John Adams Institute for Accelerator Science

Imperial College London

Royal Holloway University of London

University of Oxford

JAI contributions to Future Colliders

Stephen Gibson

JAI Advisory Board

Imperial College, 7th March 2019

HiLumi HL-LHC PROJECT

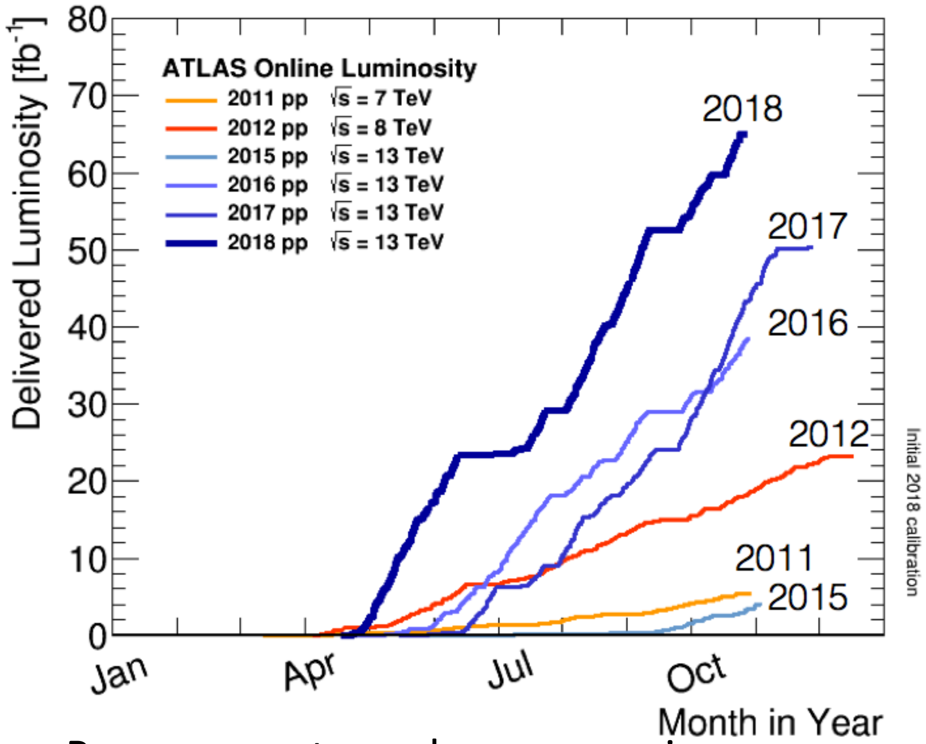
FCC hh ee he

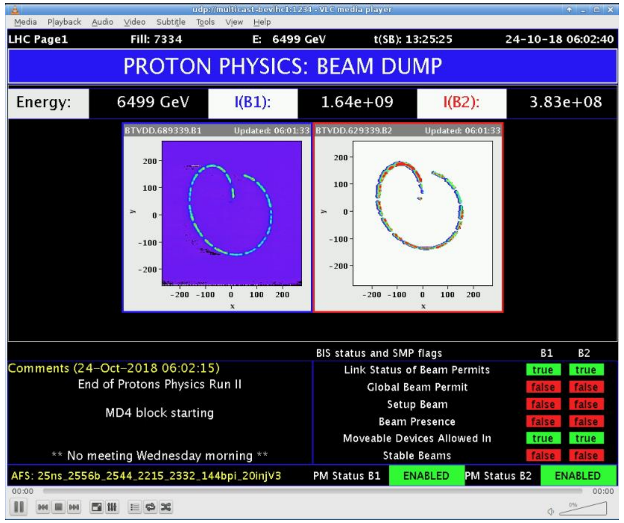
Overview

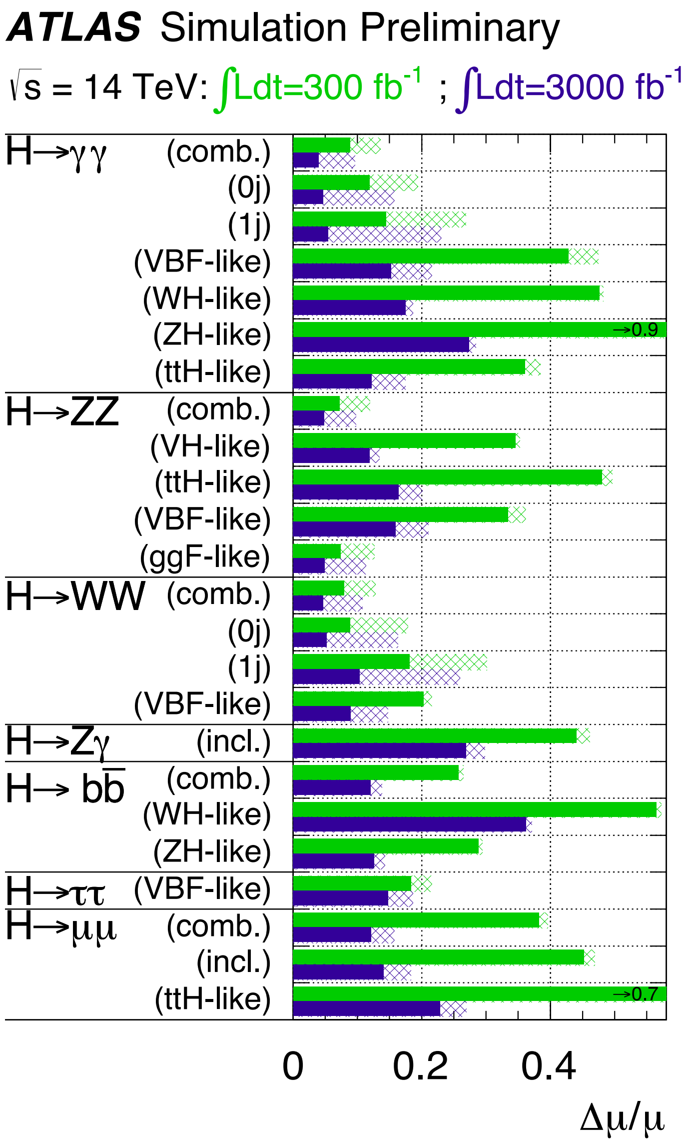
- ***High-Luminosity LHC:***
  - *LHC Injector Upgrade, **RHUL-developed beam instrumentation**:*
    - ***Dual laserwire** for Linac4, CERN's new injector.*
    - ***Beam Gas Ionisation Profile Monitor** at CERN PS.*
  - ***Machine protection at HL-LHC: novel collimation** and **IR design**.*
  - ***Diagnostics for HL-LHC**: **Electro-Optical BPMs**, BGV, Luminosity monitors.*
  - *Beam-induced backgrounds: **BDSIM** models, ATLAS upgrades.*
  - *Ramping up at Oxford: **LHC BPM** upgrade + **triplet stabilisation**.*
- ***Future Circular Collider:***
  - *IR optics, energy deposition, dynamic aperture*
  - *Ion collimation for FCC-hh, HE-LHC & **Gamma factory***
- ***ILC & CLIC:***
  - *Ongoing leading contributions + cavity BPMs*
- ***Beyond colliders program:** fixed target beamlines*

LHC performance and future

LHC performance has exceeded yearly targets in quest to measure Higgs Boson couplings and search for exotic physics:
Dark Matter, Extra Dimensions, Super symmetry, ...





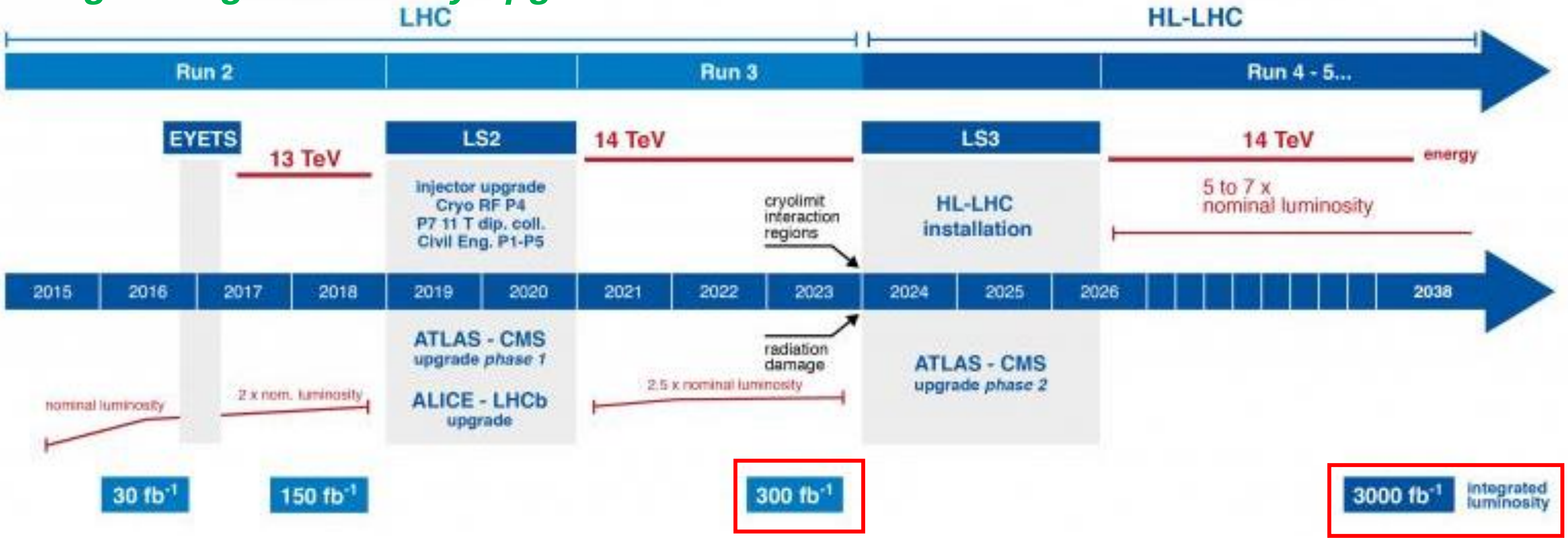


Processes extremely rare, requires many collisions = luminosity!

160 fb^{-1} achieved in Run II

The path to High Luminosity LHC

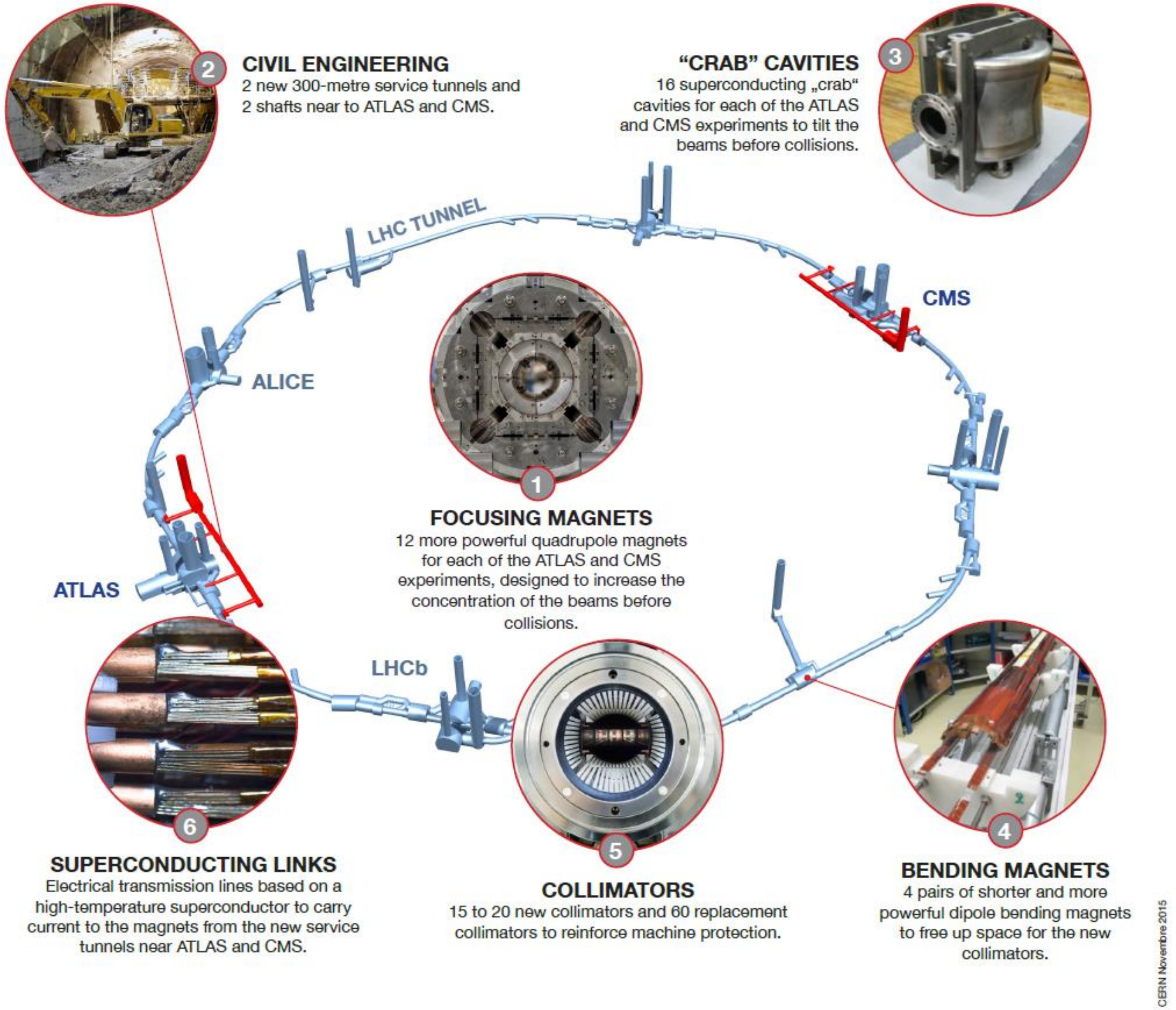
- LHC Run-II at 13 TeV, integrated luminosity of >160 fb^{-1} delivered to ATLAS/CMS at end 2018.
- Plan to increase to 14 TeV after Long Shutdown 2.
- After LS3 ending 2026, enter HL-LHC: aim to reach **5 - 7x nominal luminosity**.
- ***EU strategy 2013: Europe's top priority should be exploitation of the full potential of the LHC, including the high luminosity upgrade of the machine and detectors.***



Run 3 target

HL-LHC target

High Luminosity LHC – how?

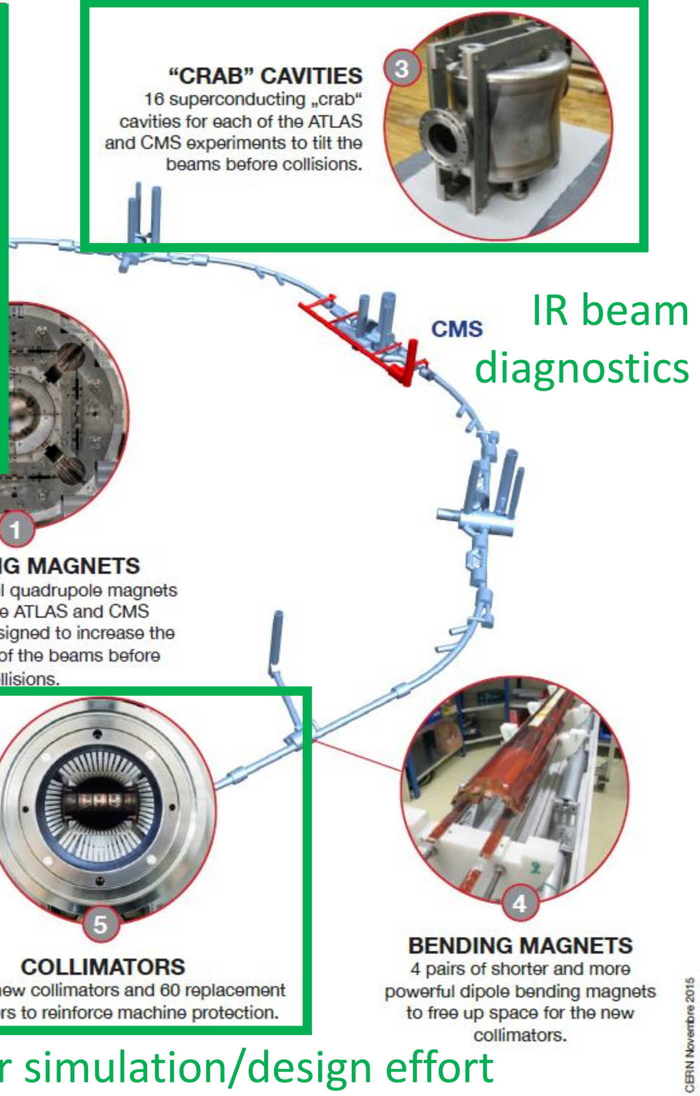


- **Lower beta* (~15 cm)**
  - New inner triplets - wide aperture Nb_3Sn
  - Large aperture NbTi separator magnets
  - Novel optics solutions
- **Crossing angle compensation**
  - Crab cavities
  - Long-range beam-beam compensation
- **Dealing with the regime**
  - Collision debris, high radiation
- **Beam from injectors**
  - Major upgrade of complex (LIU)
  - High bunch population, low emittance, 25 ns beam

High Luminosity LHC – how?

UK delivered crab cavity prototype to SPS

Complete Crab Cavity Cryomodule installed



IR beam diagnostics

UK built prototypes

Major simulation/design effort

UK institutes on ***HL-LHC-UK***

£8M CERN-STFC investment in UK

HiLumi HL-LHC PROJECT

The University of Manchester

The Cockcroft Institute of Accelerator Science and Technology

Lancaster University

University of Liverpool

Royal Holloway University of London

John Adams Institute for Accelerator Science

University of Southampton

University of Huddersfield

ASTeC

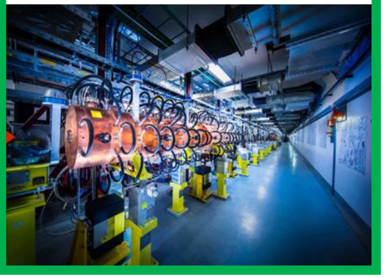
LHC Injectors Upgrade

+ new injector diagnostics

Linac2:
50 MeV protons

Linac4:
160 MeV H⁻ ions

http://home.cern/about/accelerators/linear-accelerator-4



HL-LHC team @ Royal Holloway

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Funded mainly via £8M STFC/CERN
HL-LHC-UK project, 2016-2020

Stephen Gibson


Stewart Boogert


Laurie Nevay
(JAI)

BDSIM / Collimation
(CERN based)

Hector Garcia
(JAI / HL-LHC-UK)

Sixtrack / Fluka
(**CERN based**)

Thomas Hofmann
RHUL-CERN PJAS

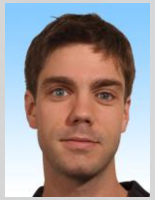
L4 Laserwire
(CERN based)

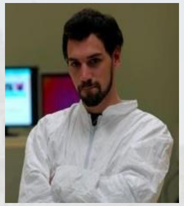
Gary Boorman
RHUL-CERN PJAS

L4 Laserwire
(CERN based)

Alessio Bosco
JAI

EO-BPM/laserwire

Marcus Palm
RHUL-CERN PJAS

HL-LHC Diagnostics
(CERN based)

Robert Kieffer
RHUL-CERN PJAS

HL-LHC Diagnostics
(CERN based)

Andrey Abramov

HL-LHC / BDSIM
(CERN based)

Helena Pikhartova

LHC backgrounds
(CERN based)

Stuart Walker

LHC / ATLAS
Backgrounds

Sophie Bashforth

EO-BPMs

Alberto Arteche

EO-BPMs

Inada Penman

EO-BPMs

Swann Levasseur

BGI at CERN

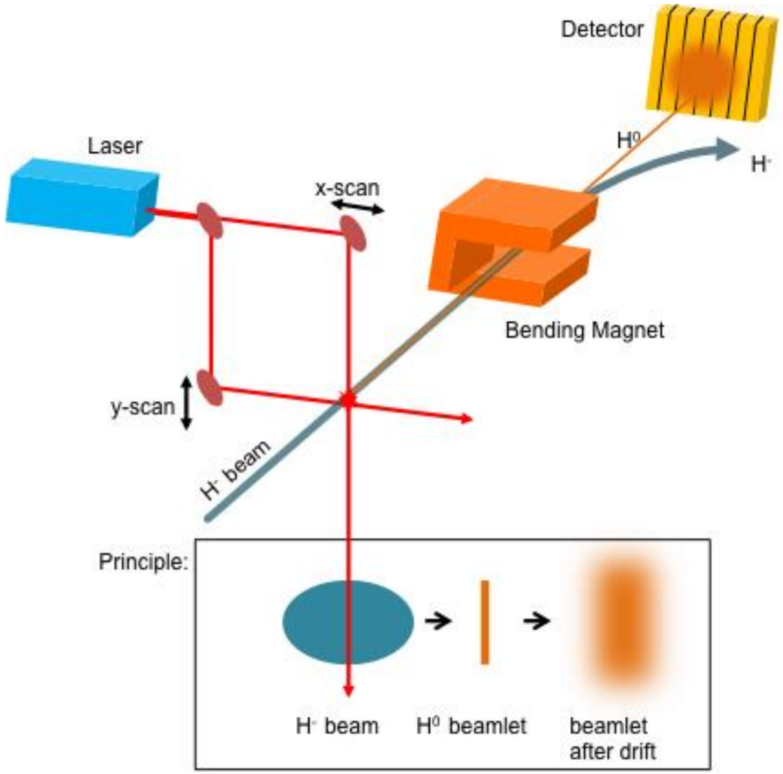
Beam Instrumentation for LIU:

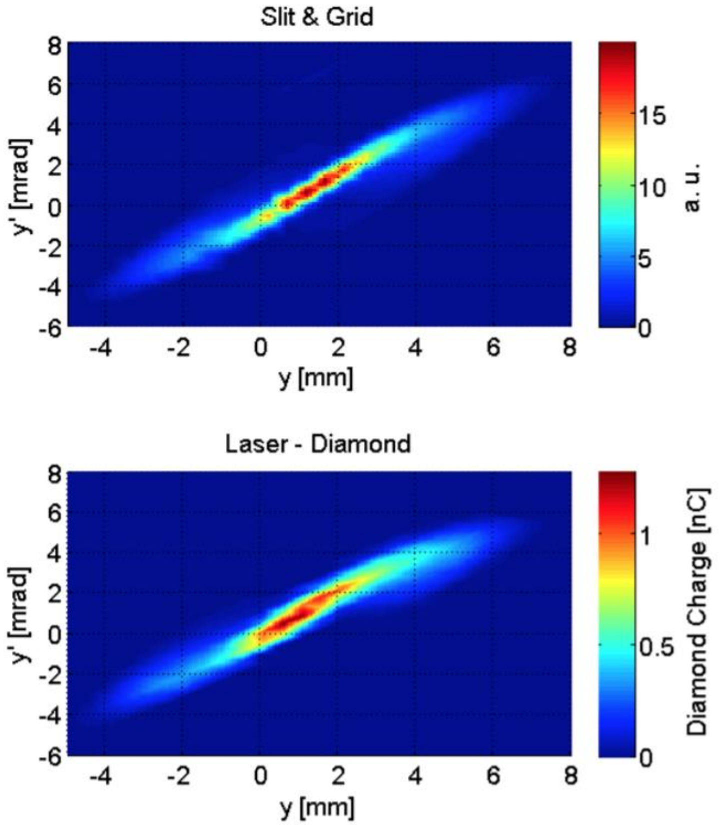
LHC Injectors Upgrade

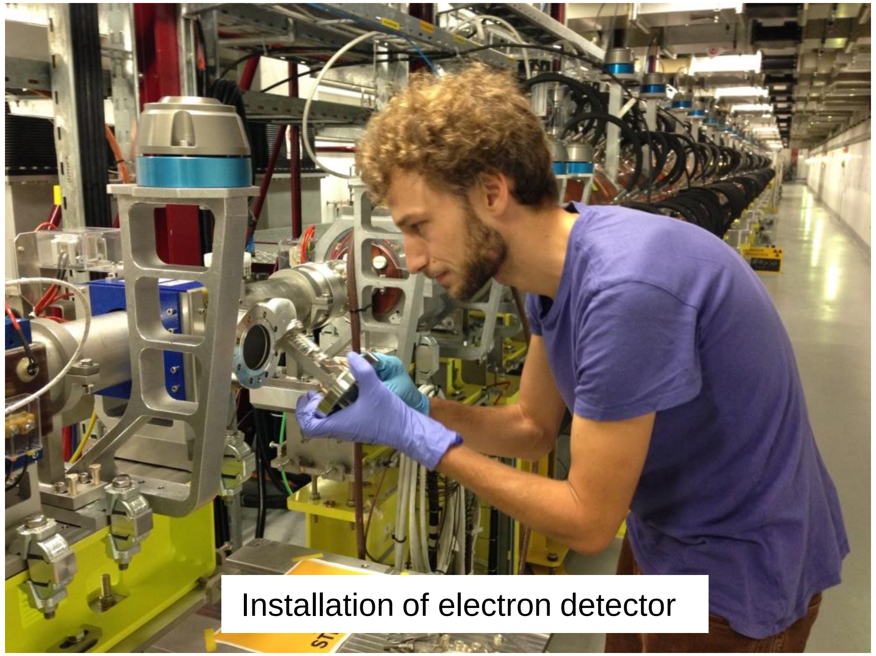
H⁻ laserwire prototype

T. Hofmann et al

- ***New instrument to measure the transverse emittance has been demonstrated with a RHUL-CERN built prototypes in recent years:***
  - Thomas Hofmann's thesis, July 2017: https://cds.cern.ch/record/2282569/






Installation of electron detector

Dual laserwire installed at Linac4

T. Hofmann et al

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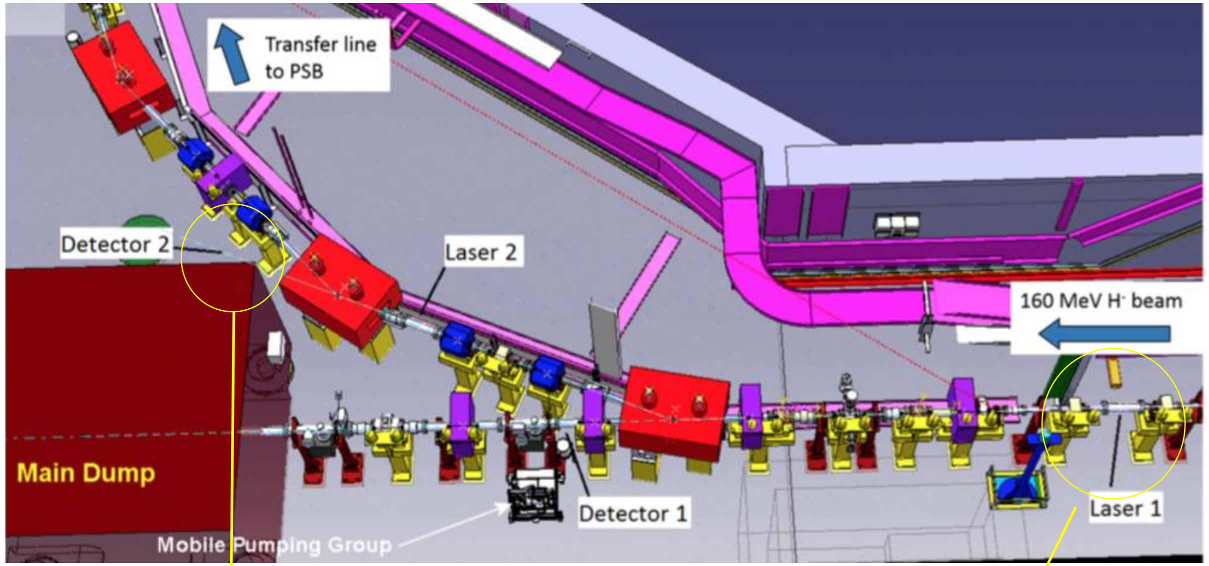
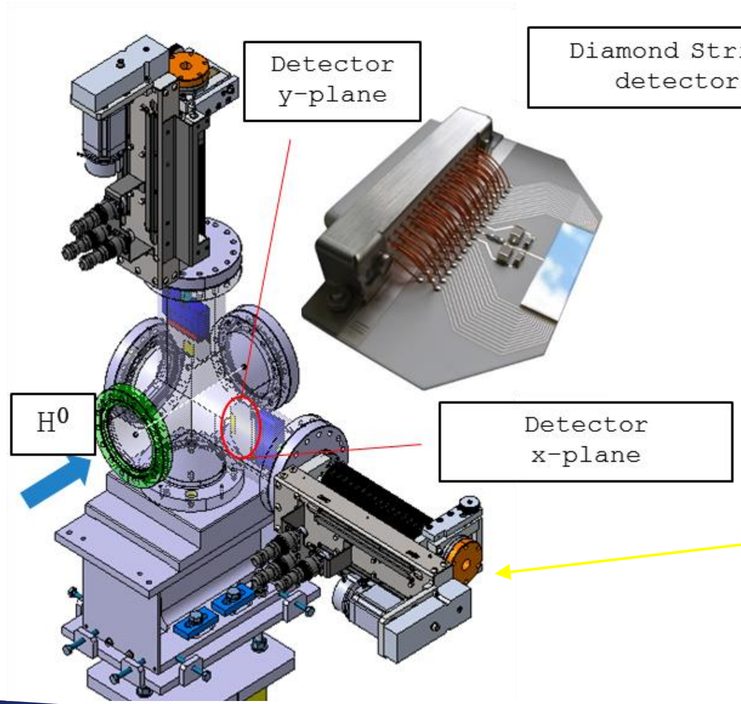
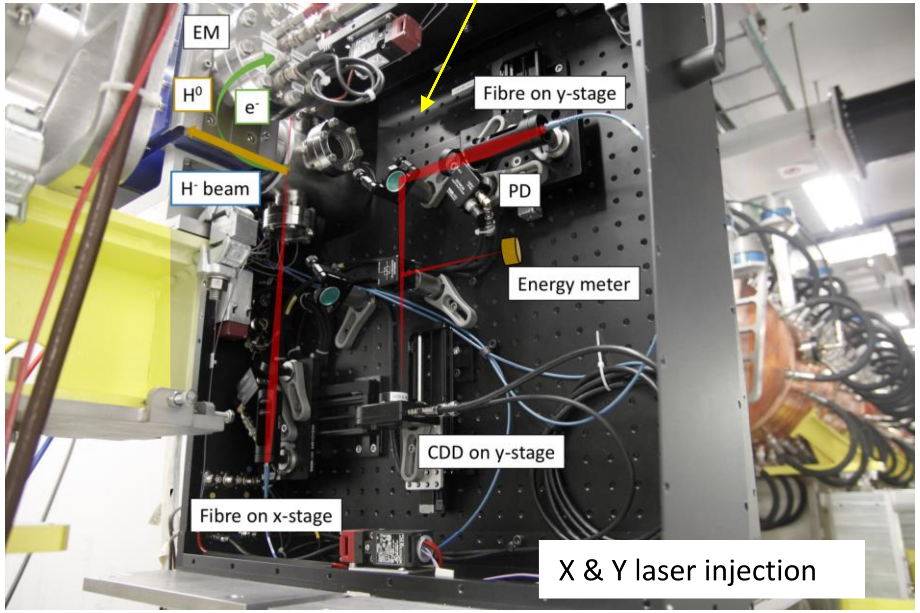
- ***Non-interceptive emittance monitor***
  - *4 laserwires: in X and Y at two locations*
  - *Commissioned in 2018 at 160 MeV*
  - *Multi-channel diamond strip-detector*





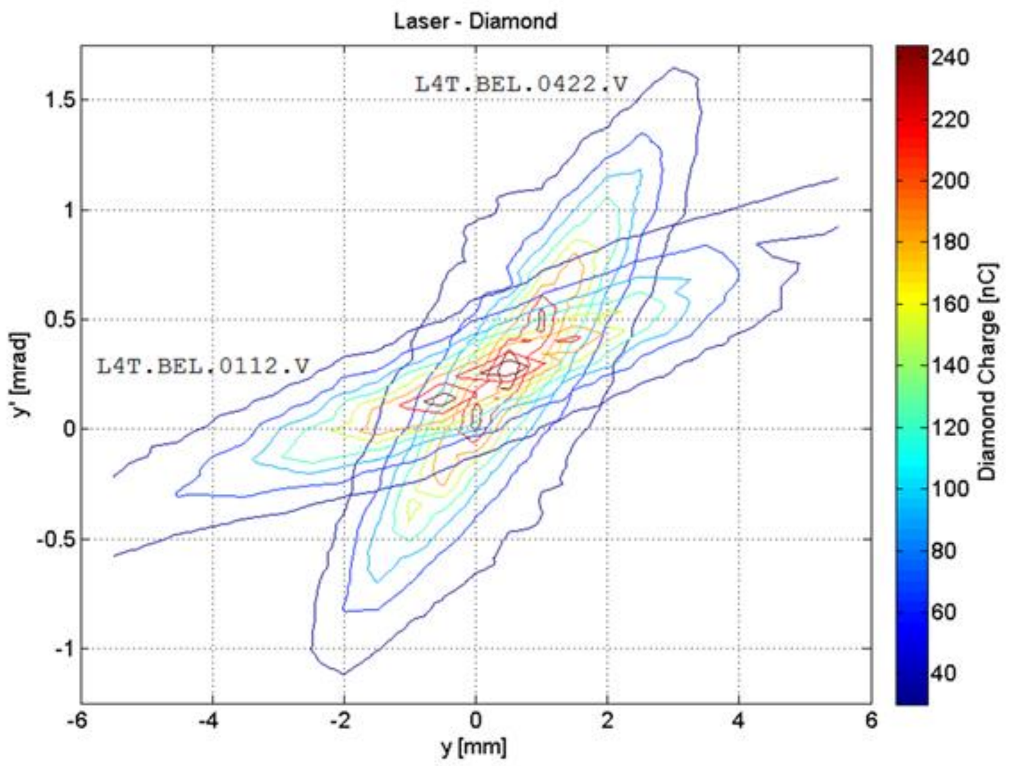


Dual laserwire commissioning results

T. Hofmann, G.E. Boorman, A. Bosco, S.M. Gibson, A. Goldblatt, F. Roncarolo

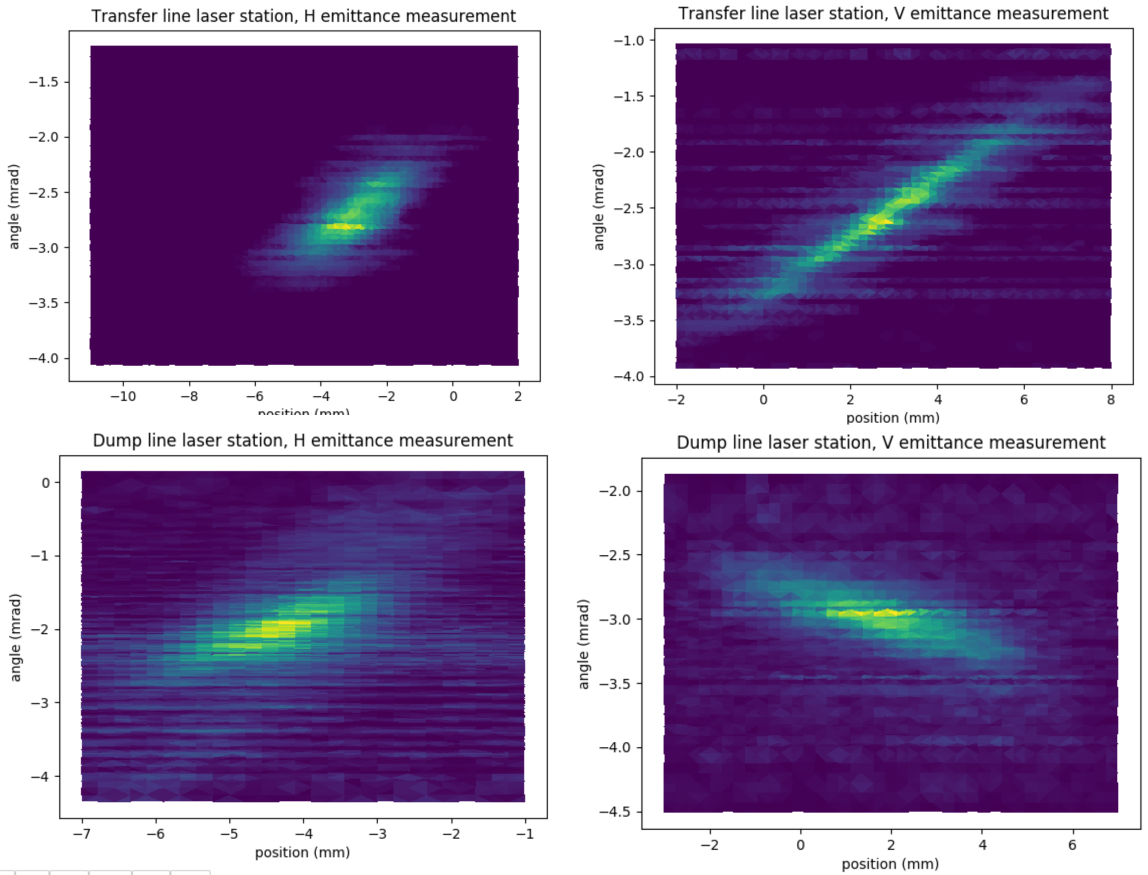
ROYAL HOLLOWAY UNIVERSITY OF LONDON

- ***Laserwire Emittance Monitor***
  – *First results showing vertical emittance for two different settings of the line.*



2018 measurements at 160 MeV

– ***Latest data with 4 diamond detectors fully operational:*** *horizontal and vertical emittance reconstruction from both stations:*



T. Hofmann et al ,'Commissioning of the operational laser emittance monitors for Linac4 at CERN', WEPAL074, IPAC 2018.

S. Levasseur et al

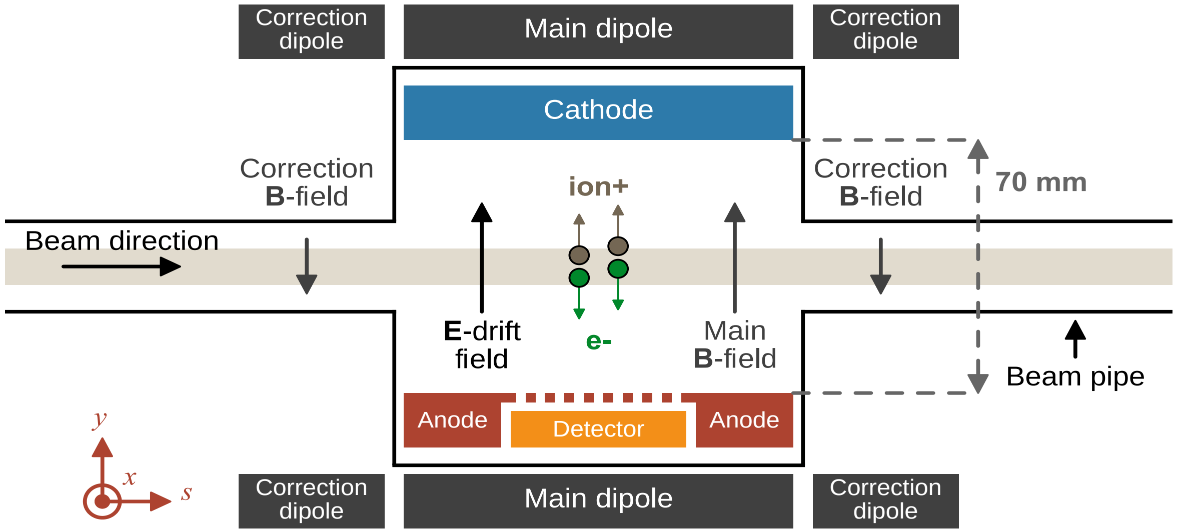
ROYAL HOLLOWAY UNIVERSITY OF LONDON

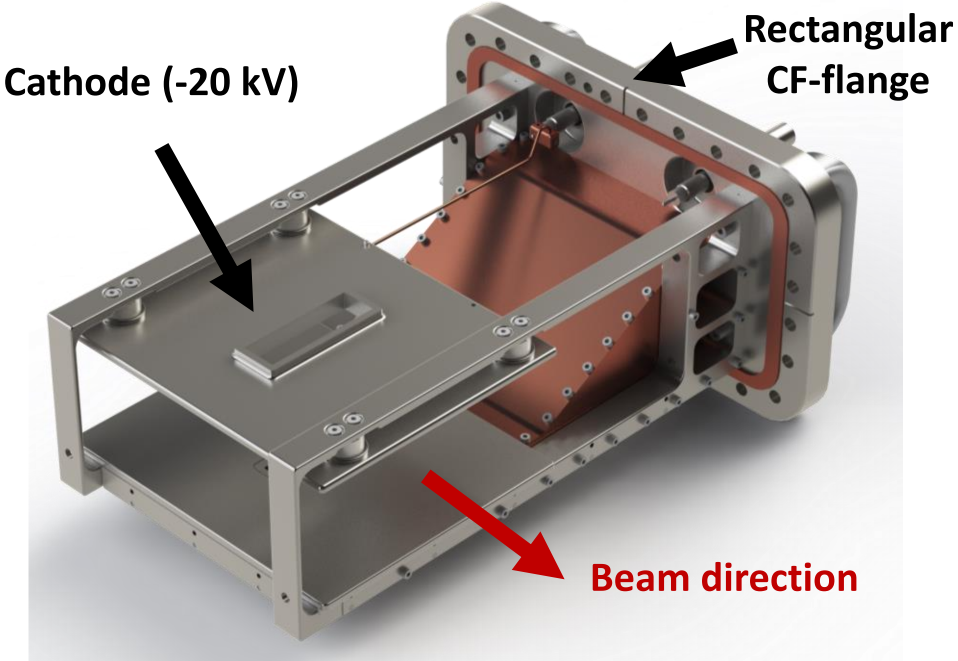
Purpose:

- Measure the transverse beam profile to improve the quality of the beam used for the LHC
- Integrated *non-destructive* beam profile throughout the cycle @ 1 kHz

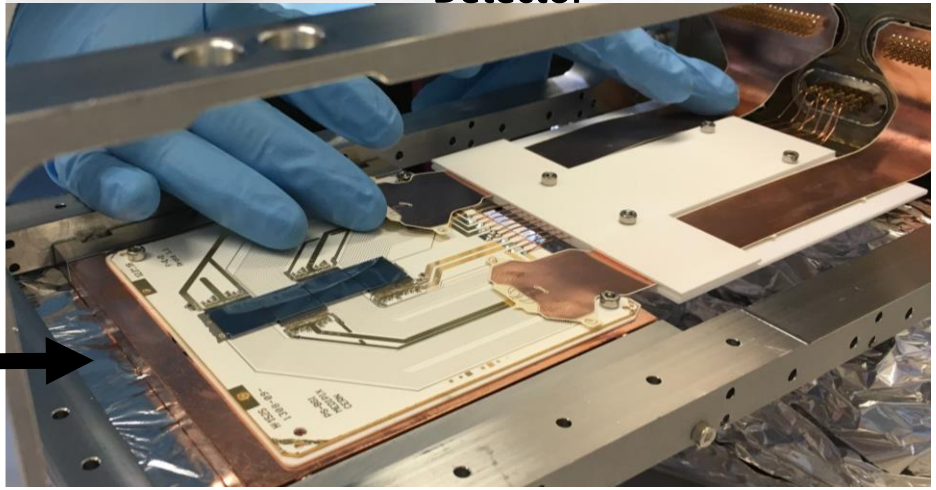
Operating environment:

- Ultra-high vacuum: outgassing ≤ $1 \cdot 10^{-7}$ mbar·l·s^{-1}
- Radiation: 10 kGy/year at beam pipe, 1 kGy/year at 40 cm
- Presence of beam with losses and electro-magnetic interference





Detector



Specifics for the PS-BGI:

- Imaging of 10 keV ionization electrons using **hybrid pixel detectors**
- 285 kV/m electric field, 0.2 Tesla magnetic field

PS-BGI: transverse beam profile measurement

S. Levasseur et al

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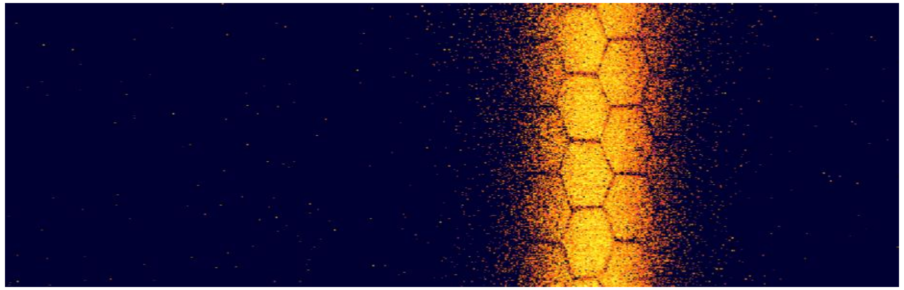
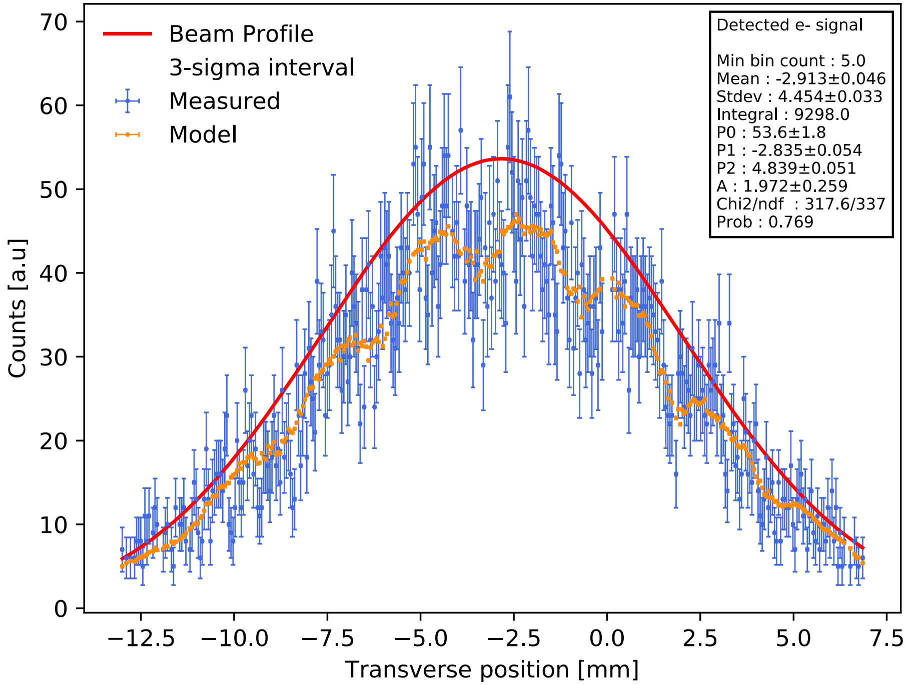
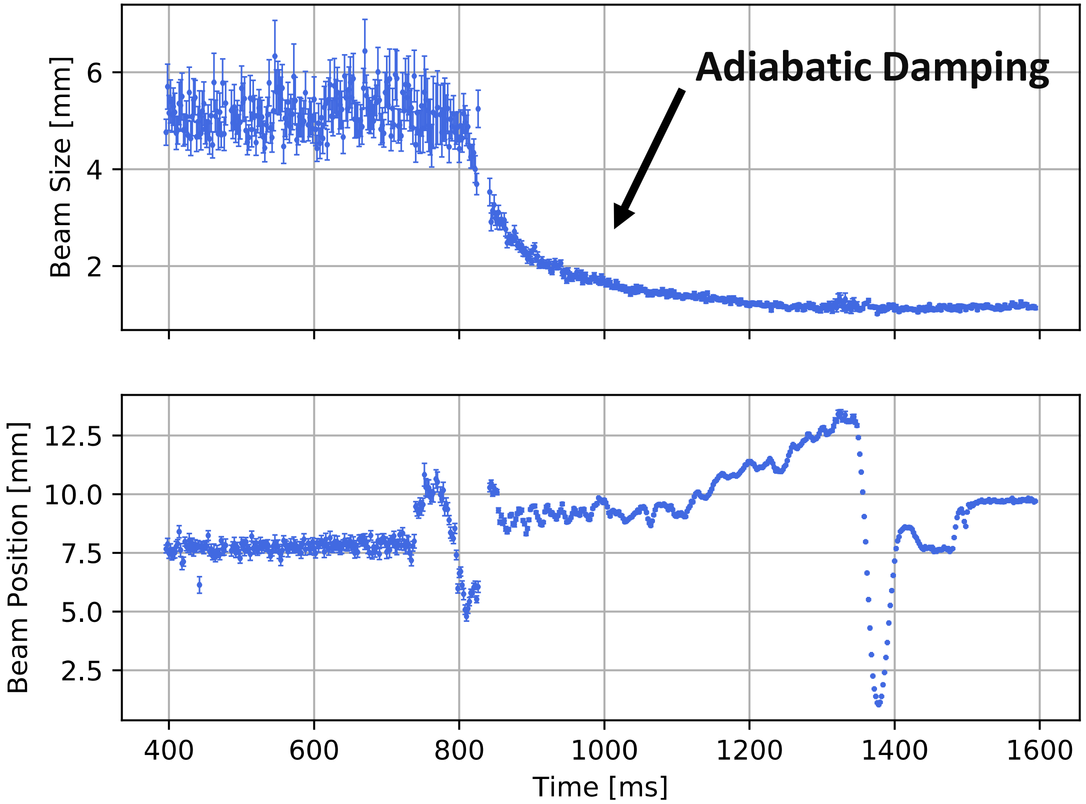
Raw Hybrid Pixel Detector Image



Transverse horizontal beam profile reconstruction



Evolution of beam size & position during the full PS cycle



- Extract beam size & position from fit to beam profile.
- Continuous measurements at a rate of 2kHz per bunch for an LHC-type beam.

PS-BGI: turn-by-turn measurements of single bunch

S. Levasseur et al

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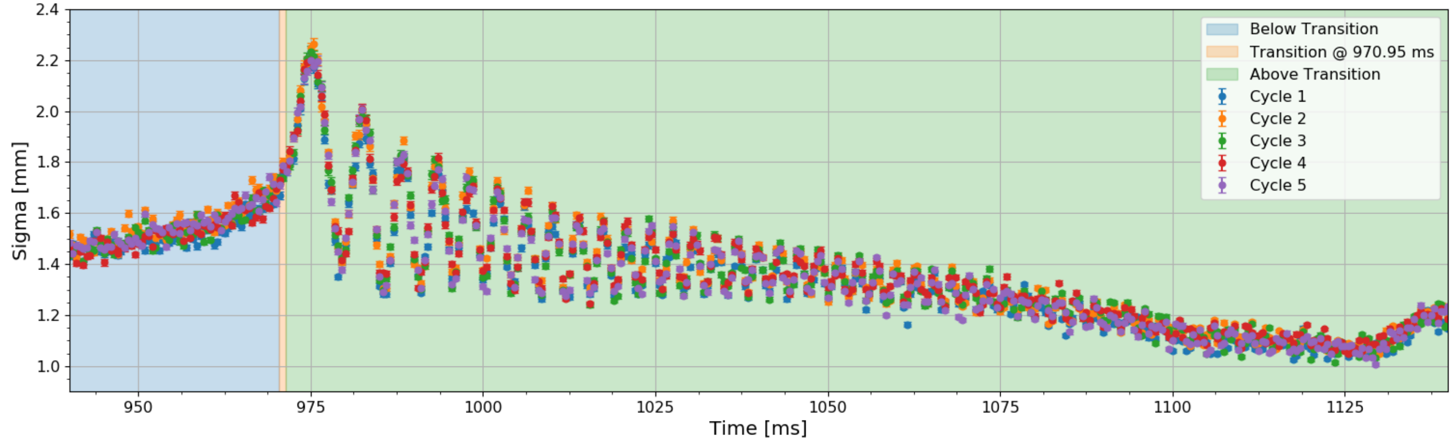
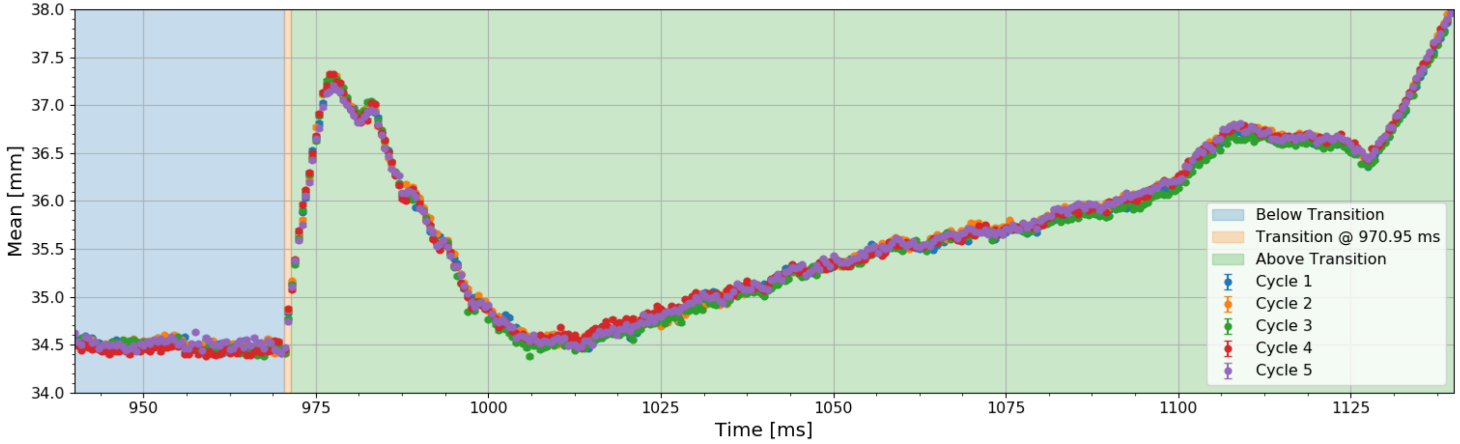
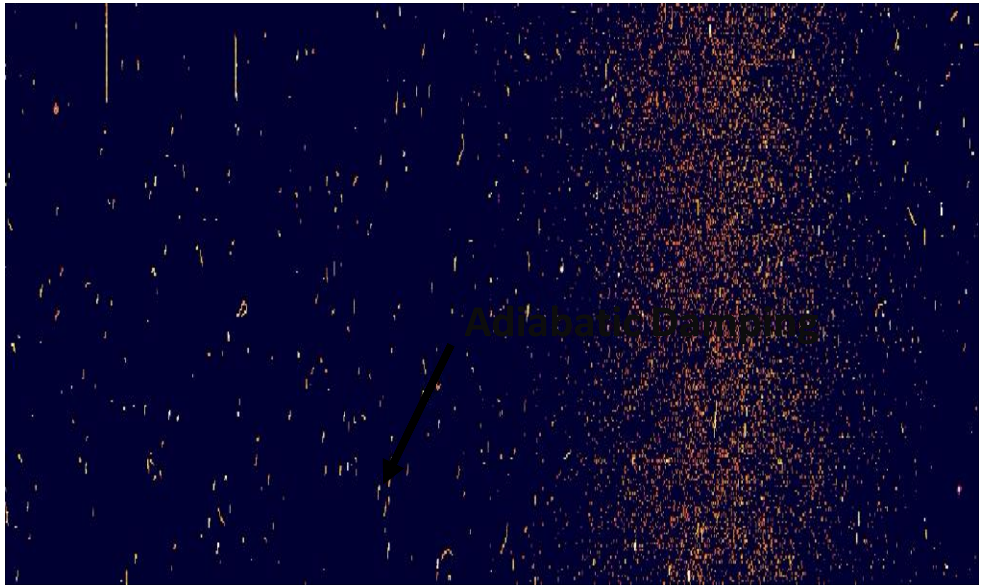
Practical use case for beam diagnostics - *transition crossing*

Sigma = width of the beam
Mean = beam centre

Beam sigma/mean measured continuously at 2 kHz
Oscillations within a single cycle can be observed!







Video of single LHC bunch in the PS as energy ramps from 2.1 GeV to 26.3 GeV

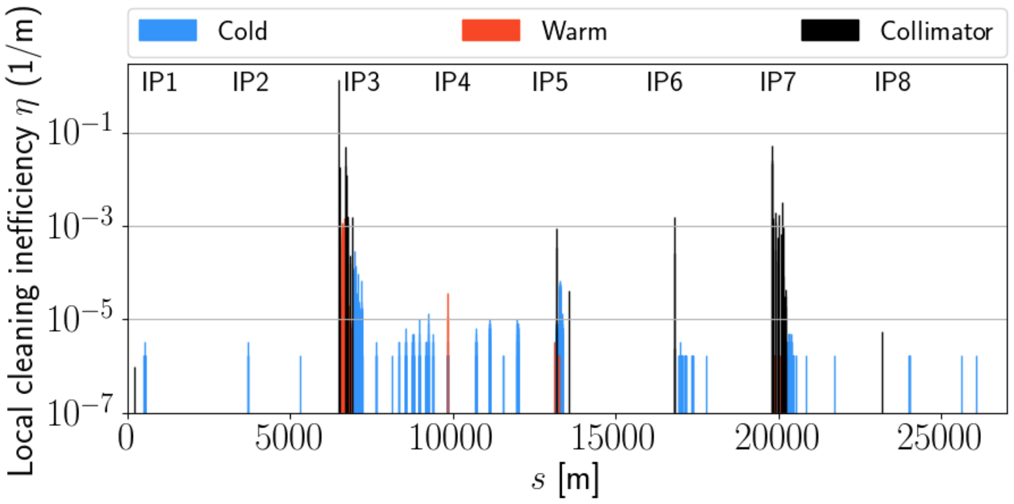
- Slowed down for viewing purposes
- Backgrounds from beam losses not removed

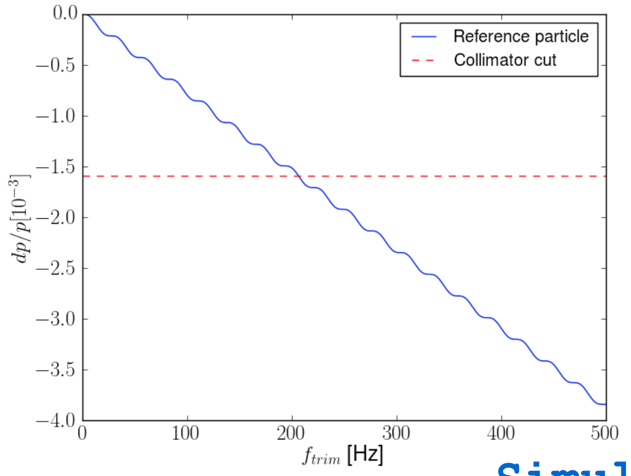
BGI-Timepix3 allows, for the first time, continuous non-destructive turn-by-turn measurement of the transverse beam profile of single bunches.

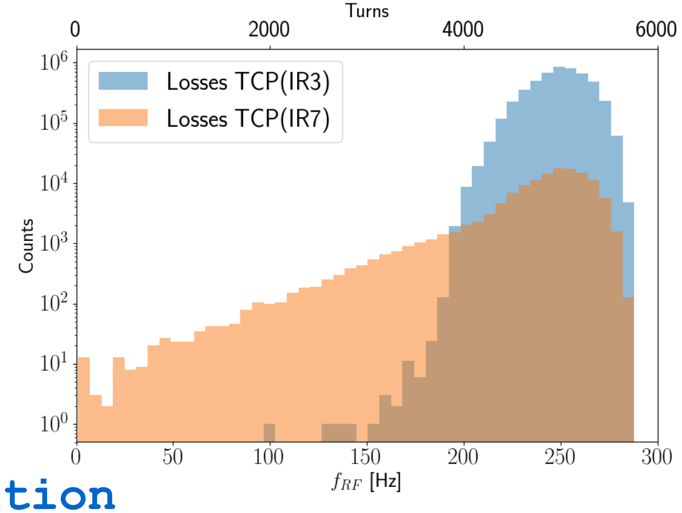
Machine protection at HL-LHC: novel collimation

- ***Can off-momentum losses be simulated?***
- *A new set of (SixTrack) simulation tools developed by **H. Garcia-Morales** et al:*
  - Off-momentum loss maps were acquired by moving the RF bucket during energy ramp.
  - Off-momentum cleaning simulations show good agreement with measurements.

Simulation

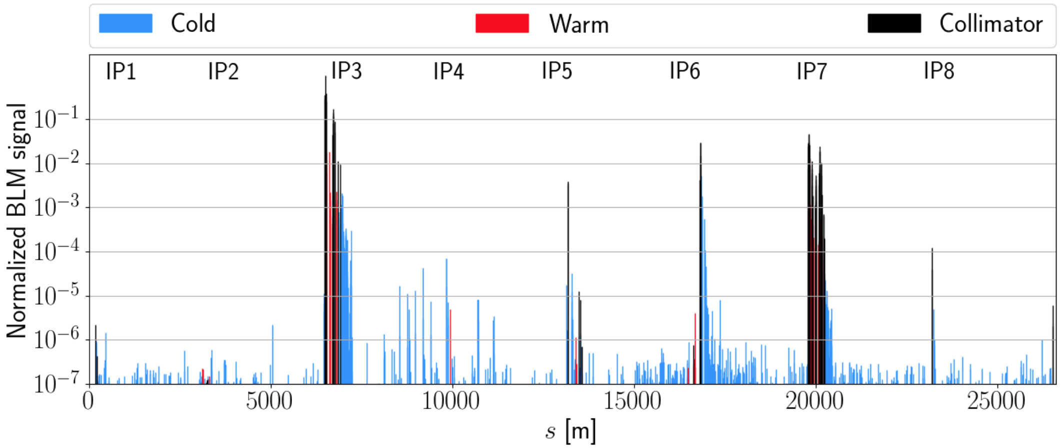






Simulation

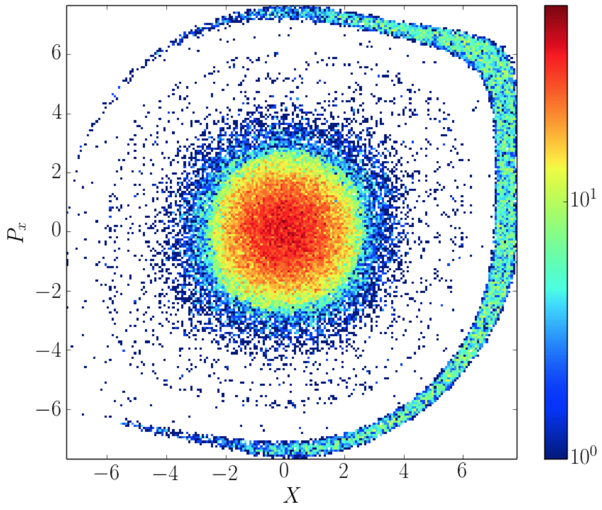
Measurement



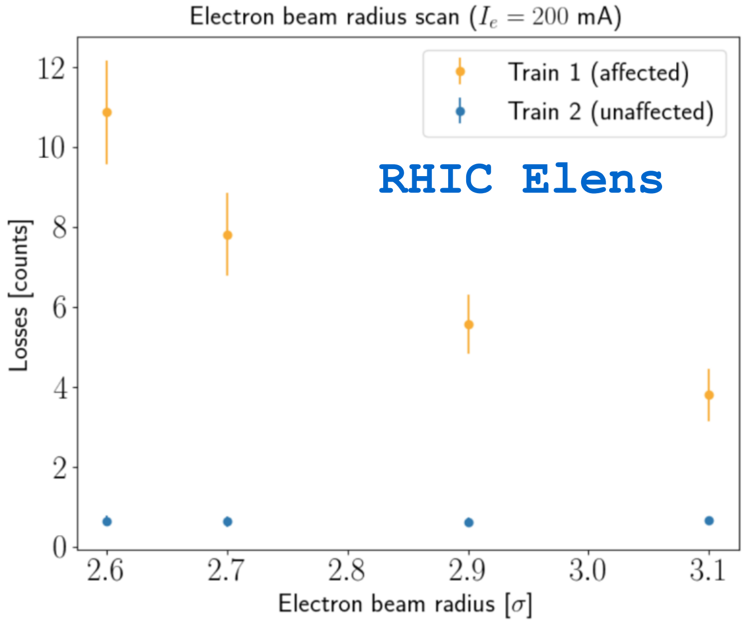
LHC active halo control studies

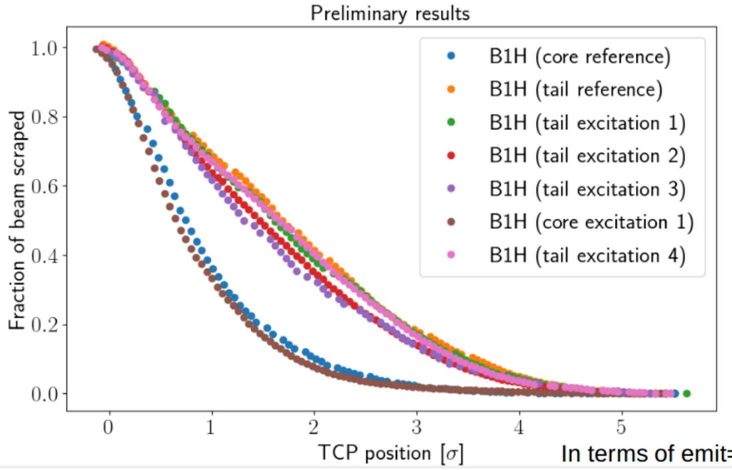
H. Garcia-Morales et al

- *How can we **remove halo** particles **without affecting** the **core**?*
- *Novel collimation techniques under consideration for HL-LHC:*

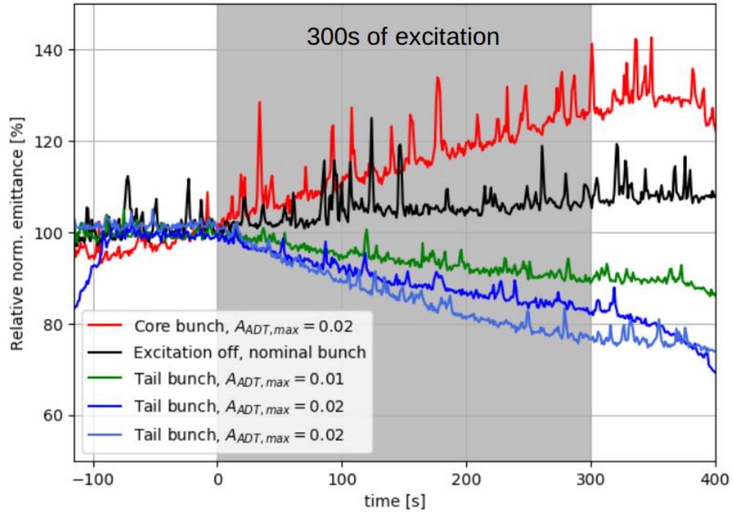


- **Tune ripple:**
  - Need further studies
- **Narrowband excitation**
  - Possible emittance blow up
- **Hollow e-lens**
  - Promising





In terms of emit=3.5mum



IR design: triplet protection upgrade

H. Garcia-Morales et al

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- *Is the **triplet protection** enough?*
  - *Aperture reduction as an effective way of introducing errors*
  - *Tracking simulations for different collimator settings*
  - *Need additional protection to current **TCT4 (TCT6)***

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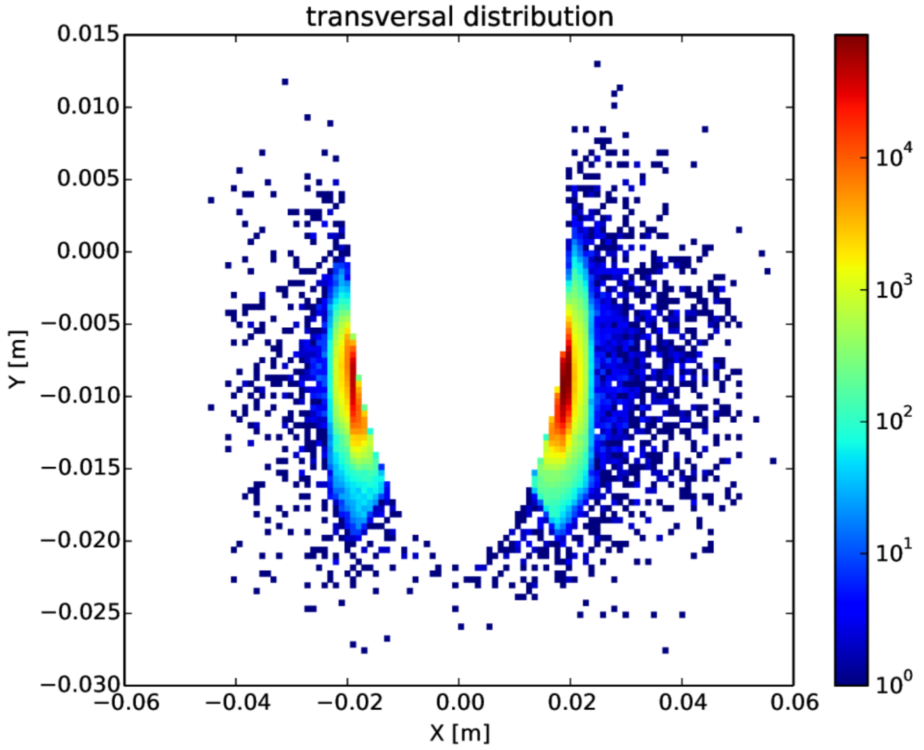

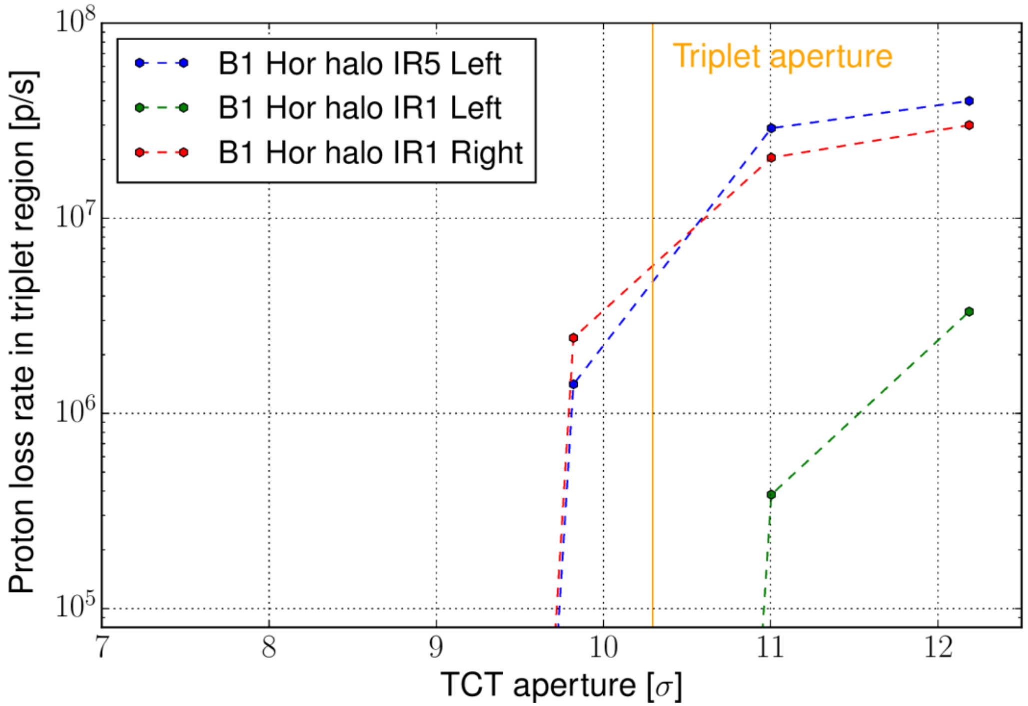

Special physics run of LHC

H. Garcia-Morales et al

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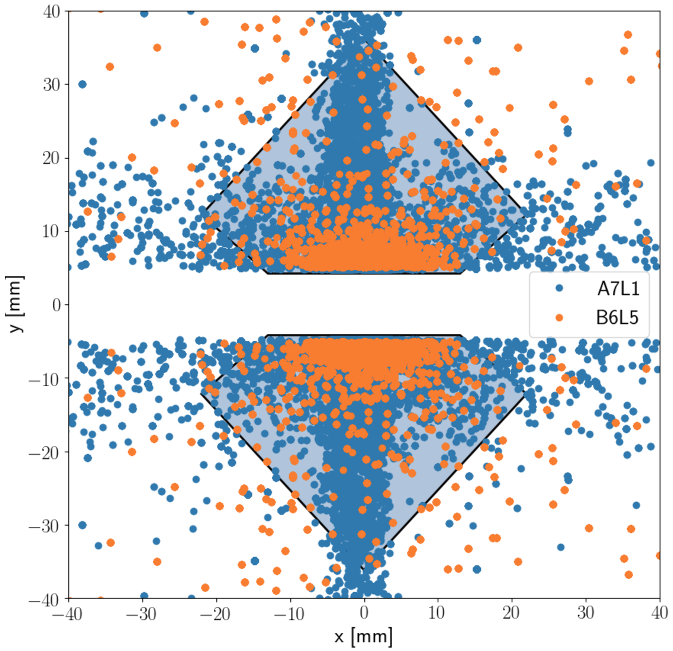
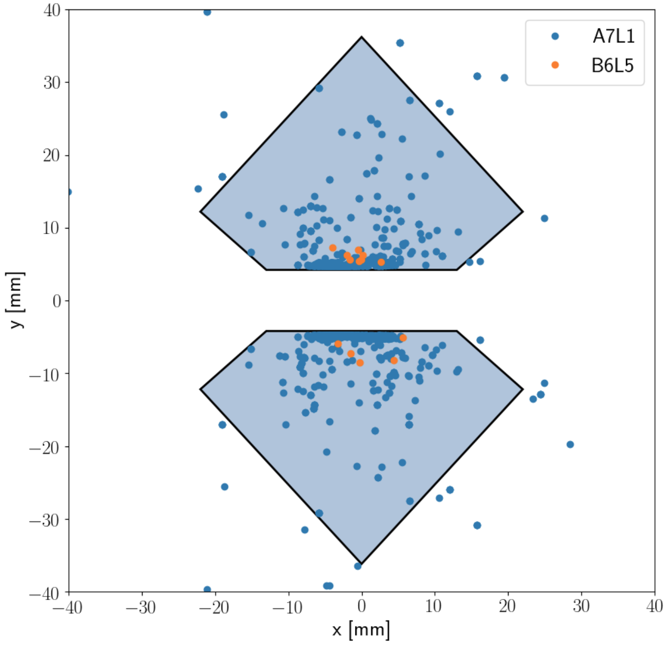
- *Is it possible to obtain clean data for forward physics experiments (ATLAS-ALFA and TOTEM)?*
  - ***New collimation scheme** with primary collimator at 2.5 sigma.*
  - *Tungsten collimators in **tightest hierarchy ever** (0.5 sigma)*
  - ***First time crystals** used for physics*
- ***<u>Real success: More than 1 Million events recorded in both experiments</u>***

Table: Collimator settings for proposed configuration.

Collimator	Standard	Tight
TCLA.A6[R/L]7.B[1/2]	10	2.5
TCLA.A5[R/L]3.B[1/2]	12	2.7
TCTPV.4L2.B 1	13	2.7
TCTPV.4R8.B2	13	2.7
TCTPV.4[L/R]1.B[1/2]	13	2.7
TCTPV.4[L/R]5.B[1/2]	13	2.7
TCLA.C6[L/R]7.B[1/2]	10	2.7
TCP.6[L/R]3.B[1/2]	8.0	5.3
TCP.C6[L/R]7.B[1/2]	5.7	5.7
TCP.D[L/R].B[1/2]	5.7	3.0
Roman Pots	3.0	3.0



Before



After

Diagnostics for HL-LHC

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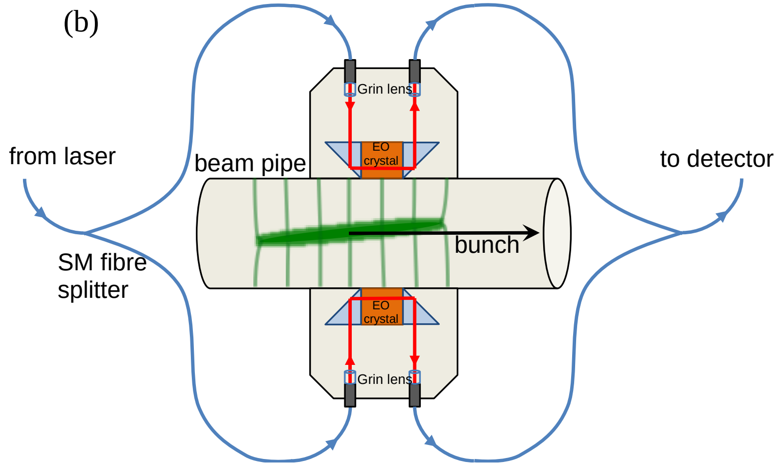
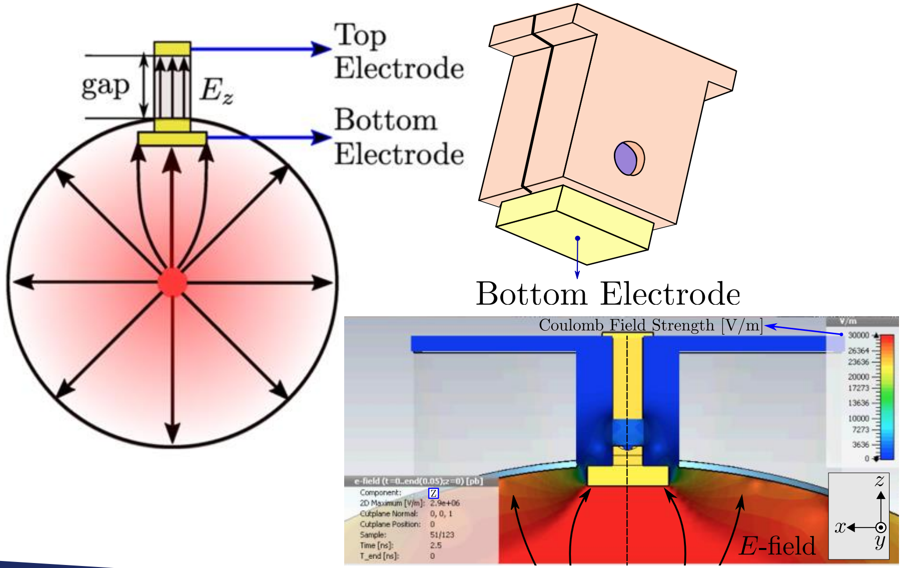
HL-LHC PROJECT

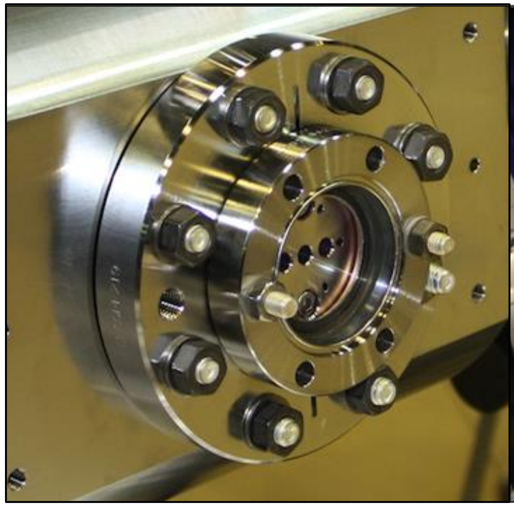
Electro-Optic Beam Position Monitor: SPS prototype

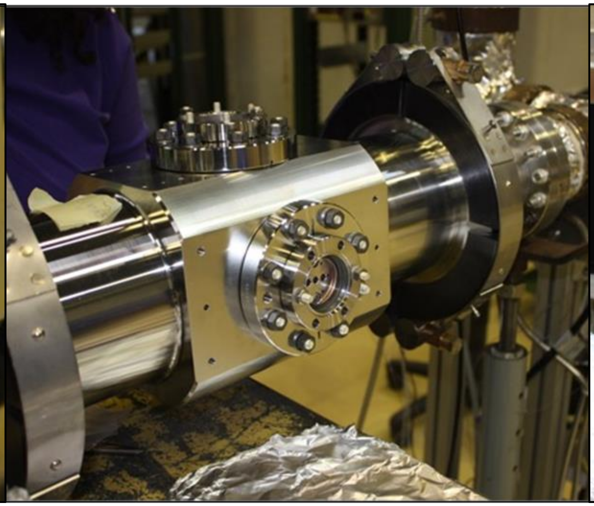
A. Arteche, S. Bashforth,, A. Bosco, I. Penman, S.M. Gibson, RHUL
M. Krupa, T. Levens, T. Lefèvre, CERN

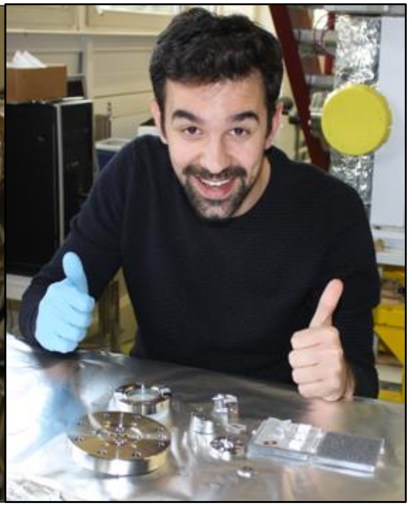


- ***Aim:*** rapid intra-bunch measurement of crabbed bunch shape & instabilities, by replacing BPM pick-ups with ultrafast eo-crystals.
- EO-prototype observed first SPS beam signal in Dec 2016; tune successfully measured in 2017 with electrode pickup.
- Beam signals match well with CST simulations and with results from optical bench tests. See A. Arteche's thesis, 2018.

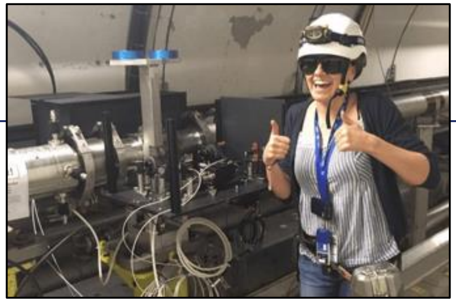






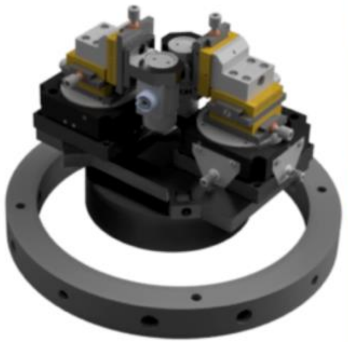


Electro-Optic BPM: interferometric design

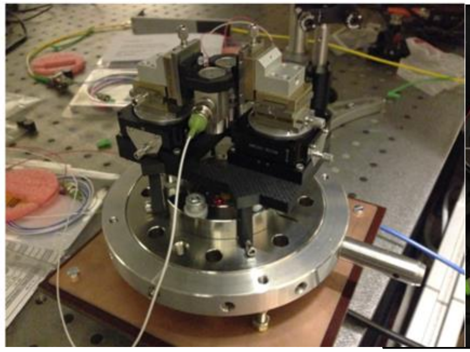


- Beam signal enhanced by a compact, fibre interferometer design: results presented at IPAC 2018.

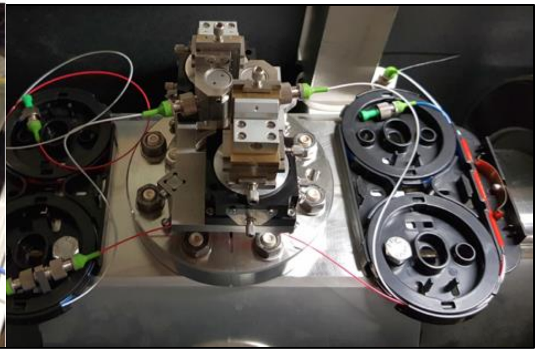
Compact design



Bench tests

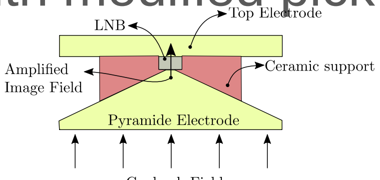


Installed in SPS, fibre readout

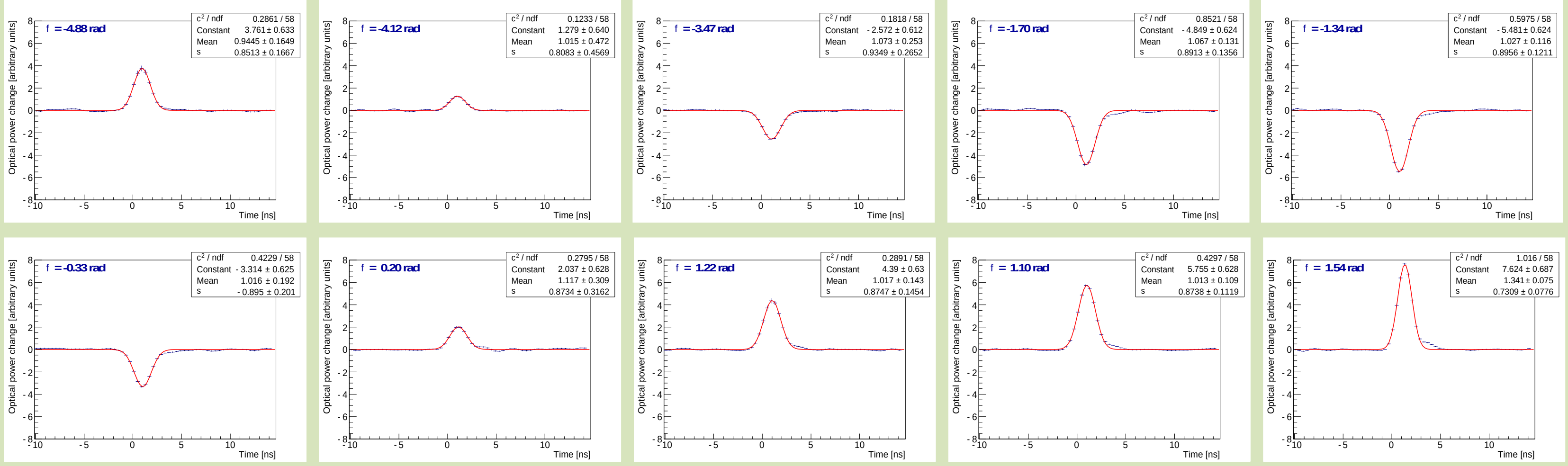


- Sensitivity of SPS prototype was initially limited by installed design and detection system:
  - Final tests with upgraded electronics now being analysed (S. Bashforth).

- Simulations show improved sensitivity with modified pick-up design.



- After SPS run; focus now on RHUL bench tests of LHC compatible design, with >10x field improvement at crystal.

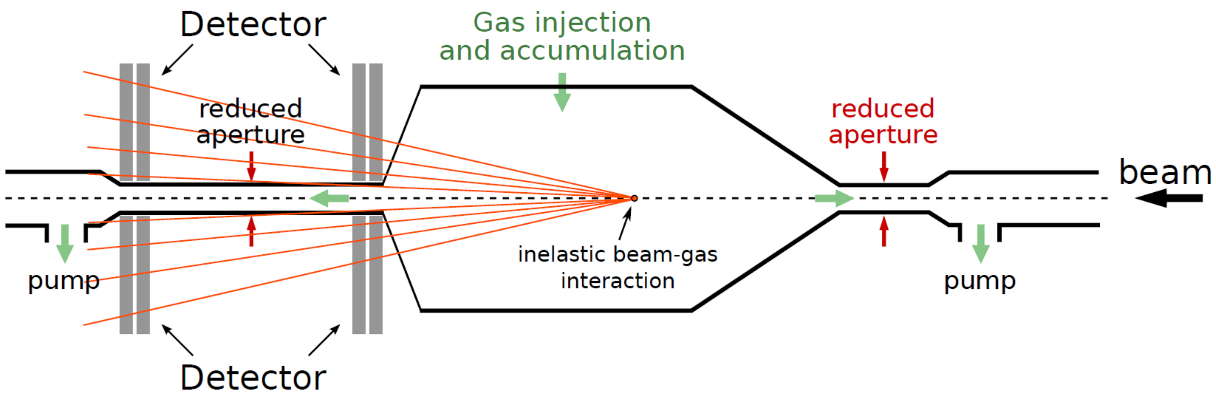


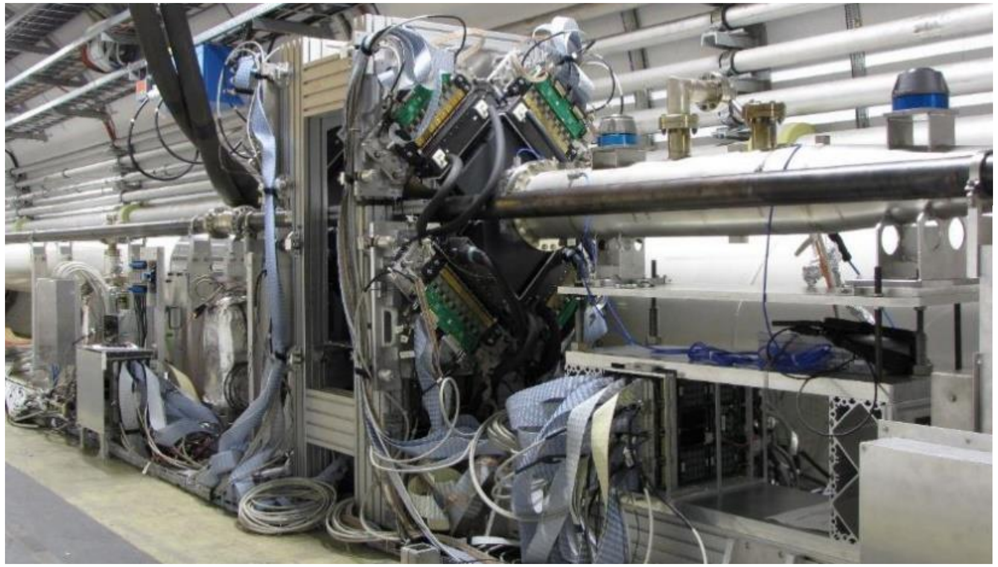
Optical response of the compact interferometer to an average SPS bunch as the laser frequency is scanned.

HL-LHC Beam Gas Vertex Detector

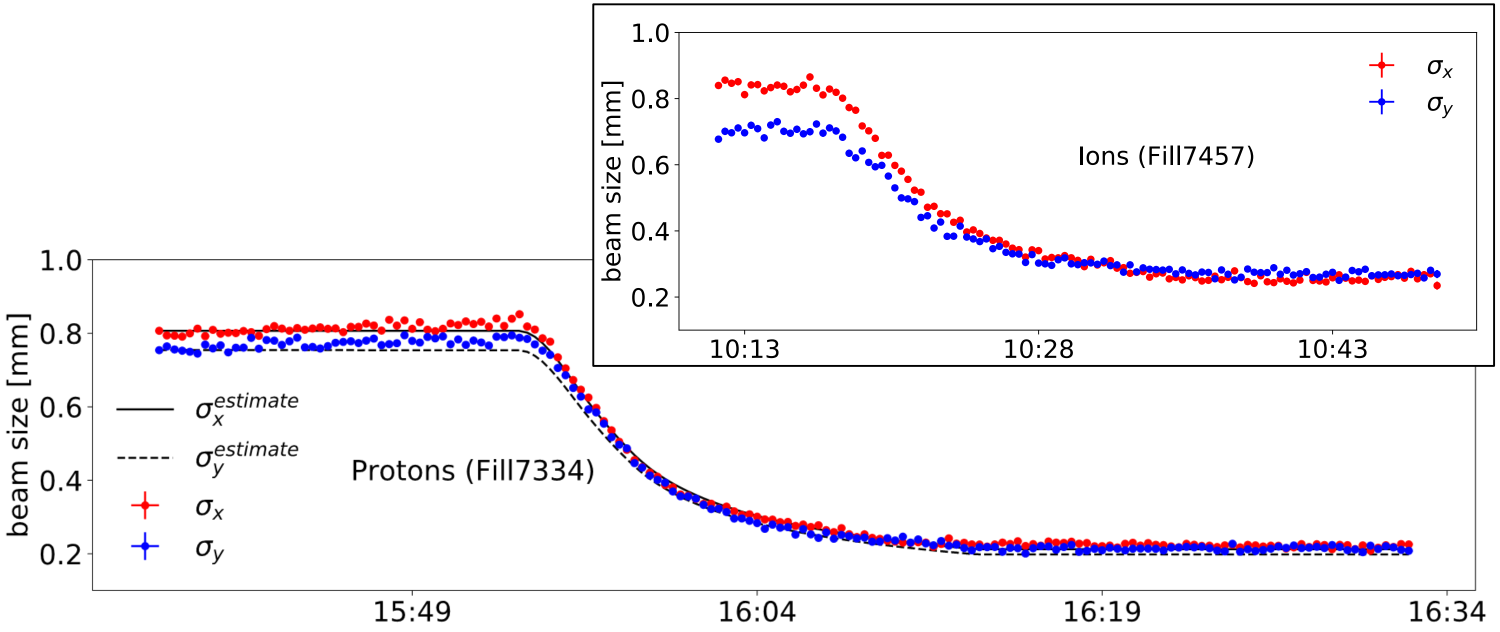
R. Kieffer et al

- 2018 Measurements
  - Beam size available in online display
  - Average resolution down to 3 µm
  - Operational measurements during both proton and ion run
  - Being used for emittance studies





Slide courtesy, R. Jones

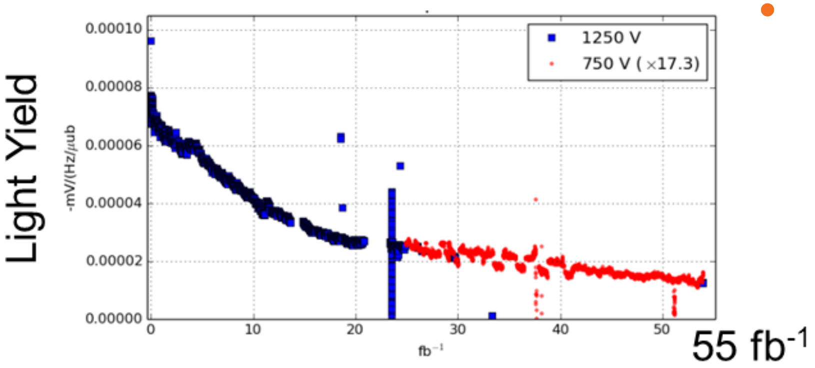


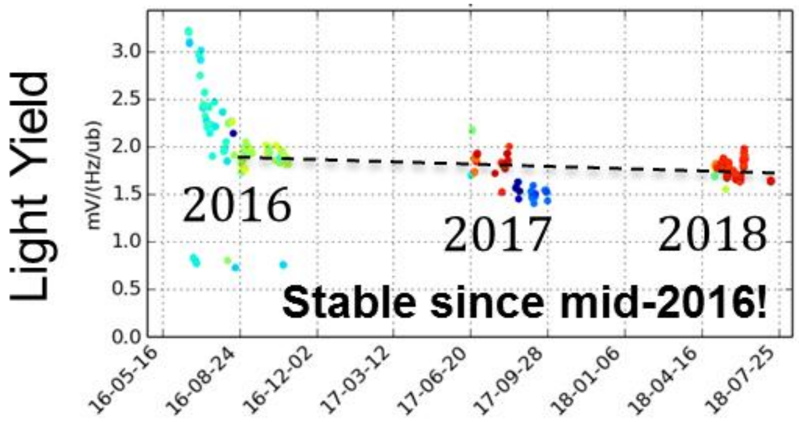
CERN-RHUL Doctoral student soon to start in 2019.

HL-LHC Luminosity Monitor

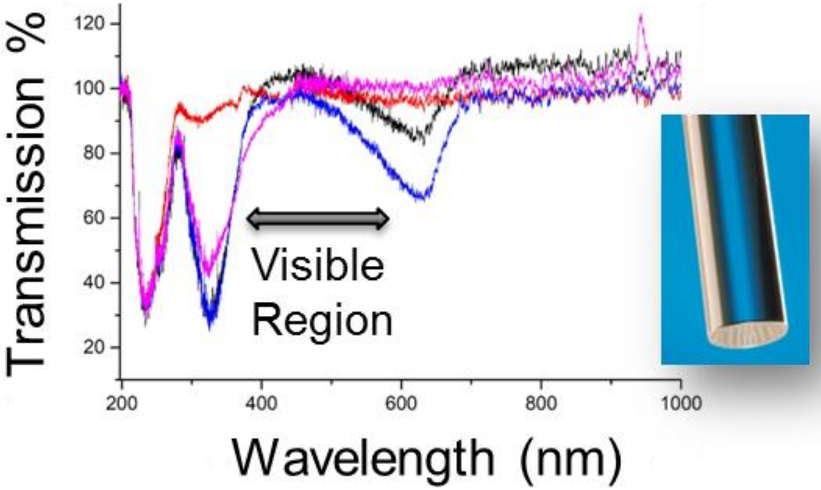
M. Palm et al

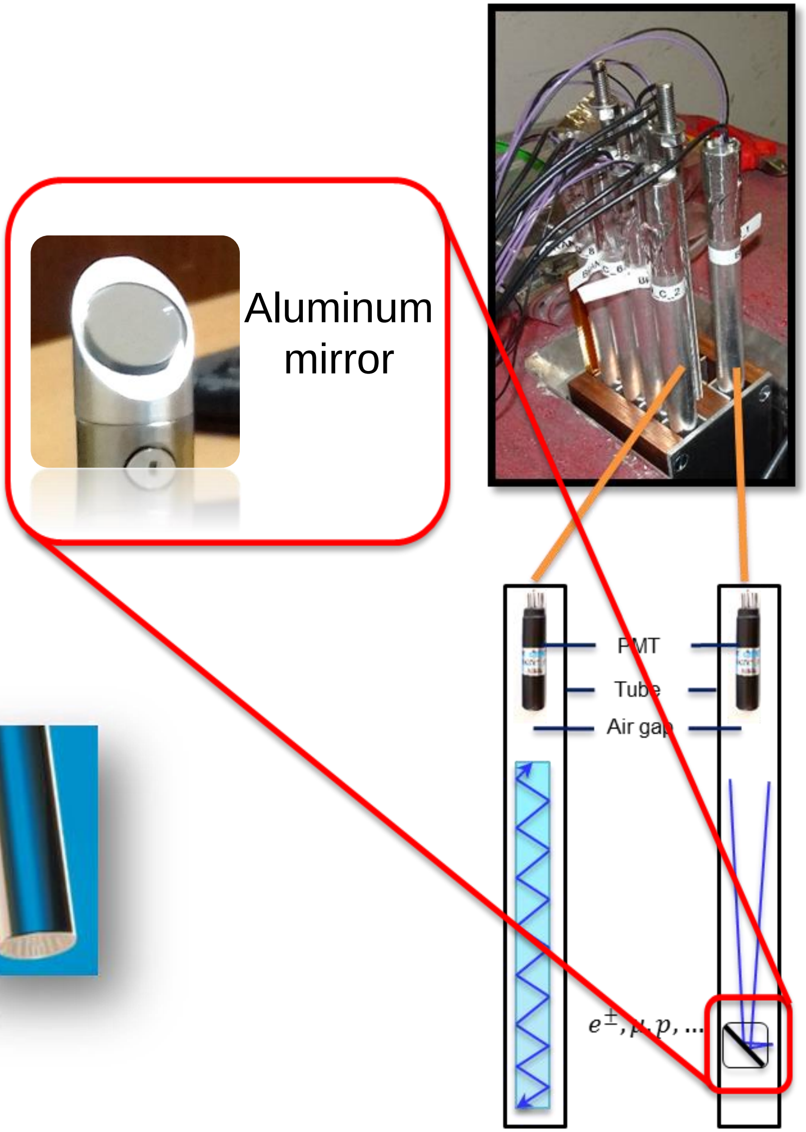
- *Cherenkov in air*
  - *80% loss in light yield for first 55 fb-1 in 2018*
  - *Not a feasible option in current state*





- *Fused Silica Rods after 1-2 years of LHC operation*
  - *Loss in UV-region but visible region intact*
  - *Promising candidate for final solution*





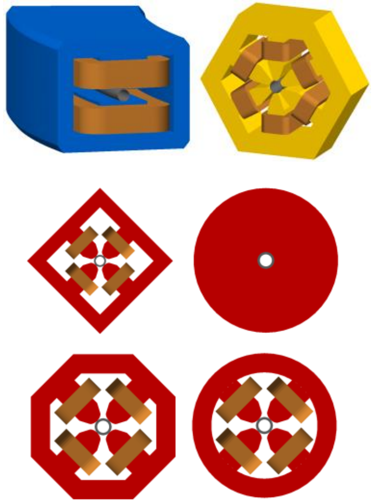
Machine-induced Backgrounds at ATLAS

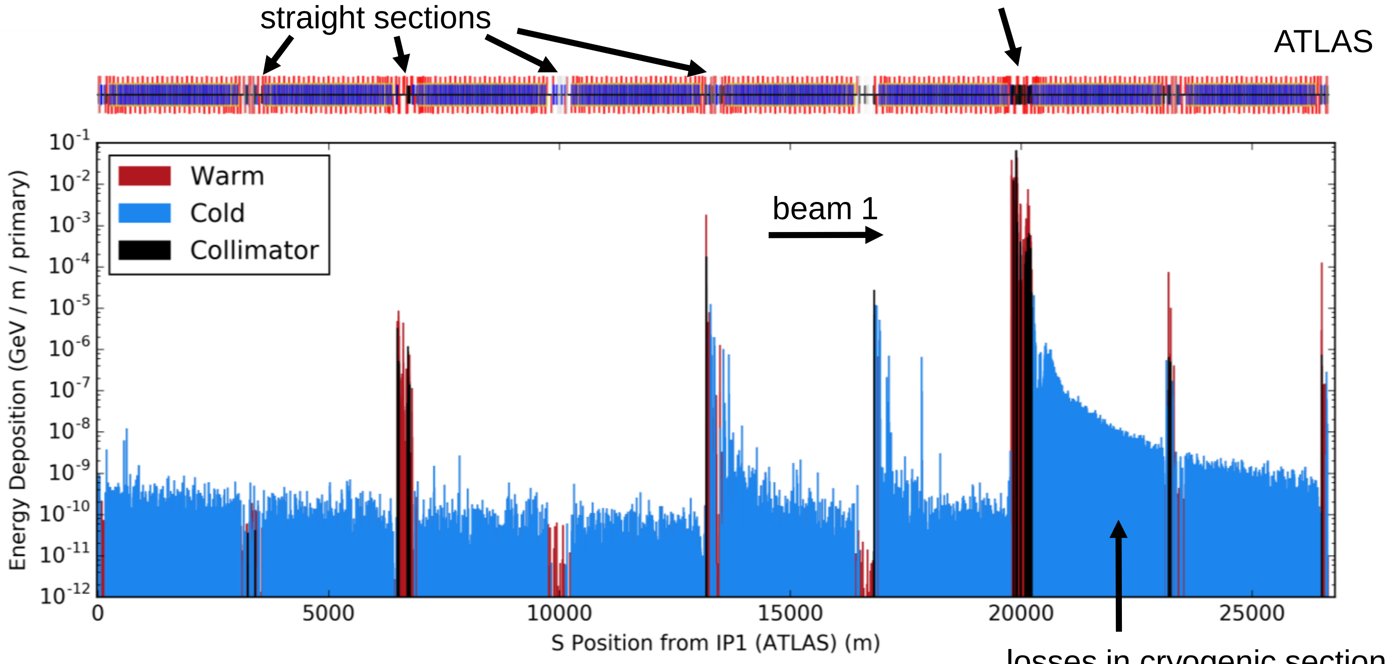
BDSIM model of LHC collimation

S. Walker, L. Nevay et al

ROYAL HOLLOWAY UNIVERSITY OF LONDON

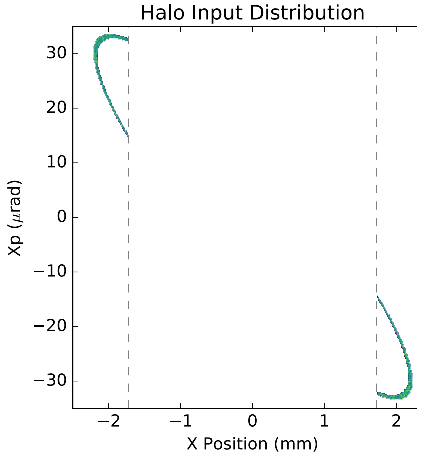
- BDSIM automatically builds a 3D, Geant4 model, from generic accelerator components.
- *LHC stores unprecedented energy in beams: 350 MJ (80kg of TNT) stored per beams at design energy.*
- *Halo efficiently cleaned by collimation system*
- *LHC model developed to simulate collimation and energy deposition. Requires 1:10^6 precision*

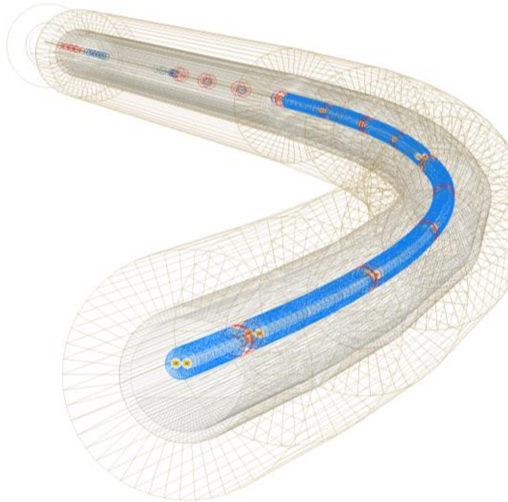




B1 4TeV energy deposition map

Example halo distribution

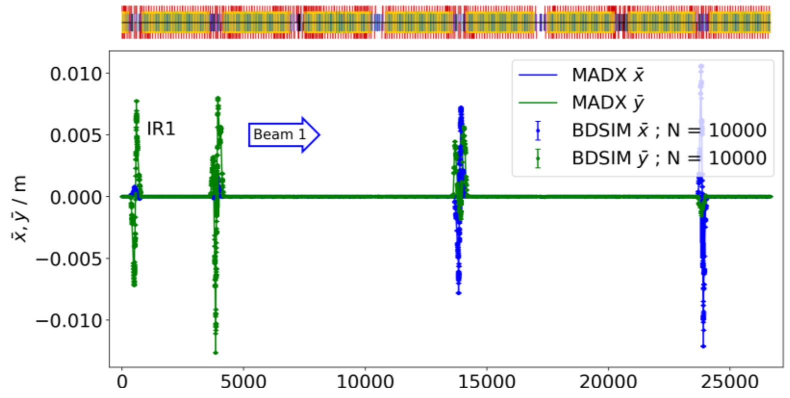


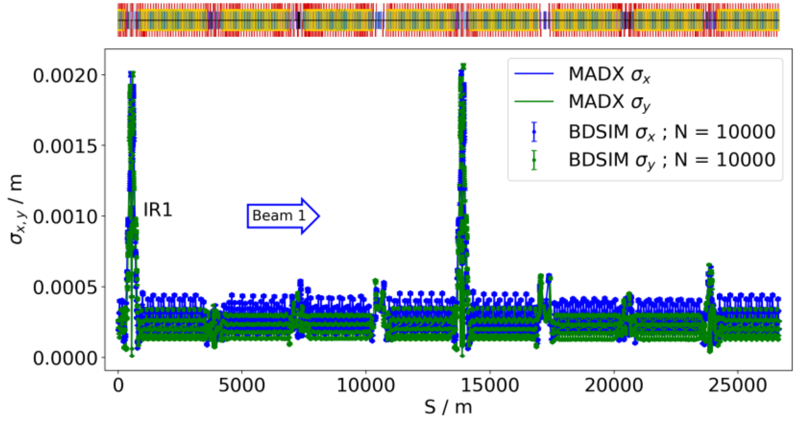


LHC model: optics validation and energy deposition

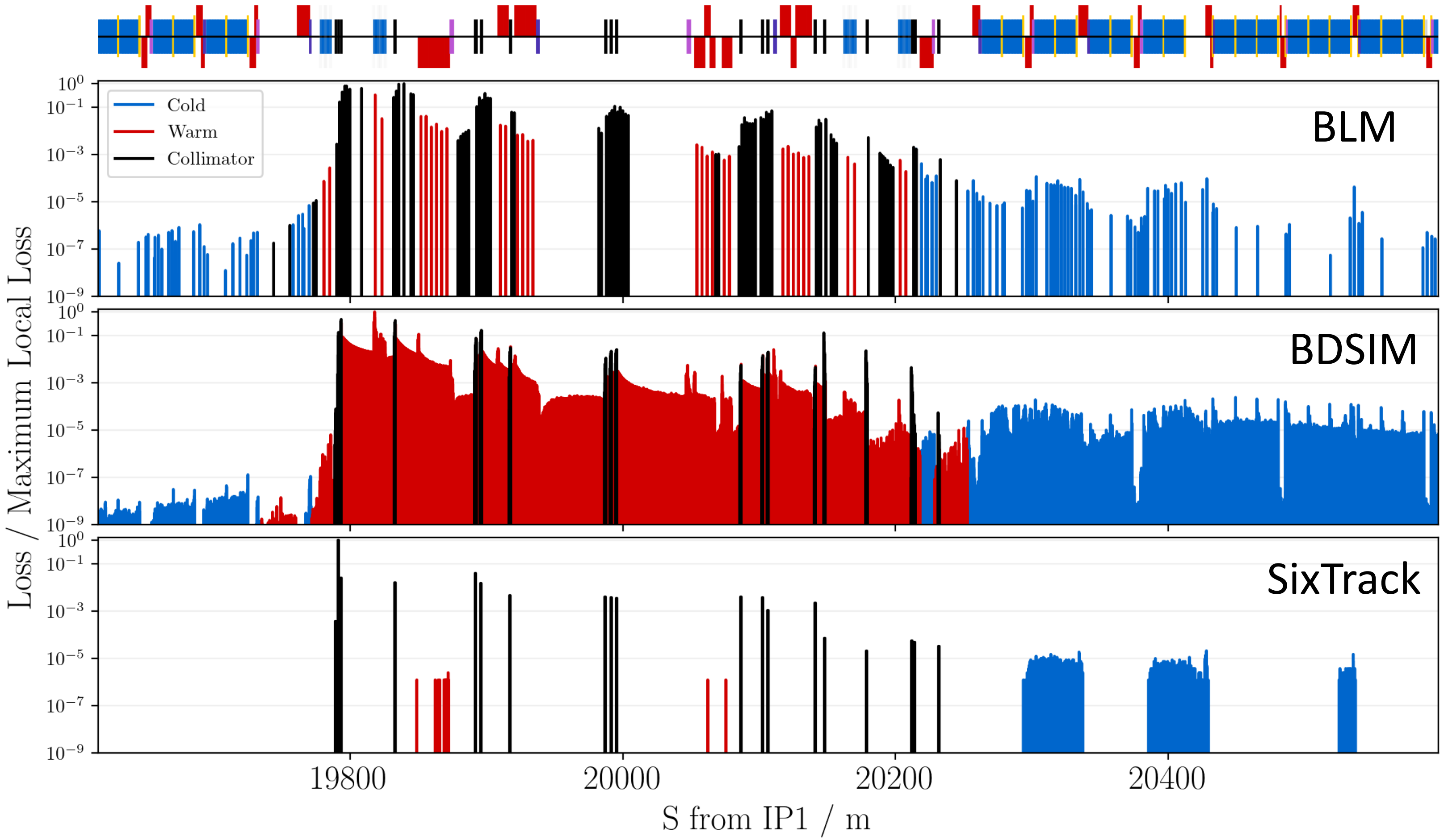
S. Walker, L. Nevay et al

- Excellent agreement between BDSIM and MADX.





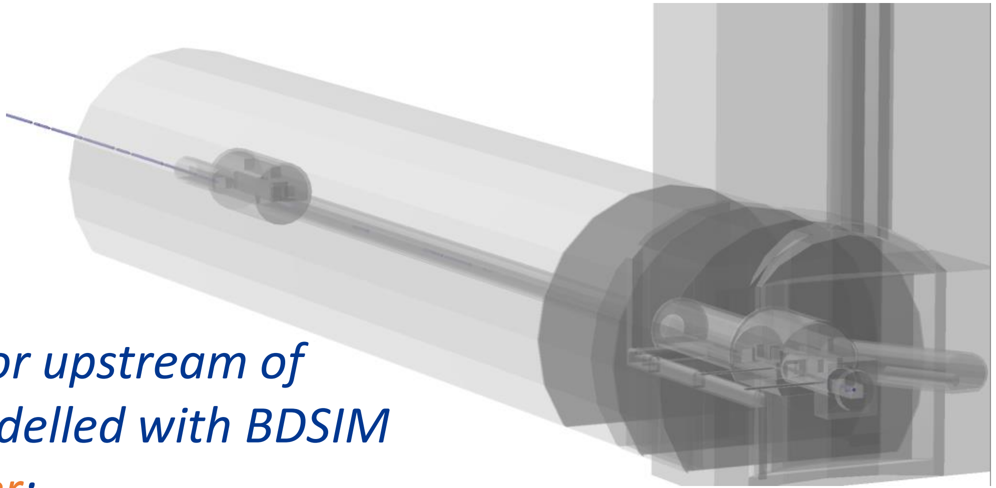
- Energy deposition with BDSIM: full tracking of secondaries:



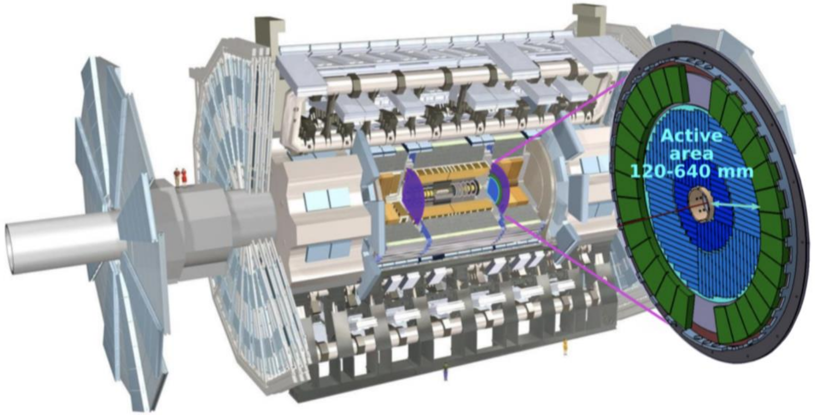
Background particle spectra reaching ATLAS

- ***Non-Collision Backgrounds studied for LHC experiments***

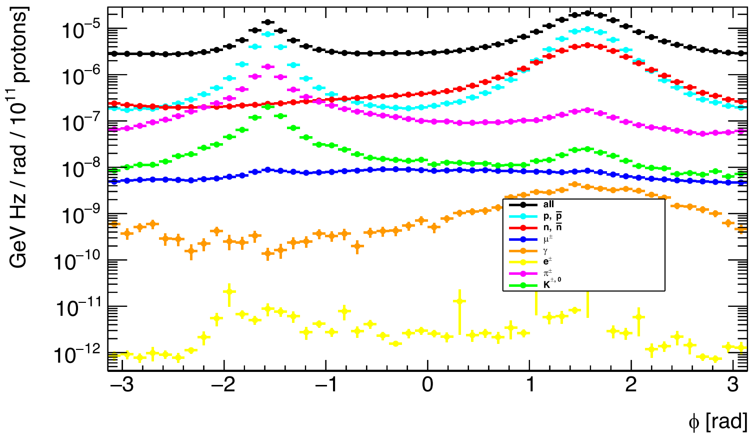
Being applied to NCB for ATLAS upgrade: High Granularity Timing Detector - H. Pikhartova



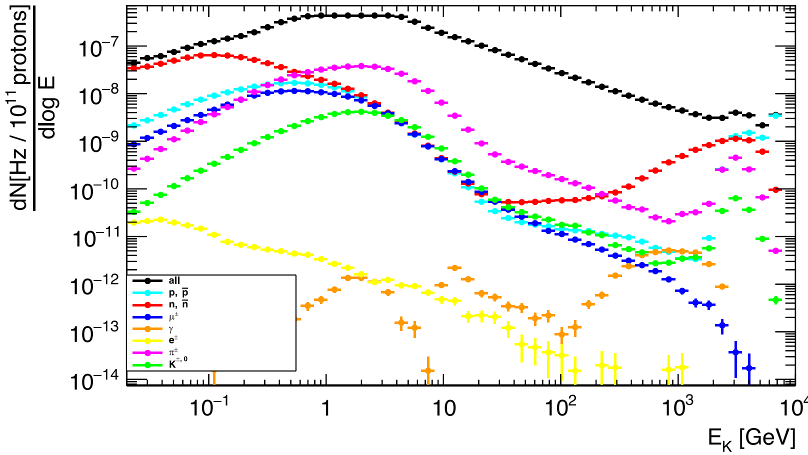
Accelerator upstream of ATLAS modelled with BDSIM – S. Walker:



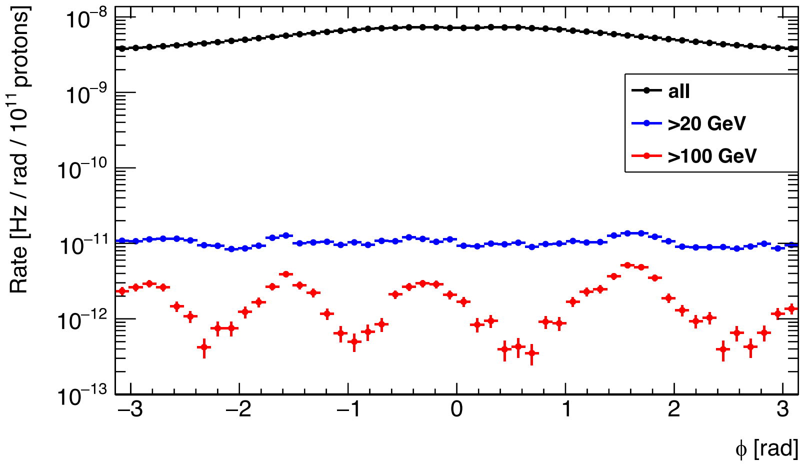
Azimuthal rate for different species



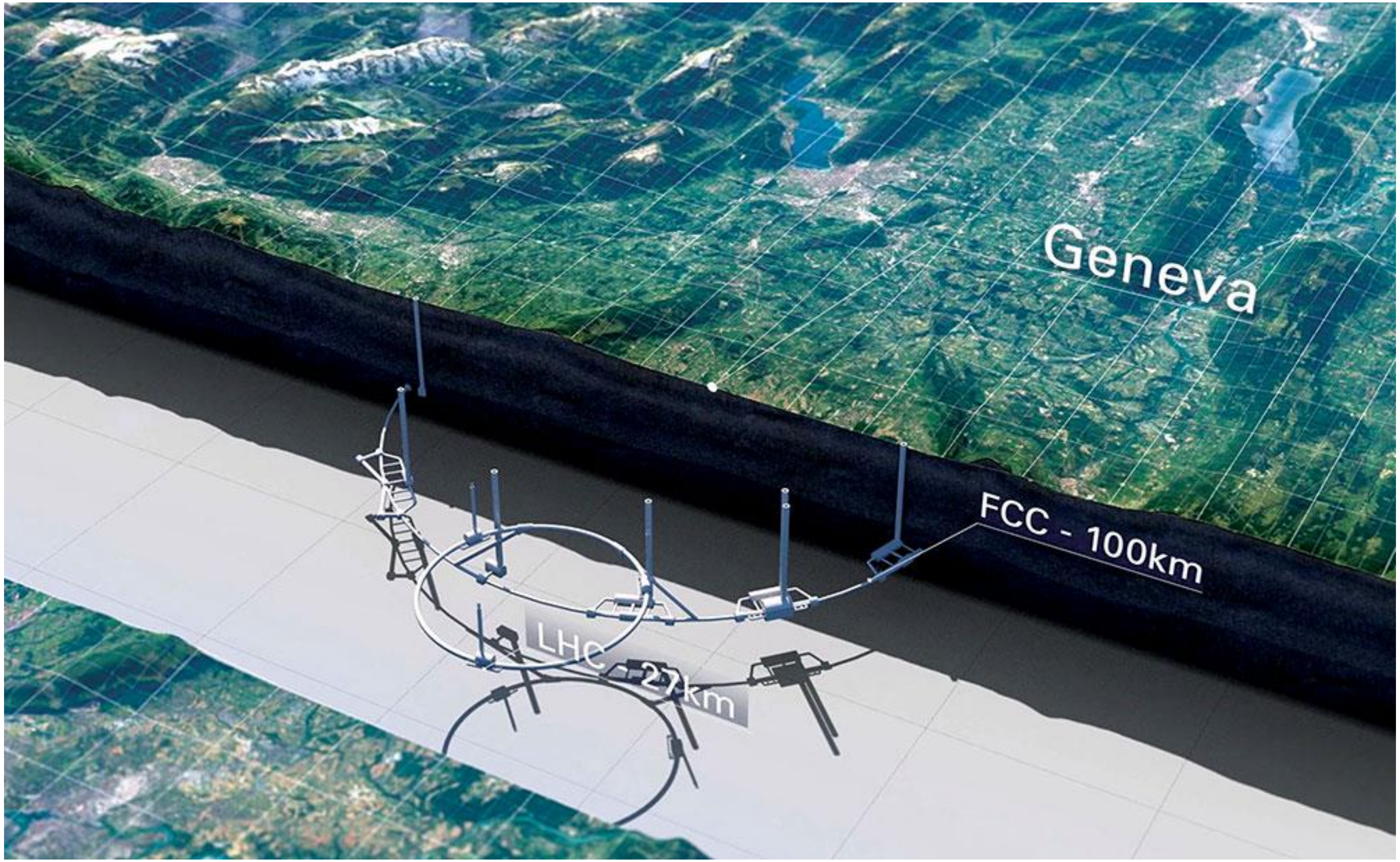
Overall particle spectra at interface plane



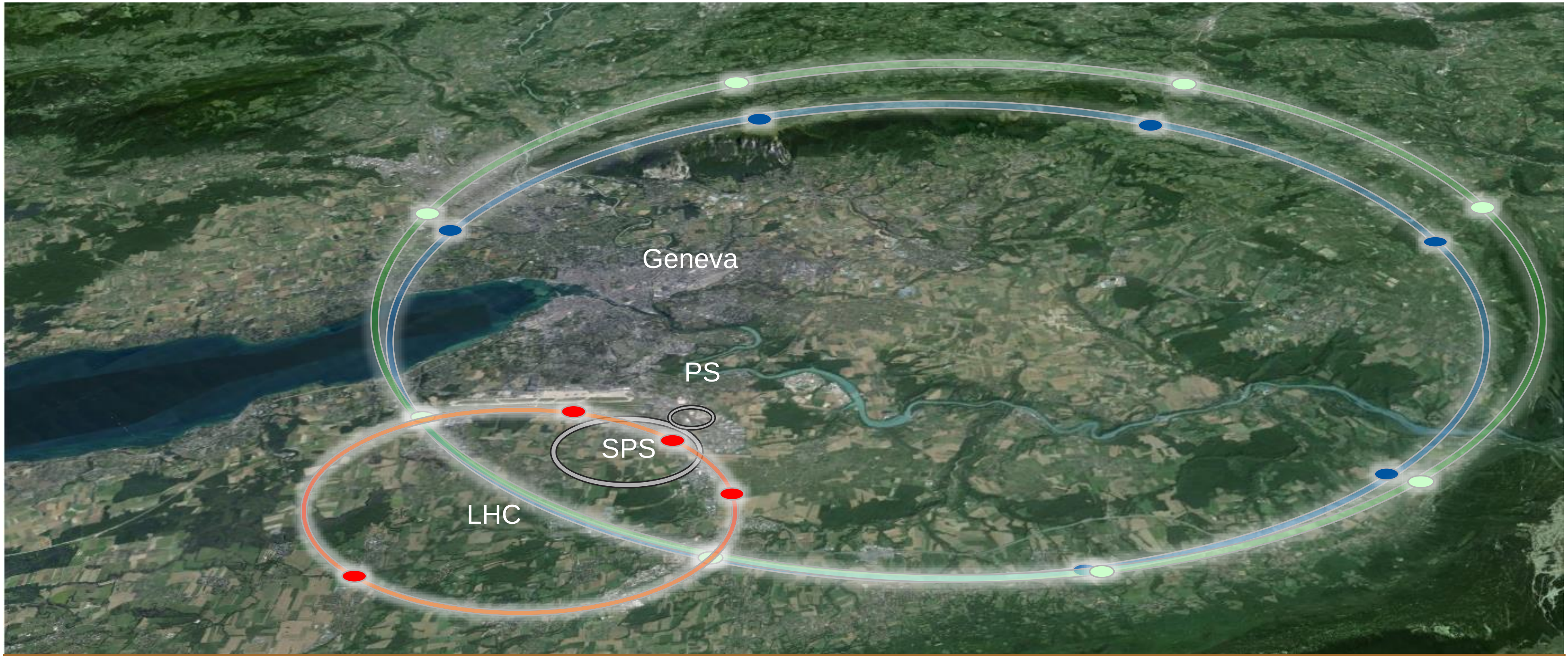
Azimuthal rate for different muon energies



Future Circular Collider



Future Circular Collider design study:



parameter	FCC-hh	**HE-LHC**	HL-LHC	LHC
collision energy cms [TeV]	100	**27**	14	14
dipole field [T]	16	**16**	8.33	8.33
circumference [km]	97.75	**26.7**	26.7	26.7
stored energy/beam [GJ]	8.4	**1.3**	0.7	0.36

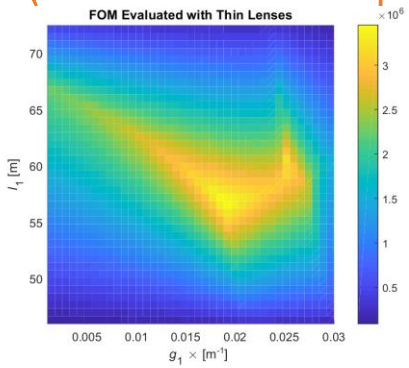
Contributions JAI to FCC-hh Design Study

- **Design of an alternative IR** *(L. Van Riesen-Haupt and J. Abelleira)*
  - A triplet optimised for length/cost
  - Developed using triplet optimisation code and done iteratively with energy deposition studies
  - Designed to accommodate both round and flat beams
- **Study stability of different lattices designs (baseline, different *, alternative, flat)** *(E. Cruz)*
  - Study impact of linear and non-linear errors on interaction region
  - Analyze dynamic aperture for different lattice
  - Draw line when non-linear correctors in the interaction region are needed.

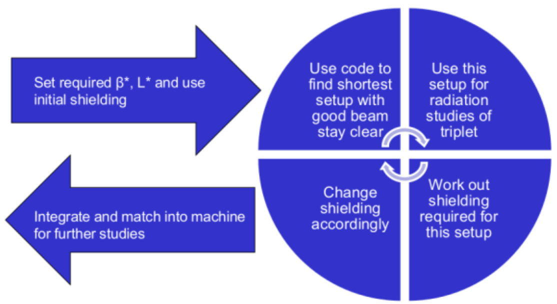
JAI FCC-hh design examples: Alternative IR

- Iterative process to find the optimal triplet

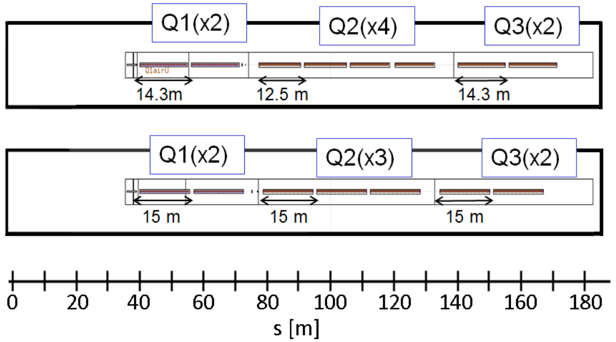
Scan of parameters (L.Van Riesen-Haupt)



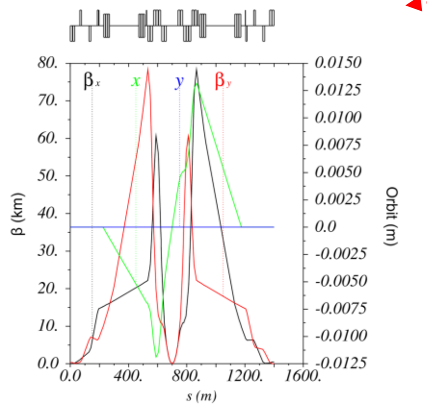
Check Energy deposition studies (J. Abelleira)

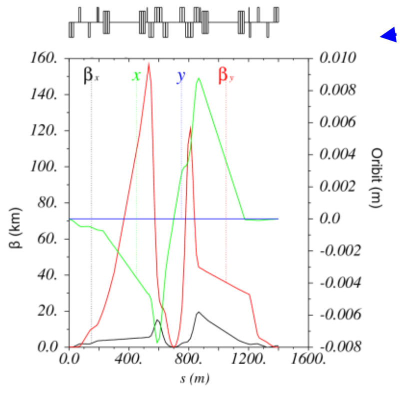


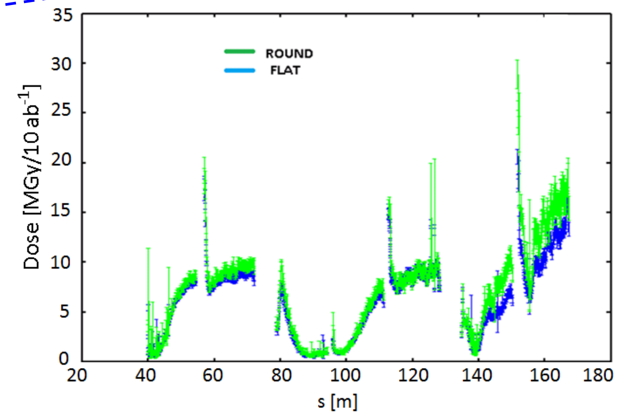
Resulting alternative triplet (down) compared to nominal (up). 4 m shorter



- New triplet validated in optics and energy deposition for both **round** beams (β*=30 cm) and **flat** beams (β*=1.2 x 0.15 m)



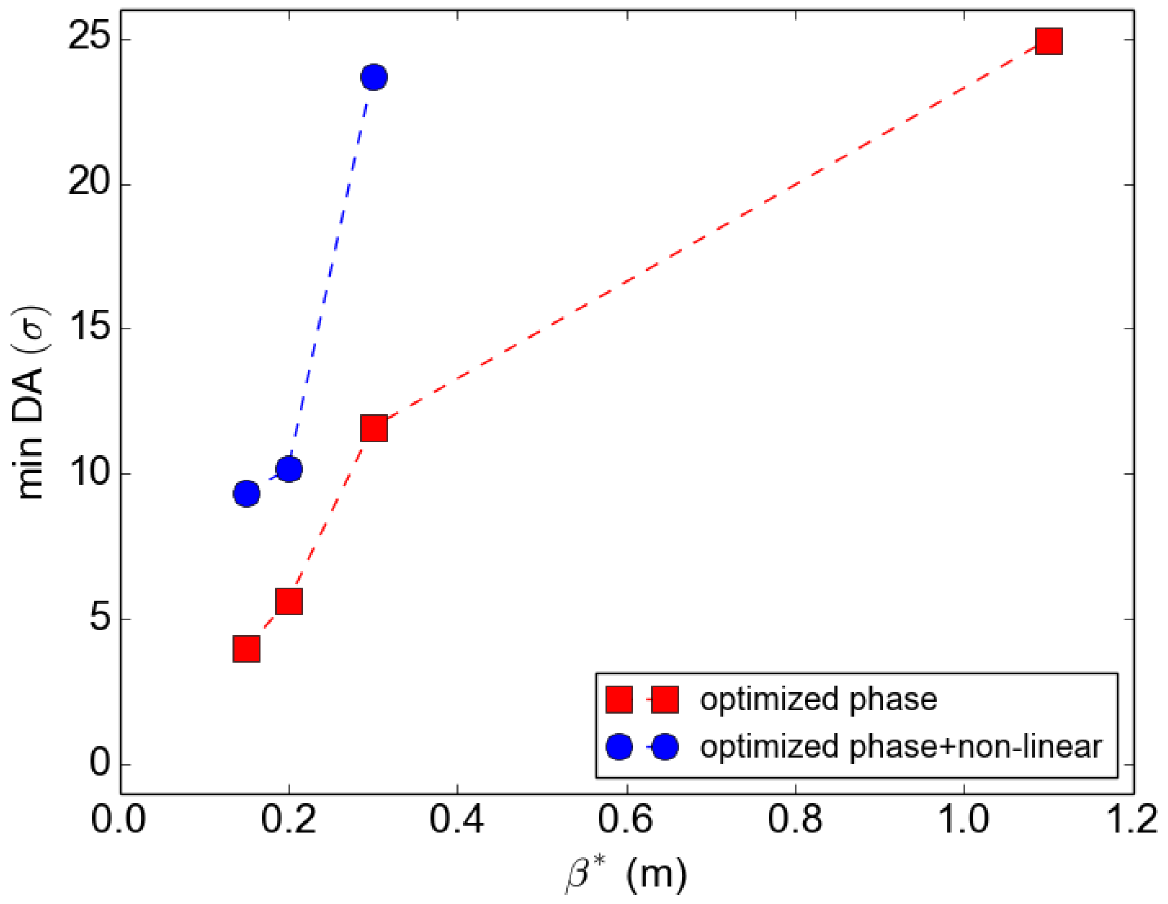




FCC: stability – dynamic aperture studies

- **Explore different options of β* for the baseline design (β*=0.15, 0.2, 0.3, 1.1 m)**

E. Cruz Alaniz



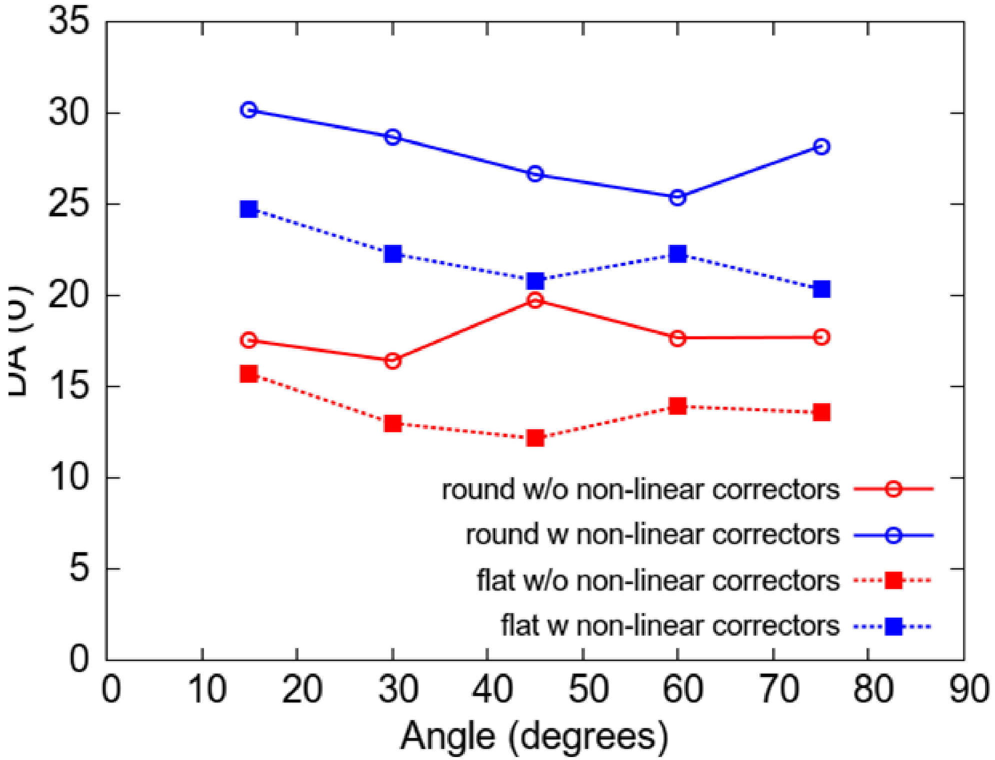
- β*=1.1 m ok even w/o non-linear correctors
- Increase of 5-10σ for other cases when using (sextupolar a3/b3 and octupolar a4/b4) non-linear correctors.
- Non-linear correctors crucial to get acceptable DA for cases β*=0.15 and 0.2 m.
- Final results w/non-linear correctors:
  - DA > 20σ for β*=0.3 and 1.1 m
  - DA > 10σ for β*=0.15 and 0.2m

FCC: stability – dynamic aperture studies

UNIVERSITY OF OXFORD

- **Study dynamic aperture for the alternative design**

E. Cruz Alaniz



o Round case (β*=0.3m) really stable
- DA=16.4σ w/o non-linear
- DA=25.4σ w/ non-linear

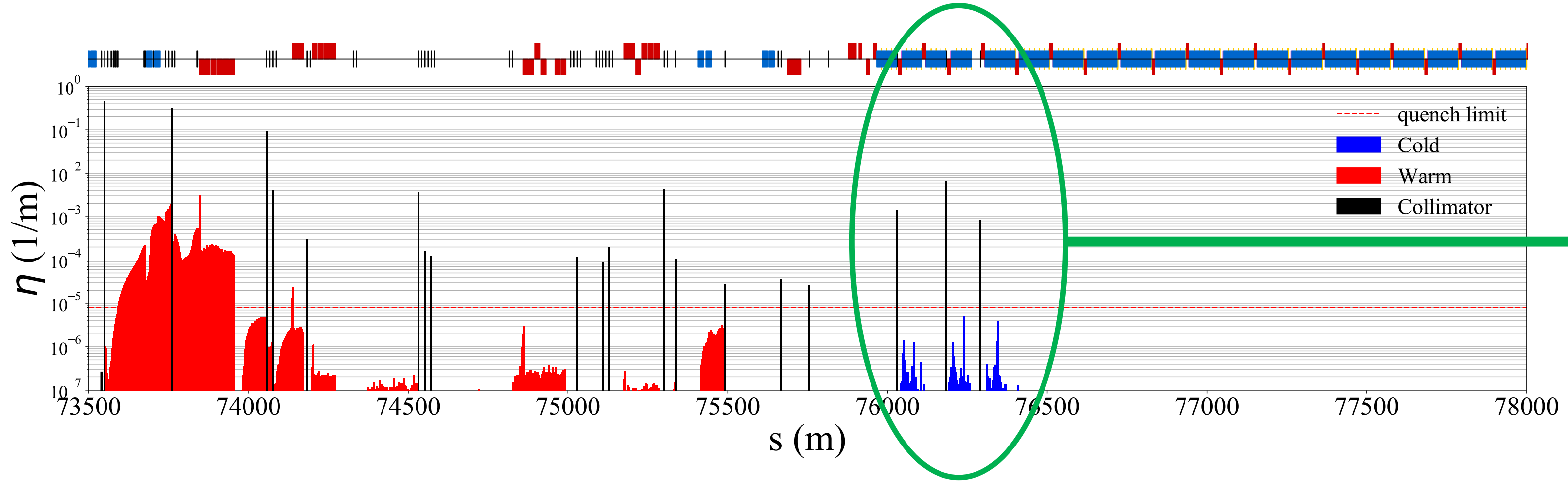
▪ Flat case lower DA but sill stable:
- DA=12.2σ w/o non-linear
- DA=20.4σ w/ non-linear

Dynamic aperture studies show similar (if not higher) values for DA. Together with optics and energy deposition studies this proves the feasibility of the design for both round and flat beams.

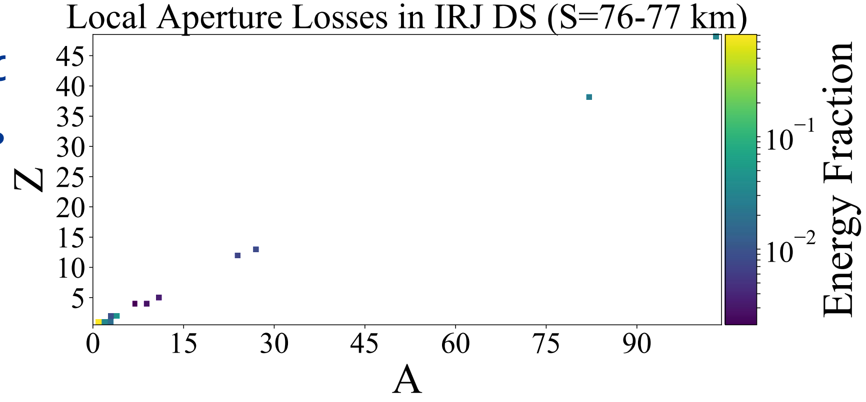
FCC-hh ion collimation

A. Abramov et al

- *For ion operation in the LHC, the collimation cleaning inefficiency limits the intensity:*
  - *Ions can undergo nuclear fragmentation and electromagnetic dissociation inside the collimators, resulting in secondary cold losses.*
  - *Detailed studies of collimation cleaning performance for ion beams in the FCC-hh are featured in the CDR.*
- *Studied cleaning efficiency for betatron and momentum collimation at injection and top energy for the horizontal and the vertical planes using the SixTrack-FLUKA active coupling framework.*
- *No show-stoppers found, even for the most critical cases of momentum cleaning at injection and betatron cleaning at top energy. The dispersion suppressor collimators are effective for intercepting ion losses.*



Loss map for betatron cleaning insertion (IRJ), For beam 1 in the horizontal plane



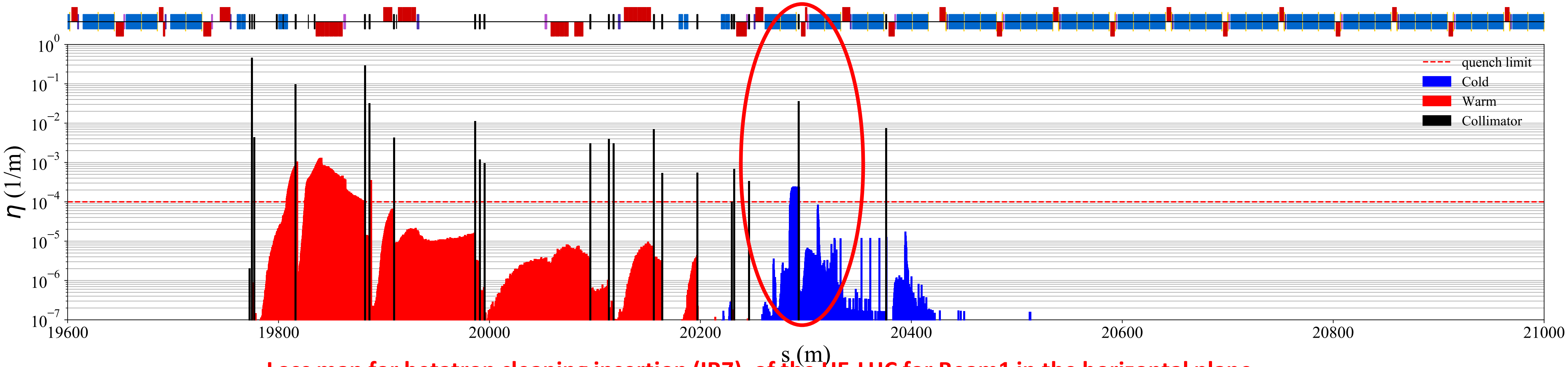
Mostly light fragmets seen in cold losses – collimation successfully removes heavier species

HE-LHC ion collimation

A. Abramov et al

ROYAL HOLLOWAY UNIVERSITY OF LONDON

- *High-Energy LHC (CoM = 27 TeV) has collimation system designed under stringent space constraints and differs in layout to the one used in the LHC.*
  - *Crucial to characterise the performance of the new collimation system design for ions as well as protons.*
- *First studies performed of the HE-LHC collimation system in ion beam operation*
  - *Large losses are observed in the dispersion suppressor of the betatron collimation insertion for the nominal collimator settings.*
  - *Currently investigating the sources and mitigation strategies for those losses*

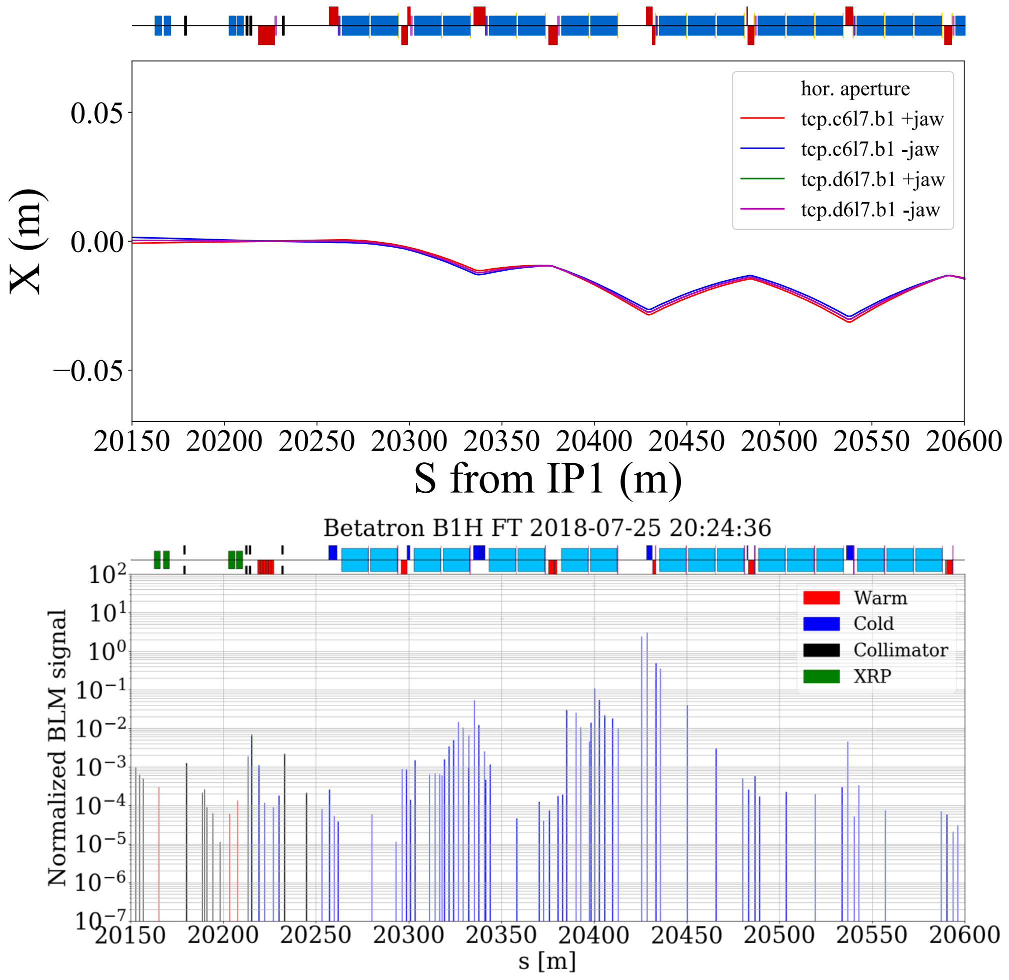


Loss map for betatron cleaning insertion (IR7) of the HE-LHC for Beam1 in the horizontal plane

Partially Stripped Ion Collimation

A. Abramov et al

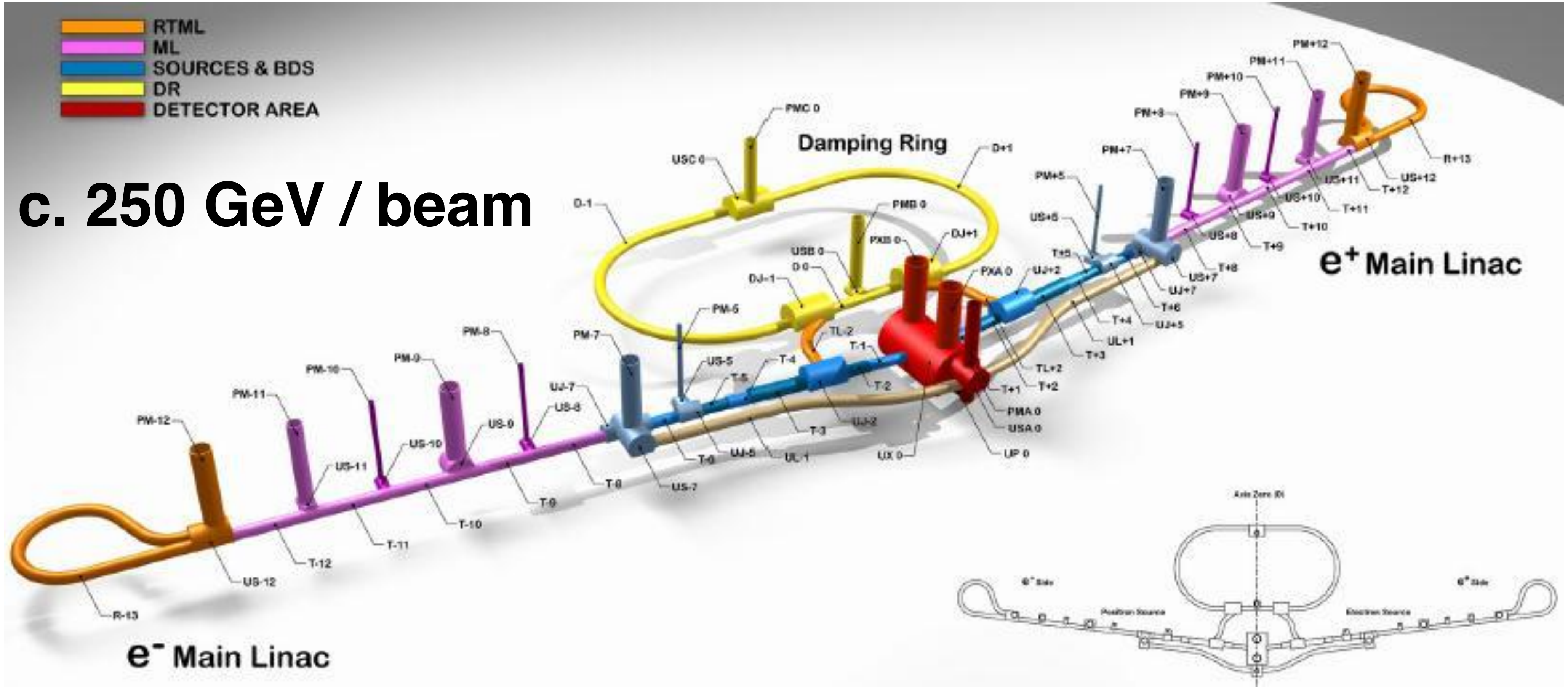
- *Partially stripped ion (PSI) beams in the LHC are studied by the **Gamma Factory** collaboration.*
- *First PSI beams tests with $^{208}Pb^{81+}$ in the LHC were performed in 2018 and the collimation performance observed during the tests was very poor.*
- *Working with the CERN LHC Collimation Group to identify the reason and study mitigation strategies.*
- *The main driver of the losses was found to be the stripping action of the collimators in combination with the rising dispersion in the dispersion suppressor.*
- *An overview of PSI collimation was authored for the Gamma Factory Yellow Report.*
- *In addition, a Geant4 process to handle stripping of PSI in matter is under development.*



MADX trajectories for PSI stripped by the primary collimators (top) agree well with measured losses in the machine (bottom). Measured loss map credit: N. Fuster-Martinez

International Linear Collider

- ***Higgs factory*** e^+e^- collider for precise measurements of Higgs & top ++, complementary to ***LHC***



31 km

International Linear Collider

- ***EU strategy 2013:*** *'There is a strong scientific case for an electron-positron collider, complementary to the LHC, that can study the properties of the Higgs boson and other particles with unprecedented precision and whose energy can be upgraded.'*
- ***ILC TDR complete, mature technology.***
- ***XFEL at DESY*** *essentially a 20 GeV prototype:*

e+e- Higgs factory

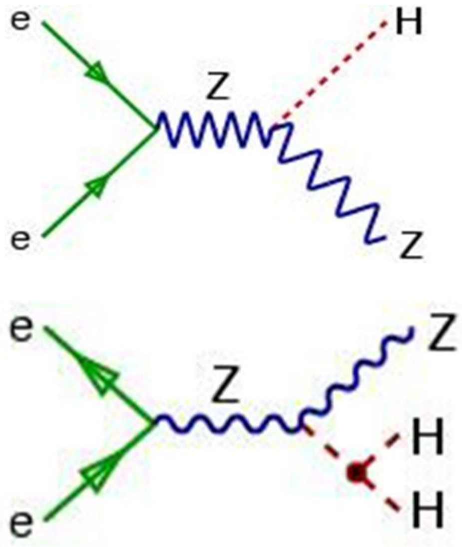
e+e- annihilations:

E > 91 + 125 = 216 GeV

E ~ 250 GeV

E > 91 + 250 = 341 GeV

E ~ 500 GeV



Phil Burrows

International Linear Collider

ILC in Japan?

meeting of Lyn Evans and Prime Minister Abe, March 27, 2013

- *Early optimism from Japan to host ILC.*
- *Proposed staging of 250 GeV CoM, Higgsstrahlung (saves ~40% cost).*
- *ICFA Meeting 7 March 2019.*

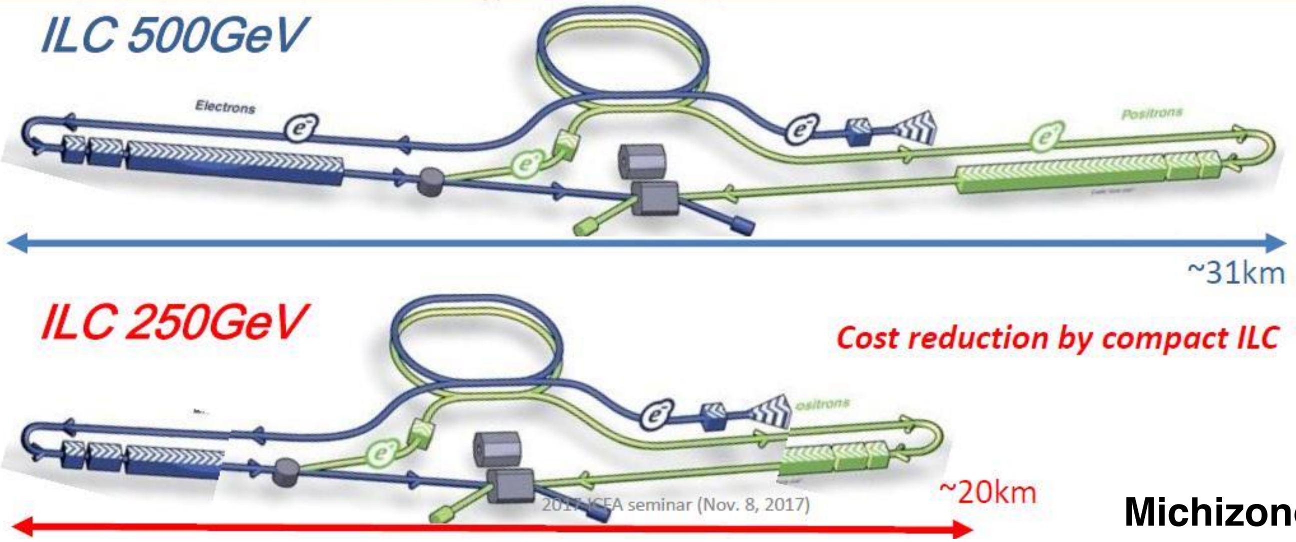
US-Japan cost reduction R&D

Cost reduction by technological innovation

Innovation of Nb (superconducting) material process: decrease in material cost

Innovative surface process for high efficiency cavity (N-infusion): decrease in number of cavities

Staging



Michizono

ICFA STATEMENT ON THE ILC OPERATING AT 250 GEV AS A HIGGS BOSON FACTORY

The discovery of a Higgs boson in 2012 at the Large Hadron Collider (LHC) at CERN is one of the most significant recent breakthroughs in science and marks a major step forward in fundamental physics. Precision studies of the Higgs boson will further deepen our understanding of the most fundamental laws of matter and its interactions.

The International Linear Collider (ILC) operating at 250 GeV center-of-mass energy will provide excellent science from precision studies of the Higgs boson. Therefore, ICFA considers the ILC a key science project complementary to the LHC and its upgrade.

ICFA welcomes the efforts by the Linear Collider Collaboration on cost reductions for the ILC, which indicate that up to 40% cost reduction relative to the 2013 Technical Design Report (500 GeV ILC) is possible for a 250 GeV collider.

ICFA emphasises the extendibility of the ILC to higher energies and notes that there is large discovery potential with important additional measurements accessible at energies beyond 250 GeV.

ICFA thus supports the conclusions of the Linear Collider Board (LCB) in their report presented at this meeting and very strongly encourages Japan to realize the ILC in a timely fashion as a Higgs boson factory with a center-of-mass energy of 250 GeV as an international project[1], led by Japanese initiative.

1 In the LCB report the European XFEL and FAIR are mentioned as recent examples for international projects.

Ottawa, November 2017

meeting of L

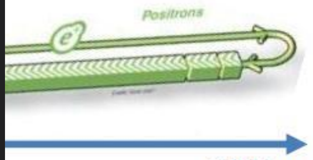
- Early
- Propo Higgs
- ICFA I

D

echnological innovation

al cost

e in number of cavities



ction by compact ILC

0km

Michizono

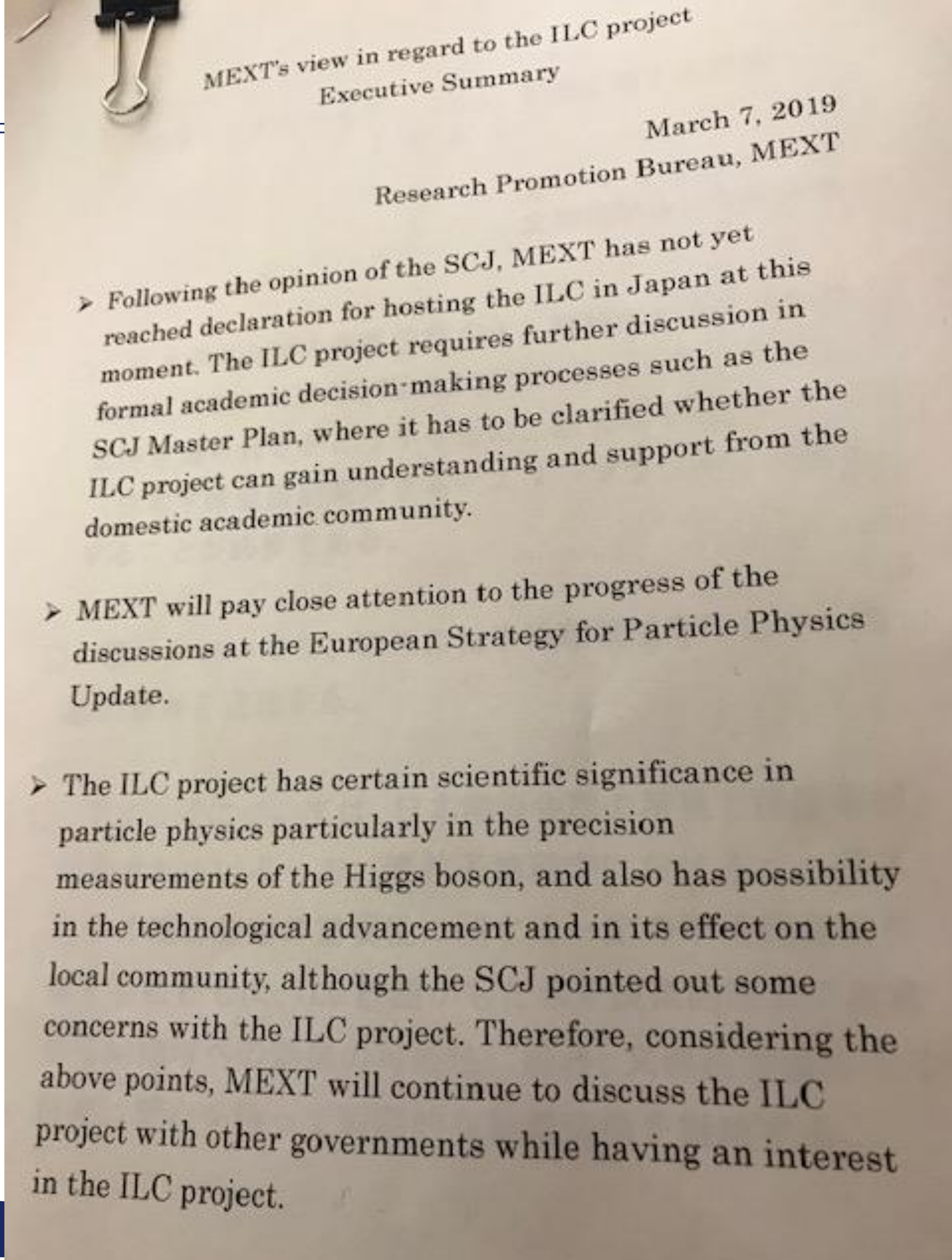
International Linear Collider

- ***Early excitement on Twitter due to leaked news:***

Wow... The official announcement is for tomorrow, but the Sankei printed this at midnight (!!!)
"National government to start international negotiations with US and Europe-They will intend to give their official announcement on March 7th"
headlines.yahoo.co.jp/hl?a=20190306-...
(JPN only)

次世代加速器ＩＬＣ誘致検討　政府、米欧と国際協議へ（産経新聞） - Yahoo!ニ...
宇宙の成り立ちを探る次世代加速器「国際リニアコライダー（ＩＬＣ）」という巨大実験 - Yahoo!ニュース(産経新聞)
headlines.yahoo.co.jp

5:17 PM - 5 Mar 2019



MEXT's view in regard to the ILC project
Executive Summary

March 7, 2019
Research Promotion Bureau, MEXT

- Following the opinion of the SCJ, MEXT has not yet reached declaration for hosting the ILC in Japan at this moment. The ILC project requires further discussion in formal academic decision-making processes such as the SCJ Master Plan, where it has to be clarified whether the ILC project can gain understanding and support from the domestic academic community.
- MEXT will pay close attention to the progress of the discussions at the European Strategy for Particle Physics Update.
- The ILC project has certain scientific significance in particle physics particularly in the precision measurements of the Higgs boson, and also has possibility in the technological advancement and in its effect on the local community, although the SCJ pointed out some concerns with the ILC project. Therefore, considering the above points, MEXT will continue to discuss the ILC project with other governments while having an interest in the ILC project.

ILC press conference today

ICFA briefing on future prospects for the International Linear Collider

Unlisted

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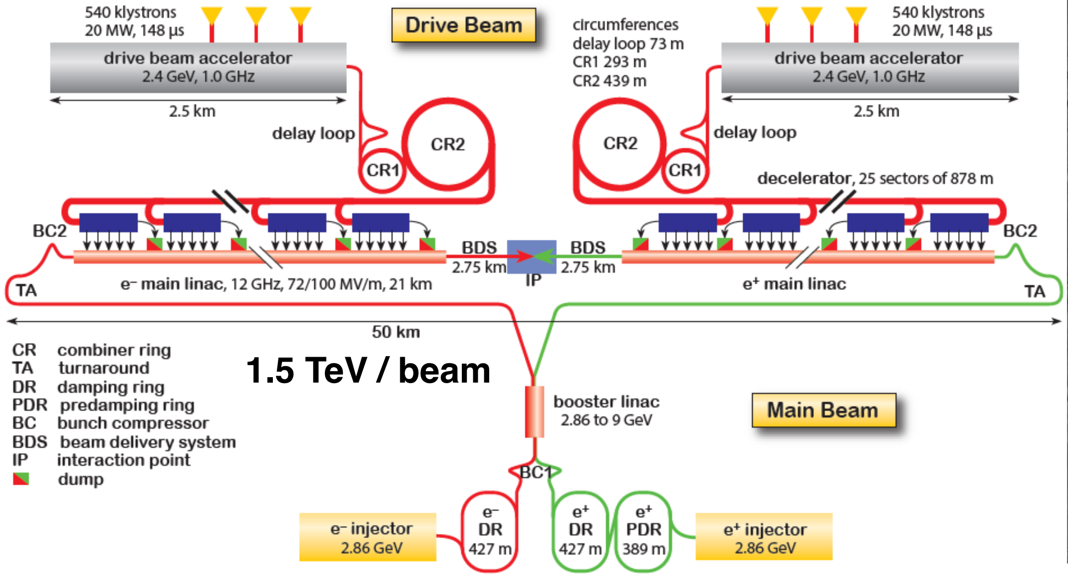
Int. Linear Collider @LCNewsLine · 5m

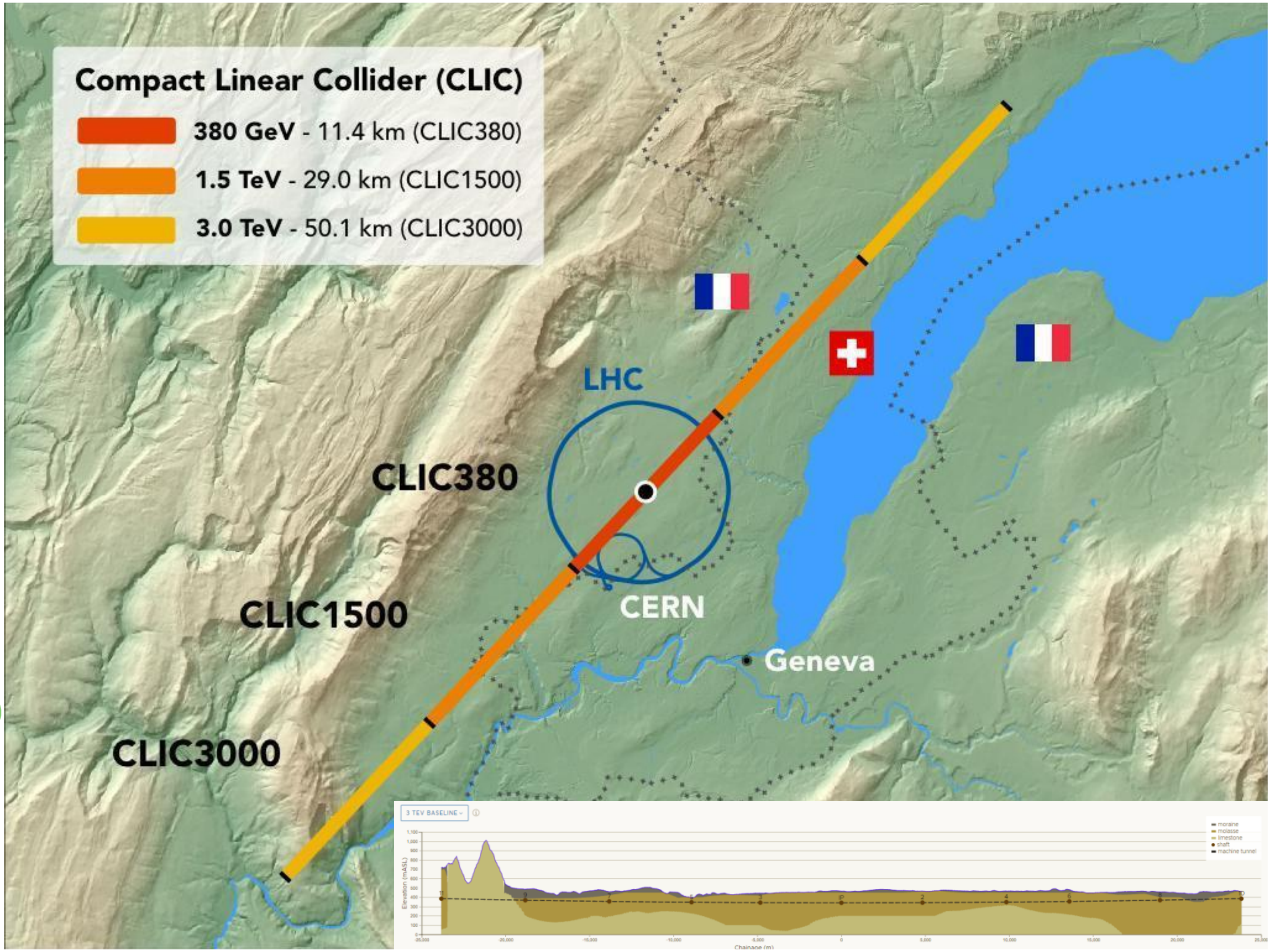
Tatsuya Nakada, Linear Collider Board chair : "We're grateful since it was the first time we could hear from the ministry @mextjapan about the #ILC"

ICFA chair, Prof. Geoff Taylor *"MEXT: not yet ready to being host of ILC, there's still a process that they must go through, but the statement did not say that they would not go through this process."*

Compact Linear Collider: CLIC

- ***Drive beam technology demonstrated*** *at CTF3, CERN, acc. gradient upto 150 MV/m.*
- *Operation **100 MV/m**, 135 MW at 12 GHz.*
- Project staging to ***multi-TeV e⁺e⁻***
  - **380 GeV, 1.5 TeV ,3.0 TeV**
- *Design report as input to EU strategy.*





UK institutes contributed to design; Phil Burrows – CLIC spokesperson

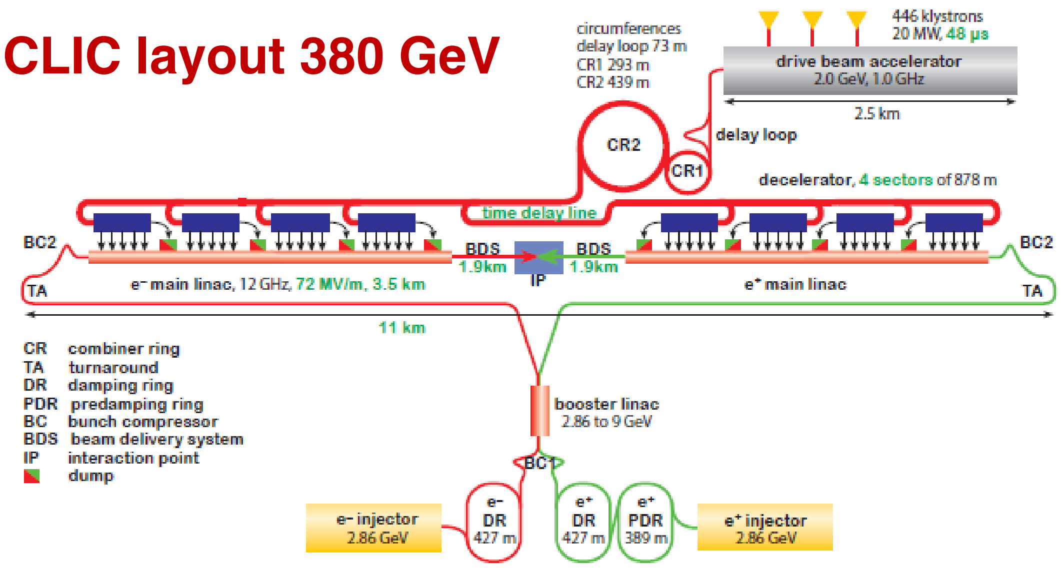
Compact Linear Collider: CLIC

- ***Drive beam technology demonstrated*** *at CTF3, CERN, acc. gradient upto 150 MV/m.*
- *Operation* ***100 MV/m****, 135 MW at 12 GHz.*
- Project staging to ***multi-TeV e⁺e⁻***
  - **380 GeV, 1.5 TeV ,3.0 TeV**
- *Design report as input to EU strategy.*

LINEAR COLLIDER COLLABORATION

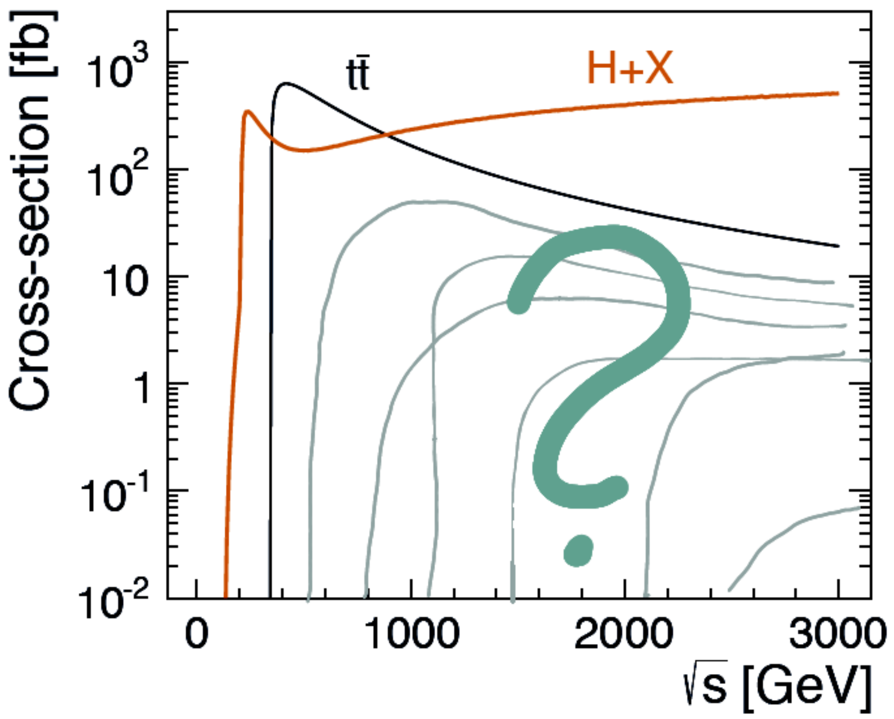
CLIC physics context

CLIC layout 380 GeV



Energy-frontier capability for electron-positron collisions,

for precision exploration of Higgs + top, as well as potential new physics that may emerge from LHC



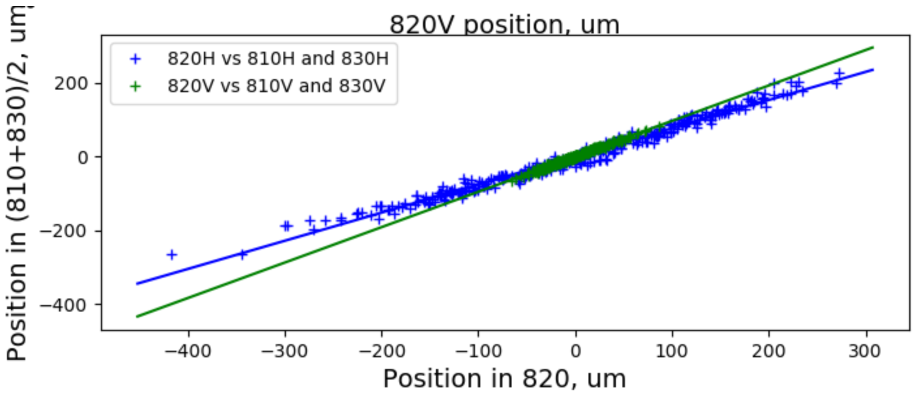
UK institutes contributed to design; Phil Burrows – CLIC spokesperson

CLIC Cavity BPMs at CLEAR

A. Lyapin, M. Cargnelutti (I-Tech)

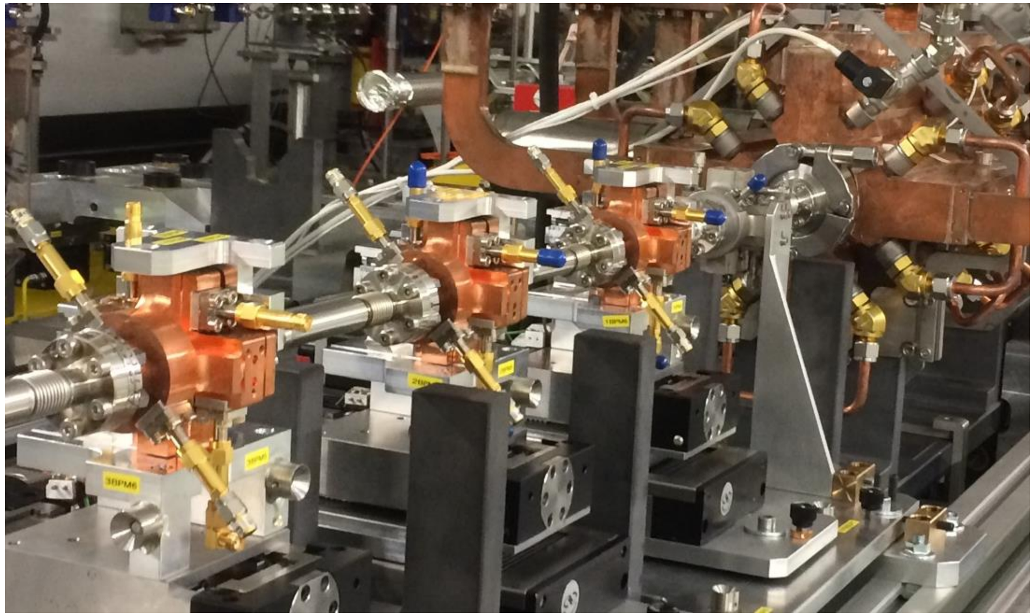
ROYAL HOLLOWAY UNIVERSITY OF LONDON

- *Demonstrator for CLIC main beam cavity BPMs*
  - High spatial (50 nm) and high temporal (50 ns) resolution needed for beam based alignment, wakefield-free steering and *online dispersion correction.*
  - 3x 15 GHz low-Q (fast decay) position cavities
  - Downconversion to a lower frequency for digitisation
  - Transverse movers for calibration and alignment



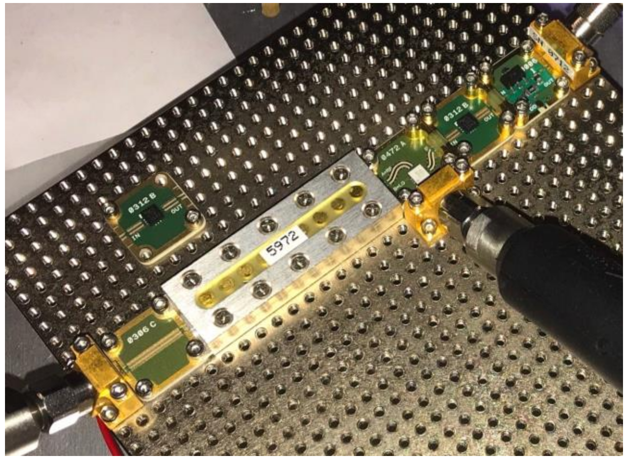
Current system resolution limited to 2 μm

Cavity performance very good -> **redesign electronics**



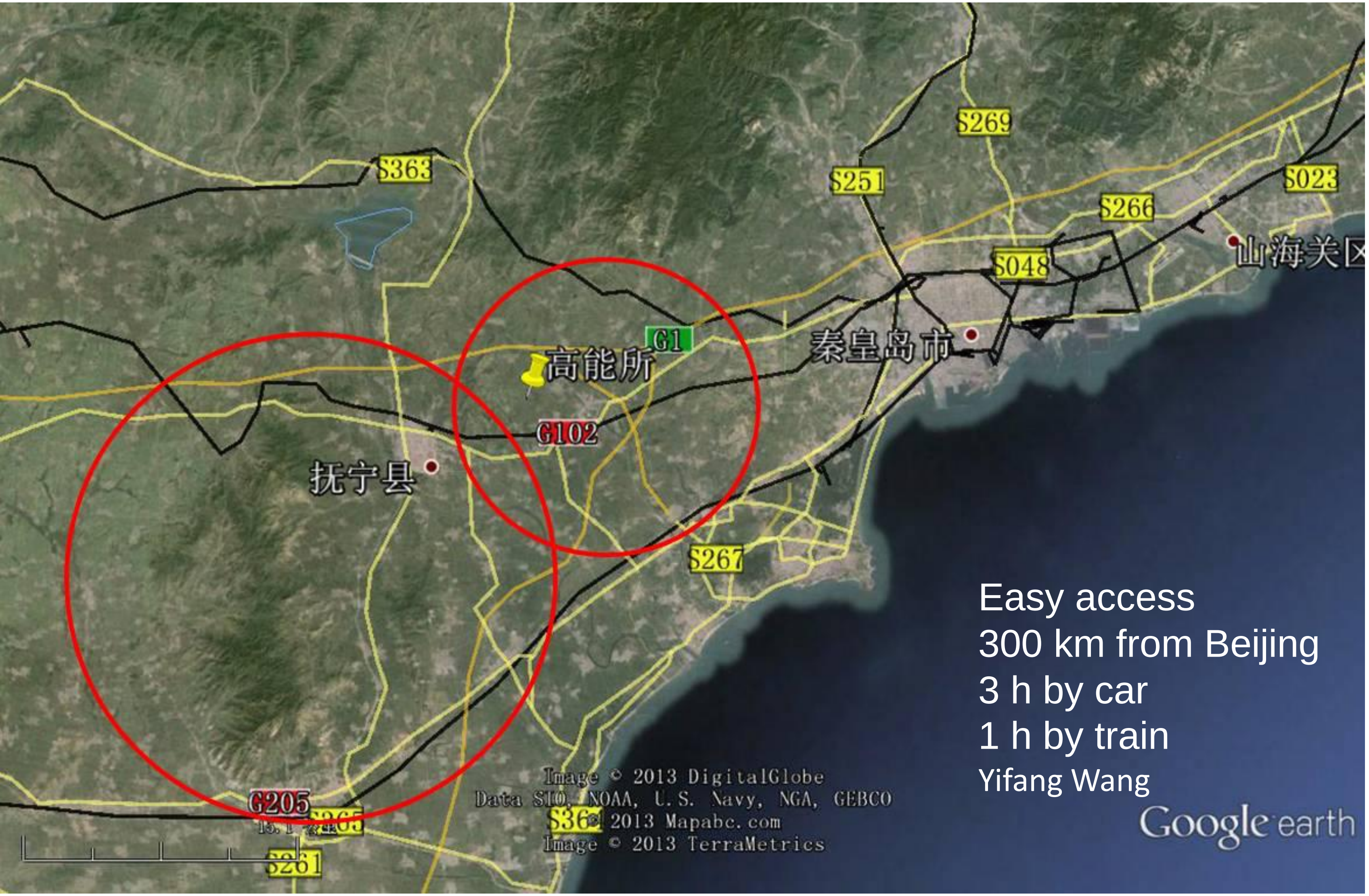
Development in collaboration with Instrumentation Technologies (Slovenia)

- Same single-stage downconverter concept, but no excessive gain, linearity important
- Proof of principle: modular “RF Lego” approach for prototyping, then PCB.



Online standalone system by Nov 2019

Proposed Circular Colliders in China



Easy access
300 km from Beijing
3 h by car
1 h by train
Yifang Wang

The International Workshop on the Circular Electron Positron Collider EU EDITION 2019

Oxford, April 15-17, 2019

http://www.physics.ox.ac.uk/confs/CEPC2019/

Scientific Committee:
Franco Bedeschi – INFN, Italy
Marica Biagini – INFN, Italy
Alain Blondel – University of Geneva, Switzerland
Daniela Bortoletto – University of Oxford, UK
Joao Guimaraes da Costa – IHEP, China
Jie Gao – IHEP, China
Hong-Jian He – SJTU, China
Eric Kajfasz – CPPM, France
Eugene Levichev – BINP, Russia
Shu Li – TDLI and SJTU, China
Jianbei Liu – USTC, China
Nadia Pastrone – INFN, Italy
Jianming Qian – University of Michigan, USA
Manqi Ruan – IHEP, China
Felix Sefkow – DESY, Germany
Chris Tully – Princeton University, USA
Liantao Wang – University of Chicago, USA
Meng Wang – Shandong University, China
Marcel Vos – IFIC (UV/CSIC) Valencia, Spain

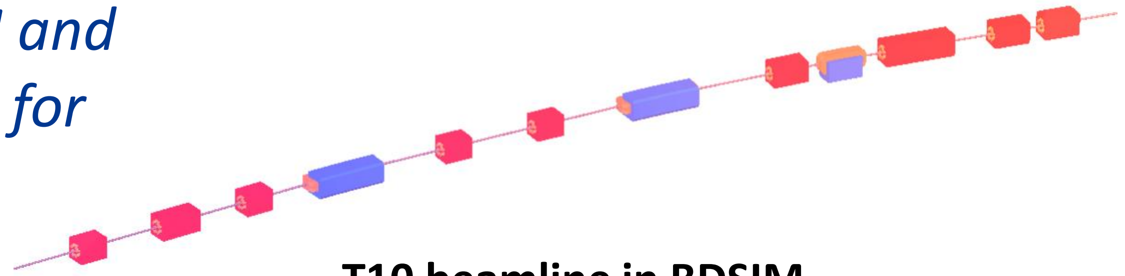
Local Organizing Committee:
D. Bortoletto – University of Oxford
P. Burrows – University of Oxford
B. Foster – University of Oxford
Y. Gao – University of Liverpool
B. Murray – University of Warwick/RAL
I. Shipsey – University of Oxford
G. Viehhauser – University of Oxford

UNIVERSITY OF OXFORD

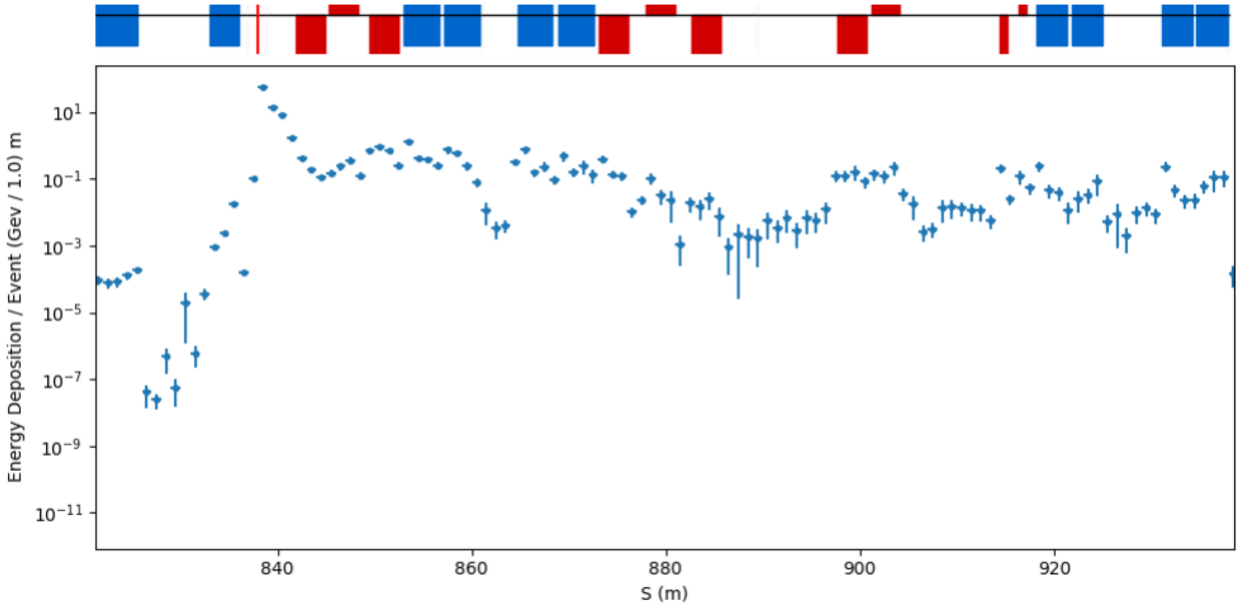
Physics Beyond Colliders

G. L. D'Alessandro et al

- *New CERN-RHUL PhD student starting BDSIM and MADX studies of CERN North Area beamlines for Physics Beyond Colliders programme:*
  - P42+K12 and T10 beamlines at CERN, implemented in BDSIM
  - Optics implemented and compared to MADX results
  - Energy deposition studies on Target area, in P42+K12



T10 beamline in BDSIM



Energy Deposition Analysis in the IP of P42+K12

Summary

- ***HL-LHC major UK effort with JAI making leading contributions to Collimation and Beam Diagnostics work packages: now preparing HL-LHC-UK II bid.***
- ***Excellent progress with new collimation techniques, and operational tests of accelerator models + machine induced backgrounds at ATLAS.***
- ***FCC-hh: JAI contributing EuroCircCol studies to inner triplet layout, energy deposition, dynamic aperture.***
- ***Ion collimation: studies applicable at FCC, HE-LHC, and Gamma Factory.***
- ***Leading contributions to CLIC & ILC: stable final beam delivery, and CBPM diagnostics.***
- ***JAI is making key contributions to future colliders!***

Thank you!

The Queen at Princes Gate this morning