The Next Generation of Tests: The Two-beam Test-stand

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on behalf of the TBTS team

CLIC-ACE
CERN, 17 January 2008
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   – design
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The CTF3 Test-stands

Mid-linac 30 GHz Test-stand (1BTS)
  – accelerating structure tests

CLEX Two-beam Test-stand (TBTS)
  – accelerating & power-extraction structure and module tests
  – drive- and probe-beam!
The Two-beam Test-stand

- drive- and probe-beam parallel along ~10m
- unique test possibilities
  - PETS & accelerating structures
  - two-beam operation, high-power drive-beam
  - beam loading breakdown rate & energy spread compensation
  - RF breakdown transverse kick
  - full CLIC module
  - beam-based alignment
- versatile facility
  - excellent beam diagnostics
  - easy access for changing components & layout
  - space & flexibility for future upgrades
The Next Generation of Tests: The Two-beam Test-stand

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CLEX Design

TBTS
Two-beam Test-stand

TBL – Test-beam Line
drive-beam decelerator
reserved space

TL2

CALIFES
probe-beam linac

ITB – Instrumentation Test-beam line
reserved space
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TBTS Design

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Summary

TBTS

Spectrometers and beam dumps

DUT area

CTF3 drive-beam

CALIFES probe-beam
DUT Area

PETS in the tank with all infrastructure

PETS & ACS tanks

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Installation Work

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The Next Generation of Tests: The Two-beam Test-stand
TBTS Today

The Next Generation of Tests: The Two-beam Test-stand
Installation & Commissioning

Hardware
- orbit correctors, on their way to CERN
- vacuum chambers, ready end January
- BPMs, under calibration
- MTVs, arrival mid February

Cabling and tests ongoing, ready in time for closure CLEX mid April.

Beam & diagnostics commissioning from May, with beam tubes in the DUT area.
## Test Schedule

### Tests in the two-beam experimental area

<table>
<thead>
<tr>
<th>Phase</th>
<th>Tests</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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</thead>
<tbody>
<tr>
<td><strong>Structure test</strong></td>
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<tr>
<td>Phase 1</td>
<td>PETS w/o damping material</td>
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<td>PETS with damping material</td>
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<td>PETS with recirculation</td>
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<td>Phase 2</td>
<td>Existing PETS + 1 accelerating structure</td>
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<td></td>
<td>new PETS generation + 1 accelerating structure</td>
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<td></td>
<td>accelerating structures with WFM prototypes</td>
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<td><strong>Module test</strong></td>
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<tr>
<td>Phase 1</td>
<td>Accelerating structures with WFM</td>
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<tr>
<td>Phase 2</td>
<td>Quadrupole on the main beam</td>
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The Next Generation of Tests

The Two-beam Test-stand is unique:
- high-power PETS operation with beam [35:100A]
- ACS operation with beam [0.5:1.0A]
- PETS + ACS breakdown & kick
- excellent beam diagnostics, long lever arms

and a versatile test facility:
- ease of access, changing components and layout
- space for additional instrumentation

Many new, unique and exciting test possibilities!
Unique Test Possibilities

1. PETS operation with correct field profile (previous tests in waveguide mode: highest power in first cell)

2. transverse beam kick due to breakdown

3. beam energy & dynamics
Beam Tests

Drive- and probe-beam
  – energy and energy loss/gain
  – average energy spread
  – transverse beam kick

Energy measurements with BPM and MTV after the spectrometer dipole.
PETS Tests

PETS, as function of beam current
- demonstrate high-power operation: 35A beam
- power production
- RF breakdown
- beam deceleration

PETS on/off mechanism
- speed (at RF breakdown)
- reliability

The TBTS is the ideal and only possibility to test RF breakdown in the PETS with a correct field profile!
ACS Tests

ACS, as function of power & beam loading
  – energy spread compensation
  – acceleration
  – RF breakdown

RF breakdown easiest at a klystron, but uniquely the TBTS allows to study the influence of the beam
  – RF gradient and breakdown rate modification by beam loading,
and on the beam
  – beam kick,
  – phase advance for in-situ damage check.
Full Module Tests

TBTS designed to hold a full CLIC module with 8 accelerating structures

– correlation and reflection of RF breakdown, due to multiple connected high-power objects

– alignment of complete module

– integrated wakefield monitor

– correlation between PETS, ACS and beam behaviour as function of RF power
Instrumentation Techniques

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Kick Measurements

M. Johnson,
*Beam-based diagnostics of RF-breakdown in the Two-beam Test-stand*,
CLIC Note 710, CERN-OPEN-2007-022
Control and Data Acquisition

Main issues

- synchronization b/w BPM and RF signal
- integrated approach with automatic logging

The Next Generation of Tests: The Two-beam Test-stand

BPM front-end
Summary

The Two-beam Test-stand offers unique possibilities for test and development of CLIC components and further understanding of its behaviour.

The installation and preparations are well on schedule thanks to the funding agencies and all our colleagues from Annecy, Barcelona, CERN, Helsinki, Islamabad, Saclay and Uppsala.