Summary of BDYN

Summary of four sessions

- Challenges for Future Machines
- Experiences from Test Facilities
- Codes and Simulations
- Individual Studies

Challenges for Future Machines (Ph. Burrows)

- Beamdynamics and Instrumentational Challenges for CLIC (D. Schulte)
- Beamdynamics and Instrumentational Challenges for the X-FEL (T. Limberg)

Experiences from the Test Facilities (V. Ziemann)

- Experiences from TTF (K. Floettmann)
- Experiences from CTF3 (R. Corsini)
- Luminoisty Monitoring (A. Stahl)

Codes (C. Biscari)

- Overview of Codes Simulating Injectors (M. van der Wiel)
- Overview of Codes Simulating Plasma Acceleration (G. Maynard)
- Overview of Codes Simulating Secondary Particles (G. Blair)
- An Example of Integrated Simulations (G. White)

Individual Studies (T. Limberg)

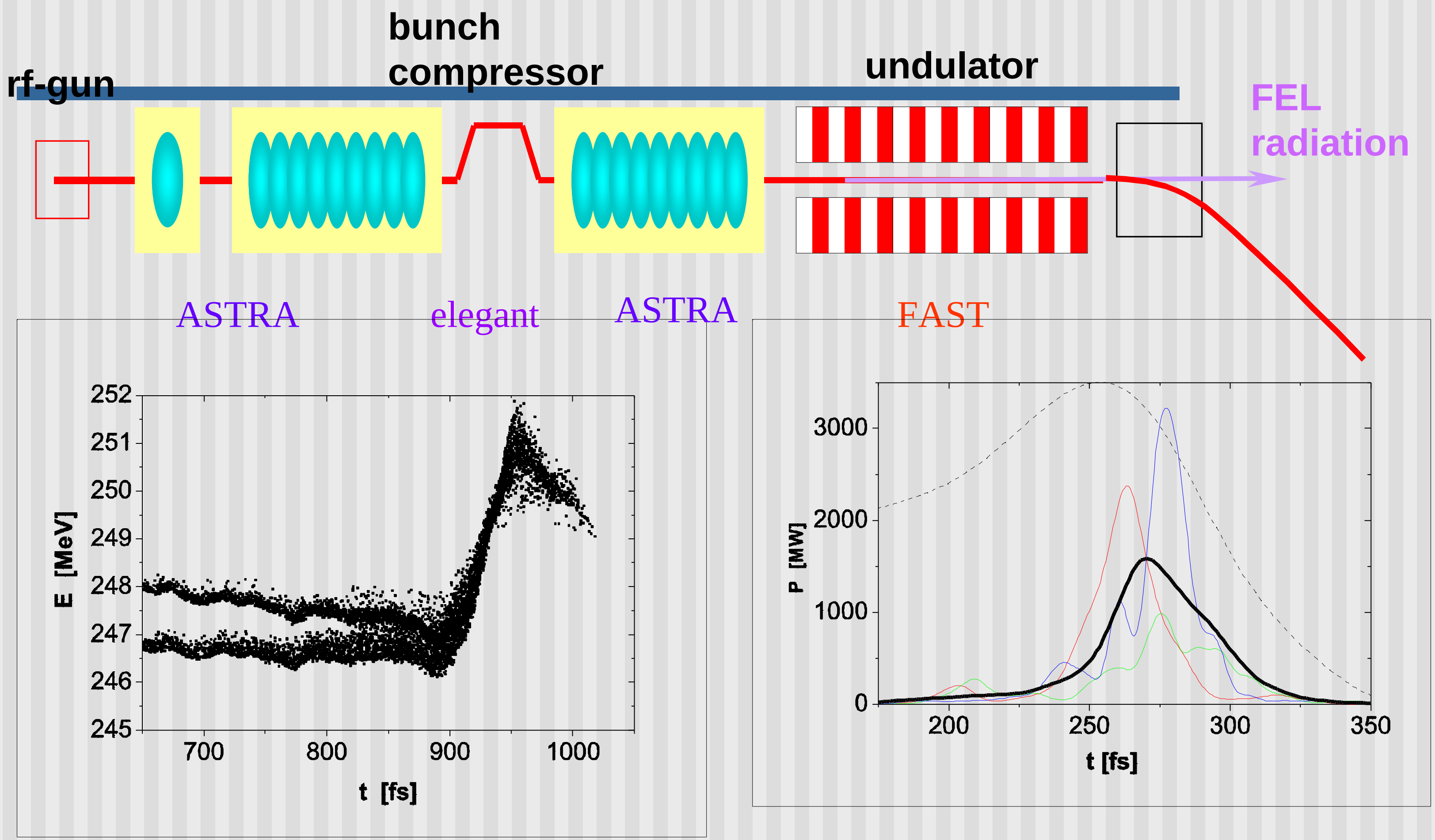
- The TESLA Damping Ring Emittance (W. Decking)
- The CLIC Combiner Ring (C. Biscari)
- Status of the TESLA BDS (D. Angal-Kalinin)
- Non-Linear Collimation for CLIC (J. Resta-Lopez)
- Post Collision Line for CLIC (V. Ziemann)
- Intra-Pulse Feedback (Ph. Burrows)

Start to End Simulations of TTF1 (K. Floettmann)

- Can simulation reproduce the lasing of TTF1?
- Substructure of bunches is important
- First simulation with Gaussian bunches did not give full agreement
- More detailed studies
- Very impressive agreement found

„Full physics“ start-to-end simulations:

General review



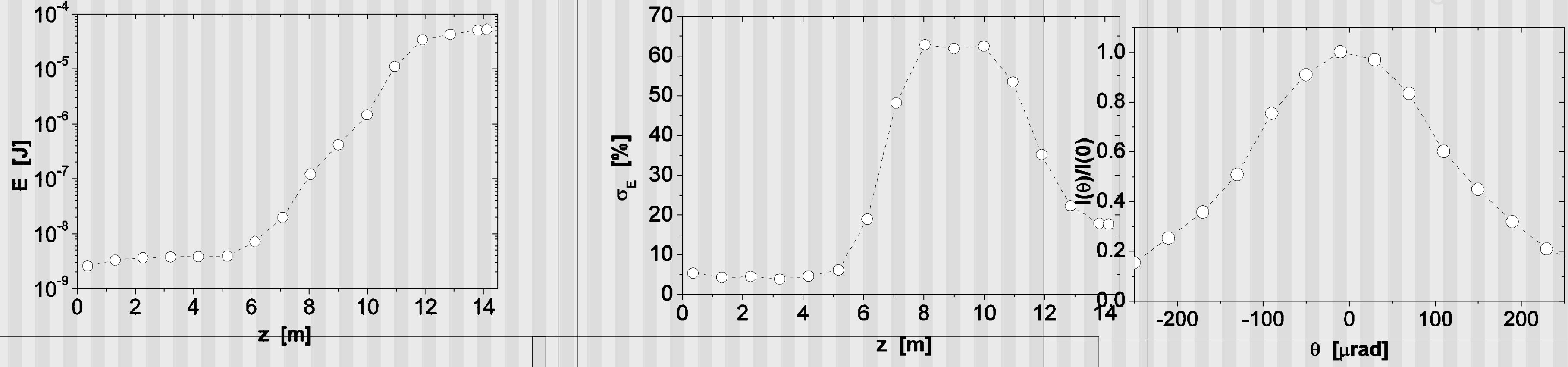
ASTRA (DESY) - space charge dominated electron beams

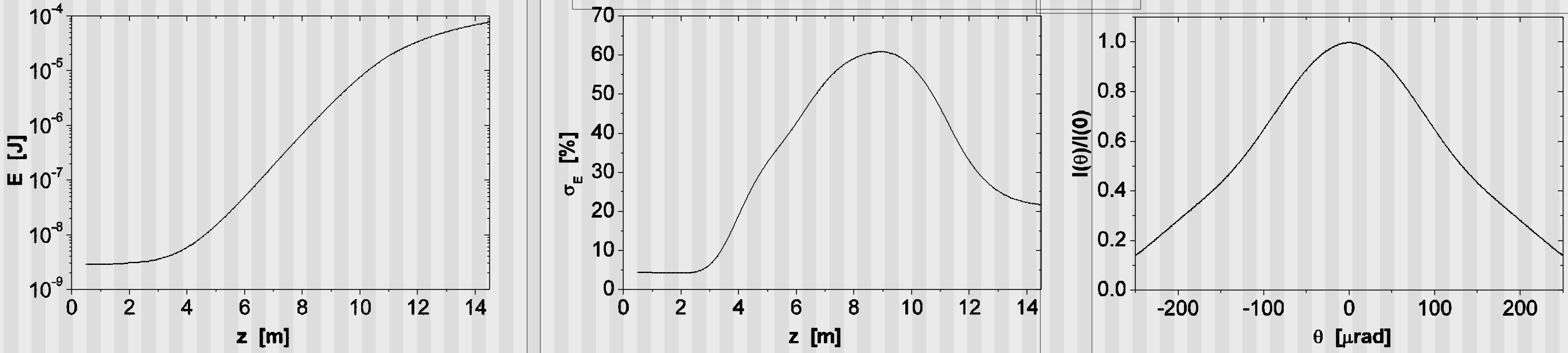
elegant (Argonne Natl. Lab.) - electron beam tracking in BC (including CSR)

FAST (DESY/JINR) - simulation of SASE FEL

„Full physics“ start-to-end simulations:
TTF FEL: experimental results versus simulations

TTF FEL: experimental results





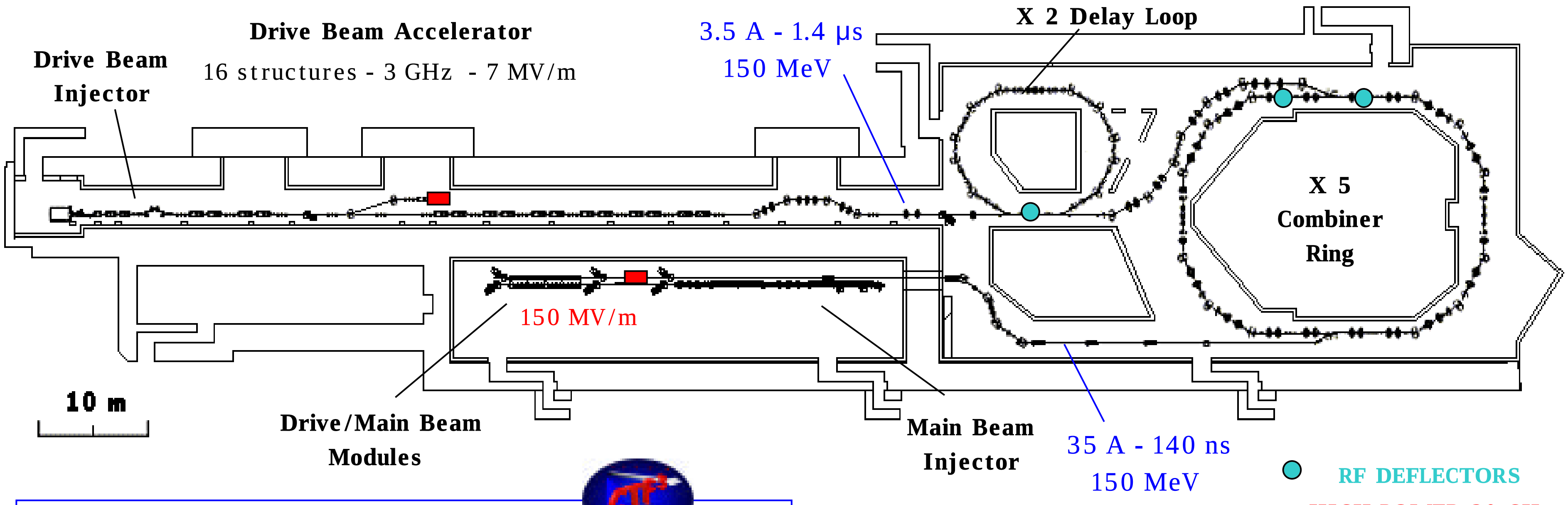
Start-to-end-simulations

Experiences at CTF3 (R. Corsini)

- Aim is to demonstrate CLIC drive beam generation
- Fully loaded drive beam accelerator
- Delay loop
- Combiner ring
- Provide power for 30GHz structure tests
- Later also decelerator test
- Comparable to PARMELA

CTF3 NOMINAL PHASE

- Provide 30GHz power
- Test drive beam generation



CTF3 COLLABORATION

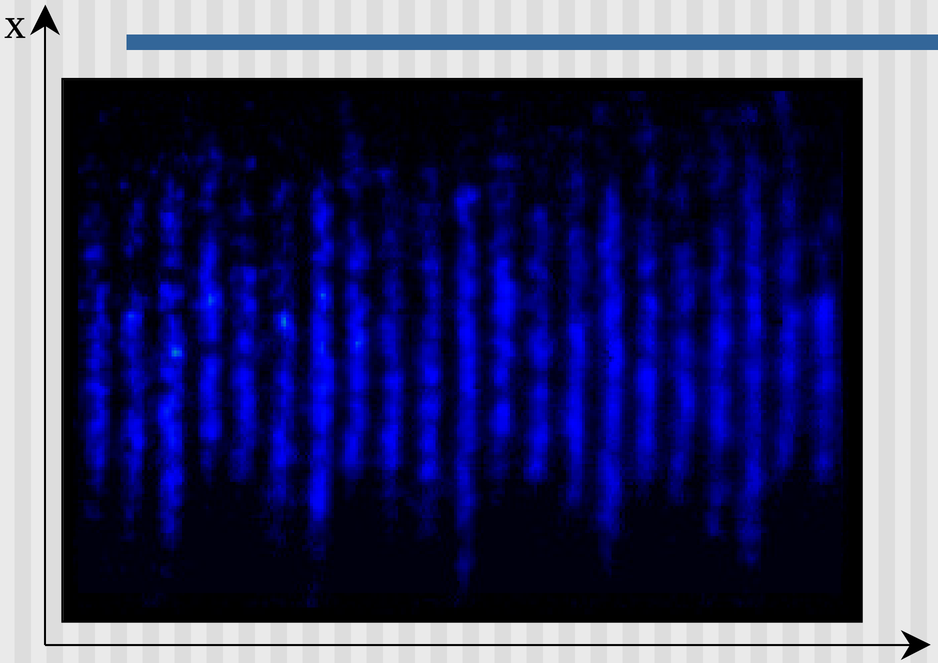
CERN, Geneva (Switzerland) Northwestern University, (USA)

INFN , Frascati (Italy) SLAC , San Francisco (USA)

LAL , Orsay (France) Uppsala University , (Sweden)

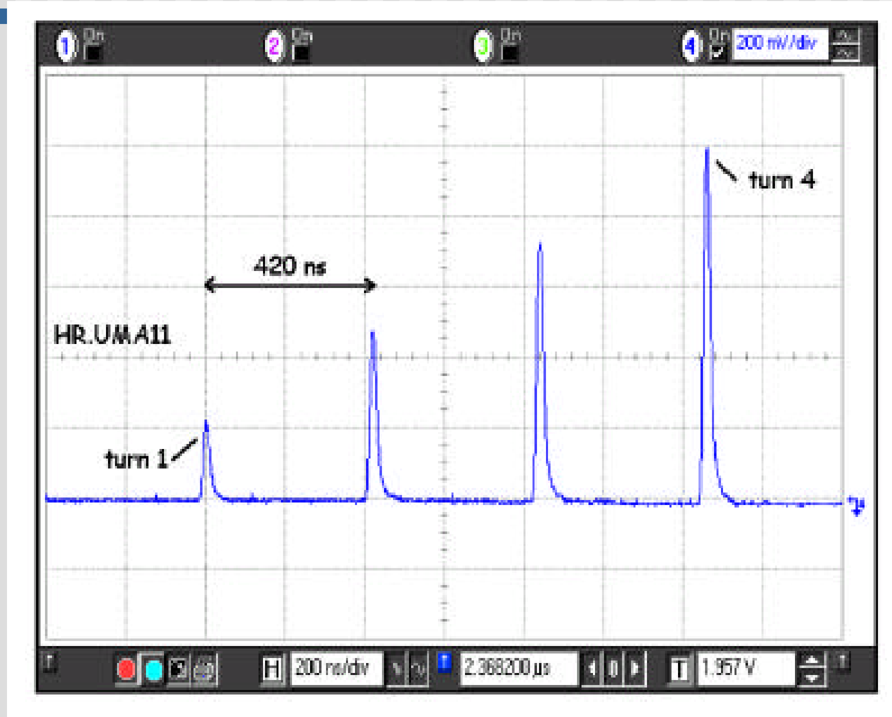
CTF3 PRELIMINARY PHASE – BUNCH COMBINATION

Combination factor 4

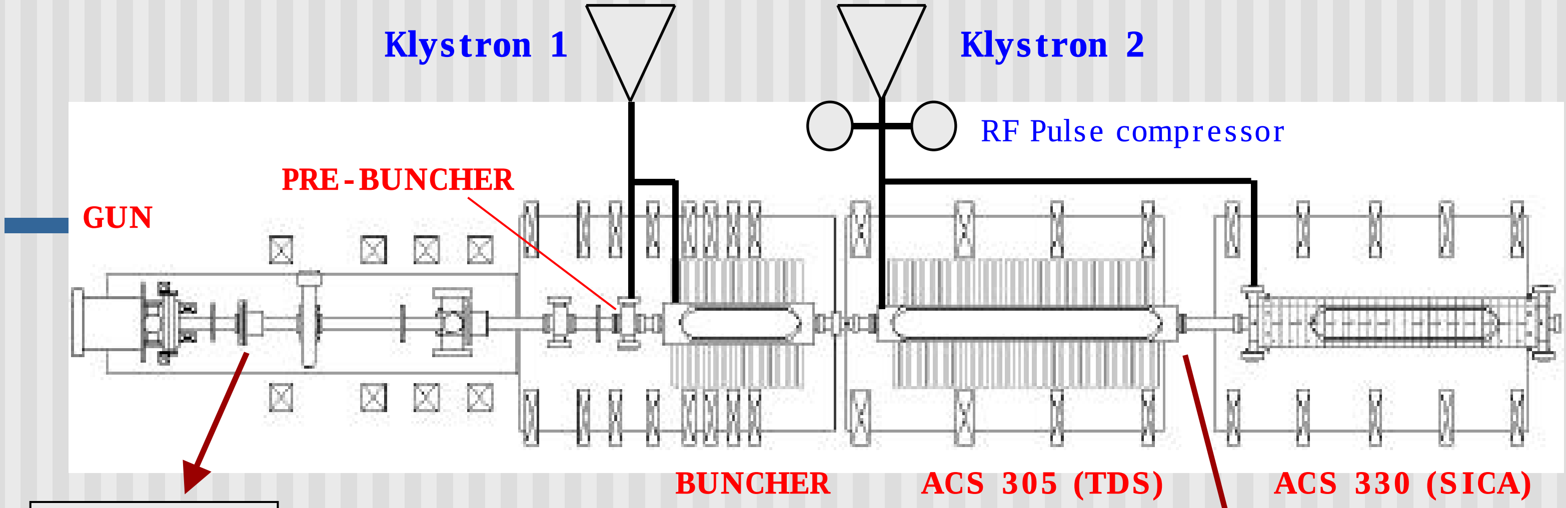


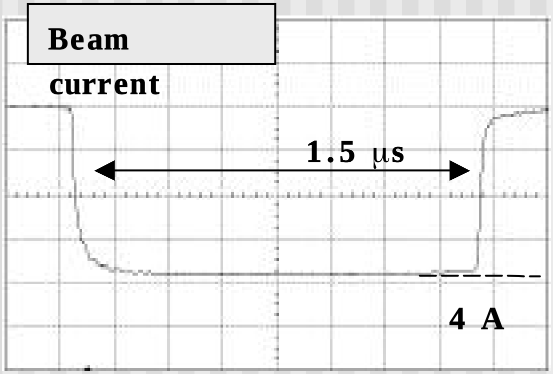
Streak camera images of the beam at different turns, illustrating the bunch combination process

(260 mm/ps scale)

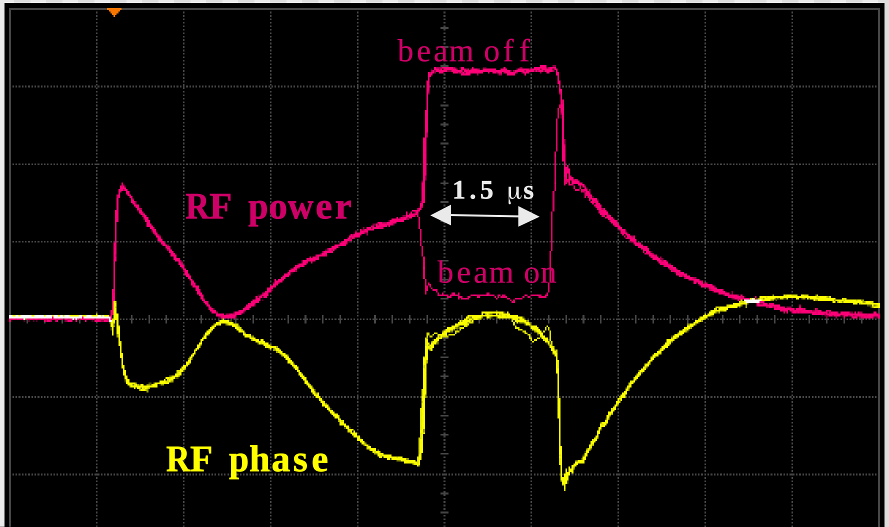


Beam current circulating in the ring measured during combination with a beam current monitor





Beam current	4 A
Beam pulse lenght	1.5 μs
Power input/structure	35 MW
Ohmic losses (beam on)	1.6 MW
RF power to load (beam on)	0.4 MW
RF-to-beam efficiency	~ 94%
Phase variation along pulse	±4°



RF signals / output coupler of structure ACS305 (TDS)

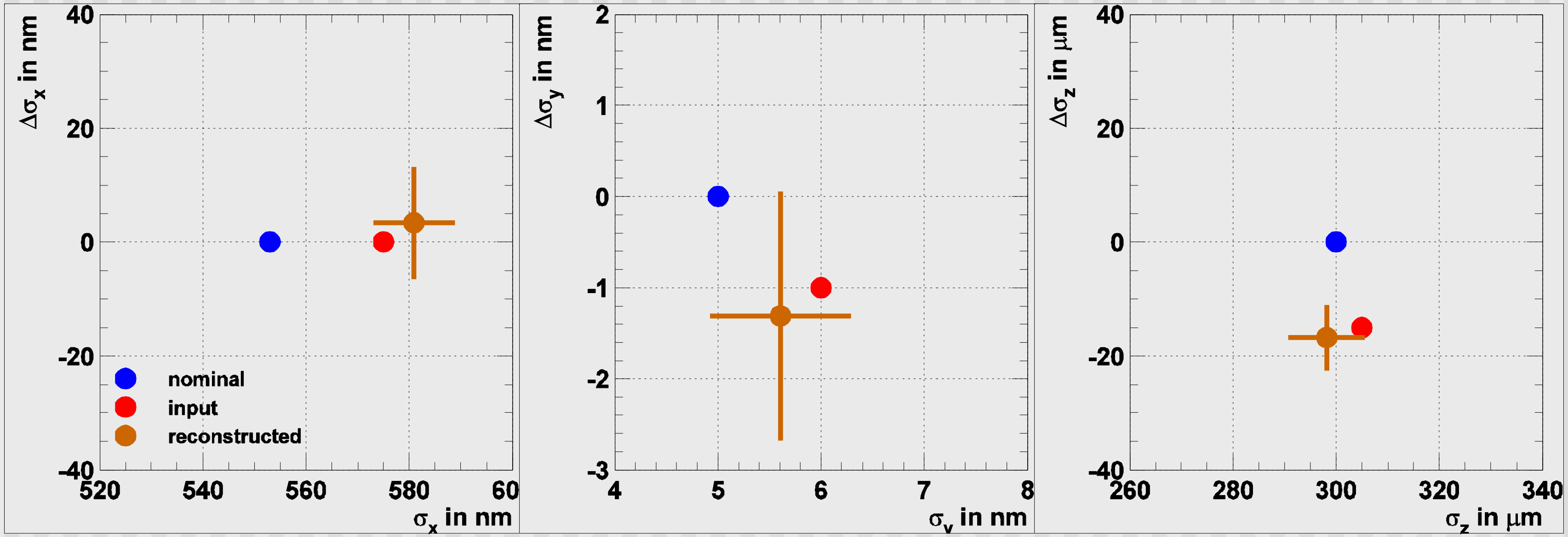
Luminosity Monitoring (A. Stahl)

- Fast luminosity monitoring is crucial for collider performance
- Good signals are beamstrahlung and subsequent pair production
- Work concentrated on pairs sofar
- Start from nominal parameters and look at effect of deviations
- Assume linear dependencies

Multi Parameter Analysis

Test with non-nominal bunches

	e^-	e^+	nom.
bunch size x:	575nm	575nm	553nm
bunch size y:	5nm	7nm	5nm
bunch size z:	290_m	320_m	300_m



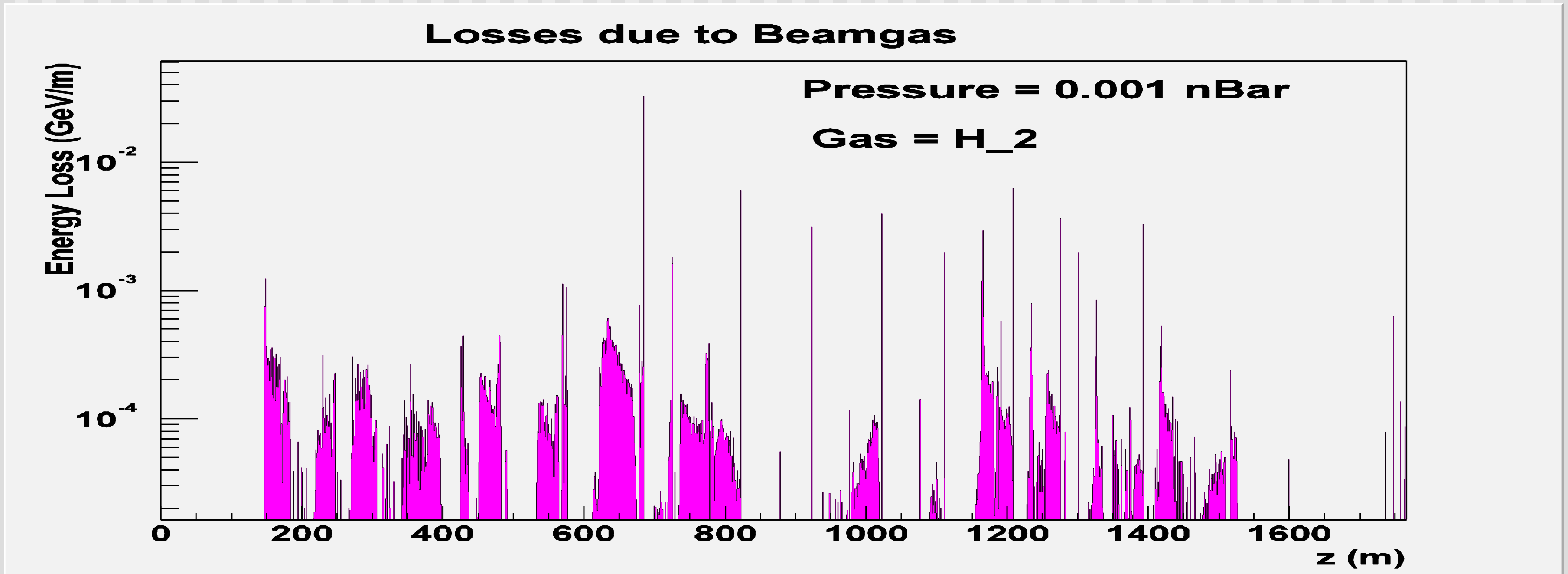
Codes Simulating Secondaries (G. Blair)

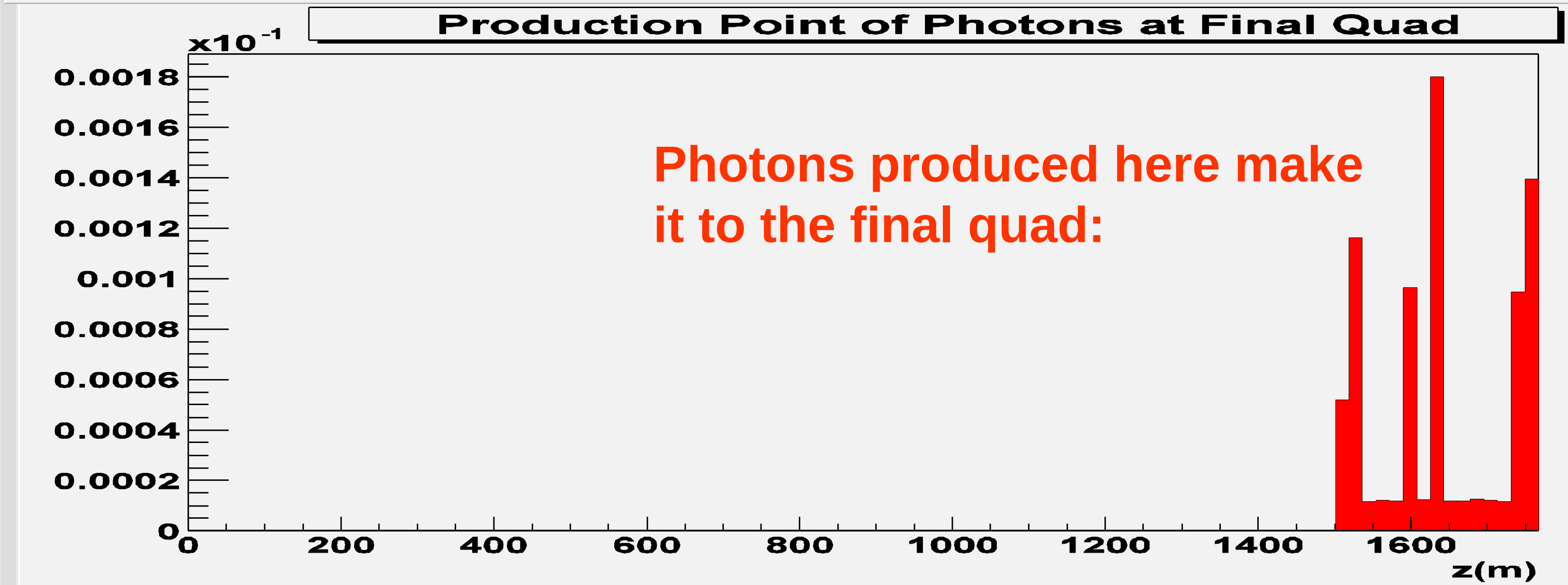
- Very important to evaluate physics conditions
- Integration of accelerator style tracking and GEANT4
- Easy building of beamlines from MAD files
- Several studies carried out (e.g. muons)

Codes for Secondaries

- N. Mokhov (Fermilab) – MARS
- L. Keller (SLAC) Turtle/MuCarlo
- T. Maruyama (SLAC) Geant3
- FLUKA
- BDS SIM (Tokyo Univ.) – Geant4
- BDSIM (GB) Geant4– see below.

TESLA Beamgas:

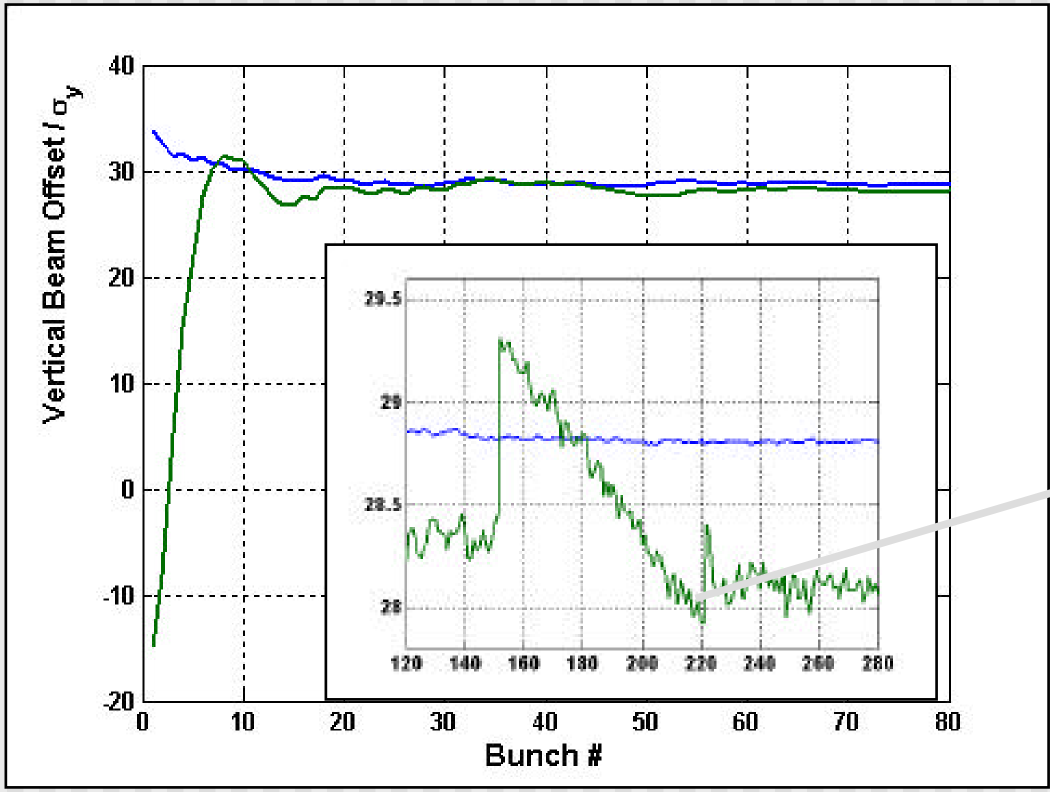


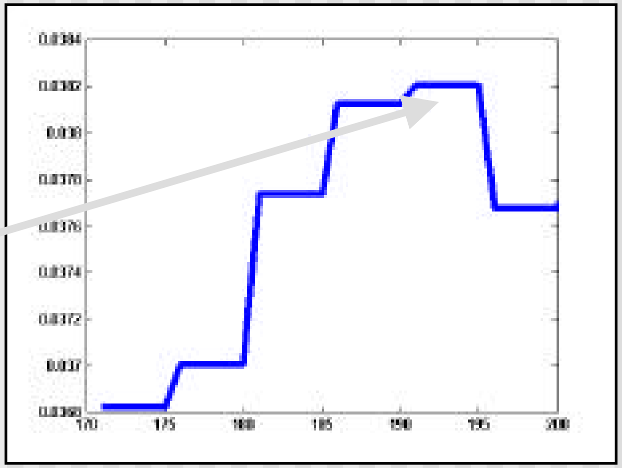


Linac to IP Simulations … (G. White)

- Simulate feedback with realistic bunches
- Multi-bunch studies using code chains (PLACET [LIAR], MERLIN, GUINEA-PIG [CAIN])
- Scans during train possible
- Results available on the web

IP Feedback

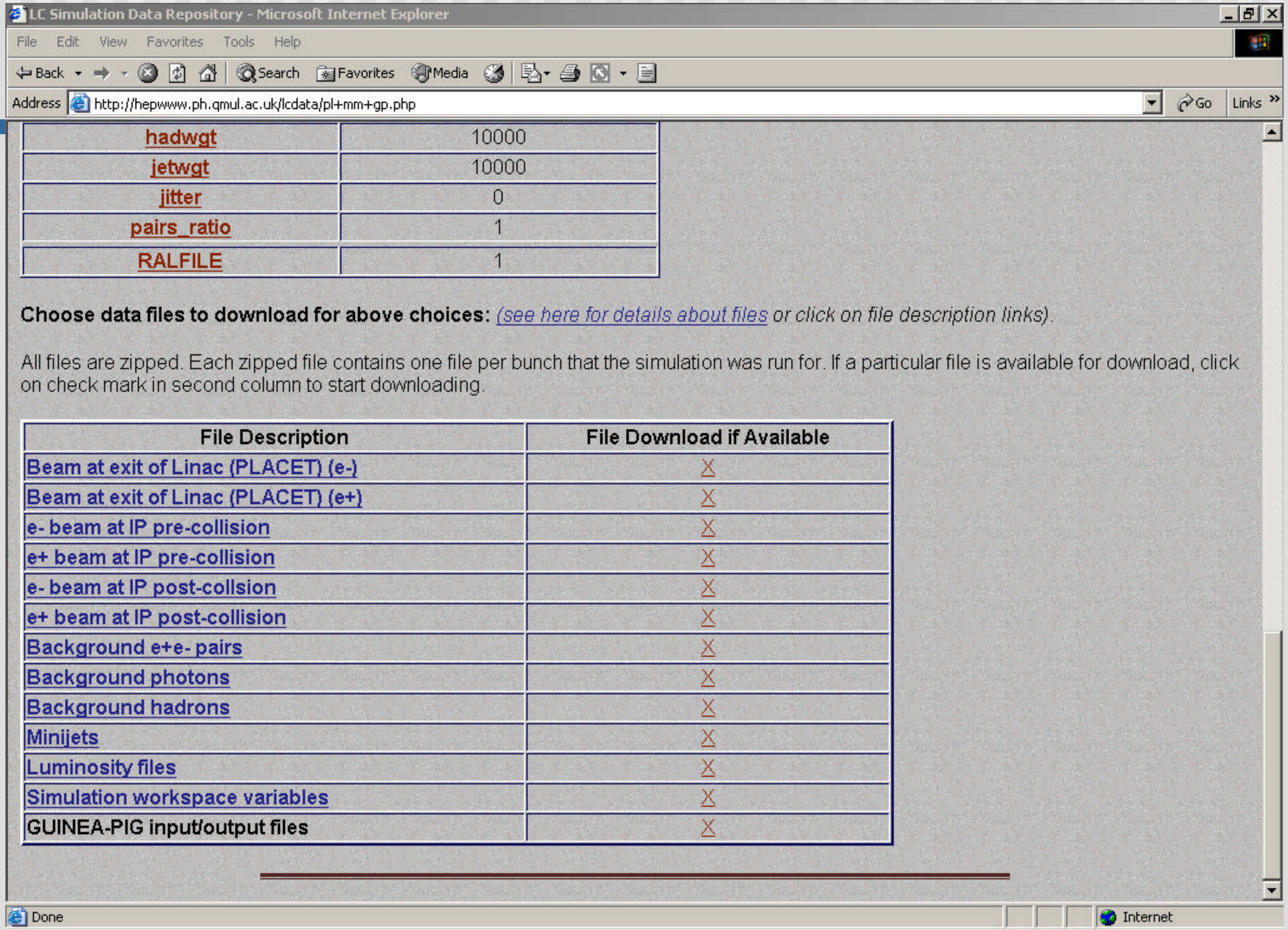




5 Bunch ele't Int Signa

- Corrects < 10 bunches
- Corrects to finite Δy due to banana bunch effect.
- Vertical Beam-Beam scan @ bunch 150.

LC Simulation Web Page



LC Simulation Data Repository - Microsoft Internet Explorer

Address http://hepwww.ph.qmul.ac.uk/lcdata/pl+mm+gp.php

hadwgt	10000
jetwgt	10000
jitter	0
pairs_ratio	1
RALFILE	1

Choose data files to download for above choices: *(see here for details about files or click on file description links).*

All files are zipped. Each zipped file contains one file per bunch that the simulation was run for. If a particular file is available for download, click on check mark in second column to start downloading.

File Description	File Download if Available
Beam at exit of Linac (PLACET) (e-)	X
Beam at exit of Linac (PLACET) (e+)	X
e- beam at IP pre-collision	X
e+ beam at IP pre-collision	X
e- beam at IP post-collsion	X
e+ beam at IP post-collision	X
Background e+e- pairs	X
Background photons	X
Background hadrons	X
Minijets	X
Luminosity files	X
Simulation workspace variables	X
GUINEA-PIG input/output files	X

Done

- Store all beam data from simulation runs online
- http://hepwww.ph.qmul.ac.uk/lcdata

TESLA DR Emittance Control (W. Decking)

- Dogbone for long train
- Sensitivity worse than existing machines
- Correction is sufficient for 88%
- More sophisticated tuning possible
- Required jitter stability has been proven (1um)
- Tight kicker tolerance

Comparison of calculated sensitivities in operating rings with the NLC and TESLA damping rings. Y_{align}: sextupole vertical misalignment; Roll align: quadrupole roll alignment; Y_{jitter}: quadrupole vertical jitter; $\Delta k/k$: fractional quadrupole strength error. [9]

Parameter	ALS	APS	ATF	SLS	NLC MDR	TESLA DR
Energy [GeV]	1.9	7	1.3	2.4	2	5
Circumference [m]	200	1000	140	288	300	17,000
$\gamma\varepsilon_x$ [μm·rad]	24	34	2.8	23	2.2	8
$\gamma\varepsilon_y$ [nm·rad]	500	140	28	70	13	14
Y_{align} [μm]	135	74	87	71	31	11
Roll align [μrad]	860	240	1475	374	322	38
Y_{jitter} [nm]	850	280	320	230	75	76
$\Delta k/k$ [0.01%]	1.5	1.4	2.1	1.5	1.8	1.1

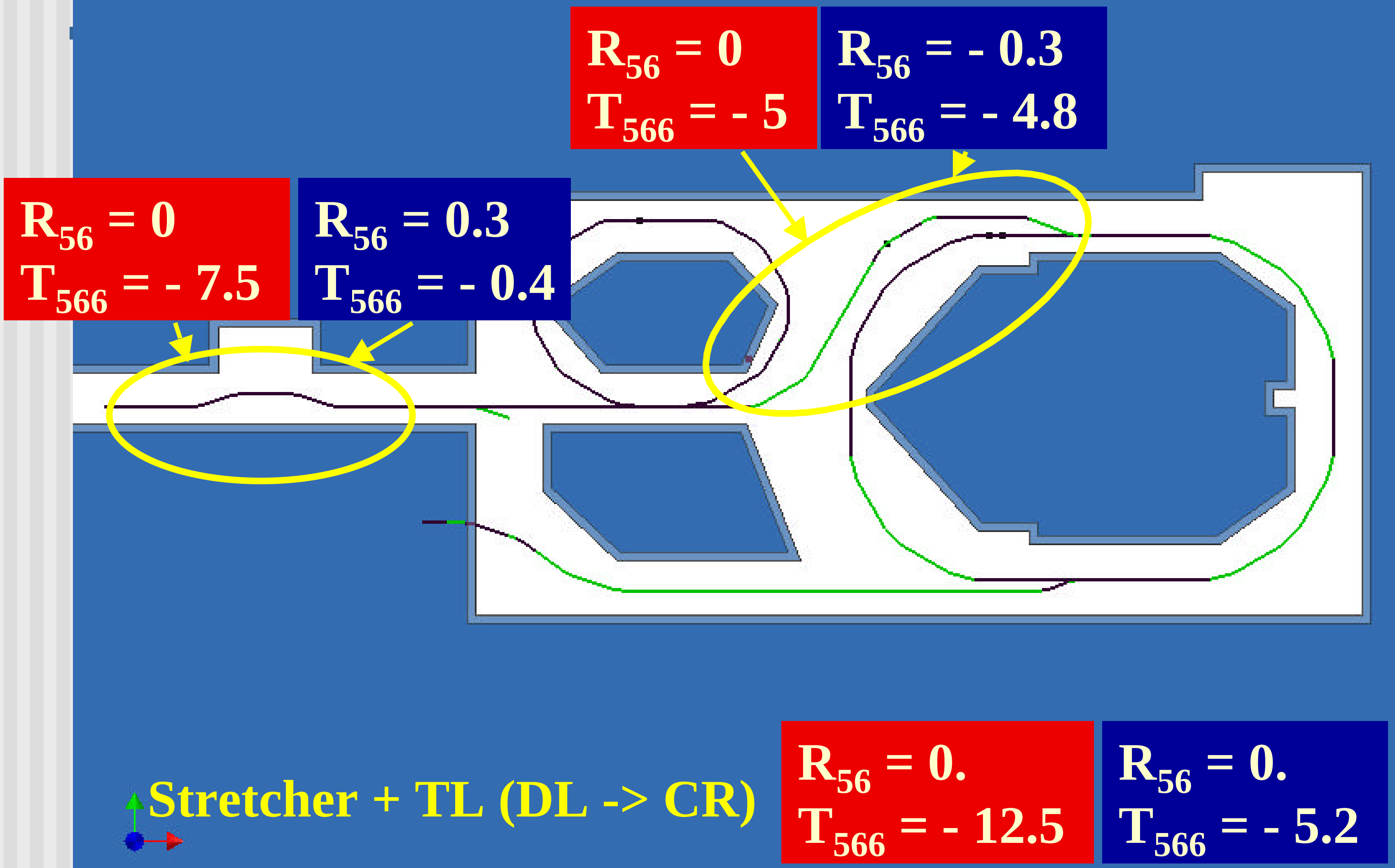
Sextupole alignment or quadrupole roll that leads to the vertical emittance

Quadrupole jitter leading to 1 σ beam jitter, Gradient error leading to ΔQ = 0.001

Combiner Ring Studies (C. Biscari)

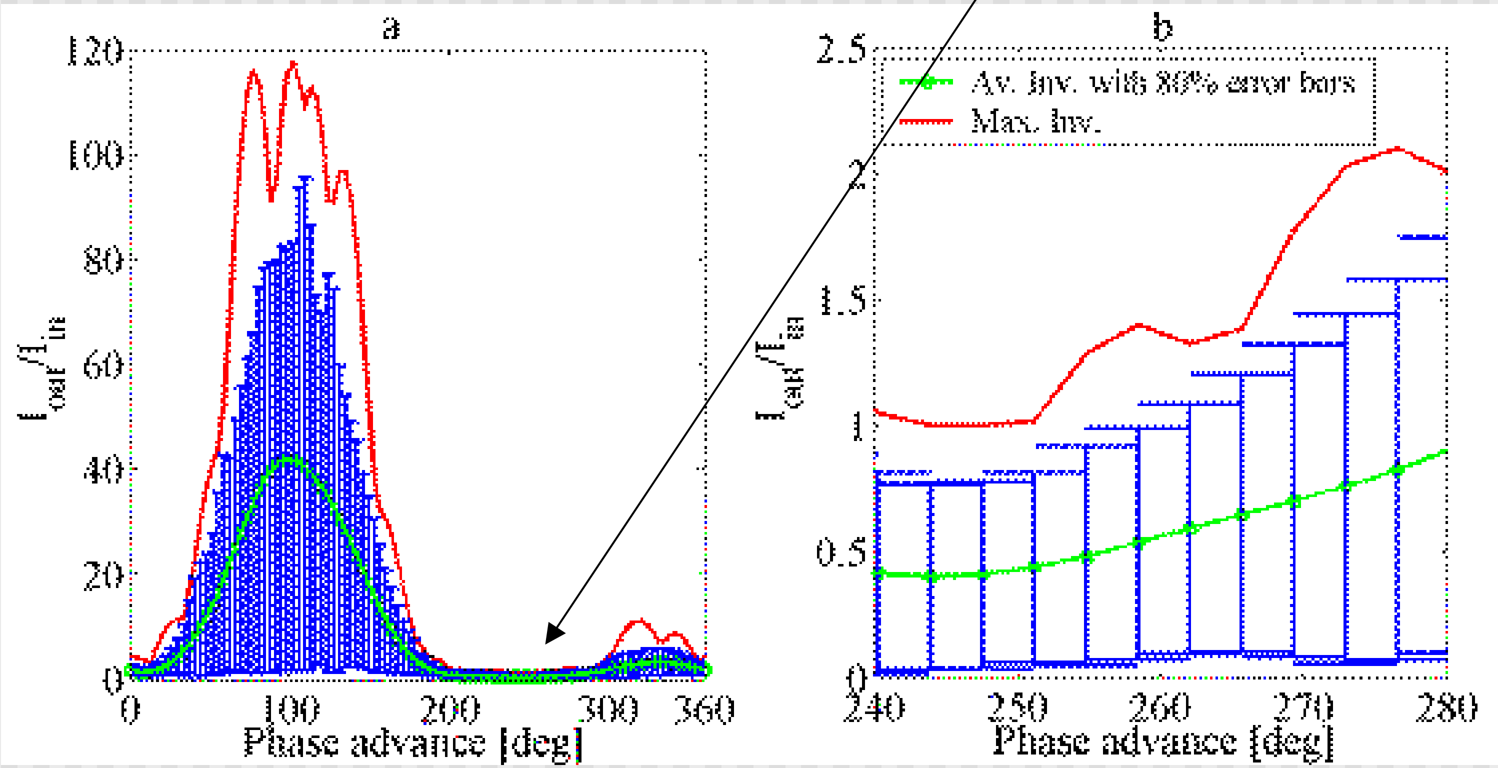
- Aim is to merge bunch trains
- Isocronicity required
- Careful lattice optimisation required
- Conditions at CTF more difficult than at CLIC
- CSR very important
- RF deflector beam loading is important

Global optimisation



tune dependence
(fixed injection error)

Around nominal CTF3 working point



Status of TESLA BDS (D. Angal-Kalinin)

- Many improvements
- In particular crossing angle

- TESLA BDS design is being improved for incorporating local chromaticity correction section, better collimation and machine protection issues.
- Re-iteration on L*.
- FFS to be optimised for third & higher order terms.
- Alternative solutions for beam extraction suggested by Saclay, Orsay and Daresbury groups.
- The details of these designs including beam diagnostics need to be worked out.

- 300 µrad vertical crossing + quadruplet to reduce beam losses :Necessary R&D on reliable 50KV/cm, 20-30 long electro-static separators.

- 2 mrad horizontal crossing angle → no electrostatic separators, 15% Luminosity loss without crab crossing, can be compensated by angular dispersion at IP.

- Large crossing angle like in NLC

Crossing angle working group to recommend the detector and physics implications.

Non-Linear Collimation (J. Resta Lopez)

- Non linear collimation is difficult
- But can allow for safe collimators (alternative consumable collimators)
- In CLIC use sextupole pair (cancelation of aberrations)
- Work will continue

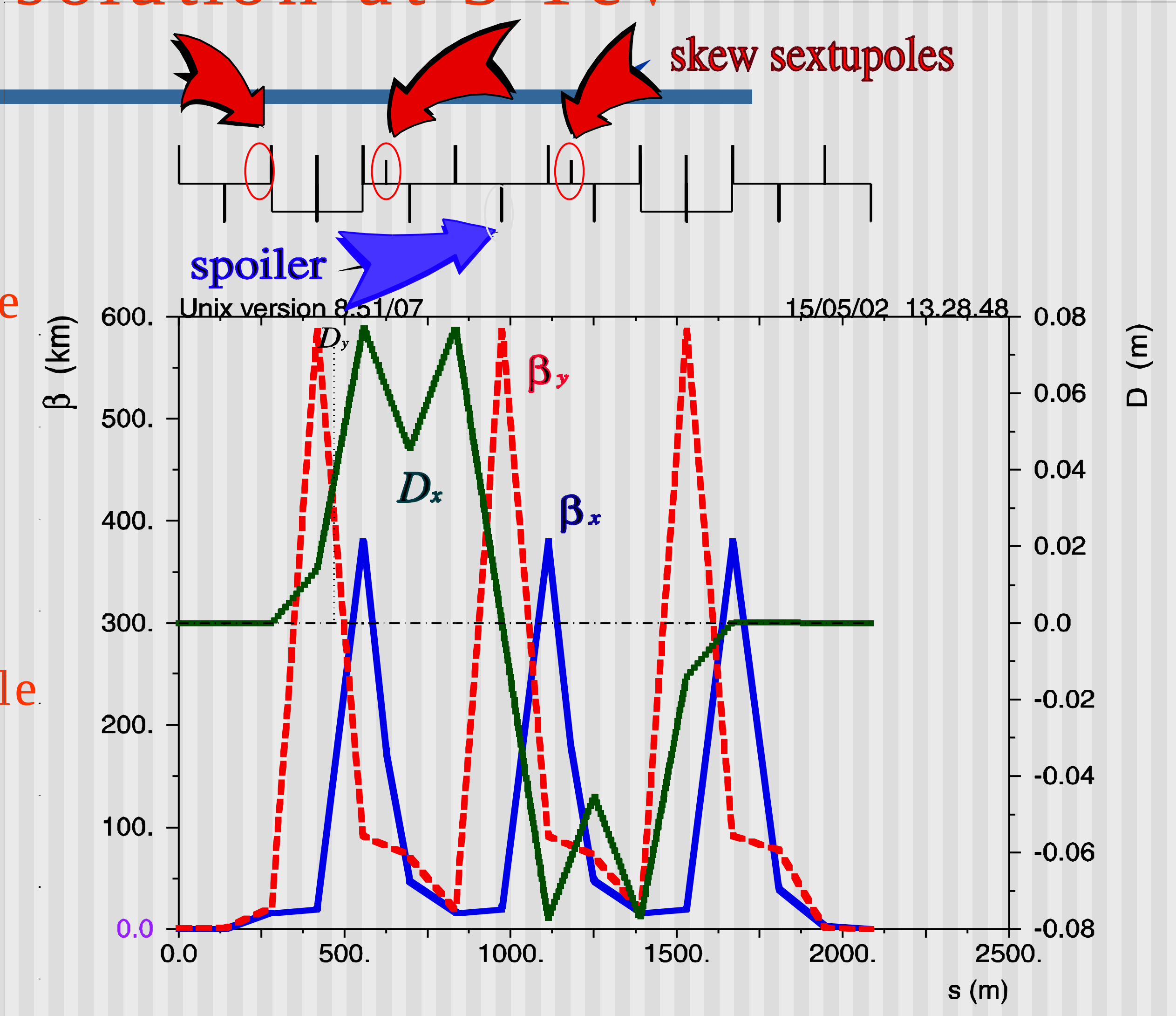
First optics solution at 3 TeV

3rd weak skew sextupole

1st skew sextupole

A single spoiler

2nd skew sextupole



Post Collision Line for CLIC (V. Ziemann)

- Post collision line is important
  - Get rid of beam
  - Avoid excessive background
  - Luminosity diagnostics
- Quite difficult
  - Spent beam
  - Beamstrahlung
  - Coherent pairs

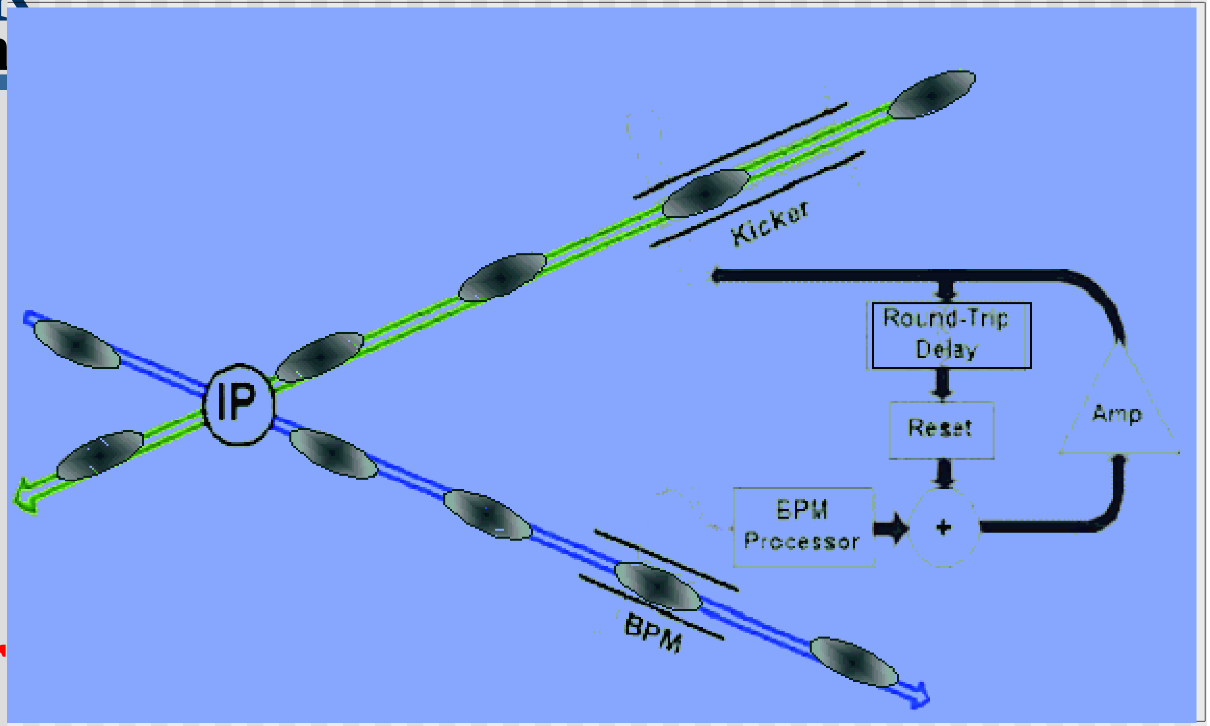
- Idea is to separate spent beam from photons by double bend
- Separates also electrons and positrons form coherent pairs
- Very useful signal for luminosity tuning

Fast Beam-Based Feedback Systems (Ph. Burrows)

- Transverse feedback within a train
- Main use IP feedback
- For linear colliders:
  - Essential in TESLA
  - Useful in GLC/CLIC
- Actual hardware test FONT1/FONT2

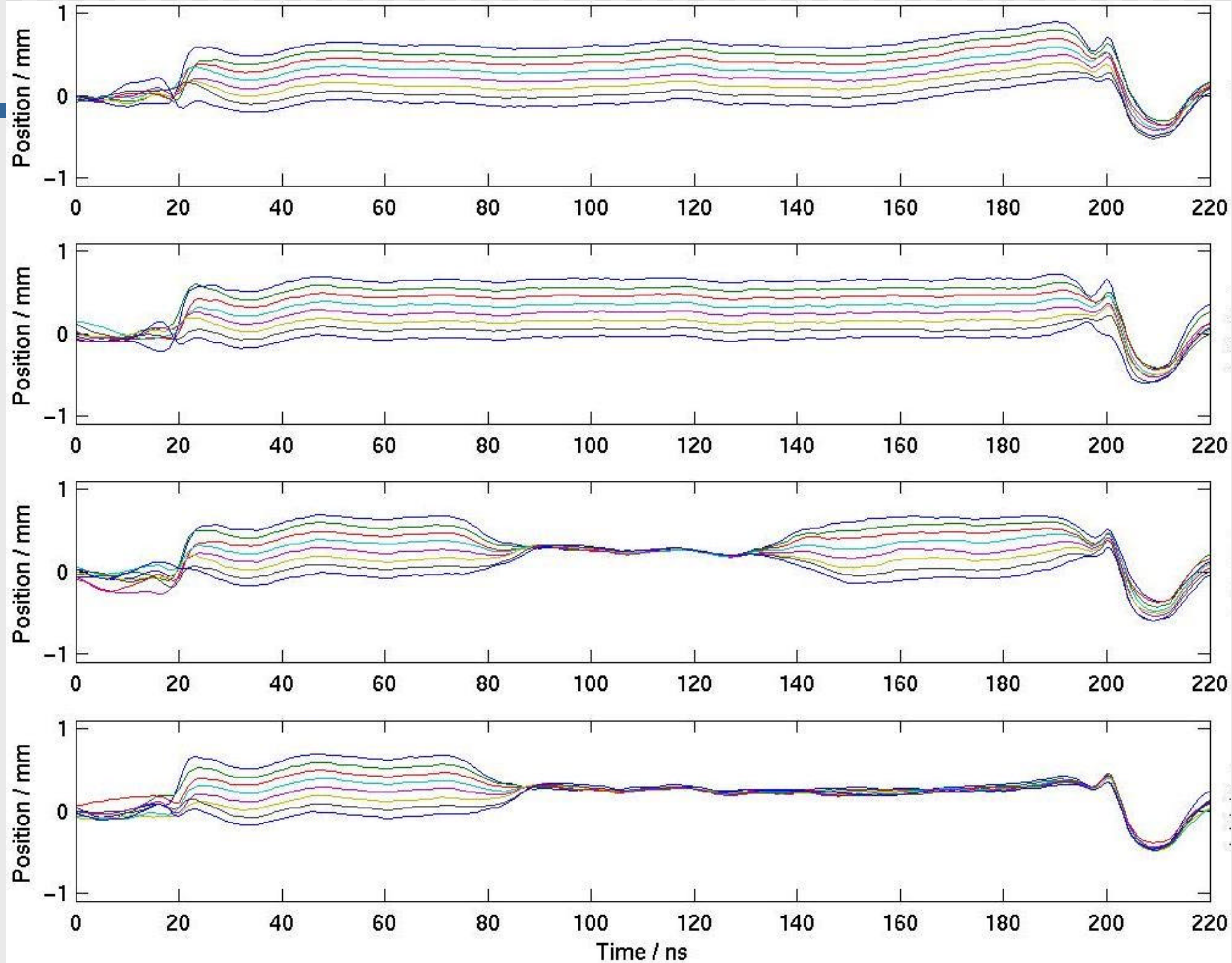
Intra-train Beam-based Feedback

- **Intra-train beam feedback is last line of defence against ground motion**
- **Key components**
- **Beam position monitor (BPM)**
- **Signal processor**
- **Fast driver amplifier**
- **E.M. kicker**
- **Fast FB circuit**



Warm: augments active stabilisation

Cold: principal ground-motion correction



Position / mm
Time / ns

Web Pages

- A workpackage web page will be provided by CERN
- Webpages should also exist for
  - Numerical methods (Univ. Rostock)
  - Required instrumentation and actual performance (to be determined)
  - Codes including benchmarks (QMUL)

Implementation of Code Repository

- Already available
  - MERLIN
  - LIAR
  - PLACET
  - GUINEA-PIG
  - CAIN
- To be added
  - Injector / bunch compressor codes
  - Electron cloud codes
  - Instability codes
  - ...

Implementation of Code Repository 2

- Experience exists at QMUL for already available codes
- People are encouraged to add their code to the data base
- Distribution should contain
  - Short description
  - Necessary code
  - Some example(s)
  - Documentation / notes connected to codes
- We should also have a wish list

Numerical Method Webpage

- Provide information about new numerical methods
- For programmers
- Inform about known fast numerical methods

Definition of Future Needs

- Need to start the discussion
- Will try to collect wishes by e-mail
- Telephone conference considered
- Hope it will work better after kick starting the process
- Use EuroTeV and project lists as starting points

Getting People Involved...

- Devise questionaire
- People should fill them in
- Try to collect information and organise it
- Use this as discussion basis
- WIKI (?) interactive web pages

Instrumentation Data Base

- Find people who will contribute lists of required performance for each project
  - Victim 1: D.S. for CLIC
  - A. Stahl will identify victim for TESLA
  - Anybody else?
- Find somebody to collect the lists in a common data base
- Complementary information on achieved/planned performance from instrumentation work package
- This should serve as a basis for the review of needed R&D