Progress of ILPS in 2006

D. Schulte

Remarks

- Activity report
  - Not enough time to really discuss results
  - Many studies are being finalised for EPAC or Valencia
- There were quite some highlights in ILPS
  - I had a hard time to chose
  - And finally did chose the BDS alignment (Glen White)

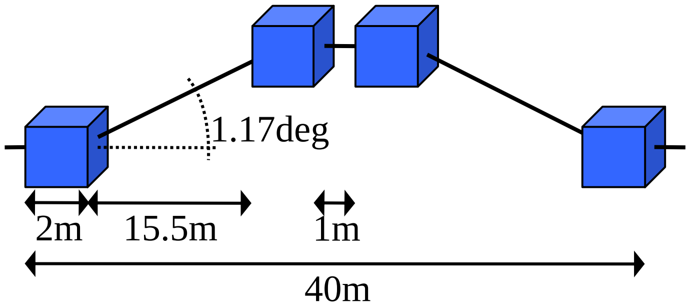
ILPS Tasks

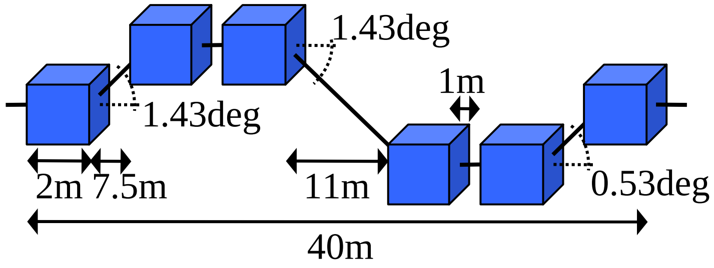
- LAST, luminosity and alignment studies
  - Develop codes, understand imperfection models, develop alignment, feedback and tuning strategy, integrate studies
- COLSIM, collimation simulations
  - Develop codes and study/optimise collimation
- FMSIM, failure mode simulations
  - Determine relevant modes and study them
- BBSIM, beam-beam simulation code developement
  - Benchmarking/improvement, e.g. spin tracking
- HTGEN, halo and tail generation
  - Provide realistic tail/halo models
- BCDES, bunch compressor design (CLIC)
- PCDL, post collision diagnostics line
  - Diagnostics potential in post collision line
  - Develop line for CLIC

Second CLIC Main Linac Bunch Compressor

Two options:

PCDES





Initial twiss functions have been optimised:

$\beta_x \approx 90$m $\alpha_x \approx 2.2$ | $\beta_x \approx 72$m $\alpha_x \approx 2.2$

Horizontal synchrotron emittance growth:

$\Delta\varepsilon_x \approx 20$ nm rad | $\Delta\varepsilon_x \approx 10$ nm rad

ISR good, CSR good | ISR worse, CSR better

no vertical ISR and CSR emittance growth

- both layouts are within specification: $\Delta\varepsilon_x < 30$ nm rad
- results obtained with 1D CSR simulations using CSRTrack and Elegant
- results confirmed by 2D CSR simulations using CSRTrack
- final decision has to depend on other criteria: e.g. error tolerances, ...

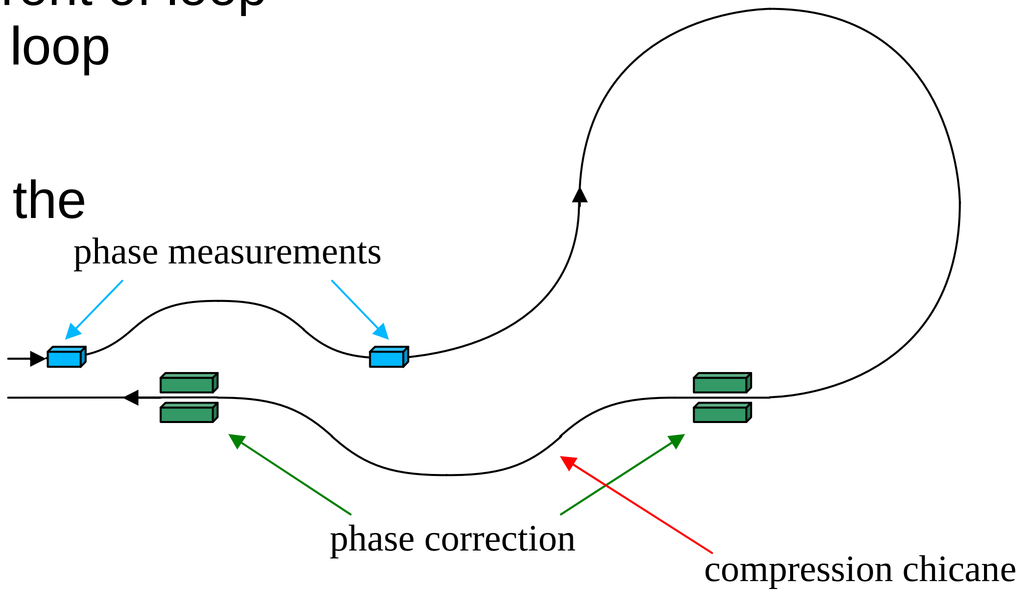
Marco Pedrozzi, Frank Stulle (PSI)

CLIC Drive Beam Turn Around Loop and Chicane

Purposes:
  compress bunch from 4 mm to 0.4 mm
  measure phase and energy in front of loop
  and correct phase error behind loop

Task:
  study CSR emittance growth in the
chicanes and the loop

Goal:
  emittance growth smaller than
50 mm mrad



First tests show:
  emittance goal is achievable

But still several open questions:
  loop length (delay time for phase correction)
  kicker requirements (kick strength for path length tuning)
  minimum possible bunch length in loop (CSR emittance growth)
  overall layout (where to compress, where to correct)
  ...

Beam Beam SIMulation task - 1

P. Bambade, G. Le Meur, C. Rimbault, F. Touze (LAL), D. Schulte (CERN)

- Pair backgrounds study in GUINEA-PIG, CAIN and BDK

  EUROTeV-Report-2005-016

  PRSTAB 9, 034402 (2006)

- Beam-beam effect on Bhabha scattering and impact on luminosity determination with GUINEA-PIG

  Ongoing collaboration with The Forward CALorimetry Group

  Participation to Status Report Desy PRC R&D 02/01

  Finalization: 06/06.

- Spin depolarization implementation in GUINEA-PIG

  To be started Summer 2006.

  Publication in 2007

- Extension of phase space for minijet production and tests in GUINEA-PIG

  To be started only in 2007.

Beam Beam SIMulation task - 2

- Web documentation & Version manager

  http://flc.lal.in2p3.fr/mdi/BBSIM/bbsim.html "official" GP support

  http://svn.lal.in2p3.fr/WebSVN/GuineaPig "official" GP repository

  – GUINEA-PIG version updated with Bhabha deflection treatment:

    http://svn.lal.in2p3.fr/WebSVN/GuineaPig/gp/tags/v1/

    Input: external Ascii file with Bhabha event 4-vectors.

    See user notes in GP support web page ; please feedback any remarks.

  – β version of object (re)oriented GUINEA-PIG (C++). Please test it !

    http://svn.lal.in2p3.fr/WebSVN/GuineaPig/guineapigPP/tags/v0/

    (Partial implementation: check implementation notes for details)

- Finalize C++ implementation in parallel with continued development of standard GP version.
- Investigation of GP parallelization
- Technical documentation notes : 2007

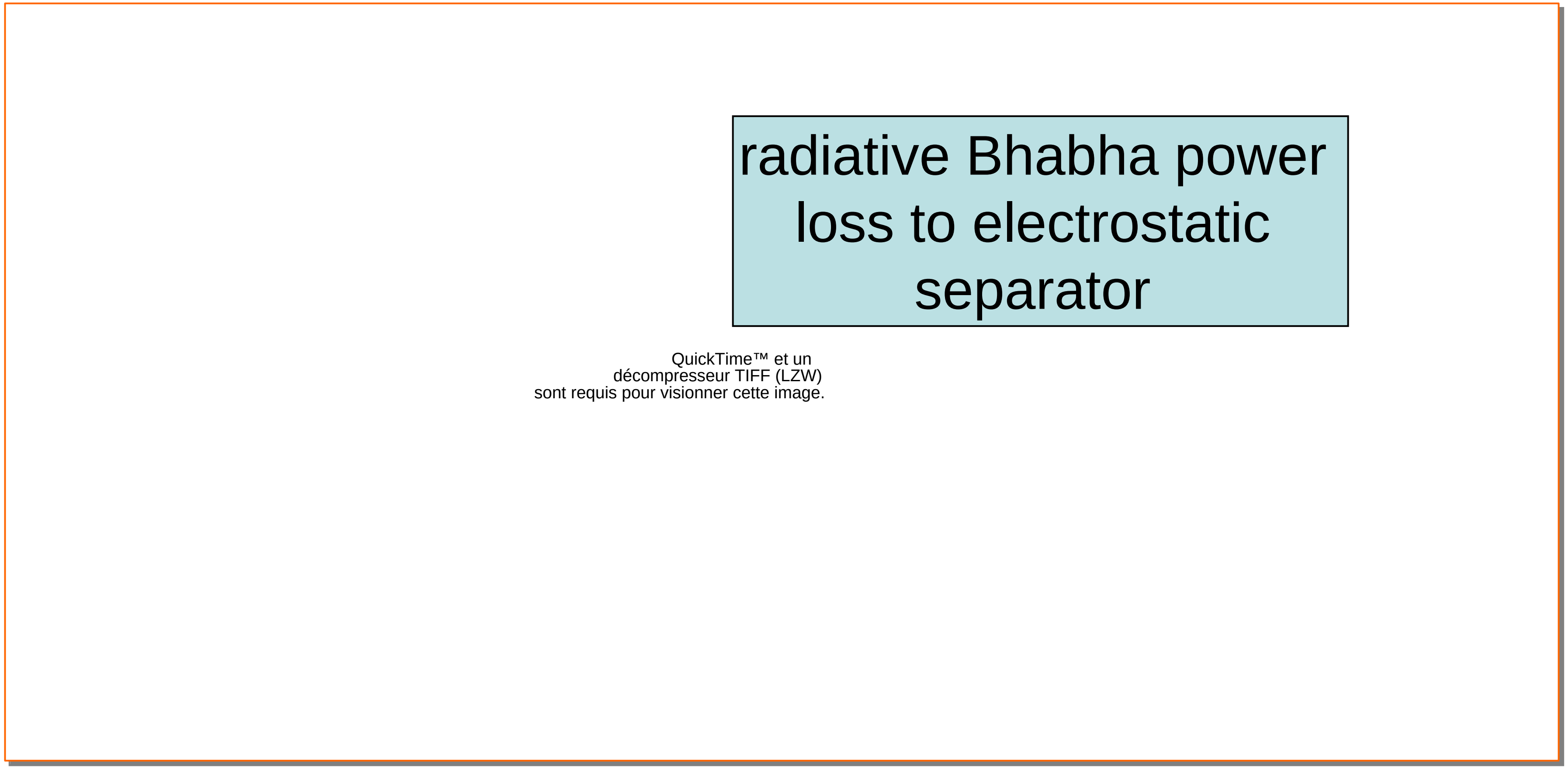
Post Collision Dump Line Activities at LAL

P. Bambade, O. Dadoun & B. Mouton (LAL)

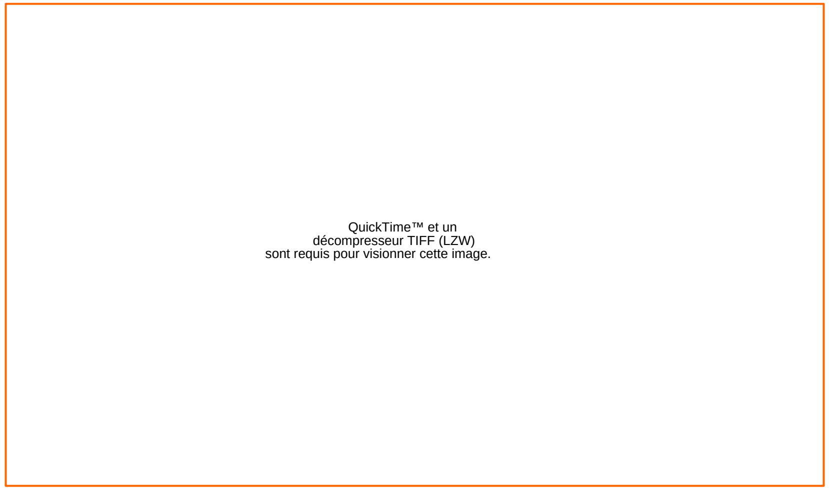
- Online visualization module to display local power losses and magnets parameters
- Benchmarking BDSIM vs. DIMAD finalised
- Management and development of BDSIM in collaboration with RHUL
  EuroTeV Report-2006-014-1
- BDSIM Mokka interface (RHUL & DESY) to implement simplified detector geometries for background studies
- Finalizing procedure for submitting BDSIM on LCG/EGEE GRID, in the context of the ILC virtual organization
- Systematic comparison of power loss in head-on, 2 & 20 mrad ILC extraction lines ▪ for complete set of ILC beam parameters
  EuroTeV report - end 2006
- Systematic comparison of backscattered (e & γ) background levels with sufficient statistics
  3 detectors concepts $\times$ 3 IR geometries
  EuroTeV report - mid 2007

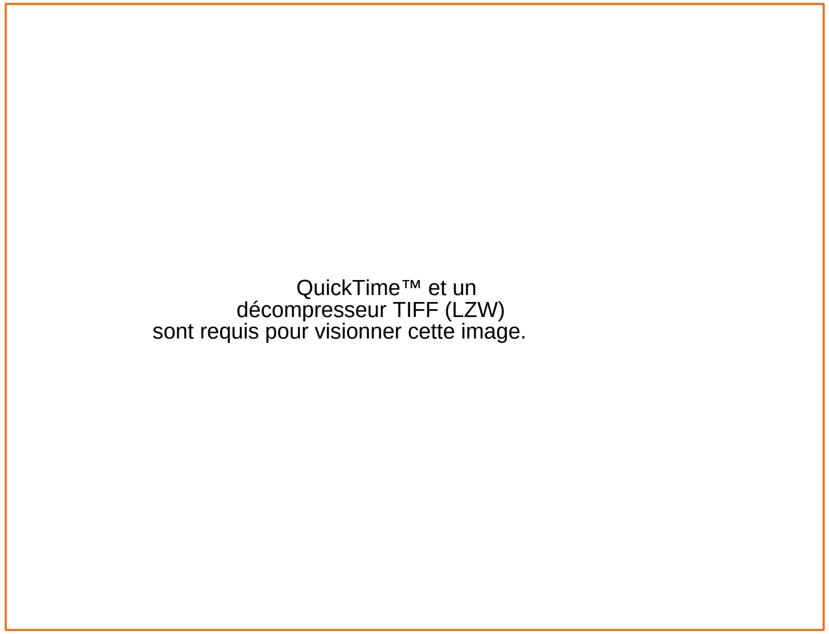
Post Collision Line

- Power loss study (beam & radiative Bhabha) for newly designed head-on ILC extraction line (CEA, Daresbury, SLAC & LAL collaboration)



Post Collision Line





- Study of backscattered secondary particles (e & γ) from beam losses in the initial part of the extraction line
- 5-10 electrons are predicted to reach the vertex detector from 500K macro-particles of the disrupted beam

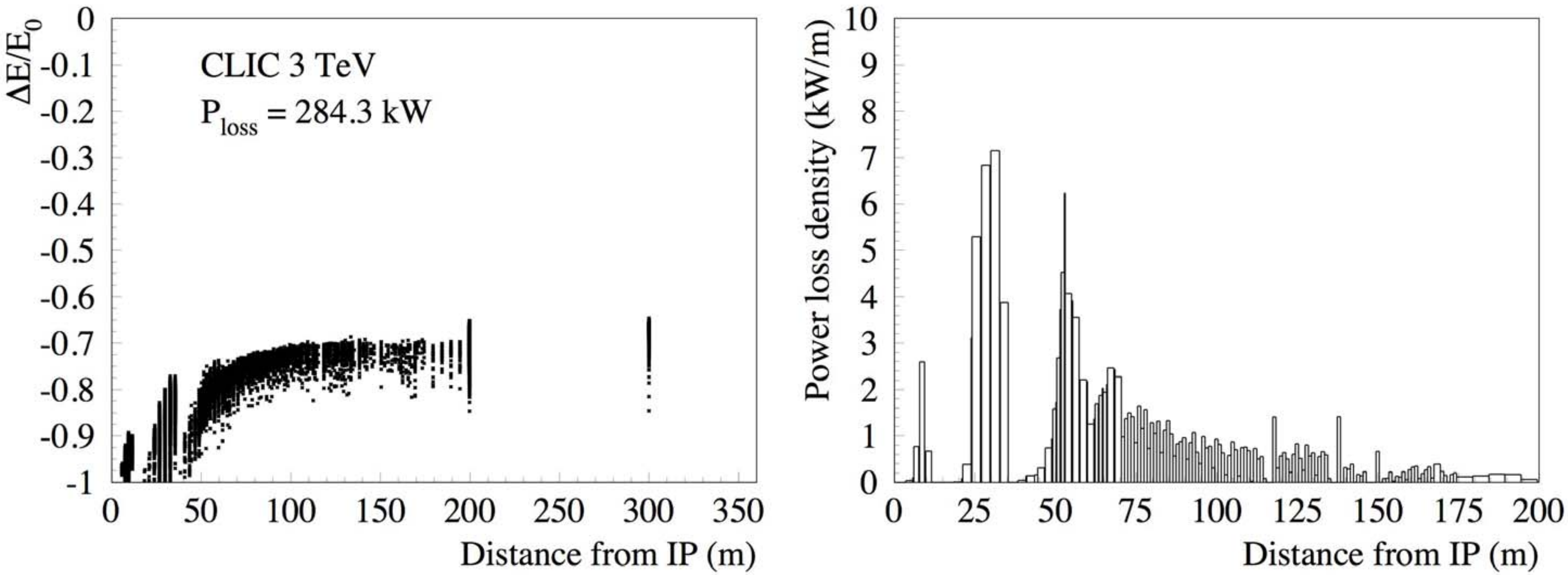
→ Increasing the statistics $\times$10

→ Delimitate most relevant regions in the extraction line by stopping the GEANT4 tracking selectively

Post Collision Line for Multi-TeV (PCDL)

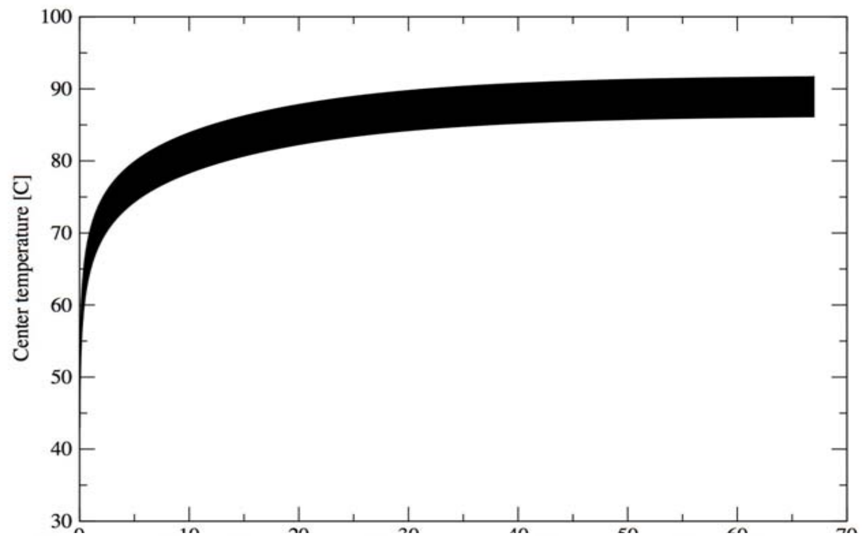
V. Ziemann, A. Ferrari (Uppsala)

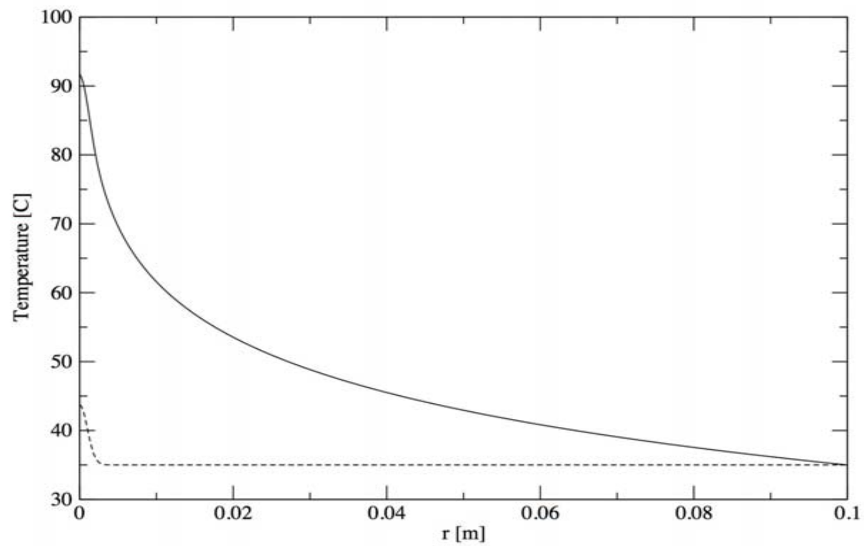
- Scaled ILC 20~mrad extraction line leads to too large loss (284~kW from disrupted beam and 36~kW from coherent pairs)
- Can be improved by scaling down the magnetic field of dipoles and quadrupoles
  - But optics at the nominal energy is destroyed: no post-collision beam measurement seems possible
- Base design on chicane only



Heating of the Dump Window

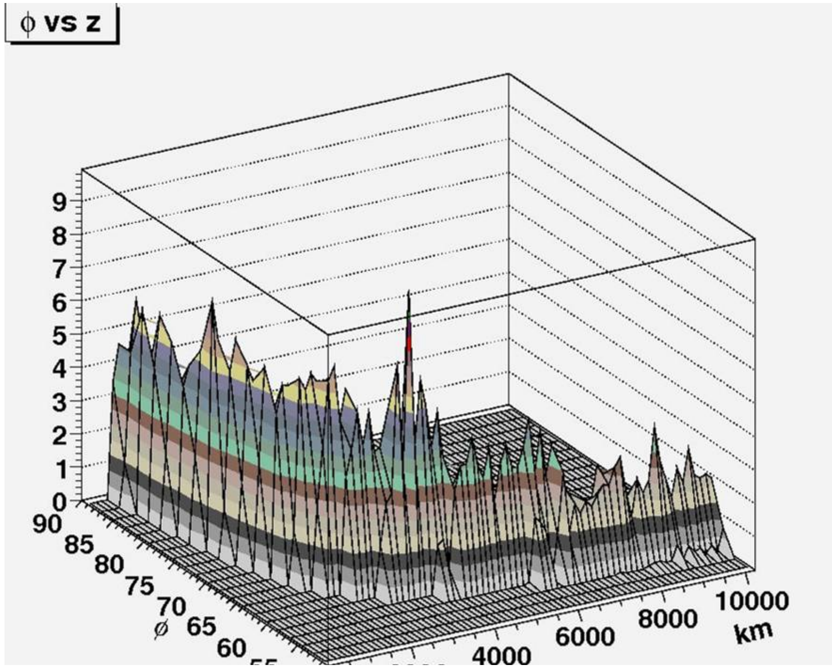
- (Vertical) dipole to separate beamstrahlung, disrupted beam and coherent pairs
- Detailed study to identify extraction magnet contraints
  - ideal collision
  - with offsets
- CLIC beam power is 20MW (undisrupted)
  - Deposits about 3.5 J/g in the thin dump window through ionization losses.
- Beam size of 1~mm yields small temperature increase (less than 10K)
  - reasonable stress on the window.
- The dynamics of the temperature distribution is being studied using the Helmholtz equation with a periodic excitation (150 Hz).

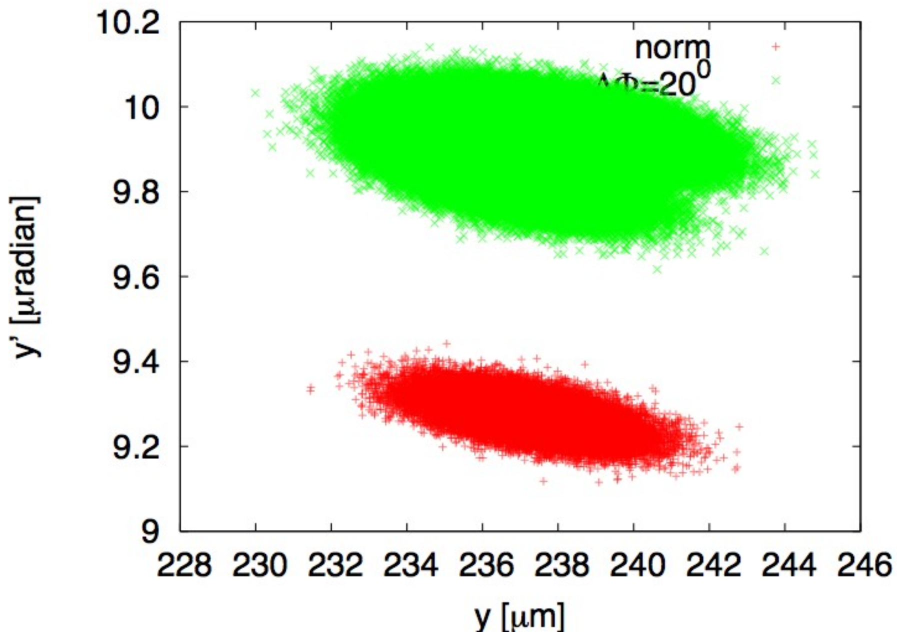




Failure Modes

- Focus on two main concerns
  - Losses in the main linac (DESY, with some checks from CERN)
  - Beam after failures going into BDS (CERN, with some checks from DESY)
  - Model of hardware failure (DESY)
    - E.g. RF model
    - Or quadrupole failure
- Work has started
  - DESY now going fast
  - CERN sent first beam files to BDS area group waiting now for input





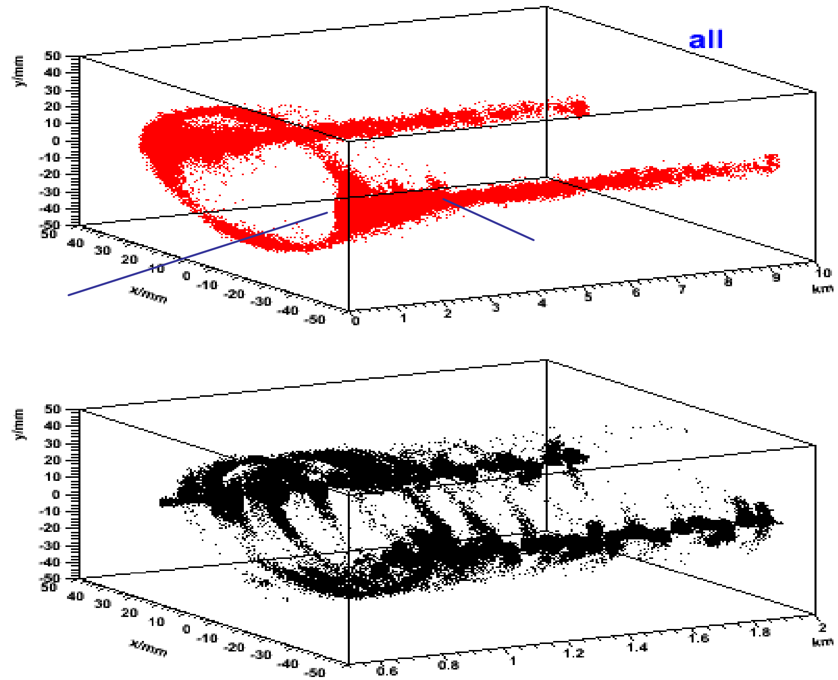
FM Simulation with Merlin – Klystron Phase Shifts

D. Krücker, F. Poirier, G. Xia
(DESY)

Φ offset	Beam energy/Gev
0º	251.5
9º	248.6
18º	240.0
27º	225.9
36º	206.4
45º	182.3
54º	154.0
63º	56.26
72º	29.30
81º	19.36
90º	15.00

Beam is less accelerated and is lost at large phase shift > 54º. (Dp/p>>0)

Where the beam is lost depends on the phase:



Beam-Based Alignment

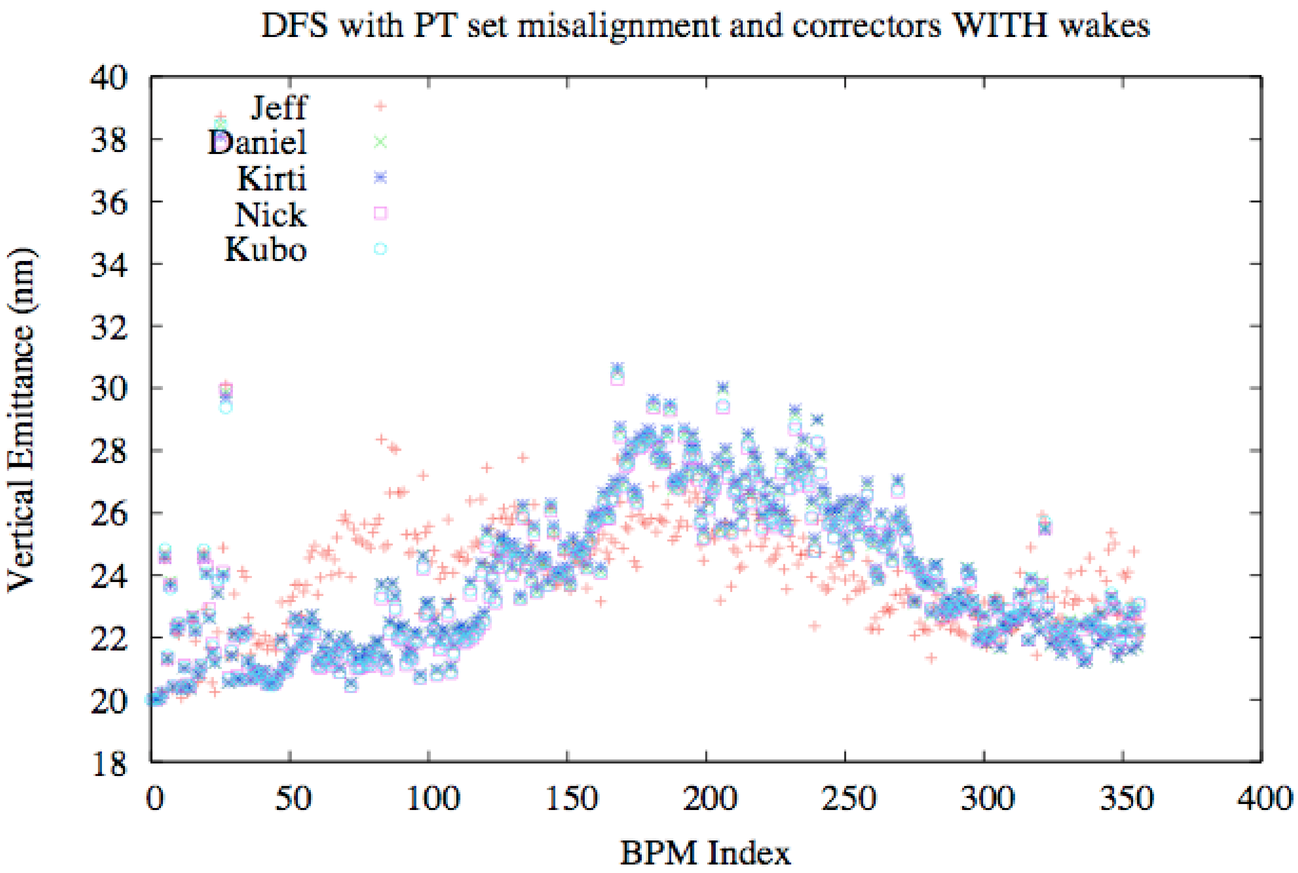
- At LET workshop we agreed
  - RTML: P. Tenenbaum, RTML area group
  - Main linac: D.S.
  - BDS: Glen White
- In main linac several options
  - « Dispersion free steering »
    - Use beams with different energies
    - Different flavours
      - Switch on/off different cavities for correction of each bin (SLAC, Cornell)
      - Change gradient/phase in fixed patters along the linac (CERN)
        - Can be used in a single pulse
      - Artificial change of energy at corrector bin (DESY)
    - Main problem are the first few modules
  - Ballistic alignment, Kick minimisation, Quadrupole shunting

Code Benchmarking

N. Walker (DESY), D.S. (CERN)

- Vital, performed in international collaboration
- Previous status
  - Comparison of offset beam in perfect lattice (LIAR, MERLIN, PLACET)
  - Ballistic alignment (PLACET, MERLIN)

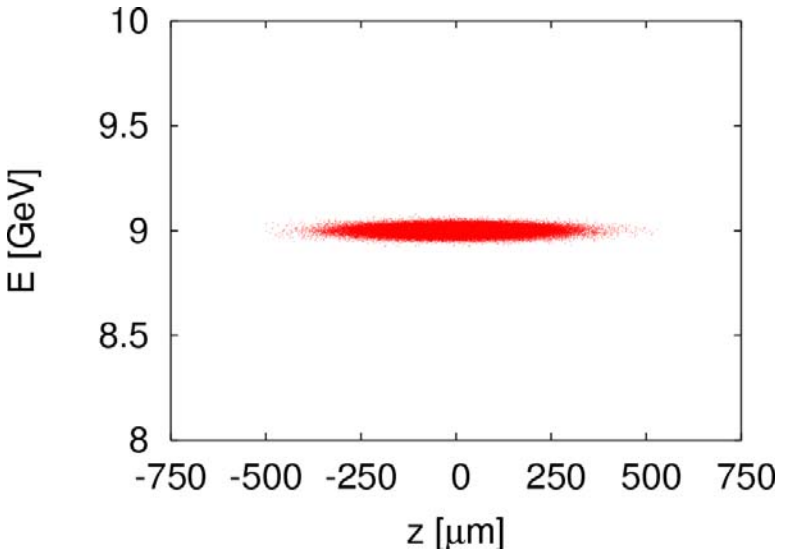
- Now used corrected machine
  - Strong cancellation of quadrupole offsets and correctors
- Good agreement found with one exception
- Will continue by comparing correction

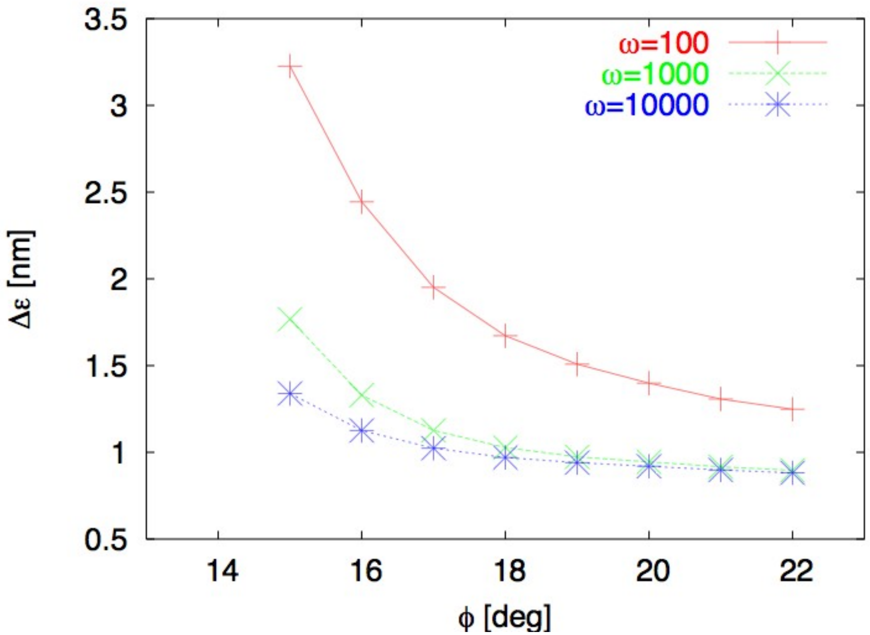


Alignment of the First Part of the Linac

A. Latina (CERN)

- Critical since do not yet have the energy difference
- Idea is to use bunch compressor to generate different energies
  - Problem due to modification of the longitudinal bunch shape
- Results for CLIC show very good performance
  - Verfication for ILC is being performed right now but looks promising





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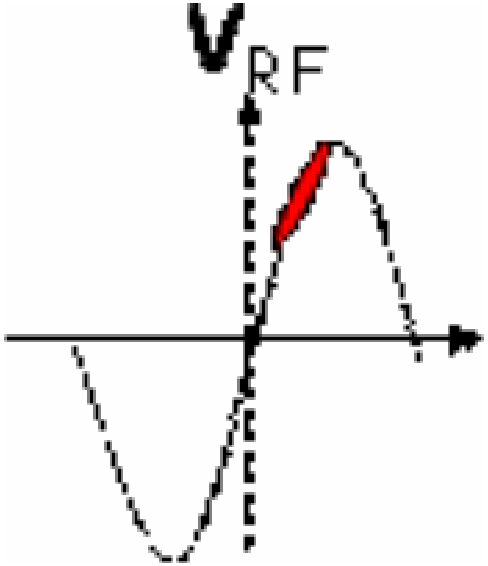

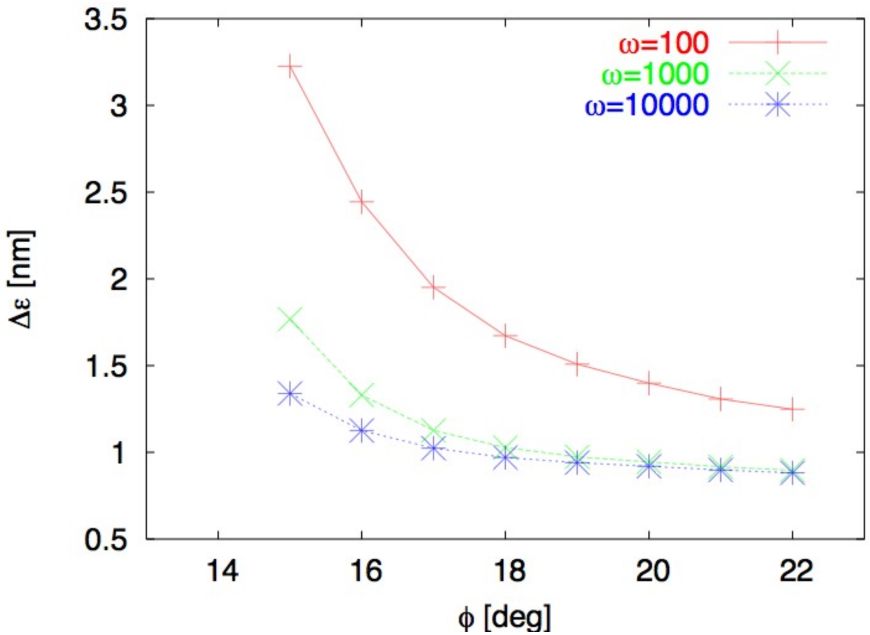

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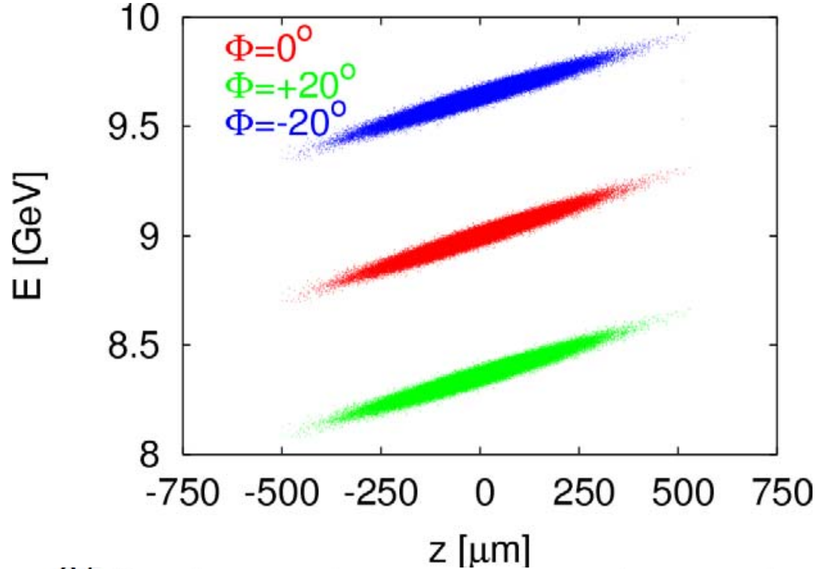

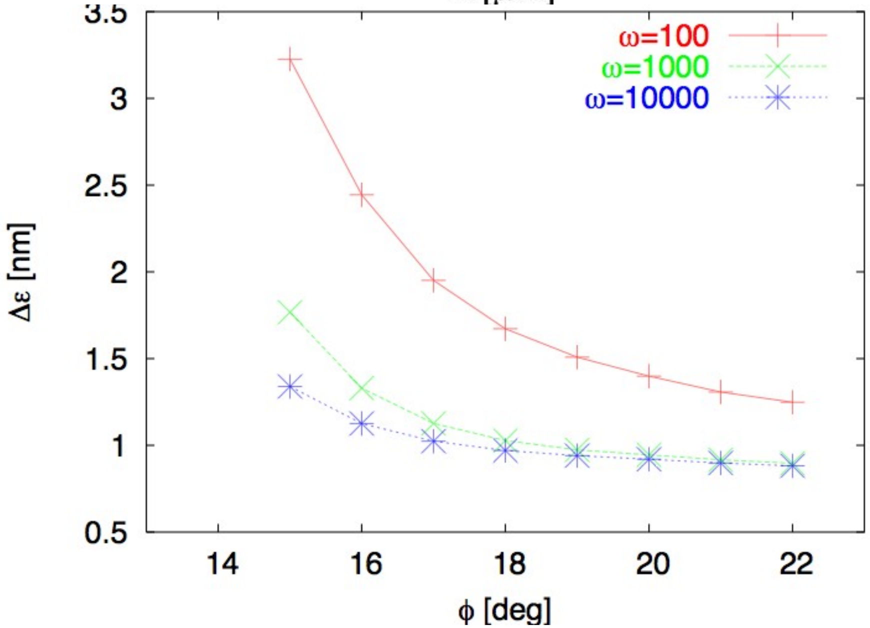

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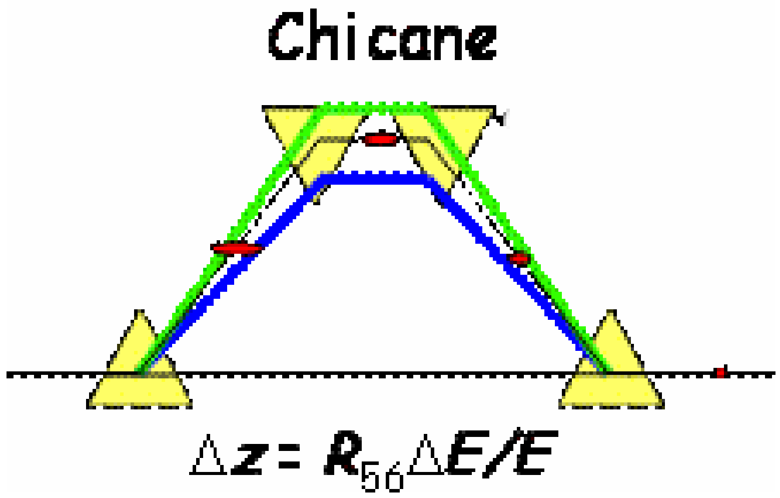

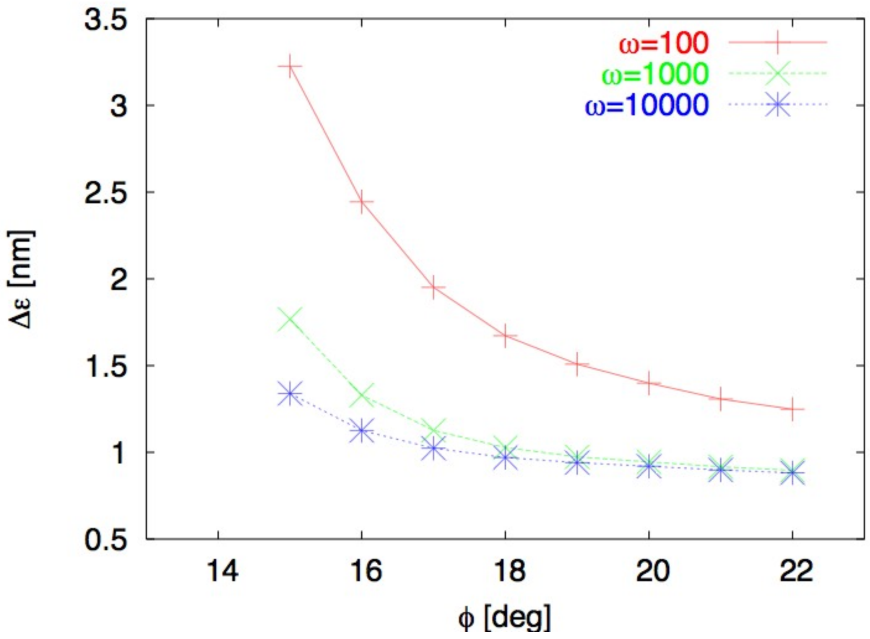

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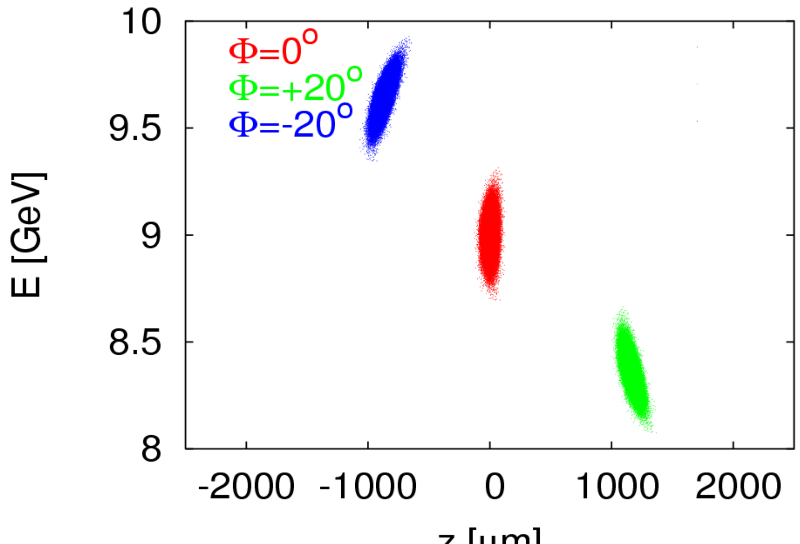
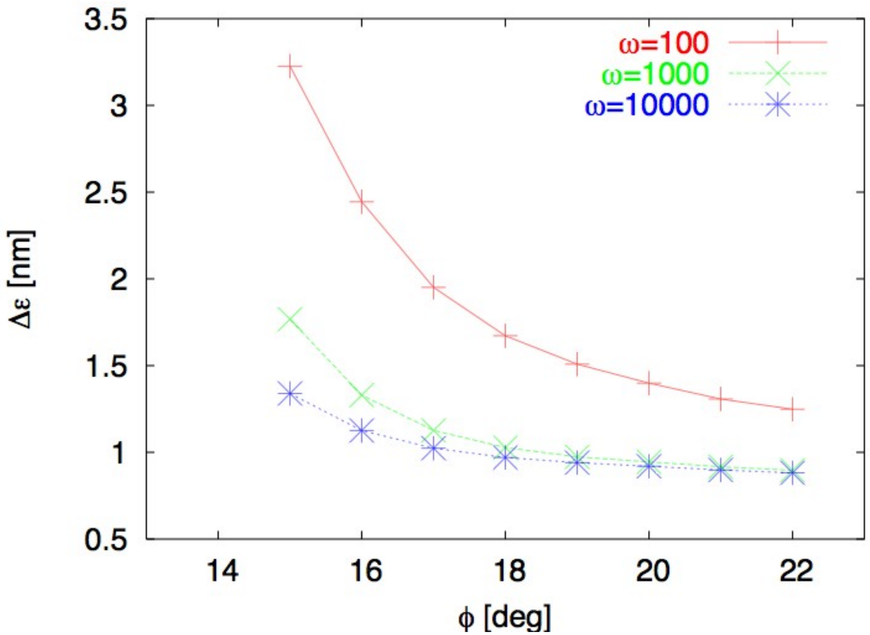




Effect of the Earth Curvature

Focus on effects not included in N. Walkers study (confirmed last year)

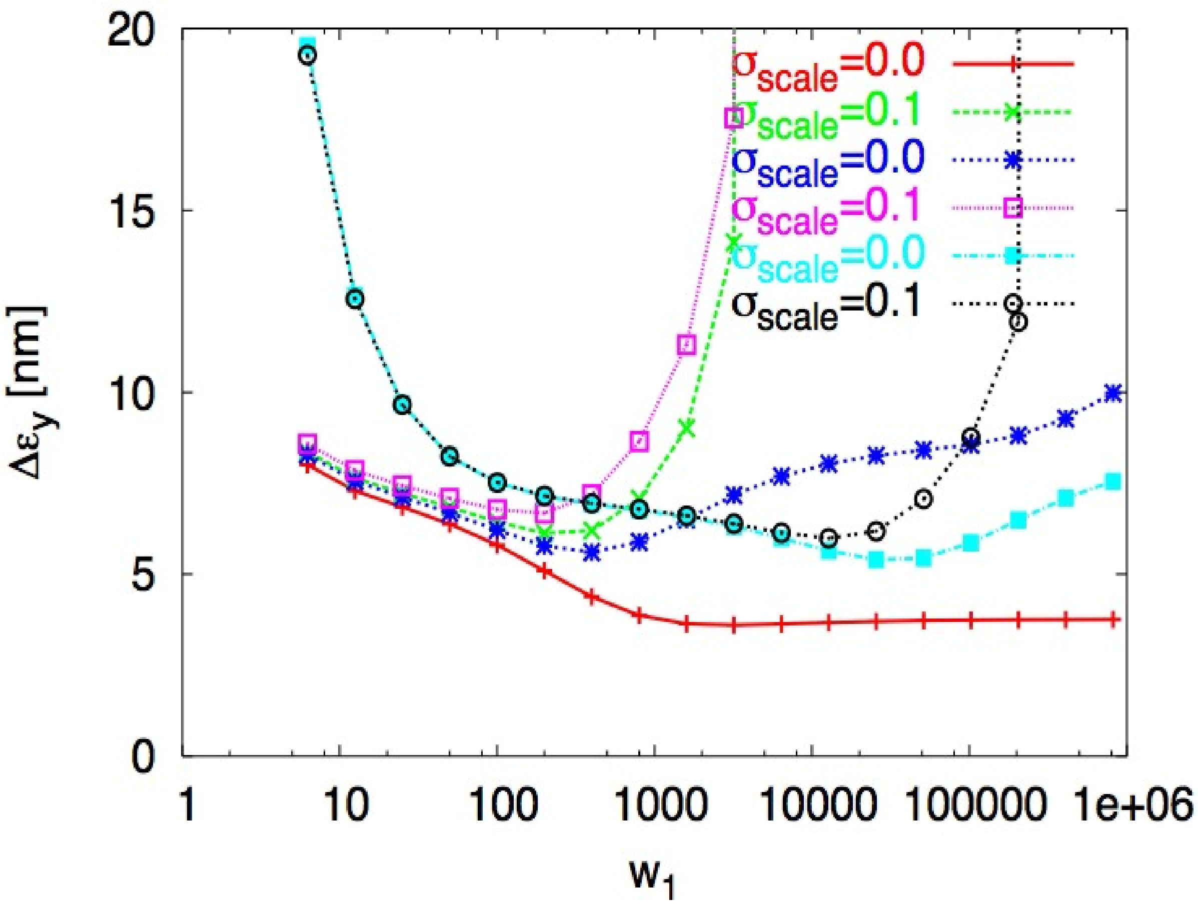
Need to steer the beam around the curvature

D. S. (CERN)

- Synchrotron radiation
- Power supply stability for quadrupoles or correctors
  - A variation of the field strength leads to transverse beam jitter

- Need to use target dispersion which is not equal to zero
  - BPM scale errors (Δa) are important since the measured dispersion D is wrong $\Delta D = \Delta a\ D$
- For good BPM resolution scale error becomes dominant
  - Dependence should be reduced if disperison bumps are applied (see 2005 results of P. Eliasson)

–Can use smaller energy difference



Dispersion Free Steering with MERLIN

F. Poirier (DESY)

Used to compare curved vs. Laser-straight tunnel

Qualitative results had been verified with PLACET

Added functionality to quantitatively compare to PLACET results

- Scale errors
- BPM resolution
- Weight dependence
- Method not yet the same

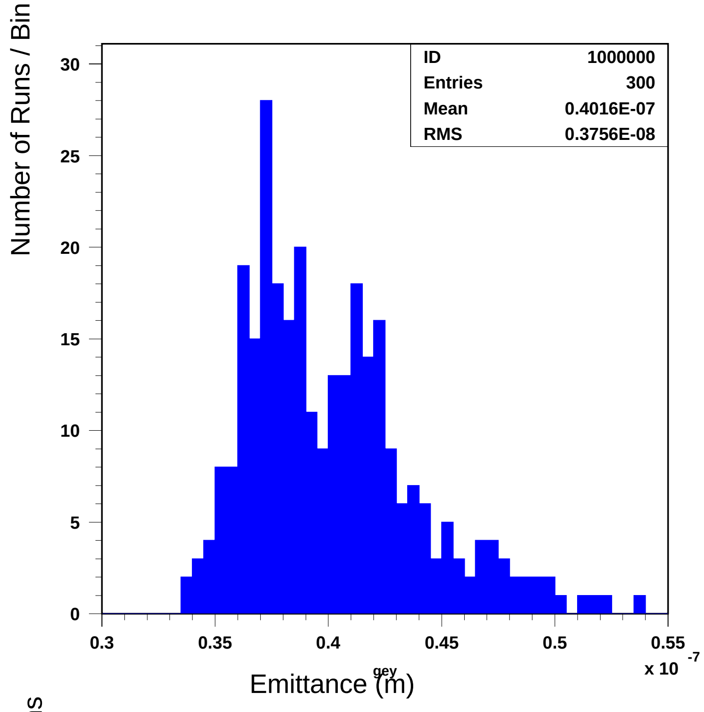
100 runs (seeds)

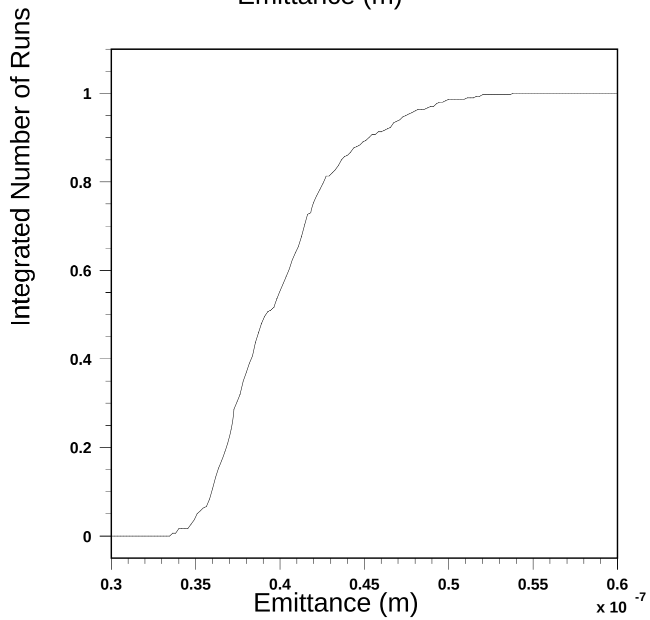
Mean Normal Emittance at the end of linac= ~40 nm i.e a emittance growth of 100%

(90% level= ~45 nm)

A correction of the energy correlation (similar to a perfect dispersion dump) brings the emittance to 27 nm (90% level) i.e an emittance growth of 35%

A new version of the code is underway (for EPAC) which will take into account energy gradient strategy

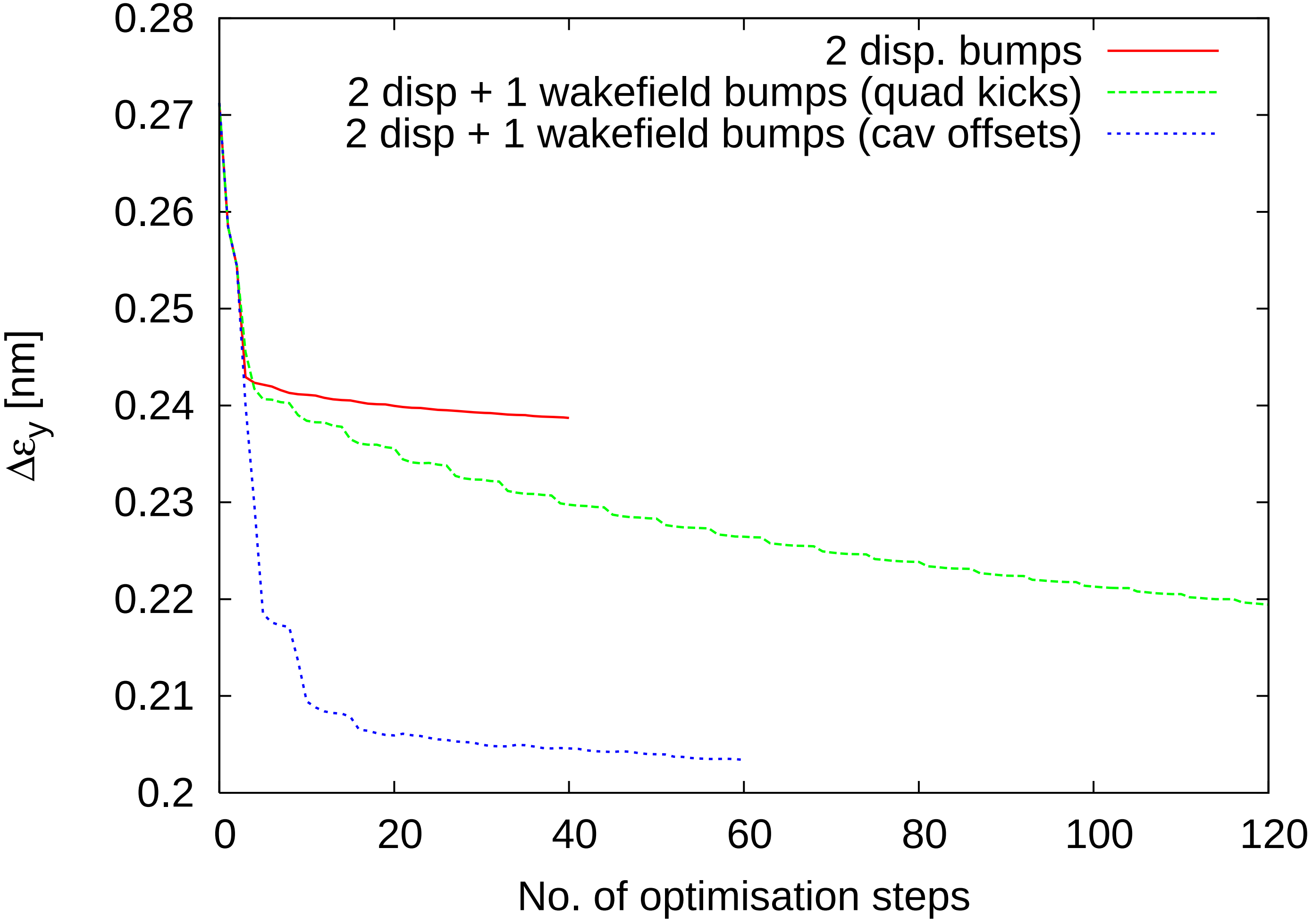




DFS + Tuning Bumps

P. Eliasson (CERN)

- 1 μm BPM resolution, 2% initial energy difference for DFS, 10% BPM scale.
- Comparison of three bumps setups. Slow convergence using quad kicks.



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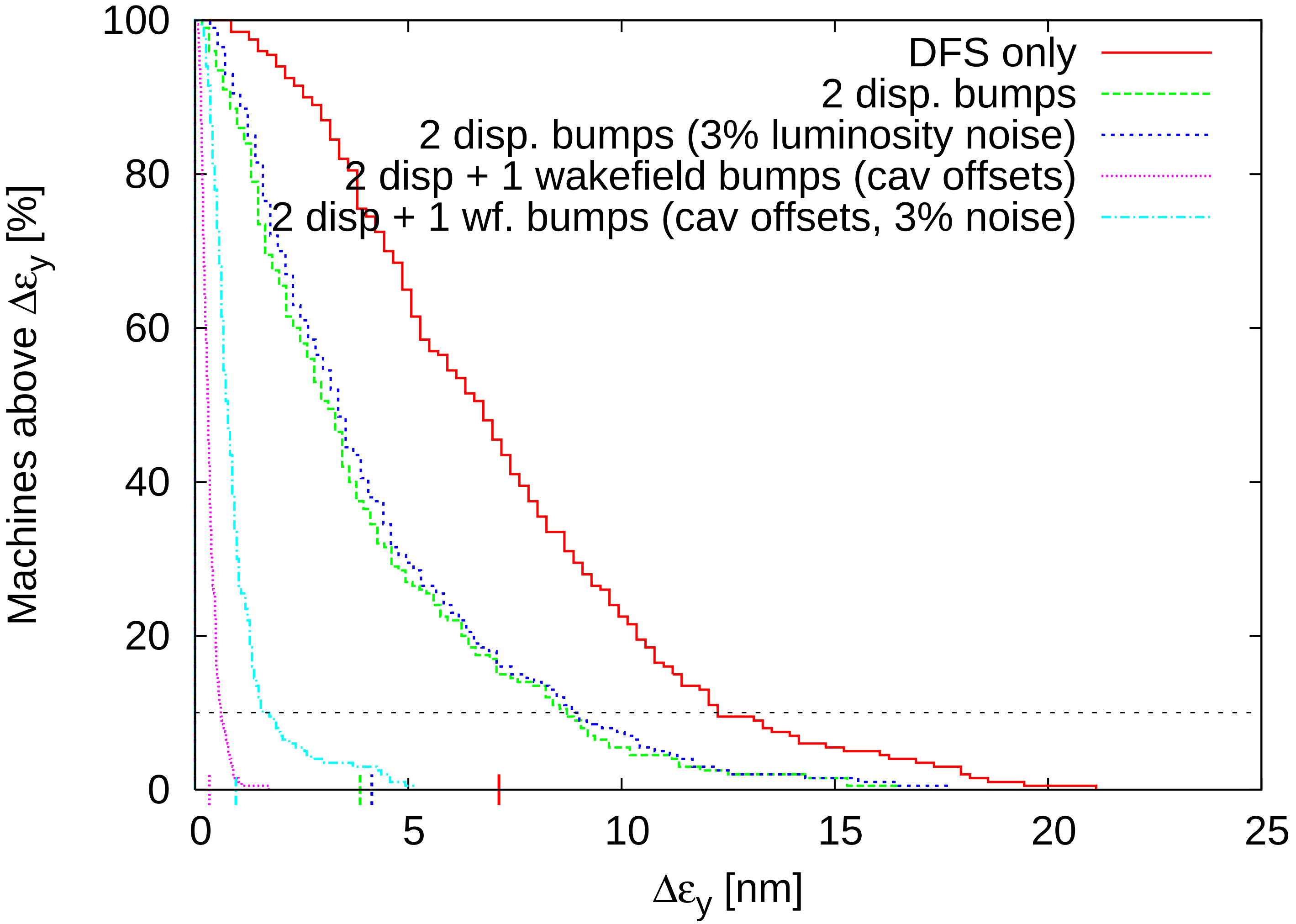
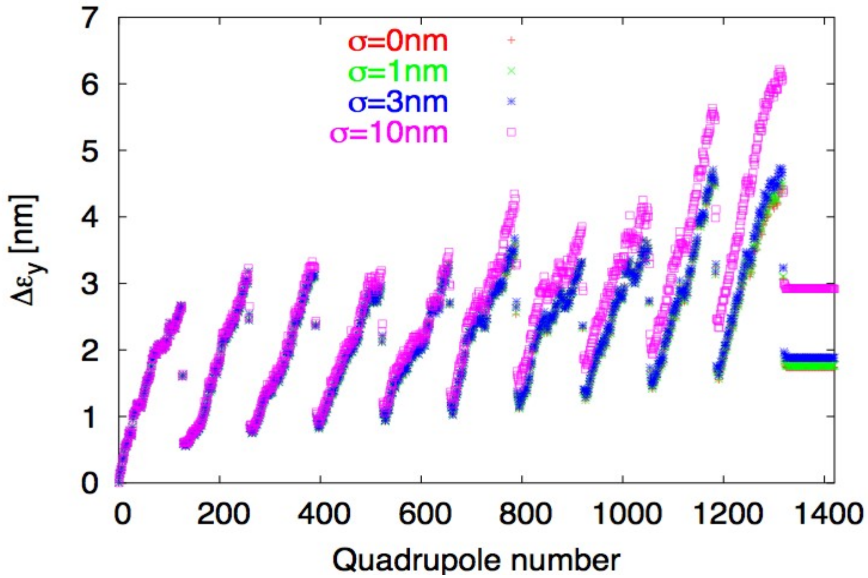
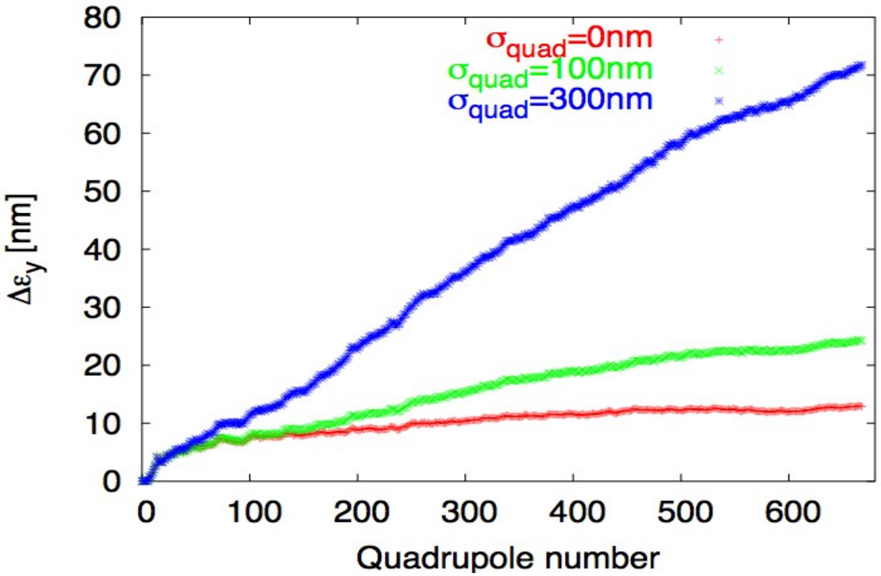


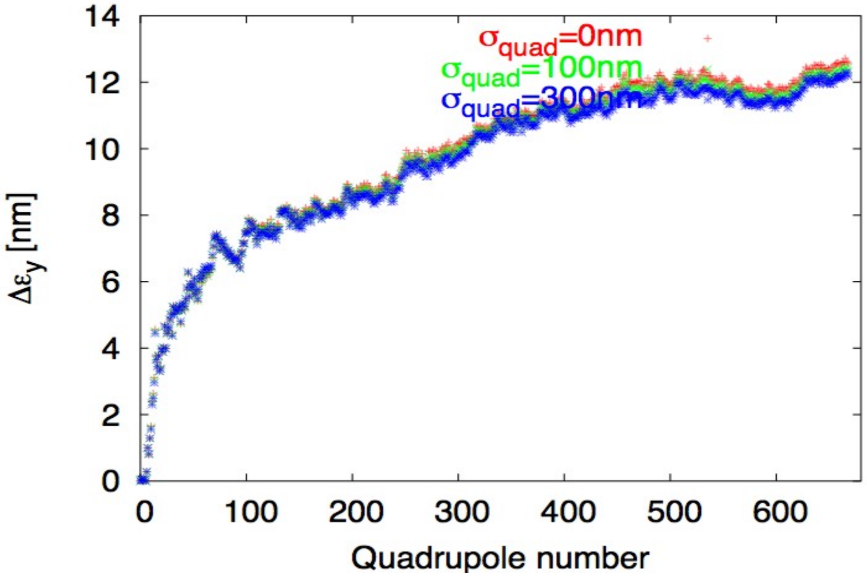
Dynamic Effects During Correction

- Potential source of increased emittance growth due to imperfection functioning of beam-based alignment methods
- Addressed by fully dynamic simulations, i.e. each pulse
- Example: quadrupole jitter during correction
- Used finally static one-to-one
  - Seems acceptable for ILC and CLIC

D.S. (CERN)



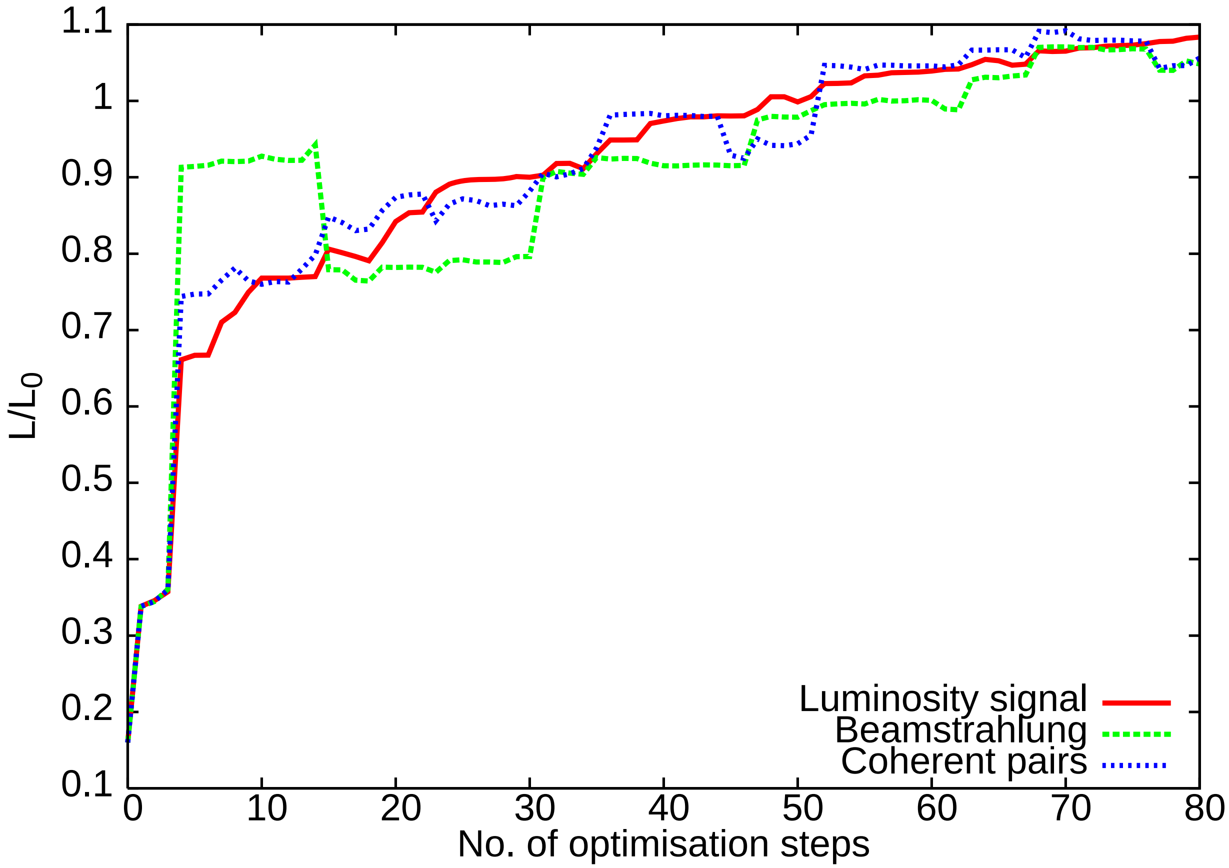




CLIC Collision Tuning

P. Eliasson (CERN)

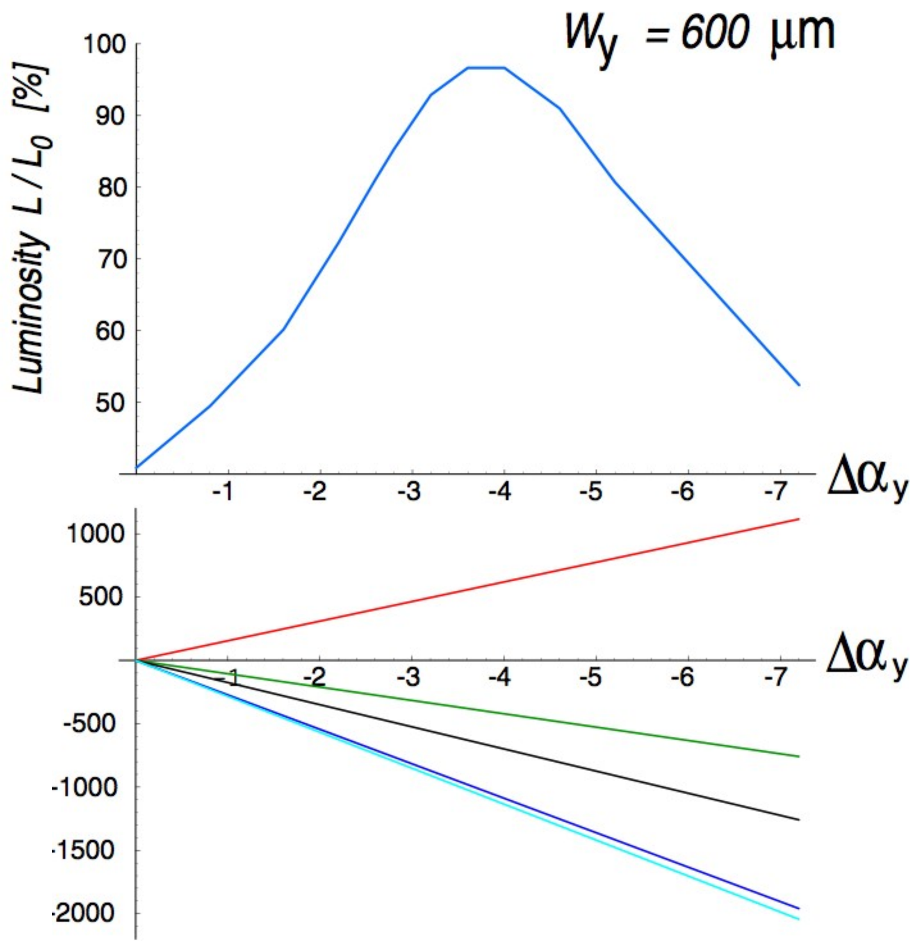
- Use of beamstrahlung or coherent pairs as an alternative to luminosity as a signal for IP parameter tuning.
- GUINEA-PIG used to simulate collision of realistic beams.
- 10 parameters for each beam initially randomly disturbed. The parameters are offset, angle, waist, dispersion and angle dispersion for both planes.
- The three different signals give a similar improvement of the luminosity

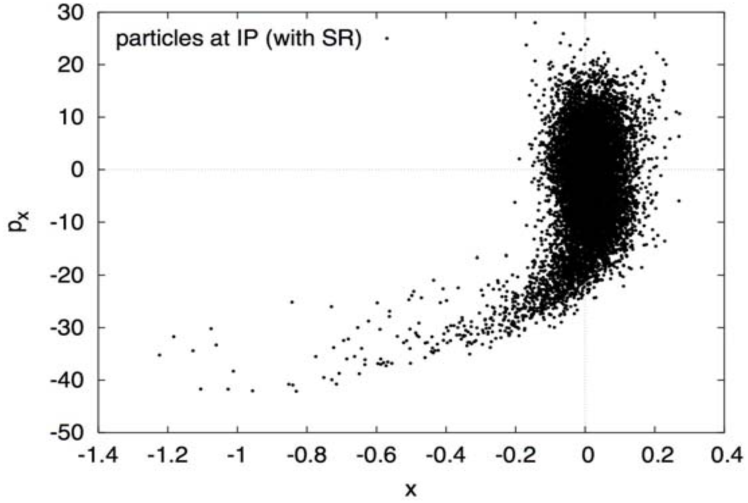


Realistic Tuning Knobs

M. Korostellev, R. Tomas Garcia (CERN)

- Develop realistic tuning knobs for BDS and alignment procedures for CLIC
- Not very linear system
- Example waist knob





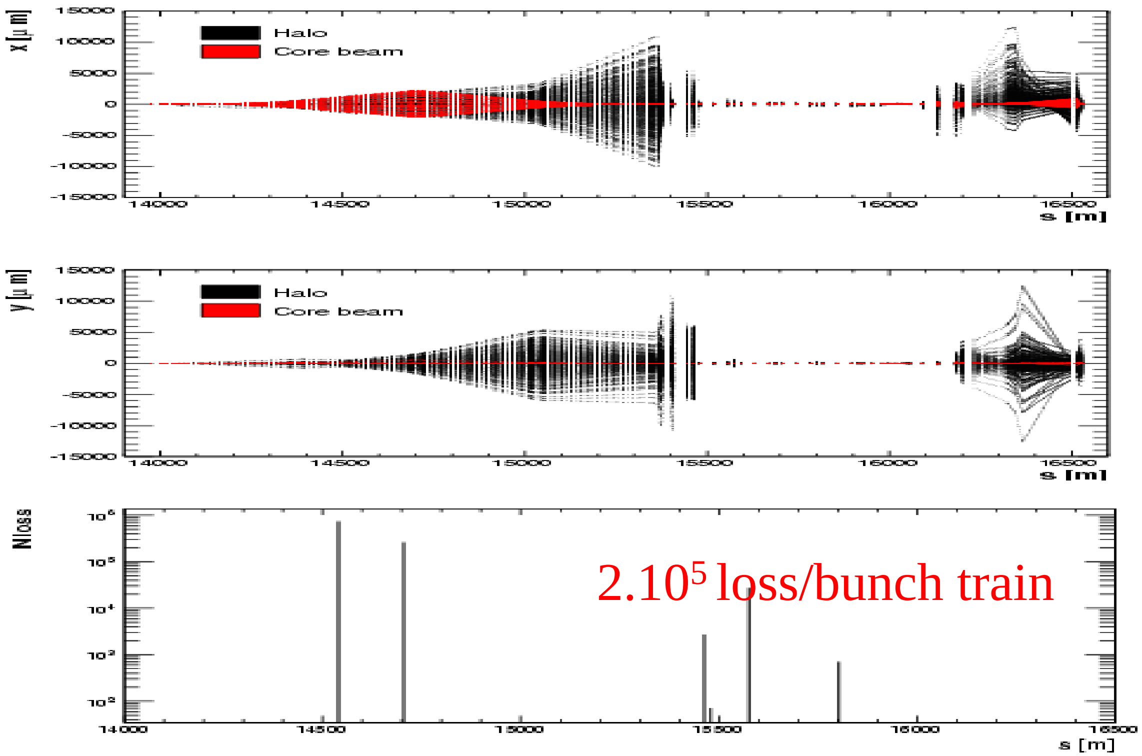
Dynamic Feedback

- Following has been proposed
  - Intra-pulse feedback/feedforward
    - After the damping ring before the main linac (reason for the turn-around)
    - After the main linac at the beginning of the BDS
    - At the interaction point
  - Pulse-to-pulse feedback
    - In the RTML to be defined by SLAC et al.
    - In the main linac
      - Localised feedback systems
      - MICADO like feedback
      - One-to-one correction
    - In the BDS permanent one-to-one correction
- CERN made a code to simulate ground motion available, using models by A. Seryi

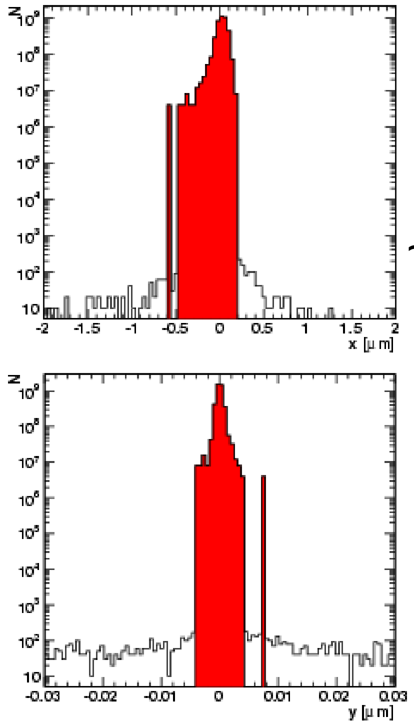
Halo and Tail Generation (HTGEN)

H. Burkhardt, L. Neukermans (CERN)

- Tools for fast Background Tracking and Application to ILC & CLIC BDS
  - Beam-gas production, tracking and loss implementation in PLACET and MERLIN
  - Synchrotron Radiation tracking and Loss in PLACET
  - Multiple scattering implemented in PLACET



Beam profile at IP

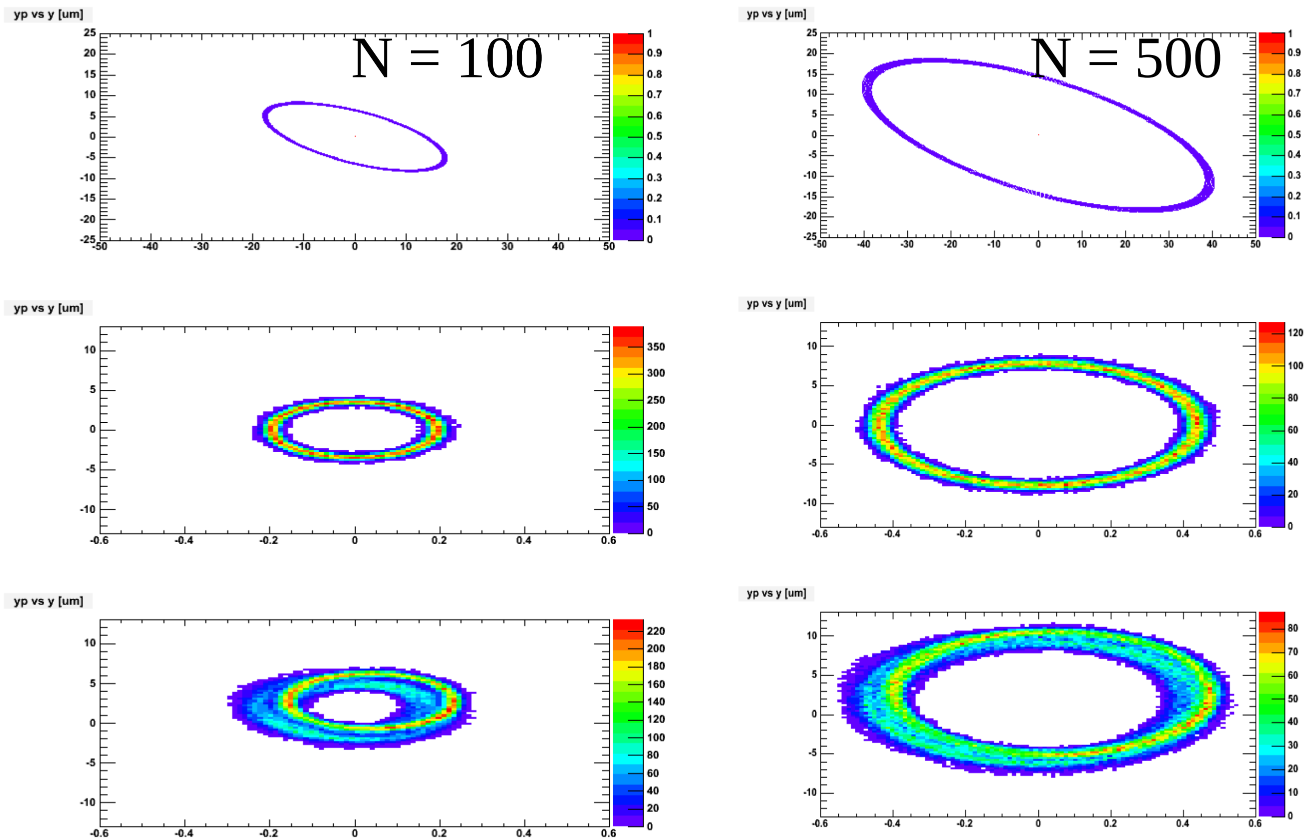


~ 3 10^{-3} in Halo above 10 s

Example here is CLIC BDS. Gaussian beam with halo from beam-gas for 10 nTorr CO

Effect of Misalignment on Large Amplitude Particles in CLIC LINAC

- Particles on Ellipse at Amplitude: A = N . Emittance
- Tracking in Perfect / D.F.S. aligned machine



LINAC Entry

LINAC exit: Perfect machine

LINAC exit: Misaligned machine

- Other activities are
  - First look at IBS tails in Damping Ring
  - New fast Synchrotron Radiation implementation in Geant4

BDSIM Code Improvements

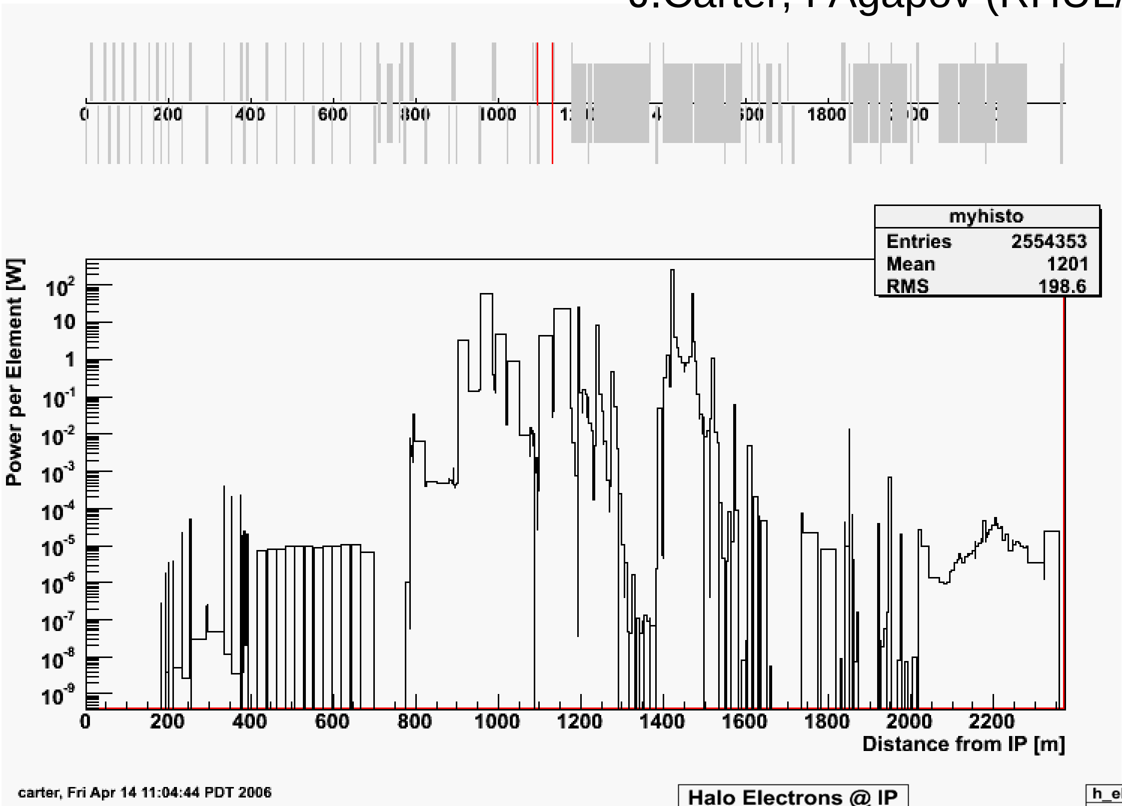
I. Agapov, J Carter (RHUL)

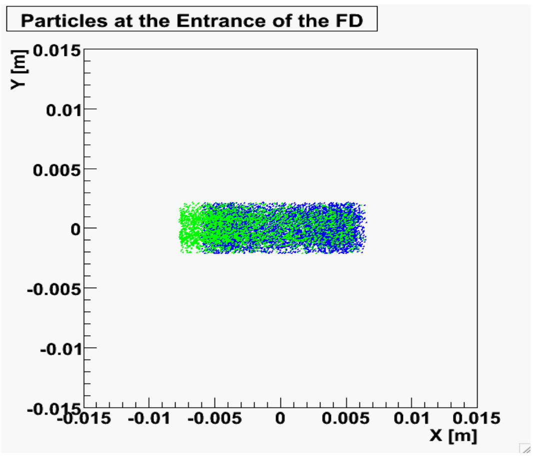
- Detailed benchmarking with STRUCT
  - Showed problem with synchrotron radiation
  - Has been solved, due to model problem
  - Neutron processes are being benchmarked with STRUCT
  - Multipole benchmarking with MERLIN
- BDSIM is now a fully integrated package on the Grid under the ILC Virtual Organisation
  - Currently have stable versions running on ~10 clusters in Europe
  - BDSIM v0.1 currently installed - soon to be upgrading to v0.2
    - Taking many modifications into account
  - Simple submission scripts have been developed for general use
  - For further info please visit: **http://flc.pp.rhul.ac.uk/bdsim.html**

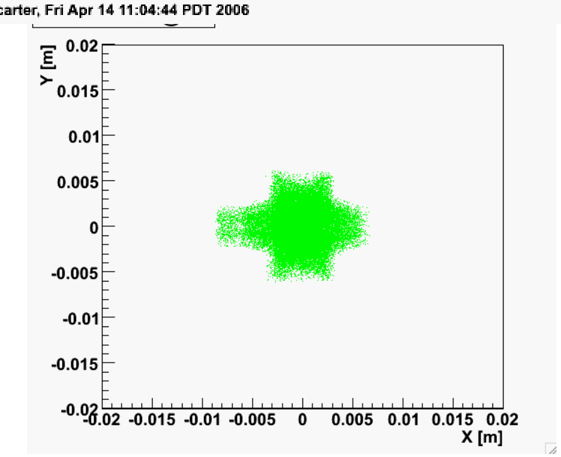
Collimation Performance using BDSIM

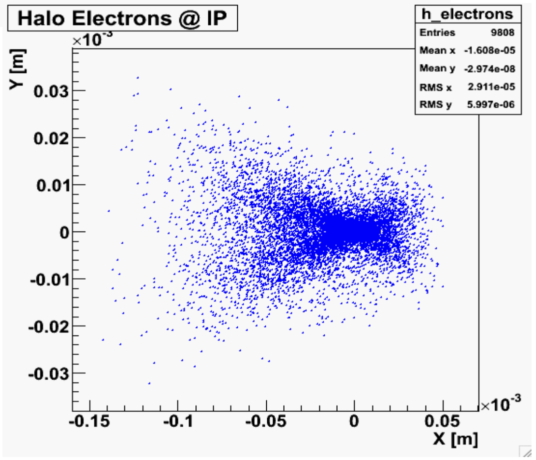
J.Carter, I Agapov (RHUL/JAI)

- All Halo related particles (e- & SR) pass through VXD aperture ~10% of Halo Electrons make it to the IP
- Losses normalised assuming Halo is 10^{-3} of the main beam





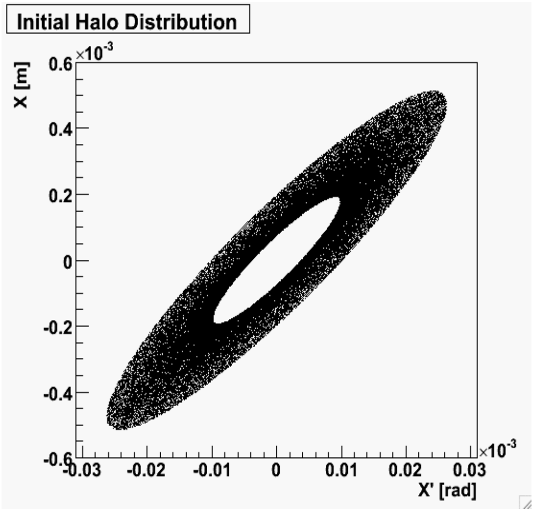


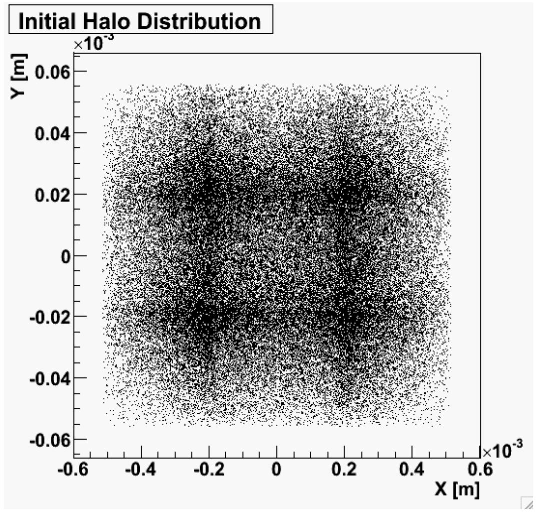


Collimation Performance using BDSIM

J.Carter, I Agapov (RHUL/JAI)

- Running 2006a ebds deck
  - 10MeV cut on charged
  - 1KeV cut on photons
- Tracking 100k Halo particles only
  - with SR turned on
  - no solenoid field in IR





Spoiler	Material	Thickness(m)	No. of Rad. Lengths	Rad. Length(m)	Aper_X(mm)	Aper_Y(mm)
SP1	Cu	0.0086	0.6	0.0143	10.0	10.0
SP2	Cu	0.0086	0.6	0.0143	0.98	0.53
SP3	Cu	0.0086	0.6	0.0143	10.0	10.0
SP4	Cu	0.0086	0.6	0.0143	0.98	0.53
SP5	Cu	0.0086	0.6	0.0143	10.0	10.0
SPEX	Ti	0.0356	1.0	0.0356	0.50	0.90

Collimation Studies

R. Barlow, A. Bungau (Manchester)

- Various shapes of collimators
- Various materials
- Hit by beam in various places
- Look at temperature distributions
- Comparison with FLUKA and EGS predictions
- Report – Nigel's talk and EUROTEV note

Performance and optics optimization (COLSIM)

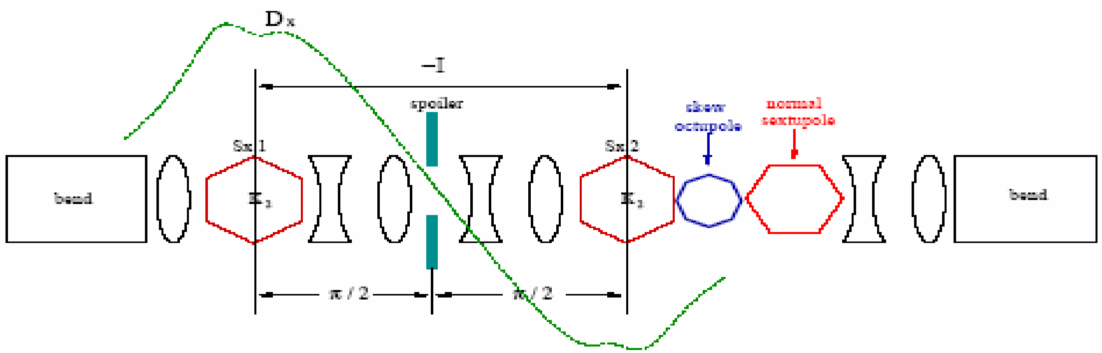
J. Resta Lopez, R. Tomas Garcia, F. Zimmermann, D.S. (CERN) A. Fauss Golfe (Valencia)

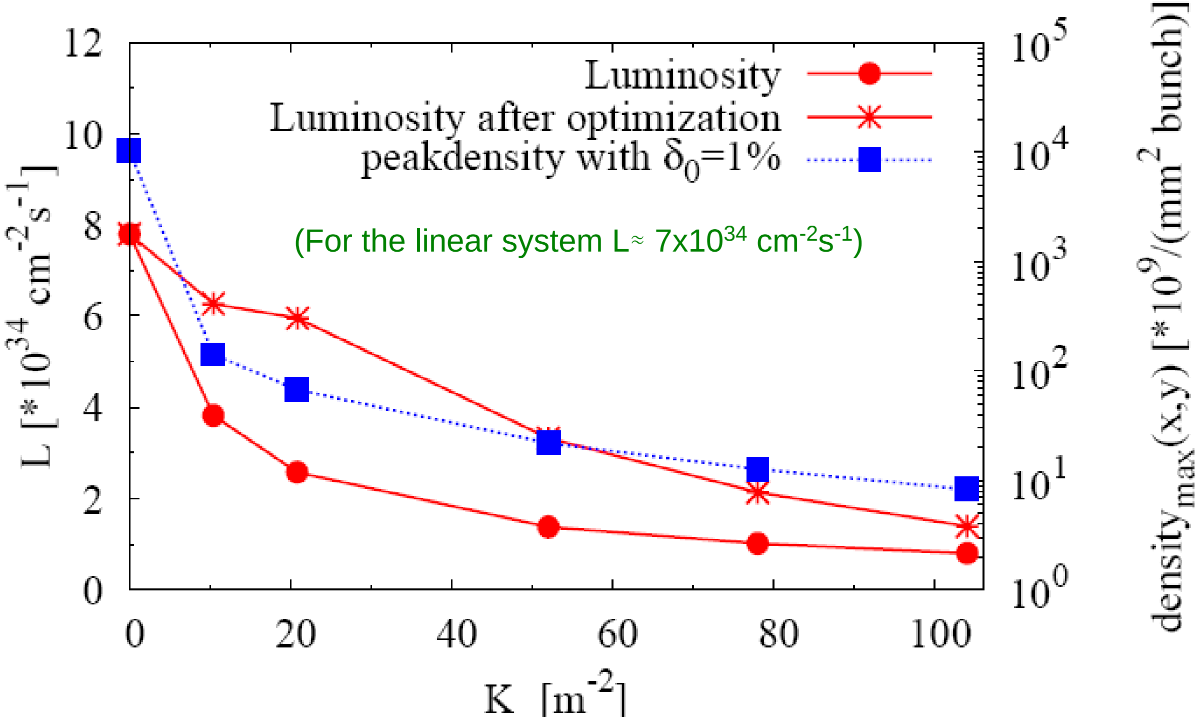
Two additional multipoles for local cancellation of the higher order aberrations

The luminosity improves by more than a factor 2 for an integrated sextupole strength $K_2L = 20.86\ \mathrm{m}^{-2}$

The spoiler survive off-momentum beams (> 1 %) with 1% full width energy spread, using an integrated skew sextupole strength $K_2L \approx 20\ \mathrm{m}^{-2}$

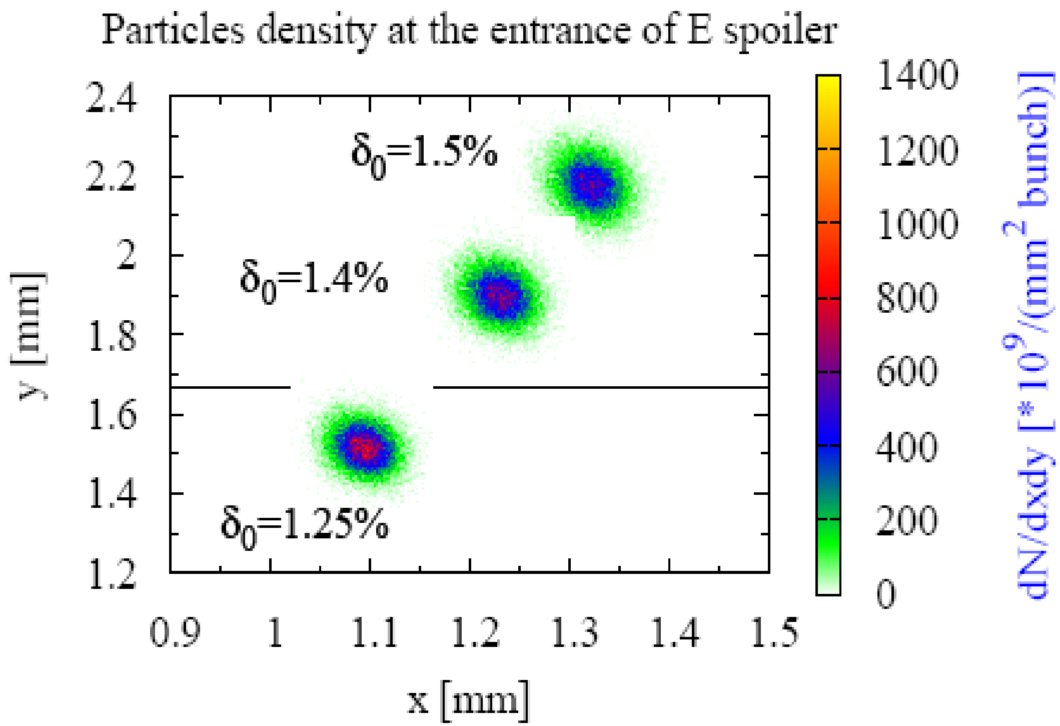
Limit density for beryllium spoiler: $46.42 \times 10^9/\mathrm{mm}^2$ per bunch

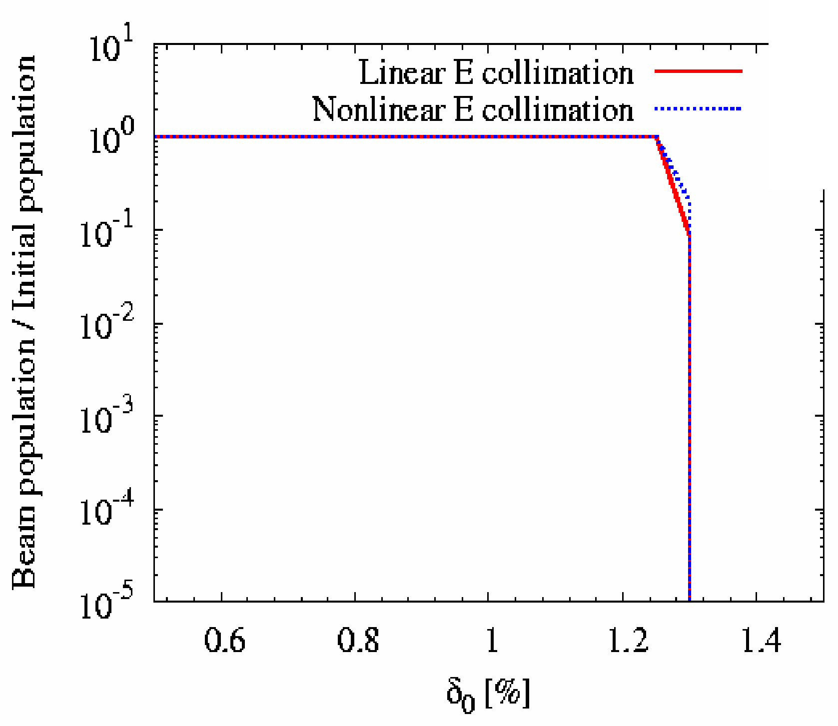




Collimation efficiency and machine protection (COLSIM)

- Gaussian off-energy beams
  - 10^5 macroparticles
  - Monochromatic
  - No transverse tails or errors





- Collimation depth is 1.3%
  - Beams are are fully collimated
- The beam density is reduced by the nonlinear system as the beam energy offset increases

Collimator Wakefield Studies

G. Rumolo (CERN)

- A C-module for wake fields has been constructed and implemented in PLACET in order to allow full tracking including the collimator wake fields
- According to the parameters of the problem, the module distinguishes between different regimes for the geometric part of the wake:
  - Inductive regime
  - Intermediate regime
  - Diffractive regime

  and for the resistive wall part of the wake:
  - Short-range
  - Intermediate-range
  - Long-range

– Benchmarking of geometric formulae with simulations (GdfidL) has started successfully

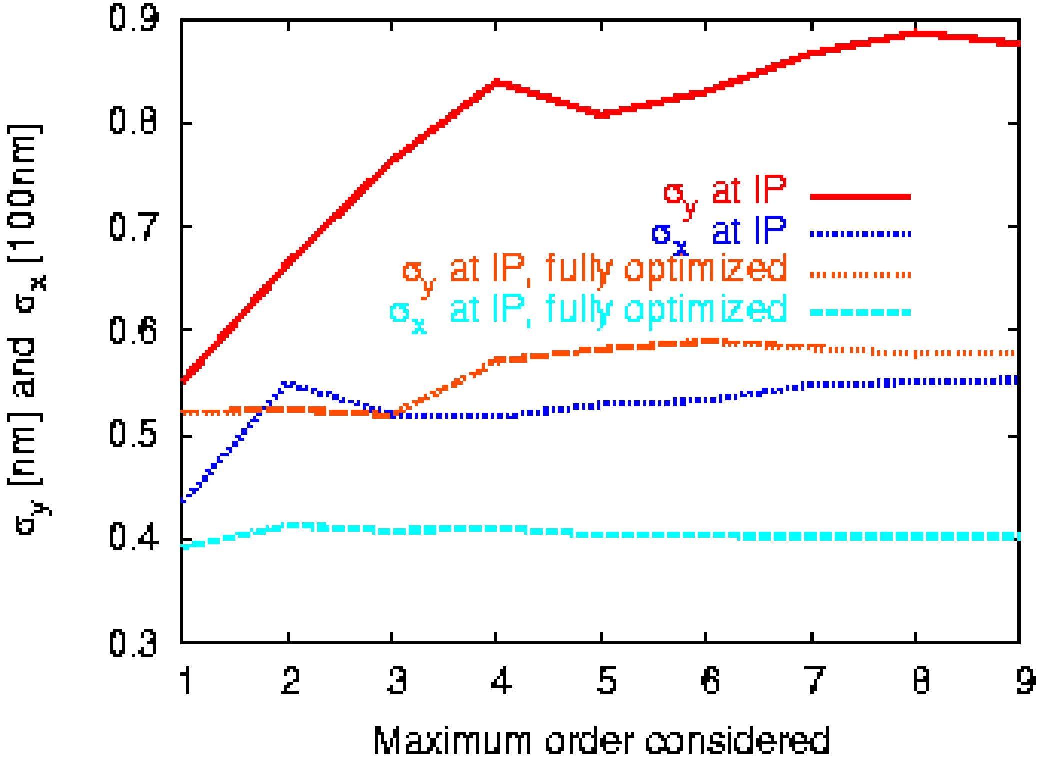
Non-linear optimization of the FFS

R. Tomas Garcia (CERN)

MAPCLASS is a Python code that minimizes the RMS beam sizes at the IP using the map coefficients from MADX-PTC.

Octupoles and decapoles are used in FFS to compensate the aberrations of the FFS

Quadrupoles are also used to focus more



-Total luminosity increased by 45% and the luminosity in the energy peak increased by 29%

-The reduction of the dispersion in the FFS helps to further increase luminosity -> Presently under study

Conclusion

- Too much work to be properly presented in this talk
- Topics have proven to be very useful for the ILC and CLIC and to address vital issues
  - No need to redefine ares of work
  - Many results planned for EPAC, Vancouver, and Valencia
  - Should continue along our current lines of work
    - Need to discuss individual topics