ILC: Beam Delivery System
Collimation System

Outline

Comments on changes since EDR plan

Nigel Watson / Birmingham Univ.

Collimation System

- No longer a large/hot topic as in EDR phase
- No longer many people available…
- Concentrate on small number of specific topics
  - **Collimator material damage at ATF2**
  - **Need to revisit spoiler survivability requirements?**
  - **Crystal collimation?**
  - **Coherent effects for short bunches?**

- Reduce risk
- Reduce cost
- Prepare project execution plan
- WP and allocation plan

- Re-affirm identified risks
  - **Mitigating fallback solutions**
- Re-visit costs
- Deliverables definition per task, single institute taking responsibility on each

From EDR Tasks Overview – 0th guesses

- Phys. design of collimators
  - **Optics design of collimators**
  - **Physical design of collimators**
  - **Theoretical analysis of collimator wakes**
  - **Computing analysis of collimator wakes**
  - **Optimiz. background & coll. w. eng. constraints**
- Eng. design of collimators
  - **Eng. design of collimators**
- Beam damage tests of collimators
  - **Prepare KEK infrastructure for tests**
  - **Build prototypes & do beam test**
  - **Define test requirements and analyze rests**

From EDR Tasks Overview – 0th guesses

InTDP?

- Phys. design of collimators
  - **~~Optics design of collimators – STFC~~**
  - **~~Physical design of collimators~~**
  - **~~Theoretical analysis of collimator wakes – SLAC, TU-D~~**
  - **Computing analysis of collimator wakes – ~~Cockroft, TU-D~~**
  - **Optimiz. bkg & coll w. eng. constraints - FNAL**
- Eng. design of collimators
  - **Eng. design of collimators – STFC – outline design at EPAC'08**
    - Marble shells - FNAL
- Beam damage tests of collimators
  - **Prepare KEK infrastructure for tests – 1st phase Mar'08 ☺**
  - **Build prototypes & do beam test – in progress for spring '09/ATF2**
  - **Define test requirements and analyze rests**
  - **Materials studies – BNL – still priority?**
- Damage detection system – **premature now?**
  - **Design/prototype – Birmingham ??**

Questions

- Connect with LHC collimation work
  - **new materials, renewable spoilers**
- “Bottom line” comparison of data/theory for transverse wakes
  - **Still factor 2 disagreement?**
- Regroup with much smaller number of active people – who else interested?
  - **Concentrate on few general topics, e.g. experimental studies of materials**
  - **New techniques (crystals)**

Backup material

- Following slides from EDR kick-off meeting Oct. 2007…historical interest now.

Process of allocation of tasks

- LoIs received from SLAC, FNAL, INP/MSU, UK
  - **All tasks are covered**
- Other institutes?
  - **Will contact others who have not replied to Andrei's call**
- Deliverables definition per task, single institute taking responsibility on each
- Agree on this as soon as reasonably possible
- Institutes should be prepared to adapt their contributions during EDR phase, e.g. if priorities change, or alternatives become baseline
  - **Resource redirection may have implication with funders**

Aims

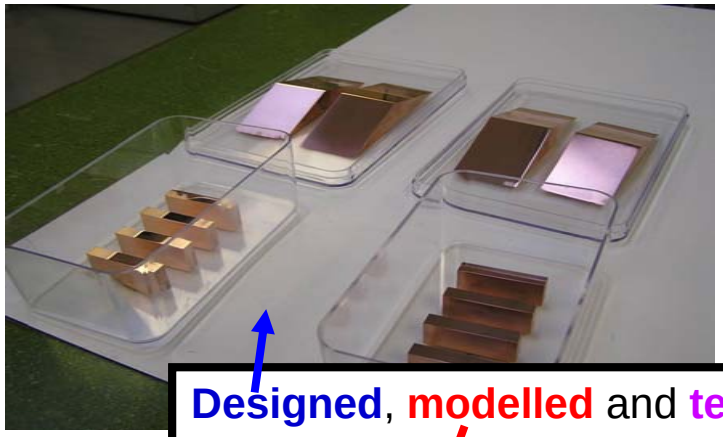
- More reliable analytic calculation of wakefields
  - **Jitter amplification/emittance dilution**
  - **Inclusion in tracking simulations**
  - **Main purpose, more realistic optimisation of**
- Improved accuracy
  - **Benchmarking with test beam data**
- 3D numerical e.m. calculations
  - **Compared with test beam data**
  - **Full geometry of physical collimator**
- Damage detection
- Alternative Configurations – higher risk, potentially large benefits
  - **Crystal collimators**
  - **Renewable spoilers – value engineering**

Examples of Deliverables

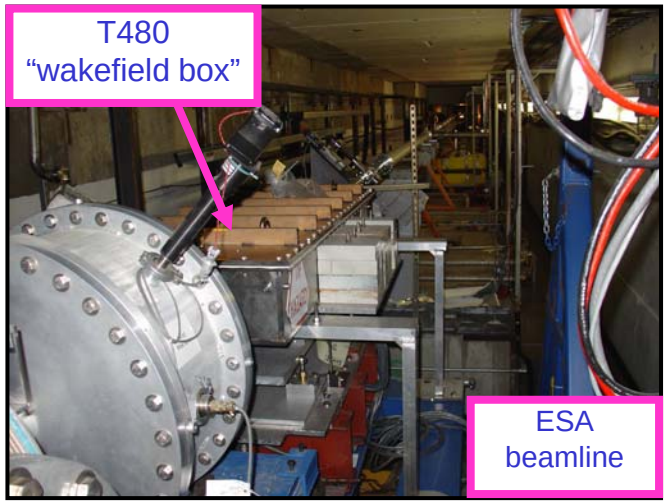
- 3D wakefield simulations for collimator prototypes
- 3D wakefield theoretical calculation (package?)
- Wakefield test beam results for collimator jaws
- Data-validated material response simulations for BDS components
- Prototype damage detection system for collimators
  - **Quantify damage after beam loss, decide whether acceptable to continue or intervention required (cf. renewable spoiler scheme)**
- Full engineering details of absorbers, protection collimators and masks in the BDS
- Prototypes of critical subsystems of adjustable jaw collimators
- + …

Examples, wakefield measurements

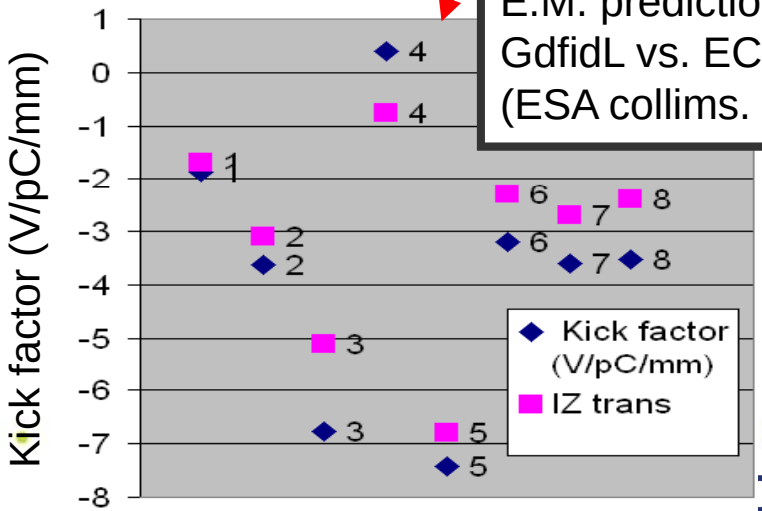
Wakefields, survivability. Strong collaboration between SLAC and EUROTeV groups.



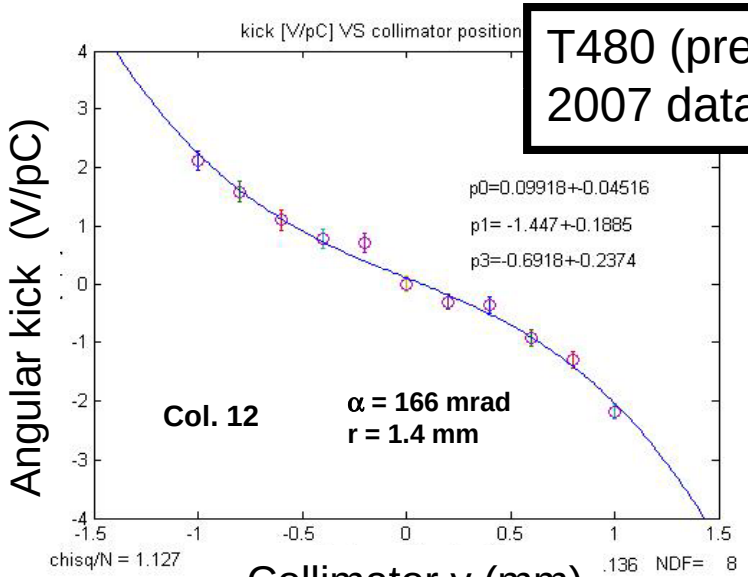
Designed, **modelled** and **tested** collimators at SLAC ESA facility



E.M. predictions
GdfidL vs. ECHO
(ESA collims. 1- 8)



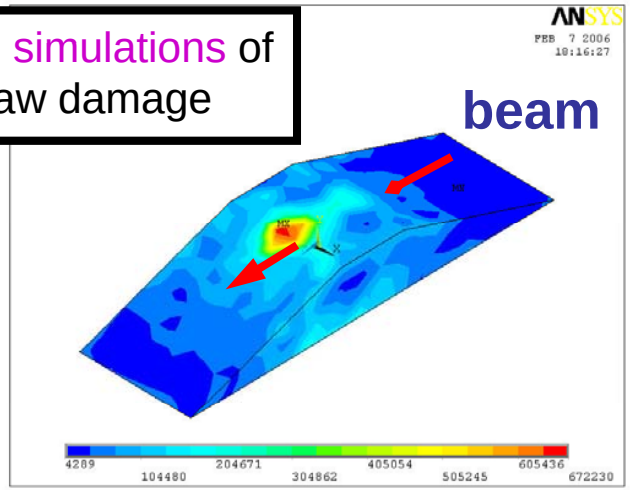
T480 (prelim.)
2007 data

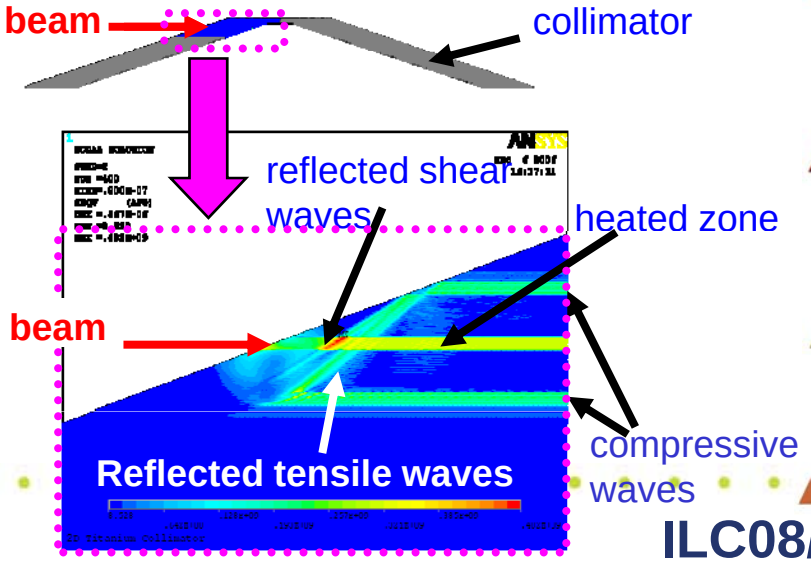


Examples, damage studies

Wakefields, **survivability**. Strong collaboration between SLAC and EUROTeV groups.

Detailed simulations of spoiler jaw damage

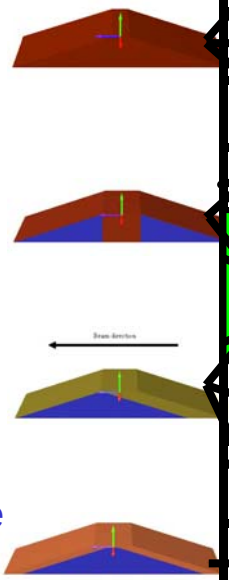




Temperature increase from 1 bunch impact

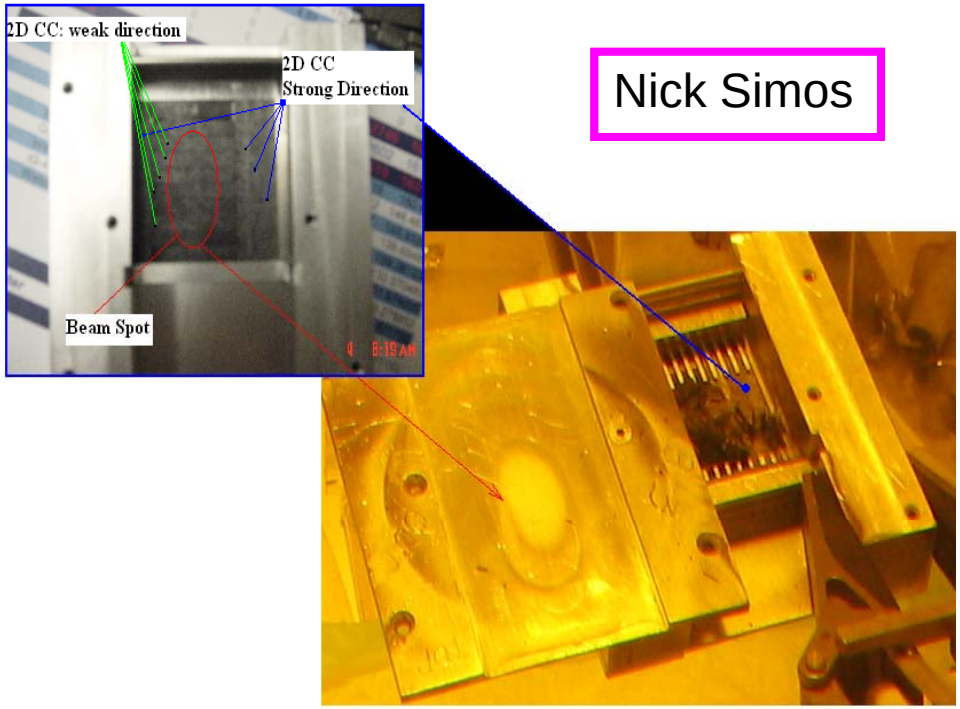
Exceeds: fracture temp. melting temp.

Best candidate designs

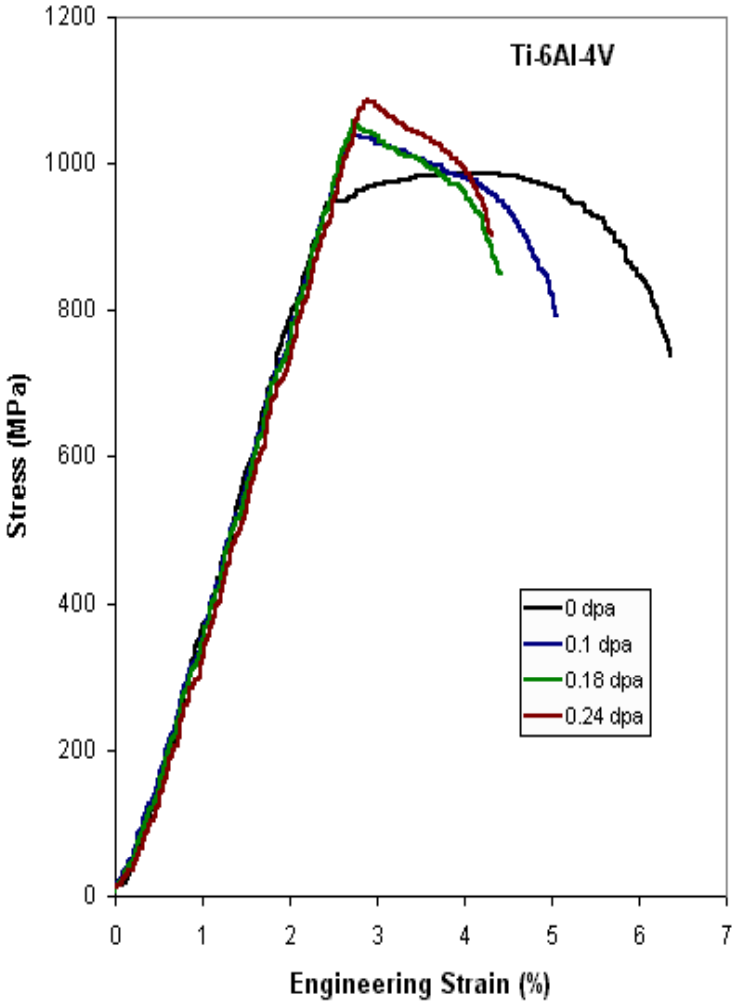


	2mm depth		10mm depth	
	250GeV 111×9 μm²	500 GeV 80×6 μm²	250 GeV 111×9 μm²	500 GeV 80×6 μm²
Ti	420 K	870 K	850 K	2000 K
Al	200 K	210 K	265 K	595 K
Cu	1300 K	2700 K	2800 K	7000 K
C+Ti	325 K	640 K	380 K	760 K
Be+Ti	-	-	-	675 K
C+Ti	290 K	575 K	295 K	580 K
C+Al	170 K	350 K	175 K	370 K
C+Cu	465 K	860 K	440 K	870 K
C+Ti	300 K	580 K	370 K	760 K

Damage studies



Nick Simos



- Also ATF/ATF2 damage study, UK + SLAC
  - **Thin coupons initially, then shockwave measurements by VISAR**

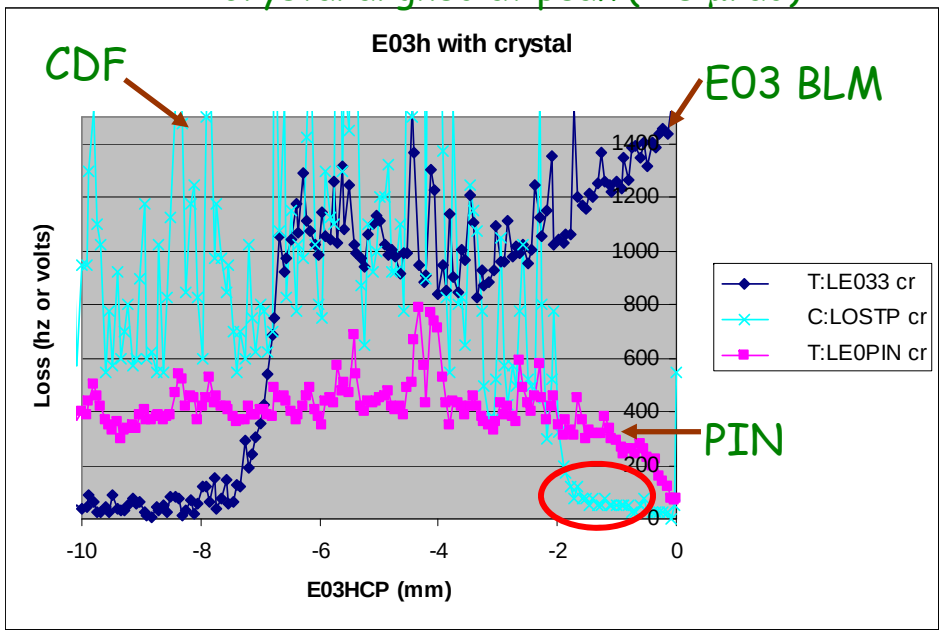
Examples

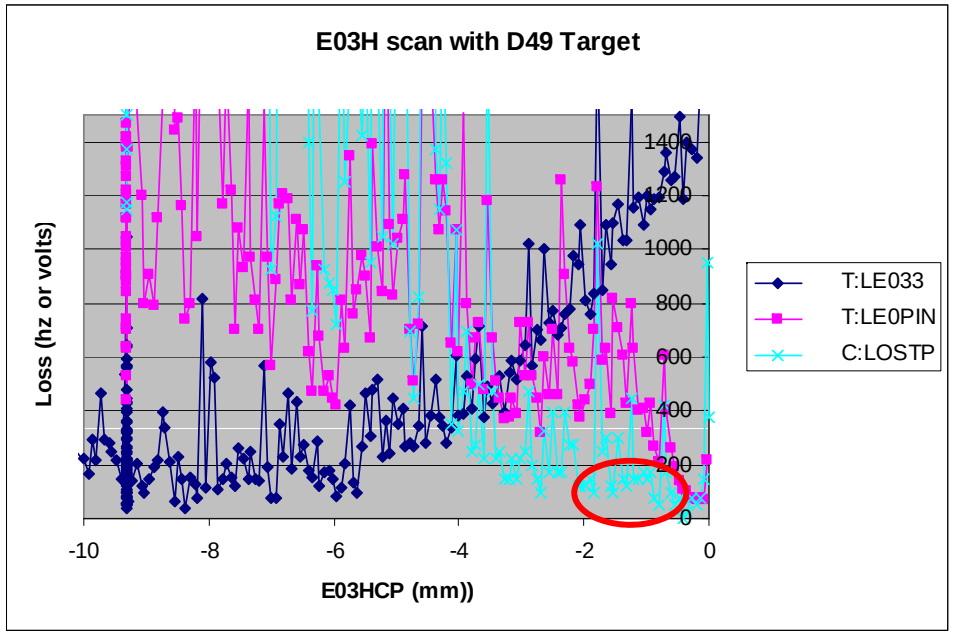
- Marble encased collimators at FNAL to reduce activation

COMPARING EFFECTS OF PROTON HALO LOSSES FOR BENT CRYSTAL AND TUNGSTEN TARGET

Nikolai Mokhov

Crystal aligned at peak (118 μrad)





Using the crystal:

- The secondary collimator can remain further (1 mm or so) from the beam thus reducing impedance.
- Almost a factor of 2 better reduction of CDF losses achieved a half a ring (2 miles) downstream (in agreement with modeling) !!!