Beam dynamics and simulation

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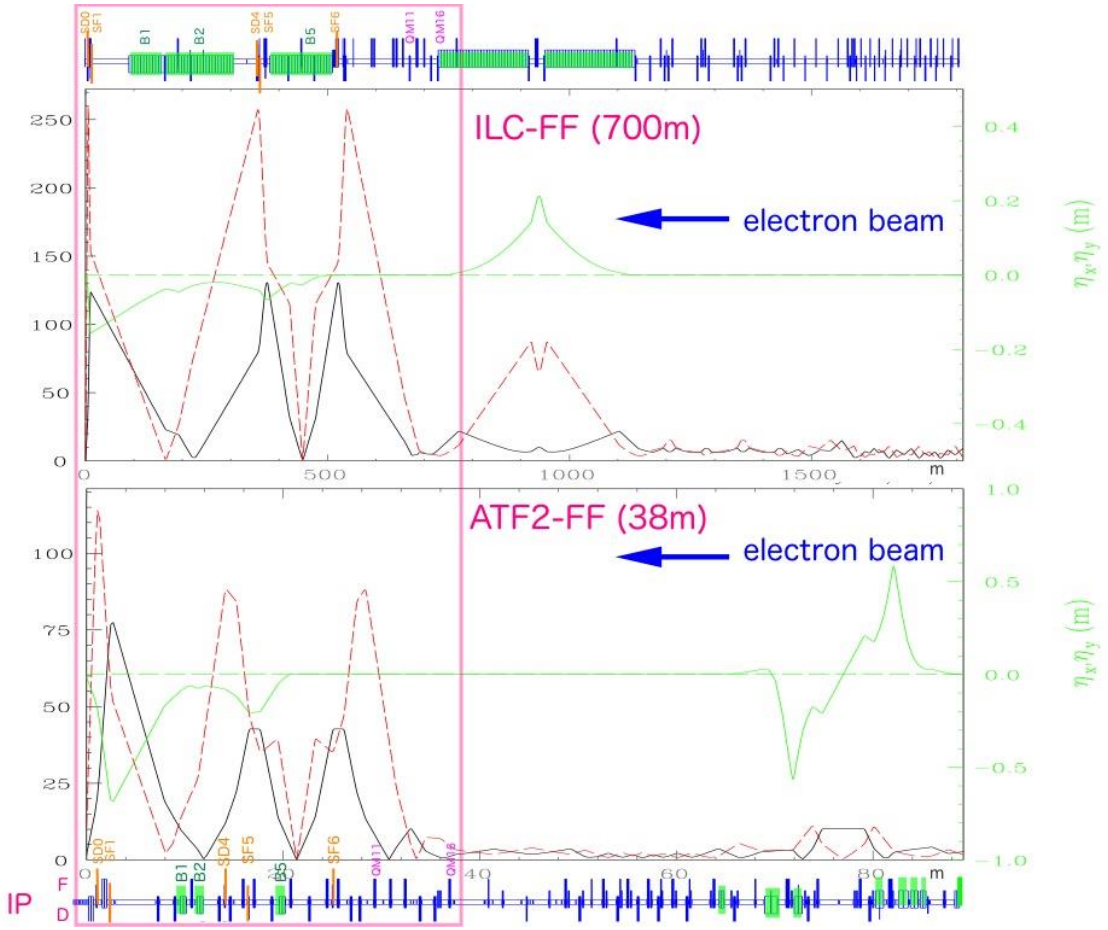
Talk introduction

- Research highlights
  - Wakefield measurement at ATF2
    - Helped achieve 65 nm beam size
  - Beam delivery simulation (BDSIM)
    - BDSIM geant 4 based simulation
  - BDSIM CLIC post collision line
    - CERN fellow L. Deacon
- Proposed work for CLIC2
  - Develop model BDSIM model for CLIC
  - Collimator (and other structure wake-fields)
  - 2 beam tuning

CLIC1 funding

	RHUL	CERN
Academic (Grahame Blair)	3.6 / 1.8	0 / 0
Academic (Stewart Boogert)	0 / 3	0 / 0
Academic (Andrei Seryi)	7.2 / 7.2	0 / 0
PDRA (Jochem Snuverink)	0 / 0	18 / 21
EUCARD - ASTeC	4.8 / 4.8?	0 / 0
TOTAL	**15.6 / 16.8**	**18 / 21**
Travel		6 / 5 k£
Material		0 / 0 k£

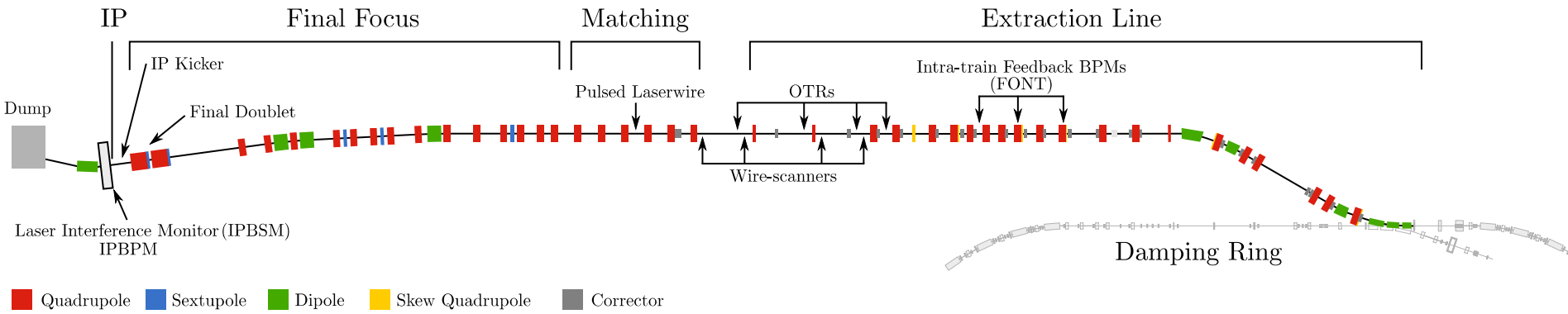
ATF2 optics



Energy scaled Raimondi-Seryi FFS optics

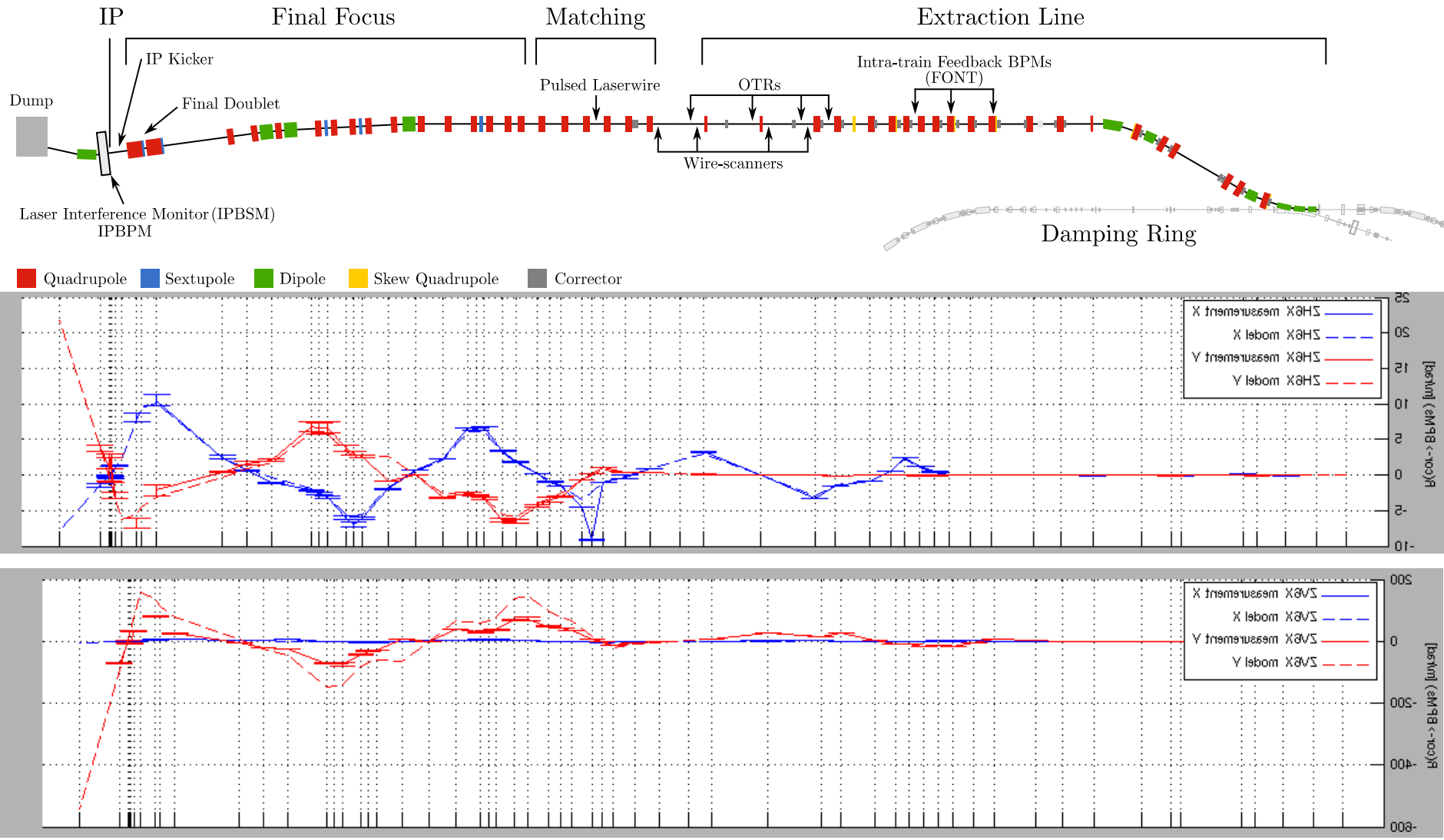
- Focus vertical size 37nm at *interaction point*
- Local chromaticity correction
- Relies on design dispersion in FF
- Preserve low emittance from ATF ring (12 pm.rad)
- Compact ~ 38 m

ATF2



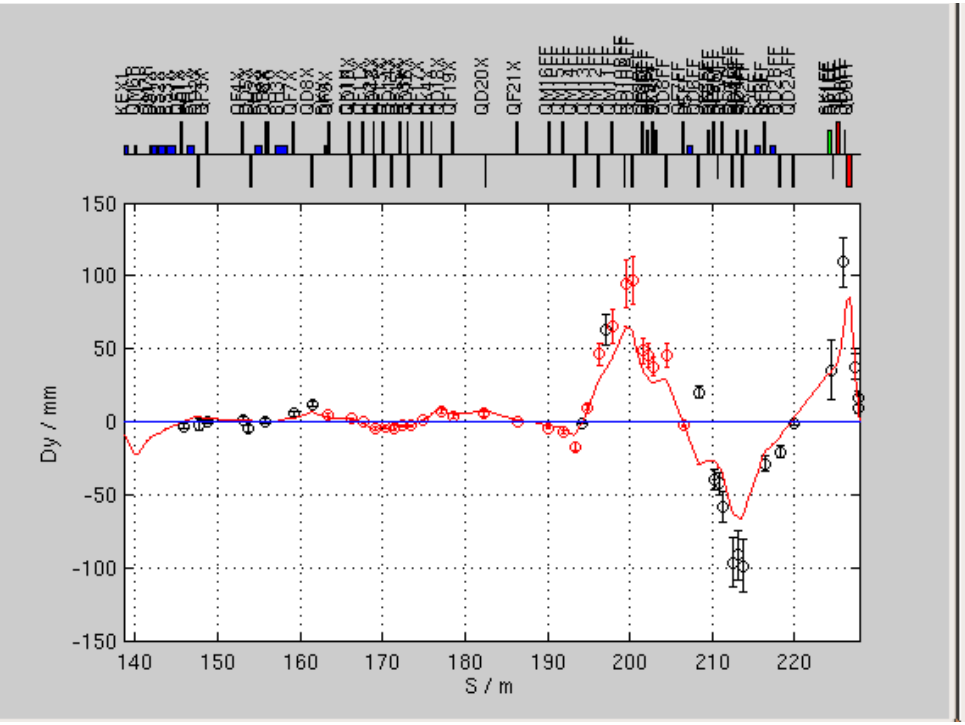
- Tuning of ATF2
  - Help develop tuning algorithms at ATF2
  - Strong integration of diagnostics (see wakefield measurements)
  - Pushed ATF2 optics
  - Compton diagnostics essential (Shintake monitor)

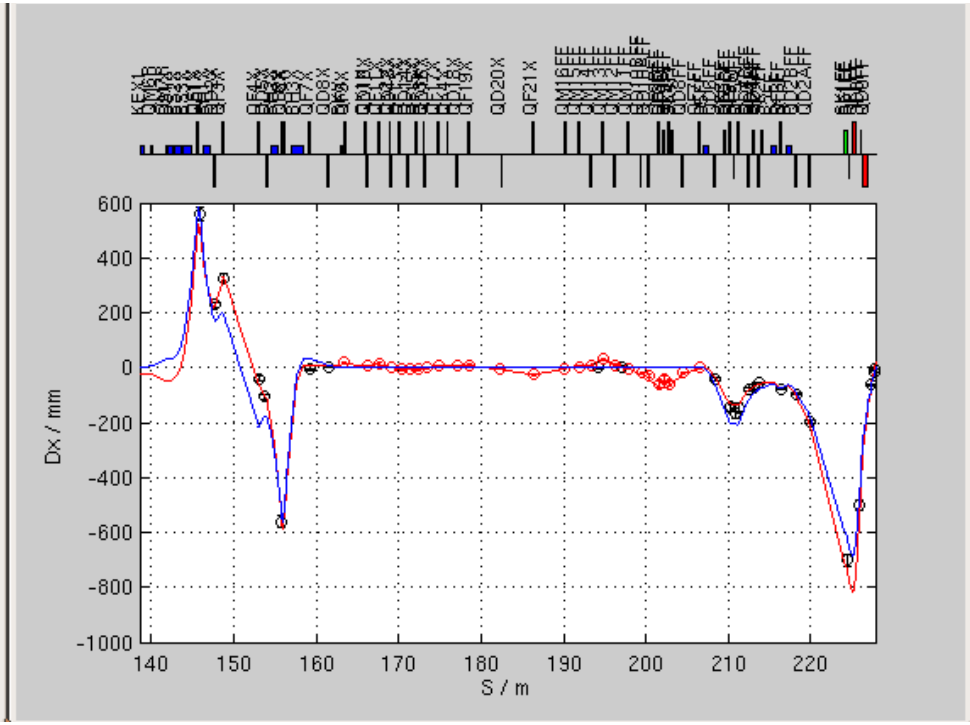
CBPM : Orbit kick response



CBPM : Dispersion measurement

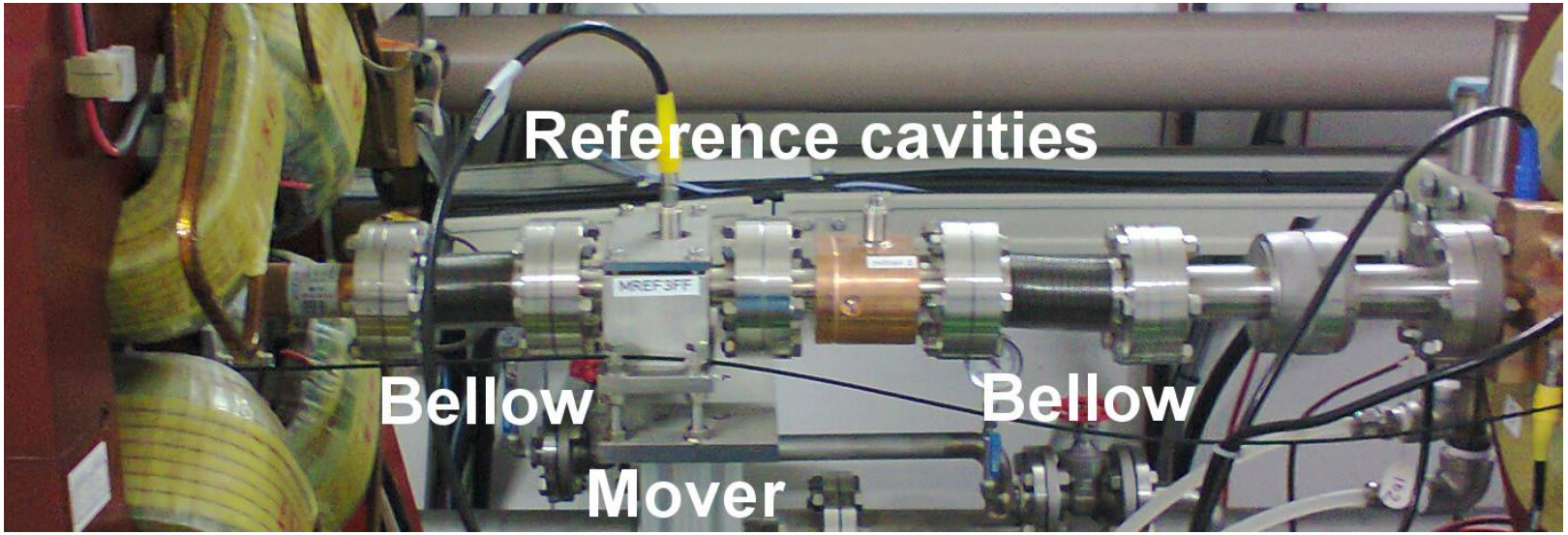
- Vary beam energy in ATF damping ring by a small shift in the RF frequency
  - Record response in stripline and CBPM systems
  - Online comparison with optics model (FFS based on dispersion)





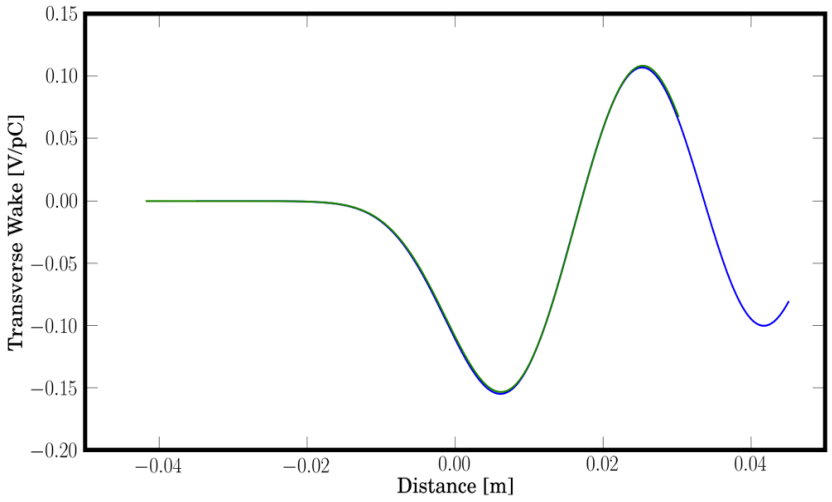
CBPM : Wakefield measurement

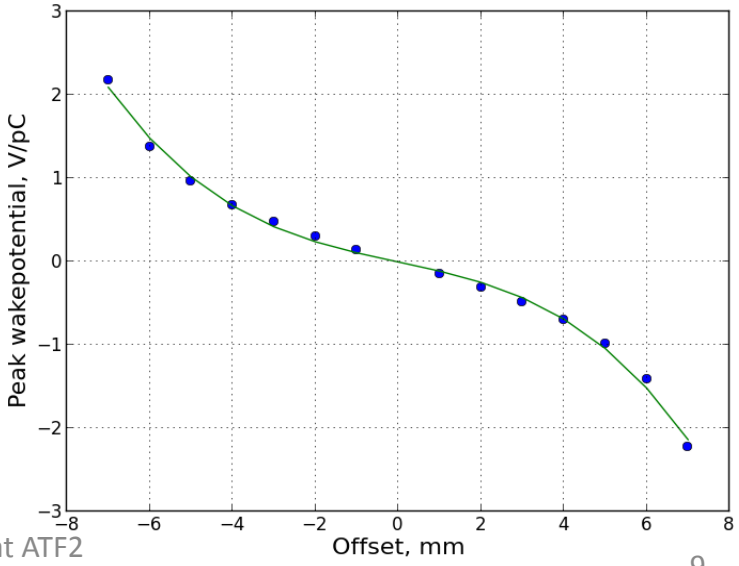
- Goal: measure wakefield from cavity BPM
- Using movable setup with 1 or 2 reference cavities
- Looking at downstream orbit change
- Setup was used to compensate wakes from other locations
- Crucial for reaching small beam size

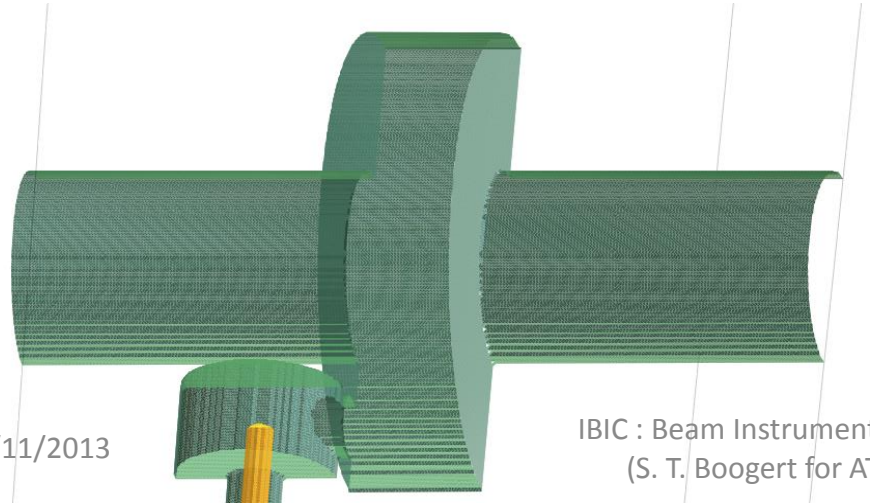


CBPM : Wakefield simulation

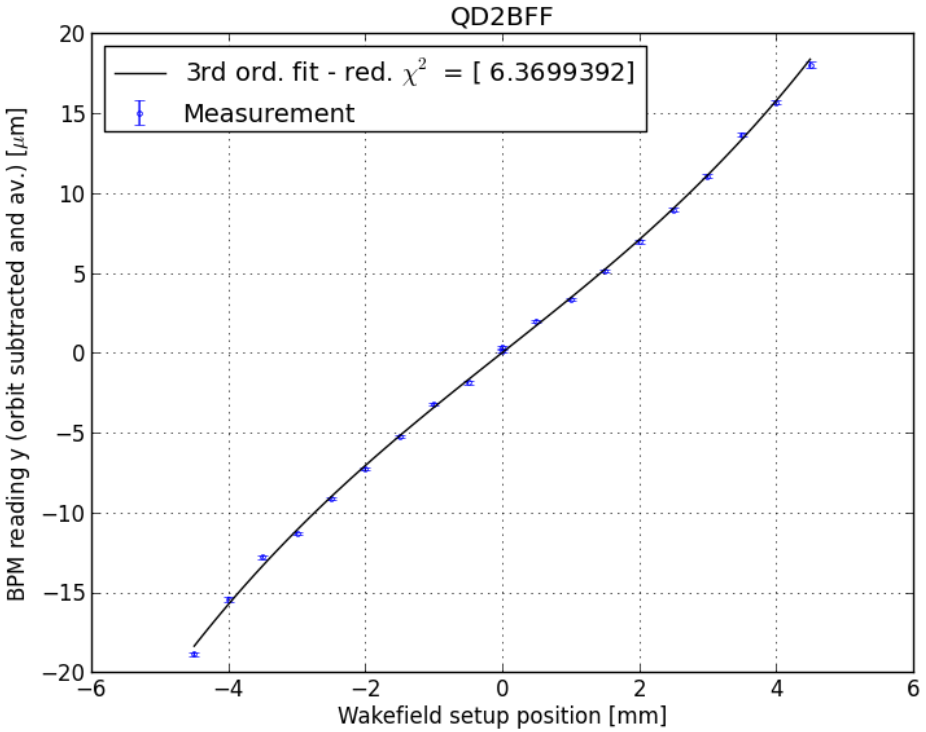
- Geometrical wake fields computed numerically with GdfidL (http://www.gdfidl.de) and ACE3P
- Electromagnetic fields calculator in any 3D-structure
- Finite element method
- All higher modes included (up to cut-off frequency)
- The beam is represented as a line charge traveling along the z-axis with optional offsets in x and y, Gaussian distribution in z
- Good agreement with different methods
- Non-linear for large offsets







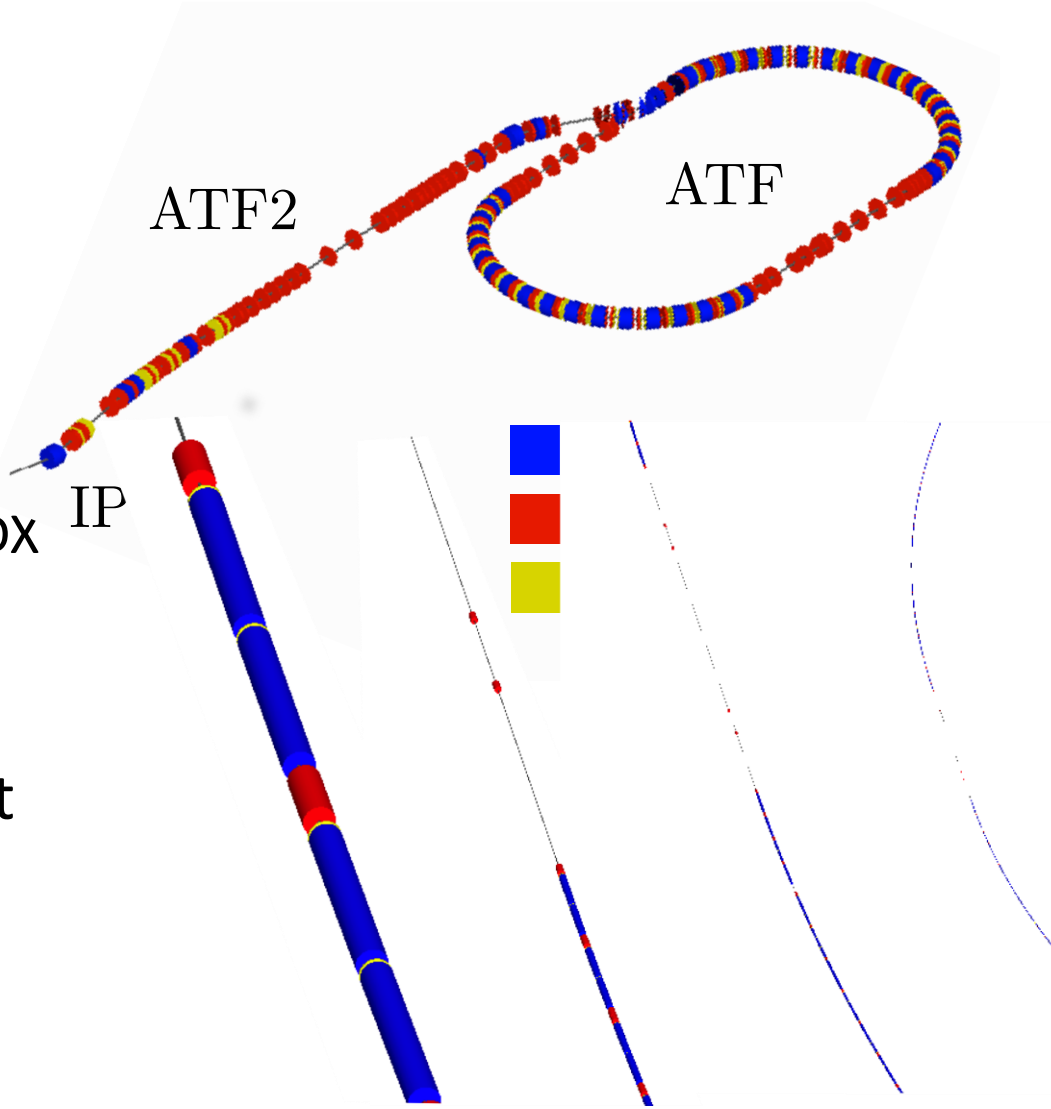
CBPM : Wakefield measurement example



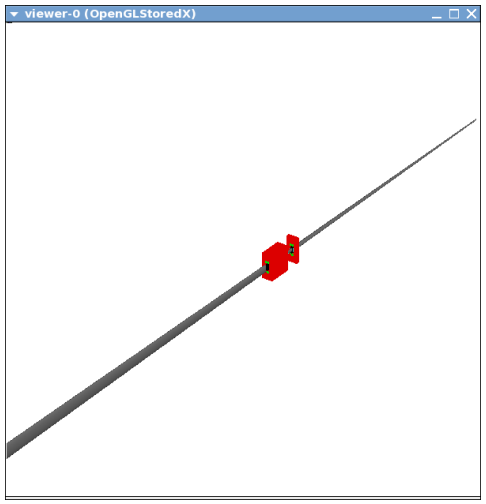
- Wakefield kick will change the beam orbit slightly
- Experiment is ideally placed as many high resolution cavity BPMs both upstream and downstream of the setup
- Procedure:
  - Take all upstream cavity BPM readings
  - All BPM readings averaged subtracted
  - Find contribution between those BPM readings and downstream cavity BPM readings
  - Subtract orbit per pulse (by SVD matrix inversion)
  - Remaining correlation with setup movement will give wakefield kick
- Orbit and shape follows simulation well
- Some discrepancy in absolute size compared to simulation (calculation + tracking).

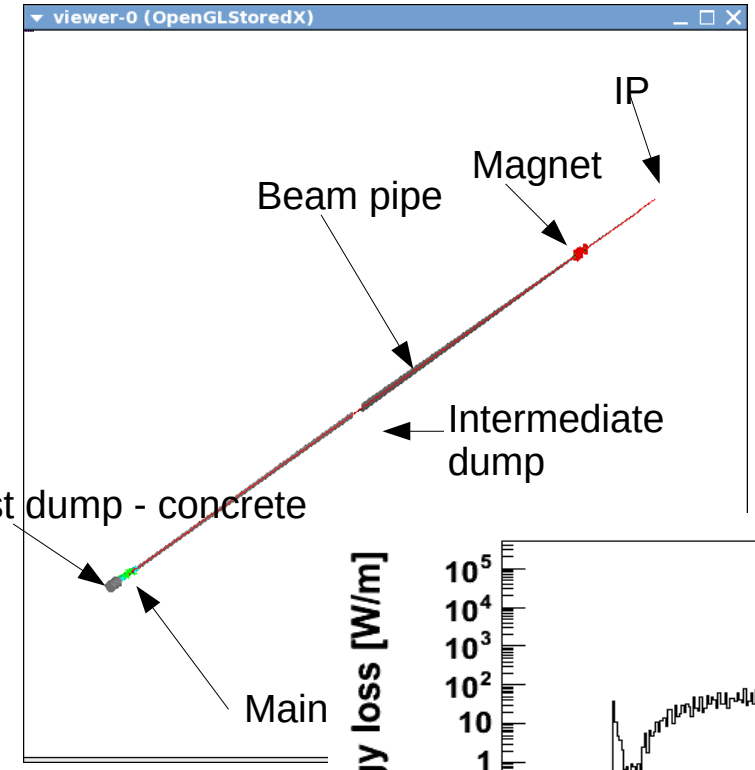
BDSIM (Geant 4 + particle tracking)

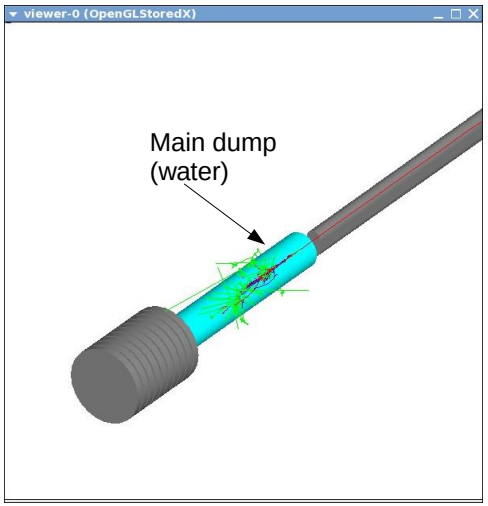
- Project of G. Blair
  - Taken over by S. Boogert, J. Snuverink and L. Nevay
- Improved
  - Base code
  - Conversion from MAD8, MADX
  - Interfaces to PLACET
  - Geometry description
- Work recently to implement LHC
  - CLIC/ILC significantly easier

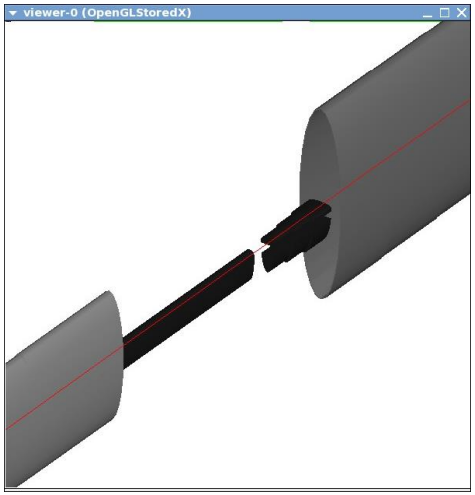


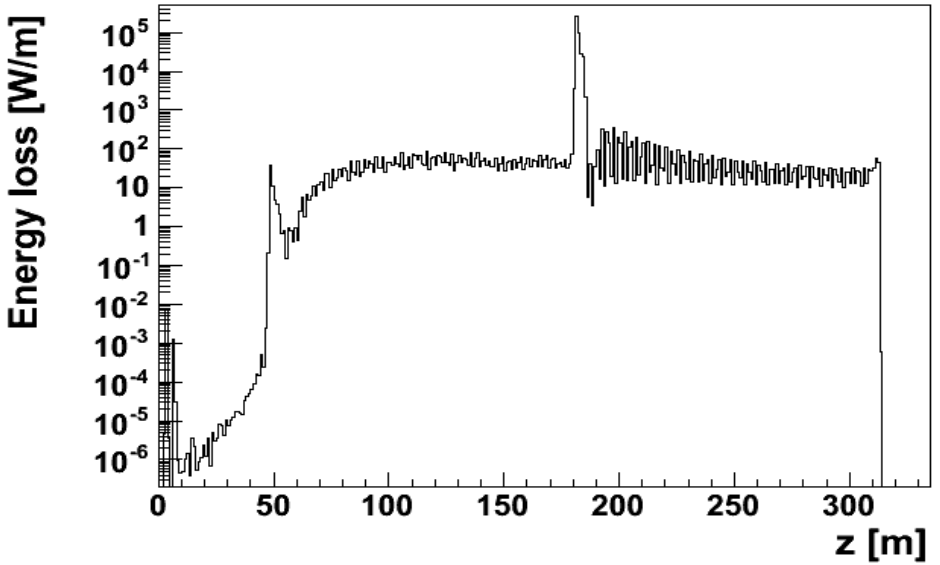
CLIC dump line (L. Deacon)











Future program

- Background studies for CLIC using PLACET/BDSIM
  - Collimator background generation
  - Compton signal backgrounds, emittance measurement system, energy spectrometers, in RTML, linacs and BDS Wakefield simulation
- Collimator wakefields
- Effect of wakes on low emittance transport
- Two beam tuning

Deliverables

- 2013 (December): Complete BDSIM simulation of CLIC collimation
  2014 (April): Integrate wakefield simulations for CLIC BPMs and other structures in PLACET
  2015 (April): Complete BDSIM simulation of CLIC beam delivery and two beam system
  2016 (April): Integrate collimator wakefield and other possible wakes, other diagnostic structures
  2016 (April): Paper on backgrounds in CLIC
  2016 (April): Paper on CLIC tuning, including effects of wakefields.

New funding request

	RHUL	CERN	Total
Academic (Stewart Boogert)	**6 pm**	**0**	**6 pm**
PDRA (Jochem Snuverink)	**18 pm**	**18 pm**	**36 pm**
Travel	**3 k£**	**15 k£**	**18 k£**
Material	**0 k£**	**0 k£**	**0 k£**