

# FCC Accelerator Design Status

FCC Week, 19 May 2025

Frank Zimmermann, CERN  
on behalf of FCC collaboration

warm thanks to **I. Agapov, K. Andre, B. Auchmann, A. Ballarino, W. Bartmann, H. Bartosik, M. Benedikt, A. Blondel, M. Boscolo, G. Broggi, R. Bruce, O. Brunner, X. Buffat, J.-P. Burnet, C. Carli, F. Carlier, S. Casalbuoni, I. Chaikovska, A. Chance, P. Craievich, P. Crivelli, B. Dalena, S. Doebert, M. Doser, Z. Duan, Y. Dutheil, A. Faus-Golfe, V. Gawas, A. Ghribi, D. Gibellieri, M. Giovannozzi, C. Goffing, C. Grojean, A. Grudiev, J. Gutleber, K. Hock, X. Huang, G. Iadarola, P. Janot, I. Karpov, J. Keintzel, R. Kersevan, P. Kicsiny, R. Kieffer, M. Koratzinos, A. Lechner, S. Liuzzo, S. Mazzoni, M. Migliorati, C. Milardi, T. Mori, E. Musa, K. Ohmi, K. Oide, F. Palla, Y. Papaphilippou, F. Peauger, G. Perez Segurana, T. Pieloni, F. Poirier, P. Raimondi, T. Raubenheimer, M. Reissig, T. Riesselada, G. Roy, L. Sabato, S. Sai, J. Salvesen, J. Seeman, K. Skoufaris, R. Soos, J. Steinmann, I. Syrathev, E. Todesco, R. Tomas, F. Yaman, A. Vanel, L. Van Riesen-Haupt, R. Wanzenberg, S. White, G. Wilkinson, Y. Wu, S. Yue, C. Zannini, ...**



Swiss Accelerator  
Research and  
Technology

<http://cern.ch/fcc>



Work supported by the **European Commission** under the **HORIZON 2020** projects **EuroCirCol**, grant agreement 654305; **EASITrain**, grant agreement no. 764879; **iFAST**, grant agreement 101004730, **FCCIS**, grant agreement 951754; **E-JADE**, contract no. 645479; **EAJADE**, contract number 101086276; and by the Swiss **CHART** program



European  
Commission

Horizon 2020  
European Union funding  
for Research & Innovation

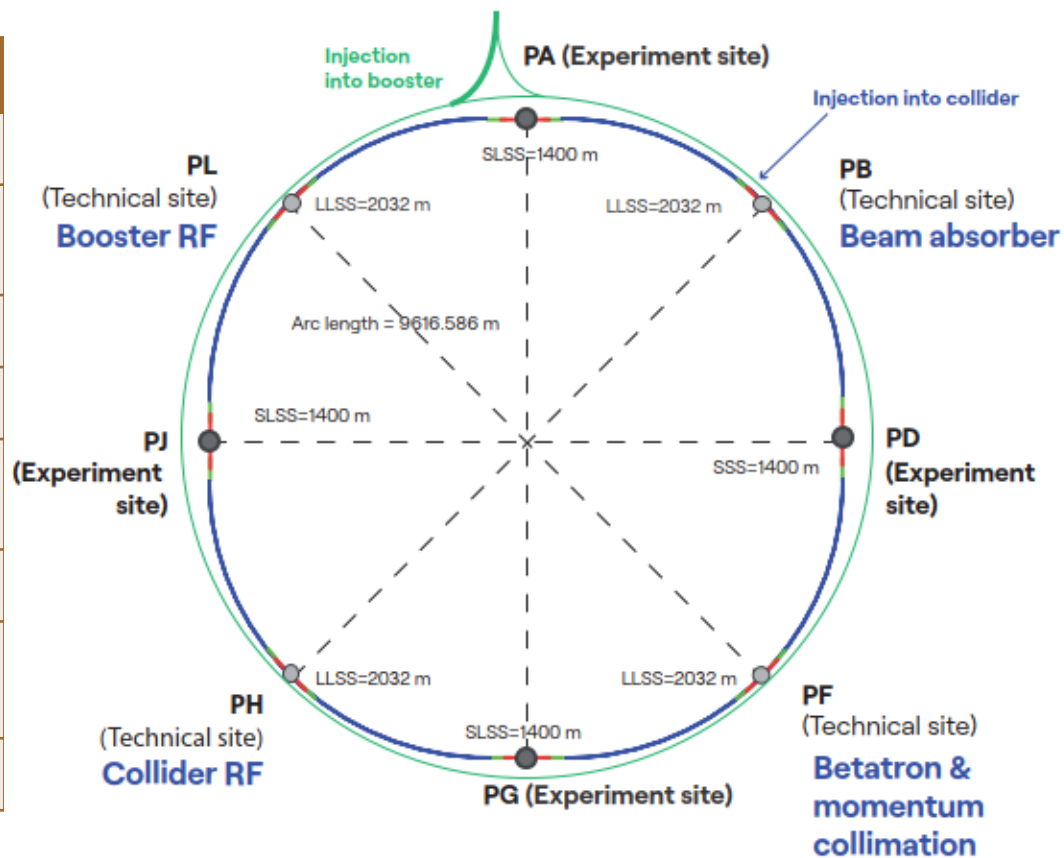
photo: J. Wenninger

# FCC-ee parameters & layout

## Main parameters FSR 2025

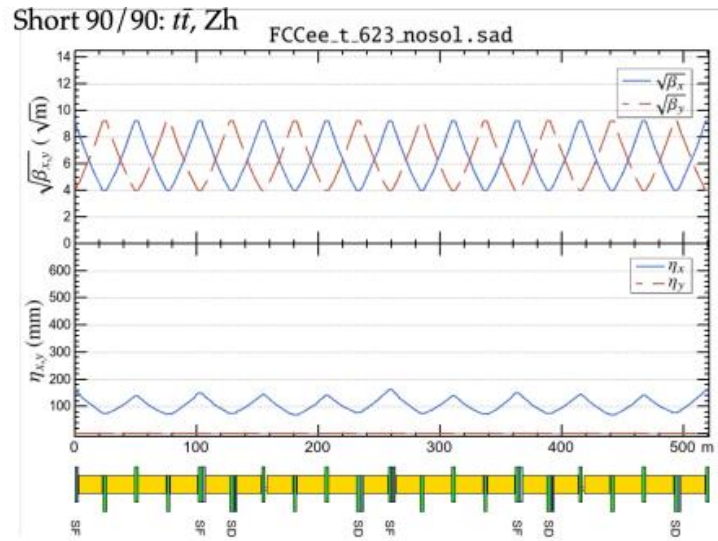
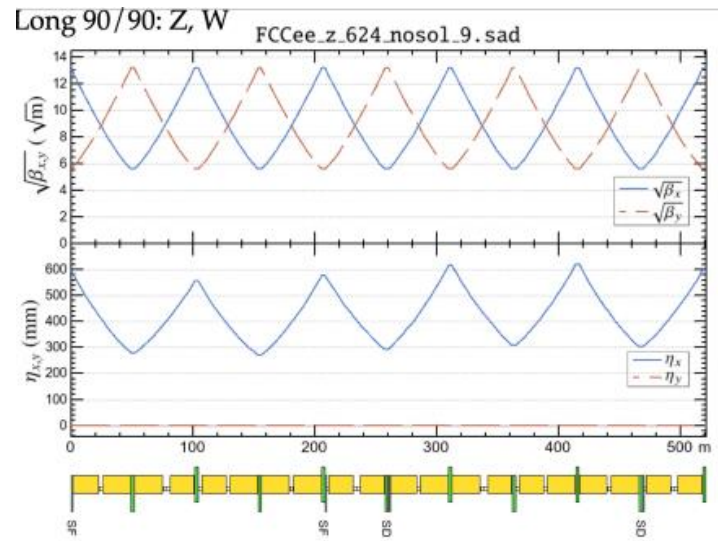
## FCC-ee functional layout

parameter	Z	WW	H (ZH)	t $\bar{t}$
beam energy [GeV]	45.6	80	120	182.5
synchrotron radiation/beam [MW]	50	50	50	50
beam current [mA]	1294	135	26.8	5.1
number bunches / beam	11200	1852	300	64
total RF voltage 400/800 MHz [GV]	0.08 / 0	1.0 / 0	2.09 / 0	2.1 / 9.2
luminosity / IP [ $10^{34} \text{ cm}^{-2}\text{s}^{-1}$ ]	145	20	7.5	1.4
total integrated luminosity / IP / year [ $\text{ab}^{-1} / \text{yr}$ ]	17	2.4	0.9	0.17
beam lifetime [min]	21	13	9	10



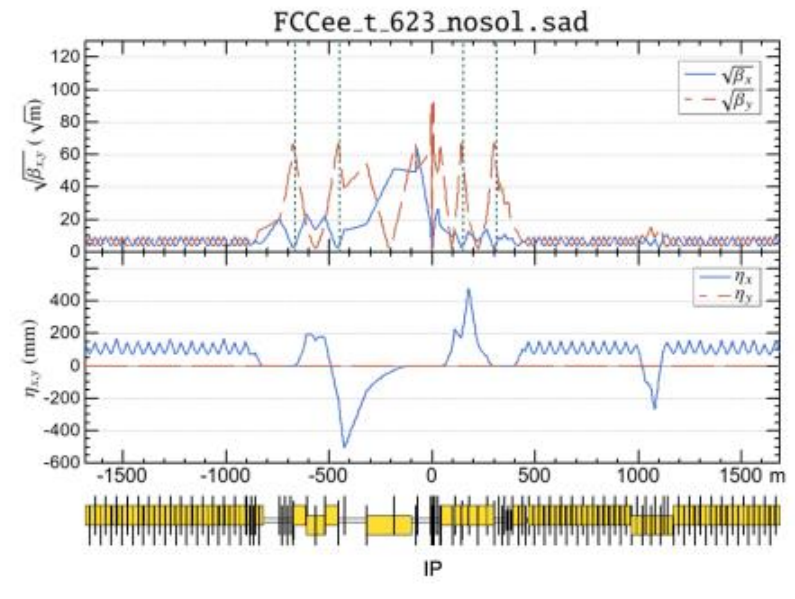
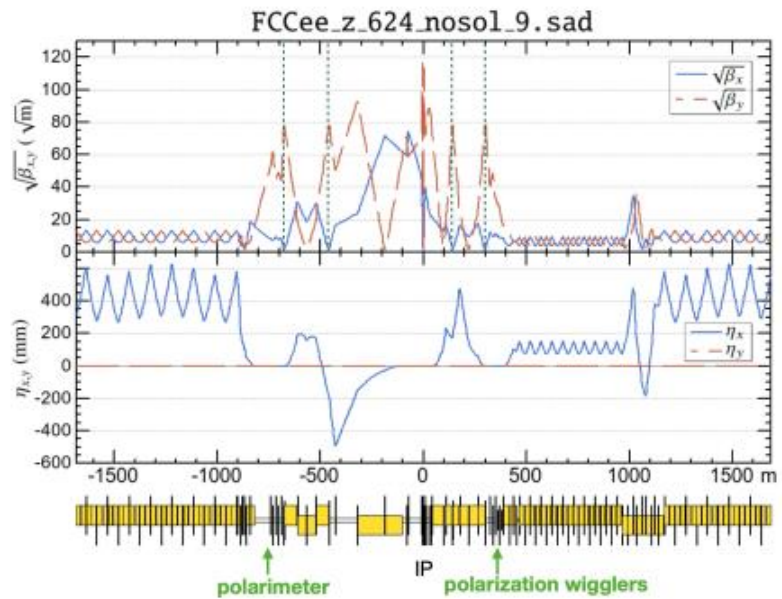
# GHC baseline optics – arc and experimental straights

Optics for the arc cell: Z/W operation modes (left) and Zh/tt operation modes (right).



PRAB 19, 111005 (2016)

Layout and optics for the experiment straight section: Z/W operation modes (left) and ZH/tt operation modes (right), including sections for an inverse-Compton polarimeter and polarisation wigglers.

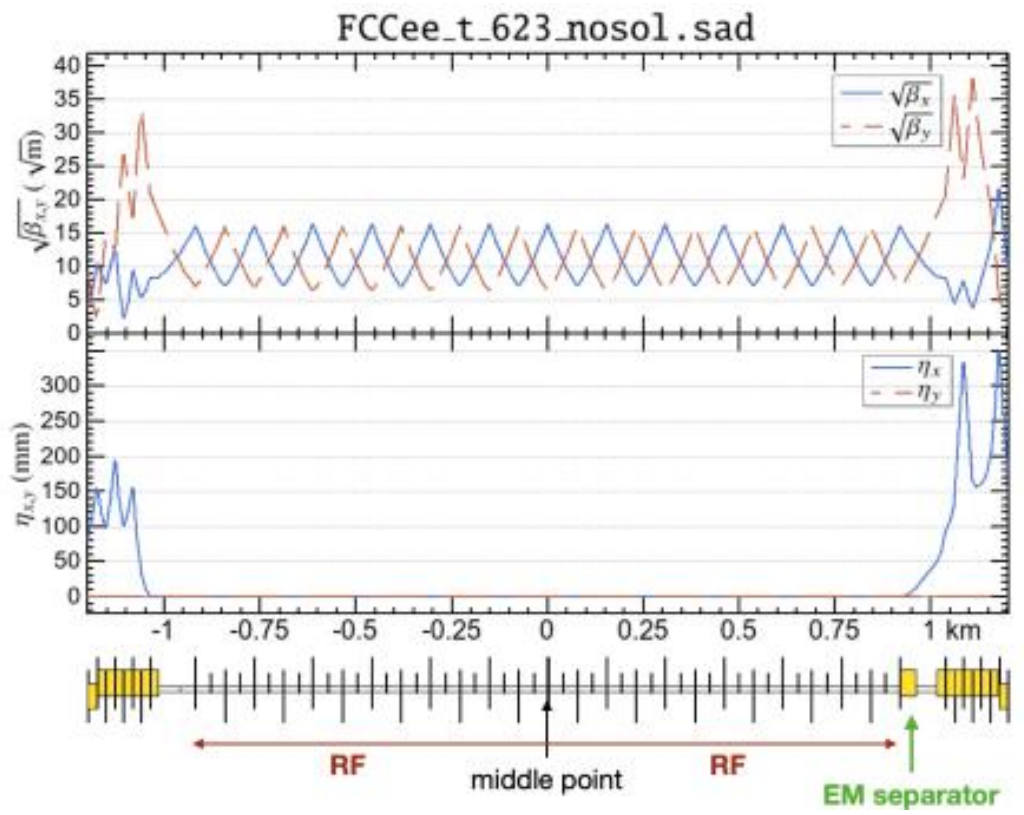
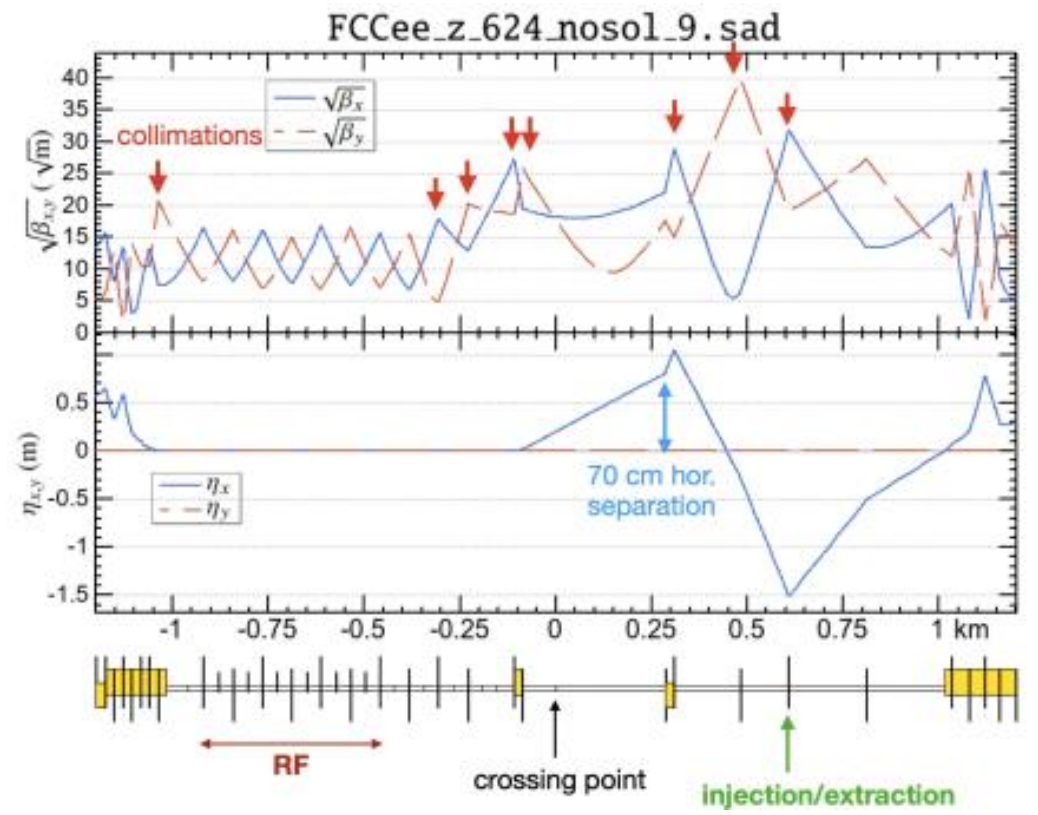


# GHC baseline optics: technical straights

K. Oide

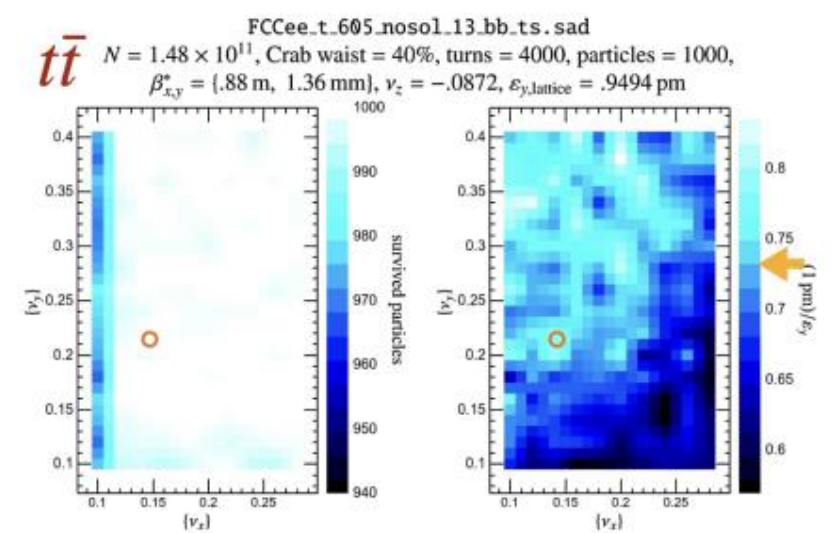
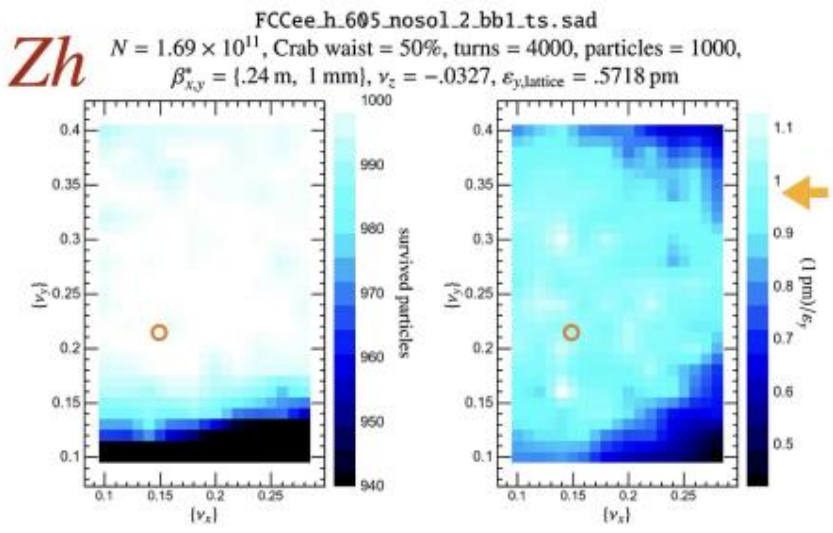
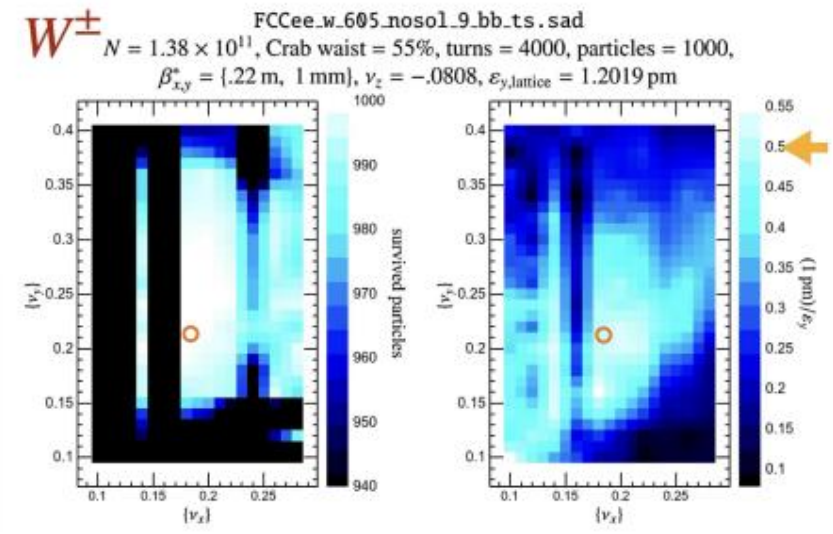
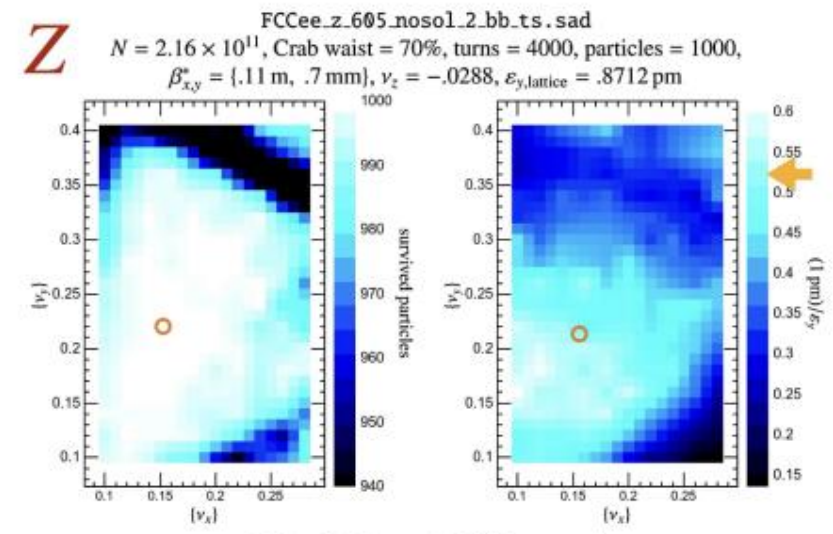
Universal optics for all technical insertions in Z/W operation: RF, injection/extraction, & collimation

Optics for the common RF section in ZH/ttbar operation



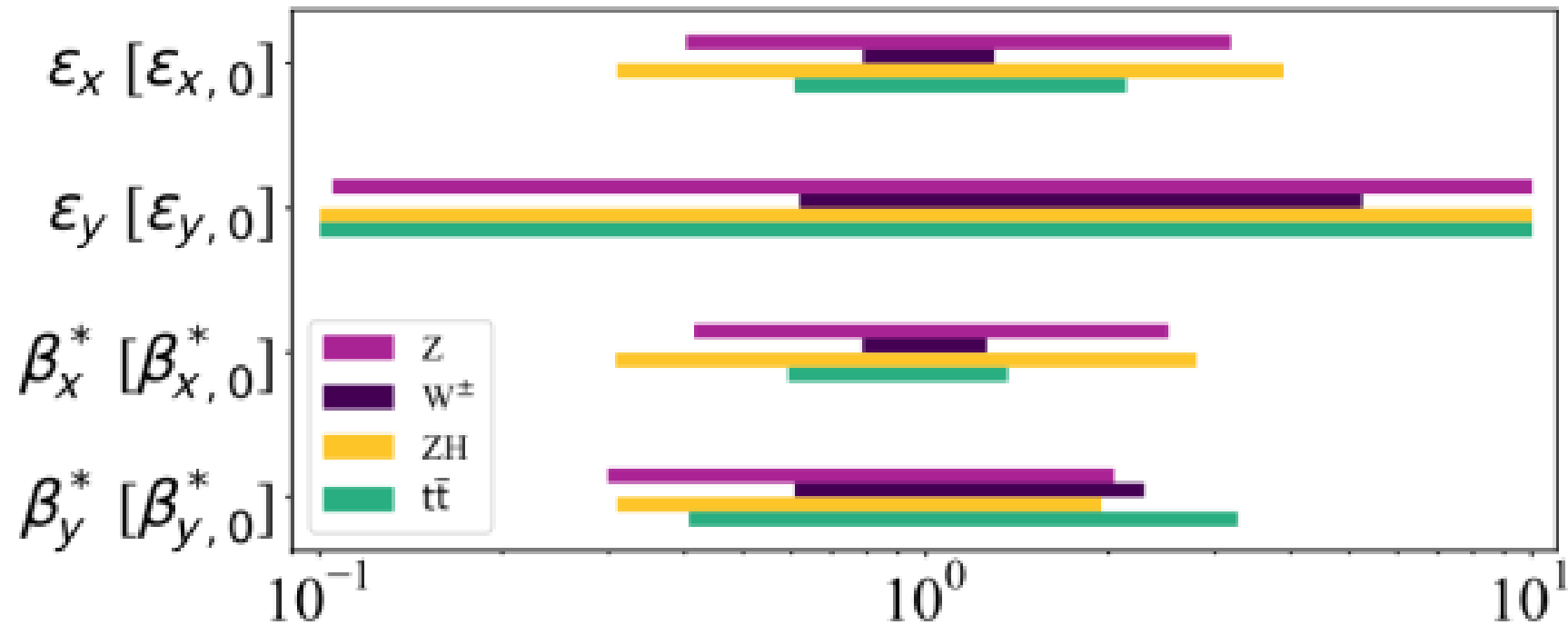
Maintaining perfect superperiodicity

# beam-beam performance with full lattice



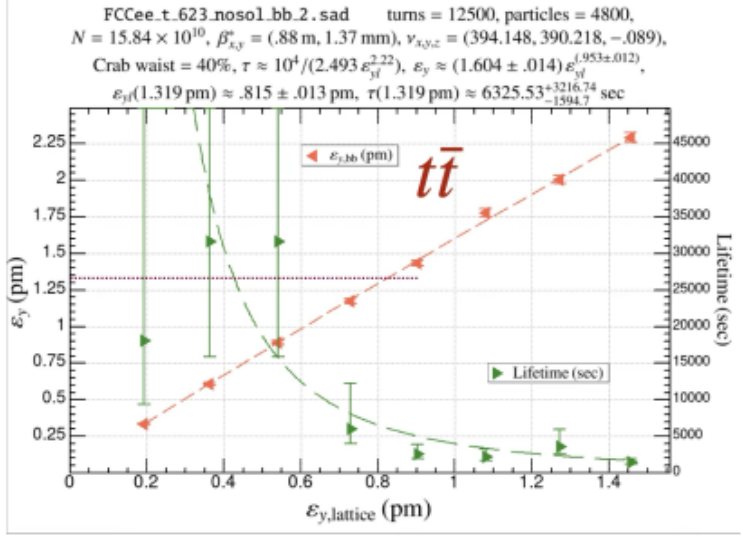
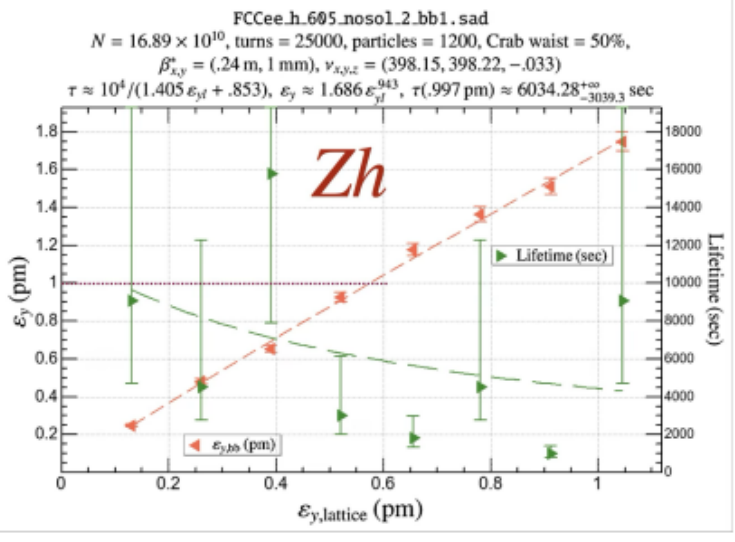
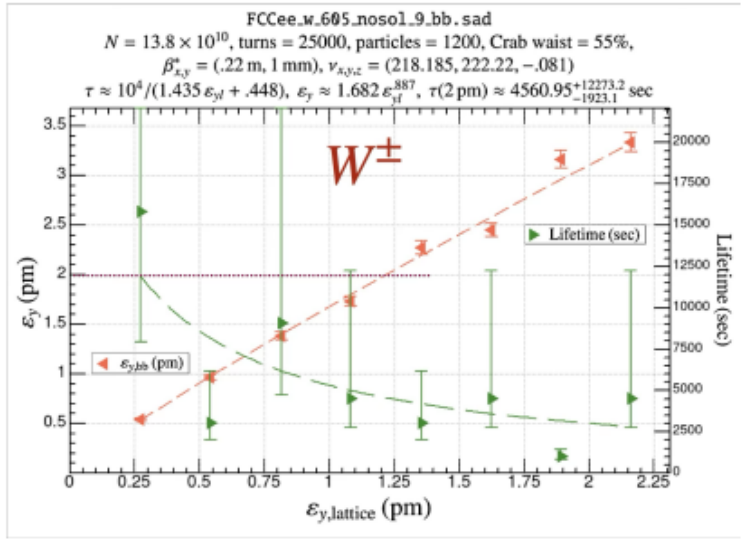
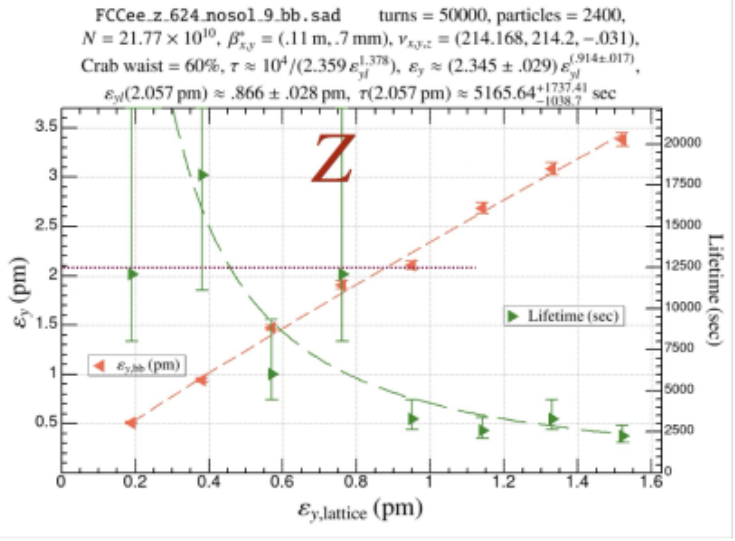
tune scan of the beam-beam effect with the full lattice

# 3D beam-beam flip flop – acceptable imbalance



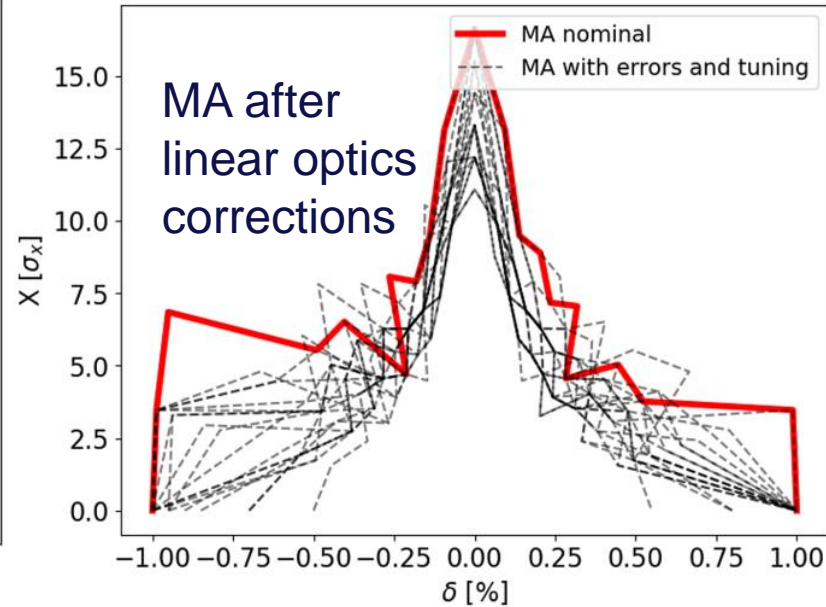
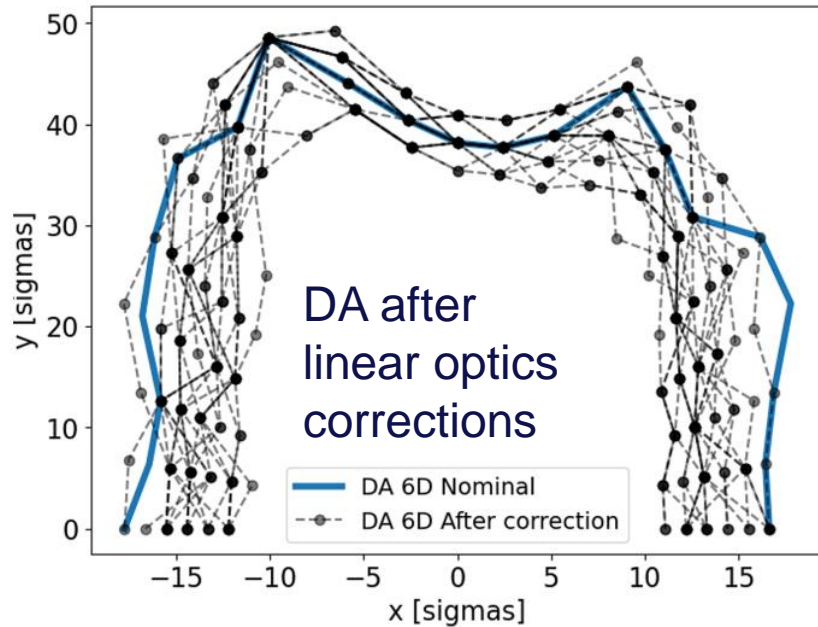
Initial studies of intensity asymmetries with LIFETRAC (D. Shatilov), reproduced and extended to other asymmetries with Xsuite

# vertical bare lattice emittance required with beam-beam



results of beam-beam tracking with lattice and beamstrahlung for each energy

# dynamic aperture & arc tolerances

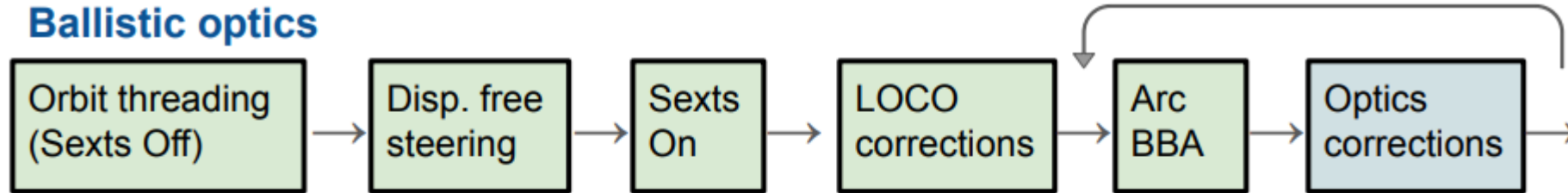


Element	$\sigma_{x/y}$ [ $\mu\text{m}$ ]	$\sigma_{\theta/\psi/\phi}$ [ $\mu\text{rad}$ ]	$\Delta k/k$ [ $10^{-4}$ ]
Arc quads & sext.	50	50	2
Dipoles	1000	1000	2
Girders	150	150	-
BPMs-to-quad	100	-	-

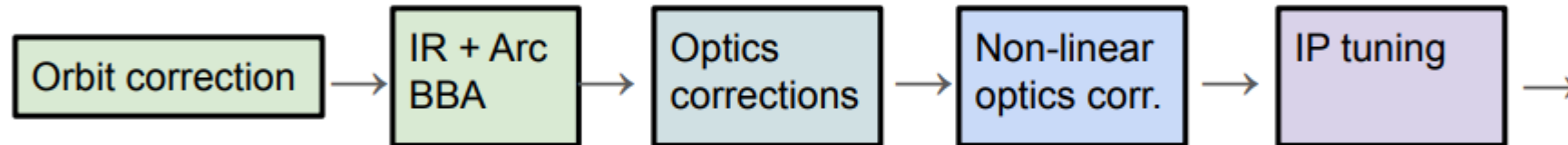
Arc alignment and strength tolerances

# commissioning sequence

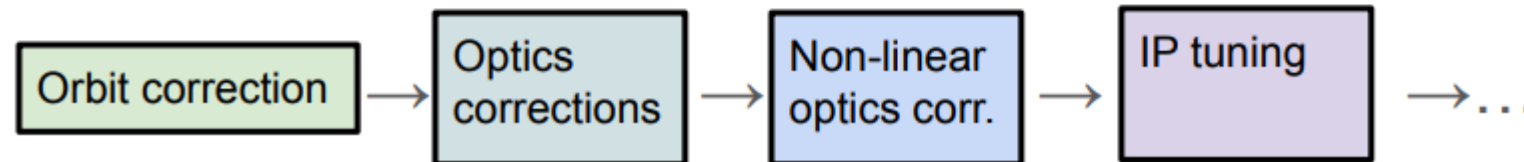
## Ballistic optics



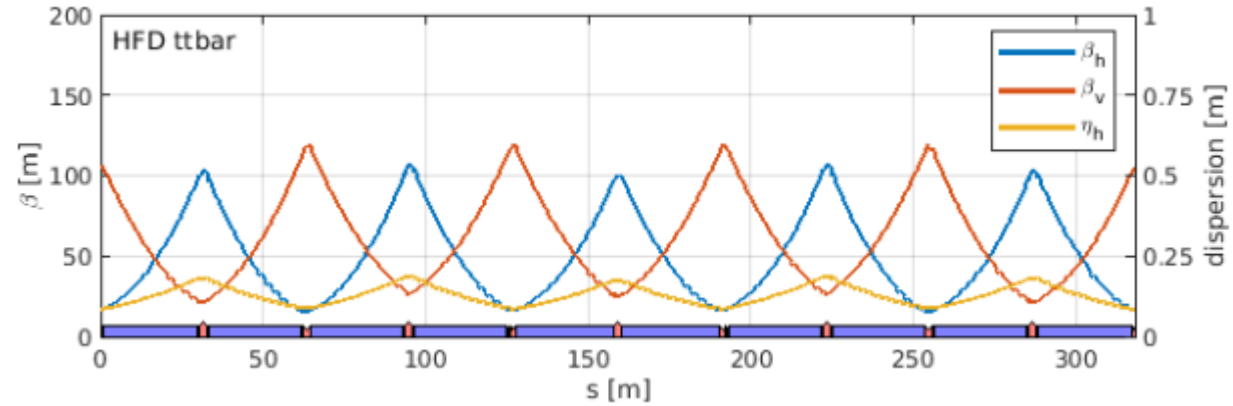
## Relaxed optics (various iterations decreasing $\epsilon^*$ )



## Baseline optics

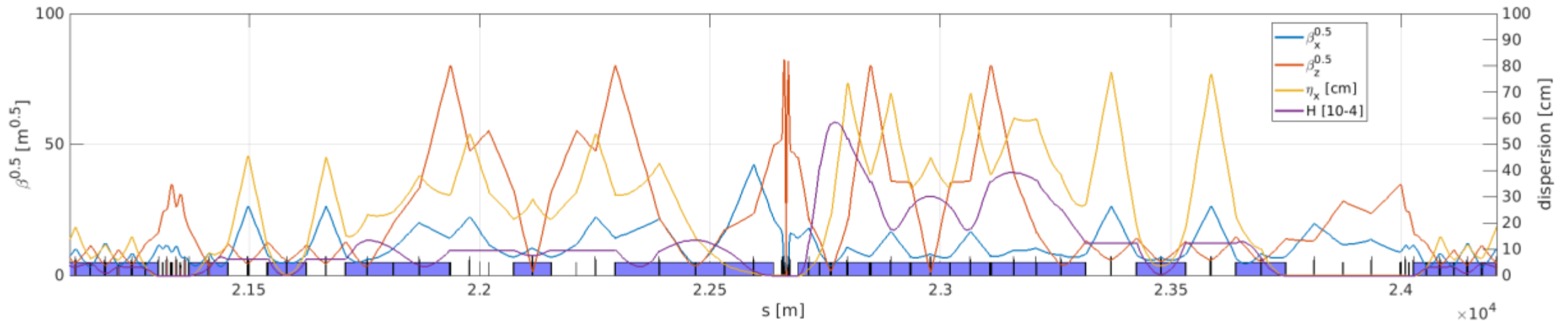


# LCC alternative optics – arc and experimental straights



PRAB 28,  
021002 (2025)

Arc cell optics at ttbar; same layout for all energies



Experimental insertion optics at ttbar

# towards new “pre-TDR” optics baseline

- **FCC Week 2025: Status and Workplan, presentation of the comparison exercise**
- Summer 2025: Repository reorganised and ready; Optics layout; naming conventions
- September 2025: Optics with technical insertions and complete layouts
- December 2025:
  - Optics Comparison Report;
  - Optics in Layout Database;
  - Geometry frozen for Civil Engineering
- ***March 2026: Decision on Optics***
- **FCC Week 2026: First Technical Design of Optics**

# automated FCC optics design with Xsuite



Reproducing from “scratch” the construction and matching of FCC-ee LCC lattice, based on

PHYSICAL REVIEW ACCELERATORS AND BEAMS **28**, 021002 (2025)

Editors' Suggestion

**Local chromatic correction optics for Future Circular Collider  $e^+e^-$**

Pantaleo Raimondi<sup>\*</sup>  
Fermilab, Batavia, Illinois 60510, USA

Simone Maria Liuzzo<sup>†</sup>, Laurent Farvacque<sup>‡</sup>, and Simon White<sup>§</sup>  
ESRF, Grenoble, France

Michael Hofer<sup>¶</sup>  
CERN, Geneva, Switzerland

(Received 18 October 2024; accepted 22 January 2025; published 13 February 2025)

PRAB **28**,  
021002 (2025)

→ **tutorial in form of Jupyter notebooks** illustrating (1) lattice “assembly”, (2) linear optics matching, (3) controlling chromatic & detuning properties

**+Xsuite SuperKEKB model**

G. Broggi, J. Salvesen, G. Iadarola

G. Iadarola

# spin tracking newly implemented in Xsuite !

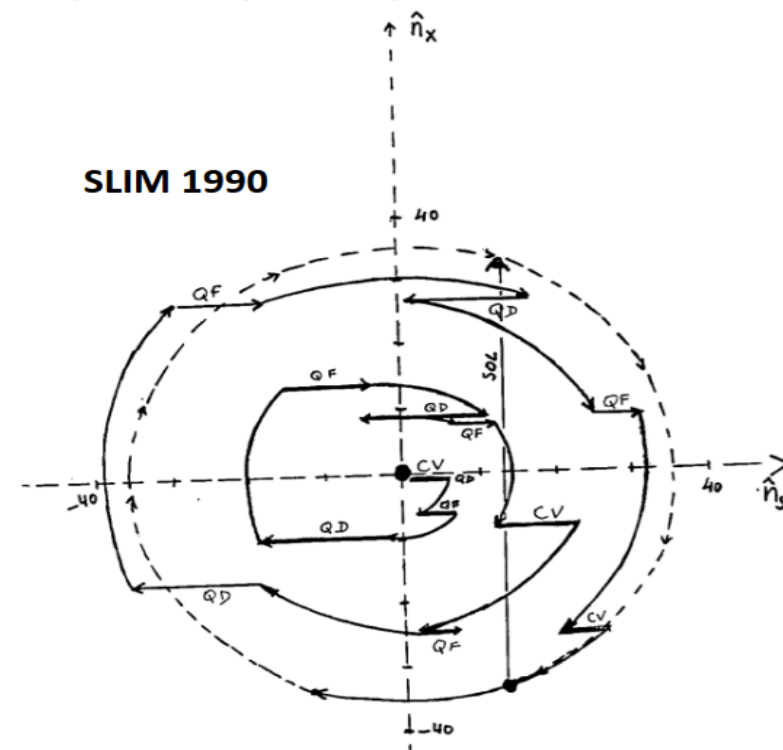
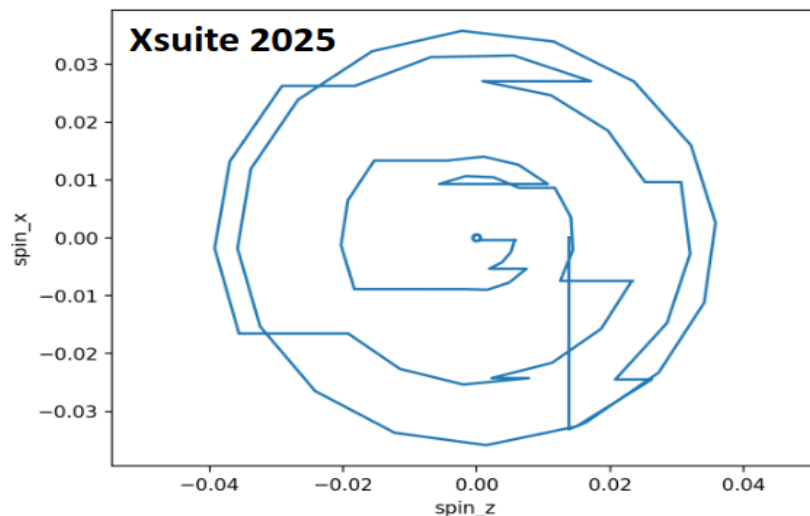
collaboration with  
BNL EIC project

tests,  
benchmarking,  
and first simulation  
studies ongoing



...and against 35-year-old SLIM simulation

Studied the case of **LEP1** with orbit bumps to compensate precession in the solenoids



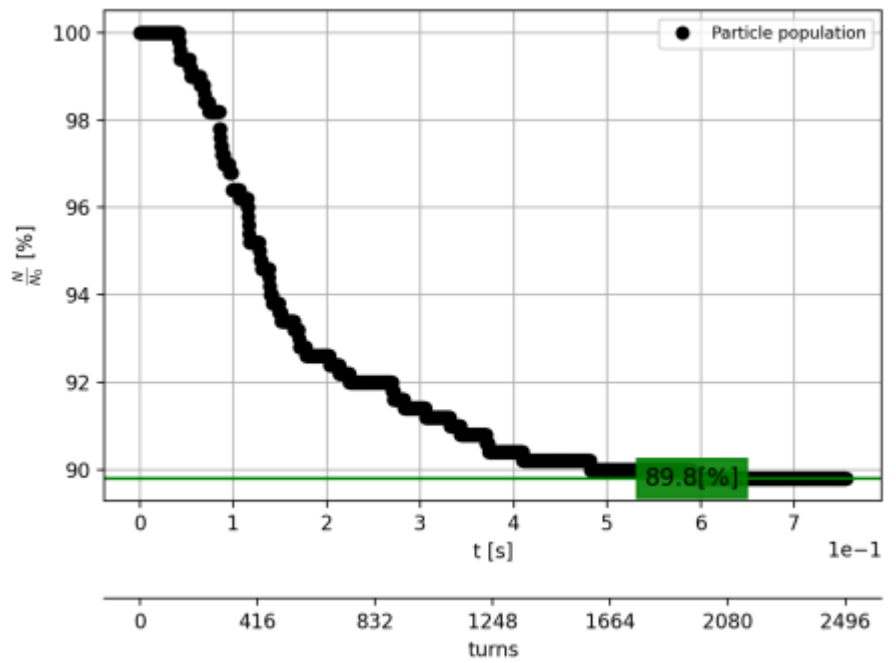
Compensation of Integer Spin Resonances Created by Experimental Solenoids

Alain Blondel  
L. P. N. B. E., Ecole Polytechnique, 91128 Palaiseau Cedex, France  
22 April 1990

G. Iadarola,  
K. Hock,  
Y. Wu,  
J. Keintzel,  
J. Wenninger

Many thanks to J. Wenninger and Y. Wu for their input and guidance!

# top-up injection



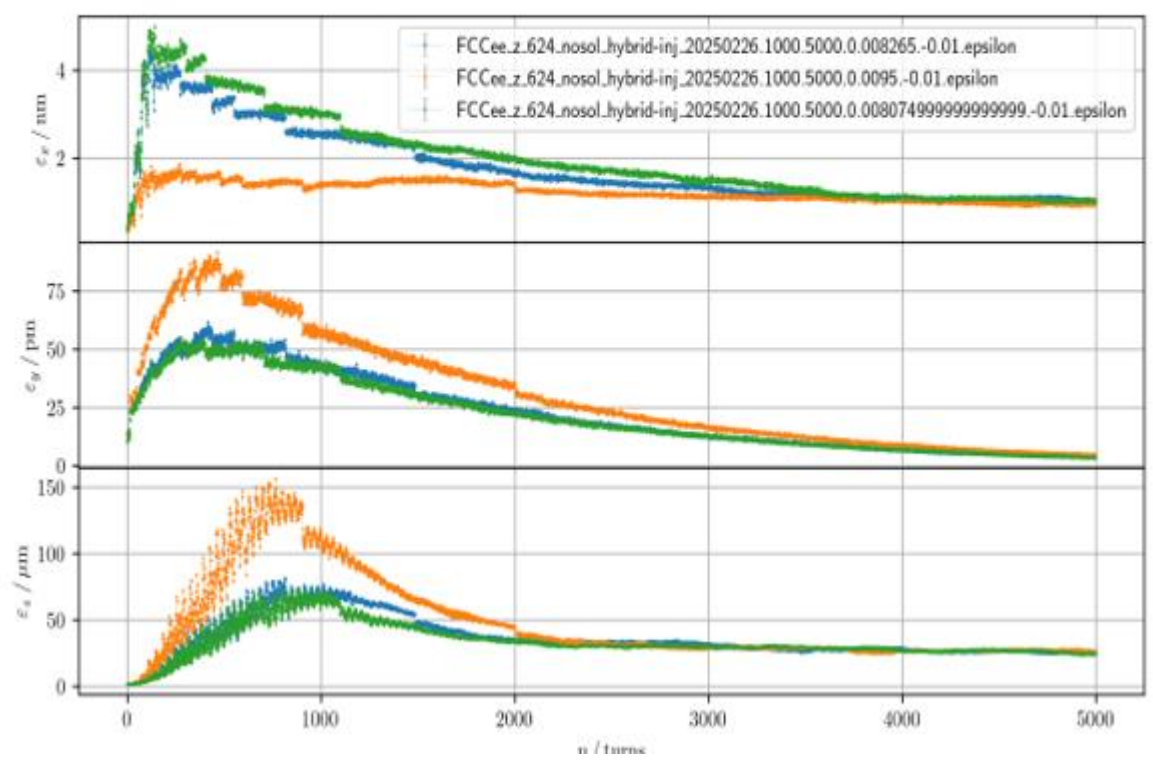
injection efficiency ~90% including beam-beam, beamstrahlung and chromatic matching

w/o beam-beam 100%

# hybrid injection

## Emittances

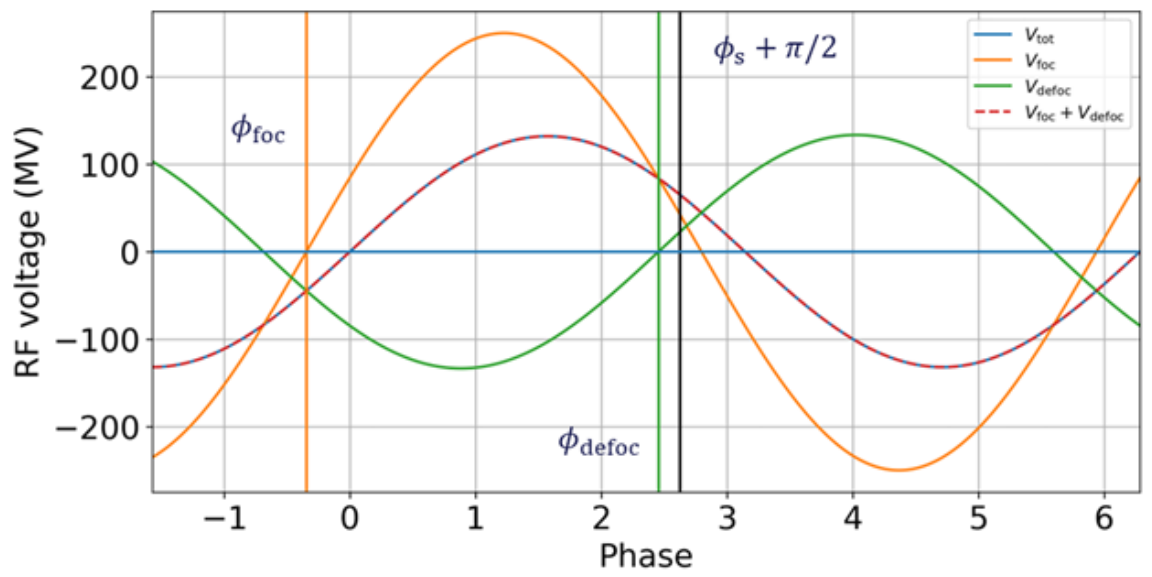
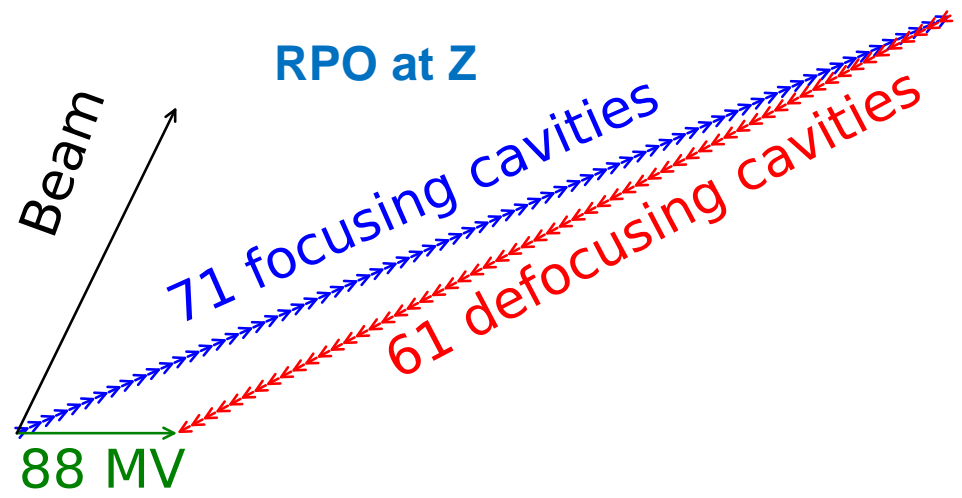
Vertical size reduction with momentum difference reduction



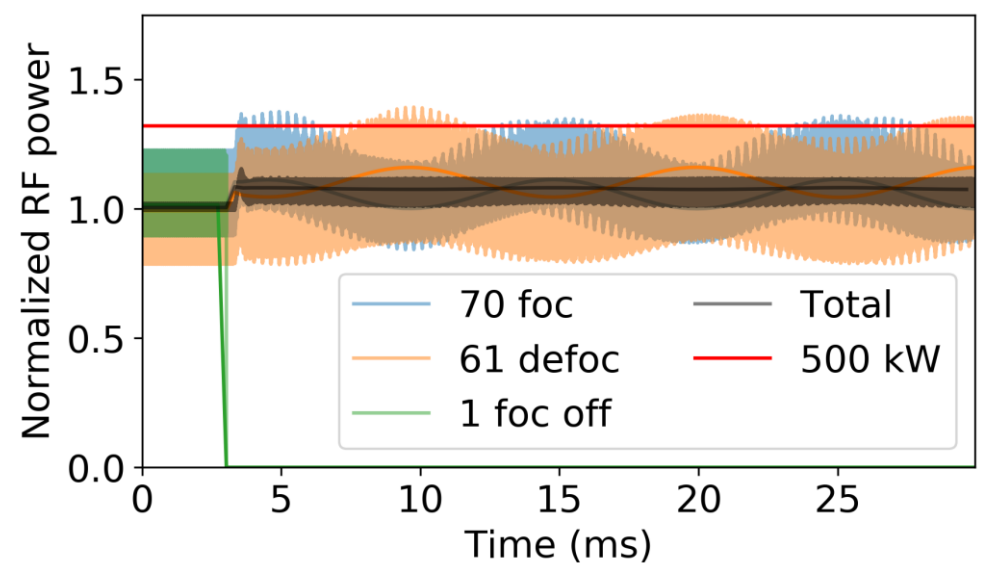
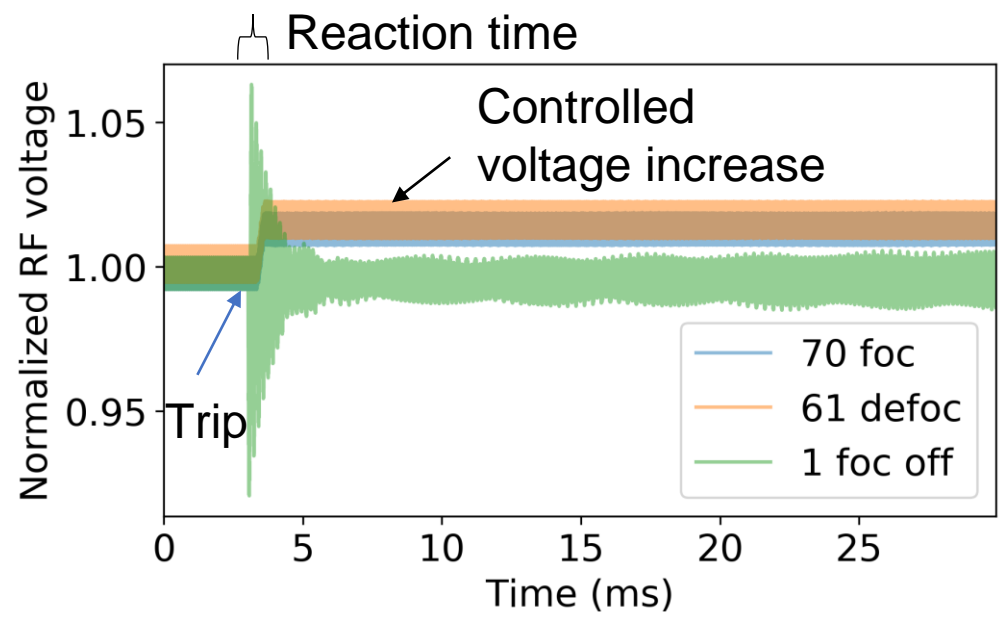
$\delta = 0.0095, 0.008265, 0.008075$

$z \equiv -0.01$  m: optimum  $z$  might be different

# RF reverse phase operation



## trip of focusing cavity

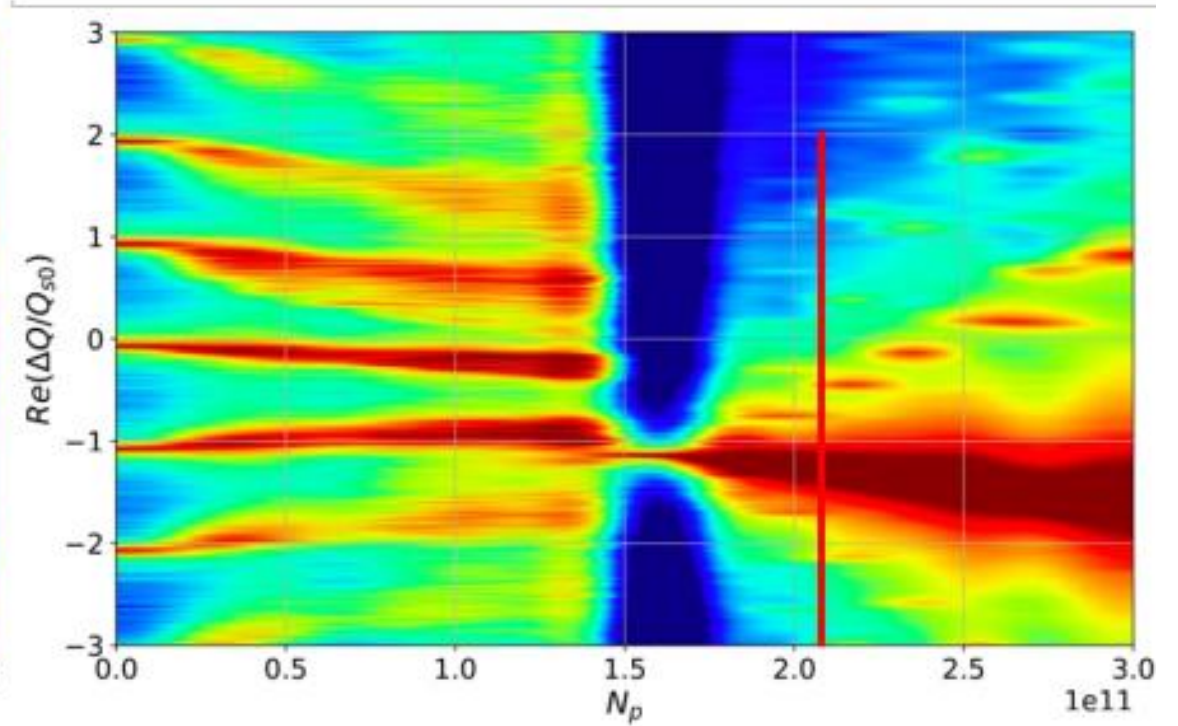
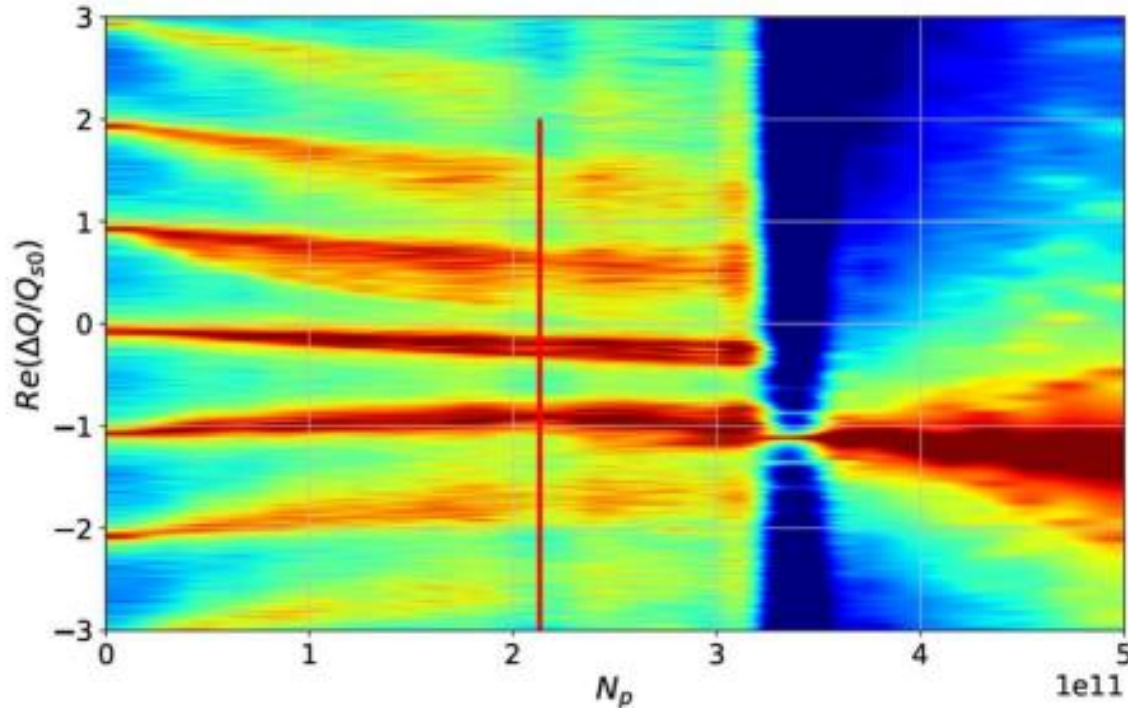


Short RF voltage transients ~6%.  
 Large power changes: : peak power of other cavities is modulated at synchrotron frequency (avg. <15%, peak <40%).  
 Initial bunch oscillation amplitude is <4% of rms bunch length

# transverse beam stability with impedance and feedback

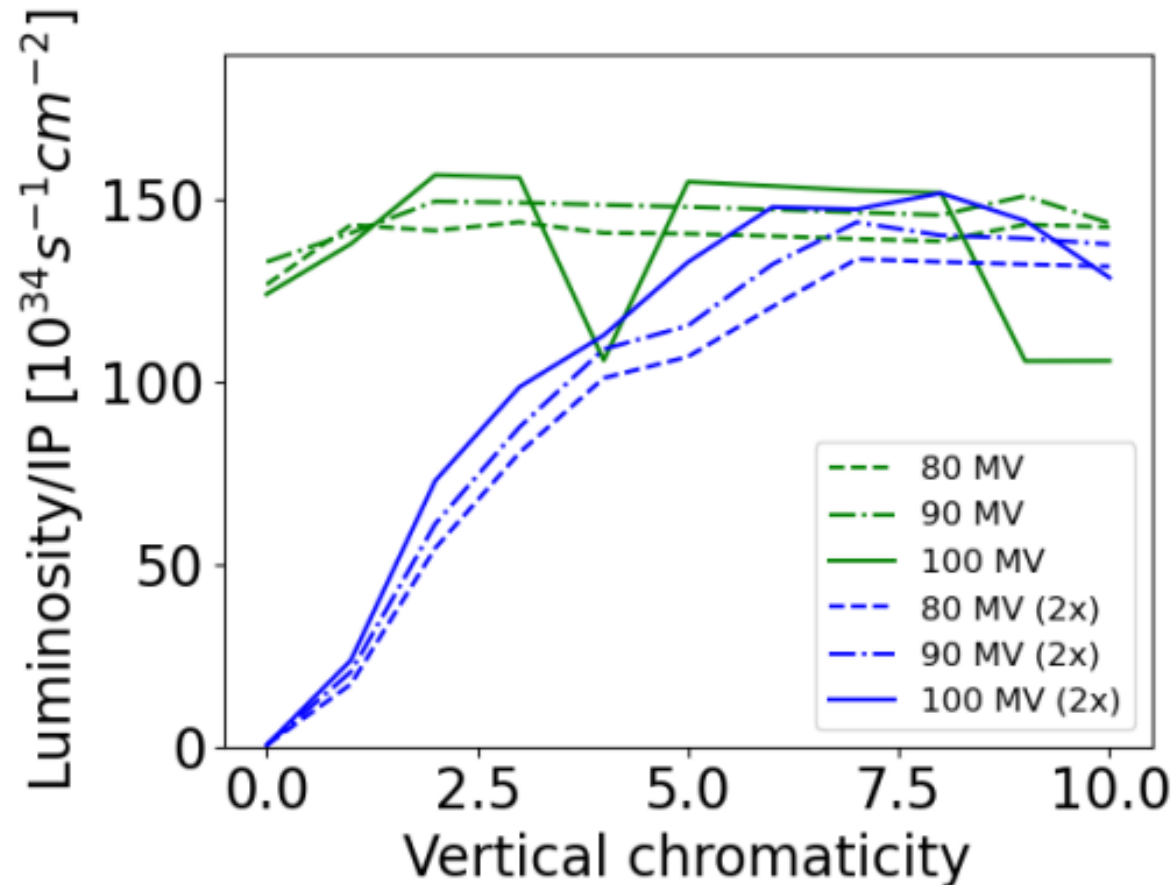
TMCI threshold

single '-1' mode instability



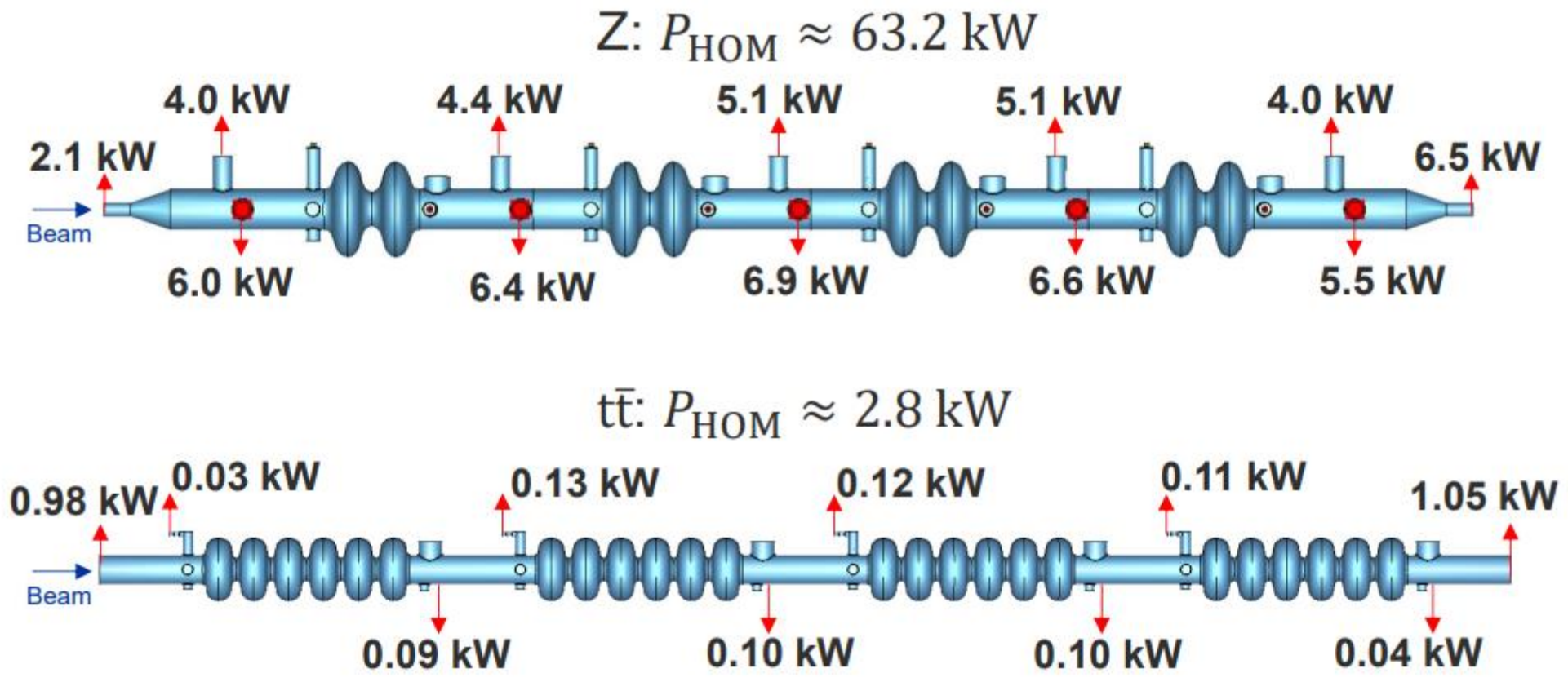
Real part of the tune shift of the first azimuthal transverse coherent oscillation modes normalised by the synchrotron tune  $Q_{s0}$  as a function of bunch population with a bunch-by-bunch feedback system and  $Q' = 5$ . On the right-hand side, the impedance is multiplied by a factor of 2 to explore the margins with the current impedance model

# luminosity at Z with beam-beam, impedance and feedback



Luminosity vs  $Q'_y$  introduced to mitigate the mode coupling instability of colliding beams for different RF voltages. The blue curves feature twice the actual impedance.

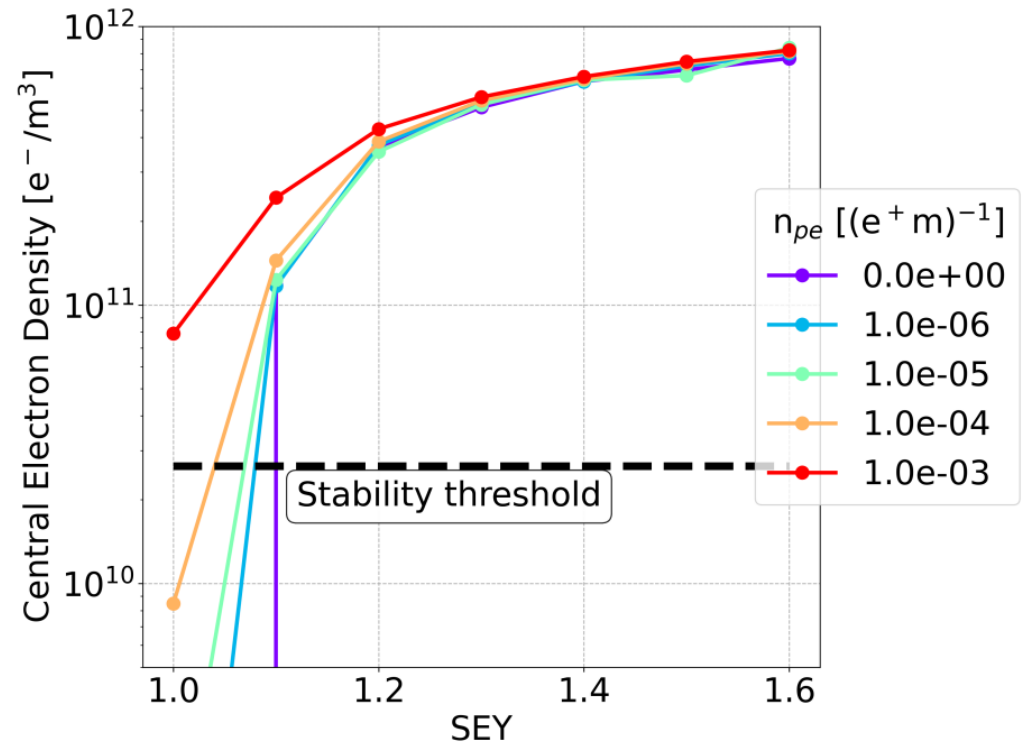
# HOM mode power distribution in RF cryomodules



also PRAB 21, 071001 (2018)

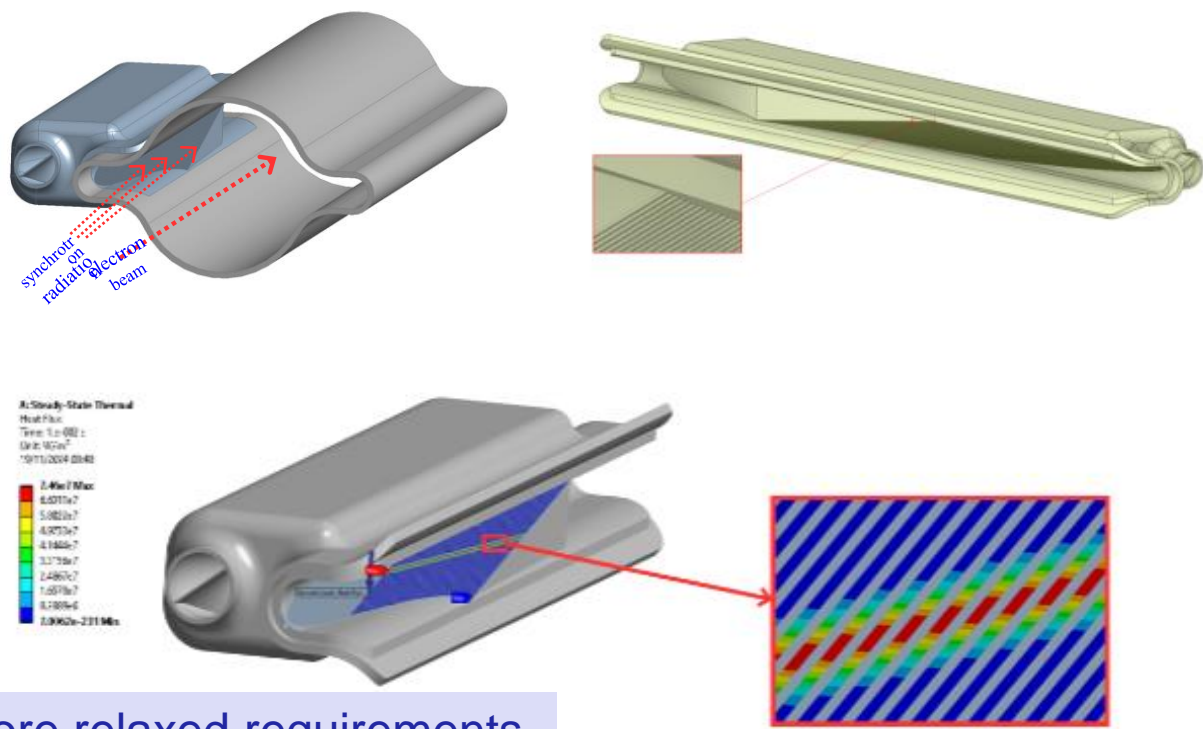
# synchrotron radiation & electron-cloud mitigation

- ultrathin NEG coating (200 nm, 10x thinner than for LHC)
- winglets with localized synchrotron radiation absorbers, cooled and externally shielded
- sawtooth pattern on absorber surface to minimize photon reflection into the vacuum chamber proper

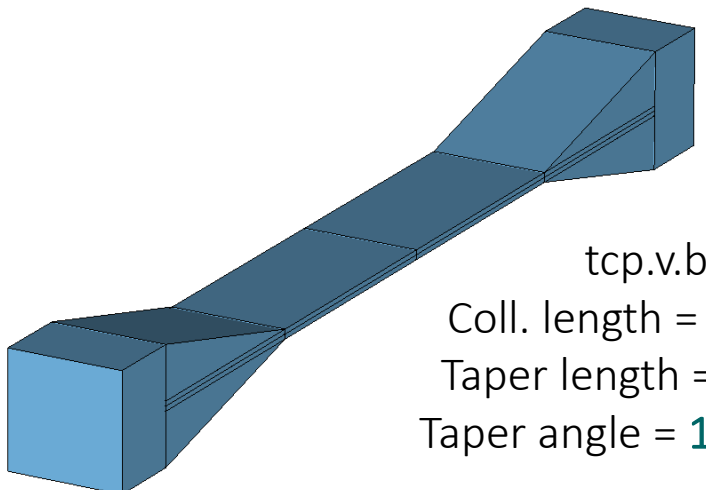
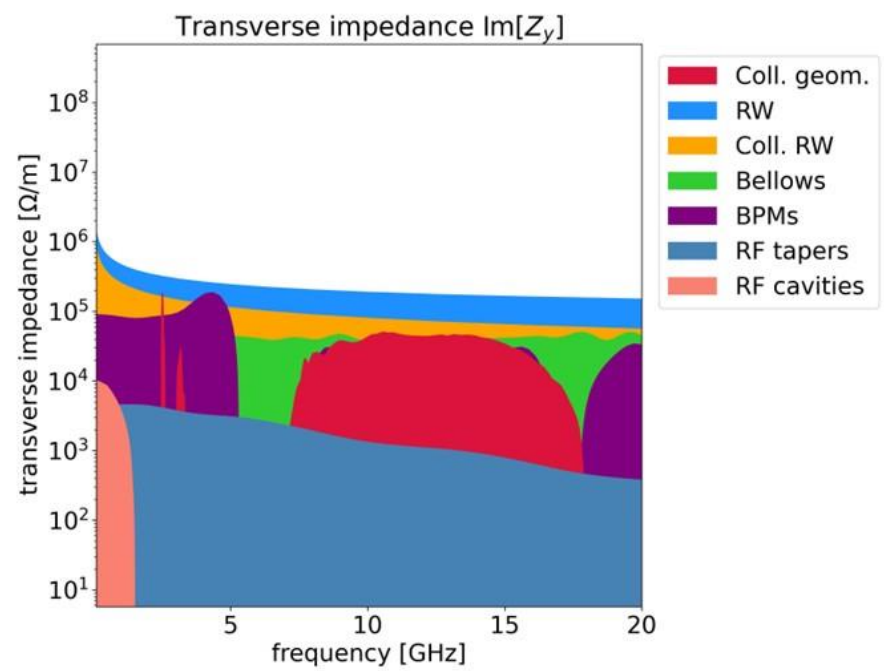
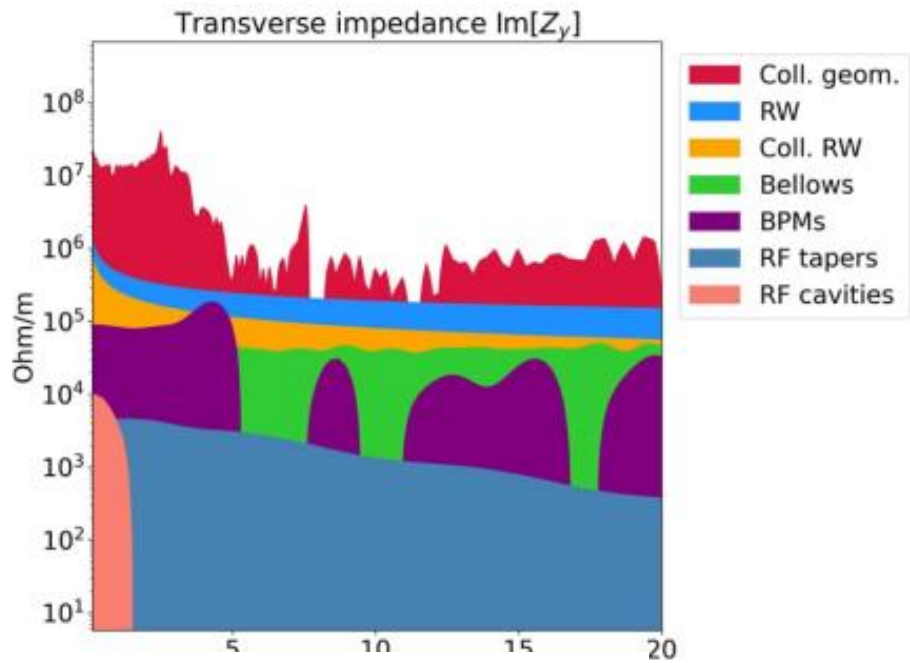


central e<sup>-</sup> density versus SEY in the arc dipoles for different photoelectron emission rates n<sub>pe</sub> at the most critical bunch intensity of 1 × 10<sup>11</sup>

scenarios with 5-ns mini-trains → more relaxed requirements

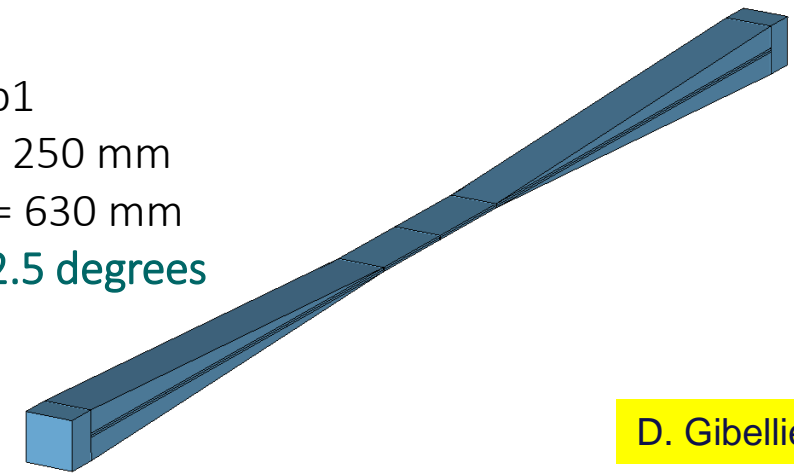


# component optimization – example collimators



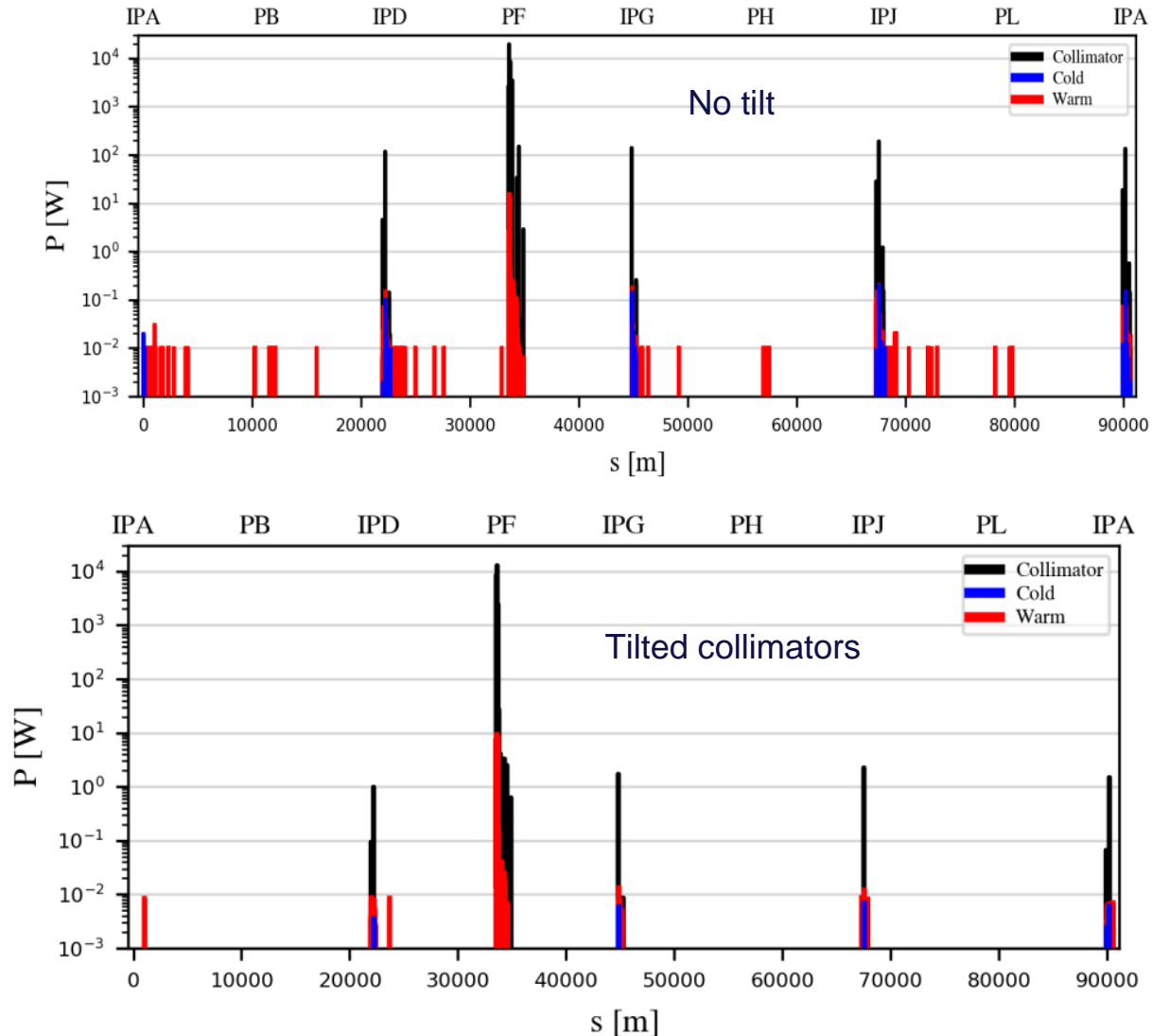
tcp.v.b1  
Coll. length = 250 mm  
Taper length = 110mm  
Taper angle = **15 degrees**

tcp.v.b1  
Coll. length = 250 mm  
Taper length = 630 mm  
Taper angle = **2.5 degrees**



# FCC-ee collimation performance

“Generic halo” loss map



- Loss suppression of factor  $10^2$  on TCTs,  $10^4$ - $10^5$  on SR collimators,  $>10^5$  on other elements
- Aligning collimator tilt angle to beam envelope  $\rightarrow$  Almost factor 100 performance increase
- FCC-ee experimental backgrounds still to be studied

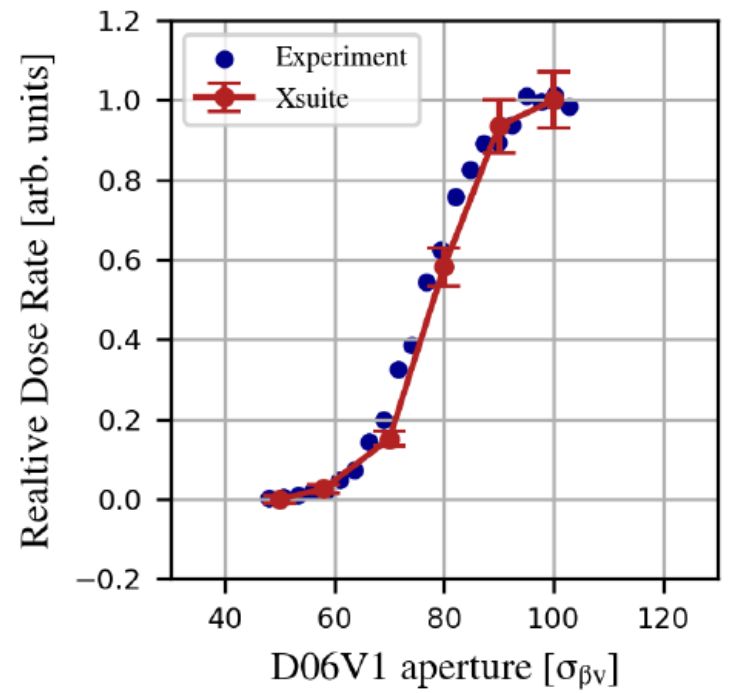
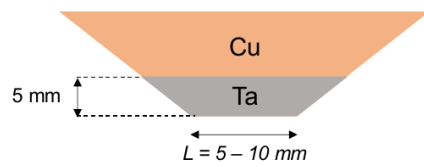
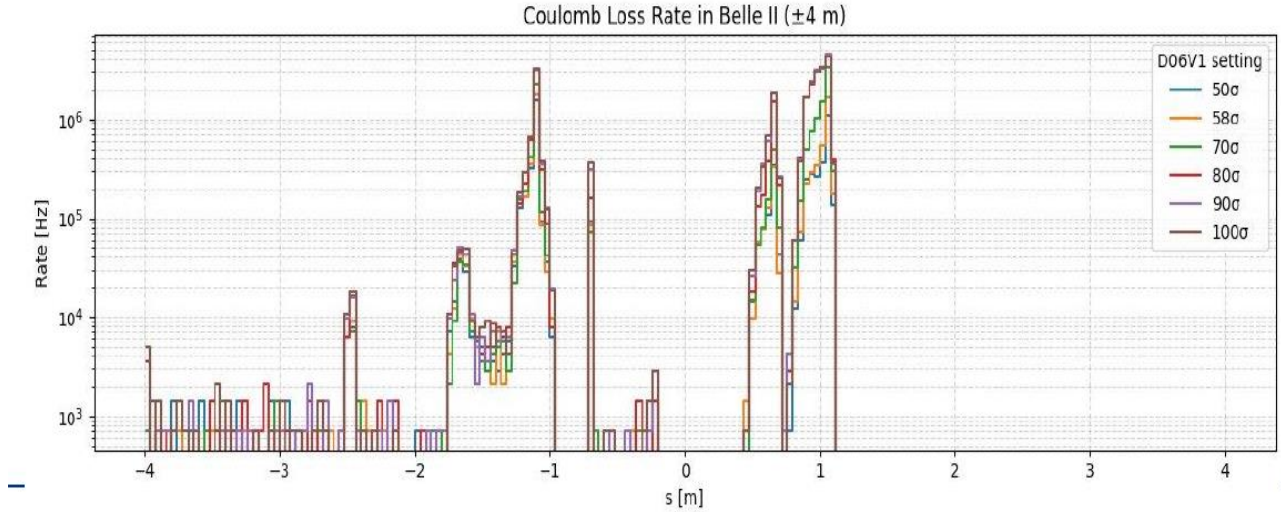
# SuperKEKB benchmark

## Simulation setup

- Xsuite simulation of beam losses from **Touschek and beam-gas scattering for different collimator settings, including collimator-matter interaction**
- **Simulation of response of Belle-II diamond detector**
- Comparison with measured Belle-II background vs collimator opening

## Results

- **Almost perfect agreement** in relative background variation
- Factor 3-4 discrepancy in absolute – still excellent result, considering the complexity of the simulation and the uncertainty on inputs (e.g. pressure profile and gas composition)

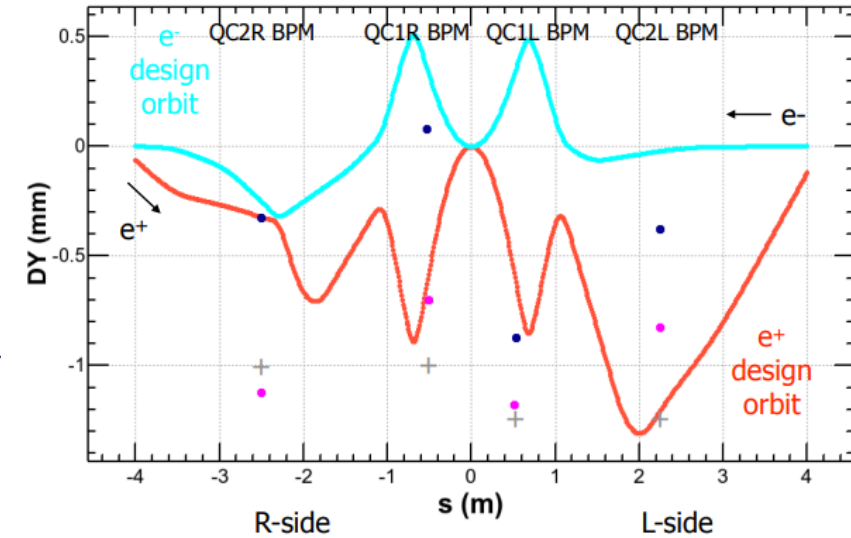


# SuperKEKB as FCC-ee demonstrator

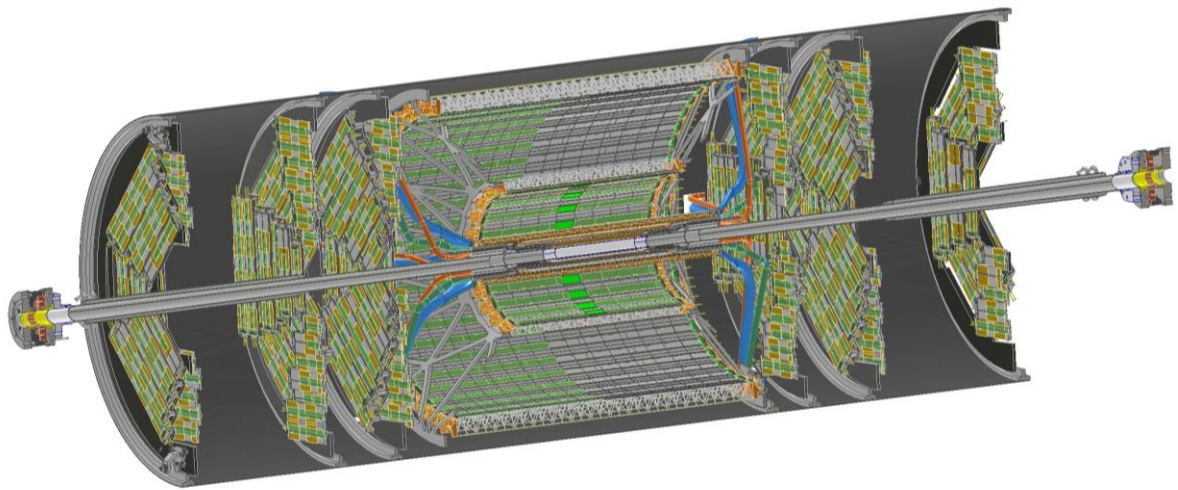
- FCC-ee’s “virtual” crab waist scheme successfully implemented in ~2020
- routine operation at FCC-ee’s  $\beta_y^* \sim 1$  mm
- beam currents  $> 1.3$  A (FCC-ee maximum current)

## issues of SuperKEKB

- complex interaction region with superimposed magnets, non-closure of optical aberrations + coil manufacturing error
- **low specific luminosity** due to residual (large) linear coupling, chromatic coupling, space charge and feedback noise
- **sudden beam loss** due to combination of special “MO” flange and use of vacuum sealant (intruding into the chamber)
- poor injection efficiency at  $\beta_y^* \sim 1$  mm, and impossibility to squeeze much further, due to **large injected beam** (huge blow up in both transfer lines):  
 SuperKEKB:  $\varepsilon_y^\mp \sim 10$  nm, FCC-ee:  $\varepsilon_y^\mp \sim 10$  pm (1000x smaller!)



# machine detector interface (MDI)



**MDI engineering design**

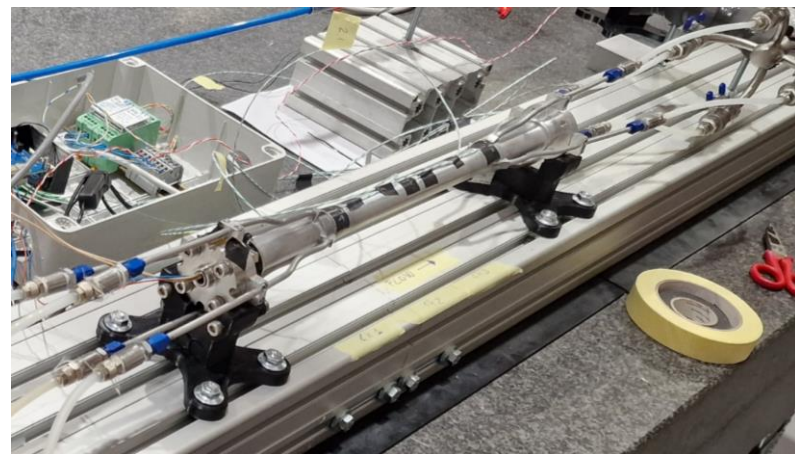
**Beam Induced backgrounds:**

- Beam Gas, injection backgrounds simulations, Touschek
- Simulation workflow for detector backgrounds in place

**Non-local Solenoid Compensation Scheme**

- closed orbit bumps and IR correctors and skew quads defined

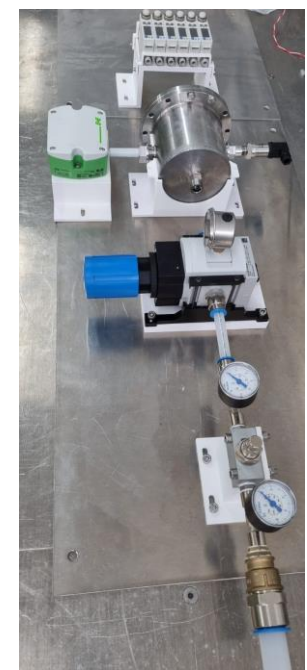
**IR magnets:** screening solenoid and correctors starting at BNL, HTS CCT magnet for QC1 starting at LAPP



**Central chamber prototype:** measurements with water as coolant successful, tests with liquid paraffin foreseen soon in Frascati



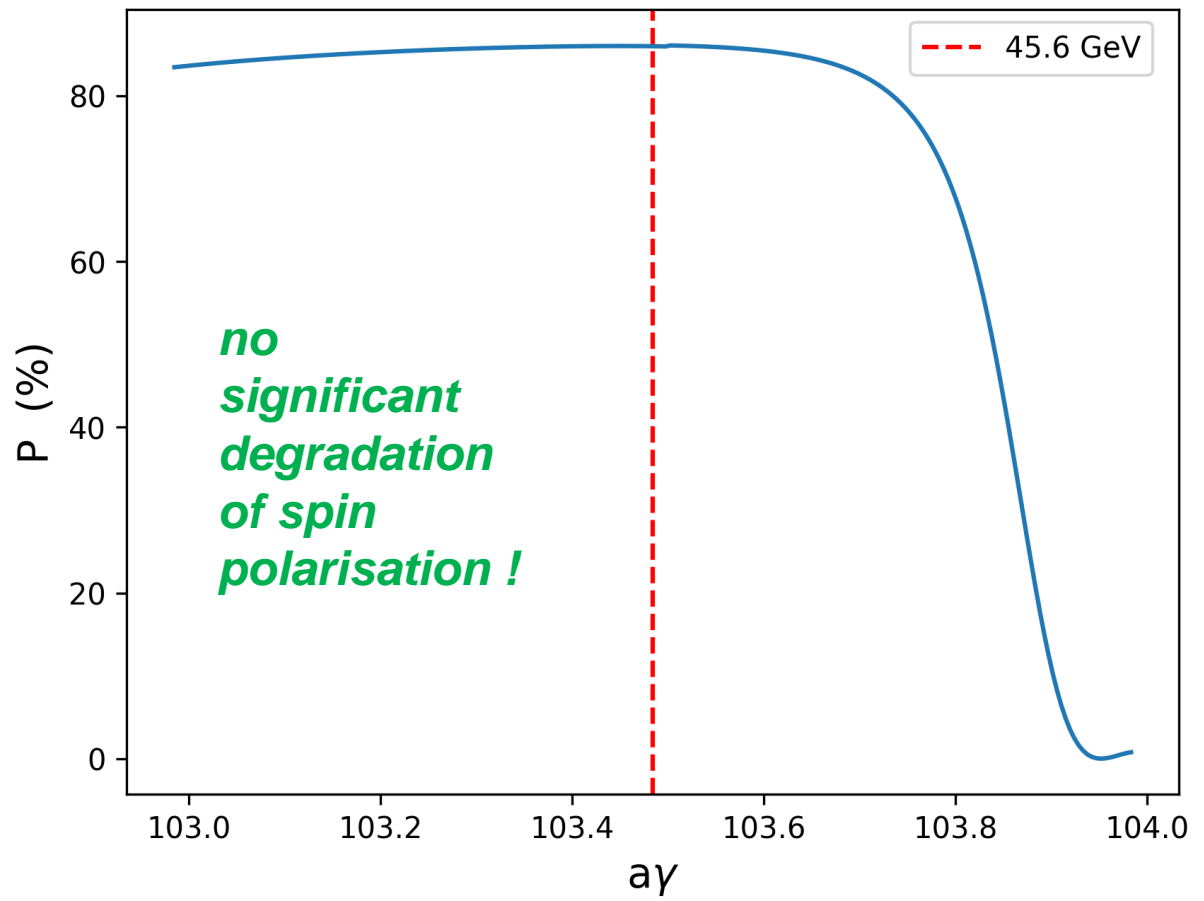
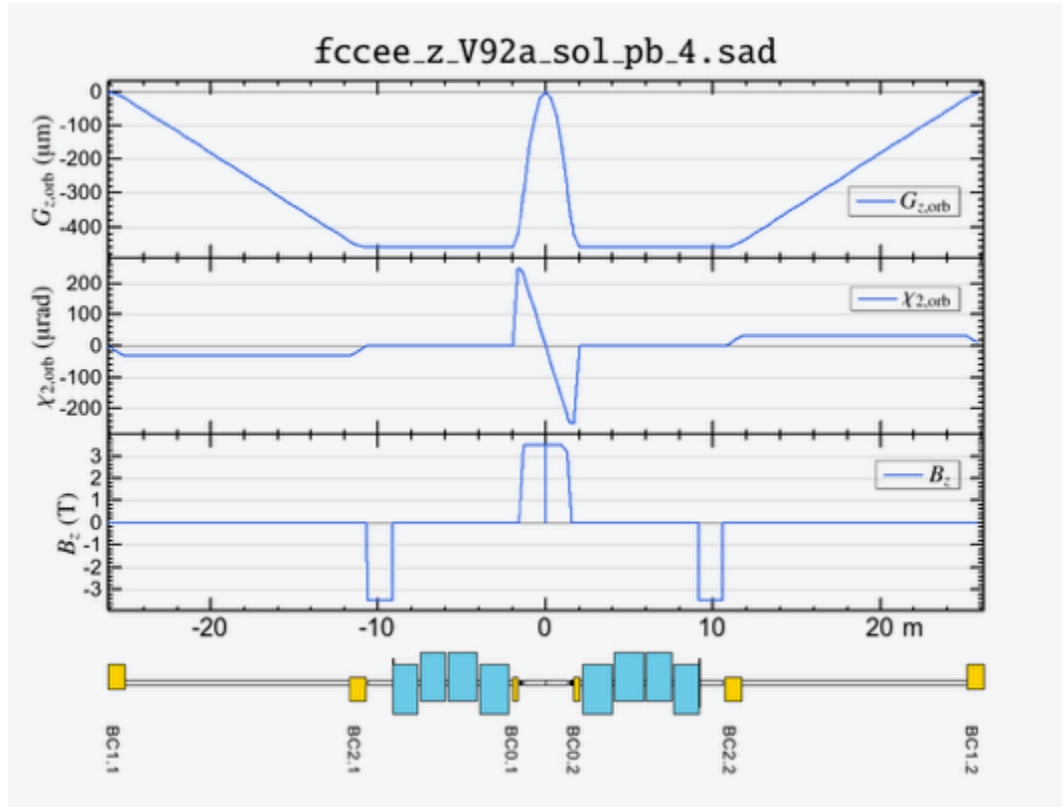
**Alignment monitoring mockup at CERN**



**Vertex air-cooling set-up** being assembled in Pisa

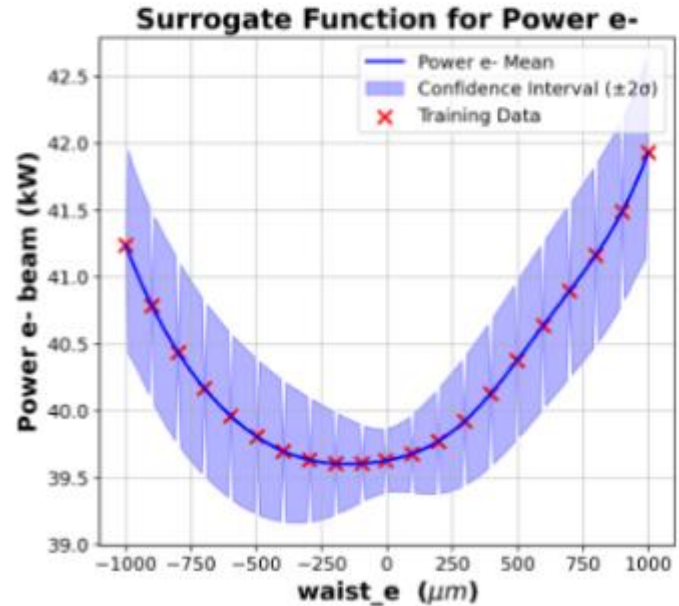
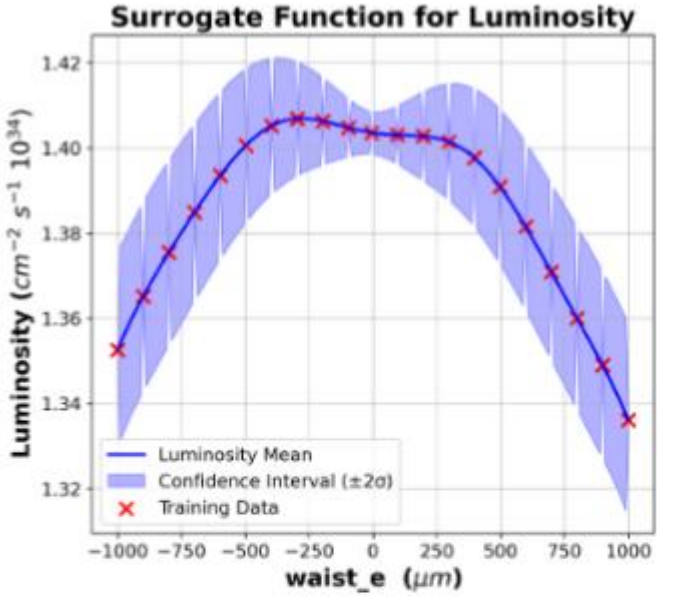
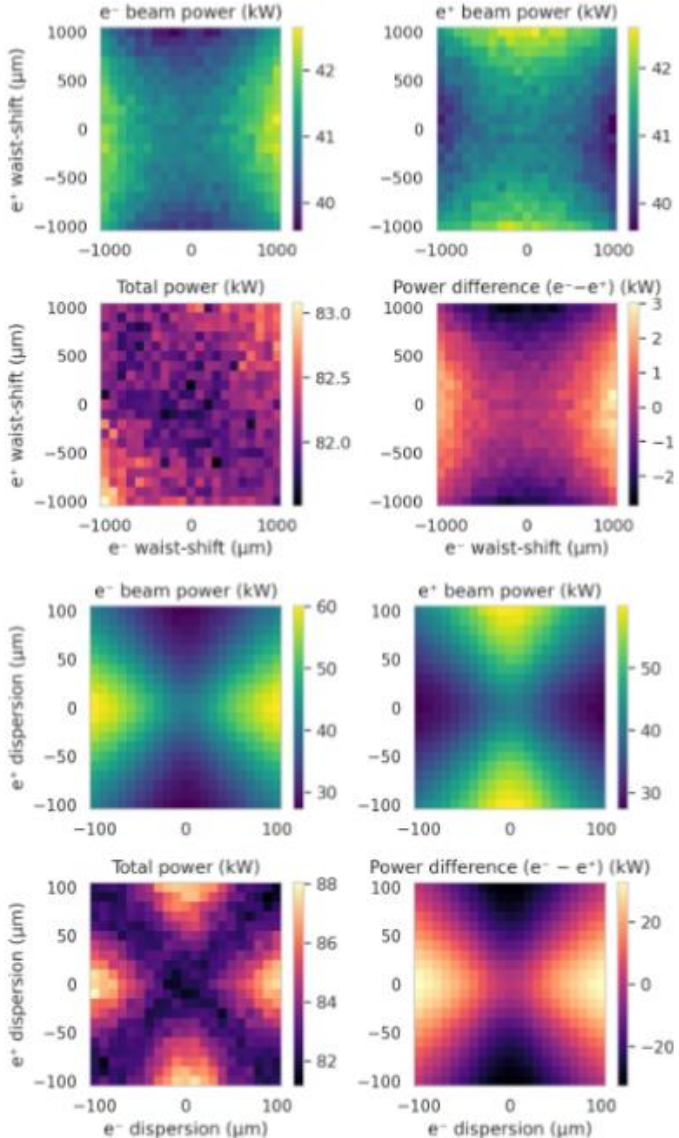
# non-local IR solenoid compensation

first order P near nominal energy

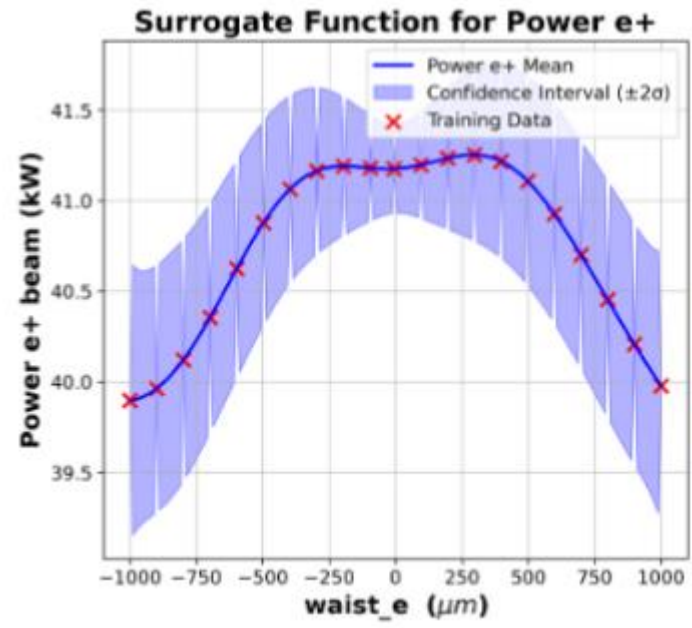


# tuning FCC-ee IP optics

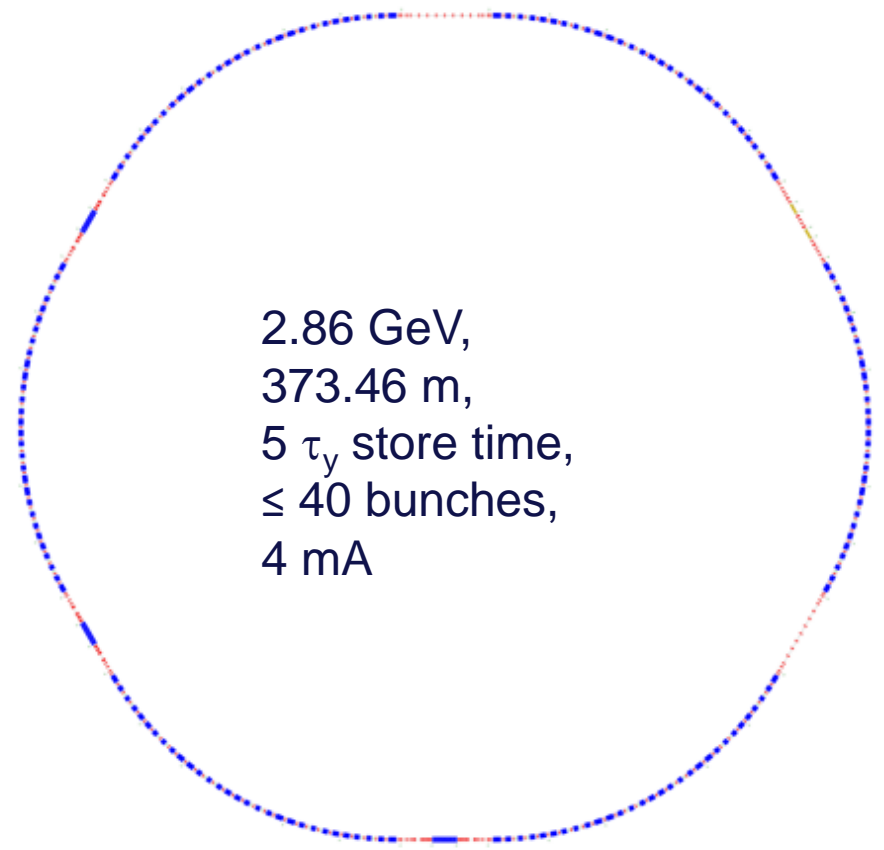
beamstrahlung  
power variations  
with residual  
waist shift and  
spurious vertical  
dispersion in  
electron  
(horizontal axis)  
and positron  
beams (vertical axis)  
for tbar  
running,  
from simulations  
with GUINEA-  
PIG



machine learning approach -  
surrogate functions computed  
for luminosity, and BS power  
from e+ and e- beams

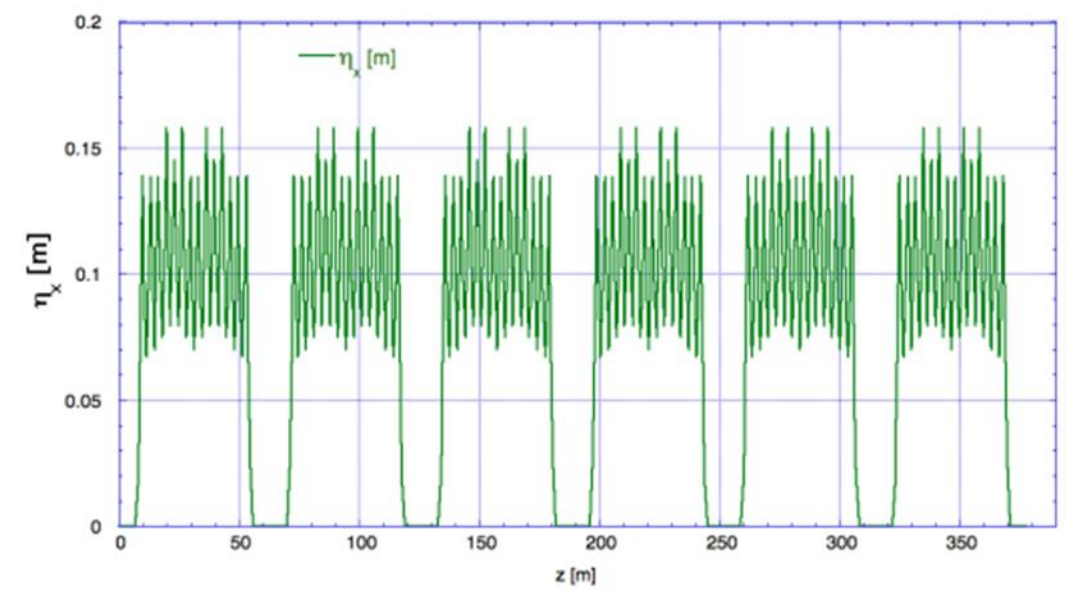
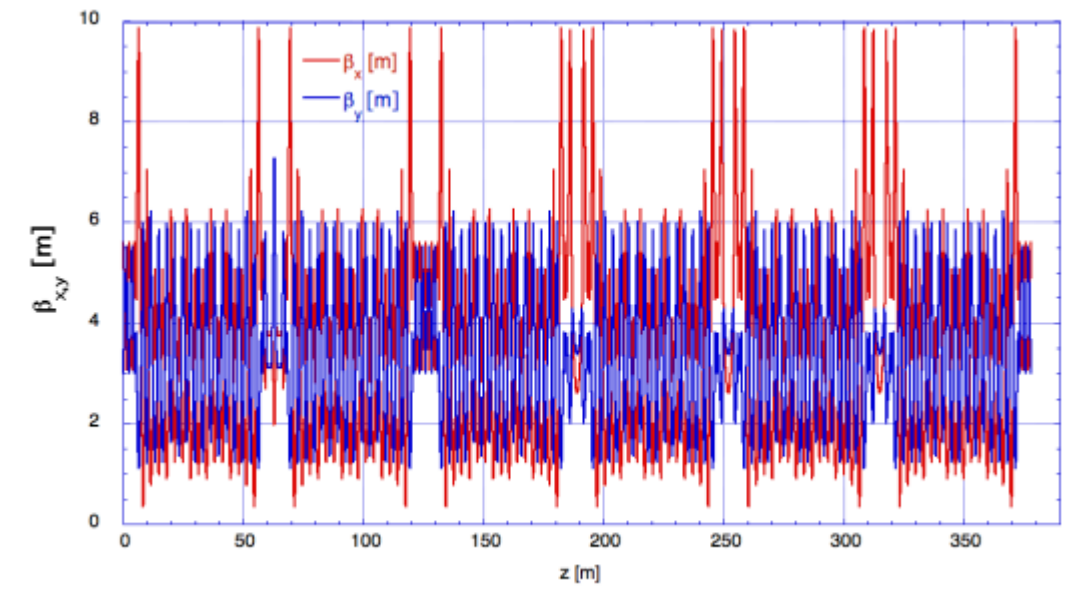
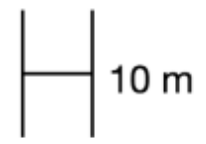


# a new damping ring



2.86 GeV,  
373.46 m,  
 $5 \tau_y$  store time,  
 $\leq 40$  bunches,  
4 mA

Damping Ring layout with six-fold symmetry



# boosting availability: polarised pilot bunches from injector

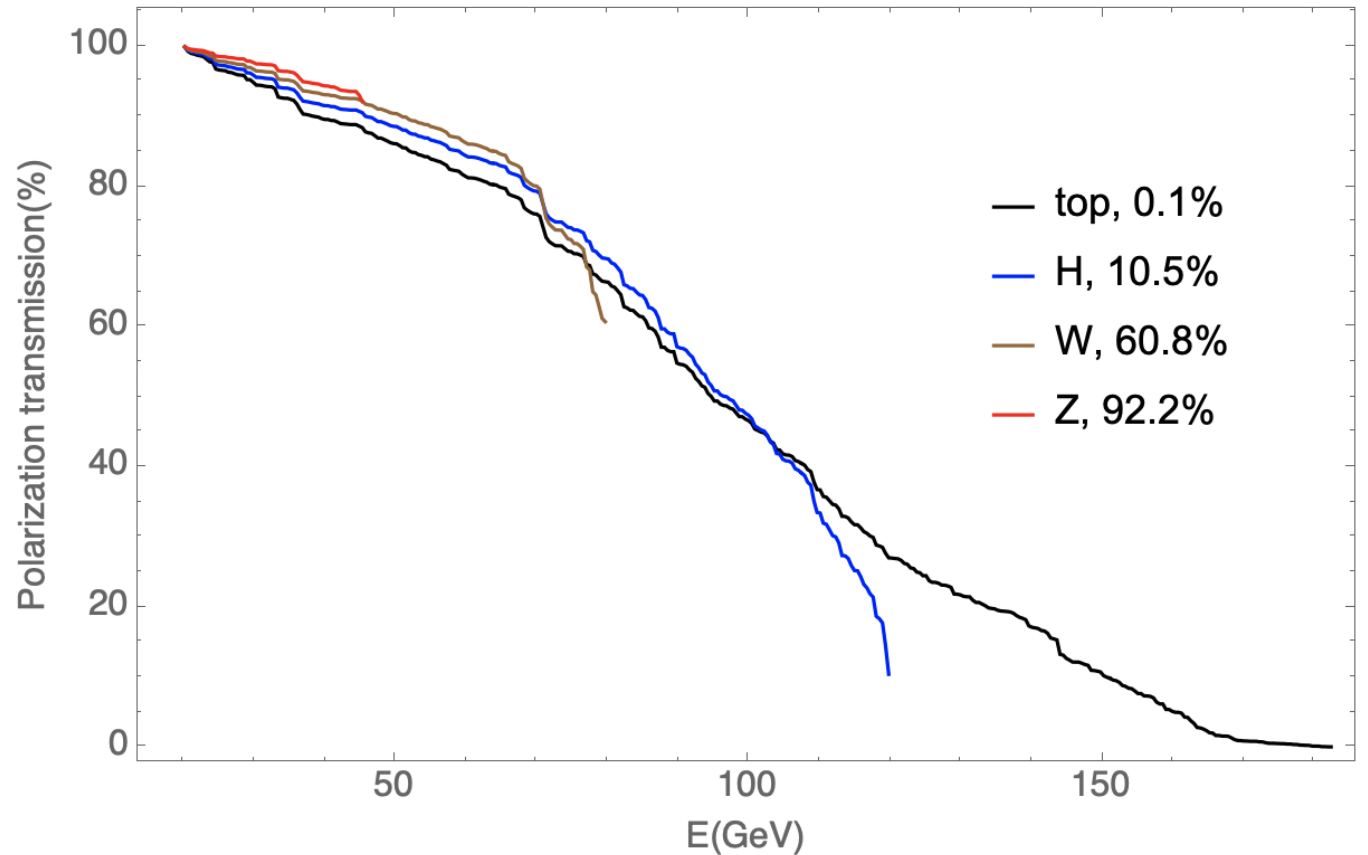
Polarised electron pilot bunches:  
polarised (dc or RF) gun

Polarised positron pilot bunches:  
polarizer ring in damping ring area

I. Koop  
2016

Energy, E	1	GeV
Circumference, C	22	m
Average radius, R	3.5	m
Bending radius, $\rho$	0.6	m
Bending field, B	5.5	T
Energy loss / turn, $U_0$	145	keV
Momentum spread, $\sigma_p$	0.00155	
Number of $e^\pm$ per bunch, N	$10^{10}$	
Number of bunches, $N_b$	16	
Total beam current, I	350	mA
SR power	50	kW
Polarization time (Sokolov-Ternov), $\tau_{ST}$	127	s
Polarization degree	70	%
Injection/Ejection time periodicity, $T_0$	10	s

Polarisation transmission in the booster with large errors – further optimisation possible



# other FCC-ee science opportunities

large circumference, high energy, abundant positron production, low-emittance beams, high-power beamstrahlung, injector complex → FCC-ee offers unique opportunities for various other fields of physics and science

## Examples:

- production of **true muonium**
- creation of a **Bose-Einstein condensate of positronium**
- **high(est)-energy photons**, Compton imaging, nuclear research etc.
- **spatially coherent photon beams**, possibly **down to 0.1 Å wavelengths**
- **higher average and peak brightness** than any existing or planned light source
- **radioactive isotope production**
- **neutron source**

## Other Science Opportunities at the FCC-ee

I. Agapov<sup>1</sup>, E.E. Alp<sup>2</sup>, K. Andre<sup>3</sup>, S. Antipov<sup>1</sup>, A. Apyan<sup>4</sup>, G. Arduini<sup>3</sup>, L. Bandiera<sup>5</sup>, H. Bartmann<sup>3</sup>, H. Bartosik<sup>3</sup>, M. Benedikt<sup>3</sup>, S. Bettoni<sup>7</sup>, J.M. Byrd<sup>2</sup>, M. Calviani<sup>3</sup>, A. Camper<sup>8</sup>, C. Carli<sup>3</sup>, S. Casalbuoni<sup>9</sup>, A. Chance<sup>10</sup>, P. Craievich<sup>7</sup>, P. Crivelli<sup>11</sup>, B. Dalena<sup>10</sup>, M. Dickmann<sup>12</sup>, M. Doser<sup>3</sup>, I. Drebot<sup>13</sup>, C. Duchemin<sup>3</sup>, K. Dupraz<sup>14</sup>, S.J. Freeman<sup>3,15</sup>, A. Frasca<sup>3,16</sup>, F. Gunsing<sup>11,17</sup>, J. Jäckel<sup>18</sup>, B. King<sup>19</sup>, M.W. Krasny<sup>20</sup>, A. Lechner<sup>3</sup>, C.A. Lindstrøm<sup>8</sup>, A. Mazzolari<sup>5,6</sup>, C. Milardi<sup>21</sup>, E. Musa<sup>1</sup>, R. Negrello<sup>5,6</sup>, F. Nguyen<sup>22</sup>, K. Oide<sup>23</sup>, Y. Papaphilippou<sup>3</sup>, G. Paternò<sup>5</sup>, V. Petrillo<sup>24</sup>, K. Piotrkowski<sup>25</sup>, B. Rienäcker<sup>16</sup>, G. Schnell<sup>26,27</sup>, C. Schroer<sup>1</sup>, I. Schulthess<sup>1</sup>, L. Serafini<sup>13</sup>, V. Shiltsev<sup>28</sup>, M. Stapanoni<sup>7,11</sup>, A. Variola<sup>29</sup>, T. Watson<sup>3</sup>, H.-U. Wienands<sup>2</sup>, M. Wing<sup>30</sup>, and F. Zimmermann\*<sup>3</sup>

<sup>1</sup>Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

<sup>2</sup>Argonne National Laboratory, Lemont, Illinois, United States of America

<sup>3</sup>European Organization for Nuclear Research (CERN), Geneva, Switzerland

<sup>4</sup>A.I. Alikhanyan National Laboratory, Yerevan, Armenia

<sup>5</sup>INFN Ferrara, Ferrara, Italy

<sup>6</sup>University of Ferrara, Ferrara, Italy

<sup>7</sup>PSI, Villigen, Switzerland

<sup>8</sup>University of Oslo, Oslo, Norway

<sup>9</sup>European XFEL, Hamburg, Germany

<sup>10</sup>CEA, Saclay, France

<sup>11</sup>ETH Zürich, Zürich, Switzerland

<sup>12</sup>University of the Bundeswehr Munich, Neubiberg, Germany

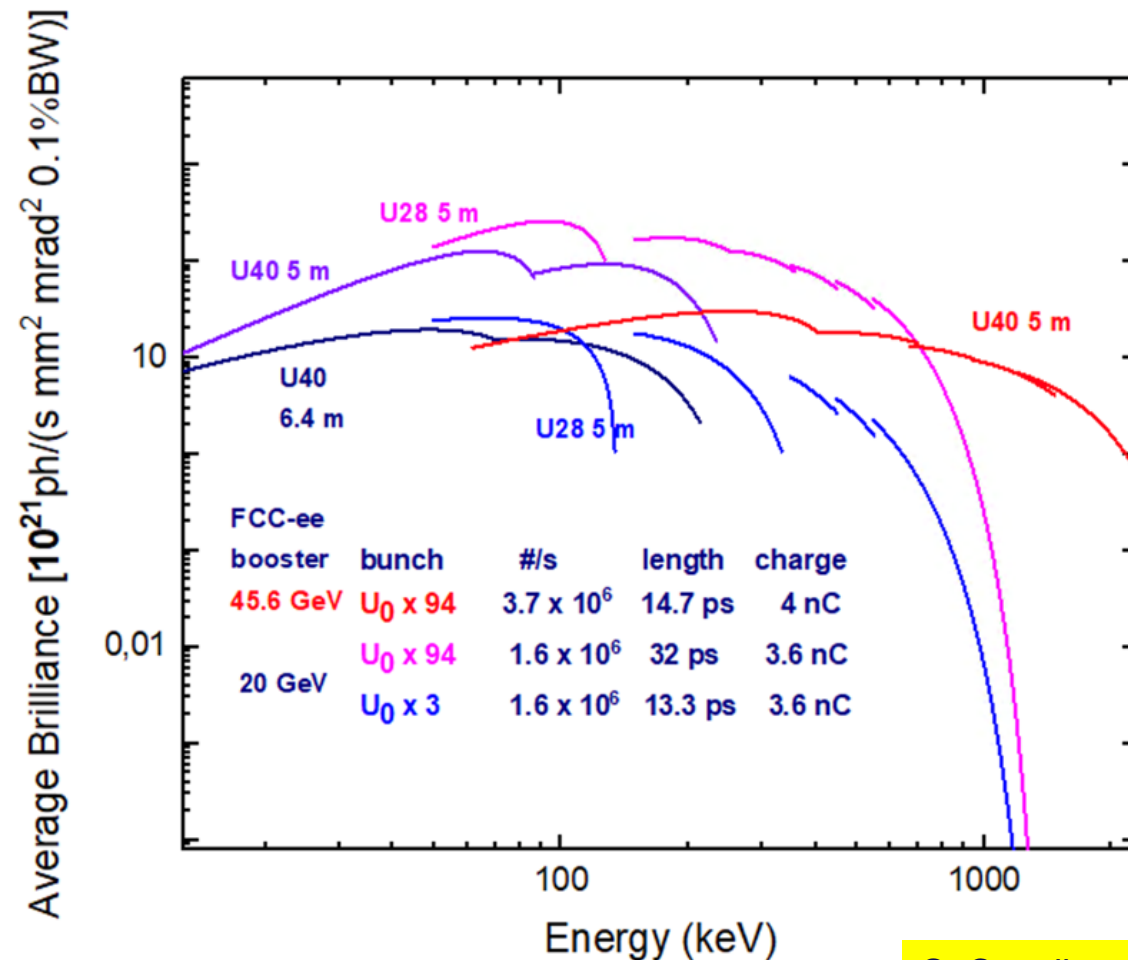
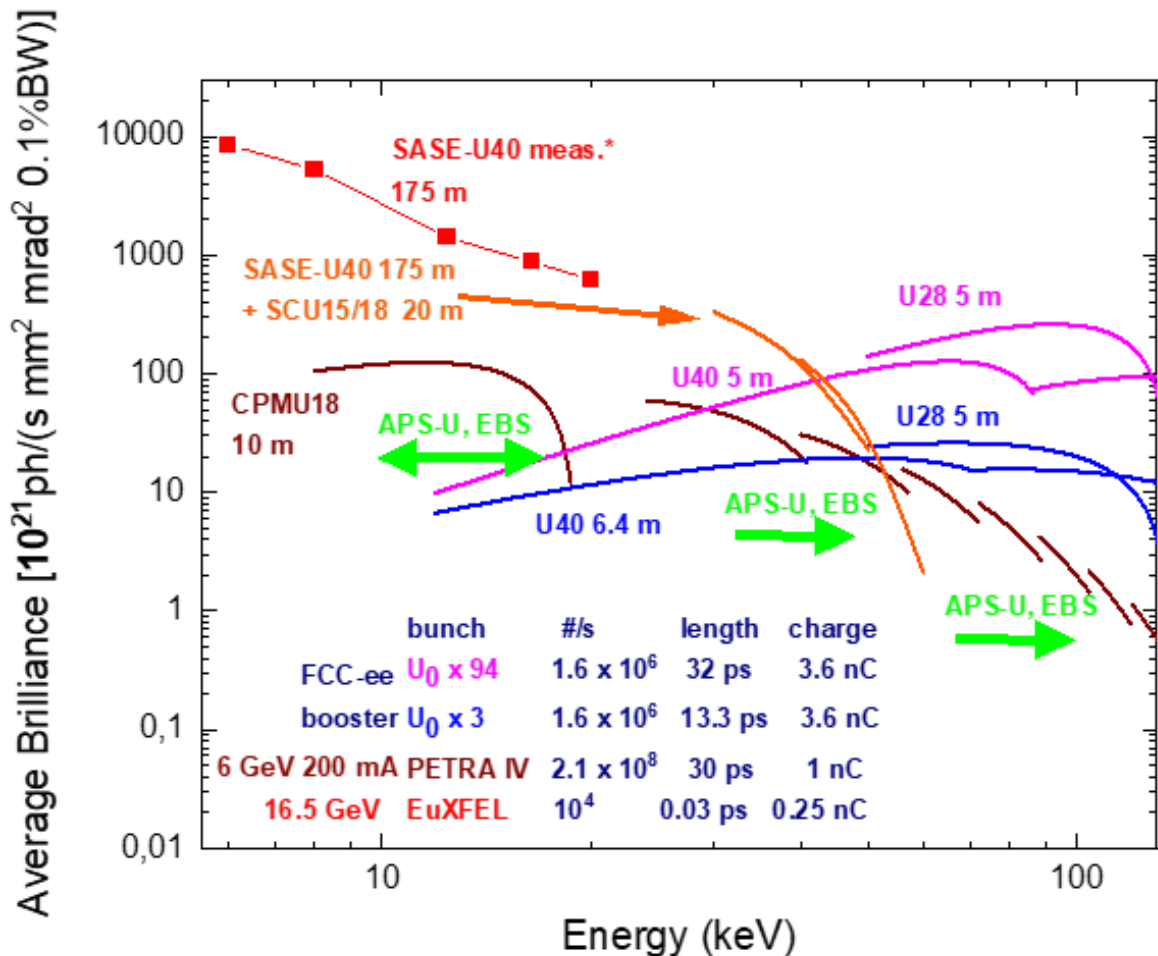
<sup>13</sup>INFN Milano, Milano, Italy

<sup>14</sup>IJCLab, Orsay, France

..

CERN-FCC-ACC-2025-0005,  
doi: [10.17181/CERN.BSP4.H8ED](https://doi.org/10.17181/CERN.BSP4.H8ED)

# FCC-ee booster as unique ultimate photon source



S. Casalbuoni

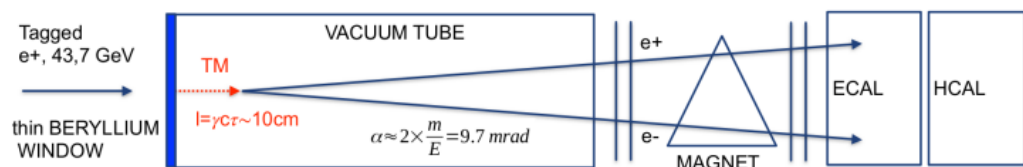
case for ≥20 GeV storage-ring light source: PRAB 28, 024401 (2025); arXiv:2505.11022 (last week!)

*“we argue that achieving further significant emittance reduction and increase in radiation brightness is only possible by increasing the beam energy”*

I. Agapov  
S. Antipov

# producing true muonium – a world’s first !?!

assuming  $\Delta E \sim 44$  MeV, one can expect to produce around 1 TM atom per  $4.4 \times 10^{13}$  positrons.

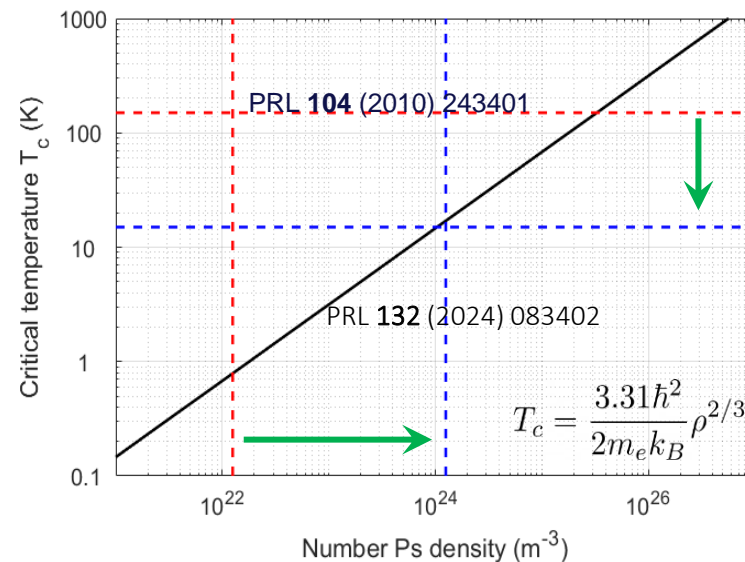


Simplified layout of the experimental set-up

with estimated rates the properties of the bound state could be studied

# Bose-Einstein condensate of Ps – also world’s first

A positronium density of  $10^{15} \text{mm}^{-3}$  is necessary for forming a BEC. Current e+ sources cannot reach that !



When a Ps-BEC annihilates, a coherent burst of gamma rays is emitted.

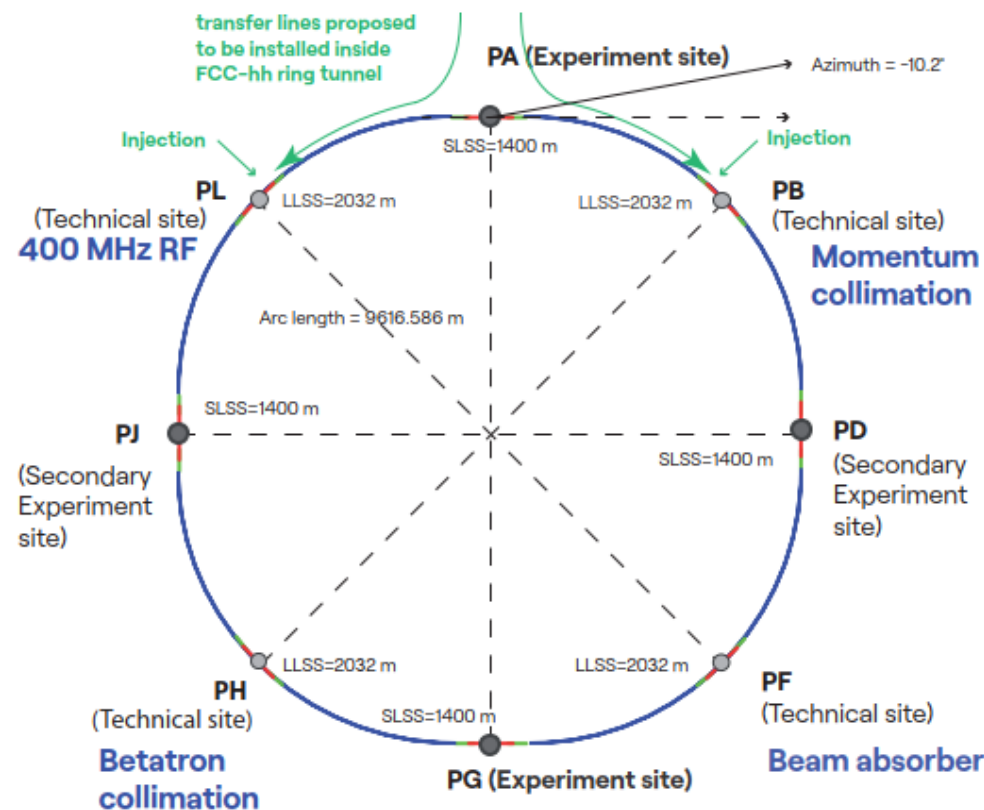
A proposed way to build a 511 keV gamma ray laser!

# FCC-hh parameters & layout

## Main parameters FSR 2025

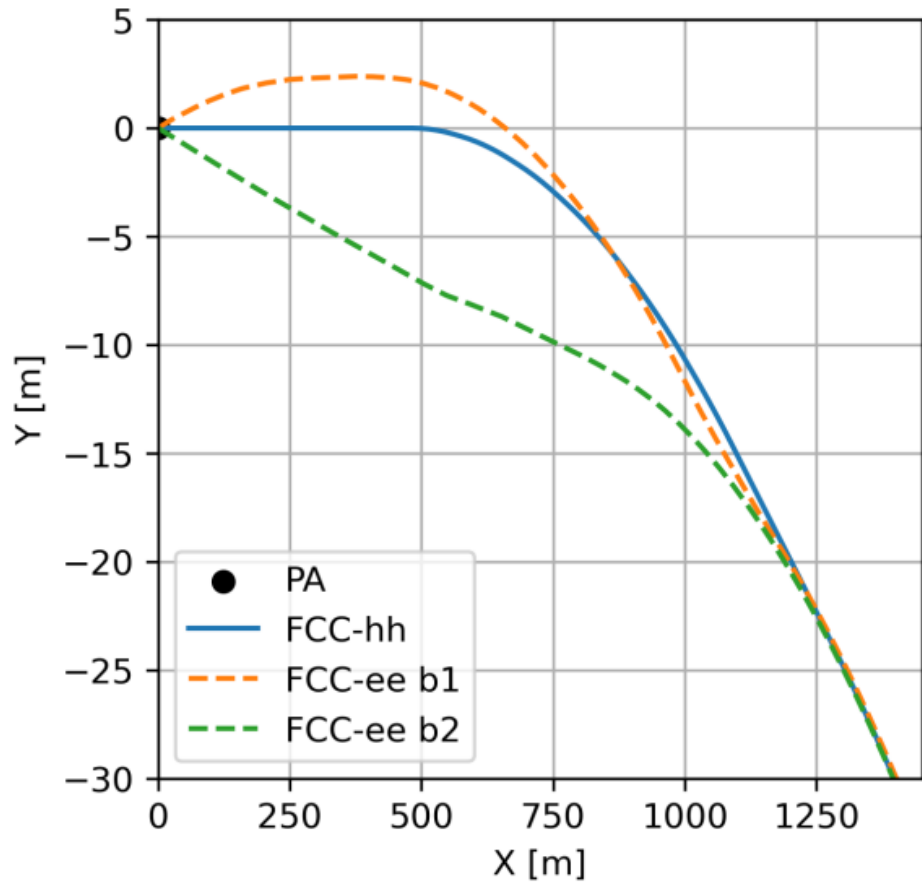
## FCC-hh functional layout

parameter	FCC-hh	FCC-hh CDR	HL-LHC
collision energy cms [TeV]	<b>85</b>	<b>100</b>	14
dipole field [T]	<b>14</b>	<b>16</b>	8.33
circumference [km]	<b>90.7</b>	<b>97.8</b>	26.7
beam current [A]	<b>0.5</b>	<b>0.5</b>	1.1
synchr. rad. per ring [kW]	<b>1200</b>	<b>2400</b>	7.3
peak luminos. [ $10^{34} \text{ cm}^{-2}\text{s}^{-1}$ ]	<b>30</b>	<b>30</b>	5 (lev.)
events/bunch crossing	<b>1000</b>	<b>1000</b>	132
stored energy/beam [GJ]	<b>6.5</b>	<b>8.3</b>	0.7
integr. luminosity / IP [ $\text{fb}^{-1}$ ]	<b>20000</b>	<b>20000</b>	3000

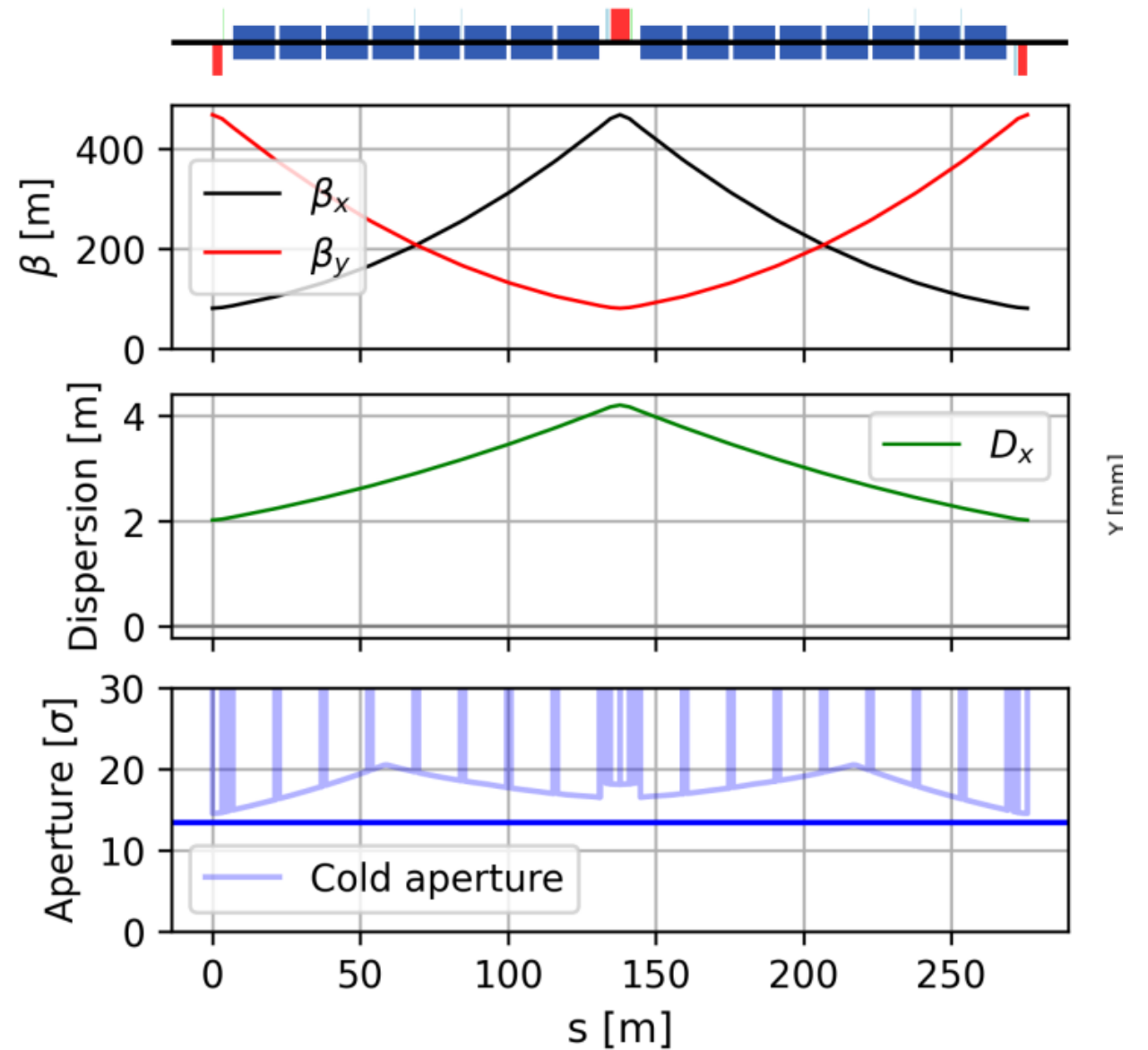


- Parameter optimization towards “acceptable power consumption” (~max. consumption of FCC-ee)
- Magnetic field considered realistic with today’s technologies ( $\text{Nb}_3\text{Sn}$ , ~14T)

# FCC-hh layout & optics



geometry of FCC-hh and FCC-ee at PA



16-dipole periodic arc FODO cell



## conclusion - fantastic progress and more to come

- **relaxed alignment tolerances**; good dynamic aperture & momentum acceptance with errors, **top-up injection efficiency including collision >90%**
- **Xsuite framework** extended to needs of FCC-ee & lepton colliders; SuperKEKB benchmarks
- **RF reverse phase operation**

*next / ongoing:*

- definition of **new baseline FCC-ee optics by March 2026**
- **adding spin polarisation** in Xsuite – **DONE !**
- **generating polarised pilot bunches** in the injector complex & spin transport to colliders
- further **complete the impedance model; finalize damping ring design**
- **study the interaction of dust / macroparticles** with FCC-ee beams
- **beam tests** of  $e^+$  production at SwissFEL P3 experiment

<b><u>Tuesday</u> - FCC-ee baseline optics,</b> chair: Ilya Agapov/DESY, 8h30-10h00
<b>Update on the GHC optics,</b> Katsunobu Oide/U Geneva
<b>Top-up injection status and studies,</b> Yann Dutheil/CERN
<b>Numerical tools for beam-beam effects,</b> Peter Kicsiny/CERN
<b>Collimation studies for FCC-ee,</b> Giacomo Broggi/Sapienza
<b>FCC-ee Alternative Optics,</b> chair Angeles Faus-Golfe/IJCLab, 10h30-12h00
<b>Alternate Optics for the FCC-ee,</b> Kevin Andre/ESRF
<b>GHC vs LCC design concepts and next steps for pre-TDR,</b> Ghislain Roy/CERN
<b>Xsuite evolution for FCC studies,</b> Giovanni Iadarola/CERN
<b>Nested magnets &amp; ballistic optics for FCC-ee,</b> Cristobal Garcia/EPFL
<b>Spin polarization in the EIC electron storage ring,</b> Yunhai Cai/SLAC
<b>FCC accelerators: Tuning and Operations,</b> chair: Rogelio Tomas/CERN, 13h30-15h00
<b>Correction &amp; tuning strategies,</b> Jacqueline Keintzel/CERN
<b>Optics tuning simulations for FCC-ee lattices,</b> Elaf Musa/DESY
<b>Integrated simulations for calculation of tolerances,</b> Kyriacos Skoufaris/CERN

<b>BBA for FCC-ee and Beam Test at KARA,</b> Christian Goffing/KIT
<b>IR alignment and Xsuite migration,</b> Satya Sai J./U Geneva
<b><u>Still Tuesday</u> - FCC-ee collective effects,</b> chair: Lenny Rivkin / PSI, 15h30-17h00
<b>Overview on collective effects for the main rings,</b> Mauro Migliorati/Sapienza
<b>Main rings impedance budget,</b> Carlo Zannini/CERN
<b>Impact of Collimators' Geometric Impedance on Beam Stability,</b> Dora Gibellieri/U Caen
<b>Beam-Beam and Wakefield-Induced Collective Instabilities and Mitigation Strategies,</b> Roxana Soos/U Paris-Saclay
<b>Electron-cloud effects and possible mitigations strategies,</b> Luca Sabato/EPFL
<b>Beam-Beam effects in presence of errors: results and strategies,</b> Leon Van Riesen-Haupt/EPFL

**20 talks on Tuesday**

<b><u>Wednesday</u> – FCC-ee injector: Overview</b> , chair: Mark Boland/CLS , 8h30-10h00
<b>Injector Overview and Outlook</b> , Paolo Craievich/PSI
<b>Update on the filling schemes</b> , Hannes Bartosik/CERN
<b>Positron production for FCC-ee</b> , Iryna Chakovska/IJCLab
<b>Positron target design, fabrication – updates on P3 integration</b> , Ramiro Mena Andrade/CERN
<b>FCC-ee top-up operation: photocathodes and laser systems</b> , Eduardo Granados/ CERN
<b>Injector linacs and damping rings</b> , chair: John Seeman/SLAC, 10h30-12h00
<b>New damping ring at 2.86 GeV</b> , Antonio De Santis/INFN-LNF
<b>Approach for low impedance design of the FCC-ee vacuum chamber</b> , Shalva Bilanishvili/INFN-LNF
<b>Linac Design and RF frequency choices for the TDR</b> , Alexej Grudiev/CERN
<b>Linac design for single and multi-bunch effects</b> , Simona Bettoni/PSI
<b>RF-Track development for FCC-ee injector studies</b> , Andrea Latina/CERN

15 talks on Wednesday

<b>Booster and transfer lines</b> , chair: Jörg Wenninger/CERN, 13h30-15h00
<b>Overview of the booster status</b> , Antoine Chance/CEA
<b>Updates on FCC-ee High Energy Booster collective effects studies</b> , Adnan Ghribi/GANIL
<b>Status and perspectives of the emittance tuning of the FCC-ee High Energy Booster ring</b> , Quentin Bruant/CEA
<b>Injection/extraction systems across the FCCee complex</b> , Sen Yue/CERN
<b>Swap-out injection with beam recycling in the booster: design and commissioning at the High Energy Photon Source</b> , Zhe Duan/IHEP
<b><u>Thursday</u>– MDI #1</b> , chair: Fabrizio Palla/INFN Pisa, 08h30-10h00
<b>MDI activities and IR mock-up status</b> , Manuela Boscolo/INFN
<b>MDI alignment monitoring</b> , Leonard Watrelot/CERN
<b>FCC-ee HTS CCT magnet design proposal for the last final focus quadrupole</b> , Laurent Brunetti/LAPP
<b>MDI efforts at BNL: Corrector Magnets and Screening Solenoid design for Interaction region of FCC-e</b> , Vikas Teotia/BNL
<b>Integration of vertex detector services &amp; cooling</b> , Gherardo Ammirabile/INFN Pisa

**Still Thursday**— MDI #2, chair: Angelika Drees/BNL, 10h30-12h00

**First look at injection backgrounds**, Giulia Nigrelli/Sapienza

**IR beam losses and MDI collimators**, Giacomo Broggi/Sapienza

**TID and Fluence in the detector and IR**, Alessandro Frasca/CERN

**Update on IR HOM evaluations**, Alexander Novokhatski/SLAC

**Joint with PED: EPOL I**,  
chair: Anke-Susanne Müller/KIT 13h30-15h00

**Beam Polarisation studies: status and challenges**, Yi Wu/EPFL

**Development of spin tracking in XSuite**, Kiel Hock/BNL

**Inverse Compton polarimeter design**, Robert Kieffer/ CERN

**Inverse Compton polarimetry simulations**, Juba Tamazirt/IJCLab

**Joint with PED: EPOL II**,  
chair: Alain Blondel/U Geneva, 15h30-17h00

**Studies towards a depolariser design**, Wolfgang Höfle/CERN

**Polarized electron sources in Linacs**, Kurt Aulenbacher/JGU Mainz

**Polarization status at the EIC**, Kiel Hock/BNL

**Injecting polarized beams**, Jorg Wenninger/CERN

**FCC-hh accelerator: baseline & cryogenics**  
chair: Vladimir Shiltsev/NIU, 10h30-12h00

**Feasibility Study Baseline Layout and Prospects for FCC-hh**, Gustave Perez Segurano/U Malta

**Hybrid REBCO-Cu coating for the FCC beam screen to achieve low surface impedance and high magnetic field homogeneity**, Dr Joffre Gutierrez Royo/ICMAB-CSIC

**TI-1223 Superconducting Films for Beam Screen Coatings in FCC: Synthesis and Performance Validation**, Emilio Bellingeri/CNR-SPIN

**Cryogenic baseline and advancements on the 4.5 K option for FCC-hh using Nb3Sn magnets**, Patricia Borges de Sousa/CERN

21 talks on  
Thursday

**Still Thursday – Poster session | accelerator related posters**

chair Frank Zimmermann/CERN

**Quasi-Strong-Strong Beam-Beam Simulation with Full Lattice for Bootstrapping Injection into FCC-ee Collider**, Takashi Mori/KEK

**FCC-ee injector experiments at FACET-II**, Brendan O'Shea/SLAC

**RF Design and Optimization of the High-Energy Linac for the FCC-ee Injector Complex**, Adnan Kurtulus/CERN

**Design Aspects of the Arc Beam Position Monitors of the FCC-ee**, Emily Rose Howling/Oxford

**Enhanced Nb/Cu Film Morphology via HiPIMS for Superconducting Accelerators**, Flyura Djurabekova, Milad Ghaemikerman/U Helsinki

**Impact of powder granulometry on the transport properties of Ba122 superconducting tapes**, Emilio Bellingeri/CNR-SPIN

**Exploration of Non-Linear FCC-ee Optics**, Patrick Hunchak/U Saskatoon

**Updated monochromatization Interaction Region optics design for FCC-ee GHC lattice**, Anna Korsun/U Paris Saclay

**AI techniques to improve optics measurements based on the Turn-by-turn Beam Position Monitors**, Quentin Bruant/CEA

**Beam dump transfer line design in FCC-ee**, Sen Yue/CERN

**Vibrational study of the booster and collider supporting system** Audrey Piccini/CERN

**Beam Loss Monitoring simulations for the FCC-ee**, Fabian Titz/TU Vienna

**Septa developments for FCC-ee Booster and Collider**, Lucien Porta/U Geneva

**Radiation damage study of the FCC-ee crystal-based positron source**, Fahad Alharti/IJCLab

**Synchrotron Radiation Diagnostics for Transverse Profile Measurements at FCC-ee**, Daniele Butti/CERN

**Coherent plane ground wave impact on the FCC-ee beam centroid**, Mael Le Garrec/LAPP

**16 posters on  
Thursday**

**“We must not wait for things to come...  
If we want it, we must do something about it.”**

Erwin Schrödinger

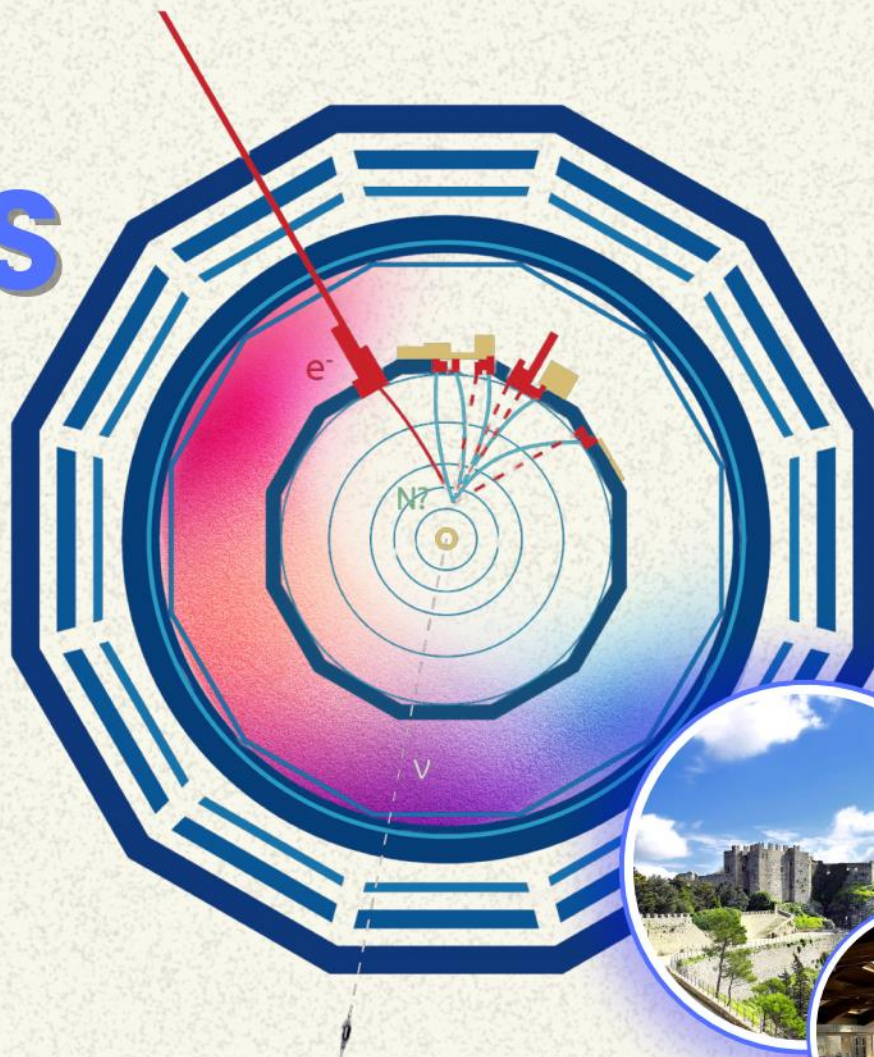
\*Vienna, †Vienna

In *What is life?*, based on 1943 lectures at  
Dublin Institute for Advanced Studies at Trinity College

# HIGGS FACTORIES FOR THE POST HILUMI ERA

**26 NOV- 1 DEC  
2025**

ETTORE MAJORANA  
FOUNDATION, ERICE



**ERICE ACCELERATOR SCHOOL**  
(DIRECTORS: LUCIO ROSSI, THOMAS TAYLOR)  
ORGANIZED WITH AND SUPPORTED BY INFN

**DIRECTORS OF THIS 2025  
ACCELERATOR COURSE:**  
MASSIMO FERRARIO, INFN-LNF,  
LUCIO ROSSI, UNIVERSITY OF MILANO  
AND INFN-MI-LASA  
FRANK ZIMMERMANN, CERN

**STUDENT FEE: 1000 EURO**  
IT INCLUDES REGISTRATION, FULL BOARD  
AND TRANSPORTATION FROM PALERMO  
AND TRAPANI AIRPORTS  
TO ERICE AND BACK

**DETAILS AND REGISTRATION**



contact: [lucio.rossi@mi.infn.it](mailto:lucio.rossi@mi.infn.it), [stefano.sorti@mi.infn.it](mailto:stefano.sorti@mi.infn.it)

