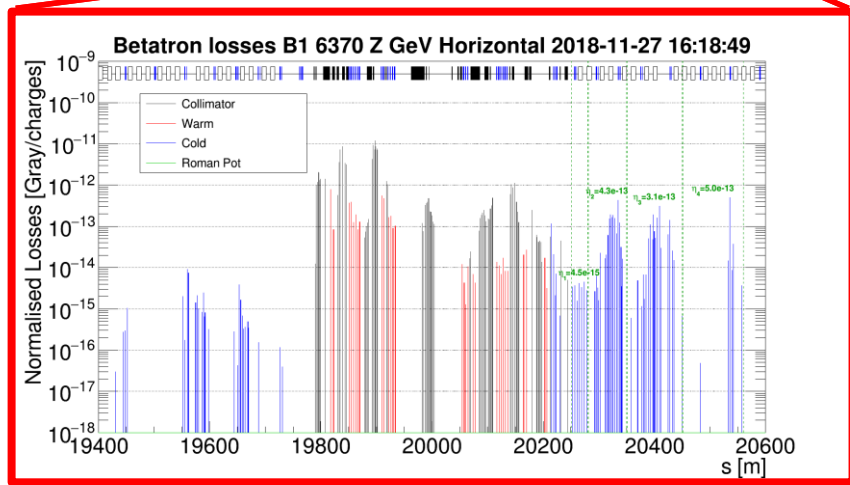
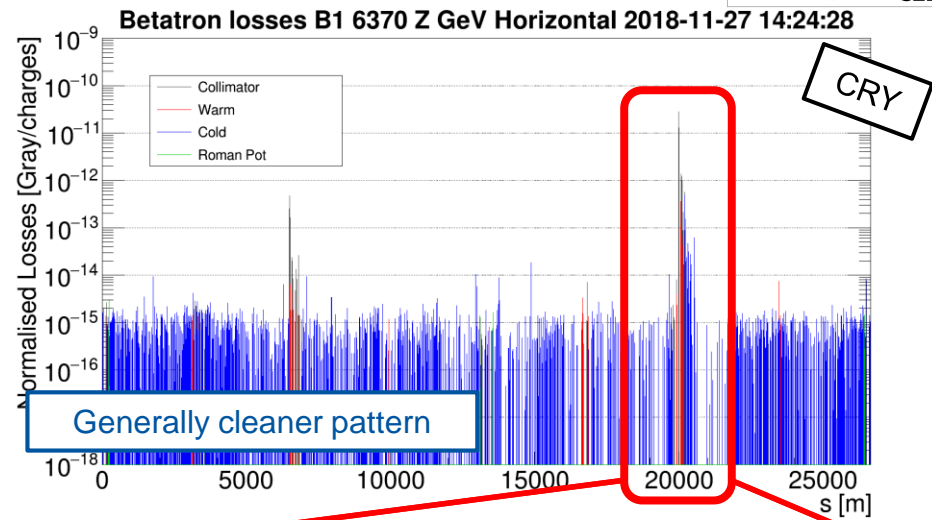
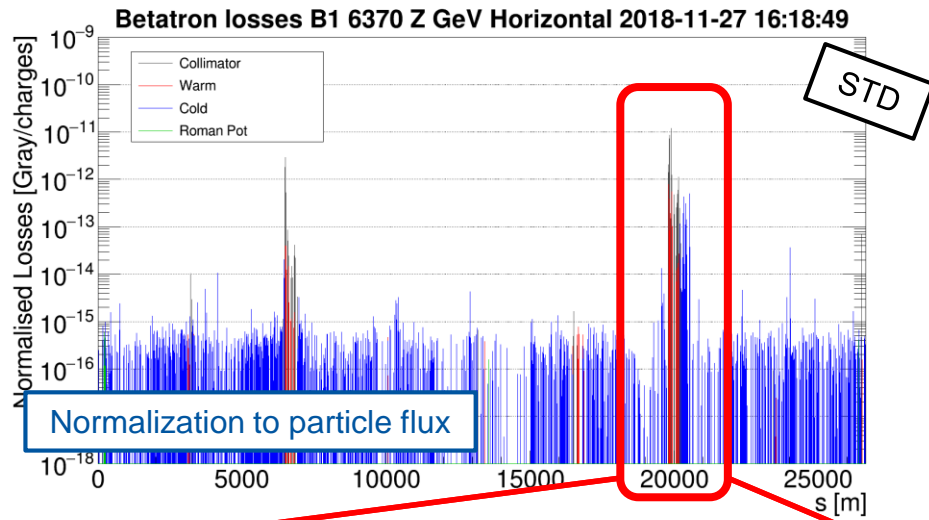
Downstream TCSGs	TCLAs
$6.5 \sigma$	$10.0 \sigma$
$6.5 \sigma$	$9.0 \sigma$
$6.5 \sigma$	$8.0 \sigma$
$6.5 \sigma$	$7.0 \sigma$

Downstream TCSGs	TCLAs
$9.0 \sigma$	$9.0 \sigma$
$8.0 \sigma$	$8.0 \sigma$
$7.0 \sigma$	$7.0 \sigma$
$6.0 \sigma$	$6.0 \sigma$

Loss maps with the standard system are performed with TCPs and TCSGs upstream the crystals in place, while applying the same changes above to the downstream collimators



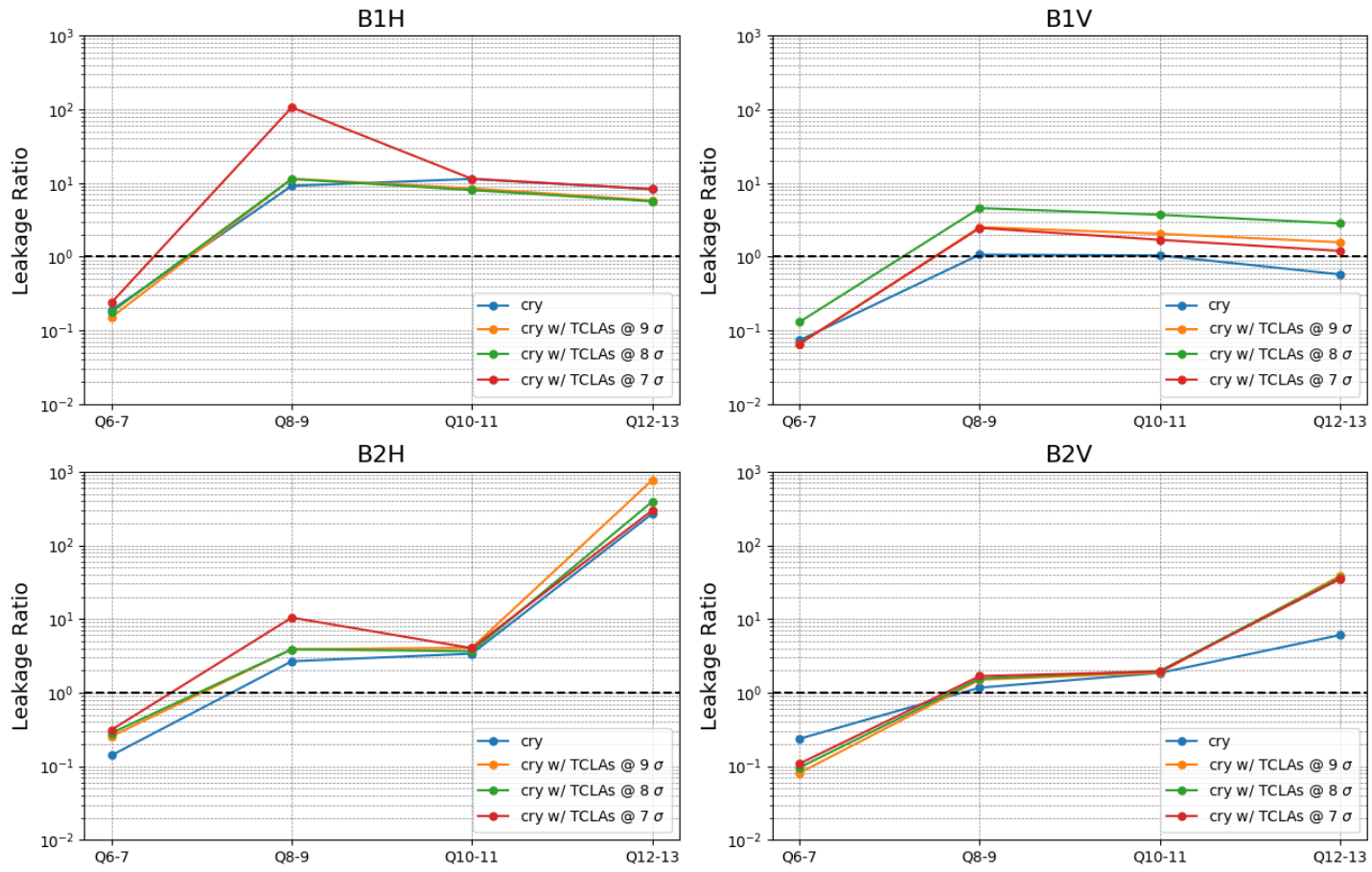
# Std and Cry system comparison



# Cleaning inefficiency comparison

Only TCLAs moved

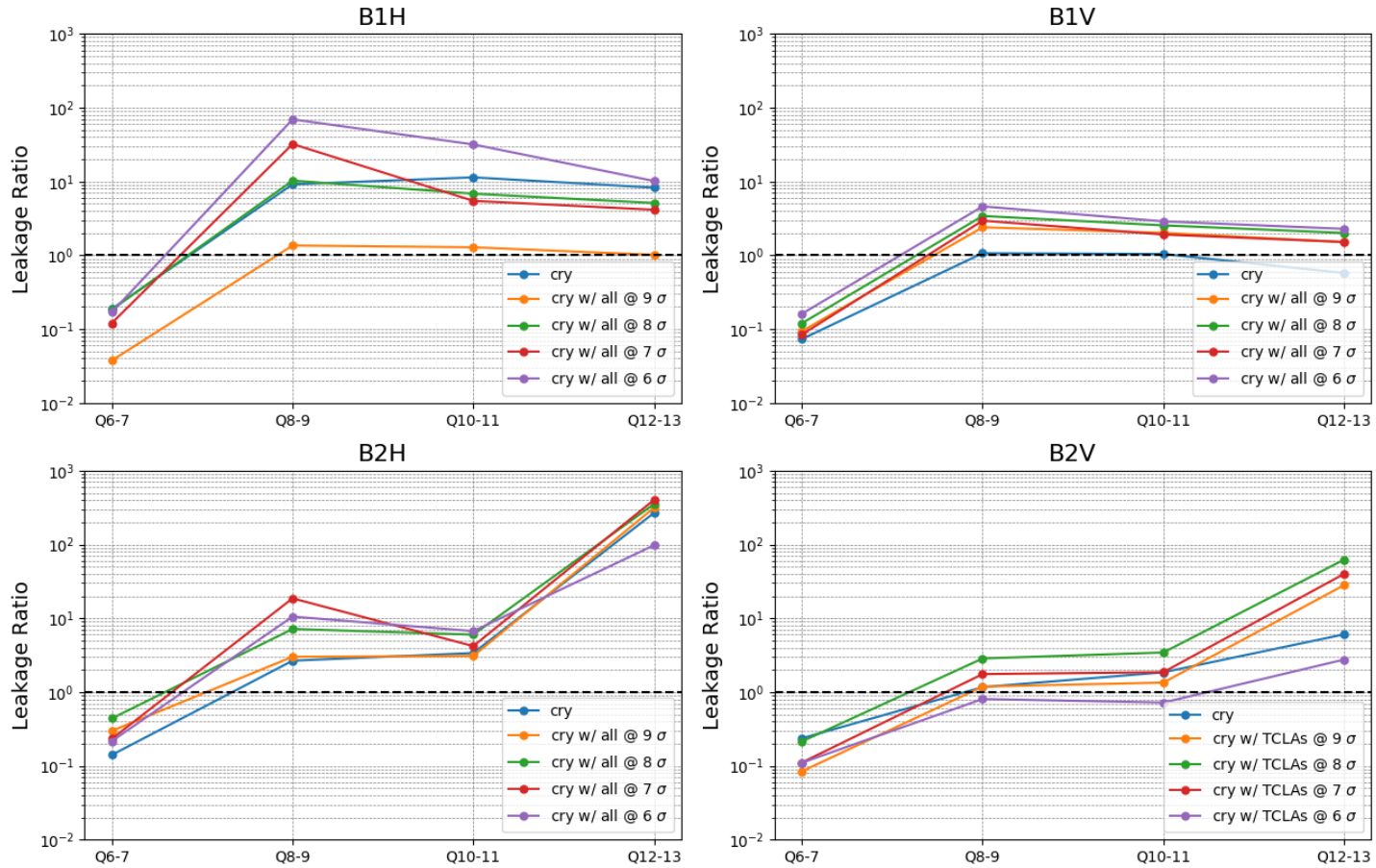
Leakage ratio (std/cry)



# Cleaning inefficiency comparison

Downstream TCSGs and TCLAs moved

Leakage ratio (std/cry)

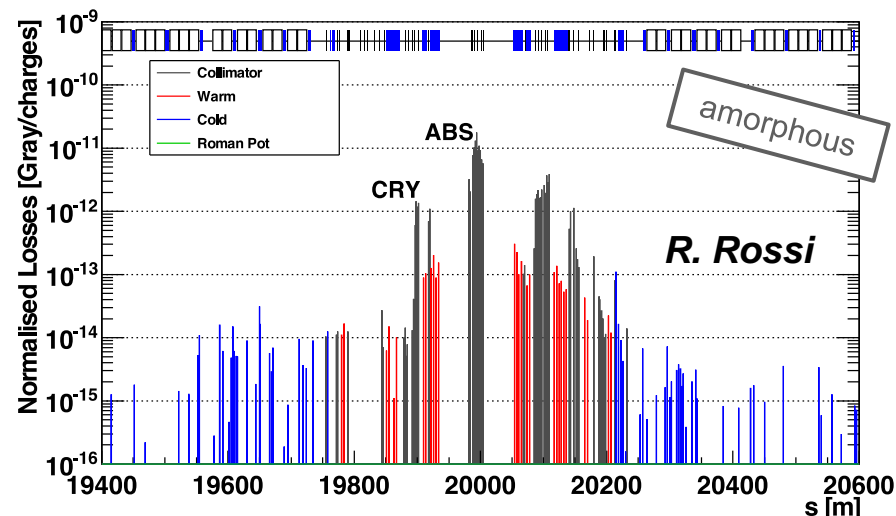
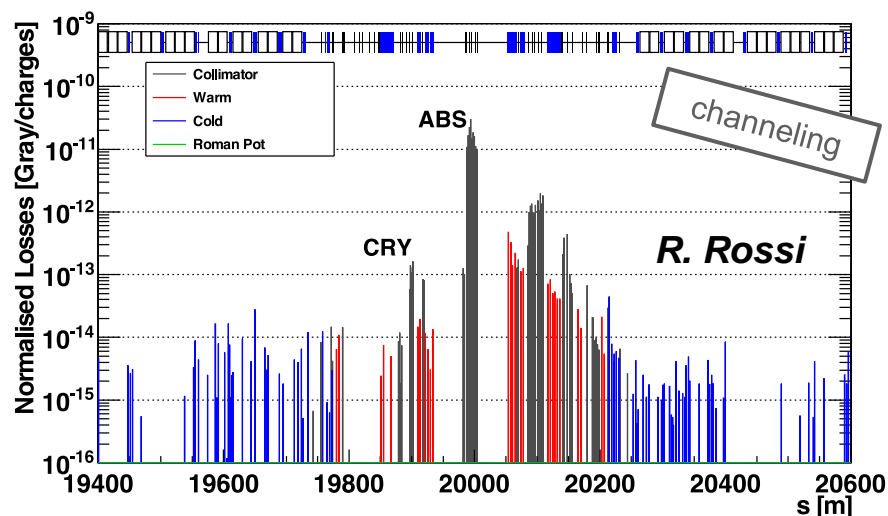


# Cry collimation in dynamical phases

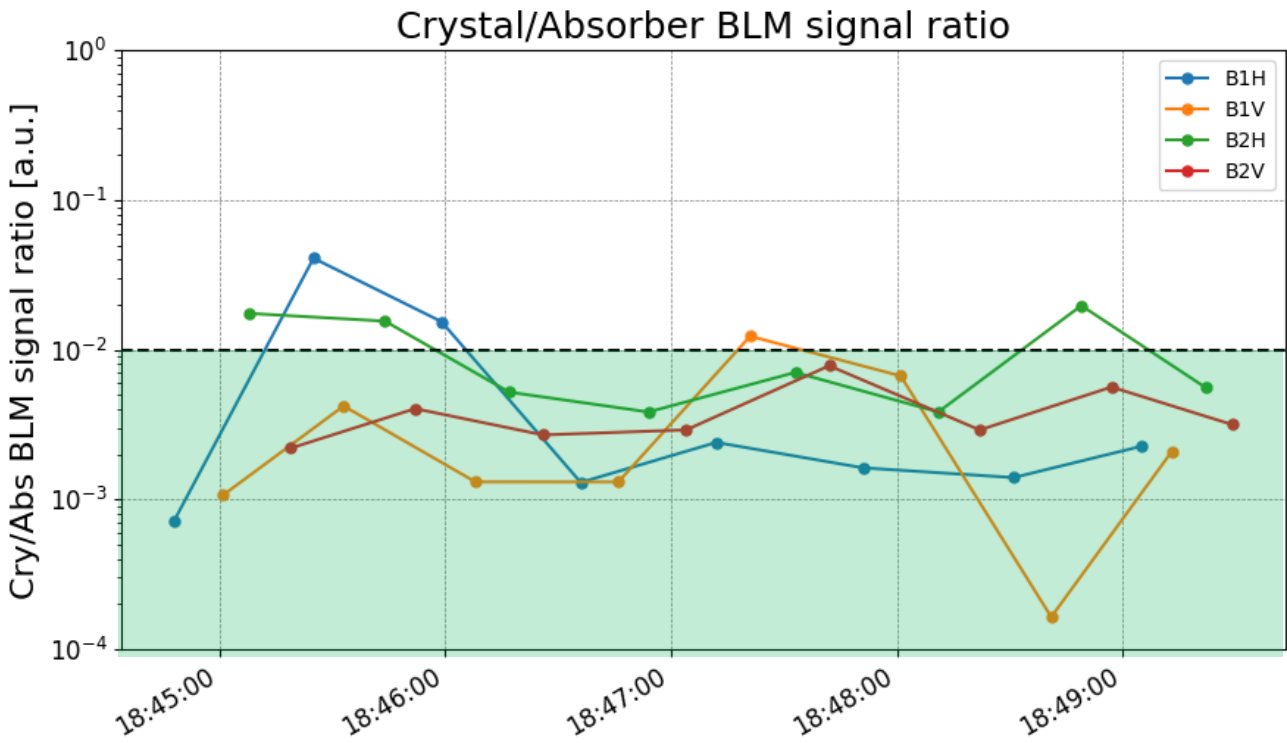
Channeling conditions assessed by means of continuous loss maps

Figure of merit: ratio of losses at the crystal and at the corresponding absorber

Channeling conditions are kept if the ratio is below  $10^{-2}$



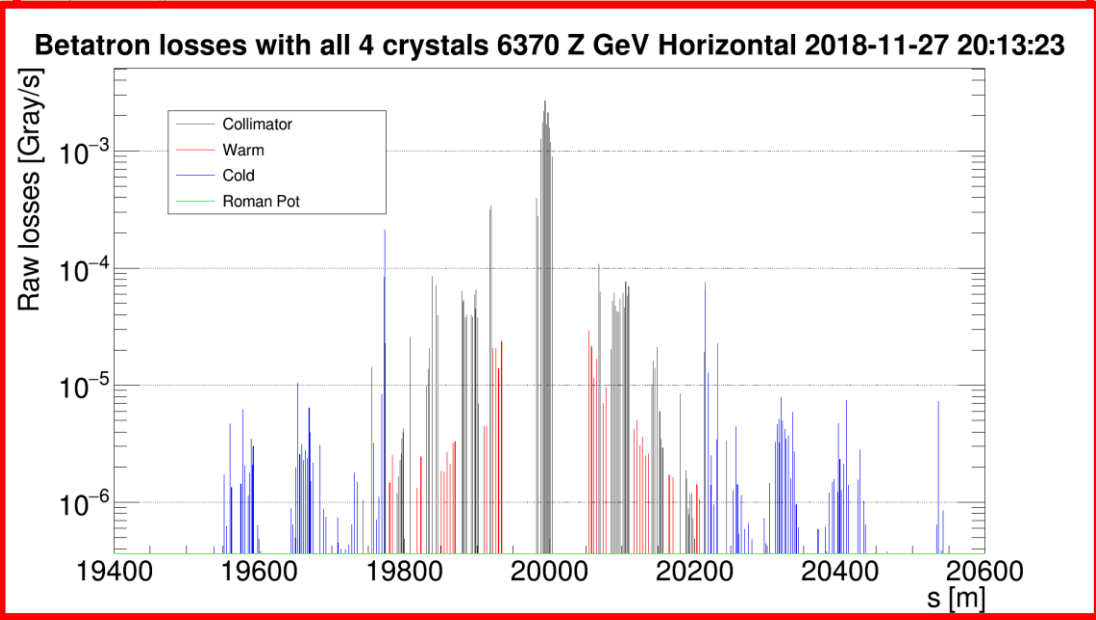
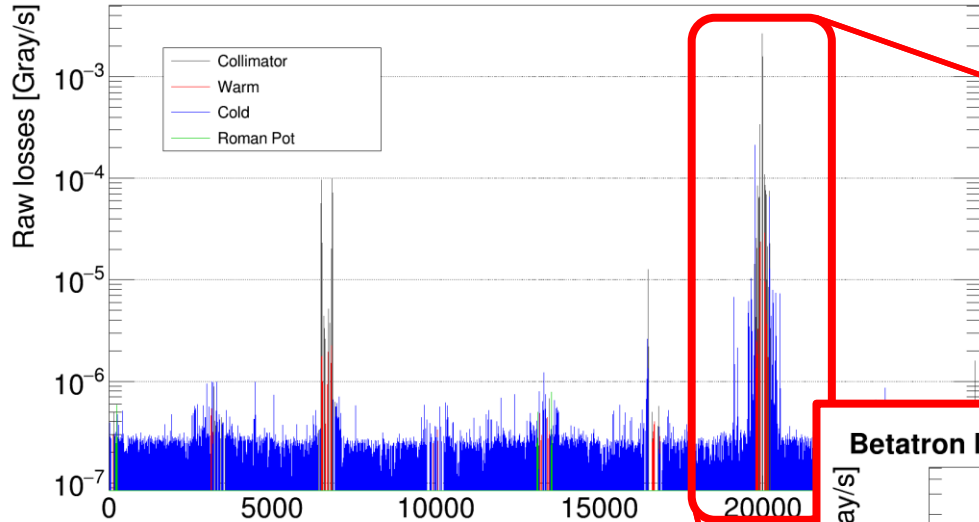
# Channeling during squeeze



Channeling was well kept for the whole duration of the squeeze

# Sustained losses on all four planes

Betatron losses with all 4 crystals 6370 Z GeV Horizontal 2018-11-27 20:13:23



Similar test performed during Ion Run setup

# Conclusions

## Full program of crystal collimation tests with ions completed

- Complete characterization of all crystal devices with Pb ion beams
- Loss map campaign with different settings to be compared with standard collimation and previous measurements
- Crystals kept in during squeeze
- Test with sustained losses on all four planes at the same time

## Preliminary results

- General improvement in cleaning inefficiency with crystal collimation
- Crystals successfully kept in channeling during squeeze
- Crystal collimation is able to sustain high losses in all planes at the same time (also tested during ion setup)

Detailed analysis still ongoing...