# SPECTROMETRY AT THE TEST BEAM LINE AT CTF3

M. Olvegård *, E. Bravin, F. Carra, N. Chritin, A. Dabrowski, A. Dallocchio,
S. Döbert, T. Lefèvre (CERN, Geneva, Switzerland),
E. Adli (University of Oslo)

UPPSALA UNIVERSITET

## Introduction

The purpose of the CLIC Test Facility 3 is to demonstrate the efficiency of the CLIC RF power production scheme, and the Test Beam Line (TBL), presently under commissioning, is a small scale version of the CLIC decelerator. The TBL must show efficient and stable RF power production over 16 consecutive decelerating structures (PETS), without beam blow-up. As the high intensity electron beam is decelerated its energy spread grows by up to 60%. A novel segmented beam dump for time resolved energy measurements has been designed to suit the requirements of the TBL. As a complement, a diffusive OTR screen is also installed in the same spectrometer line. The combination of these two devices will provide both a high spatial resolution measurement of both the energy and energy spread and a measurement with a nanosecond time response.

## Segmented Beam Dump

A new segmented beam dump has been designed for time resolved spectrometry at the TBL

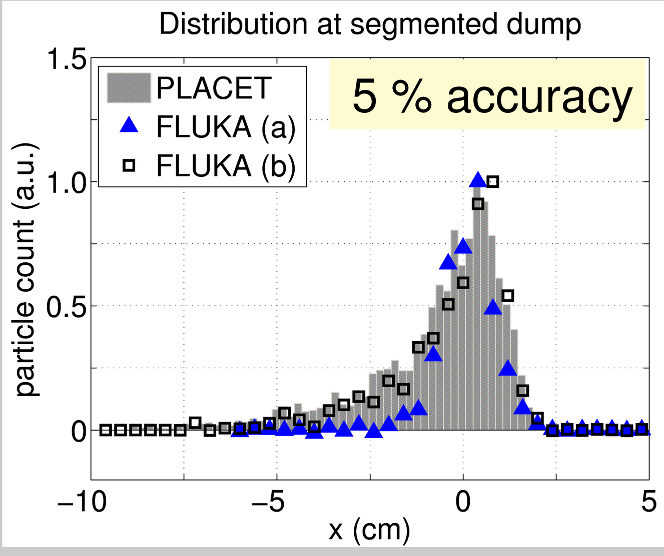
- Like segmented Faraday cup: incoming particles are stopped and the absorbed charge measured as a current. The segmentation enables a deduction of the energy spread. A fast sampling (~ns) is possible.
- FLUKA simulations study to the size and shape of the electromagnetic shower emerging from the interaction of the beam with matter.
- Penetration depth and multiple scattering of the particle depends on initial energy and material.
- High Z material means shorter and thinner segments
- The resolution of the detector has been optimized by balancing the segment horizontal width and the cross talk between adjacent segments.

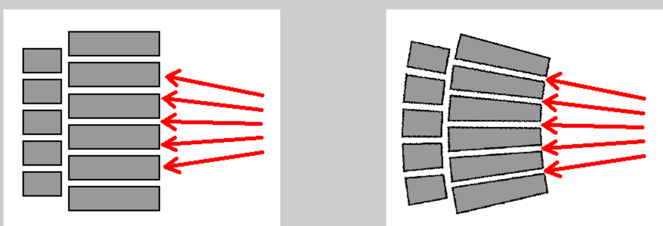
Beam distribution from PLACET and detector geometry in FLUKA:

- Compute the net charge absorbed by each plate and reconstruct particle distribution.
- A comparison with PLACET distribution shows the ideal performance of the detector.
- Concentric collimator slits increase acceptance towards divergent beam - an improvement compared to older design with parallel collimator slits.

32 tungsten segments
- transverse width: 3 mm
- transverse spacing: 1 mm
- longitudinal thickness: 20 mm

Inermet collimator with 32 slits [high tungsten content]
- slit width: 400 µm
- longitudinal thickness: 100 mm



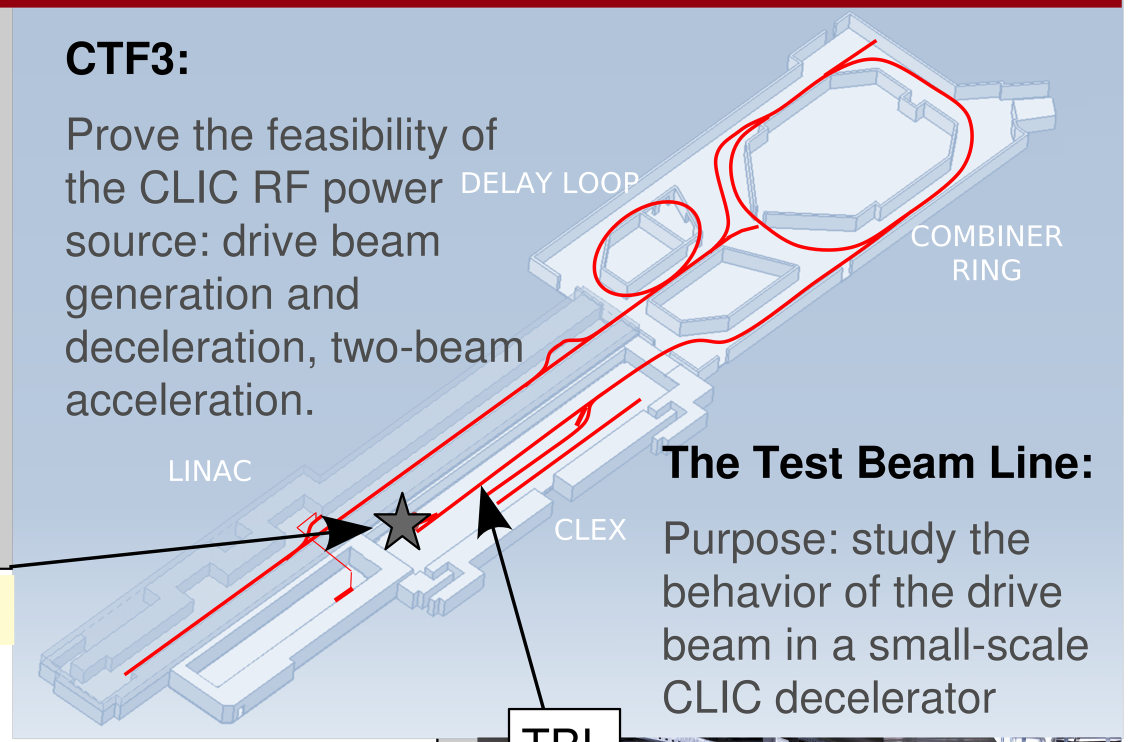
(a) Parallel slits (b) Concentric slits

**Particle distribution (rms):**
PLACET : 1.89 cm
FLUKA (a): 0.82 cm
FLUKA (b): 1.97 cm

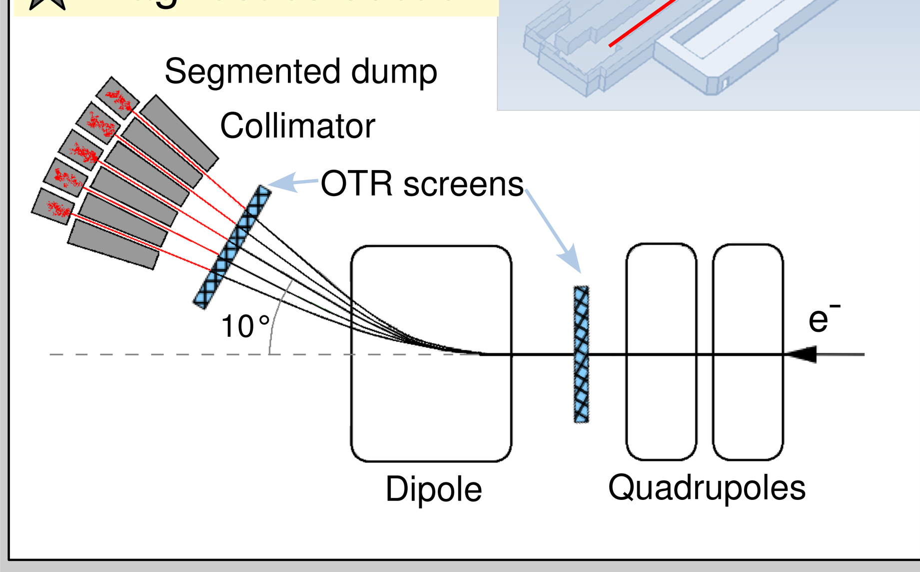
## The Test Beam Line in CTF3

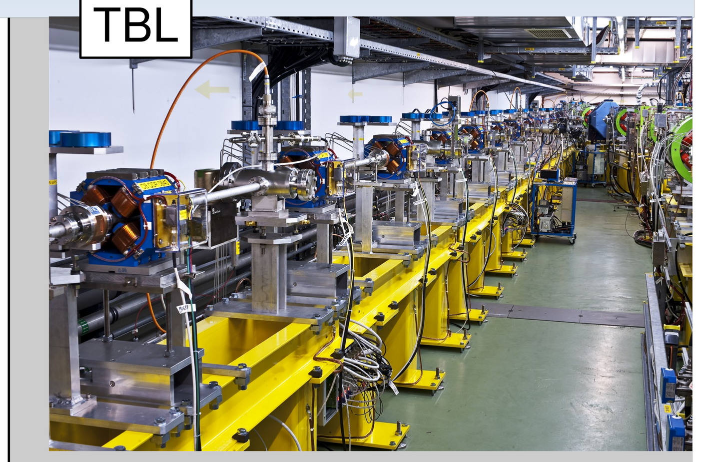
**Spectrometry at TBL:**
- detect high energy transient, due to full loading of cavities
- measure beam energy loss
- measure large intra-bunch energy spread

**CTF3:**
Prove the feasibility of the CLIC RF power source: drive beam generation and deceleration, two-beam acceleration.



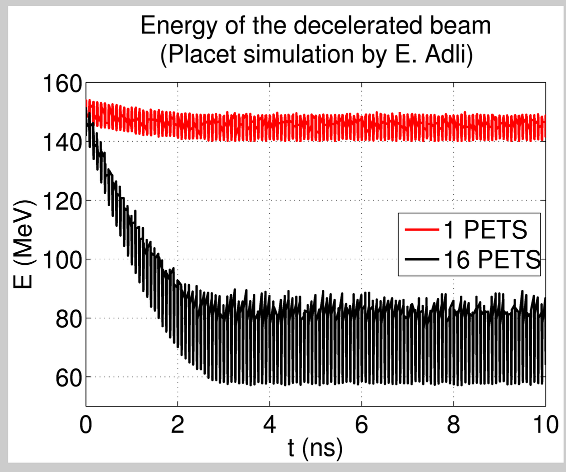

**The Test Beam Line:**
Purpose: study the behavior of the drive beam in a small-scale CLIC decelerator



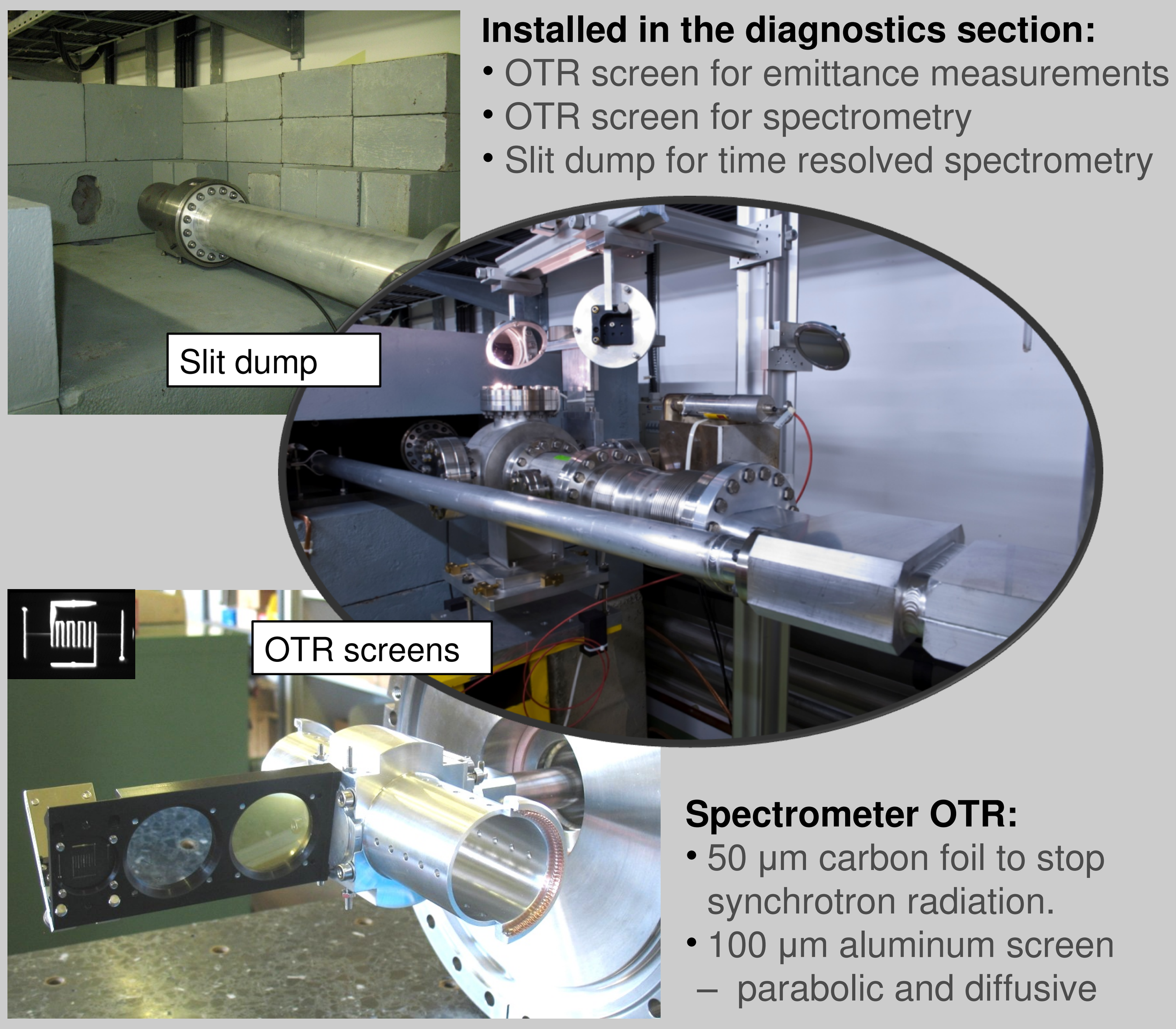



Injected beam: 150 MeV, 28 A, 140 ns

| Nº of PETS # | Mean energy <E> | Energy spread σ/<E> |
|---|---|---|
| 1 | 144.9 (MeV) | 1.04% |
| 4 | 129.7 (MeV) | 1.4% |
| 8 | 109.5 (MeV) | 2.2% |
| 16 | 68.8 (MeV) | 5.8% |



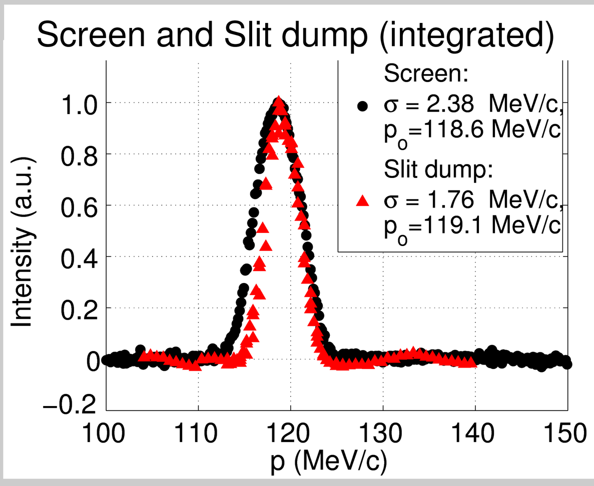

## Status and Results

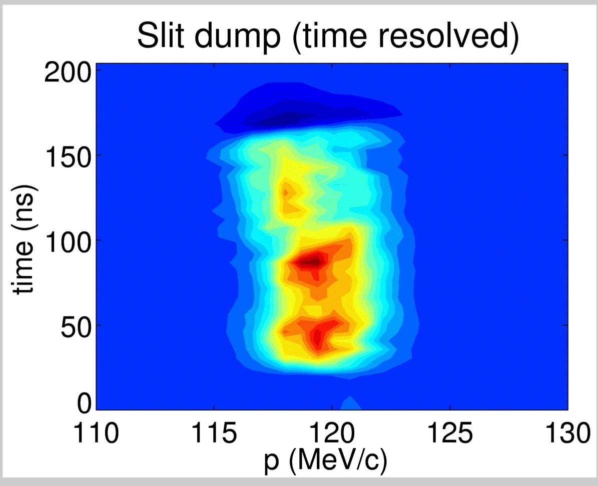



**Installed in the diagnostics section:**
- OTR screen for emittance measurements
- OTR screen for spectrometry
- Slit dump for time resolved spectrometry

**Spectrometer OTR:**
- 50 µm carbon foil to stop synchrotron radiation.
- 100 µm aluminum screen – parabolic and diffusive

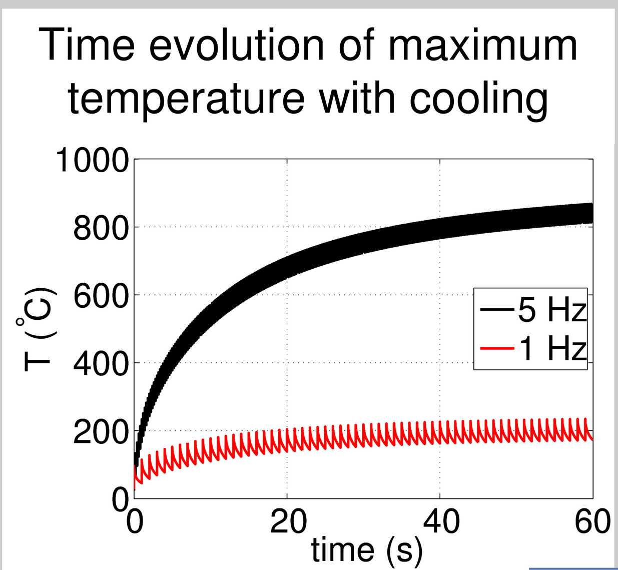
First measurement at TBL, November 2009

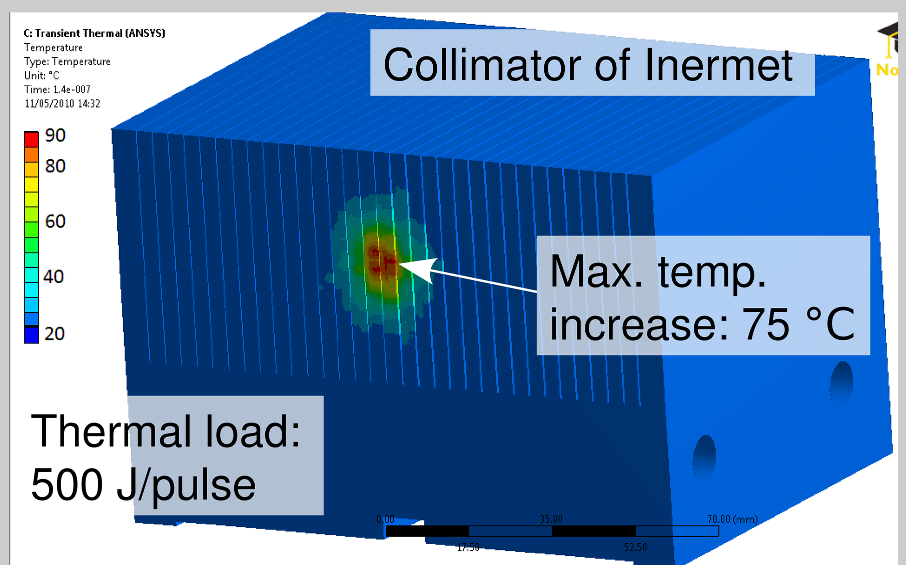


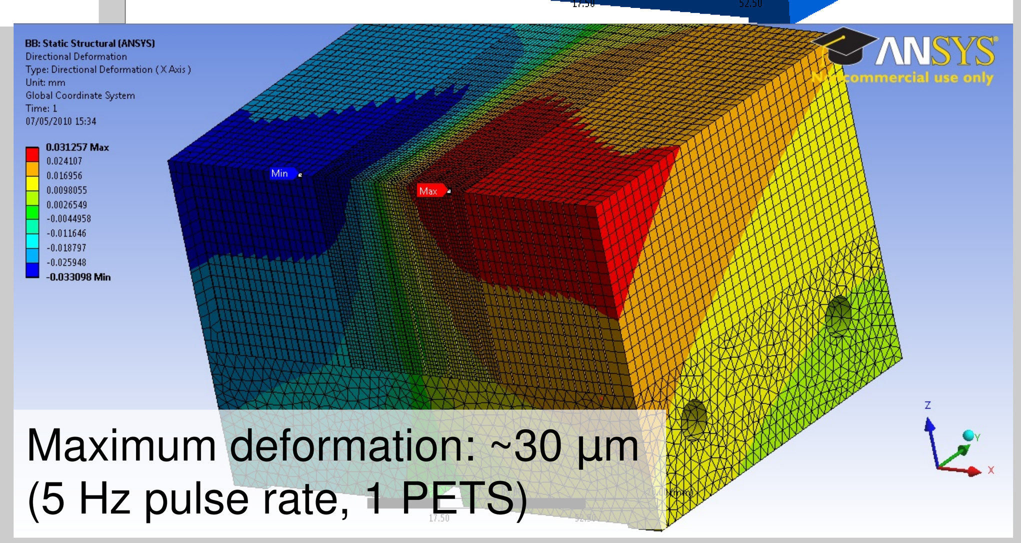




## Thermal and Mechanical Considerations

The high intensity beam in the TBL means a high thermal load on interceptive diagnostics. To protect the segments a multi-slit collimator has been designed. The collimator will be made of a material with high tungsten content, and will be cooled with water. Thus, cooling of the active segments can be avoided.



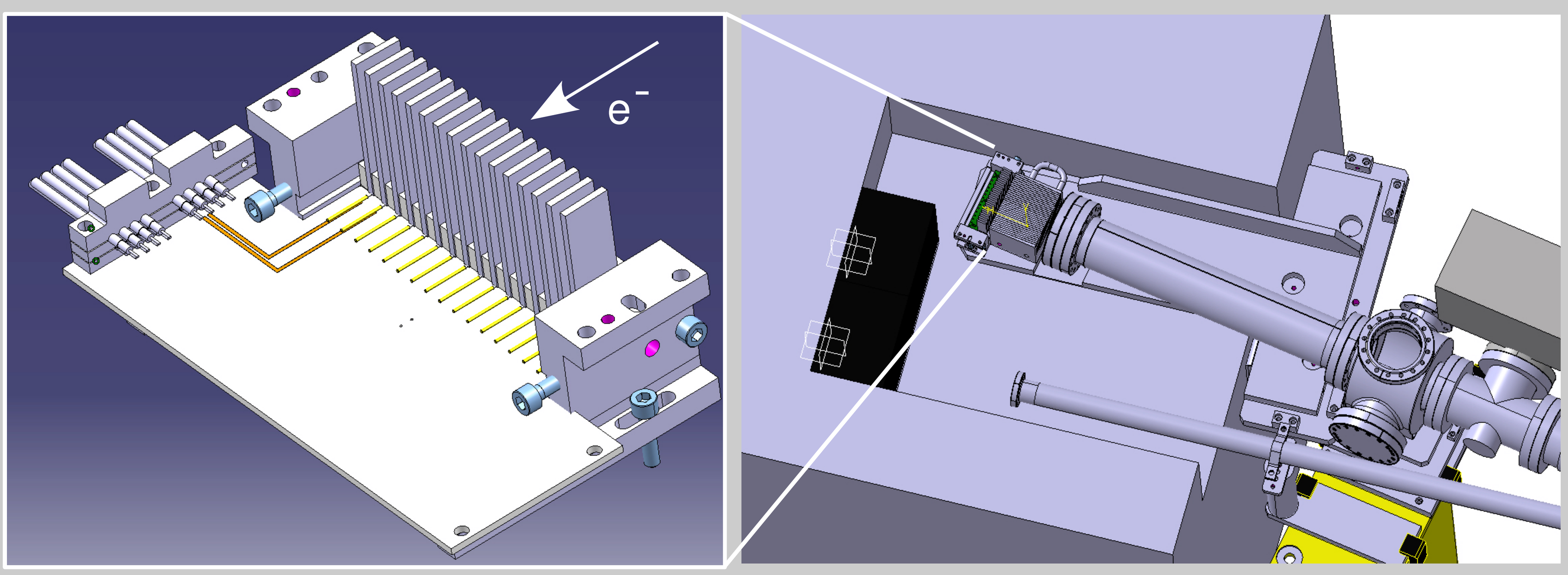




Finite Element Method thermo-mechanical analysis

## Outlook

- More measurements using the OTR screen and the slit dump: characterize the two systems and study beam optics.
- Installation of more PETS before the end of 2010
- Manufacturing and installation of new segmented dump end of 2010

Mechanical implementation of the segmented beam dump

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Maja.Olvegaard@cern.ch

MARIE CURIE ACTIONS PEOPLE DITANET

See also: THPD056: "Experimental Program for the CLIC Test Facility 3 Test Beam Line"