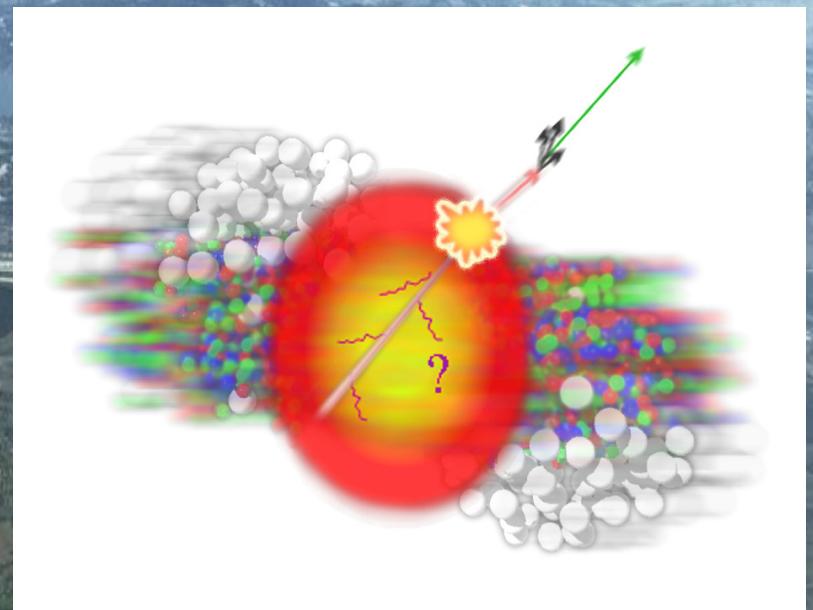


Beam loss in the Low Energy Ion Ring (LEIR) in the Light of the LHC Injector Upgrade for Ions (LIU-Ions)

M. Bodendorfer, M.E. Angoletta, J. Axensalva, D. Manglunki, S. Pasinelli, G. Tranquille

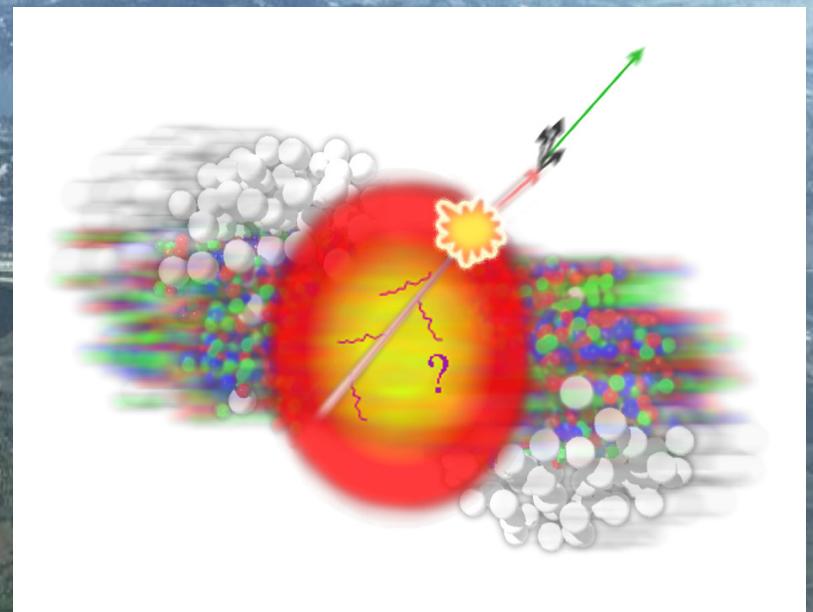
September 8th, 2015



Or: A new way to measure the chromaticity of LEIR

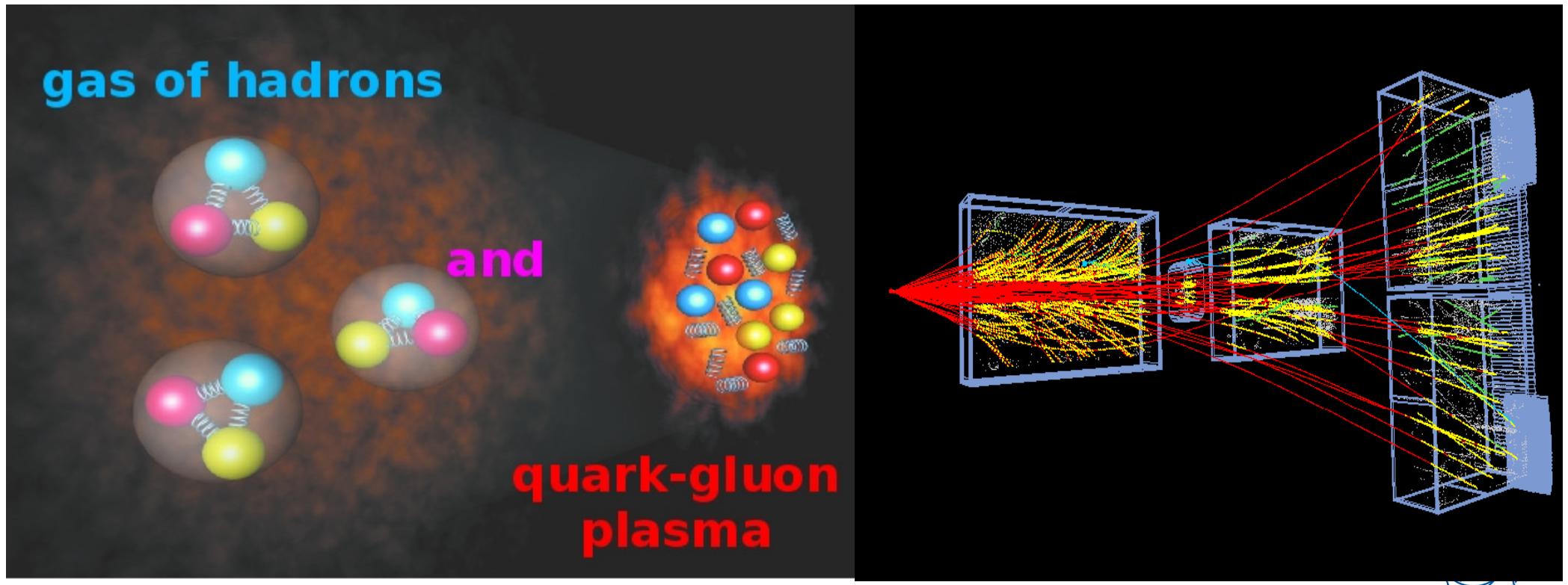
M. Bodendorfer, M.E. Angoletta, J. Axensalva, D. Manglunki, S. Pasinelli, G. Tranquille

September 8th, 2015



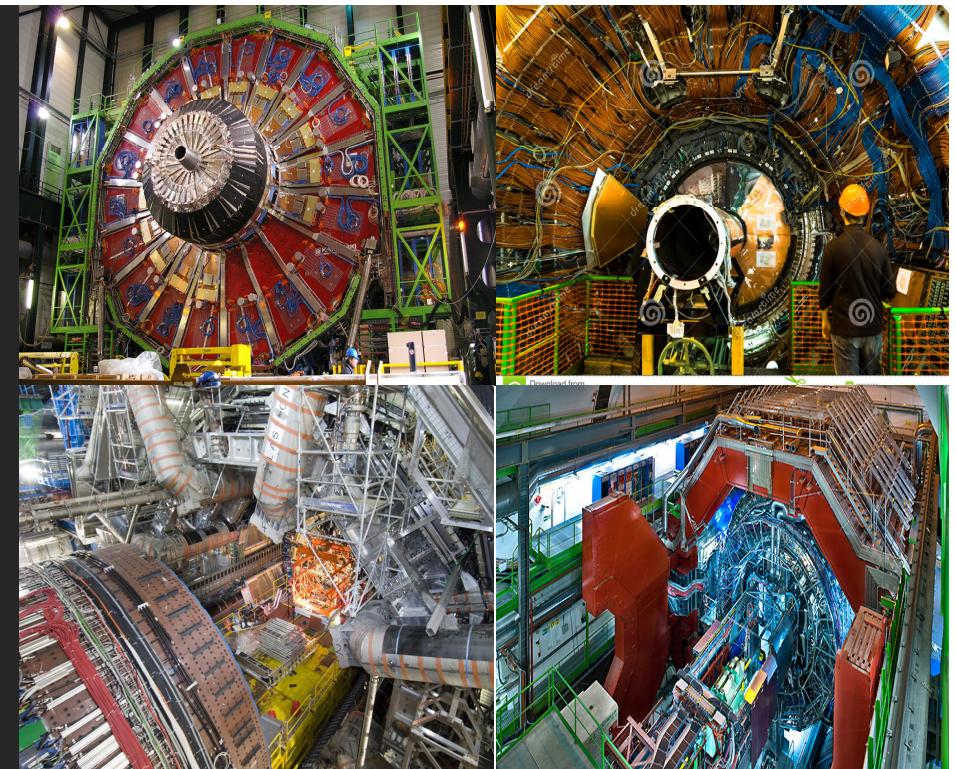
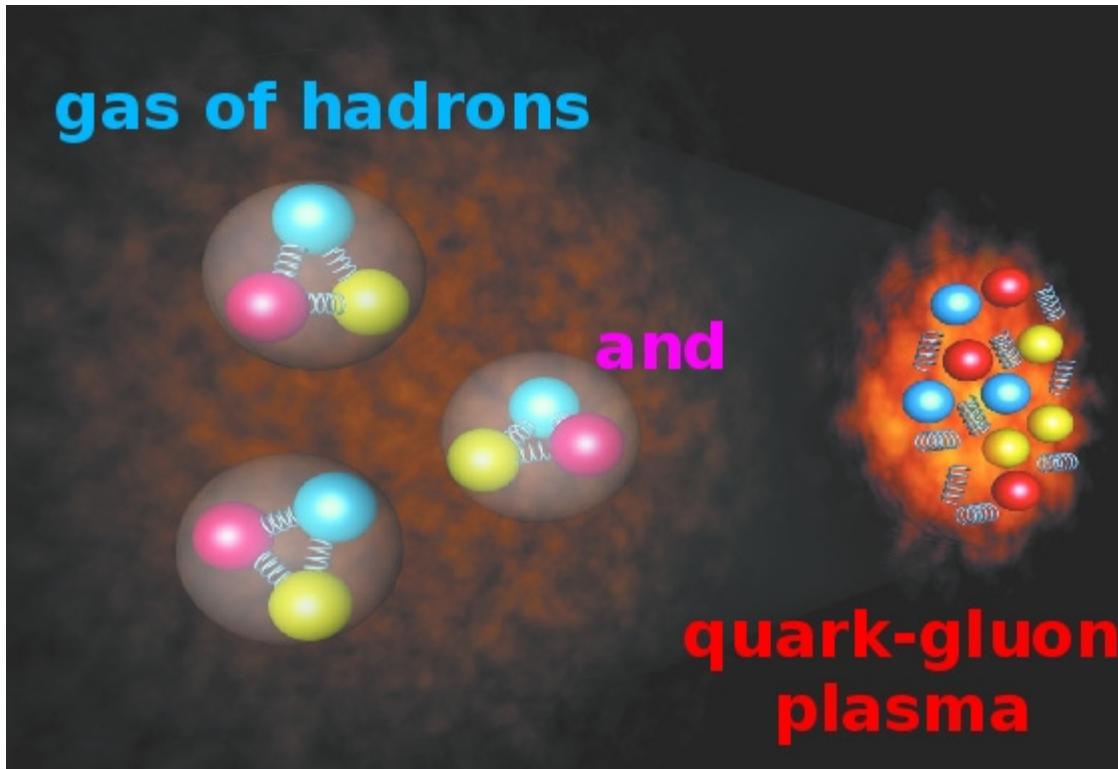
Why LEIR with Argon? – Quark Gluon Plasmas!

- SPS
 - NA61/SHINE
 - Fixed target experiment-> quark gluon plasma
 - 140 physicists, 15 countries, 28 institutions

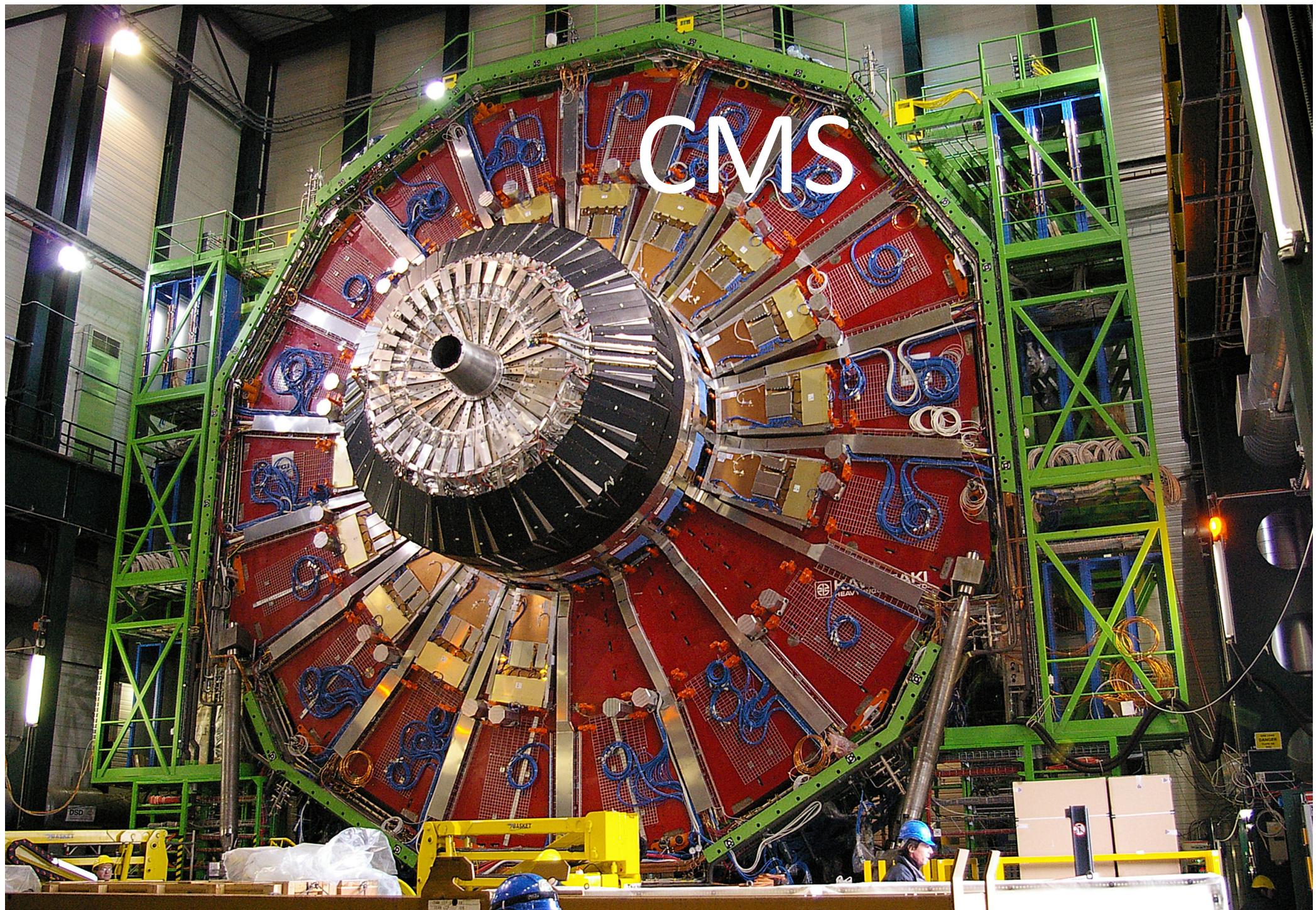


Why LEIR with Lead? – Quark Gluon Plasmas in LHC!

- LHC
 - ALICE
 - CMS
 - ATLAS
 - LHCb

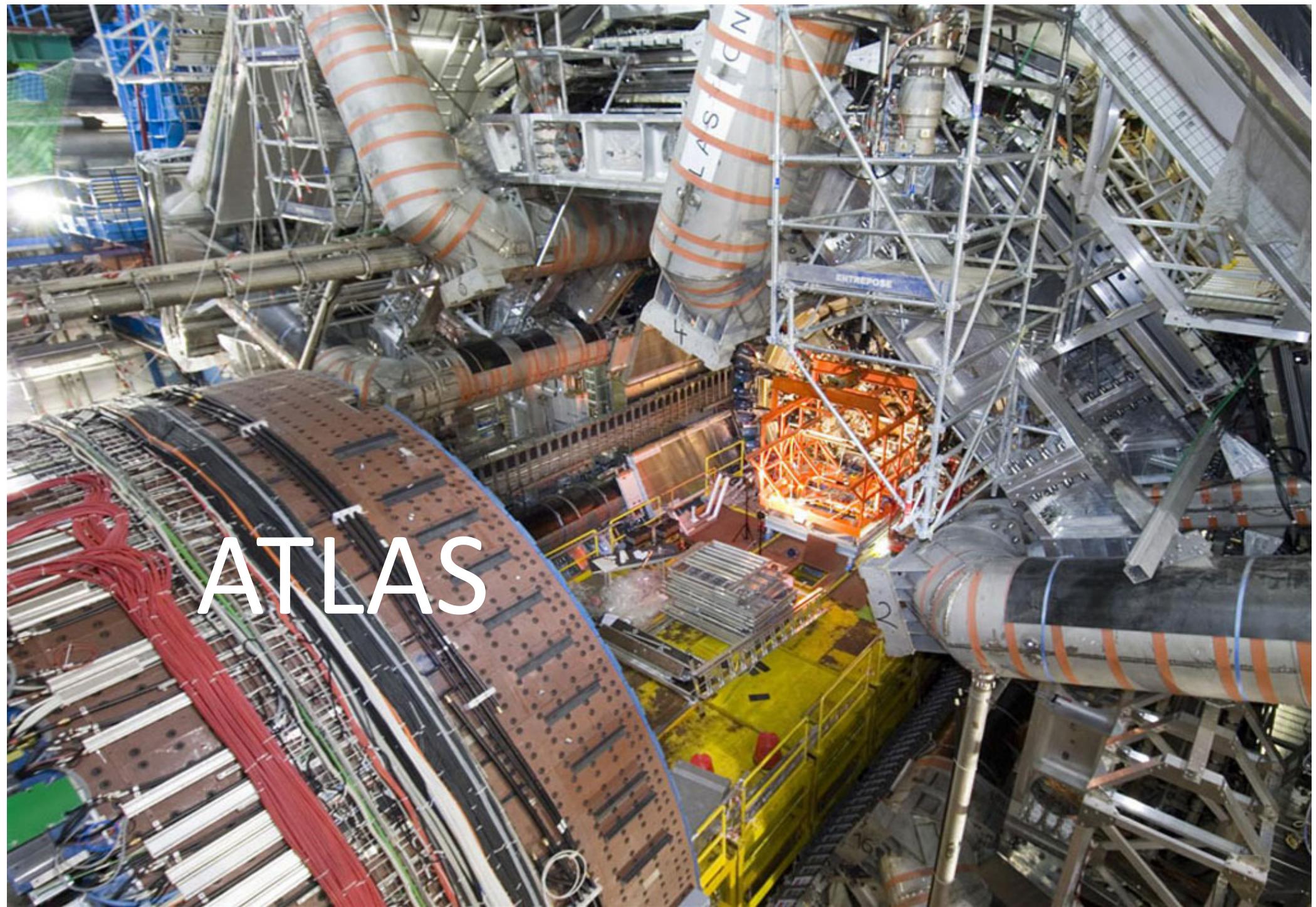


CMS

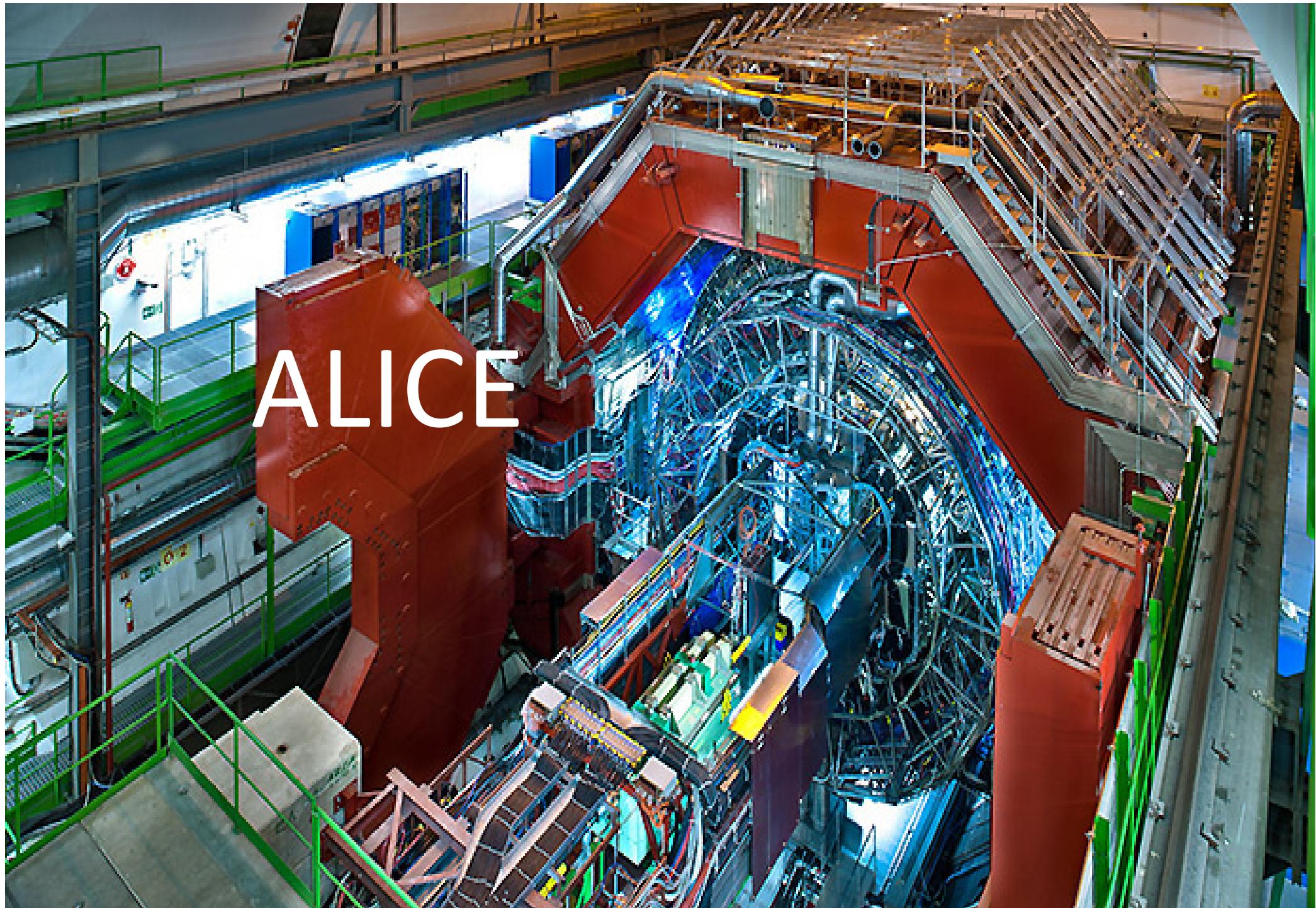


LHCb

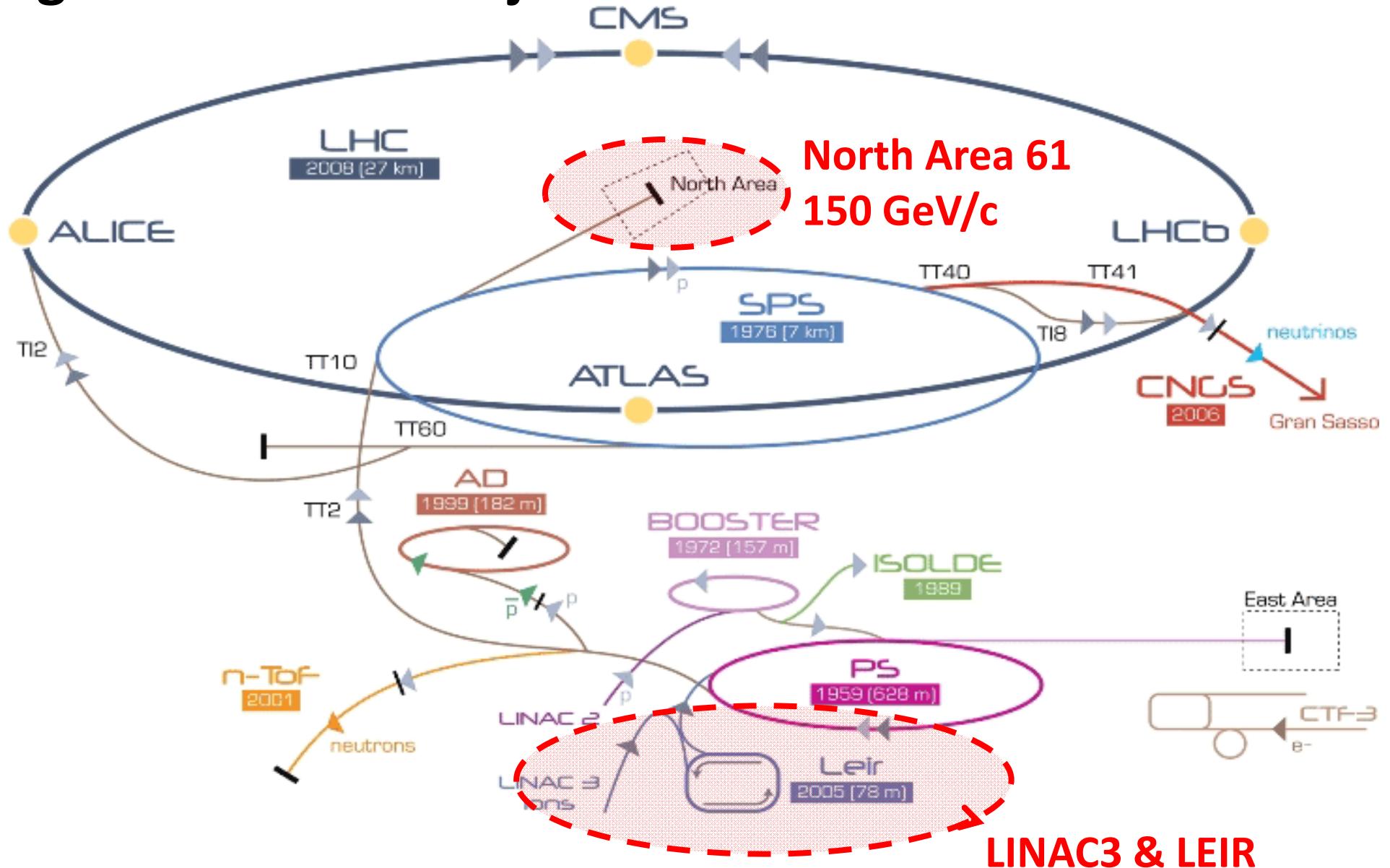




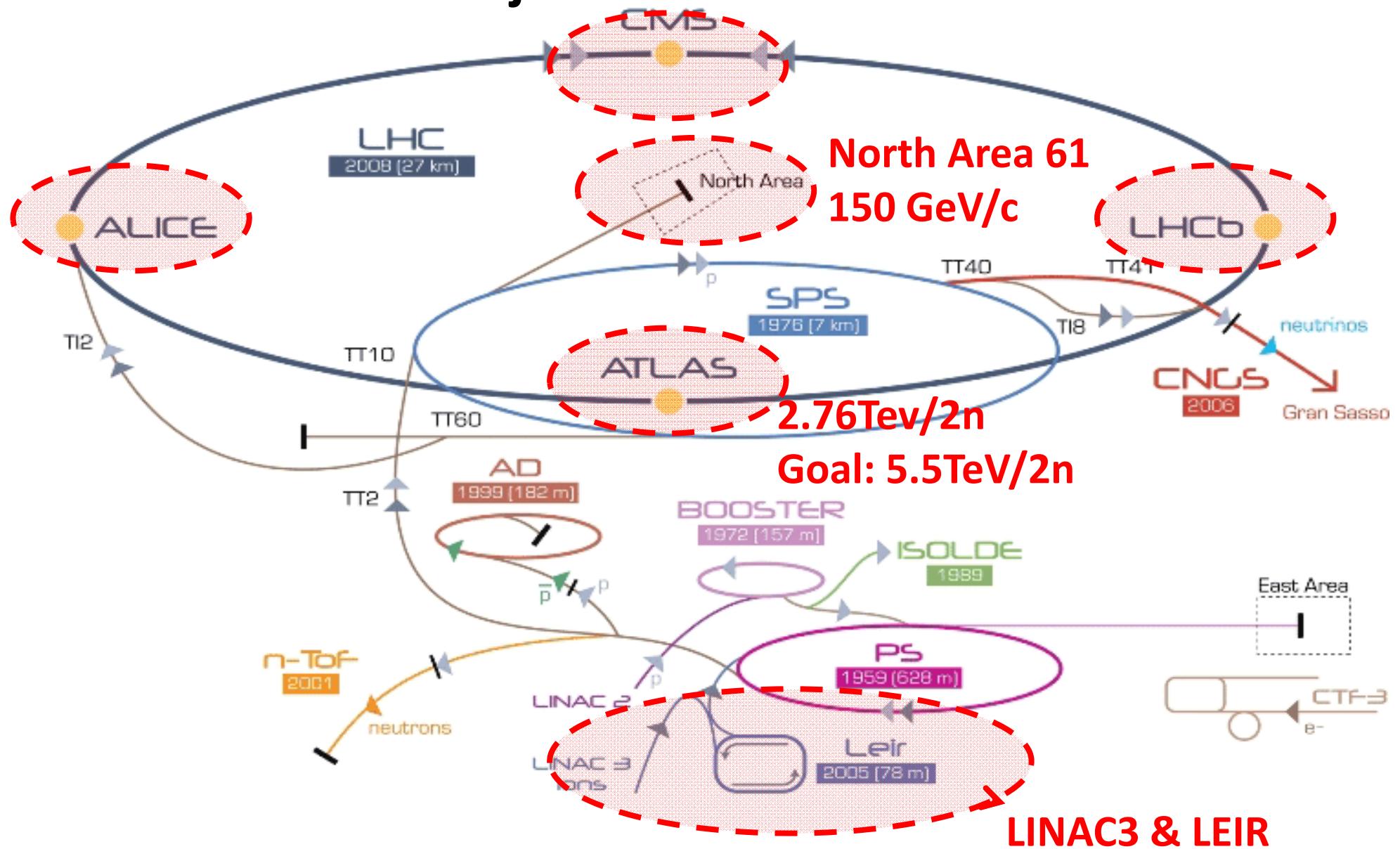
ALICE



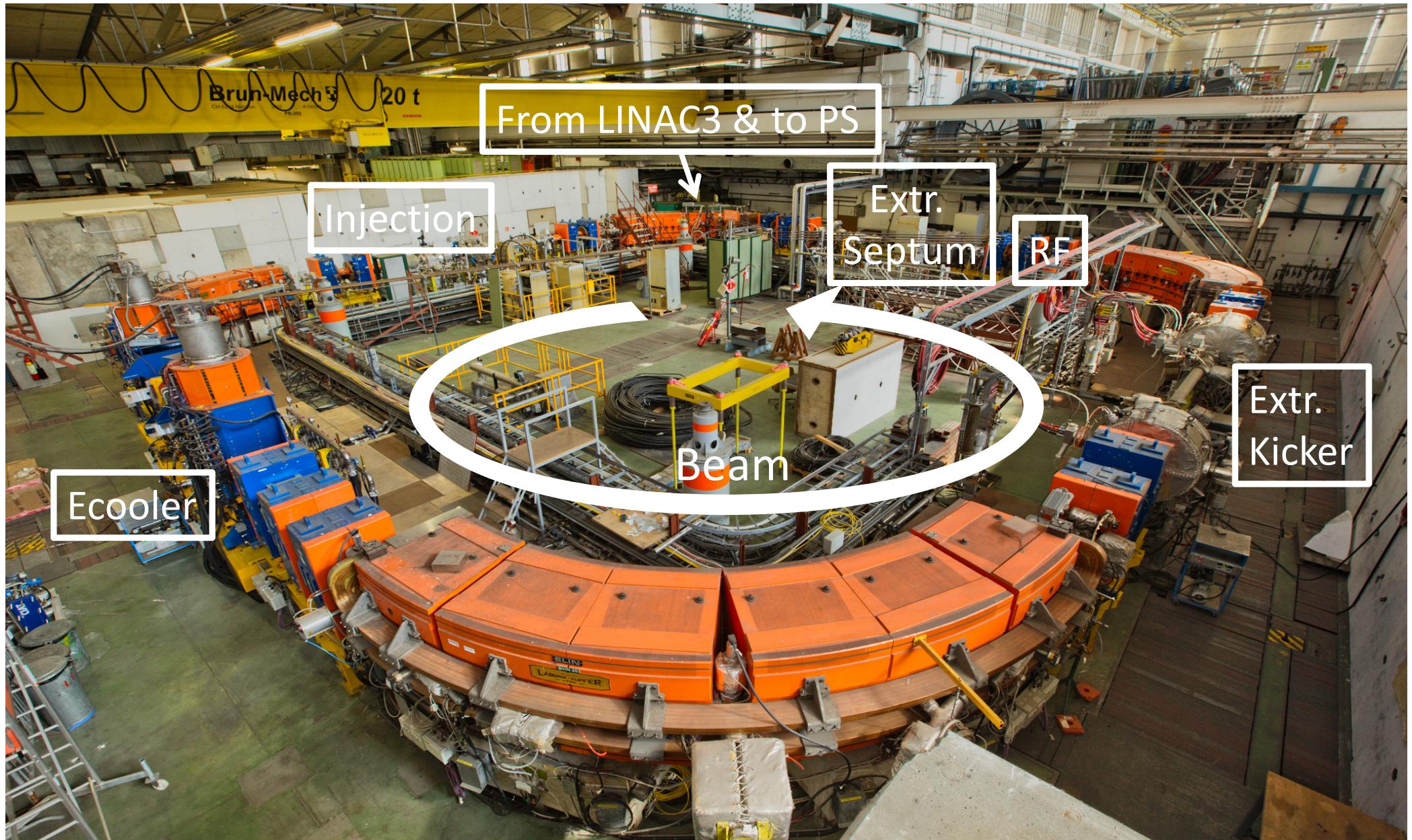
Argon in the CERN injector chain



Lead in the CERN injector chain + LHC

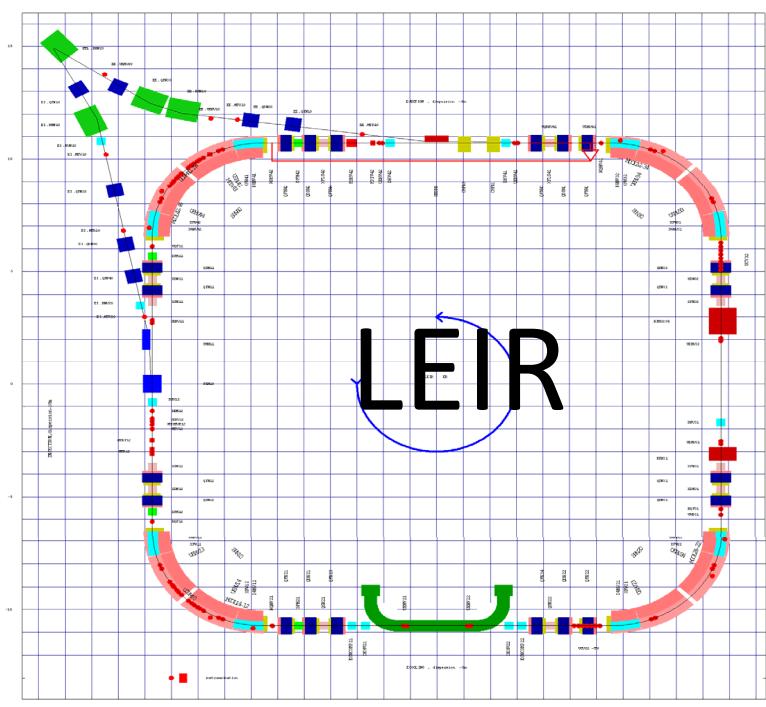
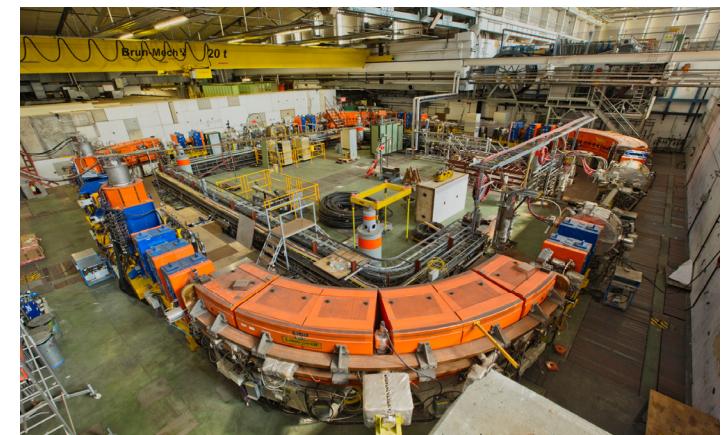


LEIR – Low Energy Ion Ring



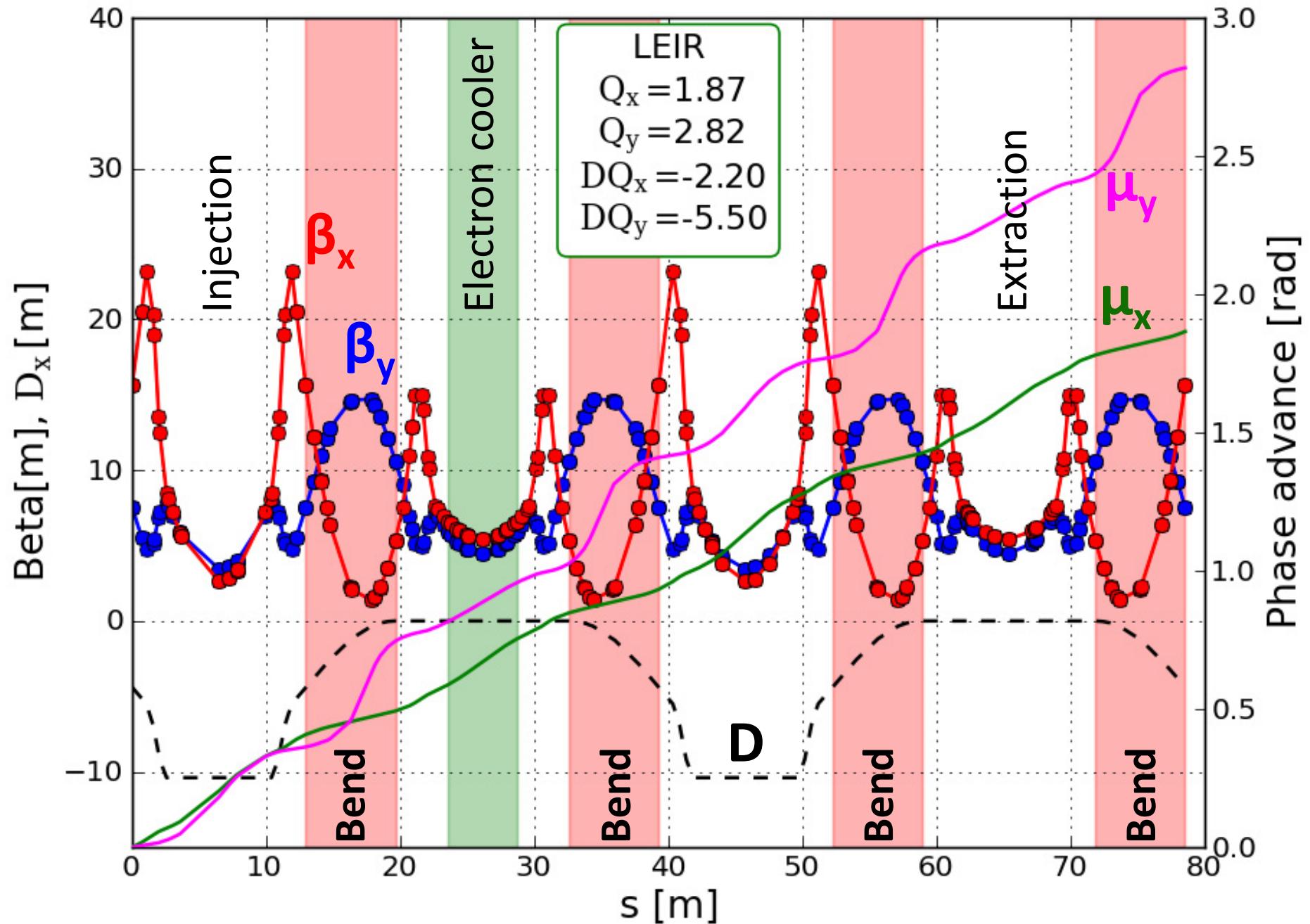
Overview

Machine	Output Energy	Charge state
ECR ion source	2.5 keV/n	...,29+,...
LINAC3	4.2 MeV/n	29+/54+
→ LEIR	72.2 MeV/n	54+
PS	5.9 GeV/n	54+/82+
SPS	176.5 GeV/n	82+



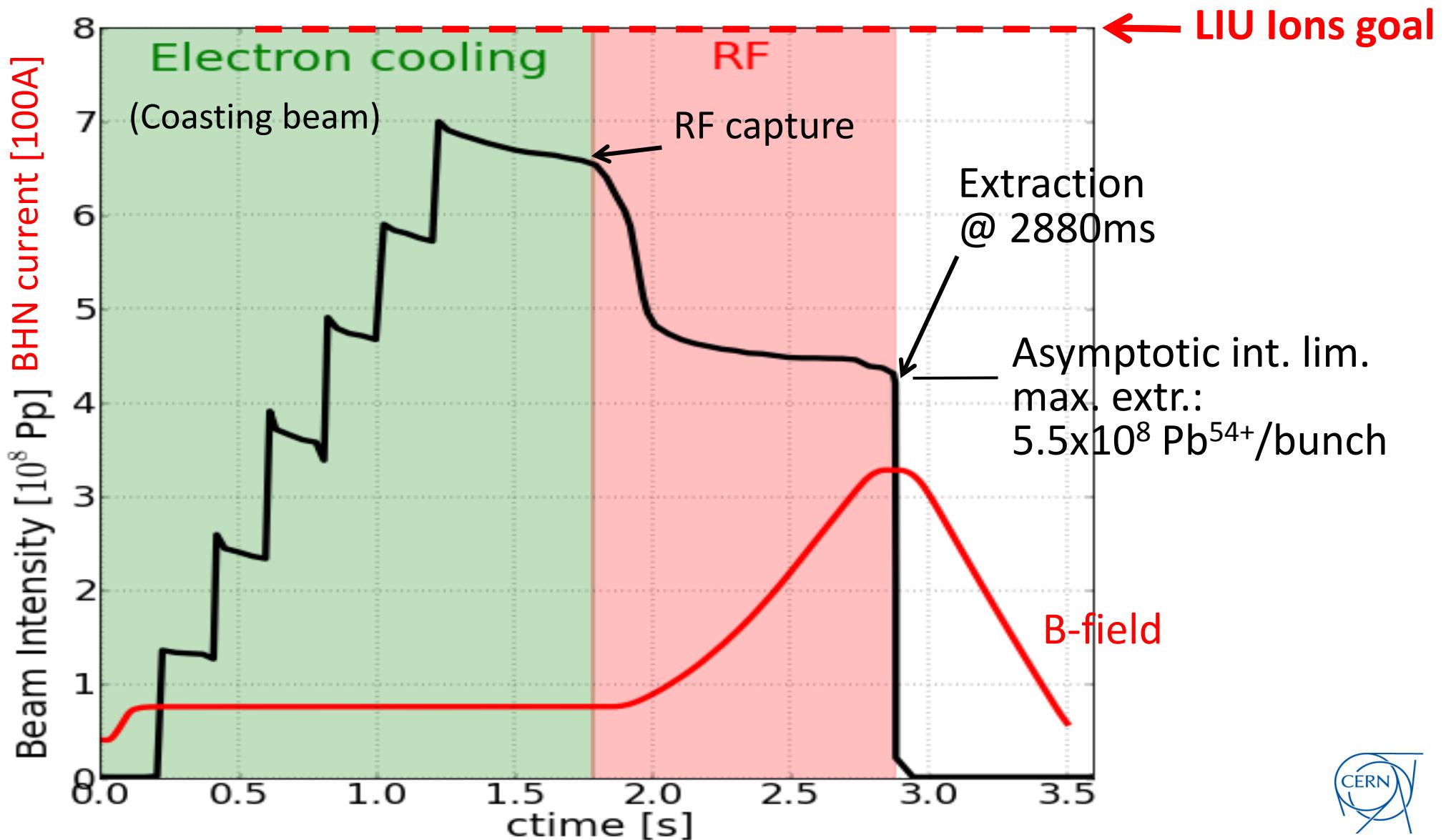
LEIR Design Parameter	Value Inj.	Value Extr.
Circumference	78m	
$\beta_{\text{rel.}} (\text{Inj.} \mid \text{Ej.})$	0.095	0.392
$\gamma_{\text{rel.}} (\text{Inj.} \mid \text{Ej.})$	1.0045	1.087
$\gamma_{\text{transition}}$	2.84	2.84
$\text{emit}^*_{\text{transv.}} (\text{hor.} \mid \text{vert.})$	6 4 μm	0.65 0.7 μm
$\text{emit}_{\text{long.}} (\text{Inj.} \mid \text{Ej.}) [\text{eVs/u}]$	0.015	0.1
Tune (Hor. Vert.)	1.82	2.72

Pb⁵⁴⁺ MADX simulations with operational parameters

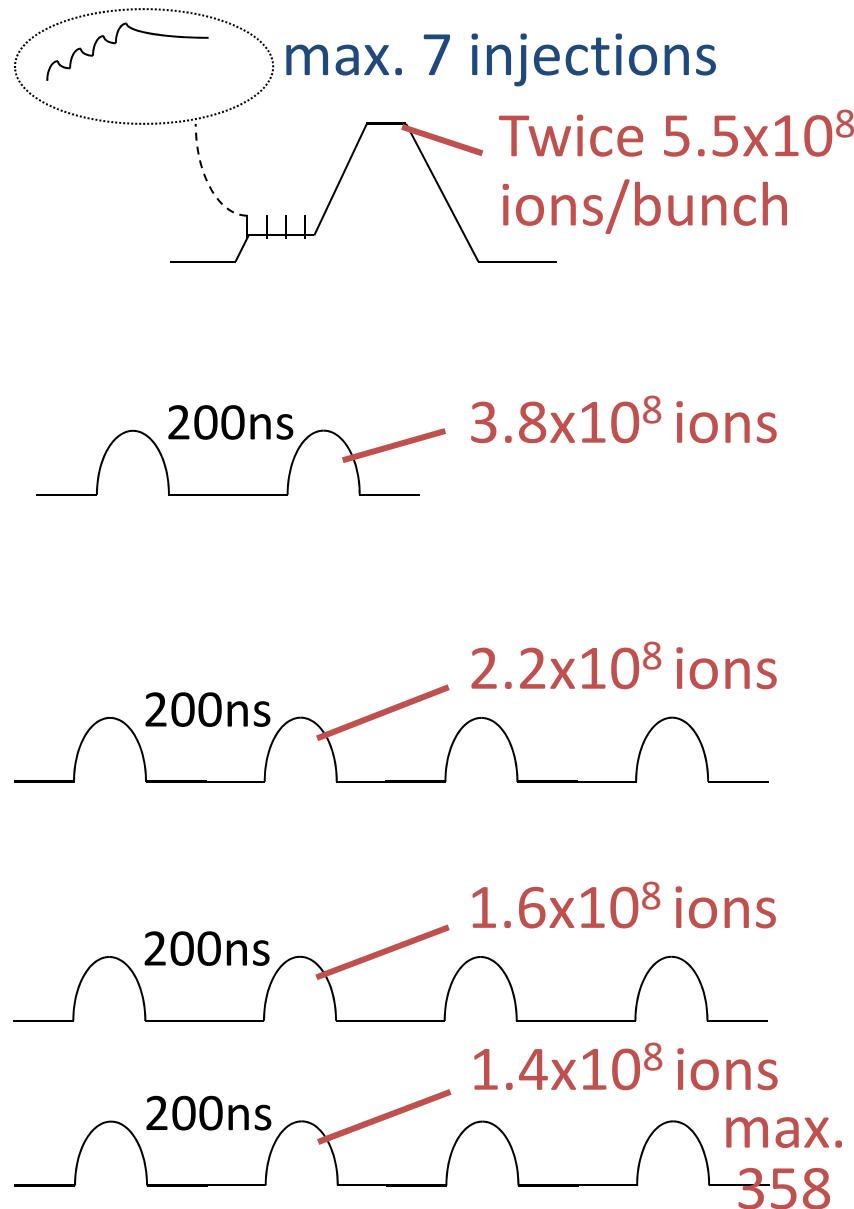


The Pb⁵⁴⁺ Mandate:

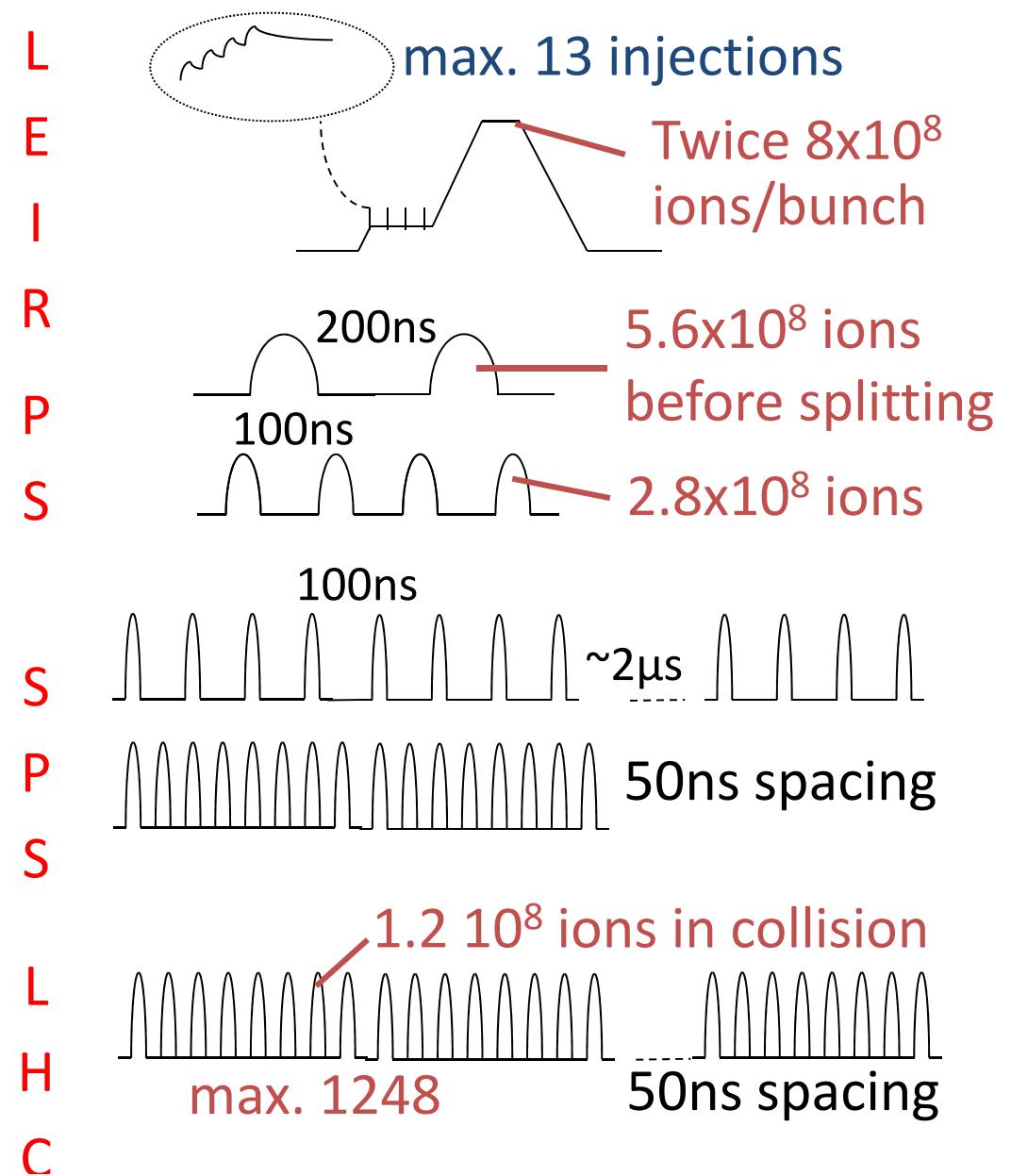
Increase extr. intensity for the LHC Injector Upgrade (LIU)



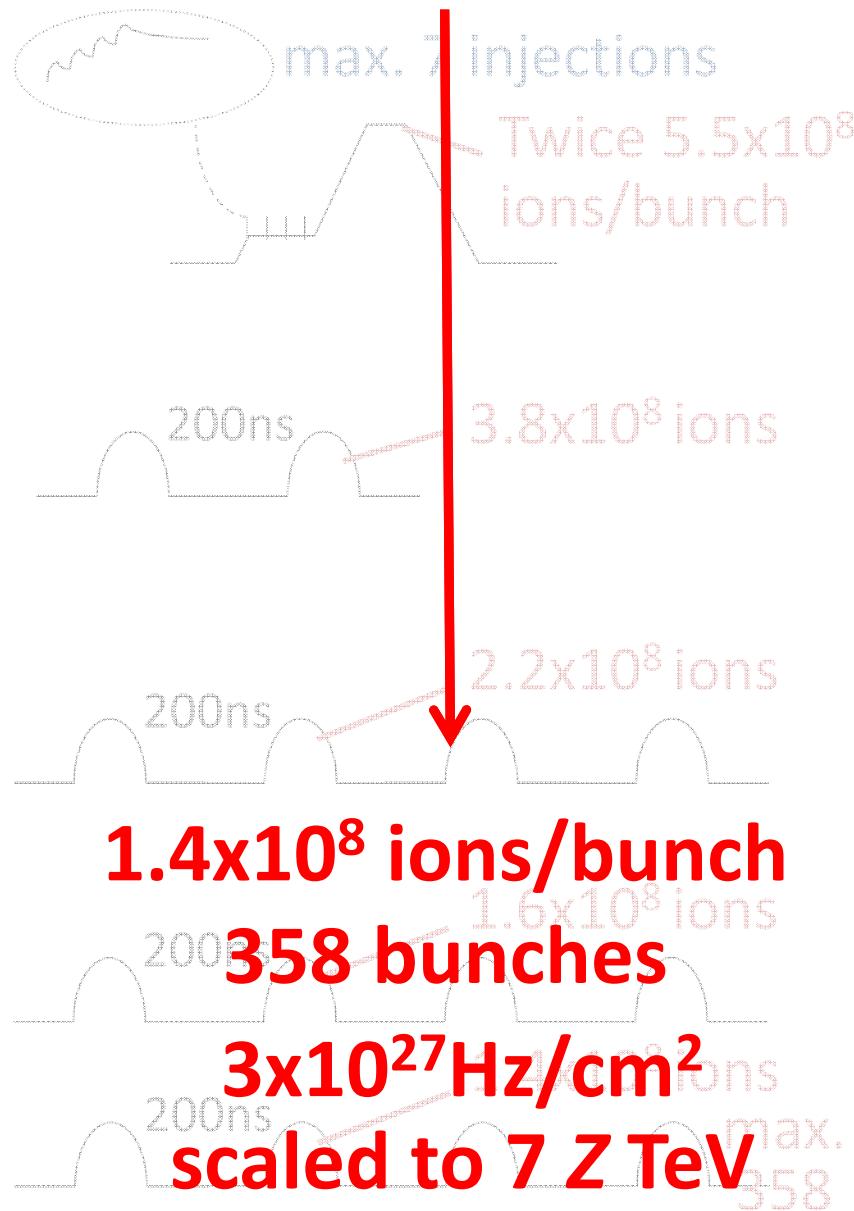
Scheme in 2011 (2013 performance)



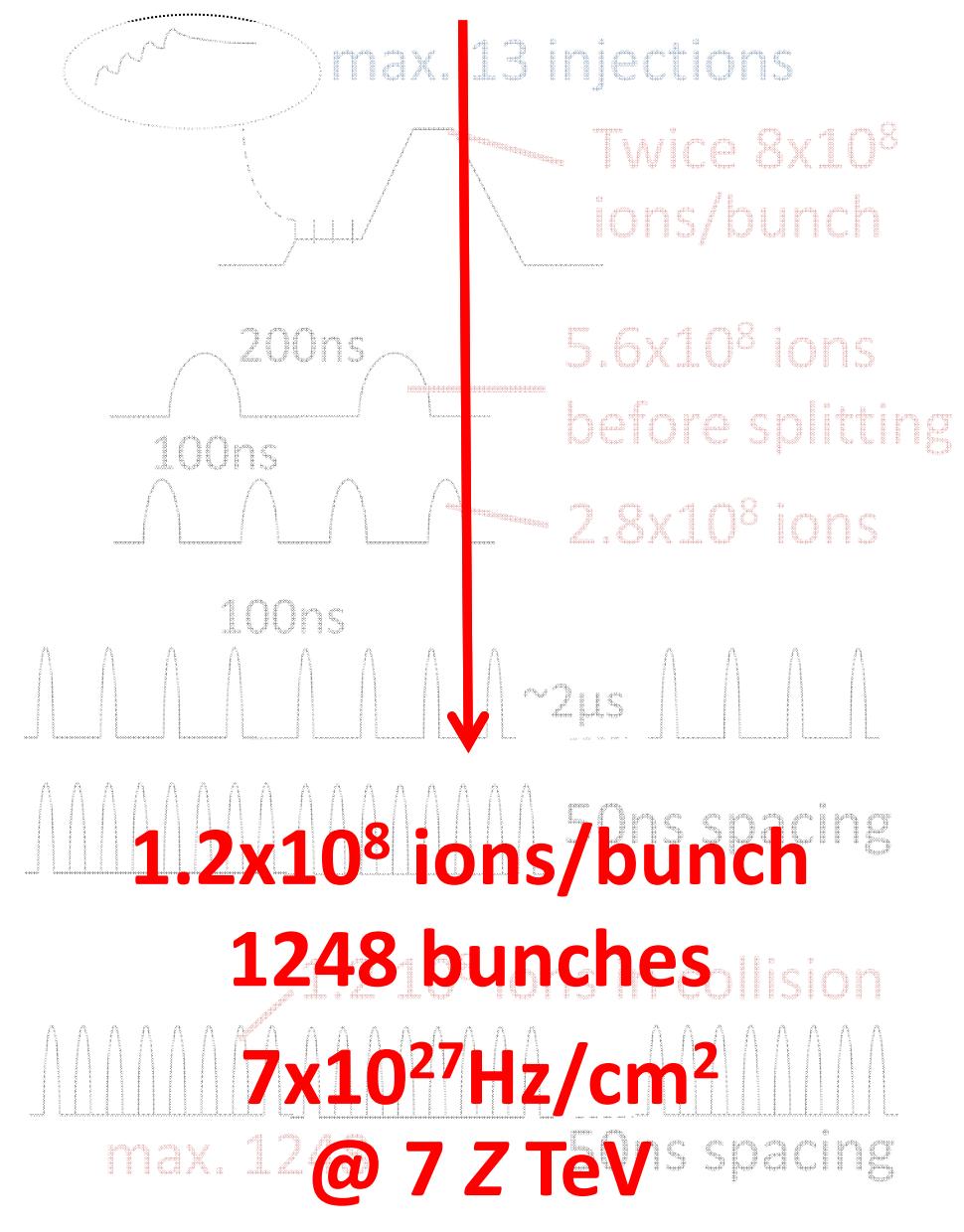
Post-LS2 Scheme



Scheme in 2011 (2013 performance)

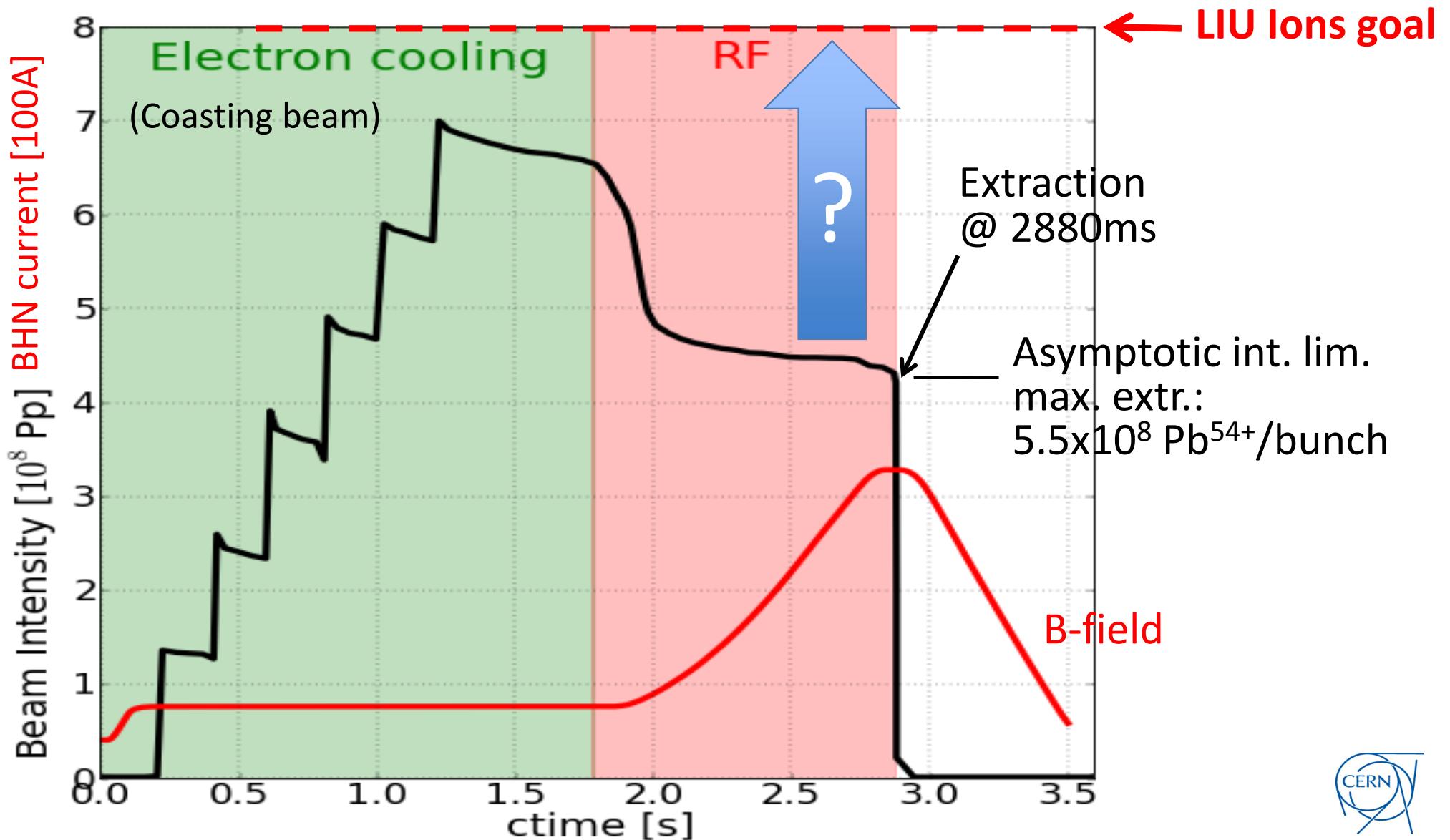


Post-LS2 Scheme

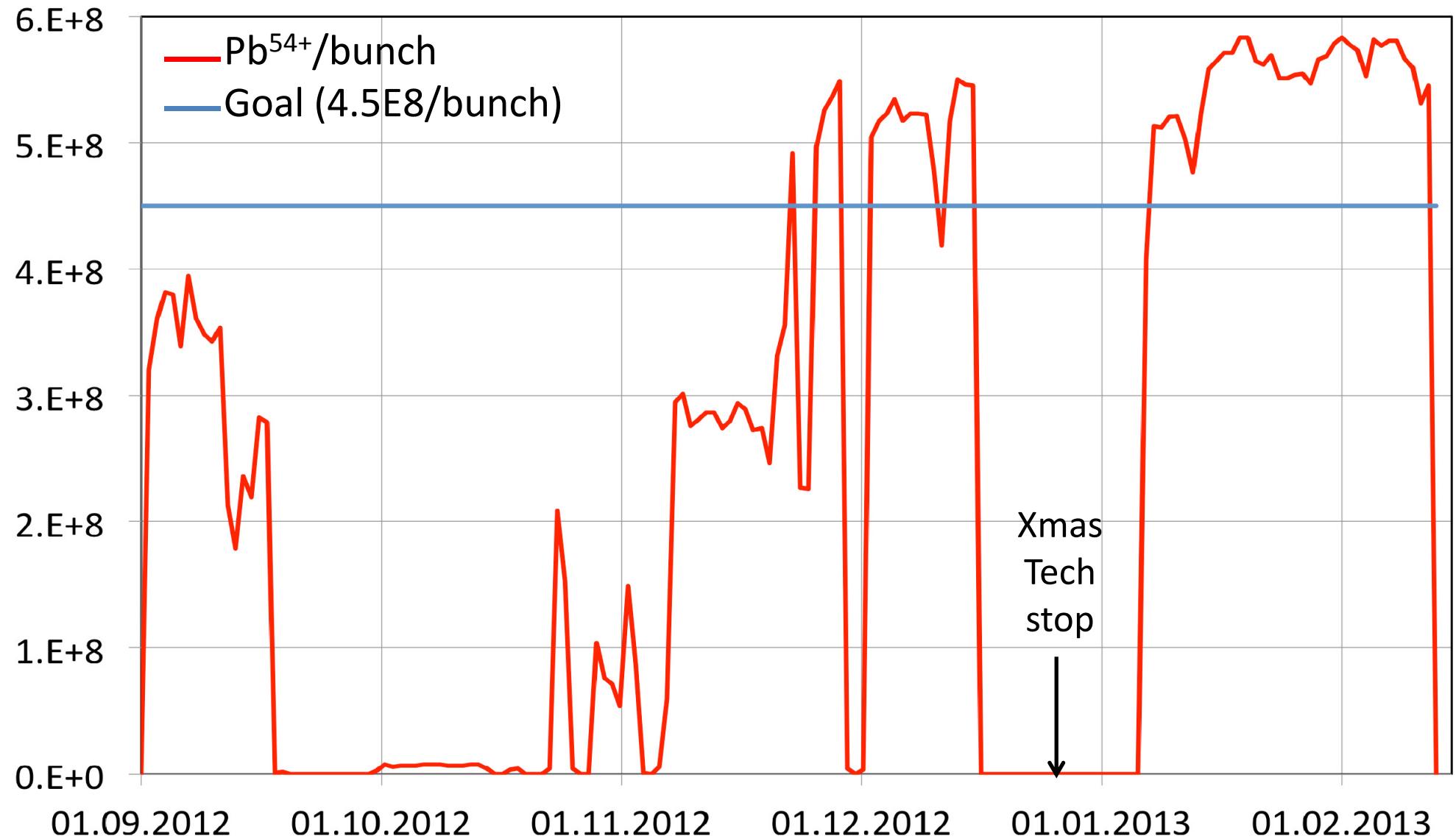


The Pb⁵⁴⁺ Mandate:

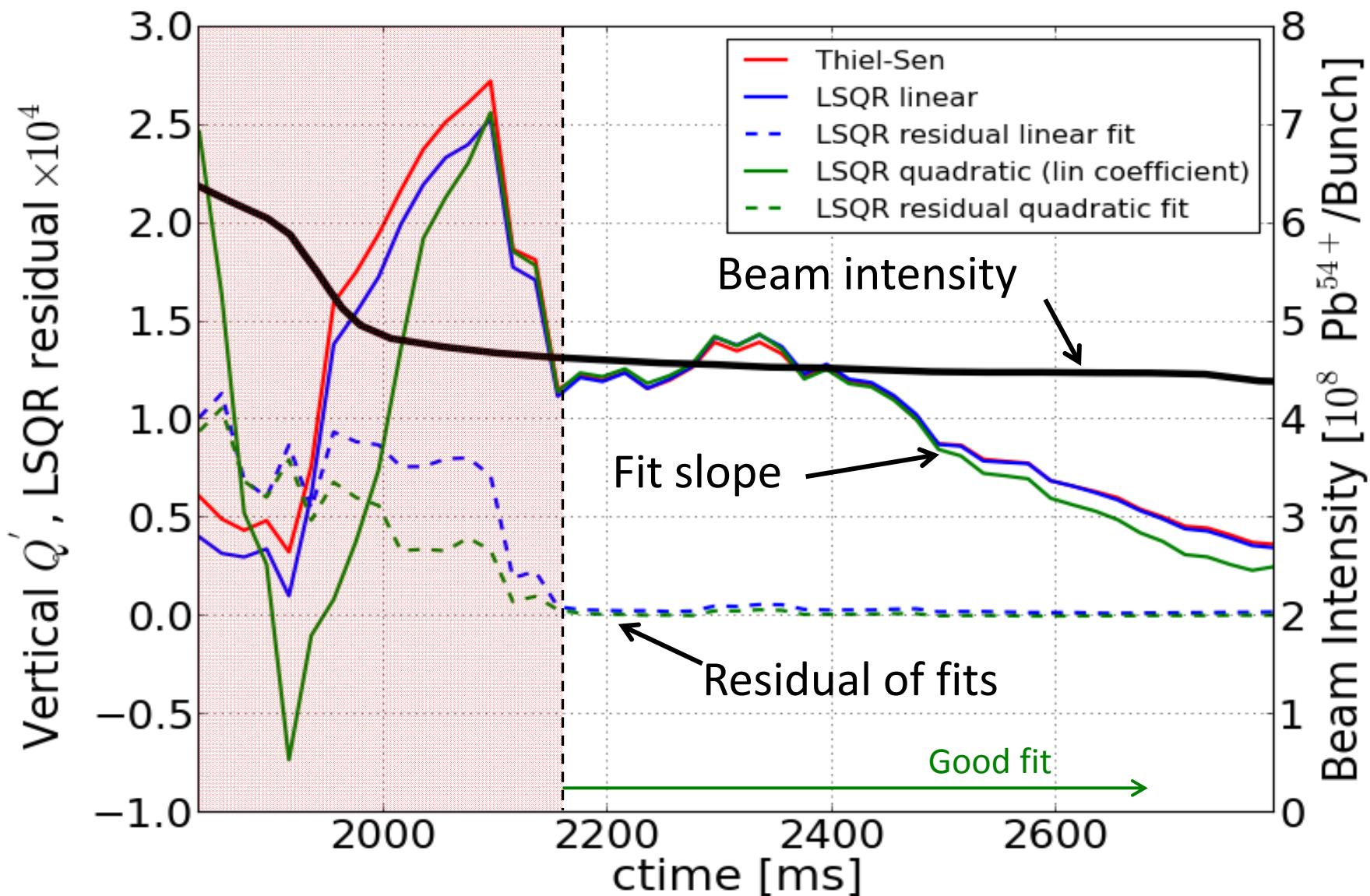
But how?



What intensity did LEIR extract?



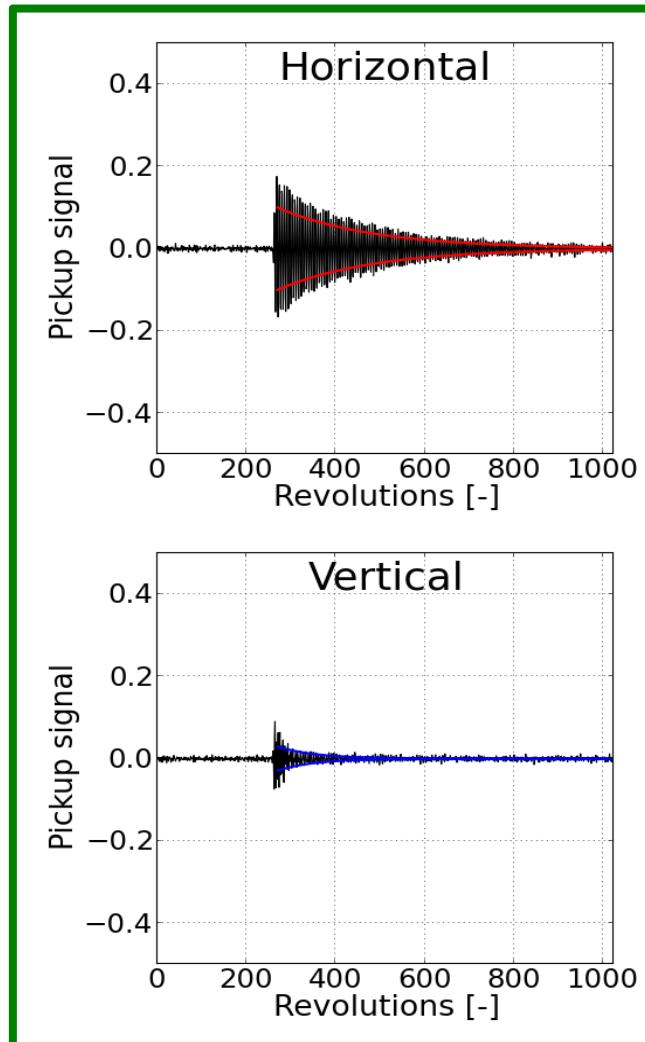
Symptoms (Pb^{54+} 2013):



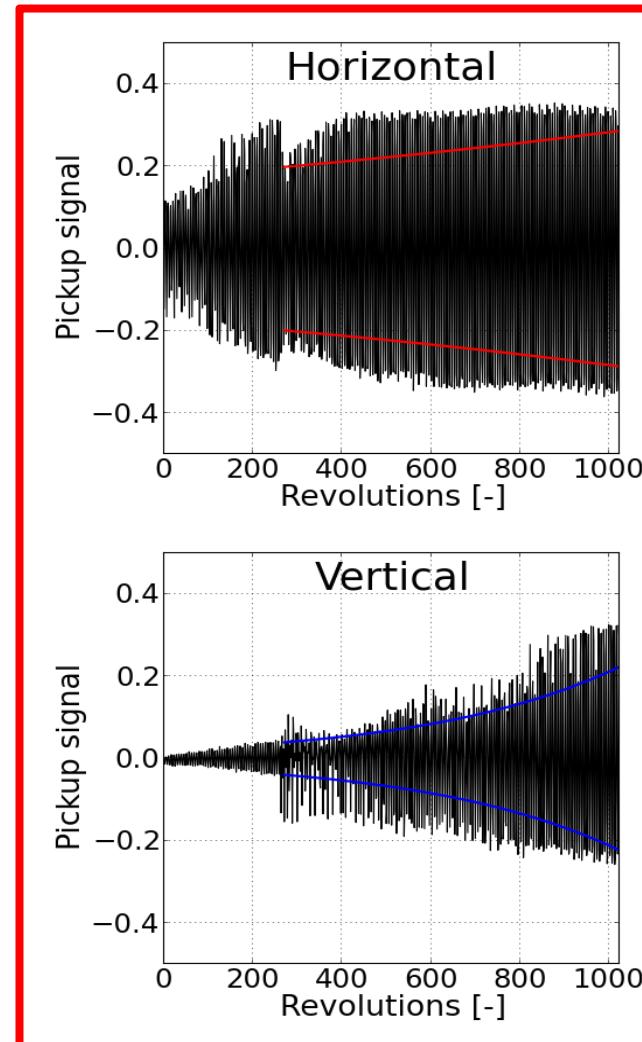
LEIR Instability at RF capture and ramp

Pickups output:

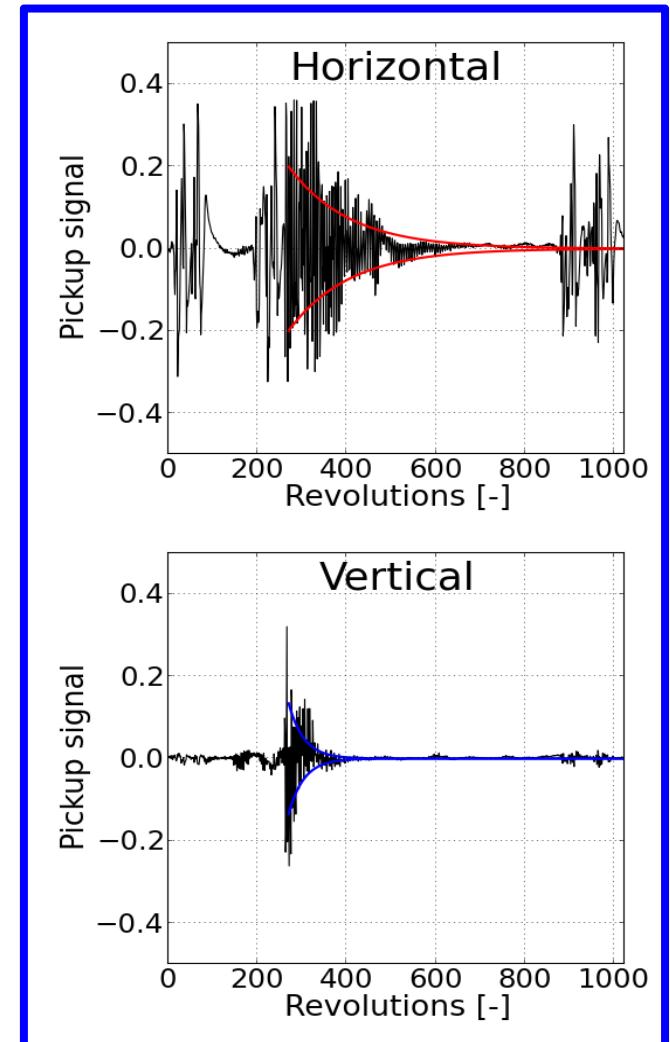
Before: -20ms

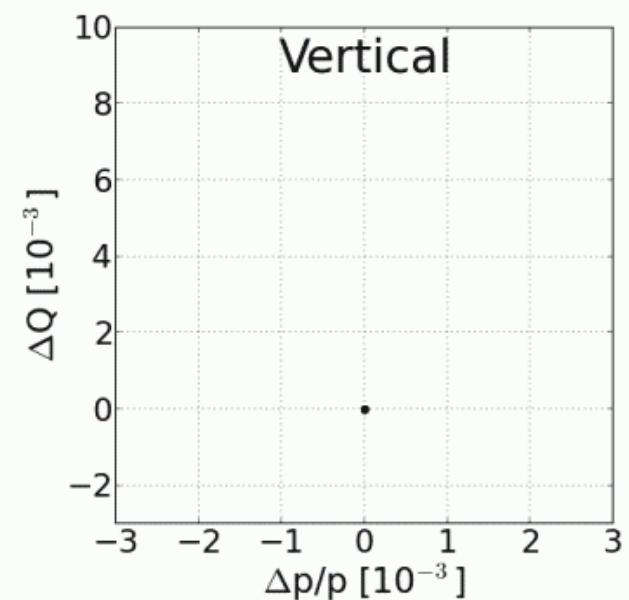
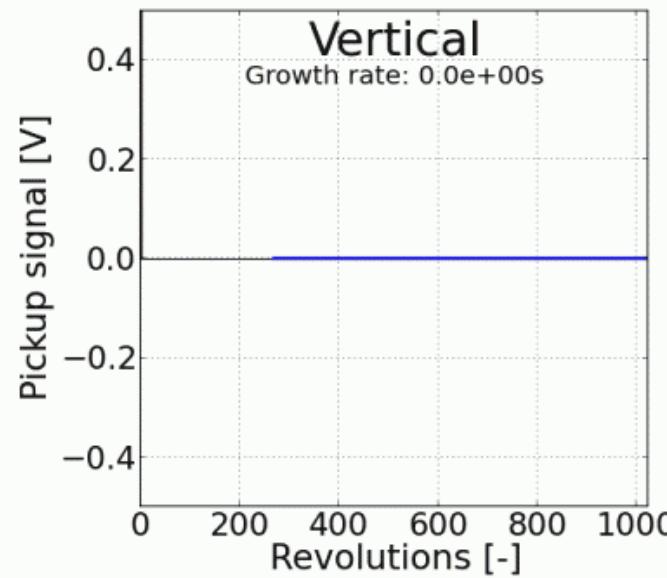
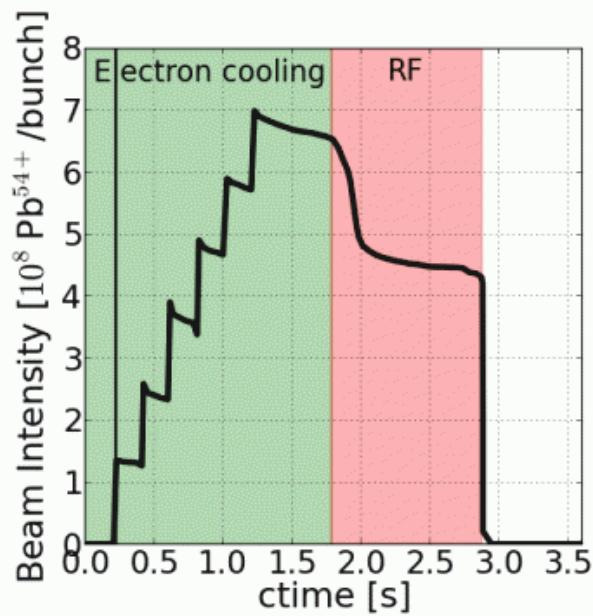
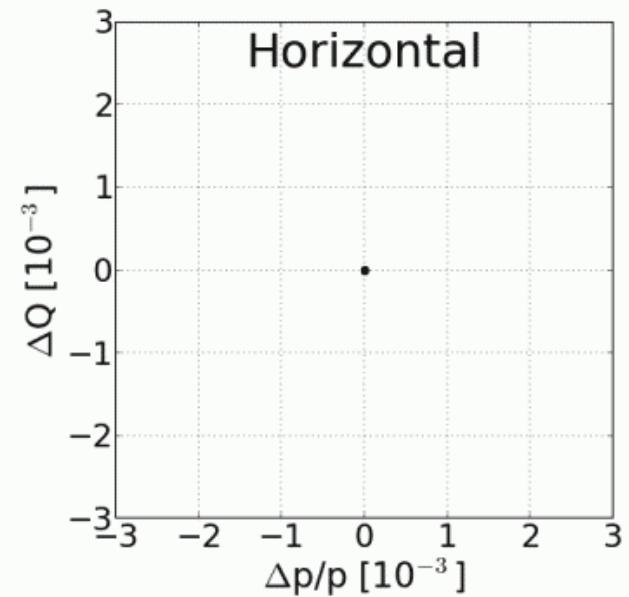
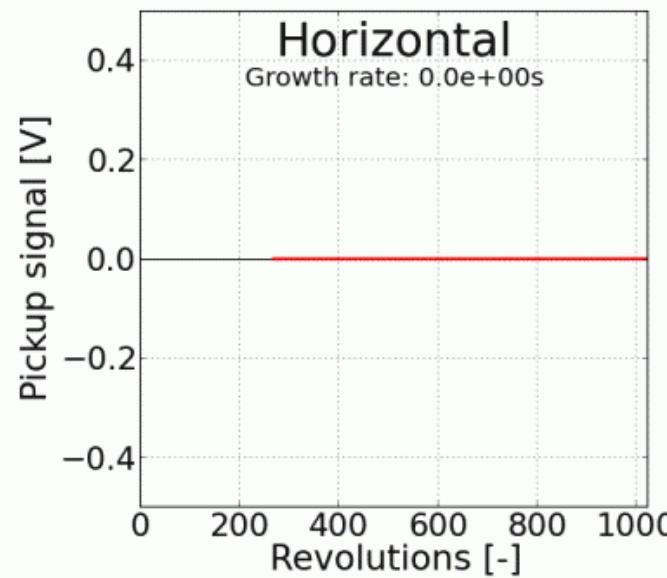
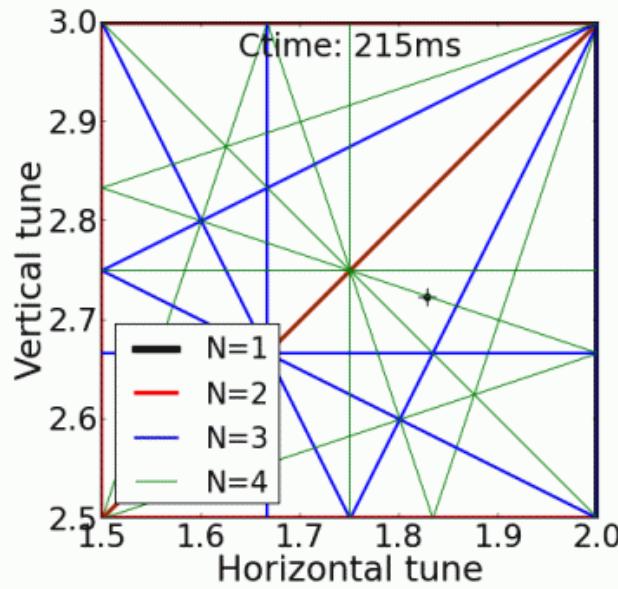


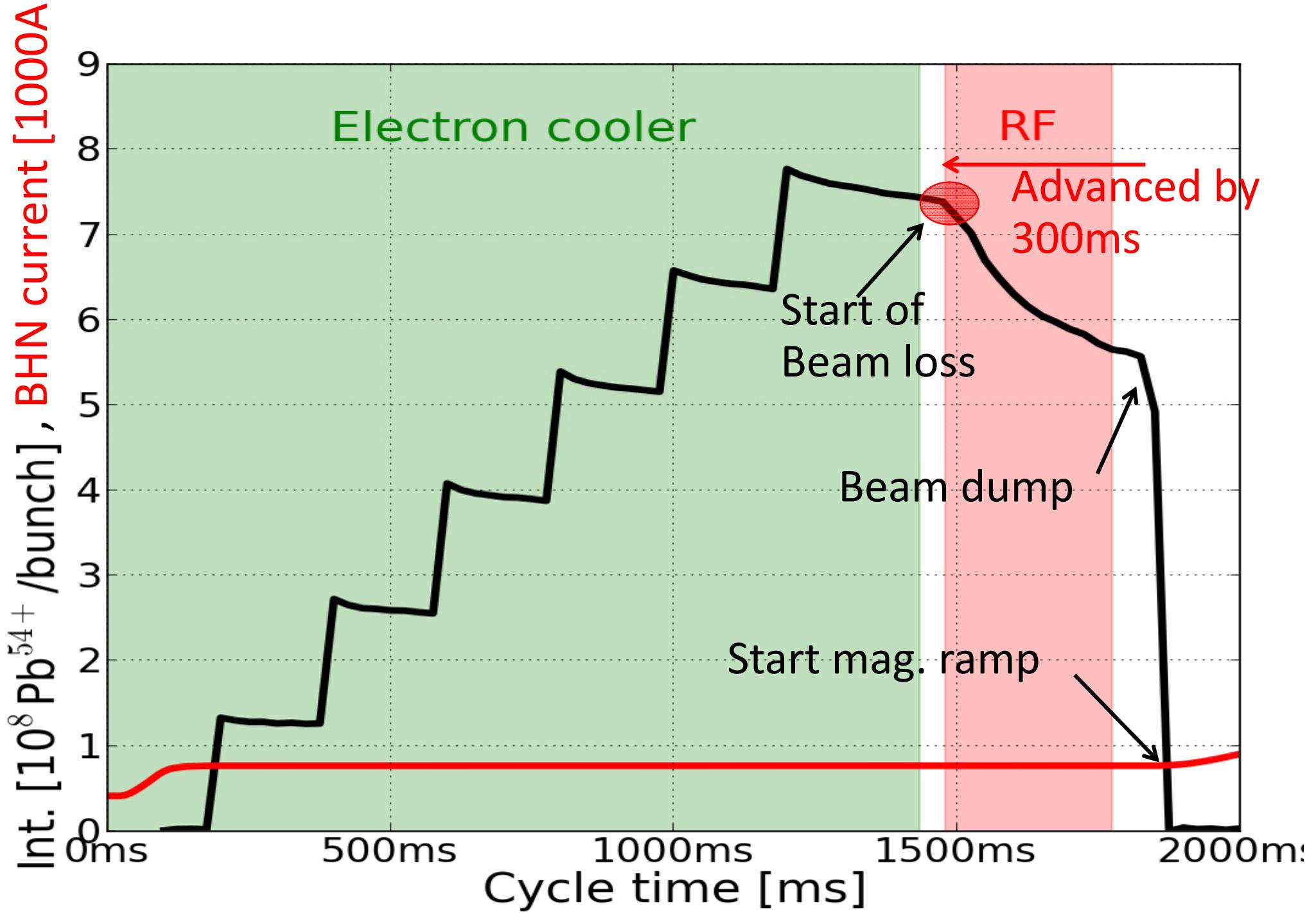
1815ms
Beam loss starts here



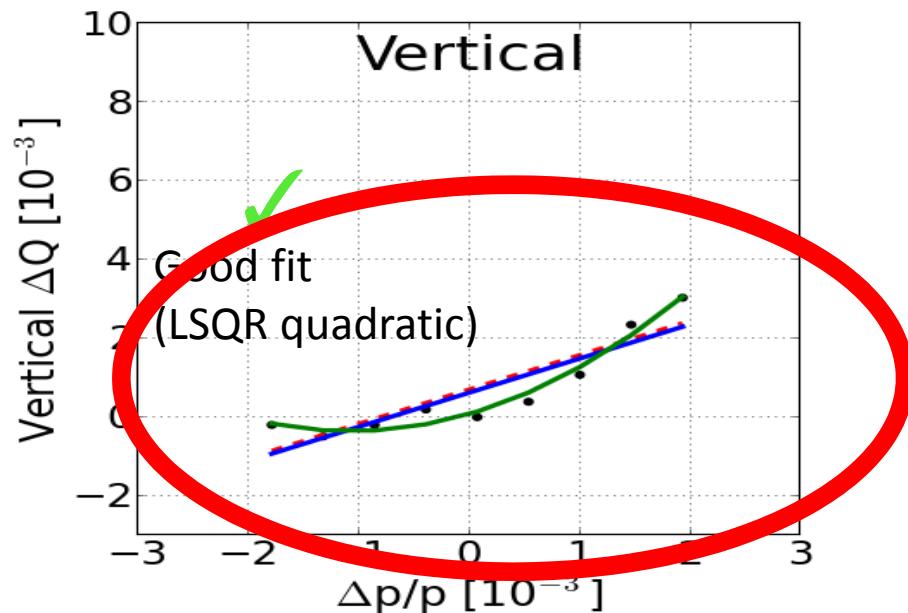
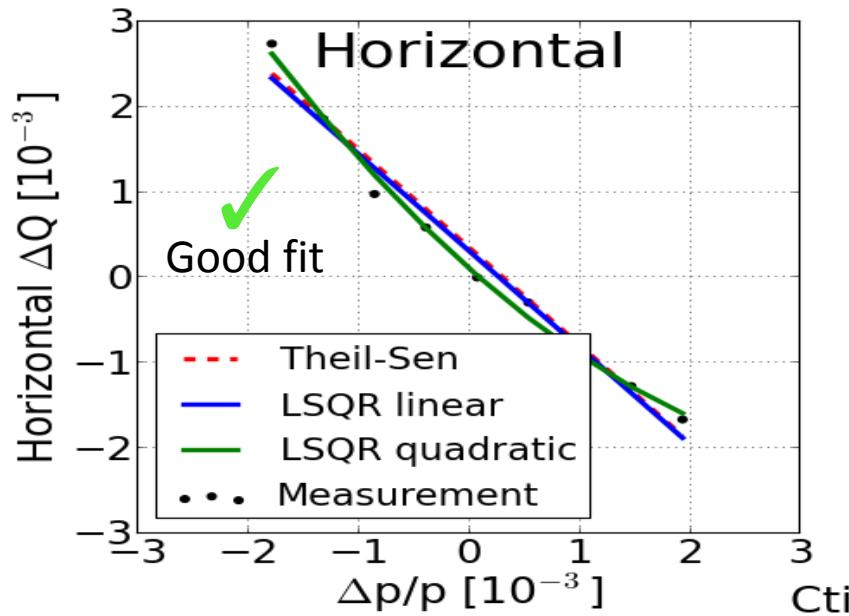
After: +20ms
Beam loss **continues**



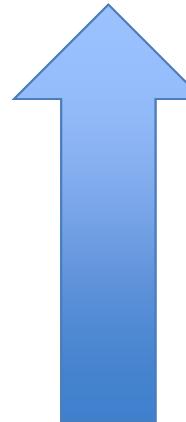




In 2013 with PB^{54+} :



Check with
Argon!



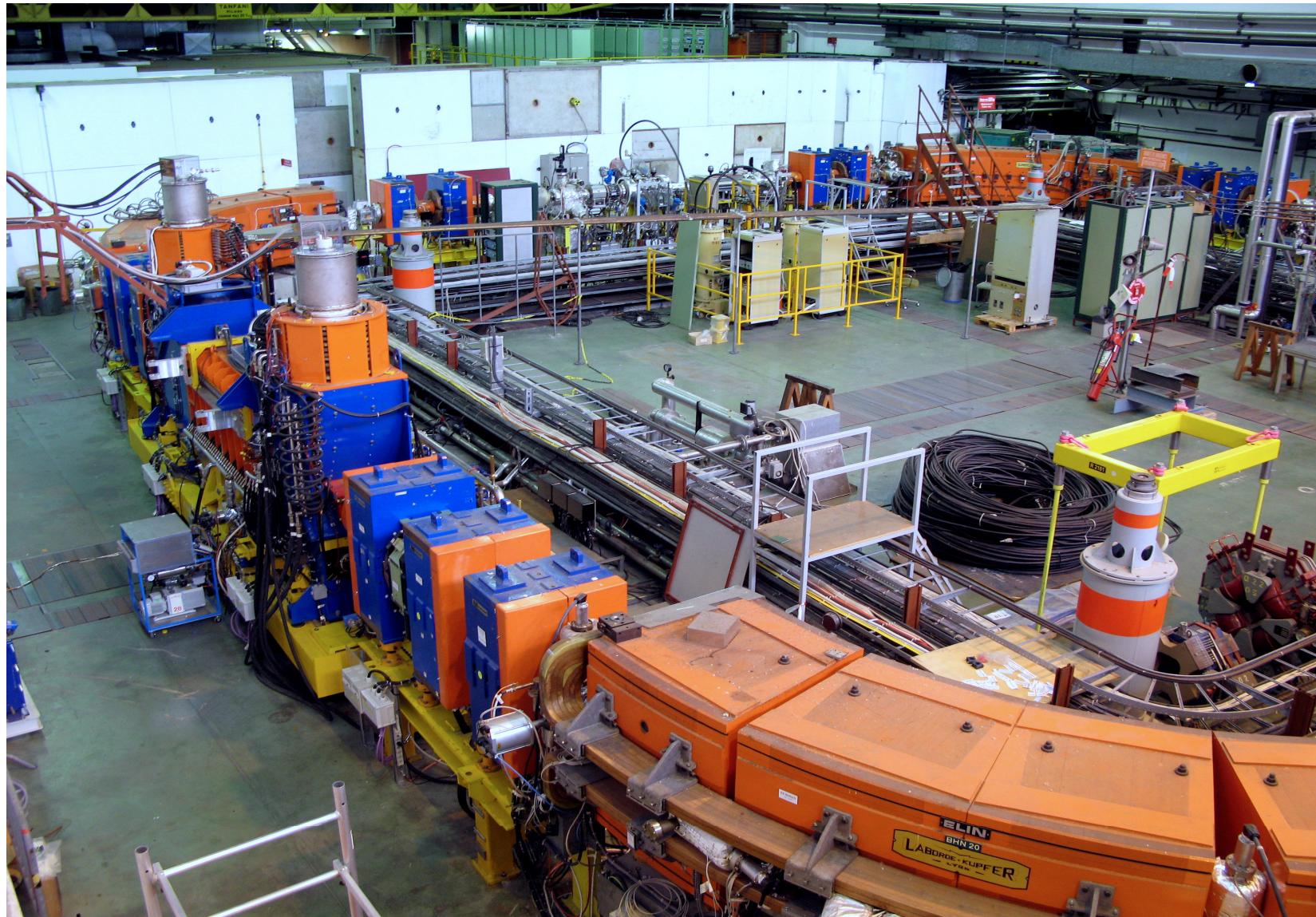
Positive chromaticity
found in vertical plane!

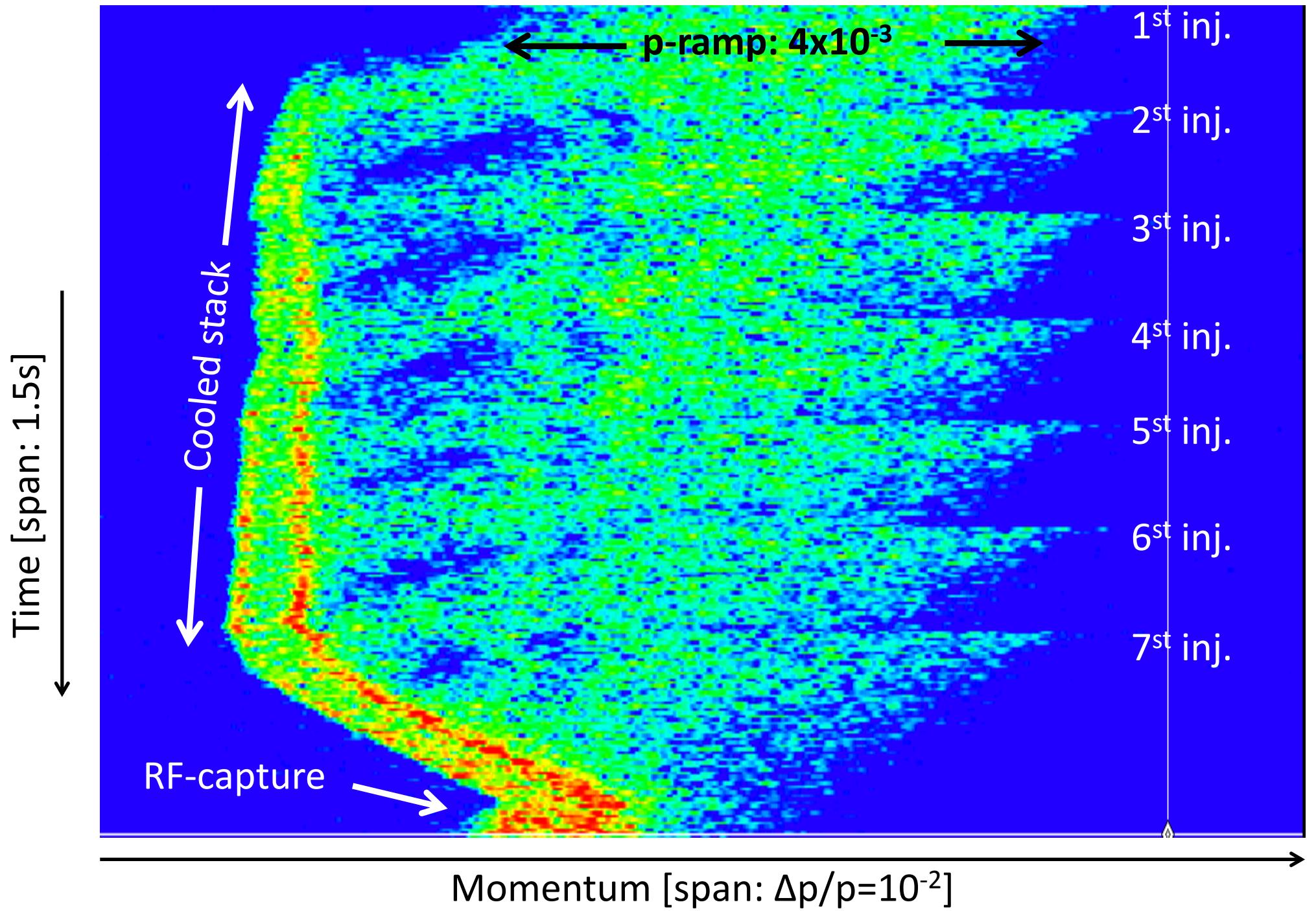


A new way to measure the chromaticity of LEIR:
with coasting beam on the low-energy plateau

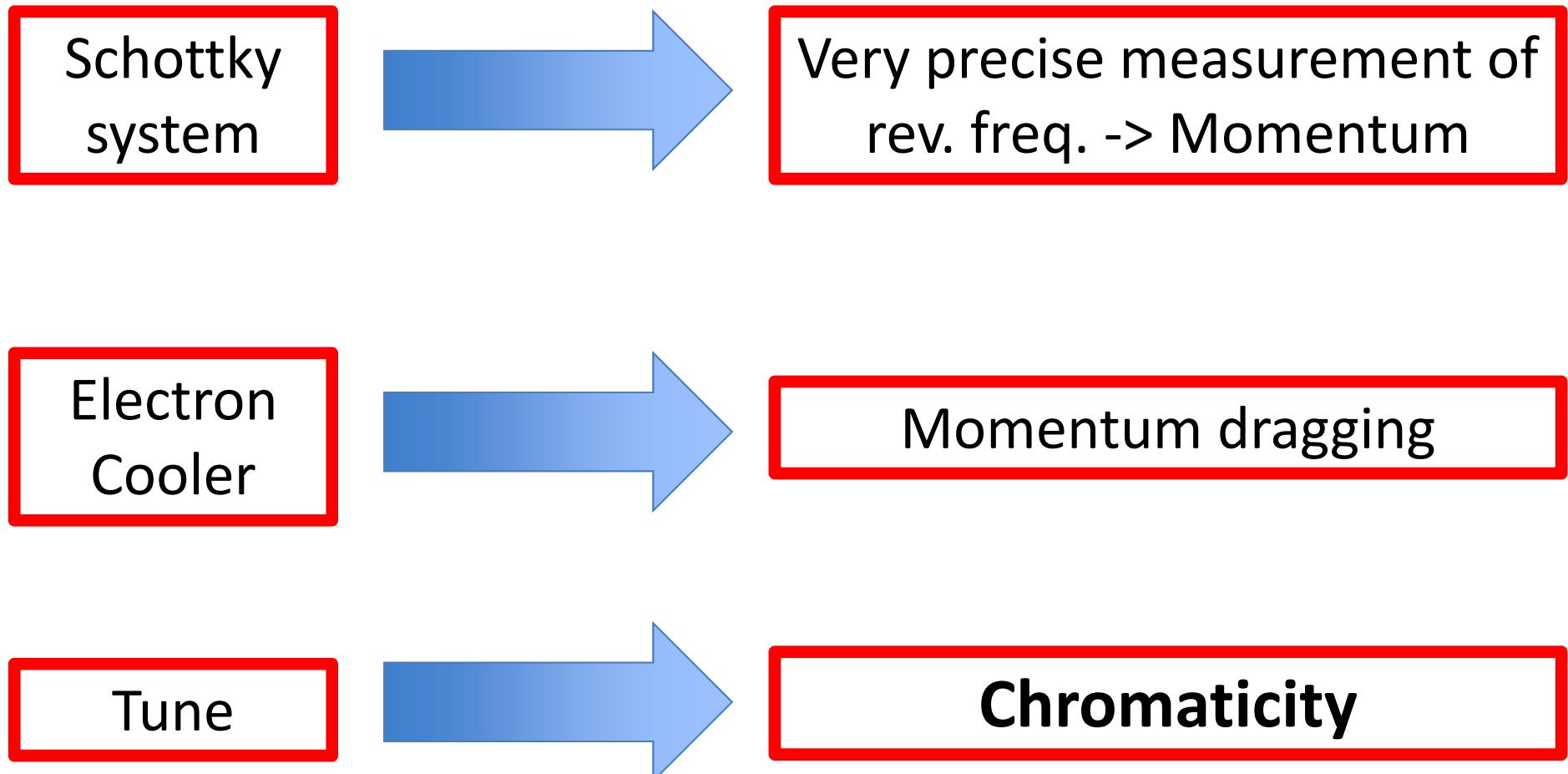


LEIR has a Schottky system and an electron-cooler!

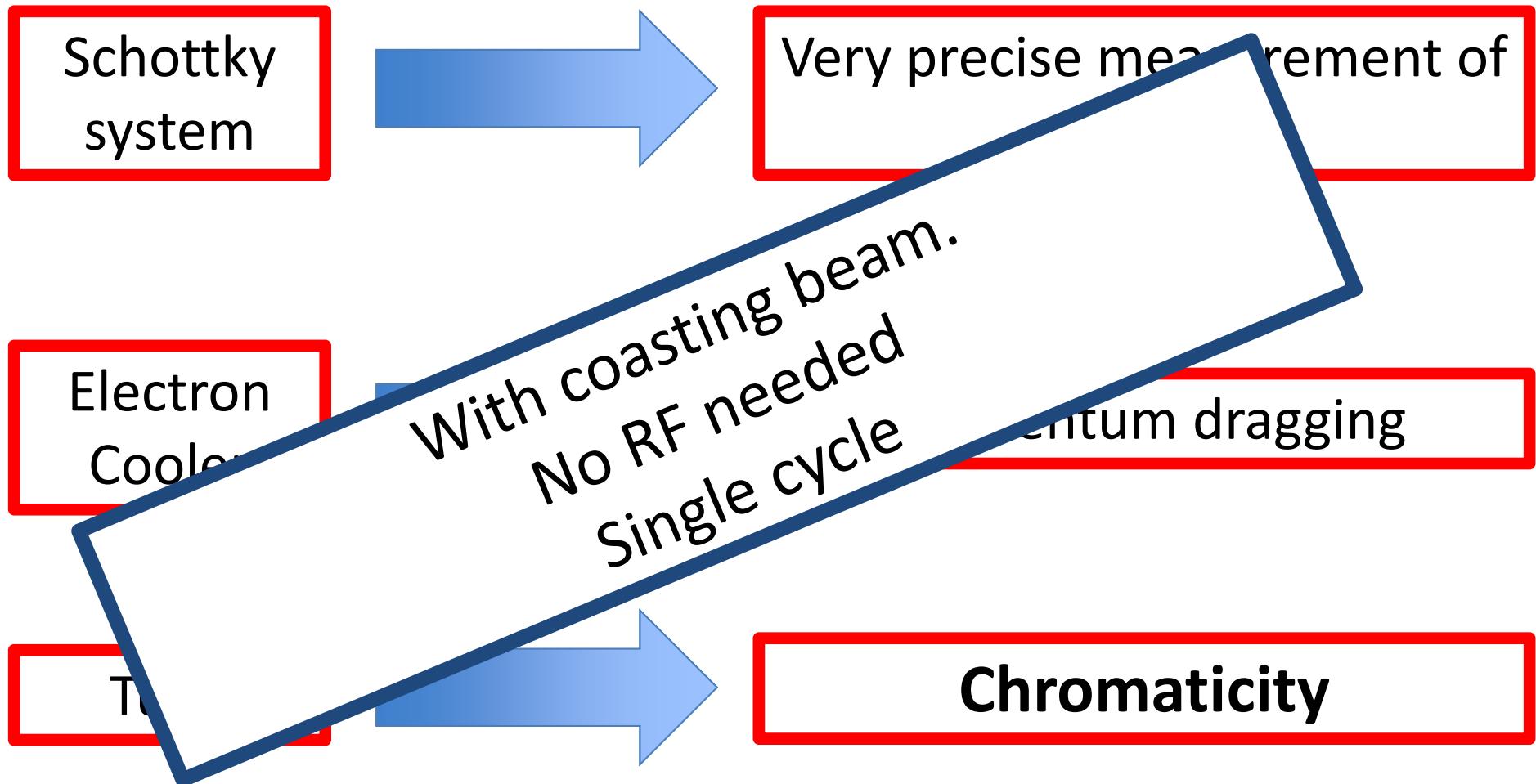




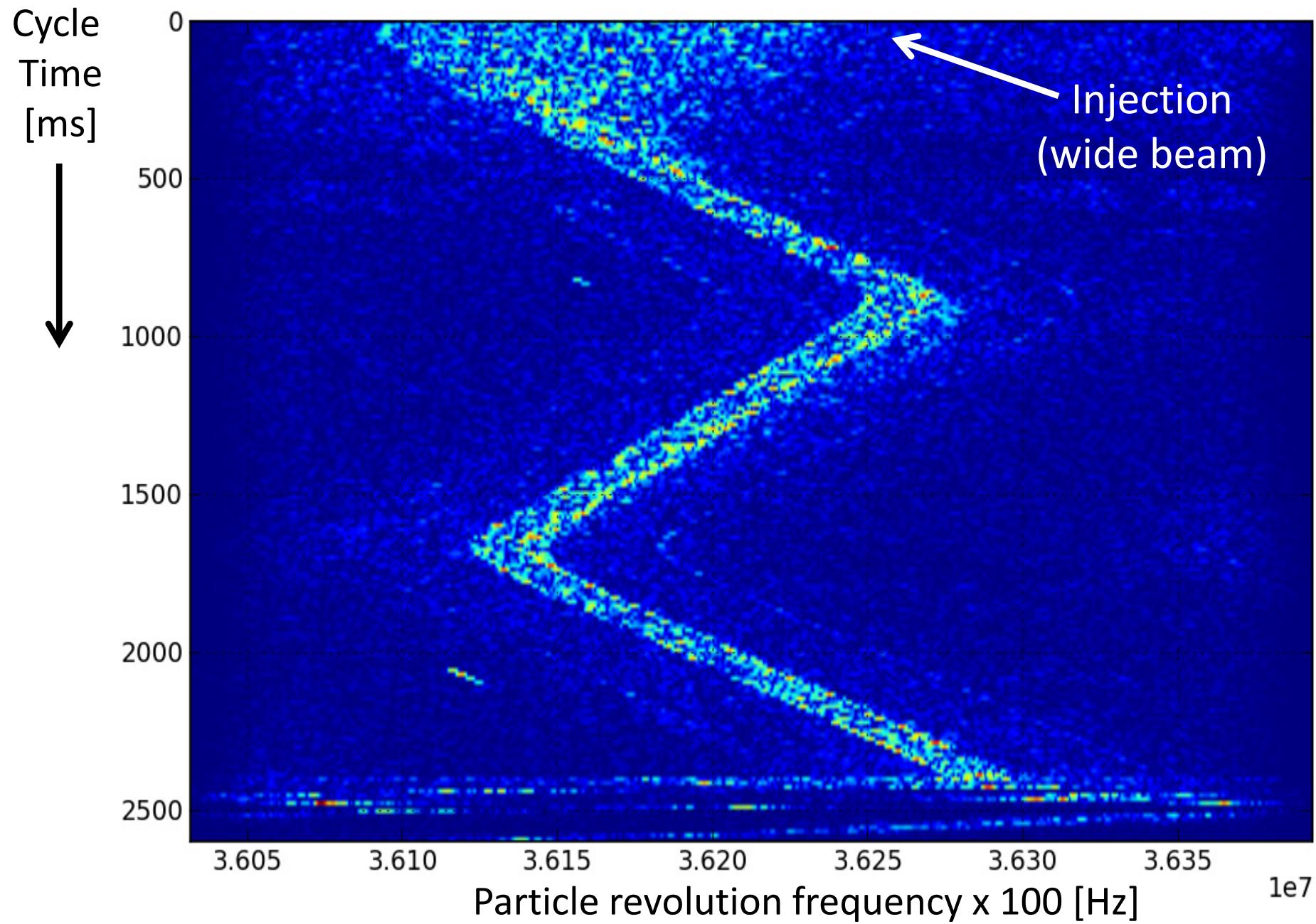
With that we can make a chromaticity measurement!



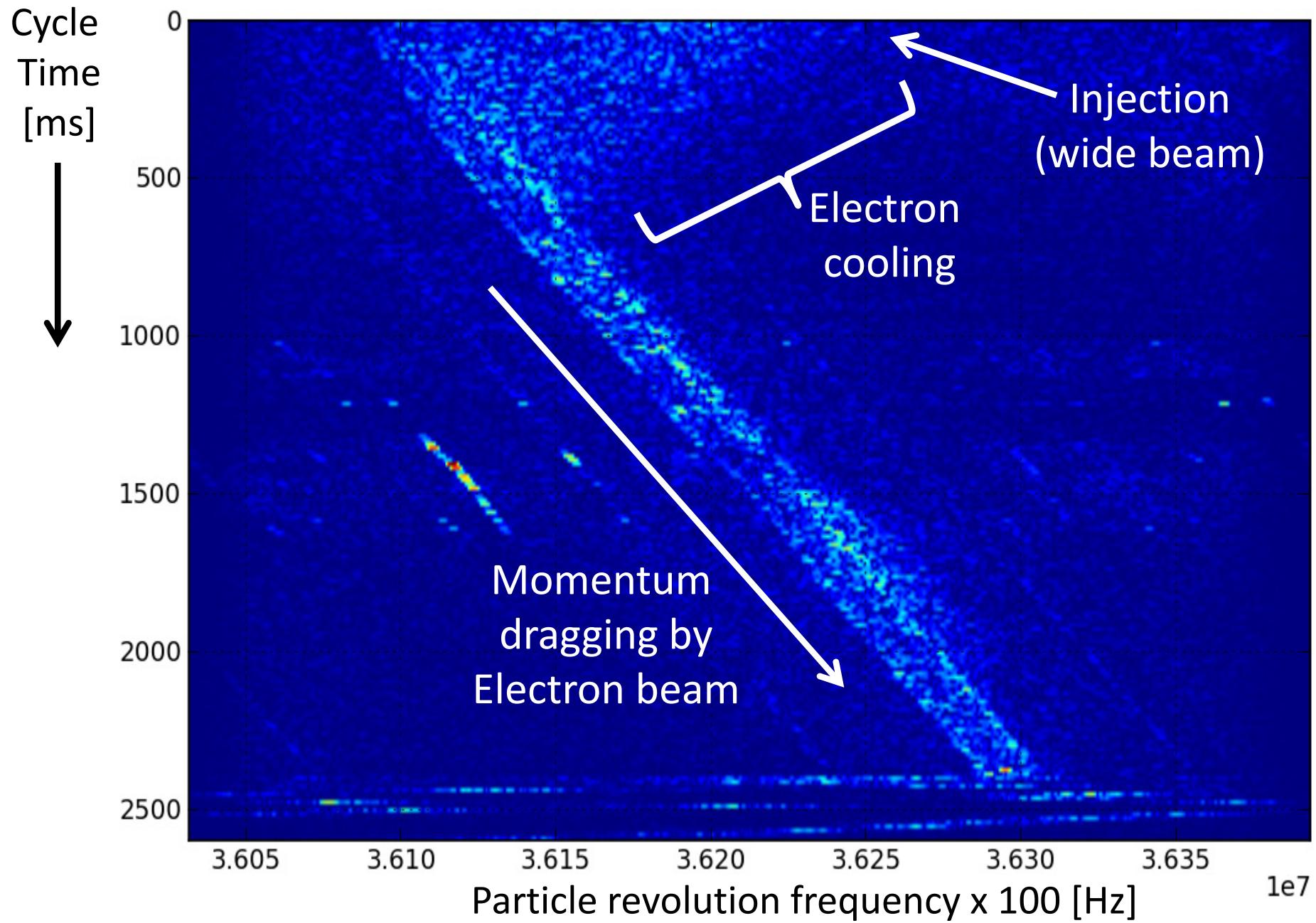
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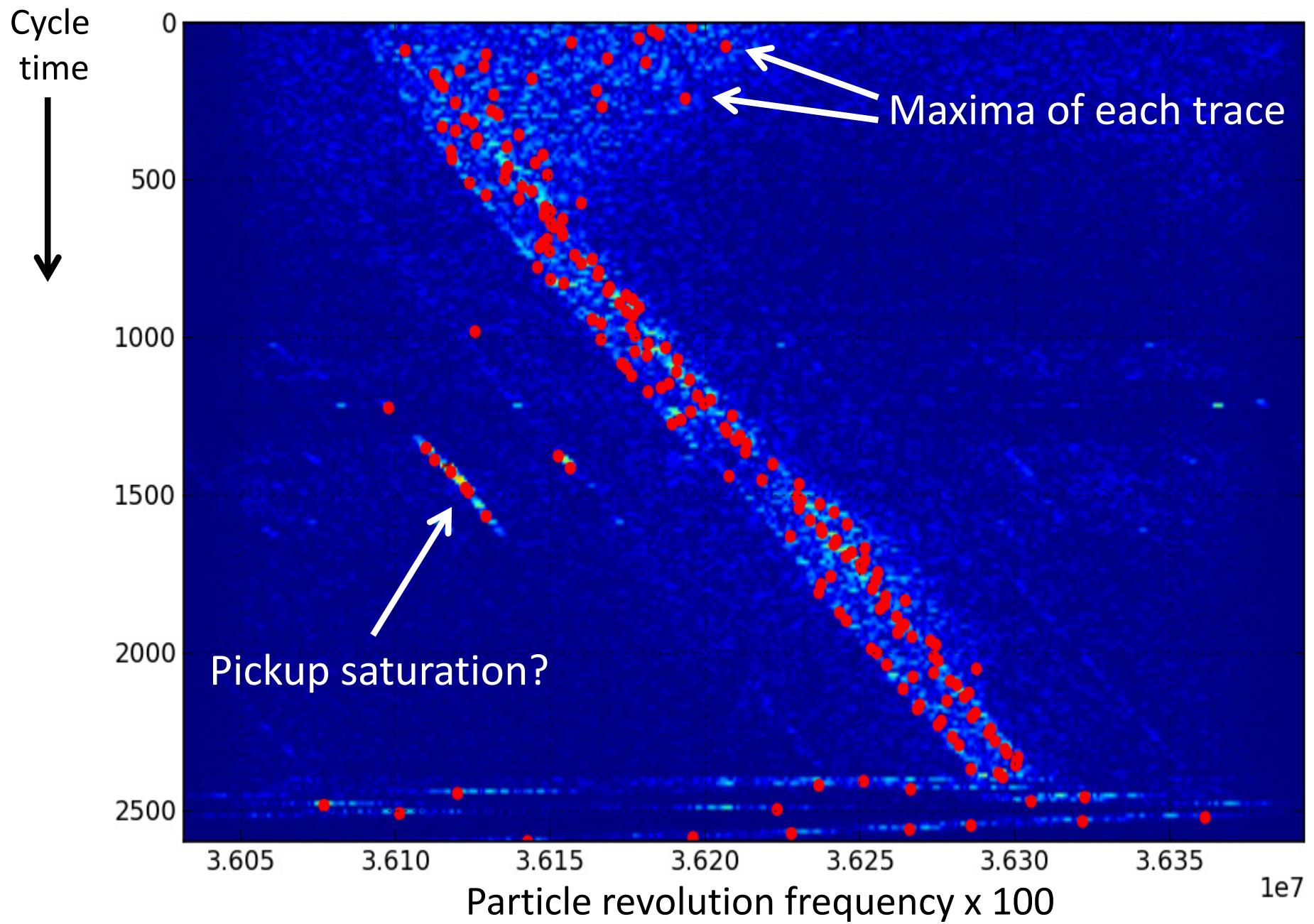
Playing with the Argon beam in the Schottky spectrum



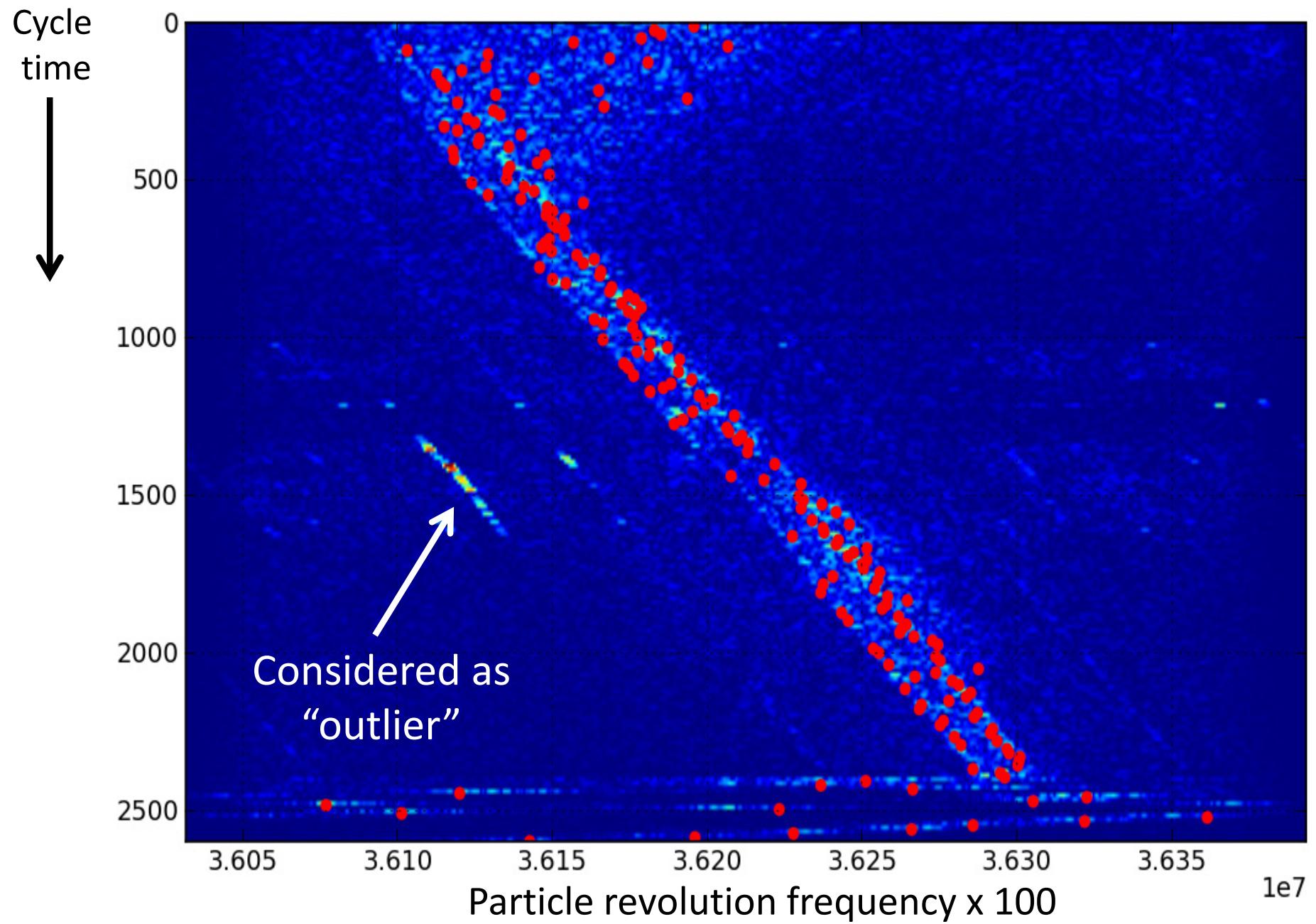
Schottky spectrum with Argon momentum dragging



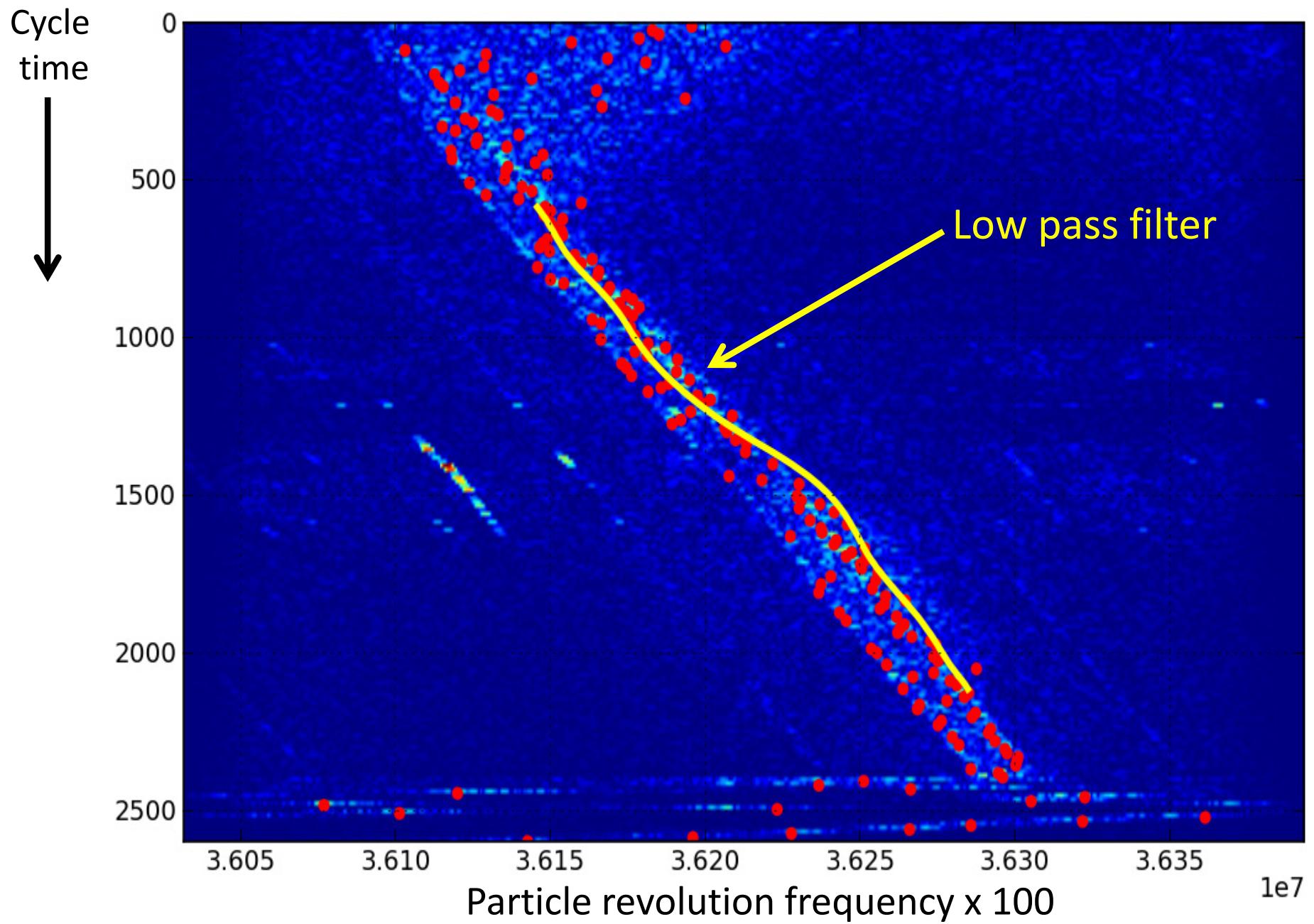
Identifying maxima



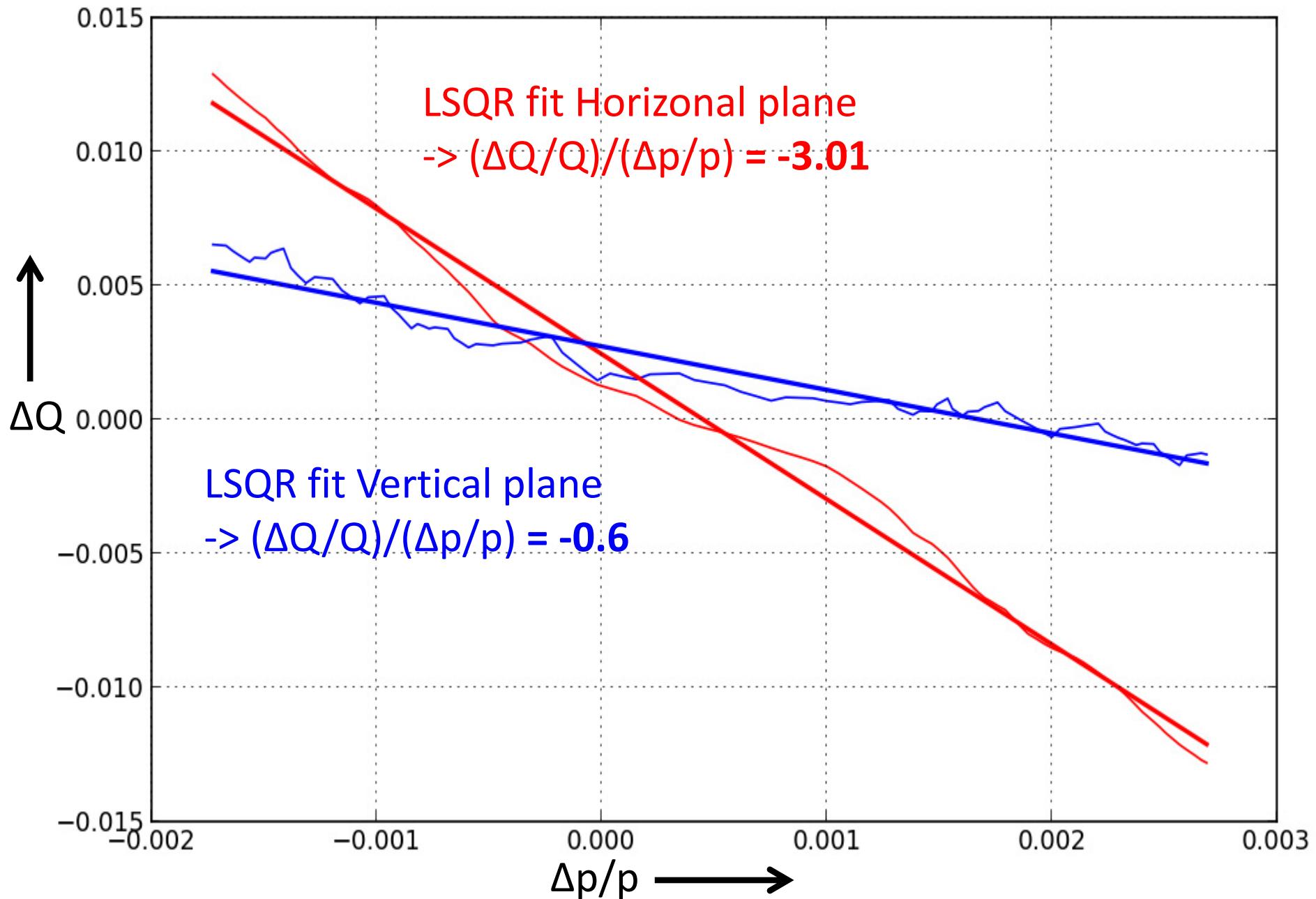
Cleaning up outliers



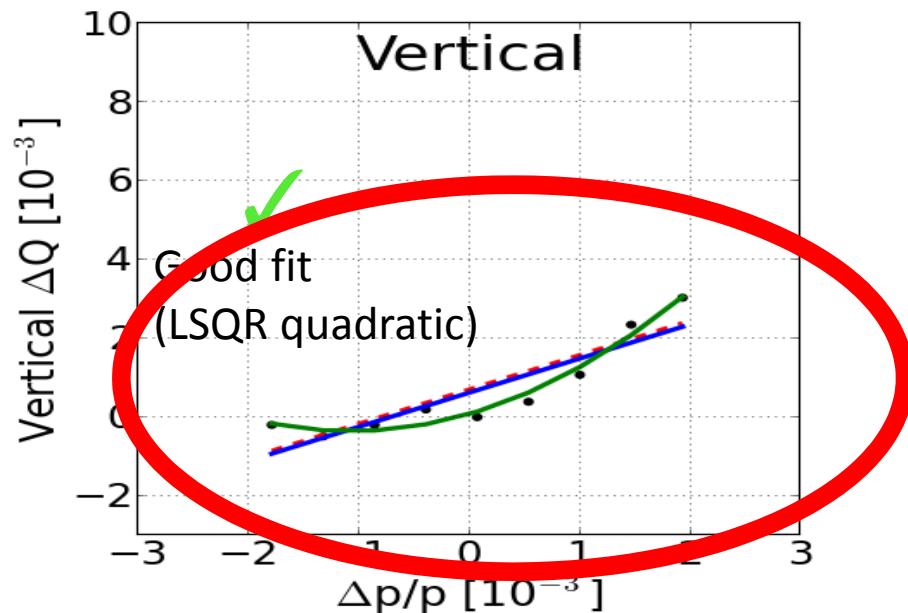
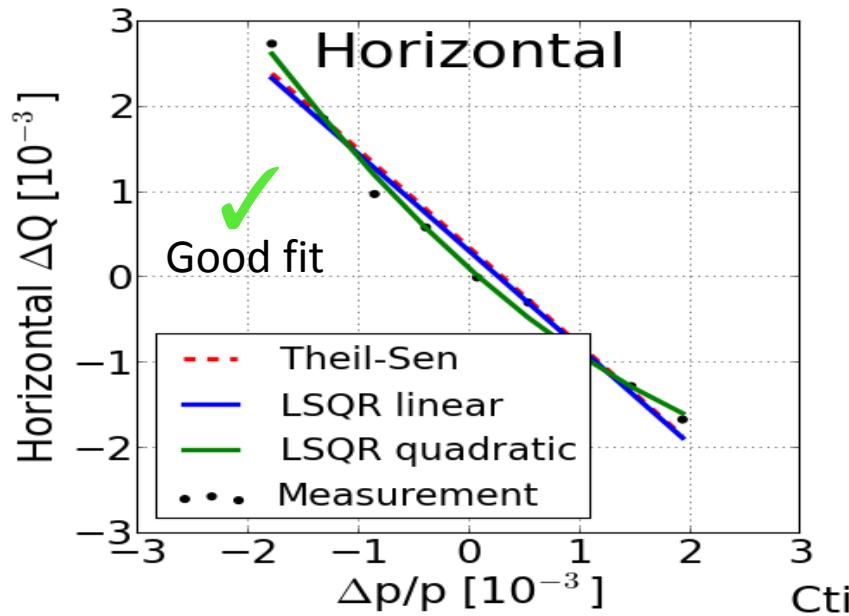
Low pass filtering



Tune change vs. beam momentum -> Chromaticity



In 2013 with PB^{54+} :

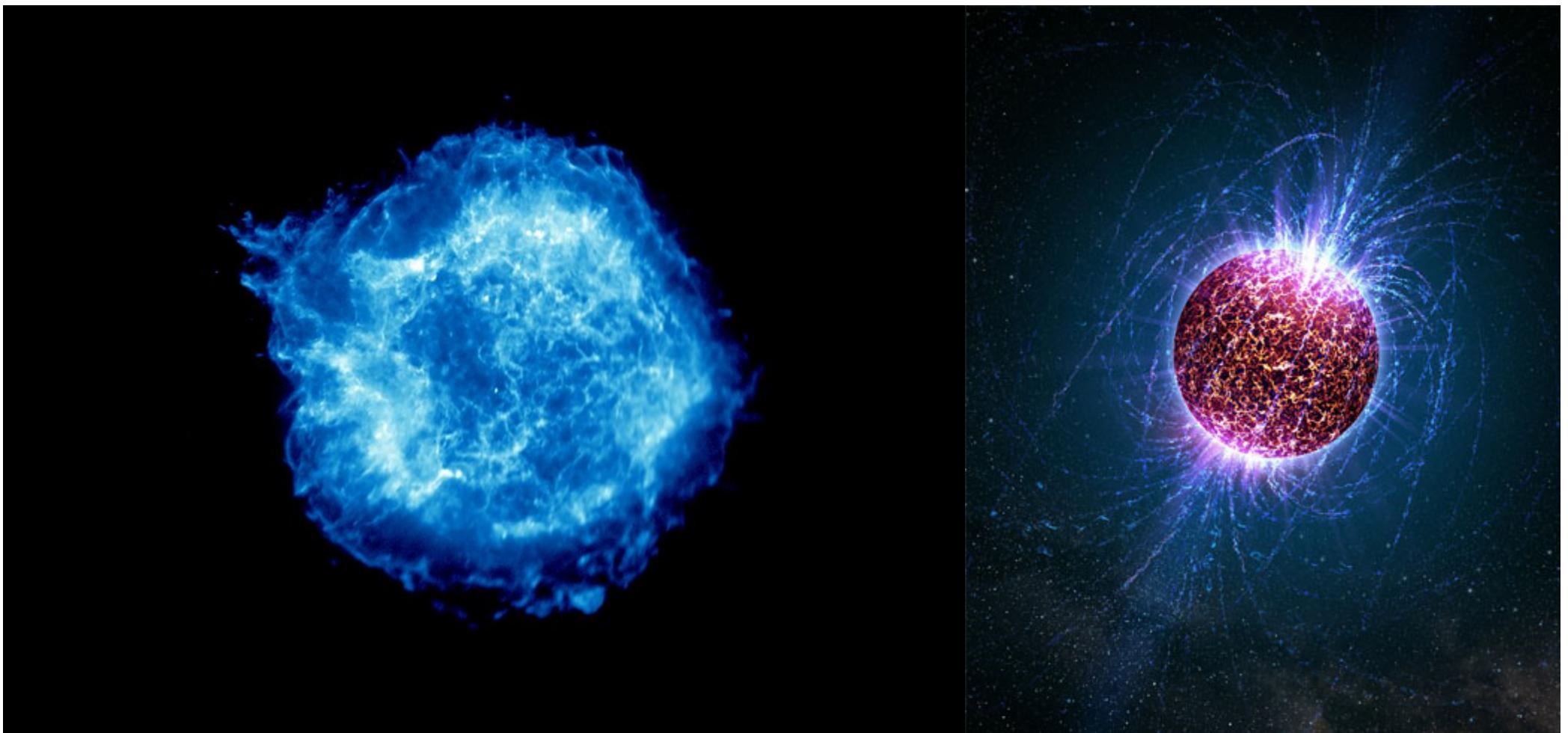


With Lead (sext. on) it
was positive...

With Argon (sext off)
it's negative!

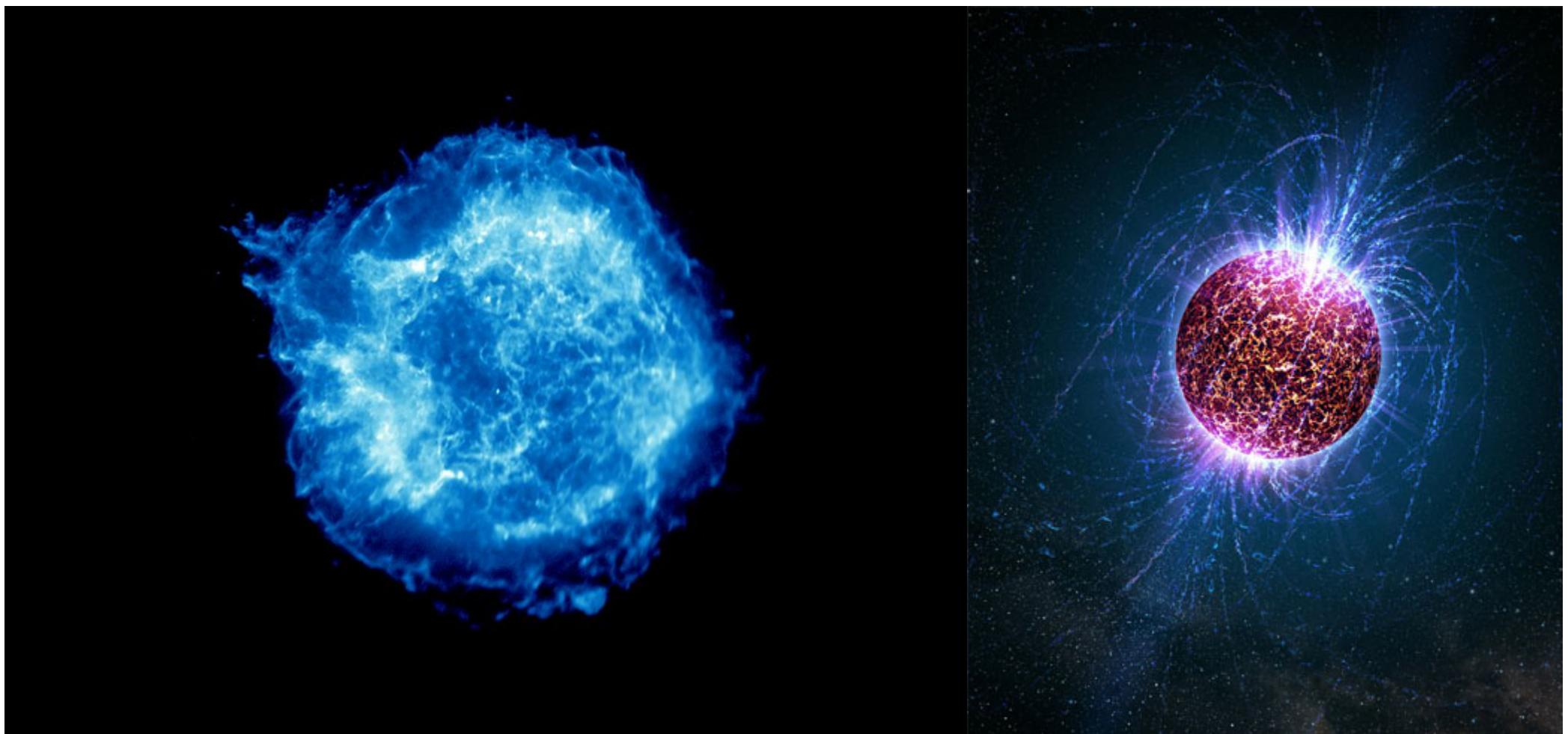
Summary:

- New method of measuring coasting beam chromaticity
- Negative chromaticity in H and V plane for Argon
- LEIR upgrade is fundamental for the success of LIU Ions
- Lots of studies necessary (S/C, instabilities)



Outlook:

- Optics measurements (LOCO)
- Refuting tests: working hypothesis
Space Charge & Intrabeam scattering
- Impedance model
- Transverse Damper
- Magnetic model (main bends)
- Instabilities
- RF during capture
- Electron cooling 100ms OP
- Power converters



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...for a better understanding
of the extreme universe

Thank you!

どうもありがとうございました!