

Beam Delivery System collimators

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The collimator mission is to clean the beam halo from e- or e+ off orbit which could damage the equipment, but mainly to clean the beam from photons generated during the bending of the beam towards the Interaction Point. These photons, if not removed, would generate a noise background that would not allow the detectors to work properly.

Task 5.3 Programme

Highlights

- T480 data analysis/test beam at ESA
- Mafra/GdfidL simulations of T480 Collimators
- Beam damage simulations (FLUKA/Geant4, ANSYS)
- Beam damage test beam at ATF (phase 1)

Achieved:

Analysis of T480 wakefield test beams. Reconstructed kick factor with errors below 10% (in most cases). Uniformity of results using different analysis methods.

Achieved:

Improved GdfidL calculations. Uncertainties attributed to the calculations using a scheme based on convergence of results to zero mesh size.

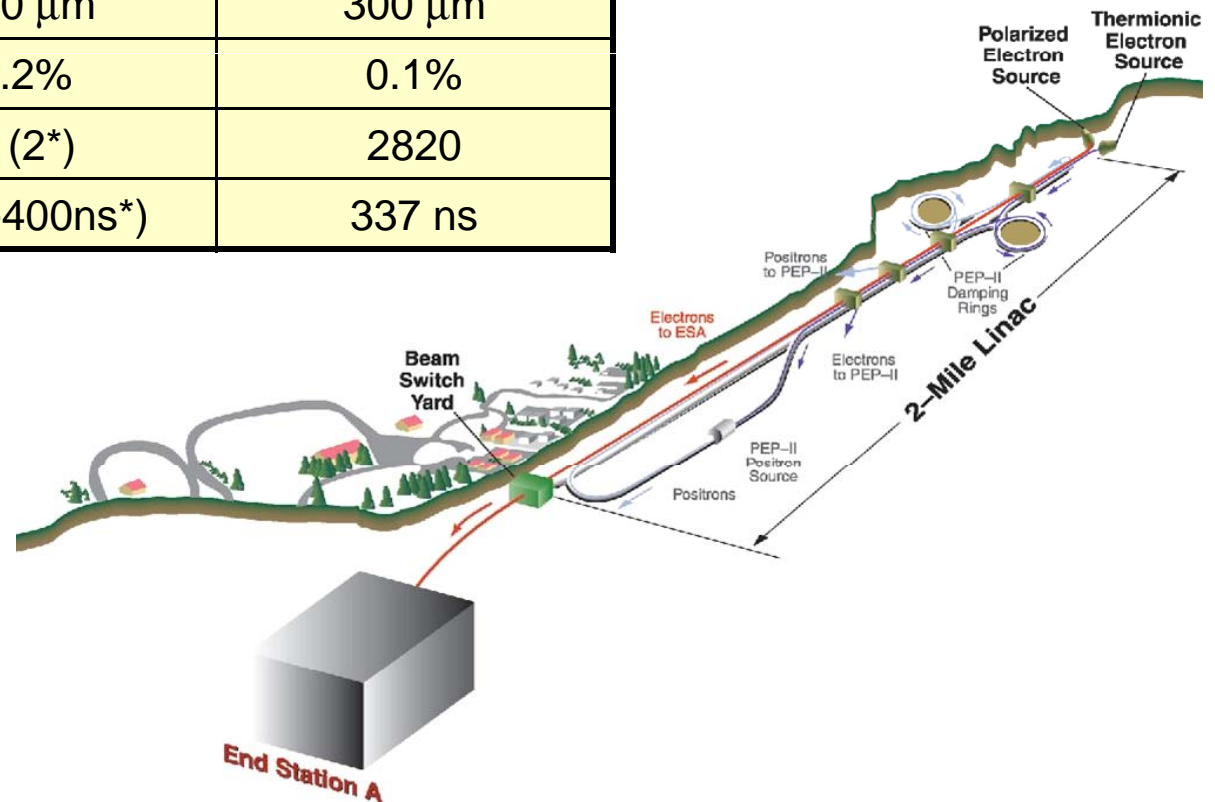
Achieved and going:

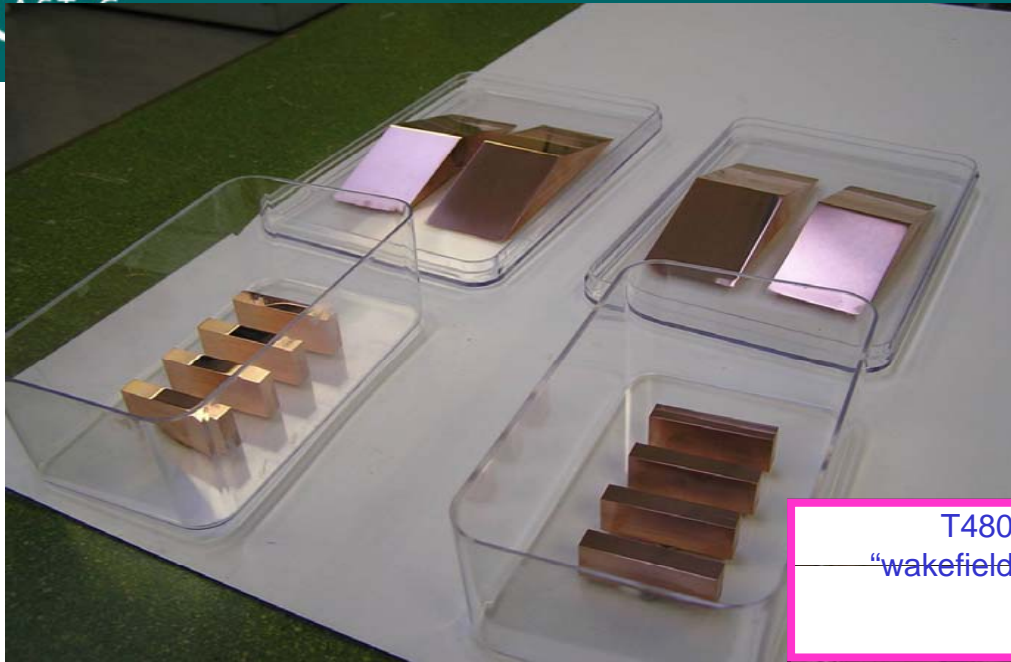
Phase 1 of the damage tests, main objective of our EUROTeV work. Damaged sample to be analysed at BegbrokeNano in Oxford.

Beam Parameters at SLAC ESA and ILC

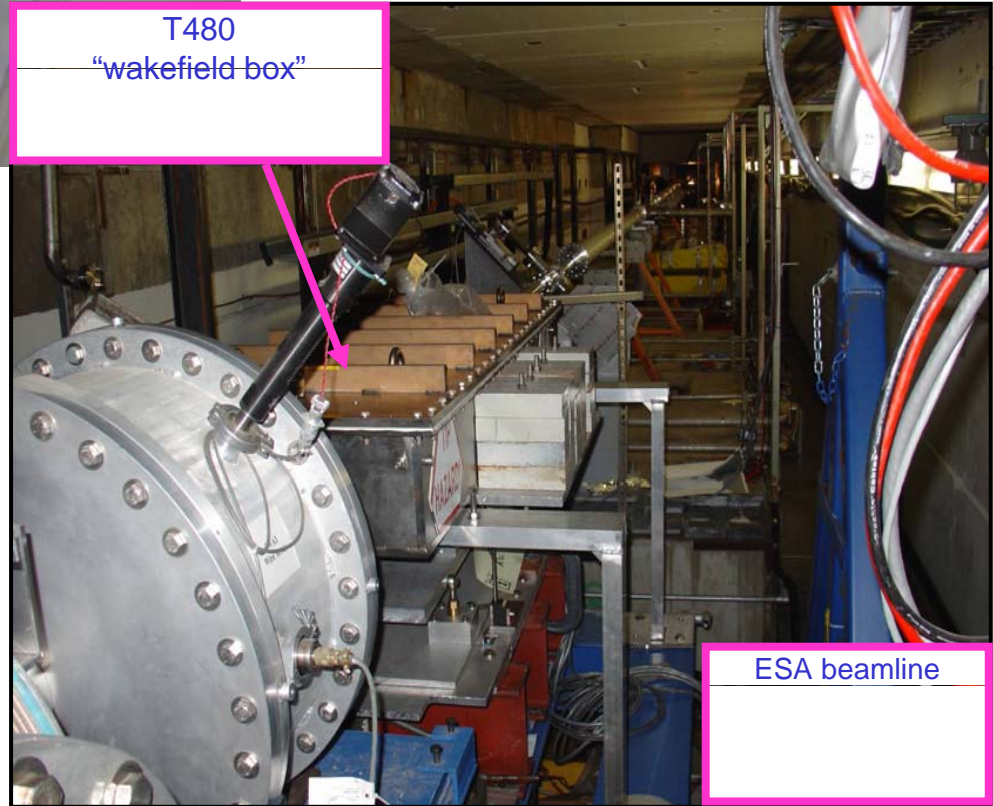
Parameter	SLAC ESA	ILC-500
Repetition Rate	10 Hz	5 Hz
Energy	28.5 GeV	250 GeV
Bunch Charge	2.0×10^{10}	2.0×10^{10}
Bunch Length	300 μm	300 μm
Energy Spread	0.2%	0.1%
Bunches per train	1 (2*)	2820
Microbunch spacing	- (20-400ns*)	337 ns

*possible, using undamped beam





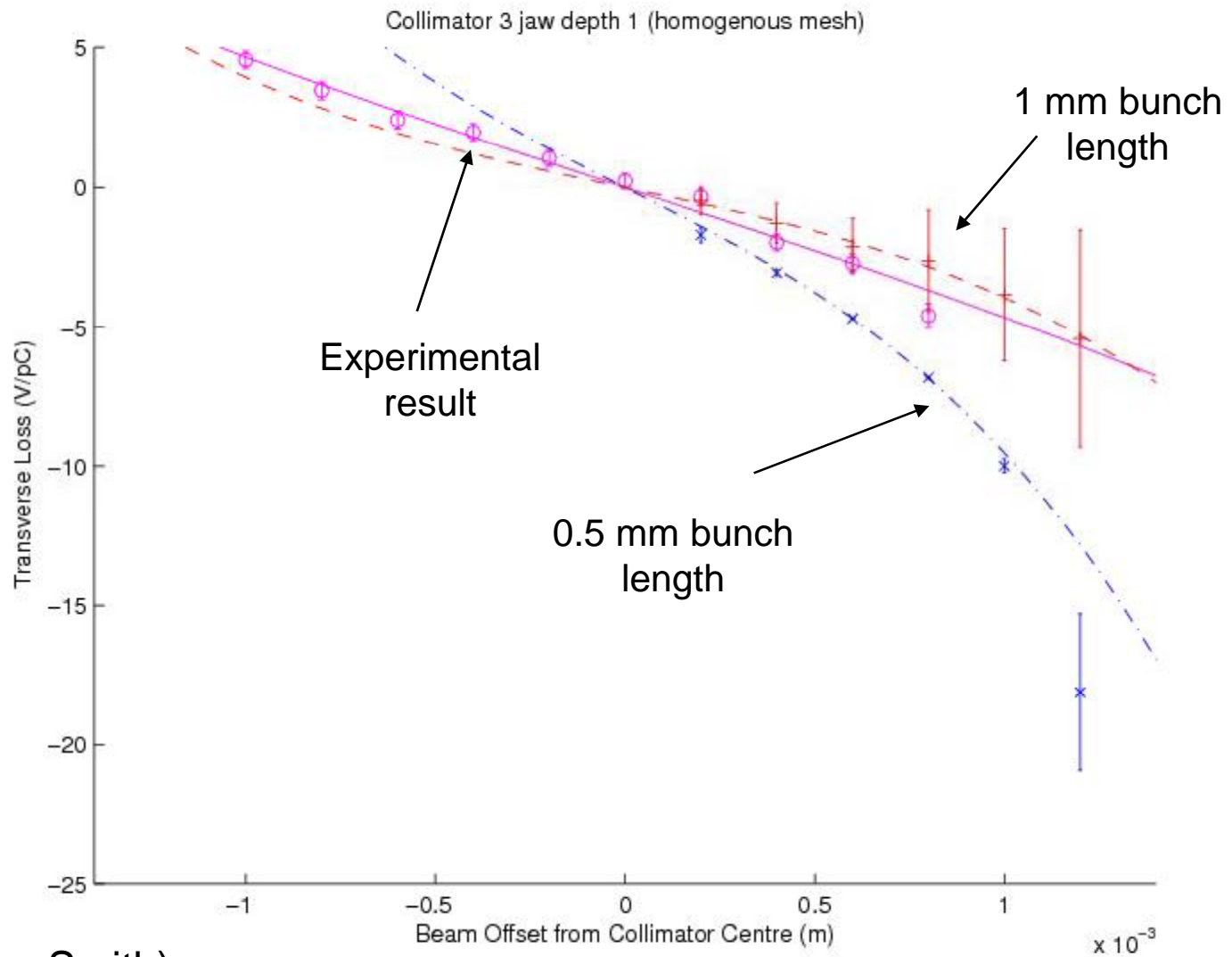
T480
"wakefield box"



ESA beamline

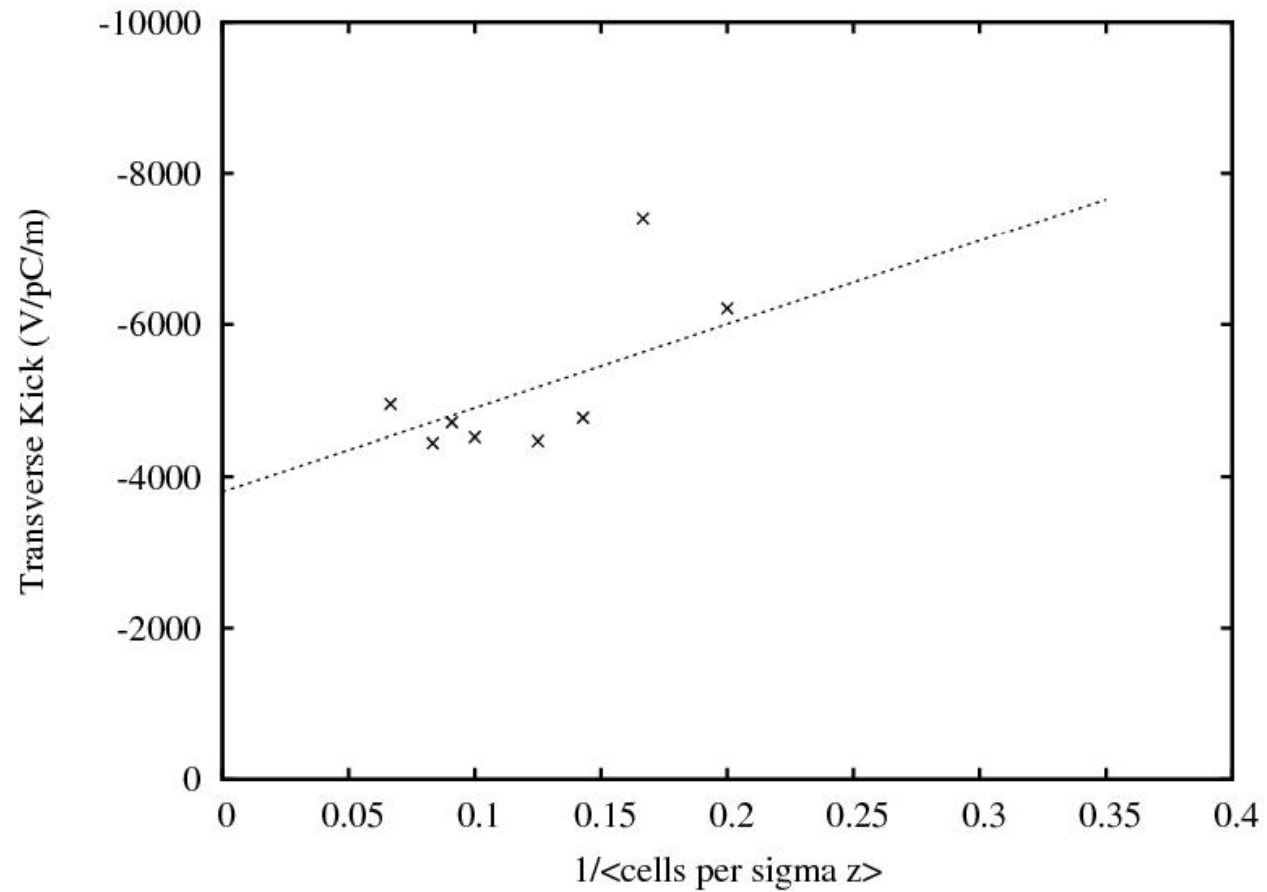
	Kick (V/pC/mm)	Error (V/pC/mm)	GdfidL 500 um (V/pC/mm)	Error*sqrt(c hisq/ndf)	GdfidL 1 mm (V/pC/mm)	Error*sqrt(chi sq/ndf)
col1	1.2	0.3	1.4	0.01	1.1	0.005
col2	1.9	0.2	4.2	0.09	2.0	0.05
Col3 (1m)	4.4	0.3	6.8	0.13	2.8	0.20
col4	0.6	0.4	0.8	0.03	0.8	0.0007
col5	4.9	0.3	5.7	0.17	4.4	0.57
col6	1	0.1	2.3	0.32	1.0	0.06
col7	1.4	0.3	3.5	0.06	3.1	0.11
col8	1	0.2	3.1	0.11	1.7	0.07
col9	1	0.1	2.3	0.32	1.0	0.06
col10	1.4	0.2	2.3	0.31	1.0	0.06
col11	1.7	0.1	2.3	0.31	1.0	0.06
col12	1.7	0.1	2.3	0.31	1.0	0.06
col13	1.9	0.2	4.1	0.05	3.3	0.09
col14	2.6	0.1	4.1	0.05	3.3	0.09
col15	1.6	0.1	3.7	0.23	2.7	0.05
Col 16	1.6	0.2				

GdfidL does not include resistive or surface effects.



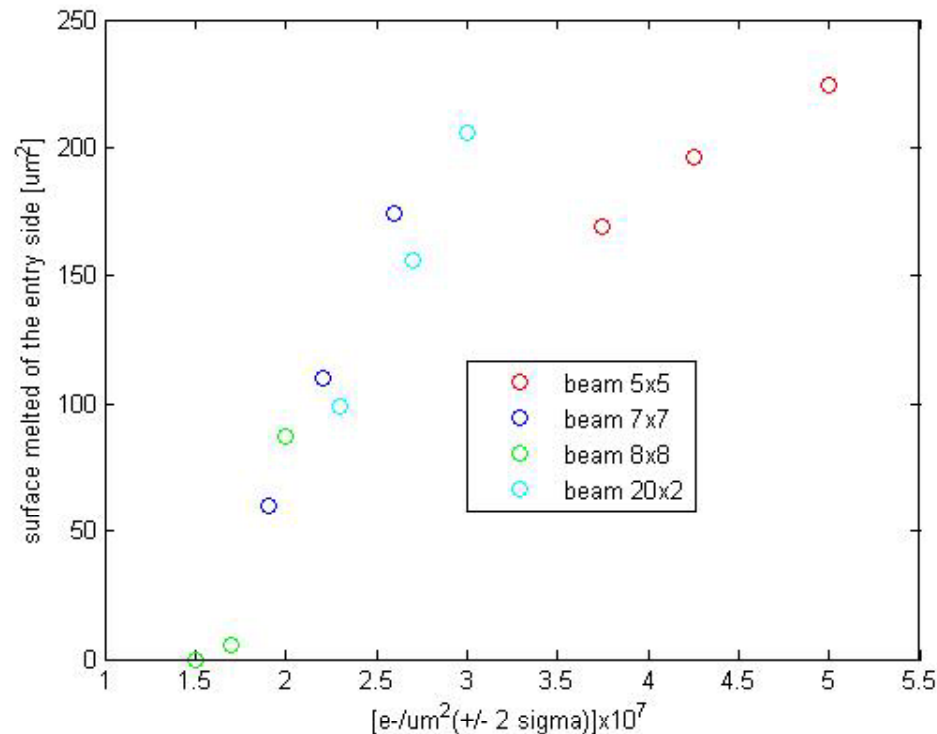
(Jonny Smith)

GdfidL: Convergence of results to zero mesh size



(Jonny Smith)

Material damage test beam at ATF



Simulations with FLUKA of melted surface on the Ti alloy target against the beam parameters.

The purpose of the first test run at ATF is to:

1. Make simple measurements of the size of the damage region after individual beam impacts on the collimator test piece. This will permit a direct validation of FLUKA/ANSYS simulations of properties of the materials under test.
2. Allow us to commission the proposed test system of vacuum vessel, multi-axis mover, beam position and size monitoring.
3. Validate the mode of operation required for ATF in these tests.
4. Ensure that the radiation protection requirements can be satisfied before proceeding with a second phase proposal.

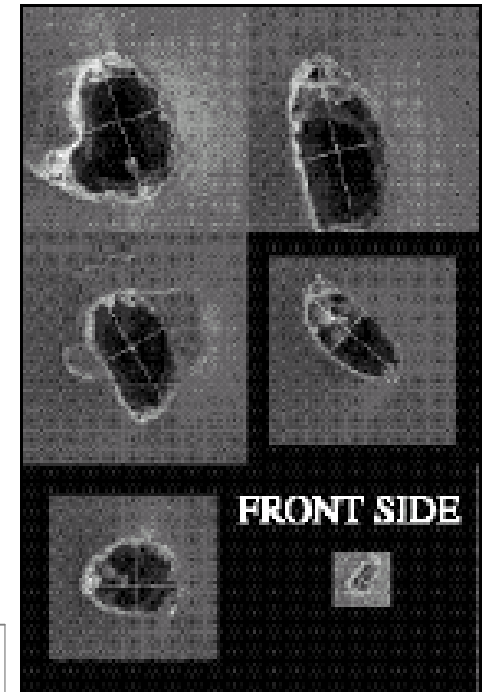
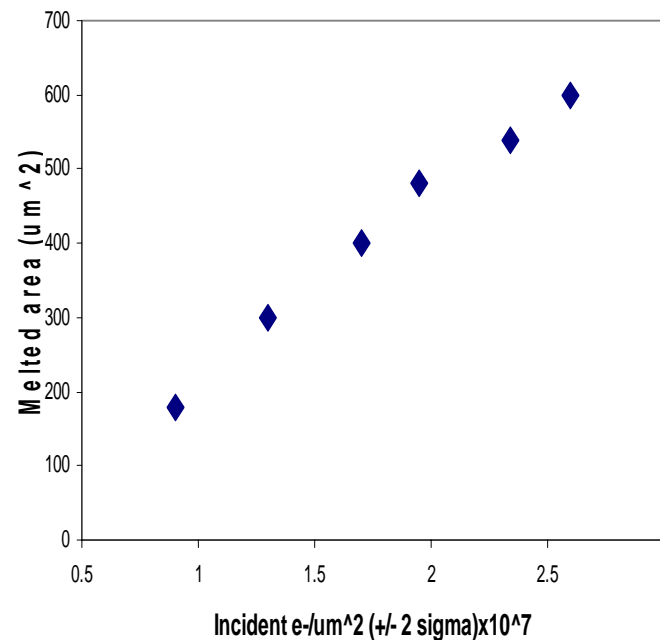
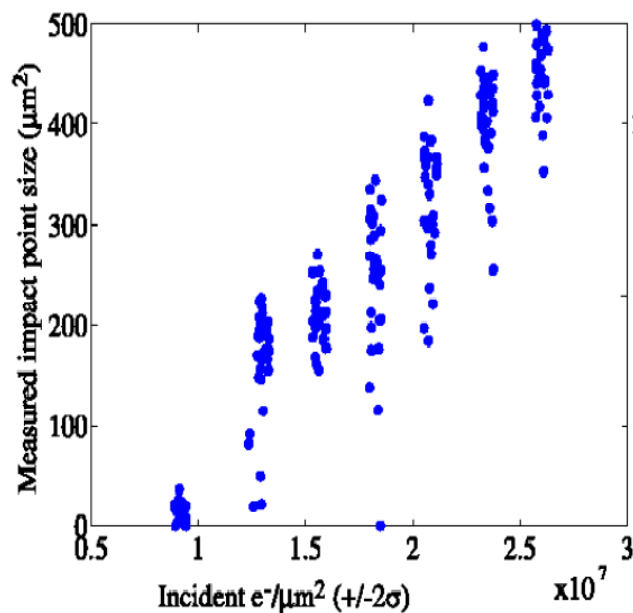
Assuming a successful first phase test, the test would be to measure the shock waves within the sample by studying the surface motion with a laser-based system, such as VISAR (or LDV), for single bunch and multiple bunches at approximate ILC bunch spacing.

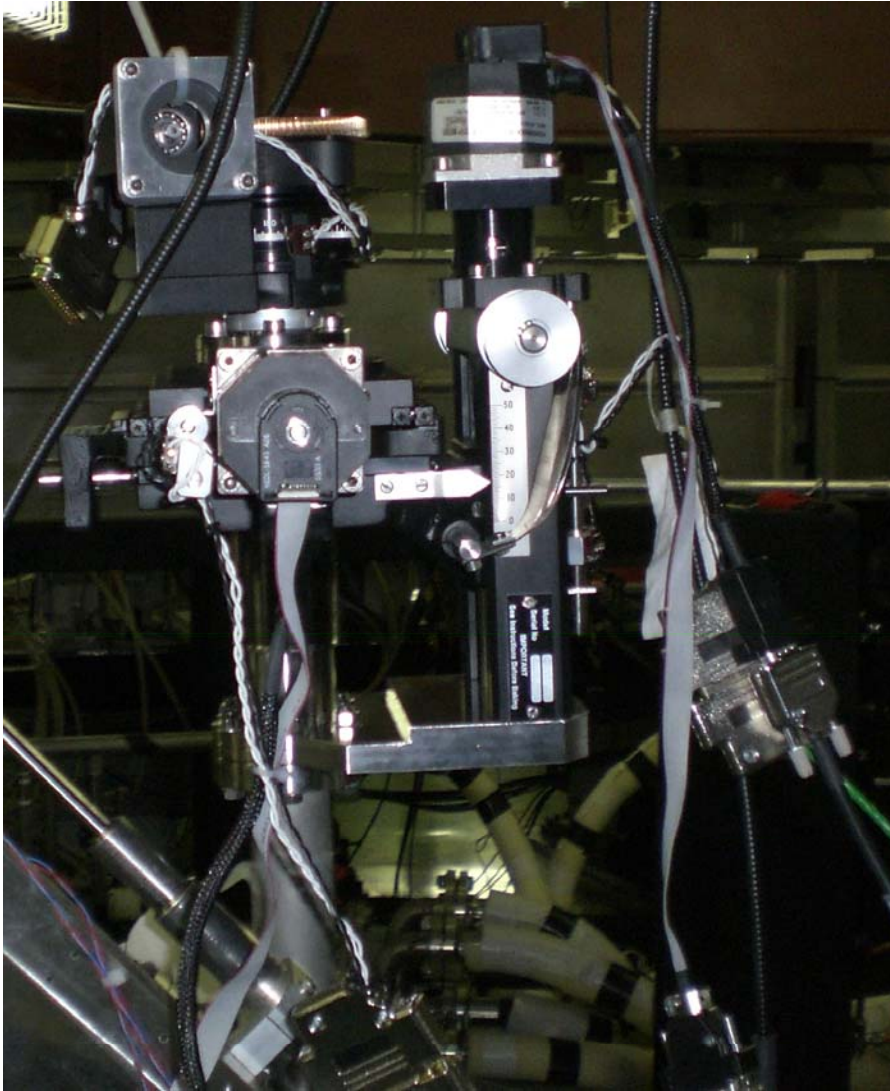
A similar test done in SLAC FFTB gave the results that can be seen in the bottom left plot of this section.

Results of a FLUKA simulation using same beam and target specification can be seen in the bottom right plot of this section.

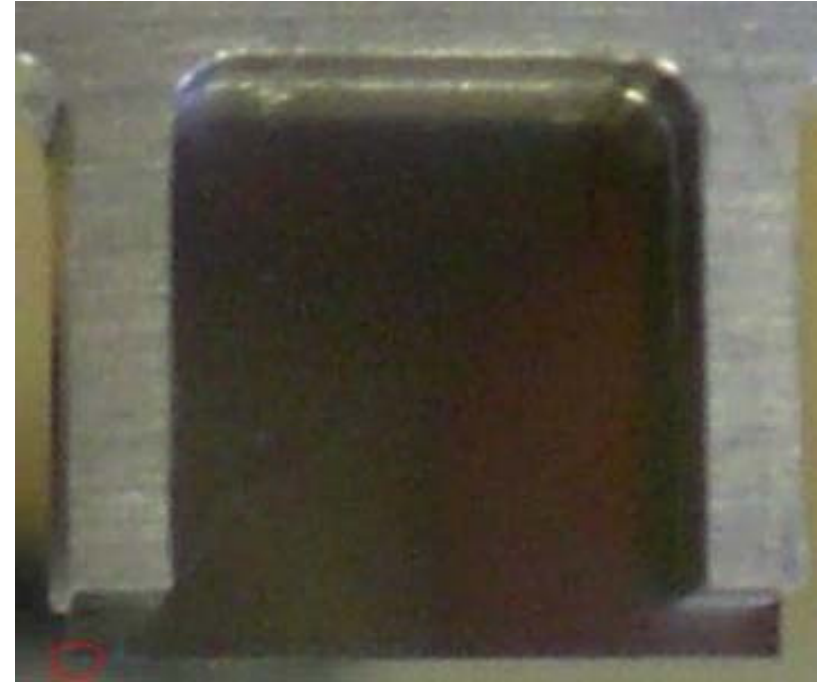
There is a systematic divergence of $\sim 100 \mu\text{m}^2$ but both plots agree in the slope.

[Measurements c/o Marc Ross et al., Linac'00]





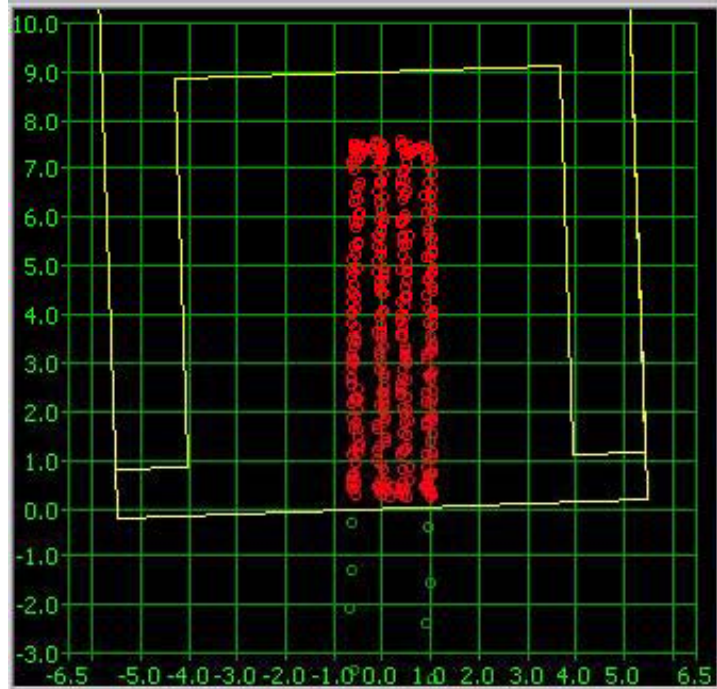
(George Ellwood)



← 11 mm →

We gained experience in working at ATF and commissioning the mover system, beam control and instrumentation.

Collimation Damage DAQ



Offset Y Offset Rotation

Current Log File

CollDamLogFile_2008_02_29_15_07_14.log

Restart Log

```
[1] encoder.2 = -35.3010 residual = 0.0020
move finished in 1 iterations, residual : 0.0020
one.
moving axis 2 over 5.0000 mm, speed 0.5000 mm/s.
moving axis 2 from -35.3010 to -30.3010
[1] encoder.2 = -30.3005 residual = 0.0005
move finished in 1 iterations, residual : 0.0000
one.
```

Controller Info

Controller link Connection Error

Simple moves

Relative move

Axis

Vertical

Dist. / Pos. (mm)

Speed (mm/s)

Move by 100um

Horiz. motion

Vert. motion

Horiz. (mm)

Vert. (mm)

ATF Info

Connected to ATF

ATF Alive

Remote Address

Port

Charge

X Pos

Y Pos

Mint Terminal Output

Error Message

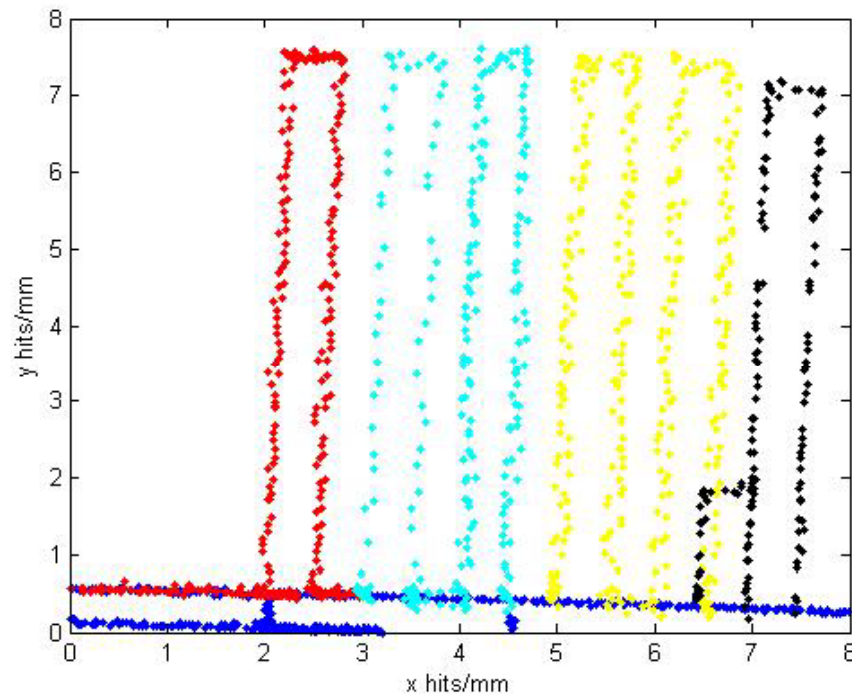
No Error



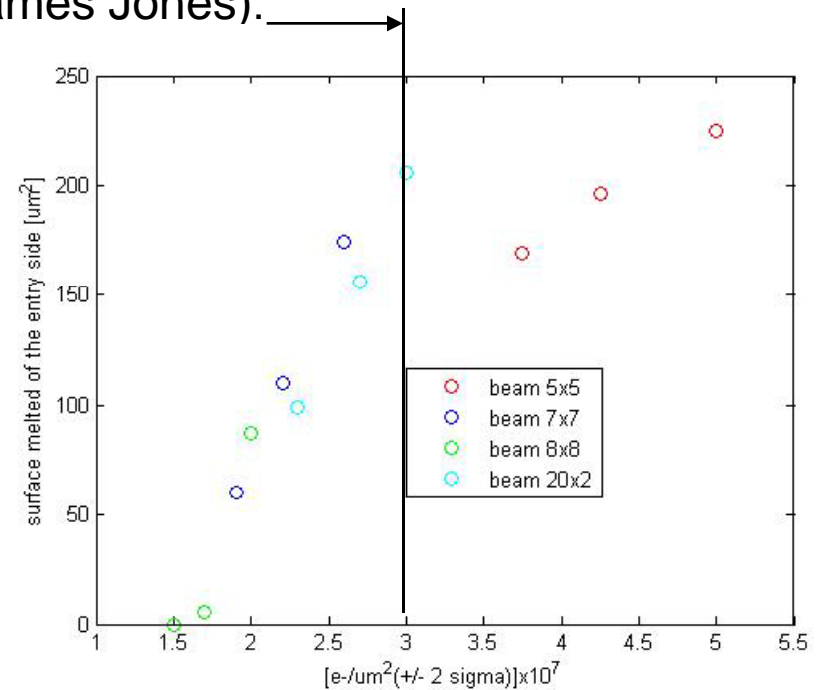
(Bino Maiheu, Mark Slater)

Phase 1 of Damage Test Beams at ATF-KEK

A **Ti alloy target**, same material as spoiler preliminary design, was hit by the **ATF electron beam**, at KEK, the amount of damage (melted surface) will be measured with the help of a SEM and compared to what FLUKA simulations predict.

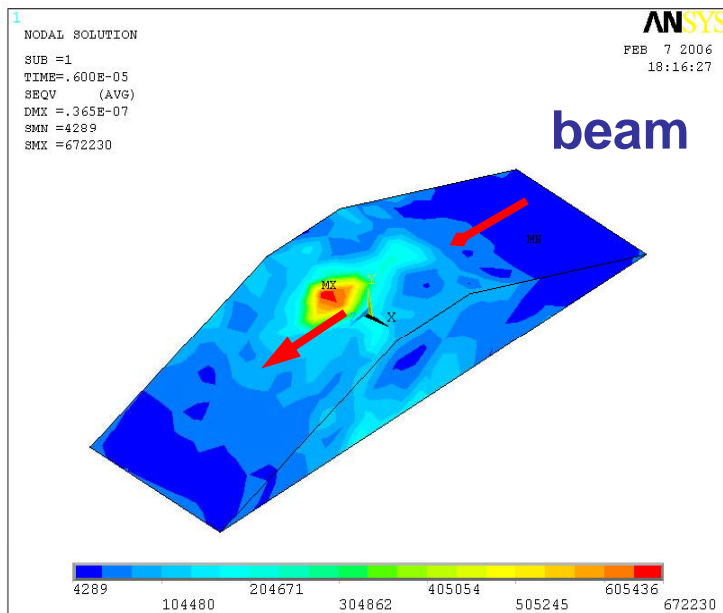


Hits with different beam charges, from 0.8×10^{10} to triple bunch hits with a total charge of 3.6×10^{10} . Calculated beam sizes of 15×2 to 15×5 microns square (James Jones).

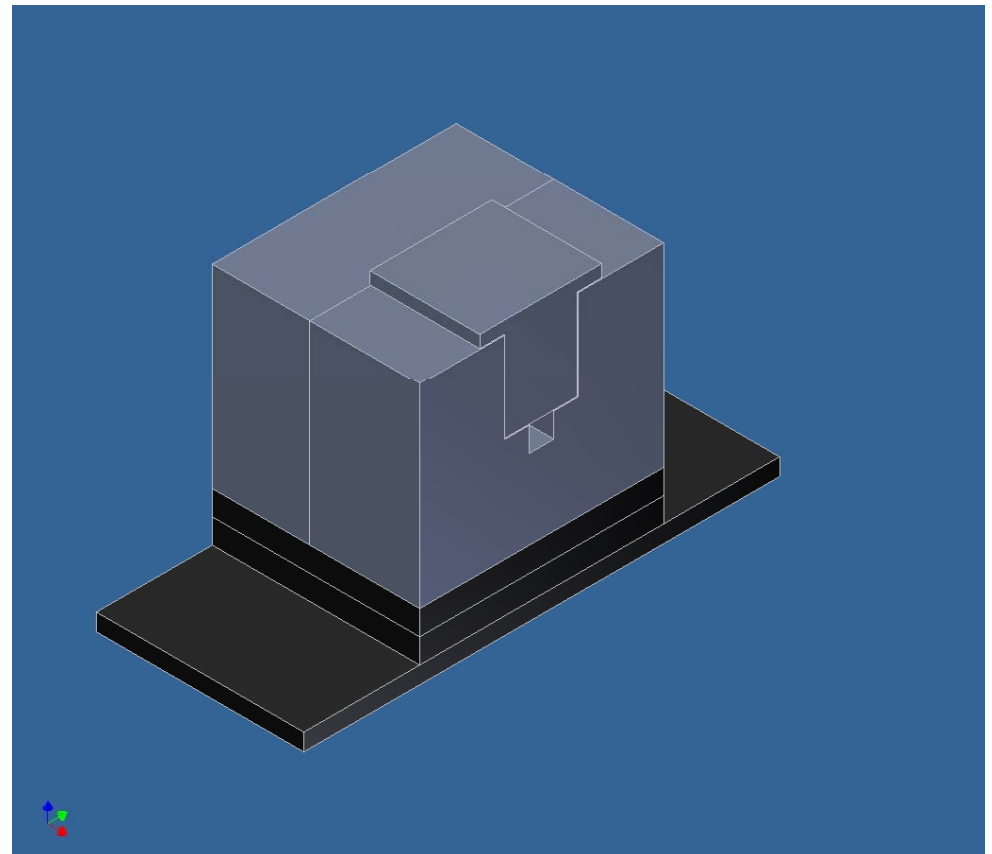


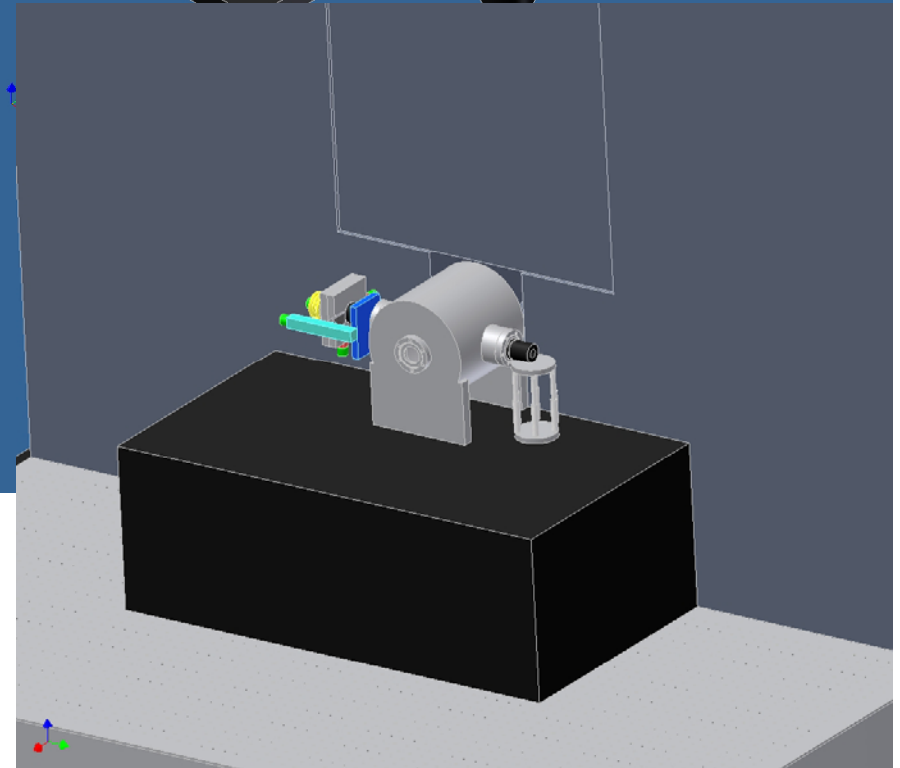
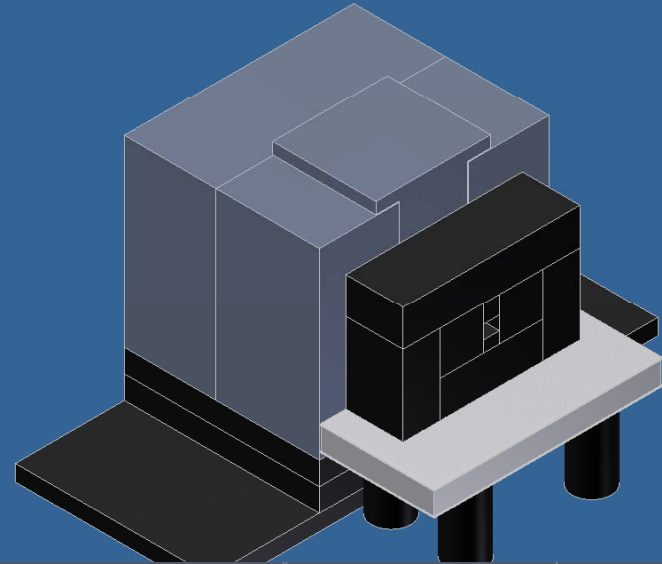
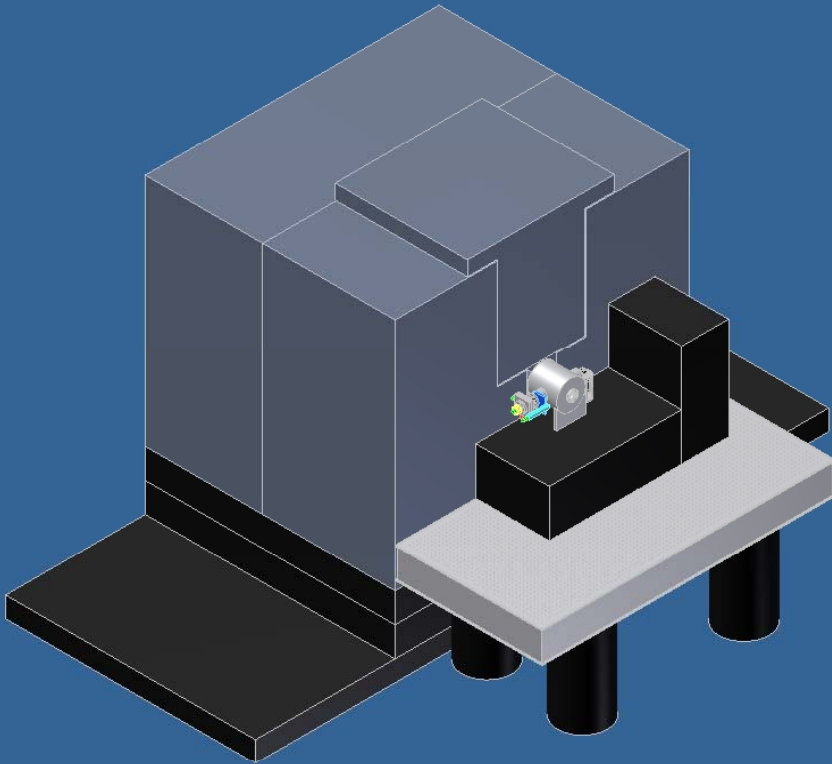
Second phase of radiation damage test beam at ATF2-KEK:

Will be used to study the stress waves generated by a bunch hitting the material and this data will be compared to FLUKA + ANSYS simulations.



(George Ellwood)





(George Ellwood)

Outlook:

June test beam at ESA that will give significant improvement in the measurement accuracy with respect to other test beams, with upgrades to the BPM system upstream.

Outlook:

GdfidL will be on a much larger (1584 core) cluster which will allow more realistic modelling. Will be used to study wakefields in a first conceptual collimator design from the DL project engineering group.

Outlook:

Phase 2 of the damage tests at ATF2 were stress-waves will be measured. Needed to fulfill our EUROTeV obligations.