# Beam Physics Studies

D. Schulte for the CLIC Beam Physics Team

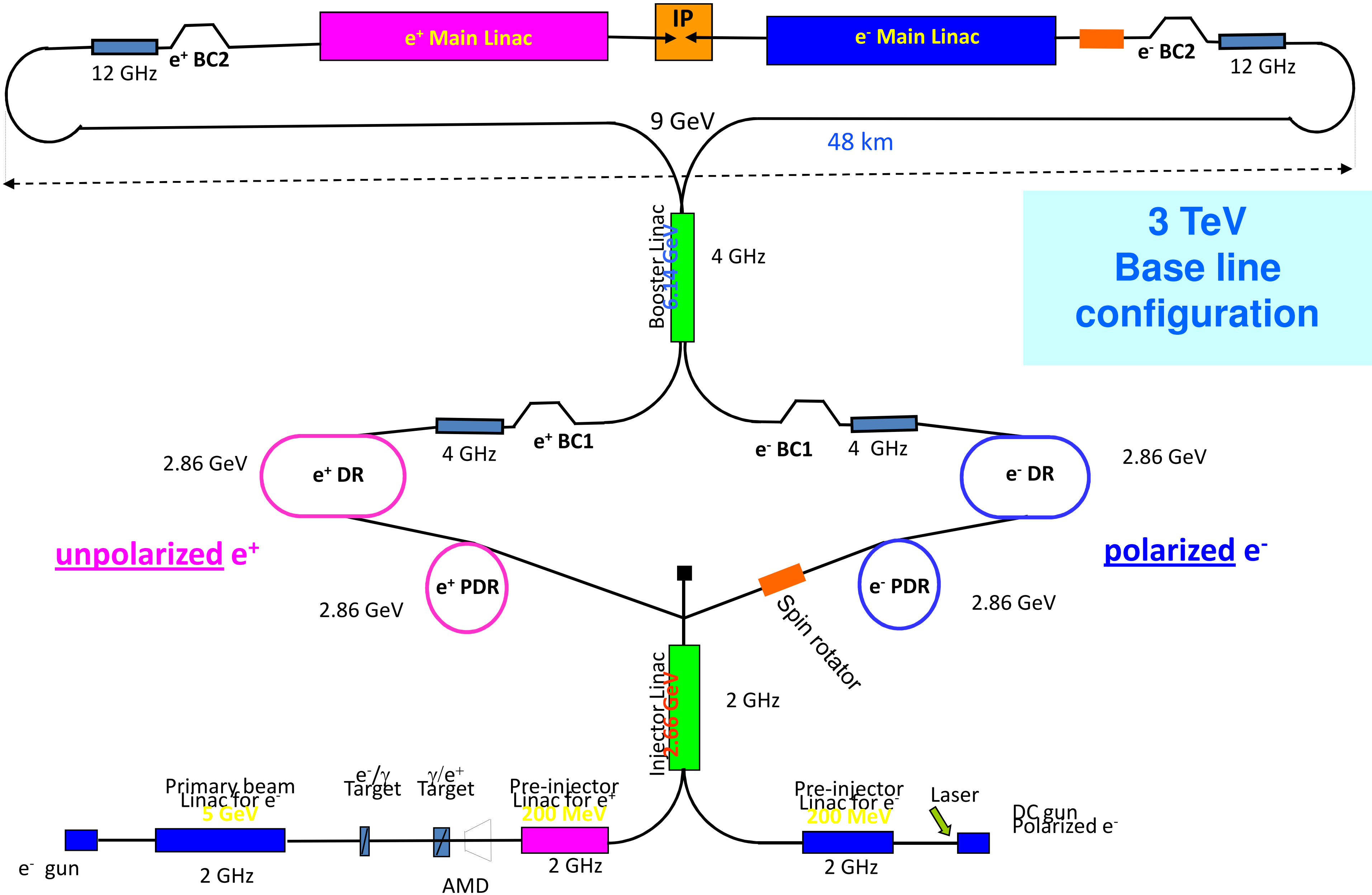
CLIC Workshop 2009

# Introduction

- Theory and simulations
  - Modelling of the machine, the imperfections and mitigation techniques
  - Benchmarking
- System design
  - Lattice
  - Hardware specifications
  - Instabilities and losses
  - Mitigation of imperfections
- Main beam emittance target (multi-pulse)
  - Damping ring exit: $\varepsilon_y \leq 5$nm, $\varepsilon_x \leq 500$nm
  - Ring to main linac exit: $\varepsilon_y \leq 10$nm, $\varepsilon_x \leq 600$nm
  - Main linac exit: $\varepsilon_y \leq 20$nm, $\varepsilon_x \leq 660$nm
  - Beam is not Gaussian at IP
- For drive beam integrated studies to show little losses, simplified drive beam emittance target
  - 100µm at injector
  - 150µm at entrance of decelerator
- Interaction region and drive beam decelerator are covered in the next presentations
- I can only show a selection of the most important results and will have to rush
  - Much work will not be included here

# CLIC Main Beam Injector Complex in 2009

L. Rinolfi et al.




J. Clarke WG 2, S. Riemann WG 2 L. Rinolfi WG 2

# Main Beam Injectors

## Electron source:

Gun experiments at JLAB (M. Poelker, WG2) and SLAC (J. Sheppard, WG2). Simulations of a bunching system done up to 20 MeV. Full injector to be demonstrated after 2010. The (double) charge for 500 GeV remains to be investigated.

O. Mete, M. Petrarca WG 2

## Positron source (Unpolarized):

No lattice yet for the 5 GeV primary linac

Simulations for $e^+$ hybrid targets promising for 3TeV (O. Dadoun, WG2)

Lattice and RF capture done for the Pre-Injector Linac at 200 MeV (F. Poirier, A. Vivoli, WG2)

## Positron source (Polarized):

Compton Ring simulations underway for a design at 1 GeV (E. Bulyak)

Study for an ERL source and 2 Storage Rings at 1 GeV after the target (A. Variola, T. Omori, L. Rinolfi, WG2)

Study for a Compton Linac at 6 GeV (V. Yakimenko WG 2)

Study for an undulator at 250 GeV (W. Gai, W. Liu, I. Bailey, L. Zang, WG2)

## Injector Linac

Previously done: Injector Linac up to 2.4 GeV (A. Ferrari, A. Latina, L. Rinolfi)

Spin rotators not covered.

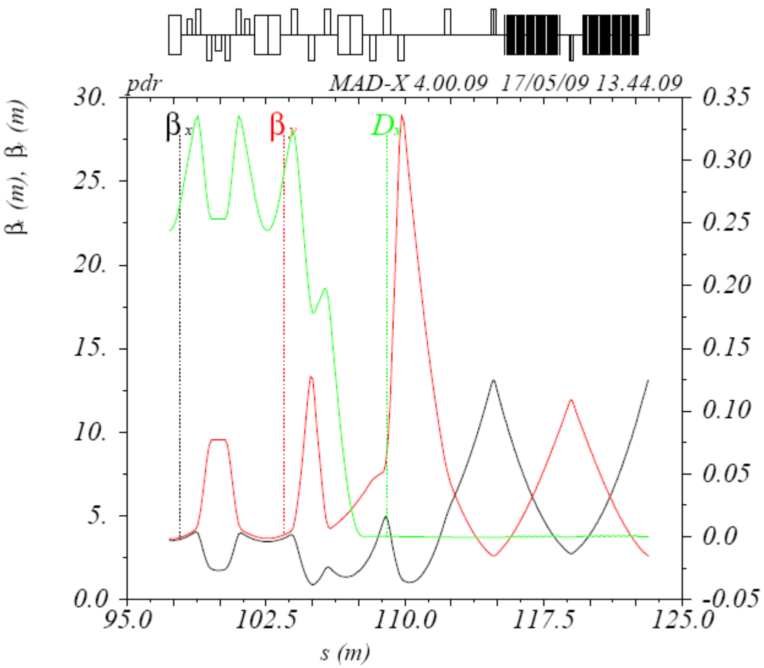
# Collaborations for the CLIC Main Beam Injector Complex

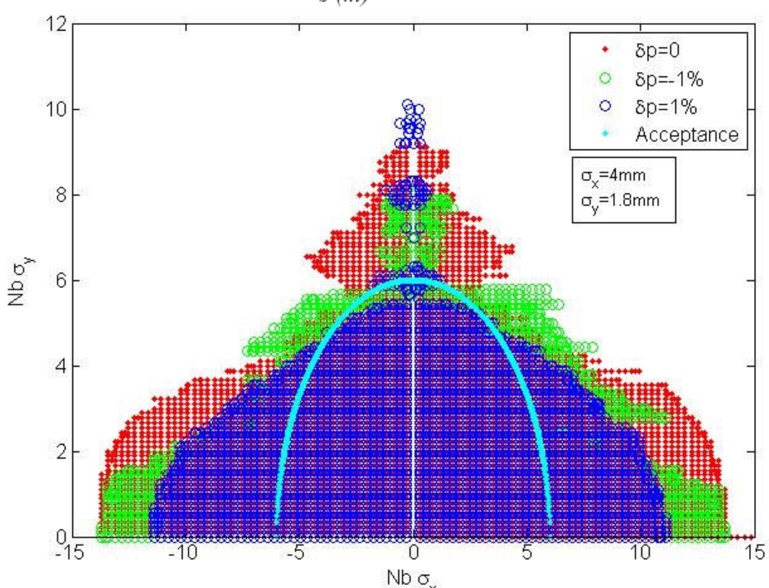
Alphabetic order for countries

| Countries | Institutes | Contact person | Collaborators | Subject |
|---|---|---|---|---|
| France | LAL | A. Variola | O. Dadoun, F. Poirier | $e^+$ studies |
| France | IPNL | R. Chehab | X. Artru, V. Stakhovenko | Channeling studies |
| Germany | FZR Rossendorf | J. Teichert | | Compton sources |
| Japan | Hiroshima Uni. | M. Kuriki | T. Takahashi | Experiments at KEKB |
| Japan | KEK | T. Omori | | $e^+$ studies |
| Japan | KEK | J. Urakawa | T. Kamitani | R&D on targets systems |
| Turkey | Uludag University | A.Kenan Çiftçi | E. Eroglu, E. Pilicer, I.Tapan | FLUKA simulations |
| Ukraine | Kharkov Institute | E. Bulyak | P. Gladkikh | Compton Rings |
| United Kingdom | Cockcroft Institute | J. Clarke | I. Bailey, L. Zang | $e^+$ studies |
| USA | ANL | W. Gai | W. Liu | Undulator $e^+$ studies |
| USA | BNL | V. Yakimenko | I. Pogorelski | Compton Linac |
| USA | JLAB | M. Poelker | | Polarized e- |
| USA | SLAC | J. Sheppard | A. Brachmann, T. Maryama, F. Zhou | Polarized e- |

# Pre-Damping Ring Design

F. Antoniou, et al., 2009, WG2




| Injected Parameters | $e^-$ | $e^+$ |
|---|---|---|
| Bunch population [$10^9$] | 4.4 | 6.4 |
| Bunch length [mm] | 1 | 10 |
| Energy Spread [%] | 0.1 | 8 |
| Hor.,Ver Norm. emittance [nm] | 100 x $10^3$ | 7 x $10^6$ |

- Main **challenge**: Large input emittances especially for positrons to be damped by several orders of magnitude
- Design optimization following analytical parameterization of TME cells
- Target emittance reached with the help of conventional high-field wigglers (PETRA3)
- Non linear optimization based on phase advance scan (minimization of resonance driving terms and tune-shift with amplitude)

F. Antoniou WG 2

# New DR Parameters and Design

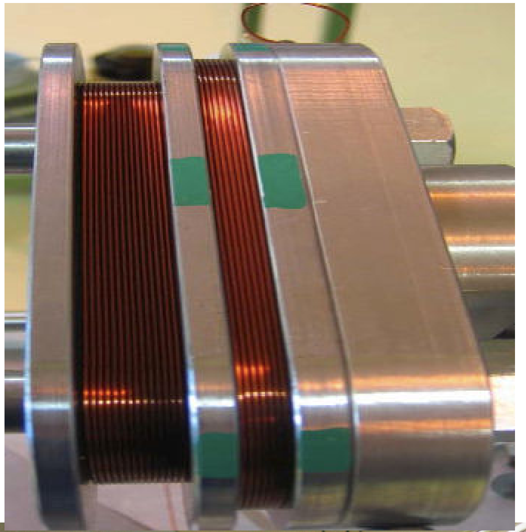
- New DR increased circumference by 30% and energy by 20%
- DA significantly increased
- Magnet strength reduced to reasonable levels (magnet models already studied)
- Combined function bend increases significantly vertical beta on dipoles
- TME optics modification and energy increase reduces IBS growth factor to 1.5 (as compared to 5.4)
- Further optimization with respect to IBS (F. Antoniou PhD thesis)

Y. Papaphilppou et al. WG 2

| Lattice version | **Original** | **New** |
|---|---|---|
| Energy [GeV] | 2.42 | 2.86 |
| Circumference [m] | **365.21** | **493.05** |
| Coupling | 0.0013 | |
| Energy loss/turn [Me] | 3.86 | 5.8 |
| RF voltage [MV] | 5.0 | 7.4 |
| Natural chromaticity x / y | -103 / -136 | -149 / -79 |
| Compaction factor | 8E-05 | 6e-5 |
| Damping time x / s [ms] | 1.53 / 0.76 | 1.6 / 0.8 |
| Dynamic aperture x / y [$\sigma_{inj}$] | **±3.5 / 6** | **±12 / 50** |
| Number of arc cells | 100 | |
| Number of wigglers | 76 | |
| Cell /dipole length [m] | 1.729/0.545 | 2.30 / 0.4 |
| Bend field [T] | 0.93 | 1.27 |
| Bend gradient [1/m$^2$] | 0 | -1.10 |
| Max. Quad. gradient [T/m] | **220** | **60.3** |
| Max. Sext. strength [T/m$^2$ 10$^3$] | **80** | **6.6** |
| Phase advance x / z | 0.58 / 0.25 | 0.44/0.05 |
| Bunch population, [10$^9$] | 4.1 | |
| IBS growth factor | **5.4** | **1.5** |
| Hor. Norm. Emittance [nm.rad] | **470** | **390** |
| Ver. Norm. Emittance [nm.rad] | **4.3** | **4.9** |
| Bunch length [mm] | 1.4 | 1.4 |
| Longitudinal emittance [keVm] | 3.5 | 3.8 |

# Wigglers Effect with IBS

Collaboration BINP – CERN – Un. Karlsruhe/ANKA



- Stronger wiggler fields and shorter wavelengths necessary to reach target emittance due to strong IBS effect
- Two wiggler prototypes
  - 2.5T, 5cm period, built and currently tested by BINP
  - 2.8T, 4cm period, designed by CERN/Un. Karlsruhe
- Current density can be increased by using different conductor type
- Prototypes built and magnetically tested (at least one by CDR)
- Installed in a storage ring (ANKA, CESR-TA, ATF) for beam measurements (IBS/wiggler dominated regime)
- Major DR performance item

K. Zolotarev WG 2, R. Maccaferri WG 2, S. Bettoni & D. Schoerling WG 2

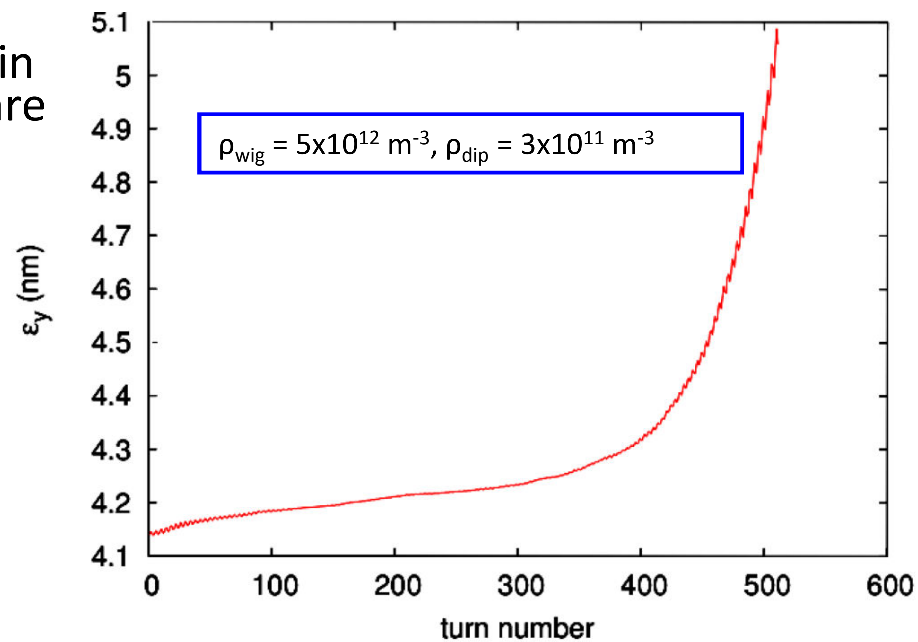
# Collective Effects in the DR

- Electron cloud in the $e^+$ DR
  - SEY below 1.3
  - 99.9% of synchrotron radiation must be absorbed in the wigglers
  - Cured with special **chamber coatings** (amorphous C chamber tested in CESR-TA)
- Fast ion instability in $e^-$ DR
  - vacuum pressure of 0.1nTorr
- Other collective effects in DR
  - Space charge (large vertical tune spread of 0.19 and 10% emittance growth)
  - Single bunch instabilities avoided with smooth impedance design (a few Ohms in longitudinal and MOhms in transverse are acceptable for stability)
  - Resistive wall coupled bunch controlled with feedback (1ms rise time)

J. Crittenden WG 2, M. Taborelli WG 2,
G. Rumolo WG 2

G. Rumolo et al., EPAC08

| Chambers | PEY | SEY | ρ [$10^{12}$ $e^-/m^3$] |
|---|---|---|---|
| Dipole | 0.000576 | 1.3 | 0.04 |
| | | 1.8 | 2 |
| | 0.0576 | 1.3 | 7 |
| | | 1.8 | 40 |
| Wiggler | 0.00109 | 1.3 | 0.6 |
| | 0.109 | 1.3 | 45 |
| | | 1.5 | 70 |
| | | 1.8 | 80 |



# Intra-Beam Scattering

A. Vivoli, M. Martini, WG 5

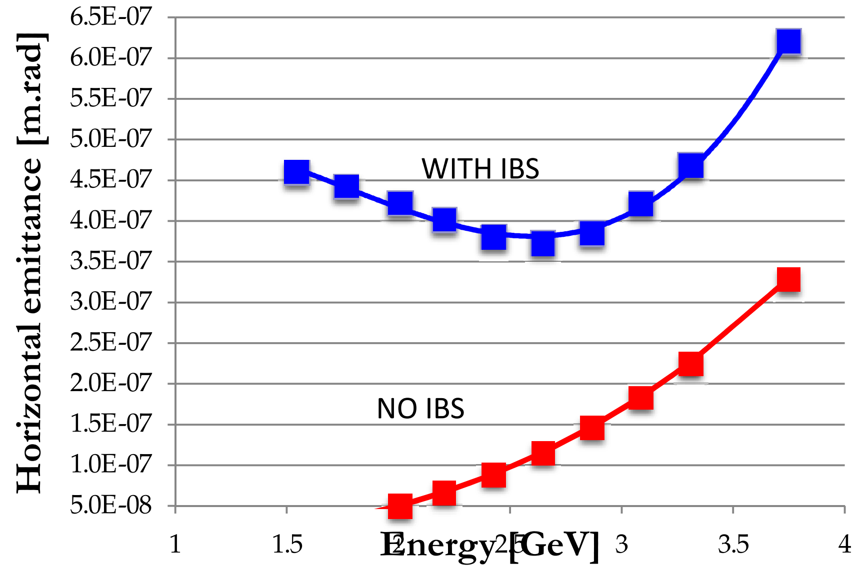
Multiple Coulomb scattering in a bunch

Important uncertainty of emittance in damping ring

Evolution of the emittance:

$$\frac{d\epsilon_k}{dt} = -\frac{1}{\tau_k}(\epsilon_k - \epsilon_k^0) + \frac{\epsilon_k}{T_k}$$

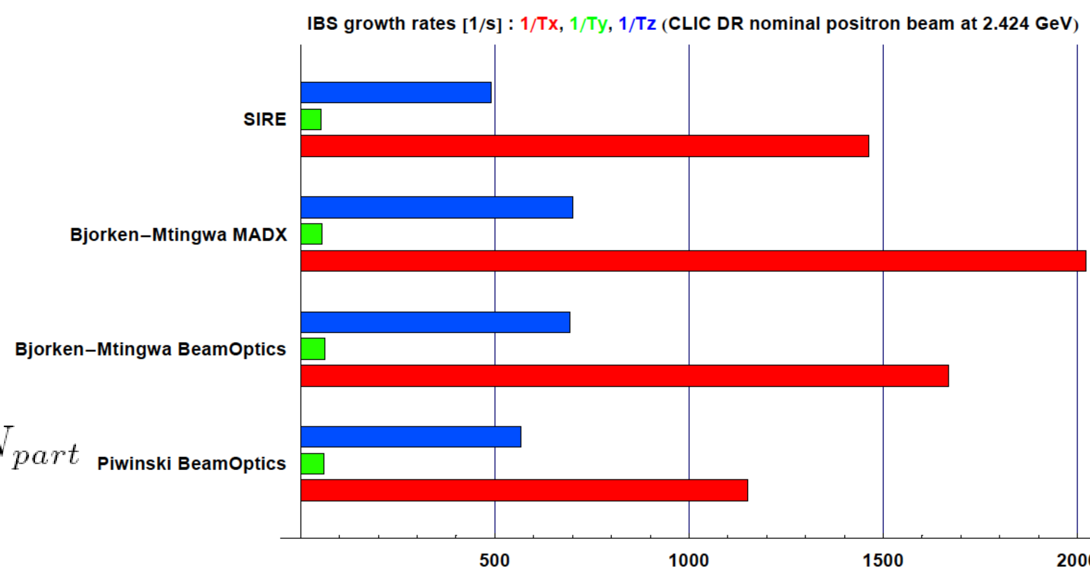
Radiation Damping | Quantum Excitation | IBS




SIRE: IBS calculated with the Zenkevich-Bolshakov algorithm (from MOCAC)

Damping und simplified quantum excitation added

$$\frac{d\epsilon_k^i}{dt} = -\frac{1}{\tau_k}(\epsilon_k^i - 2\epsilon_k^0) \qquad i = 1, \ldots, N_{part}$$



# Other Damping Ring Issues

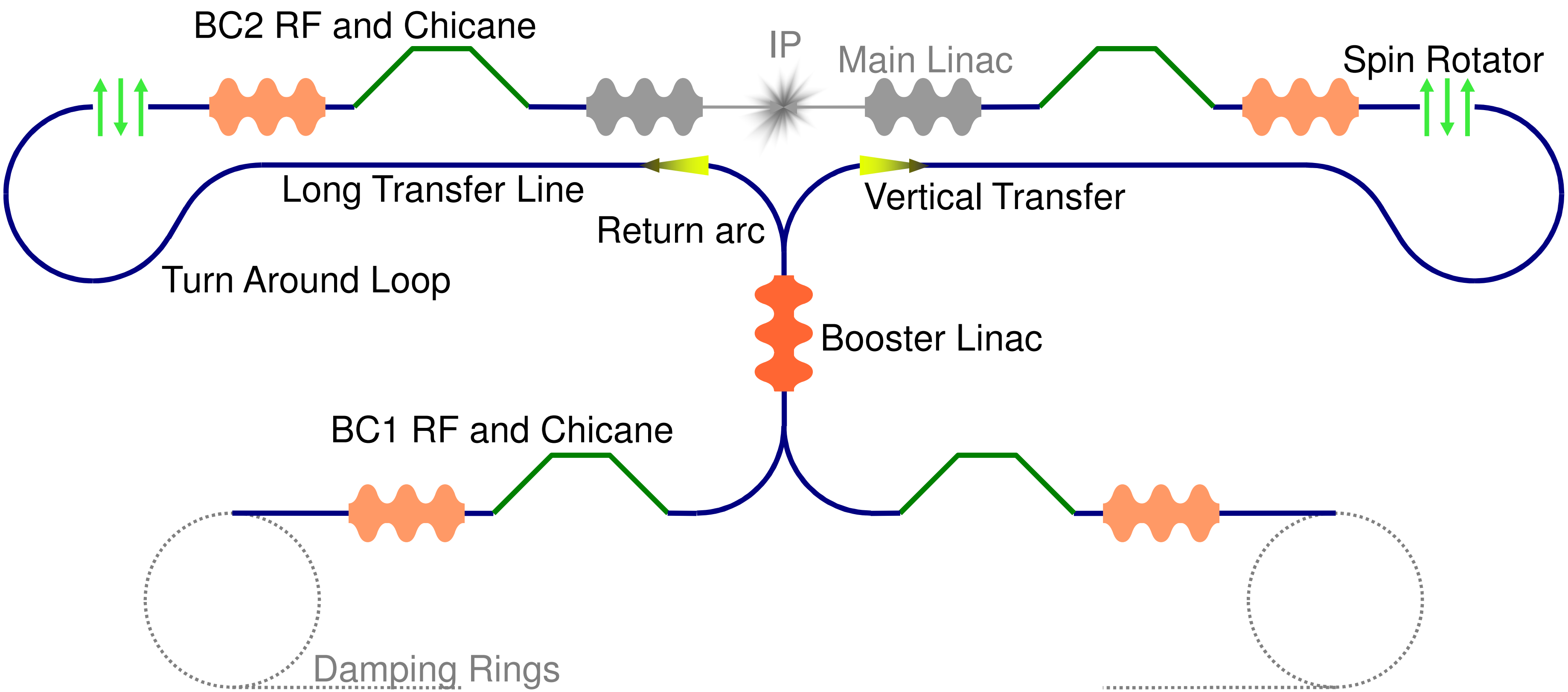
Y. Papaphilippou et al

- RF system present challenges with respect to transients and power source
- Stability of kickers tight but similar as for ILC, light sources (D. Alisini WG 2, M. Barnes WG 2)
- Beam instrumentation wish-list and crude specs established
- Scaled design of DR for CLIC @ 500GeV produced
- Formed group on CLIC/ILC common issues for DR (e-cloud and low emittance tuning)

Y. Papaphilippou WG 2, S. Guiducce WG 5, K. Zolotarev WG 5

# Ring to Main Linac Transport System (RTML)

F. Stulle et al. WG 3




not shown: Diagnostics, Collimation, Dispersion Correction, Coupling Correction, Spectrometers and Dumps

# RTML (cont.)

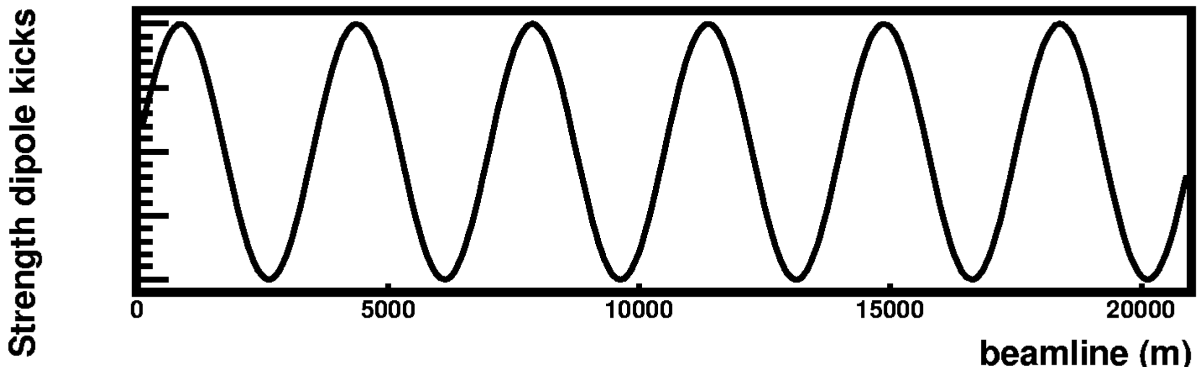
- RTML @CLIC500,
  requirements evaluated and decided to use same as nominal RTML
- Bunch compression system, i.e. BC1 and BC2,
  lattice existing, optimized to reduce RF wake fields and CSR
- Booster Linac,
  lattice existing, optimized with respect to wake fields (D. Wang, IHEP Beijing)
- Vertical transfer and return arc (K. Zengin?, Ankara University)
- Long transfer line, lattice created
- Turn around loop, lattice existing, revised due to beam dynamics issues
- Spin rotator, still open (N. Solyak, A. Latina?)
- Diagnostics sections, matching sections, collimation sections
- Simplified lattices for integrated studies available

- Tolerance and misalignment studies (S. Malloy, RHUL)
- Phase feedback concept

- People are missing

# Stray Fields in RTML

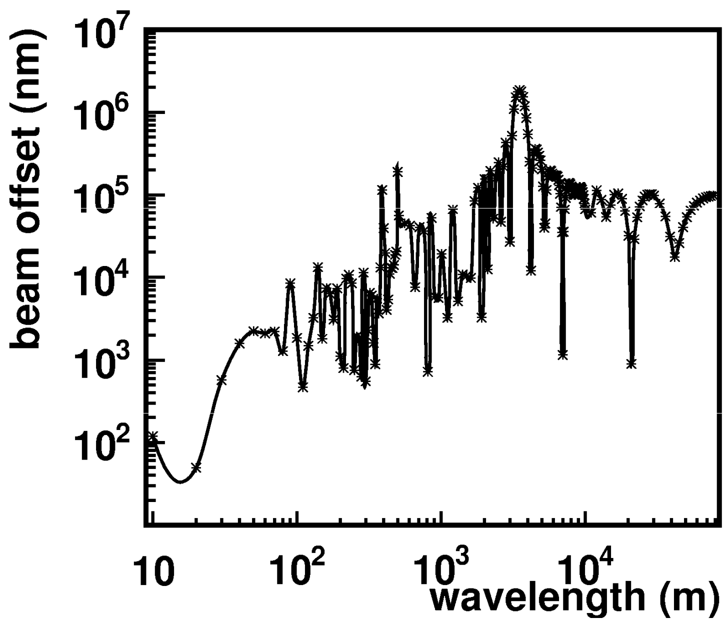
J. Snuverink, B. Jeanneret

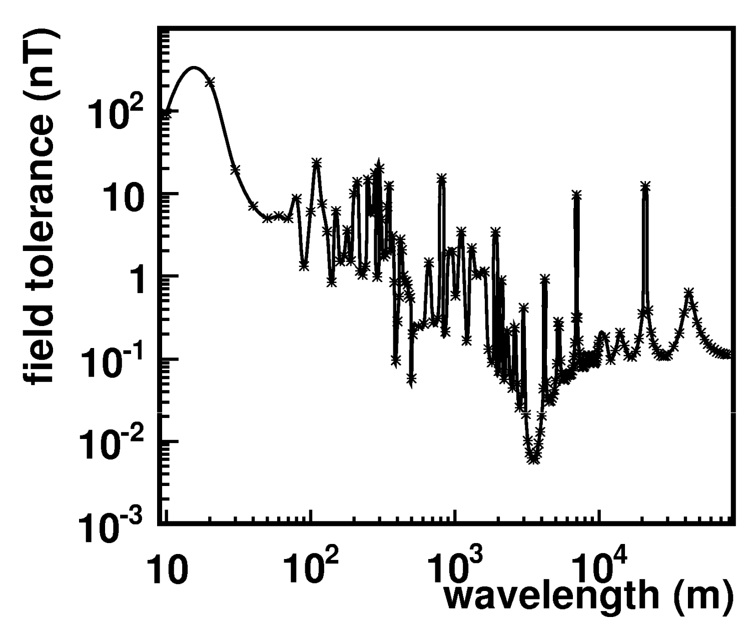



Simulated by grid of dipole kickers with 1m distance

See also C. Jach, WG3

Tolerance beam offset:
10% of geometrical emittance



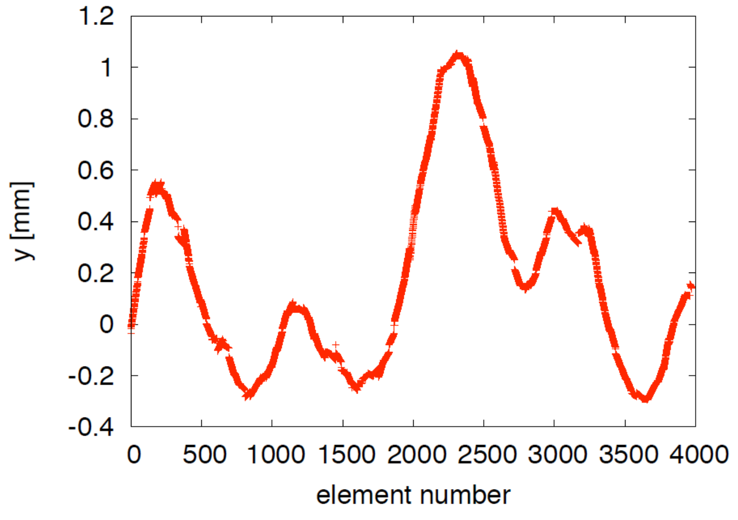

Started to collaborate with FNAL on measurements

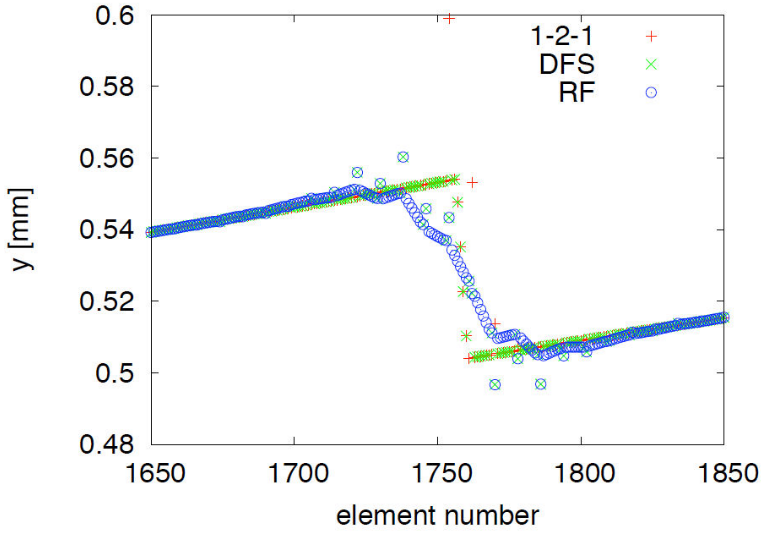
# Main Linac Pre-Alignment

- Prealignment tolerances are tight due to strong focusing -> high bunch charge -> high efficiency

- Simulations of reference line determination with wires by T. Touze (contains only long-range misalignments)
- Files are loaded into PLACET and full beam-based correction performed
- Impact on beam emittance is small
    - wire sensor resolution is relevant
    - number of pits for alignment with differential GPS is not important
- More studies to be done with improved wire modelling

| case | wire length | no of pits | sensor accuracy | $\Delta\epsilon_y[\mathrm{nm}]$ |
|---|---|---|---|---|
| 1a | 403.2 | 7 | 20 $\mu$m | 0.09 |
| 1b | 403.2 | 7 | 5 $\mu$m | $\approx 0.01$ |
| 2a | 400 | 2 | 5 $\mu$m | $\approx 0.01$ |
| 2b | 400 | 3 | 5 $\mu$m | $\approx 0.01$ |
| 2c | 400 | 6 | 5 $\mu$m | $\approx 0.01$ |



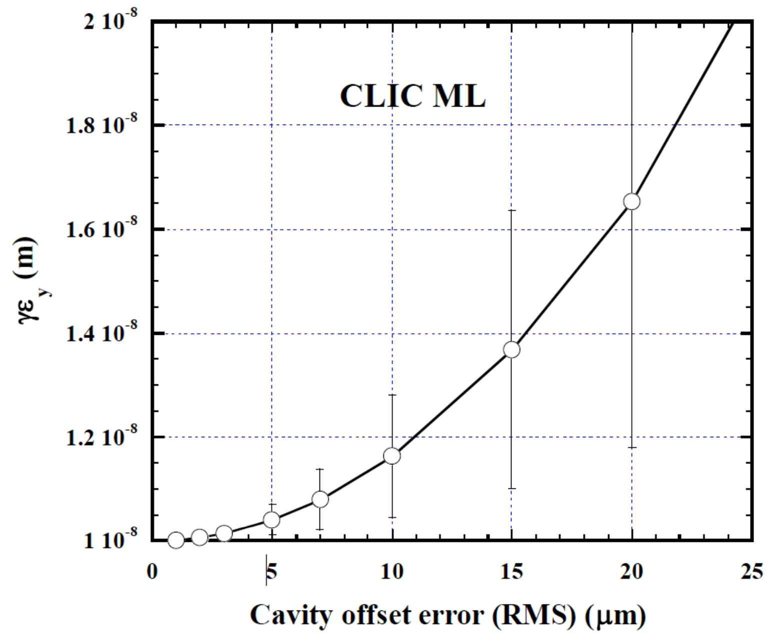




See also S. Guillaume WG 3, T. Touze WG 5, H. Mainaud Durand WG 5

# Main Linac Static Imperfections

K. Kubo

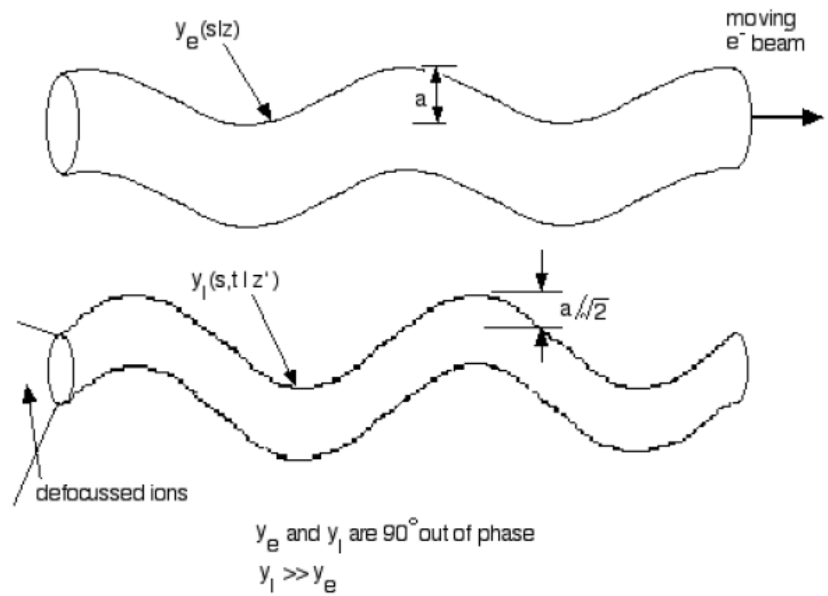
- Main linac predictions for emittance growth have been updated
  - Detailed definition of pre-alignment procedure
  - simulations of beam-based alignment
- Benchmarking of main linac results is ongoing
  - agreement seems good

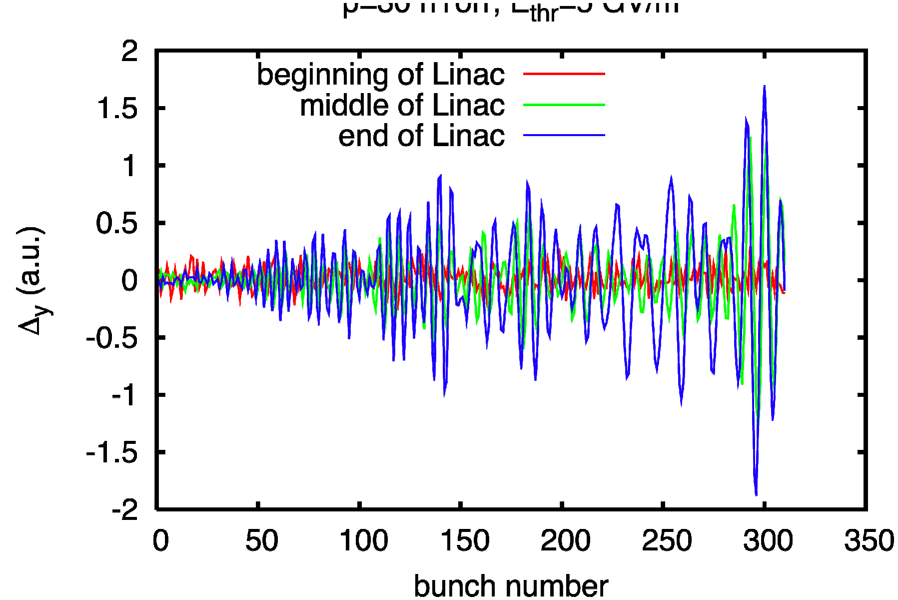



| imperfection | with respect to | symbol | value | emitt. growth |
|---|---|---|---|---|
| BPM offset | wire reference | $\sigma_{BPM}$ | 14 $\mu$m | 0.367 nm |
| BPM resolution | | $\sigma_{res}$ | 0.1 $\mu$m | 0.04 nm |
| accelerating structure offset | girder axis | $\sigma_4$ | 10 $\mu$m | 0.03 nm |
| accelerating structure tilt | girder axis | $\sigma_t$ | 200 $\mu$radian | 0.38 nm |
| articulation point offset | wire reference | $\sigma_5$ | 12 $\mu$m | 0.1 nm |
| girder end point | articulation point | $\sigma_6$ | 5 $\mu$m | 0.02 nm |
| wake monitor | structure centre | $\sigma_7$ | 5 $\mu$m | 0.54 nm |
| quadrupole roll | longitudinal axis | $\sigma_r$ | 100 $\mu$radian | $\approx$ 0.12 nm |

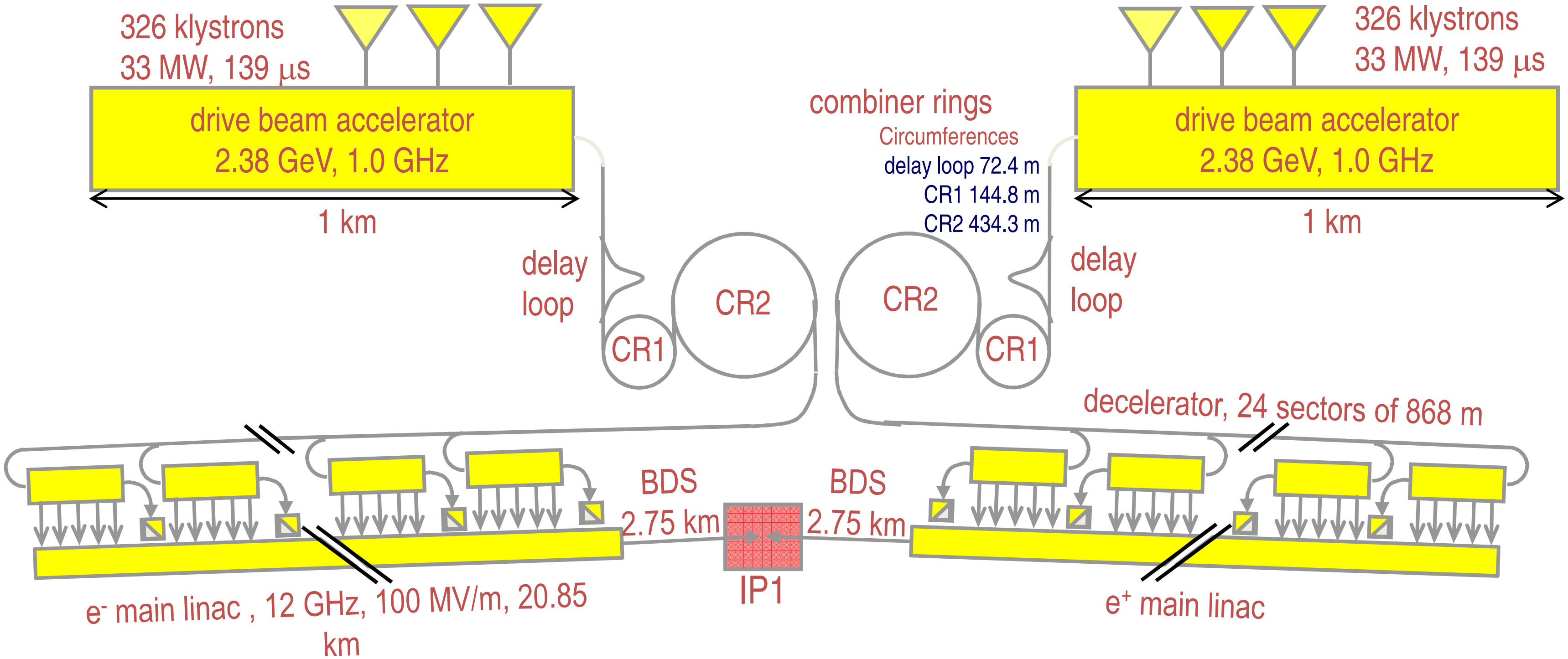
# Fast Ion Instability in the CLIC Main Linac

- Ions from rest gas can be trapped in the beam and can yield multi-bunch instability
  - Save value is 0.1nTorr
  - Can be done but difficult in main linac
- Studies with new FASTION code
- Scattering ionization:
  - $CO$, $CO_2$, $H_2O$ vacuum pressure of 50nTorr is on the limit
  - we specify 10nTorr
- Field ionization: simplified model implemented
  - Pressure needs to be reduced by a factor 2 (see right)
  - Need improved model
  - Vacuum specification may change




See G. Rumolo WG 2, 3 and 4



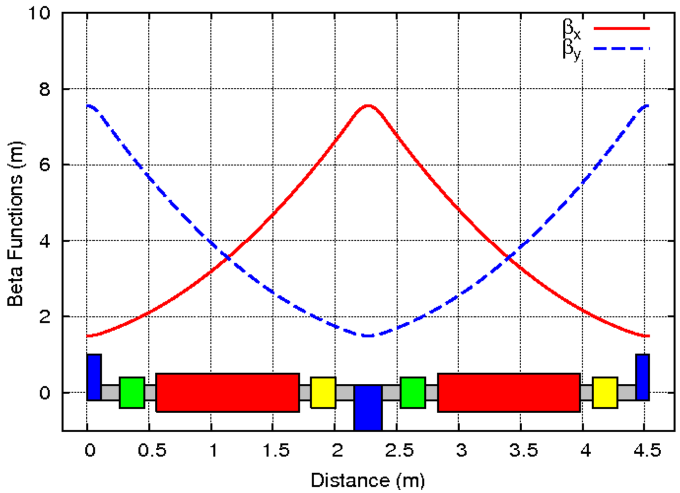

Drive beam injector, no design
Drive beam accelerator, in work
Bunch compression system, to come
Delay loop, in work
1rst combiner ring, advanced
2nd combiner ring, optimisation needed
Tranfer to tunnel
Long transfer line
Turn-around, improvements needed
Decelerator
Extraction

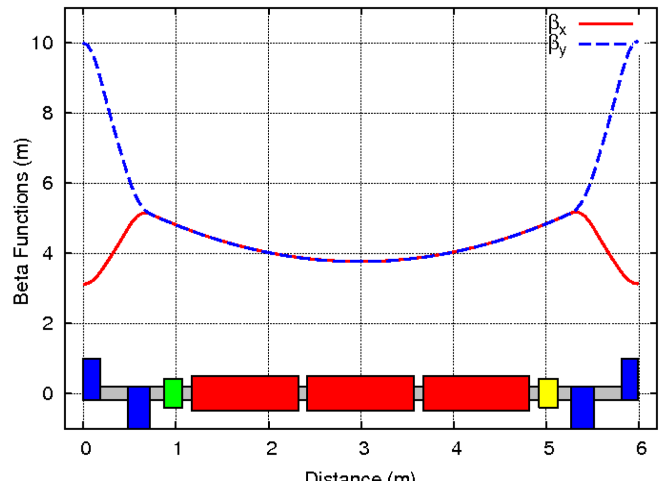
Phase feedback system
Longitudinal dynamics
Imperfections

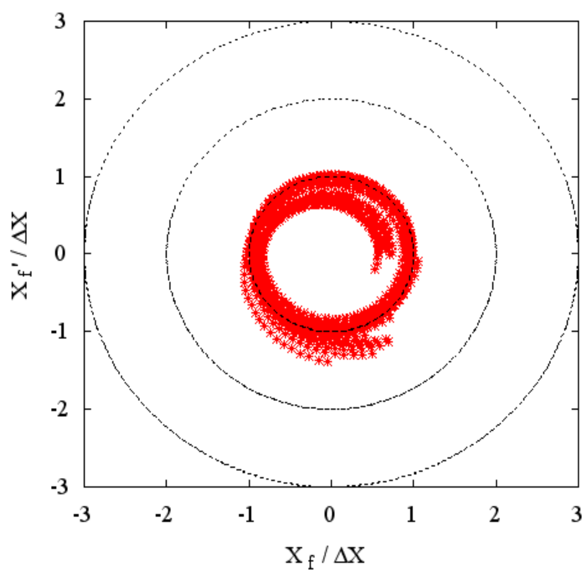
People are missing

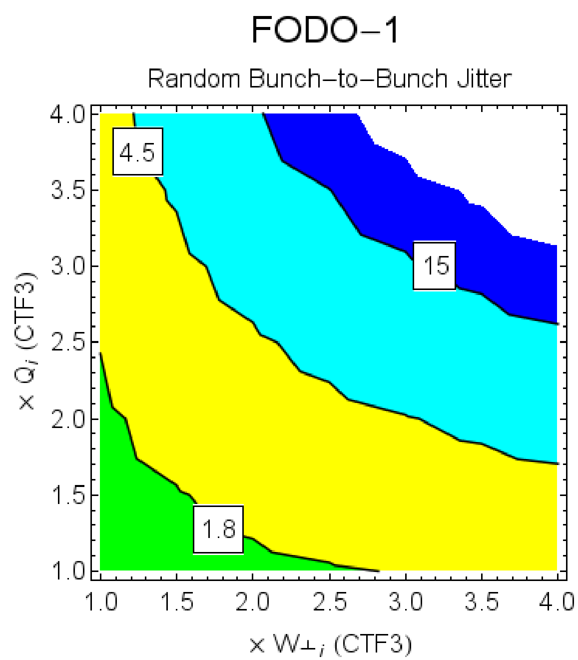
# Drive Beam Linac Design

Avni Aksoy WG 3



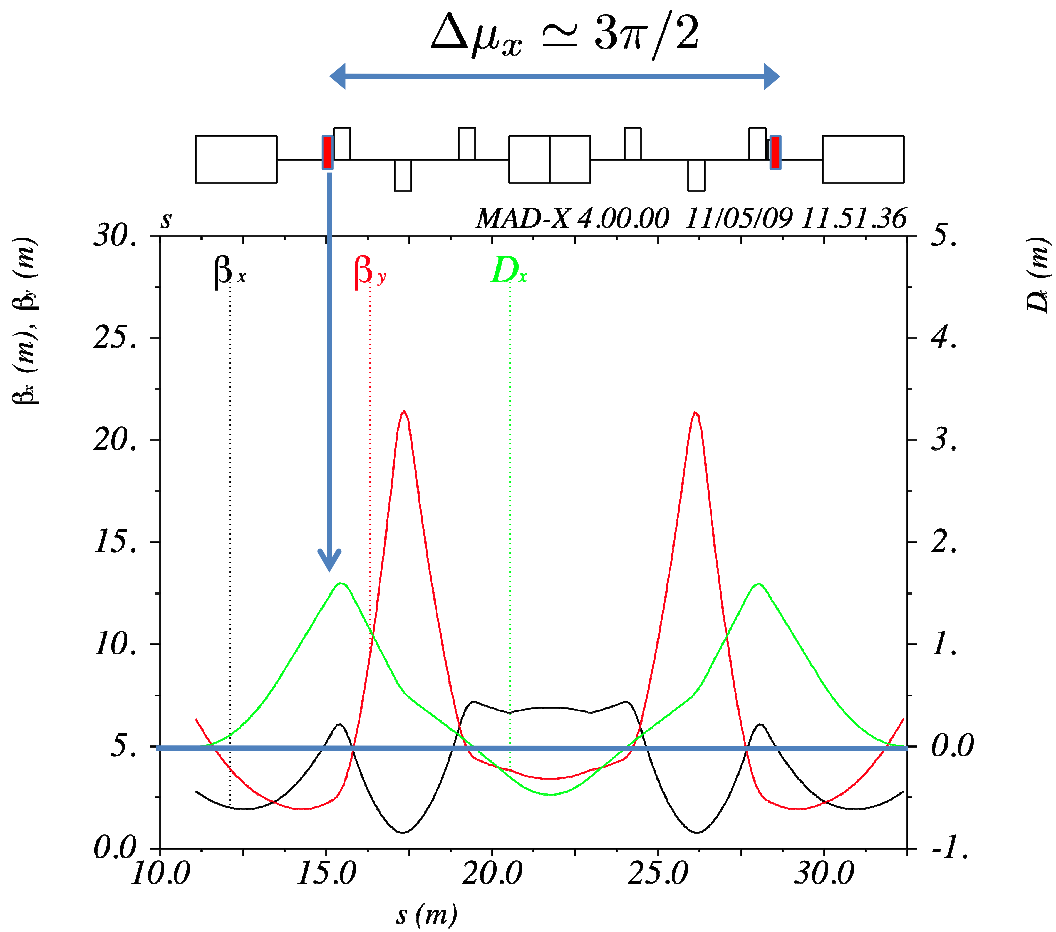




- Requires close interaction of RF (R. Wegner, E. Jensen et al.) and linac design
- Strong coupling of longitudinal and transverse requirements
- Last Design made many years ago for different parameters
- Important design activity that is starting again
- First put the tools into place

4 different type of lattices are taken into account

# CR1 Arc Cell

C. Biscari, B. Jeanneret PAC09




Dipoles and Quad-triplet :

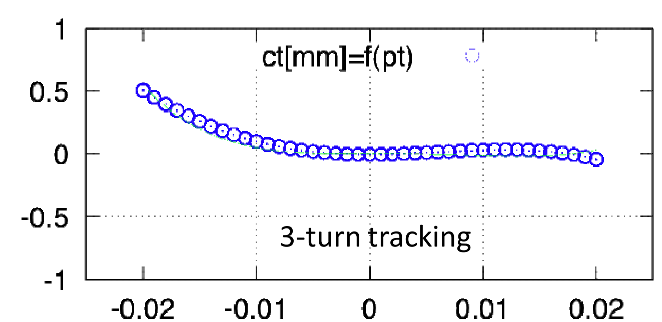
$$R_{56} = 0$$

Sextupoles : this optics allows one family :

$$T_{566} = 0$$

With good cancellation of geometric abberations and $Q'_x$ = -2 OK, $Q'_y$ = -13 barely OK

But remains a quite large 3rd order $\delta_p$- path length error :




More work , either:

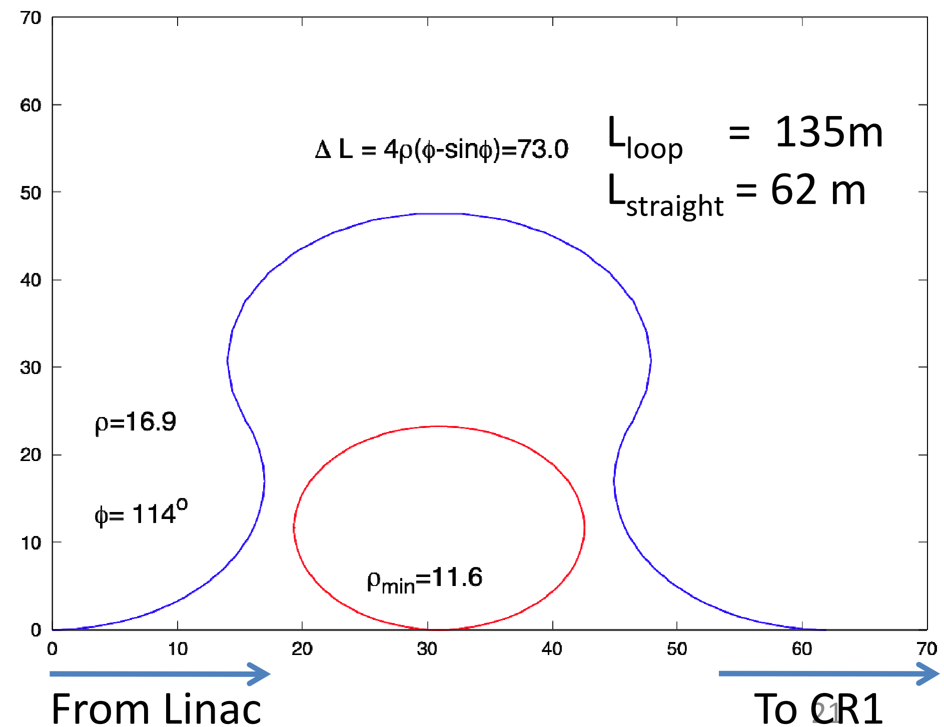
- Run off-momentum
- more flexible lattice
- Smaller $\delta_p$- band
- ...

# Delay Line and Turn-Around

C. Biscari, B. Jeanneret, F. Stulle

- Turn-around : Present length L=80m does not allow adequate chromatic correction in the transverse plane
  → length must grow to $L_{TA} \cong L_{CR1}$ = 146m
- Delay line : Presently : Layout is a ring
  - Constraint : $L_{DL}$ = 73 m (beam train length)
  - As with TA : transverse chromatic effects
  - SAME CURE :
    - longer length , with $\Delta L_{DL}$ = 73 m
- Go to a 'Ω' – shape :

Ω – shape :
- 2 variables : ρ and ϕ
- 1 constraint $\Delta L_{DL}$



# Dynamic Imperfections and Feedback

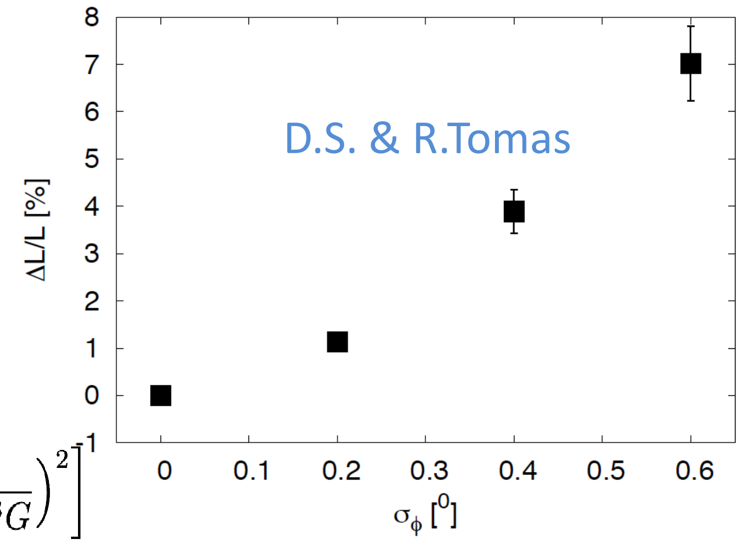
- Dynamic imperfections are an important concern of CLIC
  - The direct luminosity loss
  - Difficult to tune a machine that is moving all the time

| Source | budget | tolerance |
|---|---|---|
| Damping ring extraction jitter | 0.5% | kick reproducibility $0.1\sigma_x$ |
| Transfer line stray fields | ?% | data needed |
| Bunch compressor jitter | 1% | |
| Quadrupole jitter in main linac | 1% | $\sigma_{jitter} \approx 1.8\,\mathrm{nm}$ |
| RF amplitude jitter in main linac | 1% | $0.075\%$ coherent, $0.22\%$ incoherent |
| RF phase jitter in main linac | 1% | $0.2°$ coherent, $0.8°$ incoherent |
| RF break down in main linac | 1% | rate$< 3 \cdot 10^{-7}\,\mathrm{m}^{-1}\mathrm{pulse}^{-1}$ |
| Structure pos. jitter in main linac | 0.1% | $\sigma_{jitter} \approx 880\,\mathrm{nm}$ |
| Structure angle jitter in main linac | 0.1% | $\sigma_{jitter} \approx 440\,\mathrm{nradian}$ |
| Crab cavity phase jitter | 2% | $\sigma_{\Delta\phi} \approx 0.017°$ |
| Final doublet quadrupole jitter | 2% | $\sigma_{beam-beam} \approx 0.3\,\mathrm{nm}$ |
| Other quadrupole jitter in BDS | 1% | |
| ... | ?% | |

# RF Phase Jitter

Drive beam phase and current tolerance in decelerator

- Luminosity loss due to main beam (0.2° and 0.075% per fill time)
- Drive beam losses (approx 0.2% fluctuation bunch to bunch for 10 sigma)
- CTF3 shows about 0.1% current stability




$$\left\langle \frac{\Delta\mathcal{L}}{\mathcal{L}} \right\rangle = 0.01\left[\left(\frac{\sigma_{\phi,coh}}{0.2^o}\right)^2 + \left(\frac{\sigma_{\phi,inc}}{0.8^o}\right)^2 + \left(\frac{\sigma_{G,coh}}{0.75\cdot 10^{-3}G}\right)^2 + \left(\frac{\sigma_{G,inc}}{2.1\cdot 10^{-3}G}\right)^2\right]$$

Tolerance before feed-forward

- Assume phase noise reduction by factor 10
- Required capture range 10°=0.7mm
- Charge tolerance unchanged

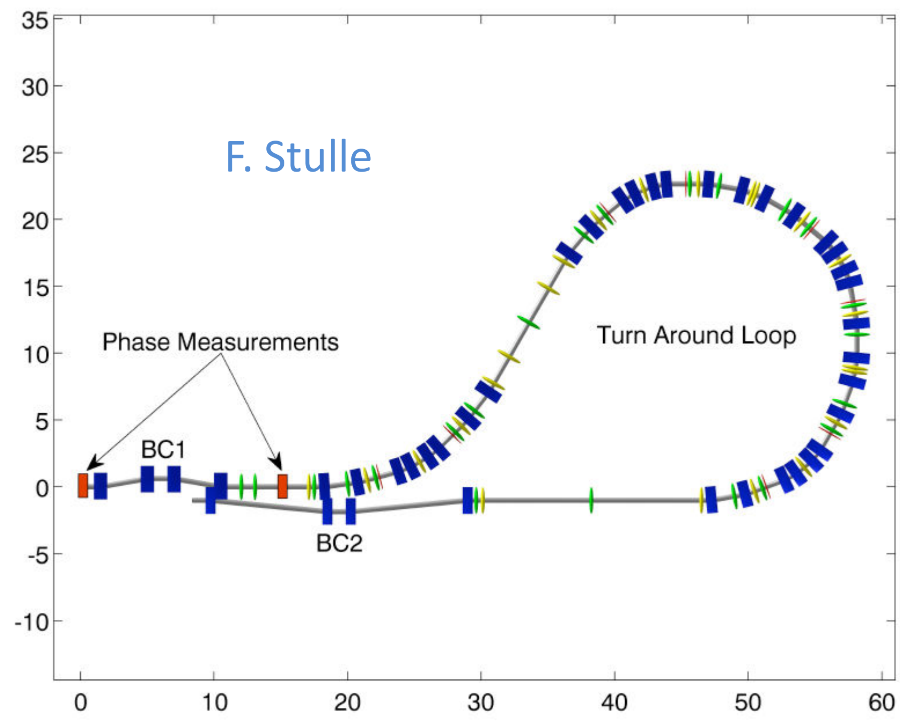
Need

- Timing reference (J. Sladen et al., need more)
- Feedback design
- Phase monitor (EUCARD)
- Kickers and amplifiers (Phil Burrows et al.)

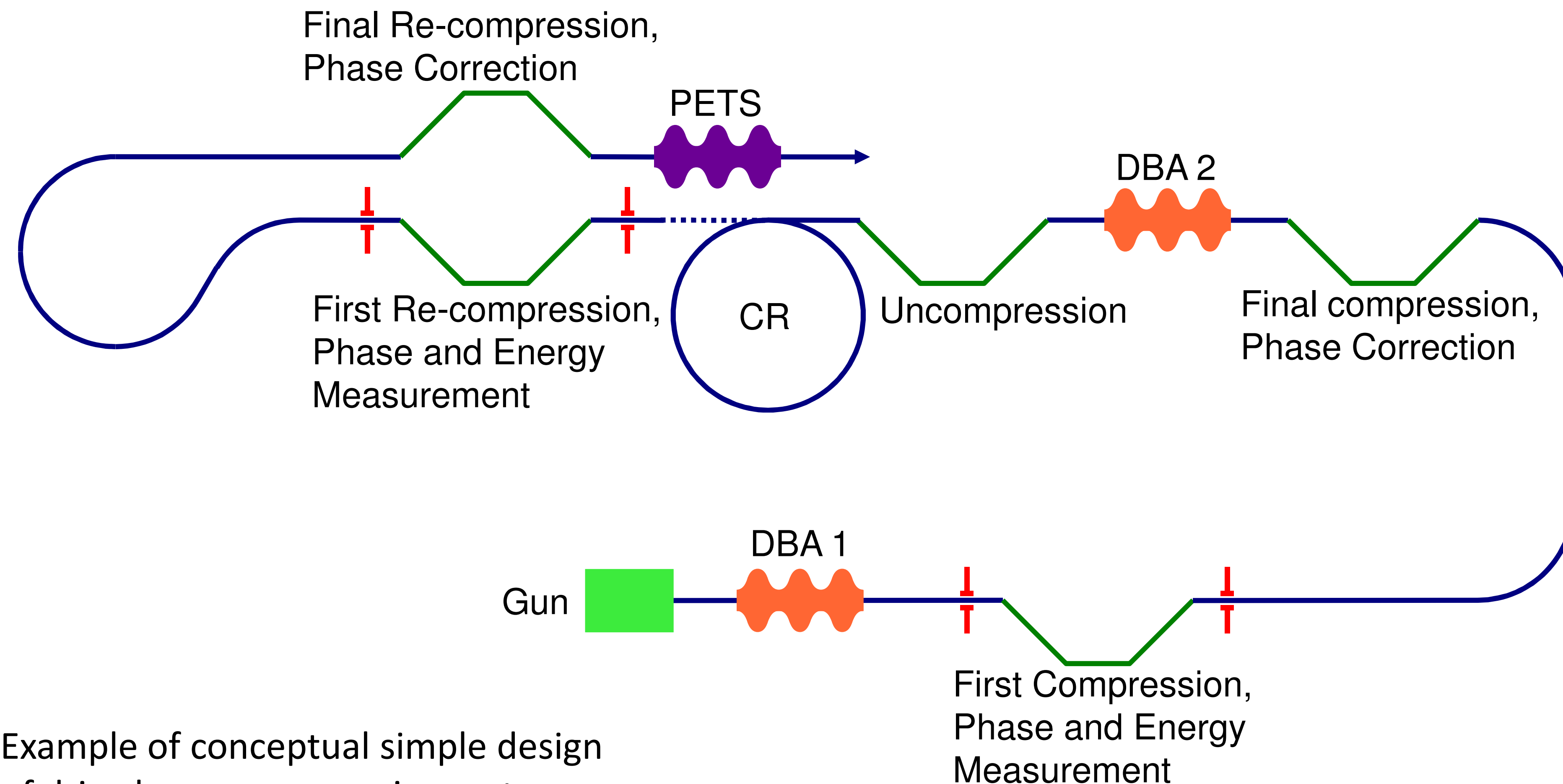
See talks this workshop :

-WG3 : M. Felber, O.Ilday, V. Arsov, F. Stulle

-WG5 : A. Anderson, B.Jeanneret



# Drive Beam Phase Stabilization




Example of conceptual simple design of drive beam compression system

- Gradient tolerance 0.5 $10^{-4}$
- Current tolerance $10^{-3}$
- Phase tolerance 0.2°

Need to choose conceptual design and make full design

Have to optimise for feed-forward or feedback between DBA1 and DBA 2

Tradeoff between different jitter sources klystron phase and amplitude, beam phase and intensity

# More Phase Stabilization

Other sources of phase noise need to be investigated
e.g. magnet strength jitter

Energy jitter from booster linac is a concern
Main beam phase tolerance in ML 0.1°
Can be addressed by using two-stage compression system (as proposed for drive beam CLIC-Note-598)

$$M = \begin{pmatrix} R_{55} & R_{56} \\ R_{65} & R_{66} \end{pmatrix} = \begin{pmatrix} 1 & R_{56}^{(2)} \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ U^{(2)} & 1 \end{pmatrix} \begin{pmatrix} 1 & R_{56}^{(1)} \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ U^{(1)} & 1 \end{pmatrix}$$

$$M = \begin{pmatrix} \frac{\sigma_{sf}}{\sigma_{si}} & 0 \\ 0 & \frac{\sigma_{si}}{\sigma_{sf}} \end{pmatrix}$$

This system can be tuned to decouple final phase from initial energy
But still can get compression

F. Stulle, WG 3

Realistic system needs to be investigated (non-linearities)

# Orbit Stability and Feedback

Orbit stability is a concern for the main beam
Ground motion, technical noise, dynamic stray fields, RF jitter etc.
Integrated study is essential

- Open issue for RTML
- Main linac feedback system defined
- Some simplified studies for BDS feedback system
- Some work on beam-beam feedback
- Some work on intra-pulse feedback

Close collaboration with stabilisation working group (C. Colette, B. Bolzon et al.) layers of feedback

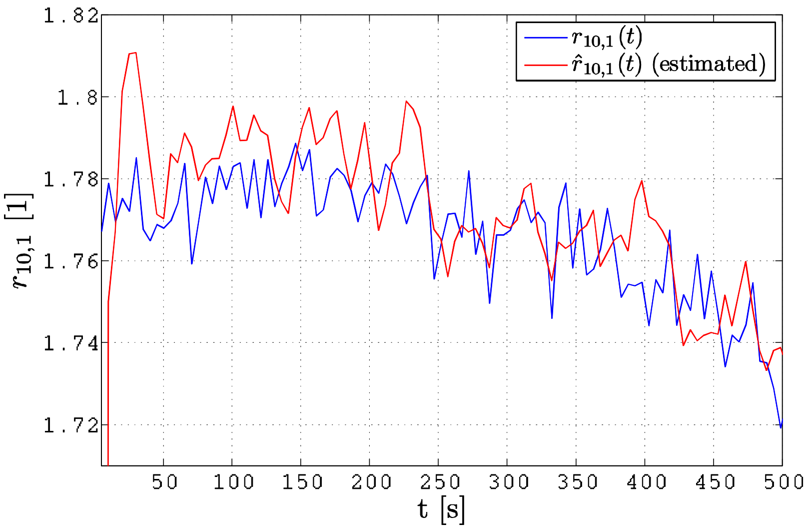
Feedbacks help at some frequencies but do harm at others
Optimal control required
But uncertainty of system knowledge is important

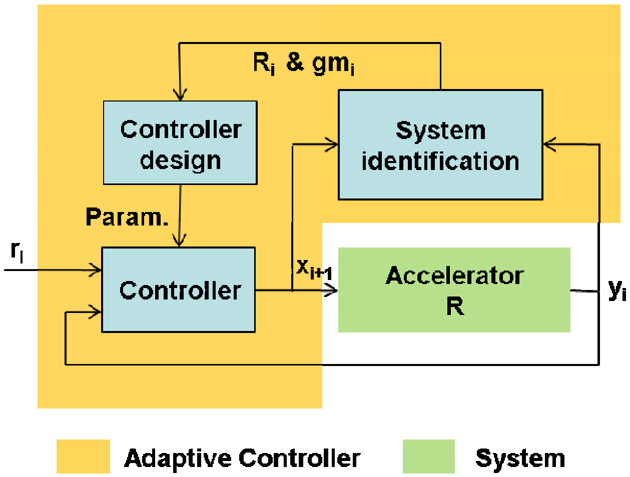
# Progress of the Beam-Based Feedback

J. Pfingstner, WG 5

Adaptive control:

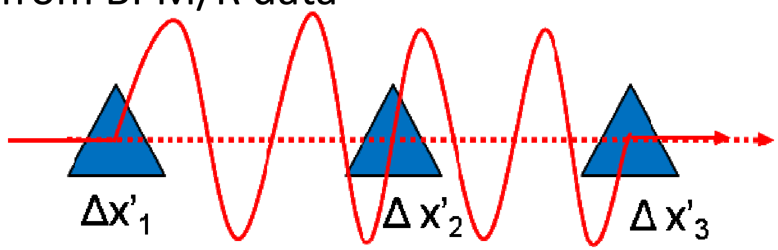
- Previous approaches balance very well noise and correction speed.
- However, system changes are not taken into account.
- **Adaptive controller scheme (STR)**




Just parts of R can be estimated. **Rest** has to be **interpolated**

- Transient Landau damping model
- - Algorithm to calculate phase advance from BPM/R data

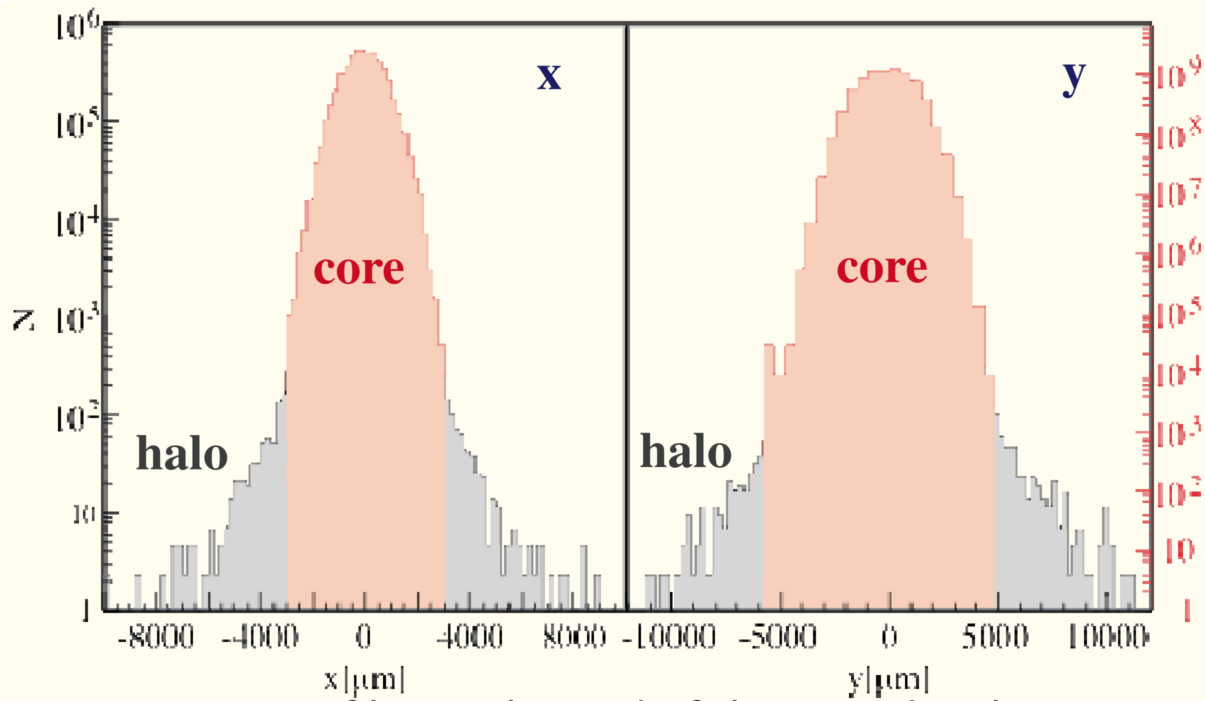


# Halo and Tail HTGEN

**HTGEN : code repository, standalone + fully integrated in PLACET**
**all relevant information and manual on http://hbu.home.cern.ch/hbu/HTGEN.html**
**2009 : major upgrade and rewrite of the HTGEN-PLACET interface**
**now allows halo generation for sliced beams**
by Miriam Fitterer, Erik Adli, Barbara Dalena, Helmut Burkhardt

in addition to LINAC and BDS now possible to apply halo generation to the CLIC drive beam

Plans:
Revisit muon background
Benchmarking at CTF3
Hep needed




Transverse profiles at the end of the CLIC decelerator for 10 nTorr rest gas
Only $10^{-7}$ of the particles are lost

 H. Burkhardt, WG3

# PLACET Main Updates

- Improvements of existing routines and documentation:
  - Benchmarking of tracking in post collision line with DIMAD (I. Ahmed A. Ferrari)
  - Benchmarking of bunch compressor with ELEGANT (F. Stulle)
  - Output files and routines improved (header, columns) (A, Latina, J. Pfingstner, B. Dalena)
  - Documentation, last update 9th April 2009 (B. Dalena)
  - Placet_BC2_Example in the distributed version ( F. Stulle )
- Improved modelling and interface
  - Collimator wakefield fixed (B. Dalena-J. Snuverink) and A. Toader wakefield method added (B. Dalena)
  - Command PhaseAdvance (J. Pfingstner)
  - TestRFAlignment and 6d transport matrixes (A. Latina)
  - Girder pitch optimization (ILC), placet-octave (A. Latina)
  - RF-kick and wakefield kicks from couplers (ILC) (A. Latina)
  - Tracking of the halo particles in PETS and Cavity, interface improved (M. Fitterer, H. Burkhardt)
  - Tracking in solenoid field exists as stand-alone program, integration is ongoing (B. Dalena)
- Other improvements and bug fixes
  - Placet-htgen-octave binary (B. Dalena)
  - AML interface (A. Latina)
  - Placet-development and placet-htgen makefile separated (B. Dalena)
  - Fixed gcc compiler warning (J. Snuverink)

# Conclusion

- Many topics left unmentioned, e.g.
  - BDS and drive beam decelerator come next
  - Participation into definition of 500GeV machine(s)
  - Parameter specifications, contributions to costing and system optimisation
  - Luminosity spectrum and background studies (WG 1+3)
  - Multi-bunch studies (e.g. resistive wall …)
  - Contributions to machine protection (mainly future see M. Jonker et al. WG 5)
  - Running the 3TeV version of CLIC at lower energies (WG 1+3)
  - Finalisation of EUROTeV
  - ILC collaboration not detailed

- Excellent progress after last workshop
- A number of outstanding issues
  - Tough to address them all before end of 2010
- Excellent team
  - But too few people
    - Continued work in all areas
    - Full drive beam design
    - Full RTML design
    - Phase feedback
    - Integrated orbit feedback
  - You are invited to join

# software availability

- In /afs/cern.ch/eng/sl/clic-code/software:

| | |
|---|---|
| bin → | binary: guinea, placet-htgen, placet-development, placet-octave, placet-htgen-octave, grid, ground, mad2gp |
| env.csh<br>env.sh → | To set up the enviroment |
| gp → | Guinea-Pig compiled with fftw-2.1.5 |
| gsl-1.9 → | GSL library version 1.9 |
| htgen | https://savannah.cern.ch/cvs/?group=htgen |
| octave-3.0.1 | Octave library version 3.0.1 |
| placet-development | latest version of placet |
| placetinstaller | Placet/GSL/Octave/Htgen **installer** |
| repository | Placet, GSL, Octave tarball |

- All the binary are exported in your $PATH by typing: #> source /afs/cern.ch/eng/sl/clic-code/software/env.(c)sh on your desk at CERN
- Latest PLACET and GUINEA-PIG tarball can be download by this web site: [http://project-placet.web.cern.ch/project-placet/](http://project-placet.web.cern.ch/project-placet/)
- The head version can be downloaded from CVS PLACET repository https://savannah.cern.ch/projects/placet/

# Halo and Tail HTGEN (cont.)

**Plans :**

**Revisit muon background**

- **check the need for muon stoppers / tunnel fillers**
- **question of betatron / momentum collimation first**
- **combined study HTGEN + PLACET + BDSIM**

**Looking for help / collaboration** **--> more details, talk by H.B. on Wednesday.**

**Benchmarking with CTF3 measurements, collaboration with MPI HD**

**Recent HTGEN related references :**

**PAC 2009,** *Halo and Tail Simulations with Application to the CLIC Drive Beam*, M. Fitterer et al. WE6PFP085

**PRSTAB 12.081001 Agapov et al.,** *Tracking studies of the Compact Linear Collider collimation system*

**Miriam Fitterer Diploma Thesis**, University of Karlsruhe, Sept. 2009

*Modelling of Halo and Tail Generation in Electron Beams*