



RD in US and Japan
? ?

RD directed for TRC-R2 items:
Luminosity, instrumentation, subsystems

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RD US/Japan:

- Energy (accelerator related subsystems) RD consumes the greater part of resources (intellectual / money) at the labs
  - Exception is ATF at KEK – largest LC RD test facility
- Decision on linac technology is imminent
  - Accelerator technologies are ready for next step
- There are no ‘show stoppers’ among ‘luminosity’ RD topics
  - None ranked R1 by ILC-TRC
  - but – there are many R2
  - must be pursued aggressively (‘needed for design’)
- *Inclusion of smaller institutes and universities vital*

Expectations for post-decision

- Work at labs will be narrowly focused on costing and project planning process (and work with funding agencies)
  - leaving little time (with present staffing) for ‘hard – (specific)’ RD / engineering development work
  - eventually project will be entirely ballistic and detailed subsystem technical choices will be locked down
    - (this may be soon – hopefully)
- Your intellectual engagement is vital to allow progress to continue as the above process is engaged.
  - for the FP6 WP topics, new ideas and tests provide the best leverage on machine design (and cost)
- the pressure to succeed → complete & operate will be greater than for past machines (TeV, SLC, Hera…)
  - our teamwork will offset difficulties integrating what will become a cumbersome global project structure → *gains us time*

TRC R2

Luminosity

Damping Rings

• For all the damping ring designs, further simulation studies are needed to understand the magnitude of the electron cloud effects

• Further simulations and tests of the fast ion instability are also necessary.

• Damping ring extraction kicker stability, required at the level of <10-3, is an important issue.

• Finally, additional simulations of emittance correction in the damping rings are needed.

Low Emittance Transport

• For all low emittance transport designs, the static tuning studies, including dynamic effects during correction.

• The most critical beam instrumentation, including the intra-train luminosity monitor and an acceptable laser-wire profile monitor must
be provided where needed in each design. A vigorous R&D program is mandatory for beam instrumentation in general; it would be appropriate for a collaborative effort between laboratories.

• A sufficiently detailed prototype of the main linac module -- on-girder sources of vibration.

Reliability

• A detailed evaluation of critical subsystem reliability is needed to demonstrate that adequate redundancy is provided

• The performance of beam based tuning procedures to align magnets and structures must be demonstrated by complete simulations.

US *'University-based'* Linear Collider RD (LCRD/UCLC)

- Bid process started in US FY 03
  - review / recommendation process to funding agencies (DoE/NSF)
    - roughly 50% for 'accelerator-related' RD (v/v detector)
    - mixed success with funding, total ~ 450K$/year, promised increase
- Strictly focused in Universities
- Warm/cold neutral
- List of proposed topics published in April 2002
- loosely integrated bid package (2nd year) submitted 12.03
  - 38 proposals for non-detector related LC RD (ranked 12.03)
  - includes: beam halo, ODR, electro-optic sampling, radiation effects, electronics development, polarimetry, fast kicker…

http://www-conf.slac.stanford.edu/lcprojectlist/asp/projectlistbyanything.asp

http://www.hep.uiuc.edu/LCRD/html_files/proposal.html

US Lab-based RD

- Big labs:
  - SLAC, LBNL, LLNL, Fermilab, BNL → DoE
  - (Cornell is a 'University') → NSF
- Non-acceleration subsystem ('energy') RD accounts for 25% of RD budget;
  - ~ 4M$/year at SLAC
  - (~20% of US SLAC/FNAL combined budget – all FNAL work is focused on acceleration components)
  - 1/3 Beam Delivery (includes instrumentation, stabilization, and collimation)
  - 1/3 'Technical' and Civil Engineering
  - 1/3 Beam Dynamics, Damping ring, injector…
  - US costs include fully 'burdened' labor
- The FP6 EuroTeV bid, if successful, will mean a significant increase in resources

RD in Japan

- KEK and universities
  - well integrated
  - 4 – 5 masters&PhD theses/year at ATF (almost all Japanese/Asian)
  - (not all on the top R2 topics)

- Accelerator Test Facility – KEK/ATF
  - first extracted damped beam in late 1997
  - operates 2200 hours/year – funding limited (22 / ‘4 day-weeks’)
  - 1.3 GeV, 135 m circumference, 1e10 ppb, multi-bunch
  - nominal emittance ~ 1 nm x 10 pm y (*4um* with routine optics)

- ATF is the best place to validate ‘*precision* beam’ dependent subsystems (transverse)
  - damping ring, beam delivery, diagnostics, metrology

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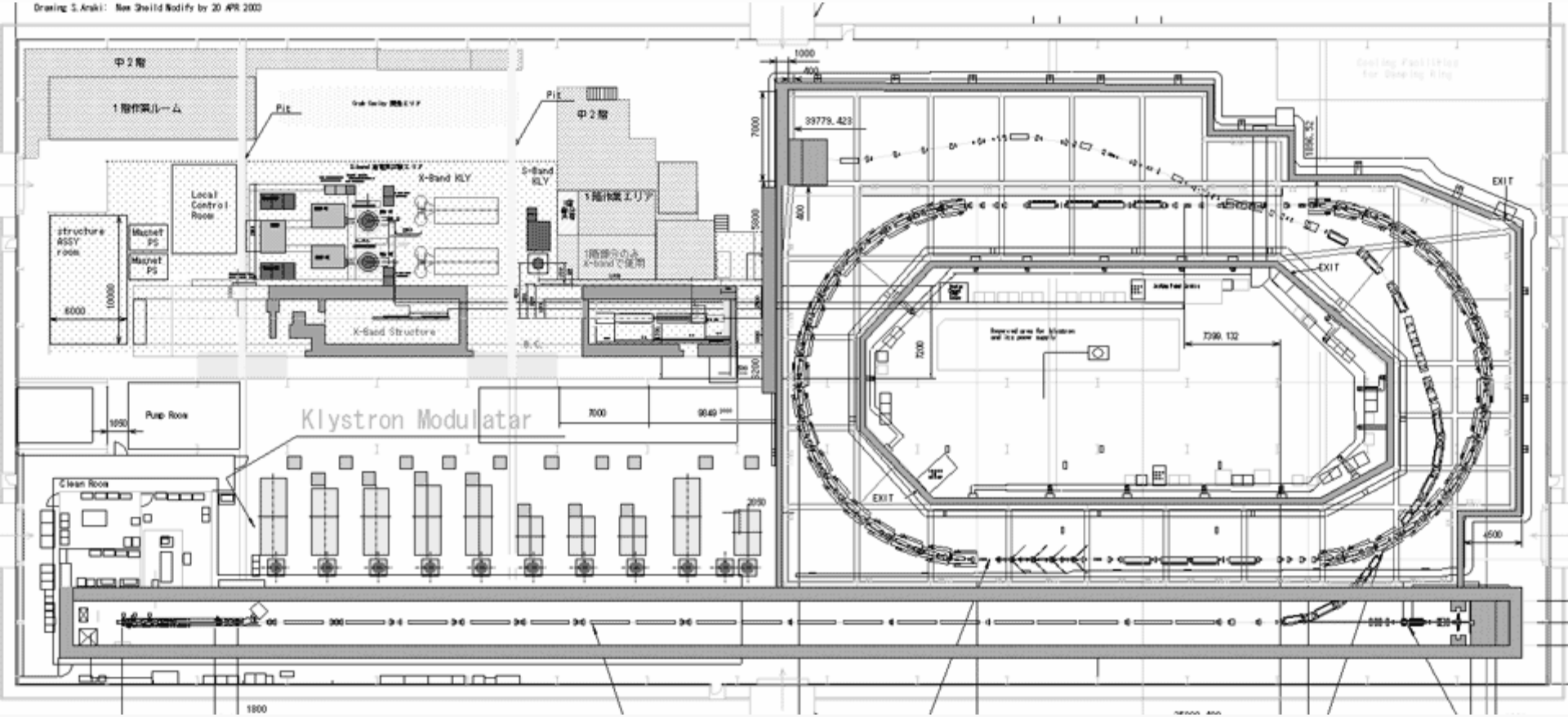


The Accelerator Test Facility at KEK

1.3 GeV Damping Ring and S-band linac

1998 →

The world's largest LC test facility

World's lowest emittance beam:

$\varepsilon_y = 4$ *pm-rad*

below X-band LC req's

KEK ATF

- International collaboration with MoU etc
  - (DESY/CERN included – however minimally involved in last 5yrs)
- Operations funding entirely from KEK
  - ~ 3M$/year
  - ongoing involvement SLAC/LBNL (~200K/year including labor)
  - SLAC workers visit in teams, for a few weeks at a time
    - like a user-facility

- KEK management welcomes Luminosity – related RD and *will support* beam tests at ATF (J. Urakawa and KEK management)
  - We (SLAC/LBNL/KEK) strongly encourage testing at ATF
  - UK funded work in 2004/05:
    - FONT (QMUL/Oxford)
    - Laserwire (RHUL/Bessy)

ATF ‘subsystem’ studies/measurements:

- Small transverse beam sizes
  - laser based (01-present)
  - x-ray synchrotron radiation (02 – present)
  - precision optical transition radiation (01-02)
  - incoherent optical diffraction radiation (02 – present)
  - high resolution wire scanners (98-present)
- precision cavity position monitors
  - nano-resolution (03-present
  - ‘inclinometer or tilt meter’(02-03)
  - tests of nano-metrology (-04)
- Laser-compton positron generation (01-04)
- Kicker – achromatic pair tests (99-01)
- high speed multi-bunch instrumentation (99-present)
- ring component alignment (-)
- laser - photo-cathode RF gun (02 -)

ATF beam dynamics studies:

- Small transverse beam sizes
  - emittance / coupling and dispersion tuning
  - intra-beam scattering
  - beam based alignment
  - model independent studies
  - error source identification
- Damping time
- Coherent instabilities
  - ions
- Beam loading
- Wiggler (04)

FP6 bid WP2-8 → US/Japan common threads:

- BD
  - vibration, magnet design, nano monitoring
- DR
  - electron cloud
- Pol e+
  - FFTB experiment
- Instrumentation
  - Many (bunch length – LOLA DESY/SLAC project)
- Luminosity/'tuning'
- Metrology
  - connected to BD work
- GAN
  - equal partner 'management' – development of RD along the SLAC/KEK connecting line
  - testing interlab management structures with ATF?

HEP must aggressively attack Controls/Instrumentation issues

- System challenges are clearly greater for HEP machines
- Look at the shift SLAC.DESY.KEK accelerator groups away from HEP toward nuclear/synchrotron radiation/FEL physics and technology
  - very active growth field
- Many accelerator designers have no intrinsic connection with HEP

Impact of instrumentation

- Typical cost of controls and instrumentation is 10% of project (no-overhead) cost
- For instrumentation, 80%+ will be for position monitors
  - (for machines like SR/B factories, this is more like 90%)
- Real impact is the leverage on other aspects of the design – esp. high cost systems
  - mechanical, microwave, power

Examples:

- This is one of the motivations, reasoning behind the development of the initial 2002 RD list:
- BPM performance sets linac emittance transport – both for warm and cold designs
- beam size monitoring also
- beam halo monitoring (if extremely well validated) can reduce cost of the collimation

Very high resolution BPM

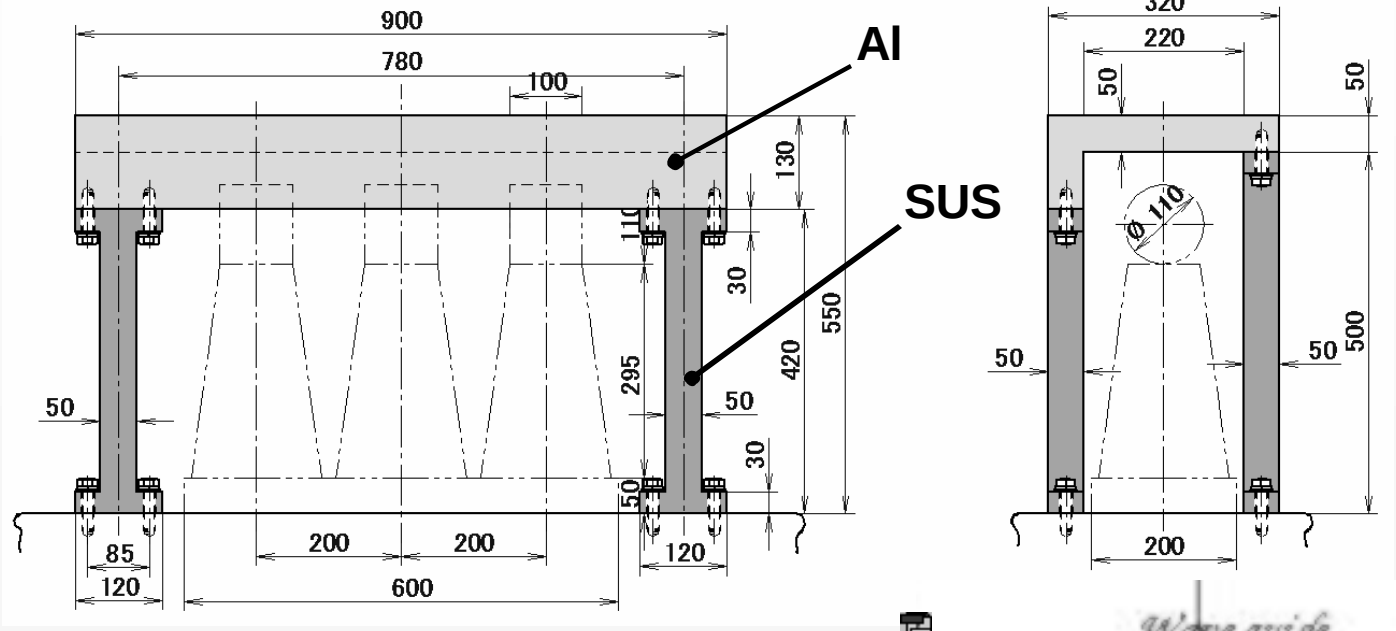
ongoing program - example

- A sequence of BPM's can be used to test
  - resolution
  - accuracy
  - stability
- Simple experiment uses 3 in a row – how well does this work? (problems similar to energy spectrometer chicane)
  - Systematics:
    - transverse wakefields – from BPM itself and from the nearby vacuum chamber (e.g. bellows)
    - stray magnetic fields
    - energy variability
    - energy deposition – longitudinal wakes
- experience with these is invaluable

LC (warm) BPM's

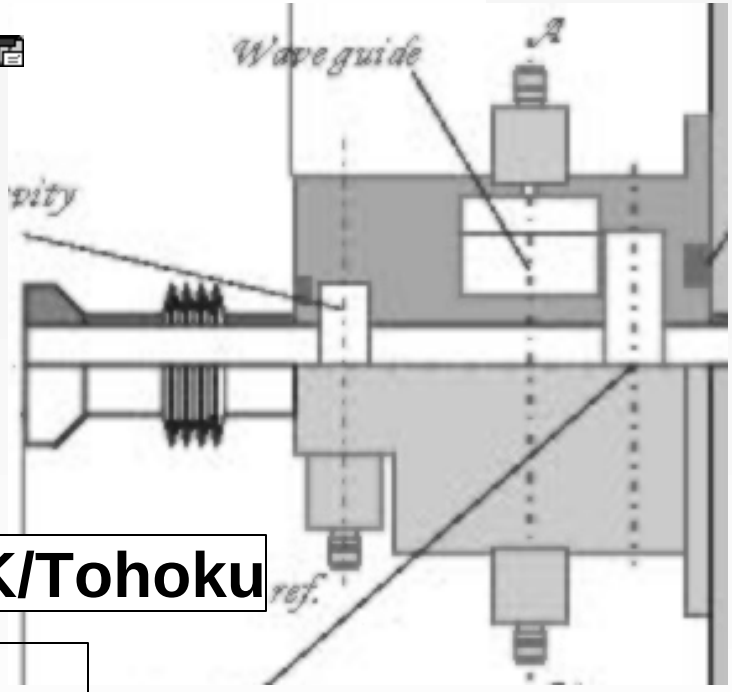
- required performance (resolution, accuracy, stability) demonstrated at SLC/FFTB (200nm resolution ; few micron accuracy)
  - demonstrations are 'proof of principle' only and do not provide real 'engineering' guidance for cost/detailed development
- multi-bunch performance ?
- cavity BPM's / stripline BPM's / hybrids
- ATF nanoBPM work pushes this hardware closer to its limit – gives insight into the operation of these
  - (TTF1 has been called a 'BPM test facility)
  - FONT / KEK Feedback tests allow tests of the hybrids

Reference Block/BPM support (not shown) - KEK



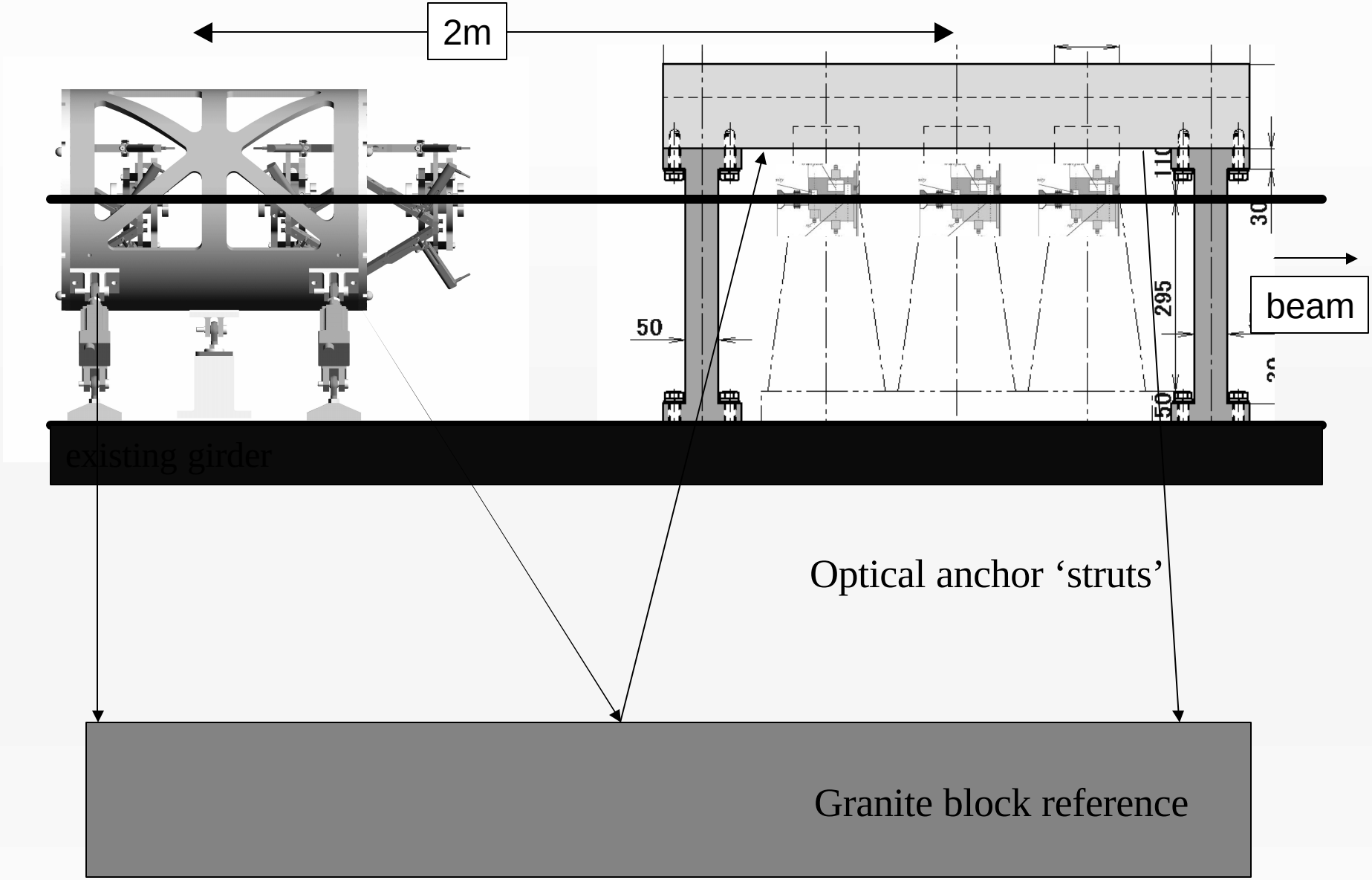
Higashi, Honda, Tauchi, Yamaoka

[C-band BPMs must be used in the extraction line because the extracted beam has $\sigma_z \sim 10$ mm at min ε_y]



C-band BPM – KEK/Tohoku

Hayano, Inoue



Extraction line stabilization test

Conclusion

- SLAC / KEK / LBL have a lot of experience working with (ultra) low emittance beams:
  - SLC (1987 – 98)
  - Final Focus Test Beam (1995-97)
  - Wakefield test system (ASSET 1996 -)
  - ATF
  - Synchrotrons – ALS

- We are eager to discuss and optimize detailed programs to best leverage project impact and best use available resources