TRC R&D Items

Ranking 1:

R&D needed for feasibilty demonstration of the machine

The key objective of these R&D items is to show that the key machine parameters are not unrealistic. In particular, a proof of existence of the basic critical constituents of the machines should be available uponcompletion of ranking 1 R&D items

Ranking 2:

R&D needed to finalize design choices and ensure reliability of the machine

Originally 1+2

. . . to establish with confidence that the design goals can be met . . .

Ranking 3

R&D needed before start of production of systems and components

Ranking 4

R&D desirable for technical and cost optimization

R1 Items for CLIC

- Test the real structure design with the real pulse

  $\Rightarrow$ CTF3 as a power source

- Validate drive beam generation. Beam dynamcis and efficiency look challenging

  $\Rightarrow$ fully loaded operation at CTF3

  $\Rightarrow$ injector, linac, delay loop and combiner ring in CTF3

  $\Rightarrow$ validation of modelling at CTF3

- A mechanism to turn off only a few structures in event of a fault

  $\Rightarrow$ switchable structures to be tested at CTF3

  we did not have a damping ring design in the TRC now we have, remaining problems seem to fall under R2

R2 Items for CLIC

- Persue tests of structures with tungsten or molybdenum irises

  ⇒ already in R1

- Validate drive beam stability and conceptually design machine protection system for decelerator

  In Energy chapter:
  Validate drive beam stability in phase and amplitude

  ⇒ stability seems critical

  very tight tolerance from main beam

  huge lever arm for imperfections

  ⇒ significant theoretical effort needed

  ⇒ measure longitudinal jitter in CTF3

  ⇒ use feedbacks, to be tested at CTF3

  ⇒ share strategies of machine protection between CLIC and CTF3

  ⇒ can we learn something on losses?

- Test a relevant linac subunit with beam

  ⇒ CLEX, but what is relevant?

- Validate multibeam klystron performance

  $\Rightarrow$ seems not too critical

- Calculate effect of coherent synchrotron radiation in bunch compressors

  $\Rightarrow$ should be done but not too worrysome

  $\Rightarrow$ can perform experiments at CTF3

- Design extraction line for 3TeV

  $\Rightarrow$ could be tricky, maybe learn something from drive beam?

  Damping rings

  in general hard to address at CTF3

  - Simulate electron cloud effects, perform experiment and explore cures with experiments
  - Simulate fast beam ion instability, verify with experiments
  - Extraction kickers are an important issue

    $\Rightarrow$ maybe can learn something at CTF3

  - Additional simulations of emittance growth correction in DR are needed with verification at ATF.

Low emittance transport (and luminosity)

- Complete static tuning studies including dynamic effects

  ⇒ is the machine stable enough to tune the main beam?

  ⇒ compare modelling, e.g. wakefields in CLEX

  ⇒ can learn somthing on drive beam stability (phase and amplitude)

  ⇒ some things are hard to do at CTF3, theoretical studies and experiments elsewhere are needed

- Develop most critical instrumentation (e.g. luminosity monitor, laser wire, BPMs)

  ⇒ some can be useful at CTF3

  ⇒ theoretical and technical work necessary (e.g. luminosity monitor)

- Sufficiently detailed prototype of main linac module to evaluate vibrations

  ⇒ could be used at CTF3 (CLEX)

Reliability

- Detailed evaluation of critical subsystem reliability

  $\Rightarrow$ maybe can learn a bit at CTF3

- The performance of beam-based tuning must be demonstrated by complete simulations, in presence of wide variety of errors in the beam and the components

  $\Rightarrow$ similar to static tuning above

- Should not forget that things might have been missed

CTF 3 Main objectives:

- Demonstration of drive beam generation
  - Final drive beam parameters (35 A, 2.3 nC/bunch, 150 MeV, 140 ns, 1.4 μs initial pulse length)

    Down-scaled with respect to CLIC (150 A, 10 nC/bunch, 2 GeV, 130 ns, 100 μs initial pulse length), but **close enough** to test relevant physical effects and benchmark simulation tools

    N.B.: different scaling laws involved for different effects !

  - Need to demonstrate not only beam current and pulse length, but also:
    - Low losses along the complex
    - Beam emittance preservation
    - Efficiency
    - Control of bunch length
    - Current stability (along final pulse and pulse-to-pulse)
    - Energy stability (" " ")
    - Bunch phase stability (" " ")

CTF 3 Main objectives (cont'd) :

- Generation of 30 GHz RF power with CLIC nominal parameters
  - Needed to test RF components (accelerating structures demonstration, but not only…)
  - Acquire experience in PETS operation (switch on/off power from PETS, …)

Open questions:

- What kind of experiments will we need to perform in CTF3 to demonstrate all the items mentioned before ? What instruments (diagnostics and techniques) ?
- As it is now planned, CTF3 cannot test fully the drive beam decelerator. Is it be possible, and how ?

Some physical effects & issues, possible experiments and measurements :

- Operation of fully-loaded linac
- Transverse stability in DBA
- Control of beam losses
- Stability of energy, current and bunch phase
- CSR & impedance in delay loop, ring
- Transverse beam stability in RF deflectors
- Phase coding
- Transverse stability, wake-fields and beam control in DB Decelerator

Some physical effects & issues, possible experiments and measurements :

- Operation of fully-loaded linac
  - RF phase control, machine protection, efficiency
- Transverse stability in DBA
  - Offset beam or structure
  - Use weaker lattice
- Control of beam losses
  - Satellites ? Machine protection, radiation levels & activation, effects on instrumentation
- Stability of energy, current and bunch phase
  - Hardware performances, measurement resolution, identification of instability sources, development of feed-backs
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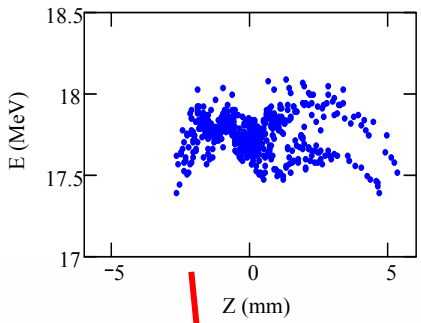
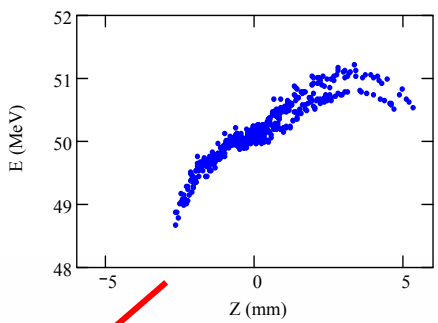
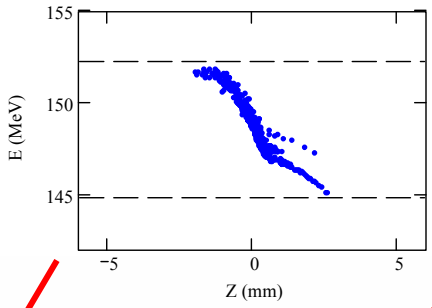
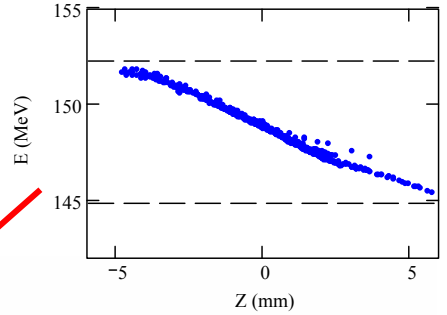
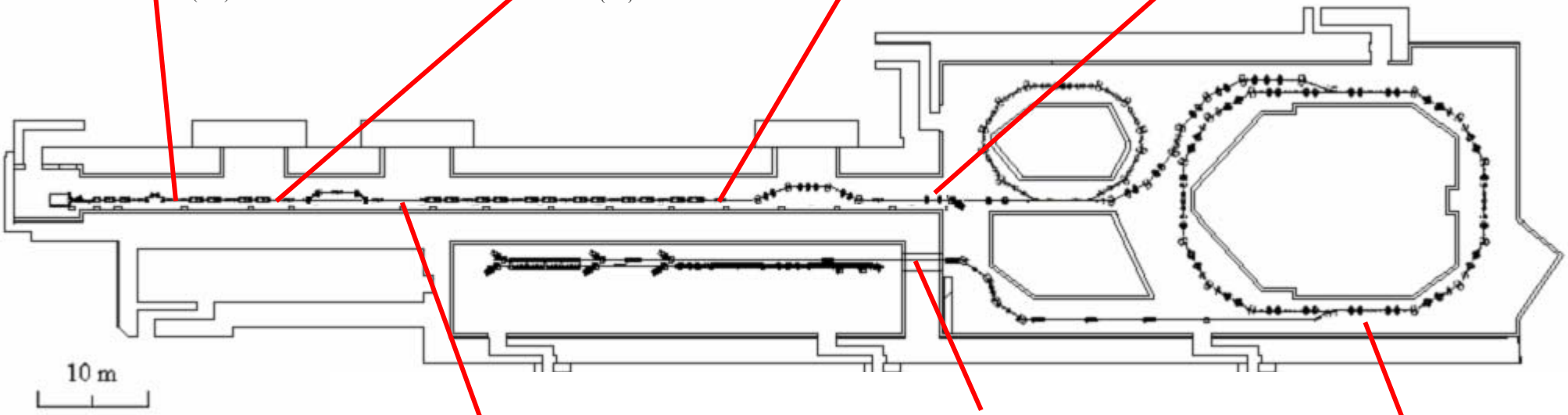
  - Measurement of single-bunch longitudinal phase space (linac phase scan, RF deflectors for combined beam ?)
  - Compress bunches before ring, increase number of turns



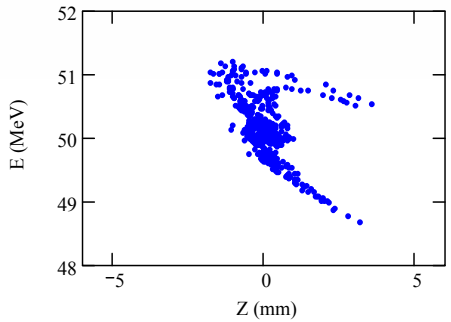


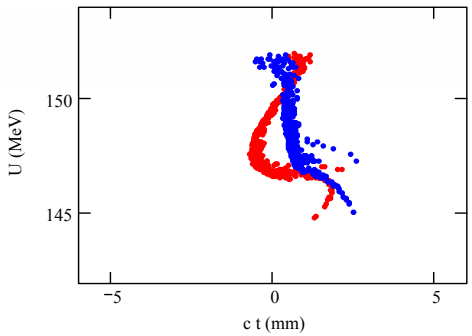


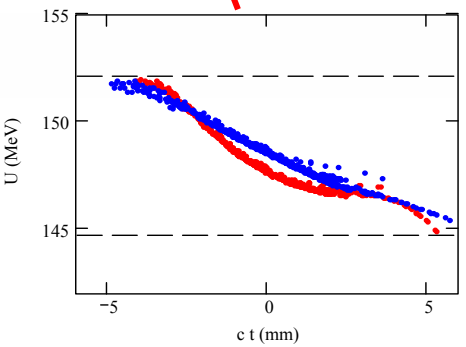




Bunch length control, longitudinal phase space gymnastics, CSR and impedance in DL and CR







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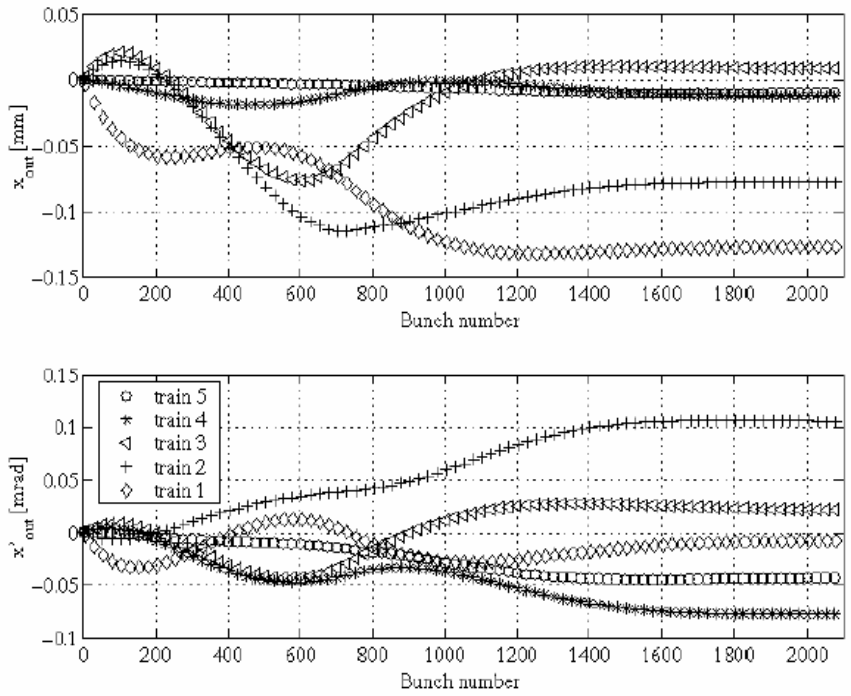
  - Off-set beam and change of ring tune, time-resolved position measurement

1.



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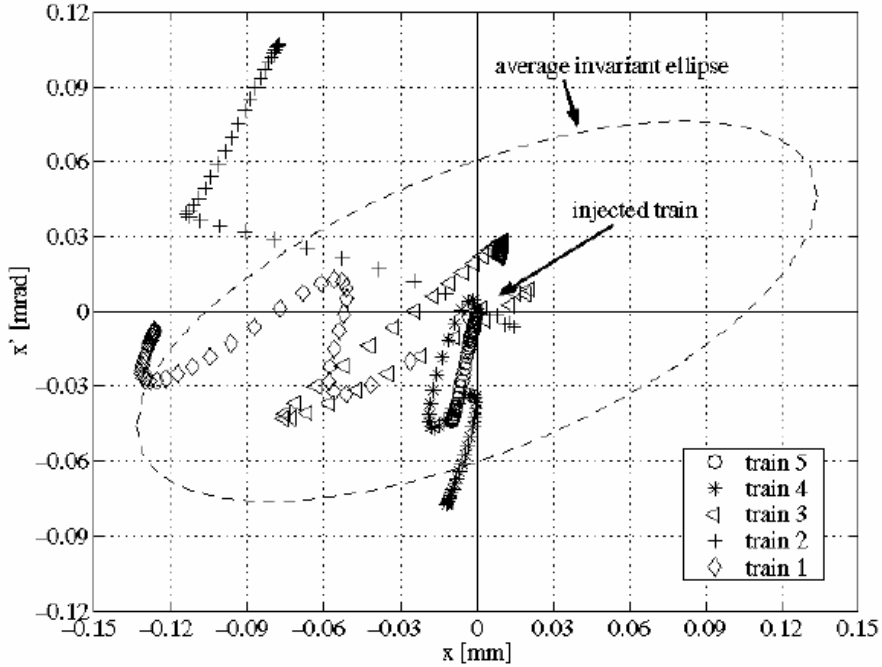
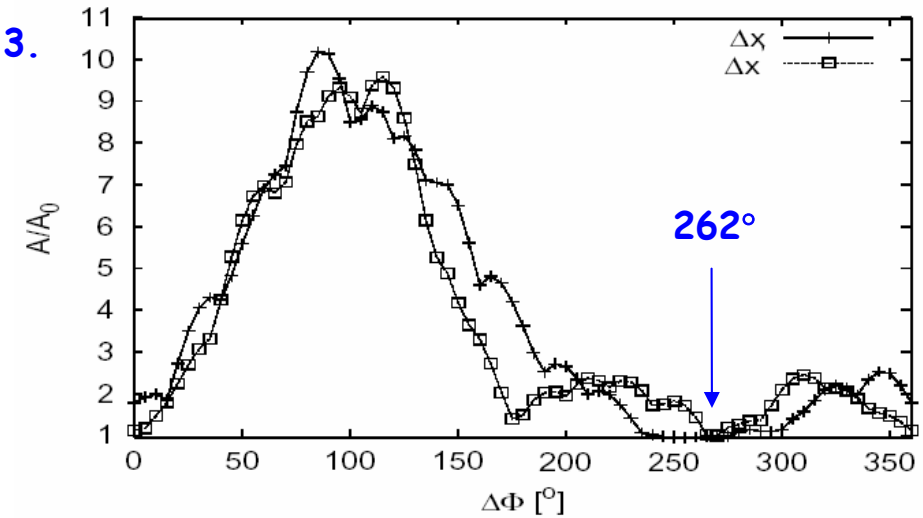


Transverse stability in combiner ring – effect of RF deflectors wake

1. Final position and angle of bunches (no injection errors)
2. Phase space footprint of merged trains (no injection errors)
3. Tune dependence of the position and angle magnification of injection errors

3.



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- Phase coding
  - Control of current dip during phase swing (gun current feed-back)
  - Measurement of RF pulse shape (sampling with probe beam single-bunch ?)
- Transverse stability, wake-fields and beam control in DB Decelerator
  - Measurement of wake-fields in PETS (with probe beam ?)
  - String of PETS (choose relevant drive beam parameters) – need several betatron wavelength
  - Halo production mechanisms in transfer beam lines (collimation ?) and in PETS