Linear Collider

32nd Japan-US Program Committee

Nobu Toge (KEK, Acc. Lab.)

JFY2004 Progress / Incidents

- April-May 2004: Successful operation of SLED-II (~500MW, 400ns, 30-60pps) for ~500hrs. Drove 8 acc structures with it for 120-200hrs.
- Preparation and presentation reviews for ITRP (http://lcdev.kek.jp/ITRP/KEK ; http://www-project.slac.stanford.edu/lc/ITRP)
- August 2004: ITRP recommends “Cold” (http://www.interactions.org/cms/?pid=1010290)

- Ad-hoc (later formalized) working groups (WGs) in Japan for Cold-LC (ILC).

- Sep-Oct 2004: Re-orientation of research focus approved by Japan-US Programm Comm (Nov. 2004)
- Nov. 2004: First ILC Workshop (at KEK, http://lcdev.kek.jp/ILCWS)
- Dec. 2004: KEK internal review for ILC dev plans (http://lcdev.kek.jp/review.php)
- Jan-March 2005: Visits to China (done), Korea (done), US (SLAC done, FNAL scheduled), Europe (scheduled) for discussing ILC development collaborative plans.

X-band Klystron Performance

	Peak power (MW)	Pulse length (μs)	Rep rate (pps)	Efficiency (%)
PPM-1	56	1.5	5	50
PPM-2	73	1.4	25	54
PPM-2’	75	1.7	60	51
	68[a]	1.7	120	51
PPM-3	68[b]	1.6	50[c]	53-54
PPM-4	75	1.65	50[c]	52
XB72K10*	50	1.5	25	35

a: Testing terminated due to gun arc.
b: Testing terminated due to window and pulse transformer BD.
c: Limited at 50Hz by the modulator performance.
*Last KEK solenoid-focused klystron.

X-band Structure Operation at NLCTA

(BD Stats Based on 120-200 hr Operation)

Structure	Manufacturer	New since April?	HOM slots?	Gradient (MV/m)	Trip Rate (#/hr)
H60vg4S17-FXD1A	FNAL	y	y	65.5	0.31
H60vg3S17-FXC5	FNAL	y	y	64.5	0.17
H60vg4S17-3	KEK/SLAC	y	y	65.5	0.23
H60vg3S17-FXC3	FNAL		y	64.5	0.13
H60vg3-FXB6	FNAL			64.7	0.01
H60vg3-FXB7	FNAL			66.6	0.05
H60vg4S17-1	KEK/SLAC		y	63.1	0.21
H60vg3R17	SLAC			64.7	0.19
Average of All 8				64.9	0.16
Average of Original 5 (May 21) with 500 more hrs run at 65MV/m since April. Previously they had 0.09trips/hr at 60.5MV/m				64.7	0.12

Program for 2nd Half of JFY2004

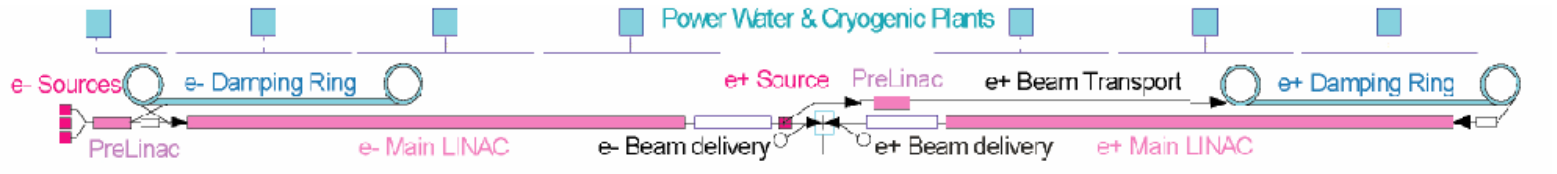
- Convergence of X-band R&D for LC.
  - X-band efforts within a limited scale will continue in JFY2005.
  - KEK injector group acts as “guardians”, but not with Japan-US budget.
- Start-up of systematic development of superconducting RF technologies
  - Particularly, the cavities (new test cells) and related equipment (new vac. Furnace for heat processing).
- Re-focus on beam control technology development at ATF with “cold” LC in mind.
  - SLAC to build a full set of extraction kickers to address the beam extraction stability issue → to help smooth out studies with extracted beams.
  - Pilot studies for fast extraction kickers (new) → to help address cold-specific beam extraction challenges at “cold” LC.

International Scenario for ILC as put forward by ILCSC/ICFA

- Feb. 2005: Site decision of Central GDI (Global Design Initiative) and appointment of its director.
- Spring 2005: Regional GDI formation.
- Aug. 2005: 2nd ILC Workshop (US). Freeze the design outline to present in CDR.
- Dec. 2005: Complete CDR.

- Dec? 2007: Complete TDR.
- 2008: Site decision, budget approval.
- 2009: Ground breaking.
- 2014: Start commissioning

Technical Issues with ILC



- Overall design of the entire system configuration and parameter choices are subject to internal discussion under GDI. Well-known issues are:
- Long machine pulse (1.4ms) → long pulse train (337ns x 2820 = 950 μ.sec) → long 5 GeV damping rings (17km).
- Long damping rings are not "long enough" → compressed bunch storage (sb = 20ns instead of 337ns) → "Fast-kicker" challenge
- High gradient SC cavities (~20000 units) : ~ 23MV/m OK, ~35MV/m may be OK, how about ~40MV/m or higher? ← site selection, operational margins
- How to produce positron beams: 2E10 particles x 2820 bunches at 5Hz.
- Issues that have not been highlighted recently, because of the ITRP-competition: beam delivery operational issues.

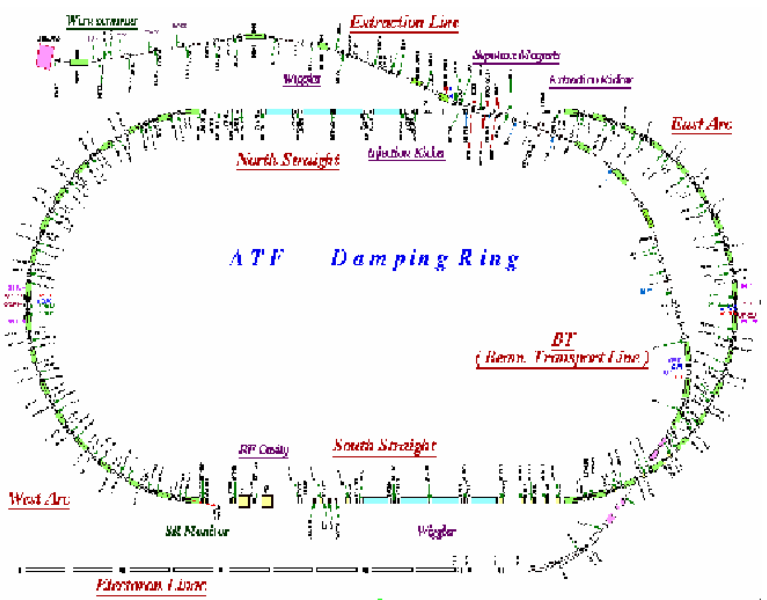
Accelerator Development for ILC at KEK (and in Japan and Asia)

- How to do the most meaningful things which contribute best to the world ILC efforts *and* to our long-term strategic position???
  - Make maximum use of existing facility: ATF → ATF/ATF2 at KEK
  - Start-up STF at KEK: Minimum essential infrastructure for SRF-based linacs first (may expand it later for a fuller facility).
    - → Three regional test facilities; TTF (DESY), SMTF (FNAL), STF (KEK)
  - Do these in the context of “new” international cooperation.

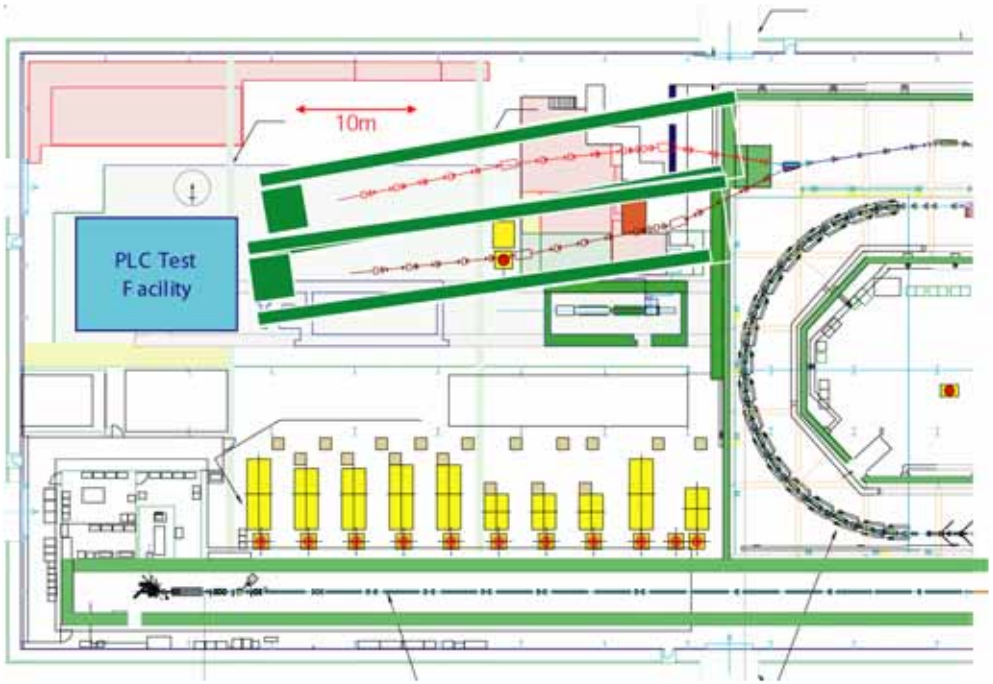
- Also work on:
  - Industrialization / cost reduction.
  - Domestic + Asian promotion of active collaborative programs.

Injector topics to address at/around around ATF

- Beam instrumentation and control (ATF)
  - Left-over issues from JFY2004.
  - Stabilize beam extraction for next-step programs.
- ILC beam injector issues
  - Fast kicker drivers.
  - Positron production target choice, i.e. undulator-photons on thin targets or electrons on metal targets.

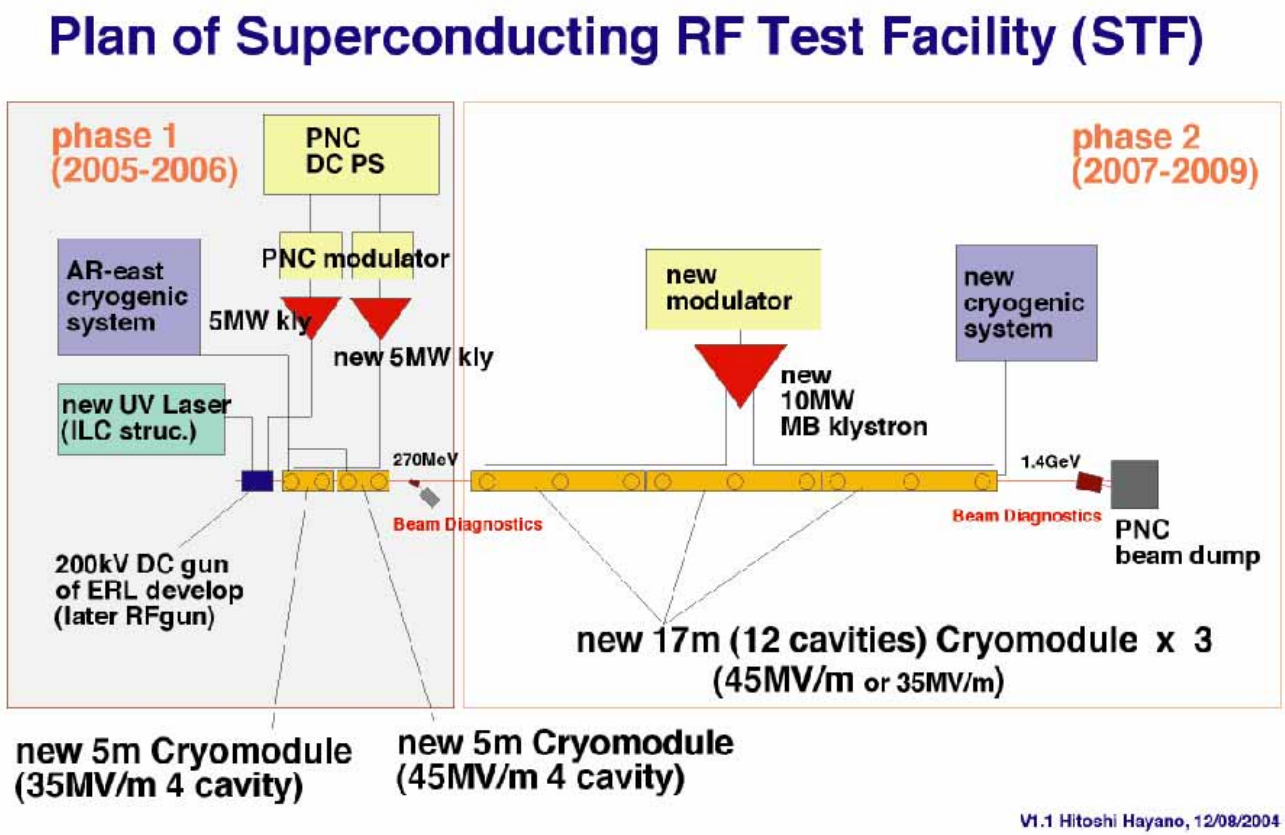


ATF2



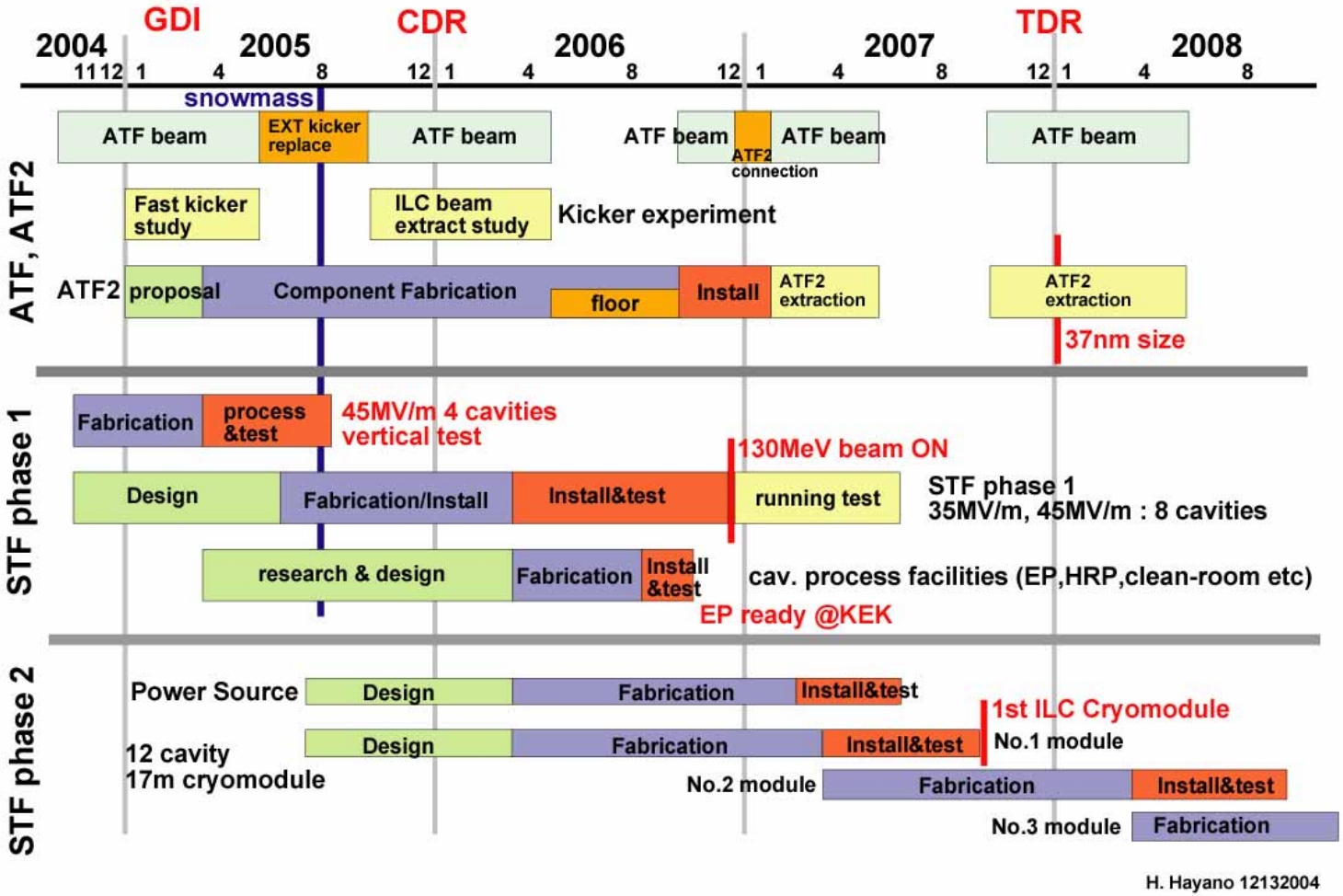
- FFS/Beam Delivery is one of the subjects which have been on the backseat for a while, due to warm-vs-cold competition.
- Proper attention is much needed and now is the time.
- ATF beam is uniquely suited for this activity.
- Issue: Reproducible ~nm-scale beam size (37nm at ATF2), and to stabilize its beam center (~2nm).
- Which means: Lots of practical engineering details and their proper execution in an international collab environment.
- Could be an ILC collaboration prototype.

STF



- SRF linac test facility with unique focus on LC.
- Build and learn.
- Form the team.
- Critical base for international collaboration.
- Phase-1 operation to start in late 2006.
- Phase-2 execution contingent on GDI management and other aspects.

Long-term Plan of KEK ILC-study



Accelerator Development for ILC at KEK (and in Japan and Asia) (cont)

- In JFY 2005 some Japanese hardware components will be contributed to US programs. Some funds will be sent to US to build components to be used at ATF/ATF2.
- Yet, a bulk part of the requested Japan-US budget in JFY05 will be spent to build-up the essential HW infrastructure in Japan first,
- Which will eventually benefit the world (inc. US) LC programs.
- As you will see, we are talking about some big money.
- And we seek the support by the Japan-US program committee to carry out our programs in this regard.

JFY WBS and our Budget Request

Check the hand-out for numerical details, please.

Participating Parties;

KEK, U.Tokyo, Nagoya U., Hiroshima U., NIRS

SLAC, FNAL, LBNL, LLNL

Participating Members:

Approximately 60 each from Japan and from US.

Now, the details follow …

Injector System Development Details

121 - Replacement of ATF DR BPM electronics

- Issues:
  - Present ATF electronics: 2 um, single pass – close to limit, yet with problems with calib and offsets (intensity dependence, etc).
  - Present ATF stored beam size: ~5 um vertical.
  - Need improved stability and emittance control for ATF2 (jitter < beam size / 3).
- Action Plan:
  - Install multi-turn, high resolution, integrated calibration system BPM electronics.
  - Commercial system used at SPEAR & Fermila and tested at ATF June 2004, with12 bit 100 MHz waveform digitizer
  - Similar system will be used at ILC DRs since it combines single turn flexibility with high speed averaging
- Cost:
  - ~ 500KY/BPM in small numbers (may be ½ this cost in large numbers)
  - Would like to replace elec. for part of the ring in JFY2005.
- Contact persons: N.Terunuma + M.Ross

122 - Extraction line beam stabilization

- Issue:
  - ATF2 will need ring beam stability beyond present performance capability
  - Right now, $J_y/\sigma_y \sim 1/2$… apparently due entirely to spurious vertical dispersion in the extraction line (related to η in the ring).
- Action Plan (Two-prong):
  - Improvement of dispersion correction
    - Simplified correction by eliminating second order dispersion (A. Seryi, SLAC)
    - Second order dispersion must be eliminated for ATF2.
  - Reduced energy jitter
    - To be controlled using synchrotron motion feedback
    - This has been attempted several times; now being re-visited
- Cost:
  - Dispersion correction elements
  - Synchrotron (dipole) motion feedback
- Contact persons: T.Tauchi + M.Ross

123 - Studies of and solution to the x-y beam coupling in ATF EXT.

- Issues:
  - ATF2 will require the extracted emittance to be closer (~) to that in the ring
  - Emittance degradation seen at EXT – due to coupling (Note: was a big problem at SLC, too)
  - Optical errors and / or spurious dispersion introduce large x-y coupling making extracted emittance ~ 3x internal ring emittance
- Analysis:
  - Problems suspected with dispersion correction (see 122) and skew errors in EXT.
  - Present correction scheme suspected not comprehensive enough.
- Action plan:
  - Stabilize the beam and introduce more accurate BPMs (like cavity BPM's or those planned for the laserwire) to better diagnose coupling sources.
  - Identify the coupling sources and either fix them or compensate with addition of skew elements
- Contact: T.Okugi + M.Ross

124 ATF Beam Studies

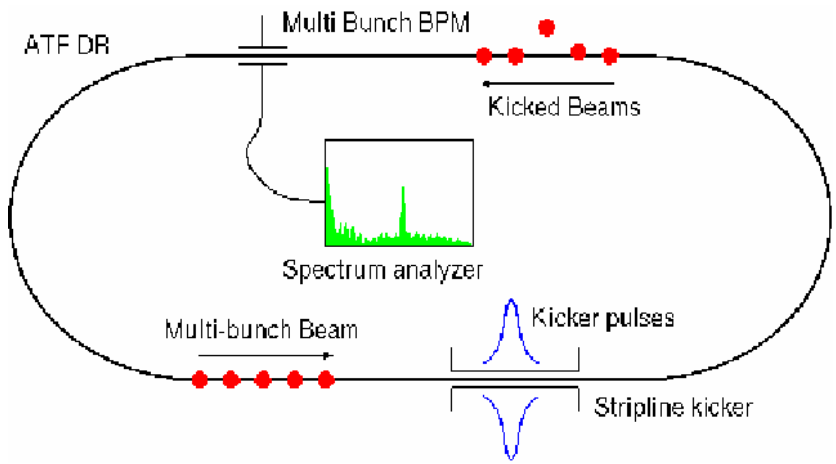
- Issues:
  - Follow-up to Fast-Ion-Instability studies (growth of bunch instability in high-intensity multi-bunch operation)
  - Follow-up to studies of operation with wigglers.
  - Commissioning of new EXT kickers to be delivered from SLAC in Spring/Summer 2005.
  - Work with 121, 122, 123, 131.
- Action Plan:
  - Comprehensive beam program plans under prep.
  - Frequent visits by US colleagues.
  - Video conferences.
- Contact: K.Kubo + A.Wolski

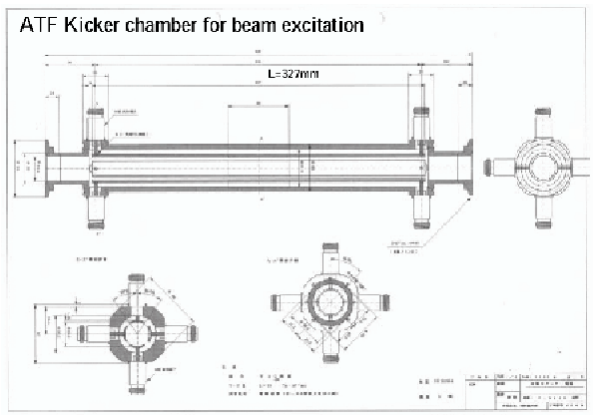
131 - Nanometer resolution Beam Position Monitor R&D

- Issues:
  - ~20nm resolution seen in a 3-cavity BPM setup at ATF (SLAC/LLNL/BINP/KEK)
  - Still need work on:
    - Required resolution and precision of linac BPMs (low loss factor, large diameter, ability to measure beam jitter ~< sigma/3)
    - Large scale implementation of non-traditional system (v/v stripline or button systems)
    - X-y coupling, angle dependence, stability
- Need to:
  - Understand performance (resolution, precision and systematics) of cavity BPM's
  - Develop cavity BPM systems for BD energy spectrometer
  - Interconnect BPM system with optical anchor mechanism
- Acton Plans:
  - Tests with improved electronics / cables.
  - Analysis of the performance.
  - Launch systematic survey into engineering implementations.
- Contact: T.Tauchi + M.Ross

153 - Fast Kickers

- Issues:
  - Have to establish this technology for ILC.
  - Have to explore the technical reach (how fast can they be?) to determine the DR designs
- Goals:
  - by Snowmass: demonstrate ~5 ns rise/fall time (at nominal ~TDR field) to show that the kicker should *not be* primary DR circumference consideration.
  - by 2007:
    - extract 3 MHz, 60 bunch ILC pulse train of nominal emittance bunches into ATF2 (WG4)
    - Demonstrate functioning ILC extraction kicker system (WG3)
- KEK/DESY/SLAC/LLNL – pulser tests at KEK using existing stripline kicker.
- LBL – low beam-impedance kicker; geometrical / mechanical design
- KEK/SLAC – ATF modifications and design
- Contact: T.Naito + M.Ross





151 Positron Source

- Issue:
  - We have to decide:
    - Conventional target + collection section or
    - Undulator → photons → target.
- Status:
  - Collecting relevant experimental and theoretical inputs for decision making, world-wide.
- Action plan:
  - Obtain exp data with KEKB beam concerning target damage limit.
    - ILC: 6GeV 3nC x 2850bunches → 18J/bunch, 51300J /pulse
    - KEKB: 8GeV 10ncx 1300 bunches → 80J/bunch, 104000J /beam
    - Note: Prelim analysis indicates that KEKB beam dump can reasonably reproduce the energy deposit density foreseen at ILC by adjusting the bunch intensity and/or sweep speed.
  - Prepare simulation, test setup, seek help from KEKB colleagues, to carry out a test run before Summer, 2005.
- Contact: M.Kuriki + J.Sheppard

STF-related Hardware Overview

341~344 – STF RF HW

Beamline components:

Vac, / support / magnets / rad safety

timing system / control CPU + network

interface

Electron gun:

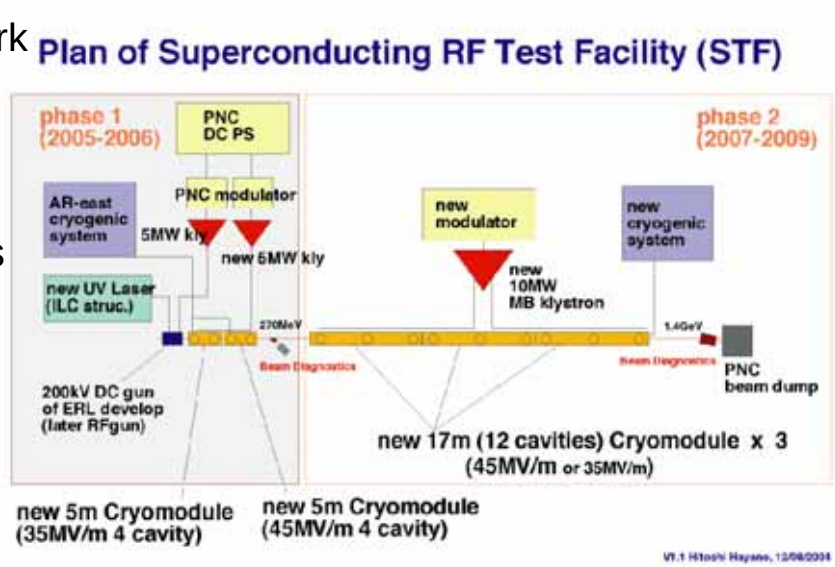
laser / relocate ERL gun / vac pumps

#1 modulator : refurbishment

#1 klystron : purchase TH2104C

Waveguide : refurbishment

Low-level RF control



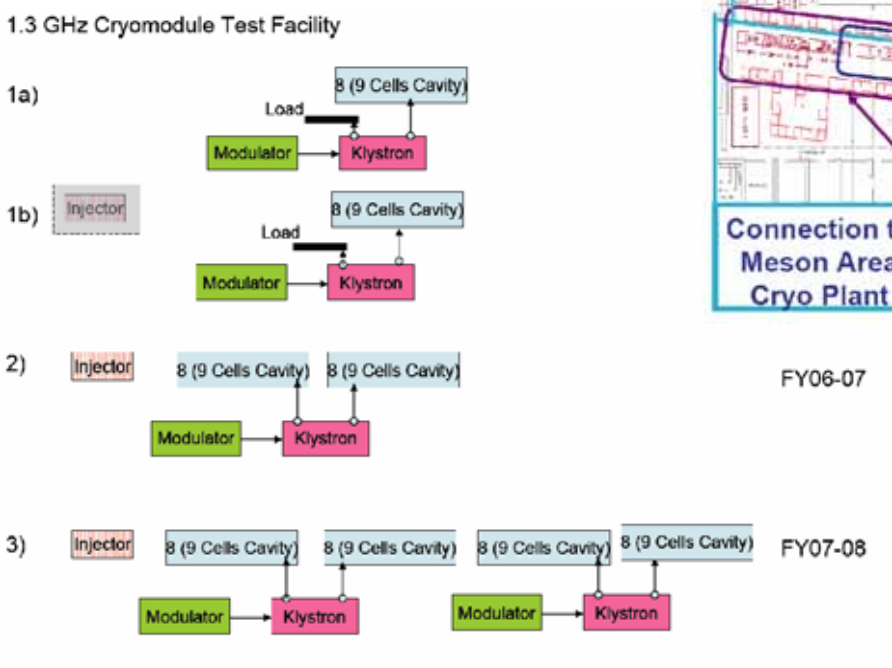
Contact: H.Hayano, S.Ohsawa, S.Fukuda + M.Ross + <FNAL>

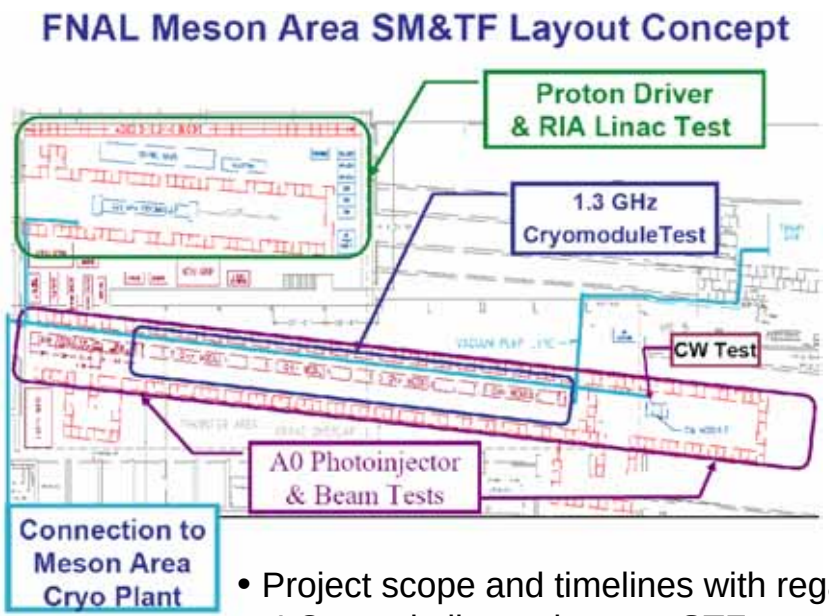
Will discuss about common HW interface / specs w. FNAL/DESY within JFY05.

211~216 L-band SRF Cavities

- 12 x 9-cell cavities
  - 8 units for installation at STF
    - 4 of these, aiming at 35MV/m operation, with particular attention to participation by the big companies.
    - Other 4 of these will aim at operation at 45MV/m (“Ichiro cavities”); How?
      - Max field likely to be limited by Bmax.
      - With suitable cavity shape, likely able to raise Eacc to max ~50MV/m while keeping the same Bmax.
      - Take full advantage of the Japanese electro-polishing technique for surface treatment
    - Test in vertical setup 2005, horizontal setup late 2006.
  - 4 units for testing at SMTF (FNAL)
- International collaboration
  - DESY – Cavity designs
  - SLAC – Beam simulation
  - FNAL – SMTF
  - JLAB – Application of KEK EP technique
- Contact: K.Saito/S.Noguchi + S.Tantawi/C.Adolphsen + (H.Edwards) + (P.Kneisel)

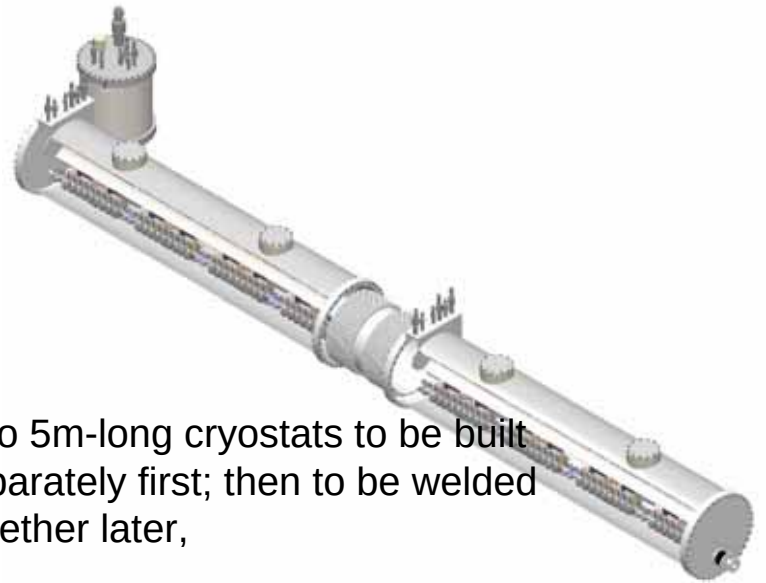
SMTF at FNAL



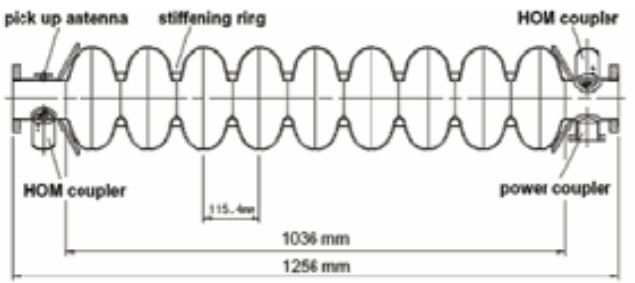


- Project scope and timelines with regards to LC are similar to those at STF.
- Exellent collaborative opportunity towards common HW interface specifications and joint performance studies.
- Multi-Lab undertaking, involving FNAL, JLAB, ANL, Cornell, SLAC …
- SMTF includes non-LC applications as part of the project goal, although the initial focus will be on LC.

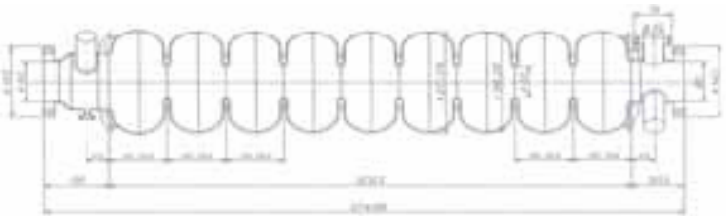
211,213, 215, 332, 333 -- STF 9-cell cavities x 8 with cryostat (324 is on KEK budget)



Two 5m-long cryostats to be built separately first; then to be welded together later,



35MV/m-type cavity

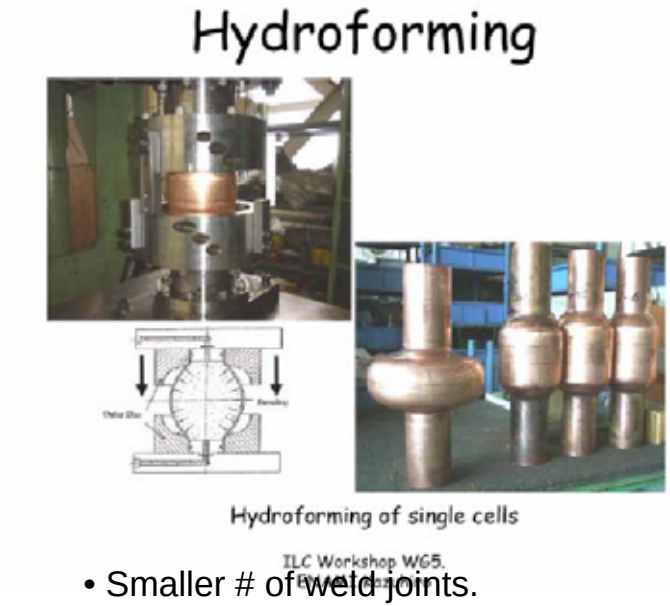


45MV/m-type cavity

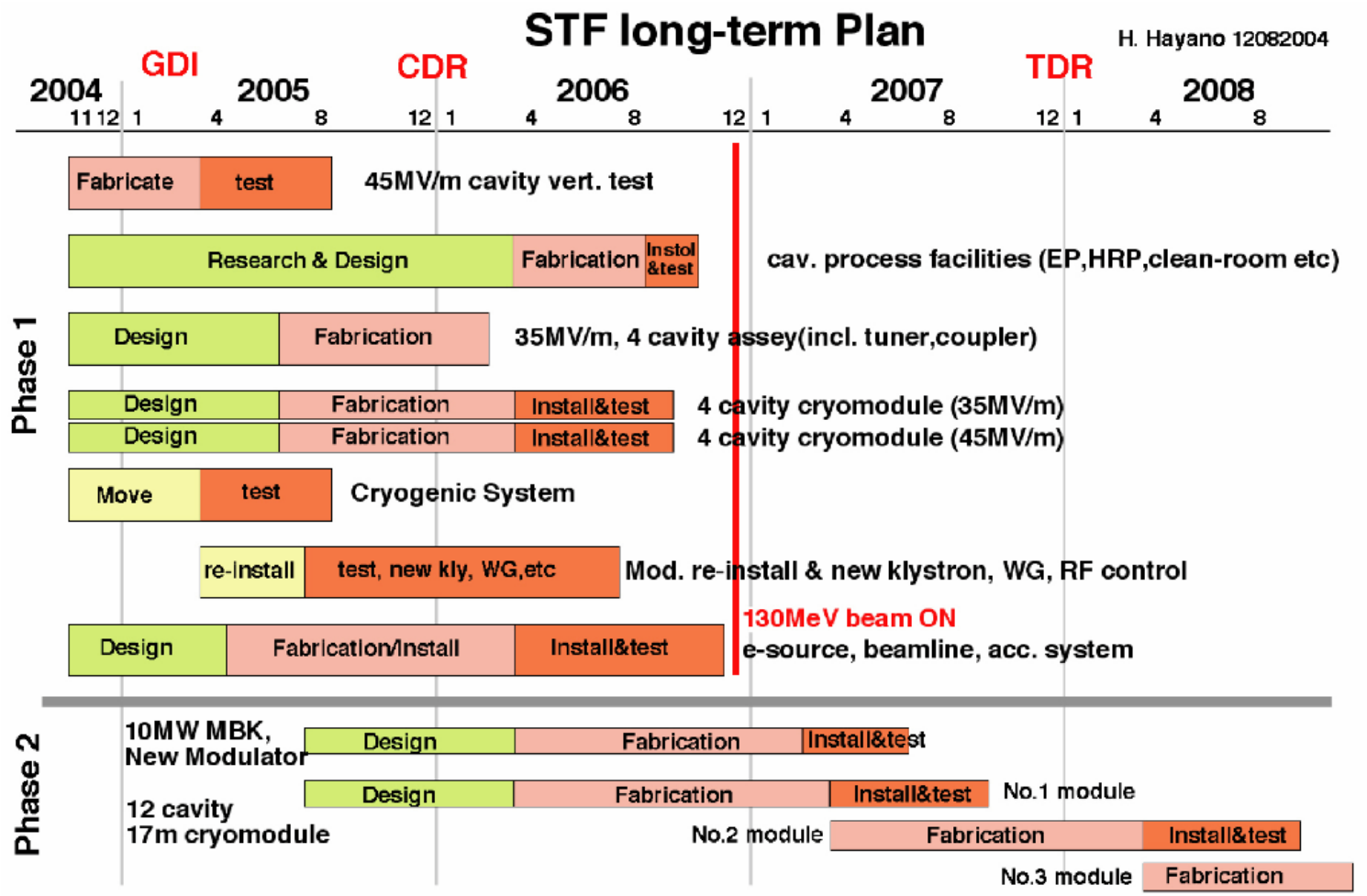
22 – SRF Cavity Indutrialization

Traditional Way of Cavity Fab.

New Way

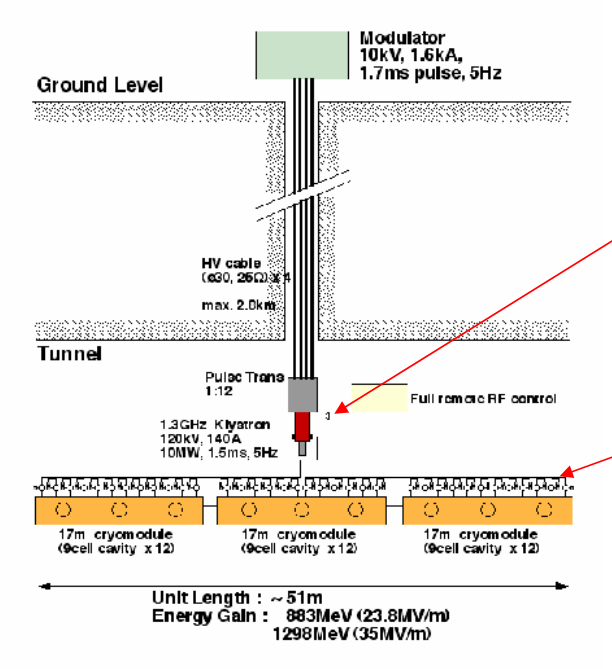


- Smaller # of weld joints.
- Smaller # of fab steps. → reduced production cost (down to ½ or 1/3).
- Contact: K.Ueno


STF long-term Plan
H. Hayano 12082004
GDI
CDR
TDR
2004
2005
2006
2007
2008
11 12 1 4 8 12 1 4 8 12 1 4 8 12 1 4 8
Fabricate
test
45MV/m cavity vert. test
Research & Design
Fabrication
Instol &test
cav. process facilities (EP,HRP,clean-room etc)
Phase 1
Design
Fabrication
35MV/m, 4 cavity assey(incl. tuner,coupler)
Design
Fabrication
Install&test
4 cavity cryomodule (35MV/m)
Design
Fabrication
Install&test
4 cavity cryomodule (45MV/m)
Move
test
Cryogenic System
re-install
test, new kly, WG,etc
Mod. re-install & new klystron, WG, RF control
130MeV beam ON
Design
Fabrication/Install
Install&test
e-source, beamline, acc. system
Phase 2
10MW MBK,
New Modulator
Design
Fabrication
Install&test
12 cavity
17m cryomodule
Design
Fabrication
Install&test
No.1 module
No.2 module
Fabrication
Install&test
No.3 module
Fabrication

STF Phase-2

To do: if the circumstances allows + demands.



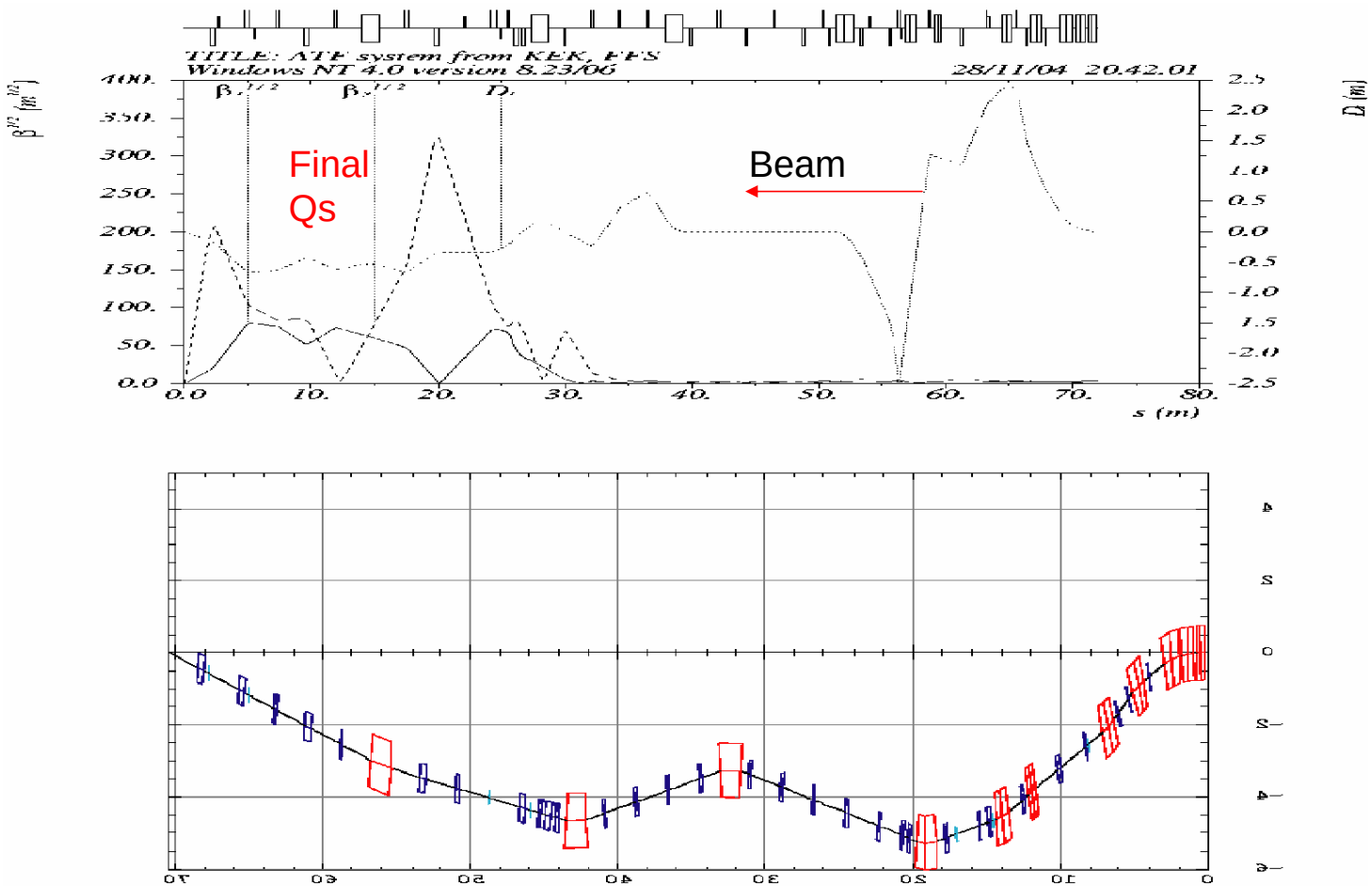
One fully-equipped ILC linac RF unit.

ATF2-related activities

ATF2 Timelines

- Nov. 2004: ILCWS at KEK
- Jan. 2005: ATF2 mini-WS
  - http://www-conf.slac.stanford.edu/mdi/sessions.htm
- ~ June, 2005: Complete Design Report.
- 2005 – Summer 2006: Build magnet PS, magnets, beam instrumentation.
- 2006: Build vacuum components, alignment systems, control systems.
- Summer 2006: Floor refurbishment.
- Fall 2006: Installation
- Early 2007: First beam operation.

ATF2: Beamline design candidate (S.Kuroda)



ATF2 Goal – Reduce ILC FFs Risks

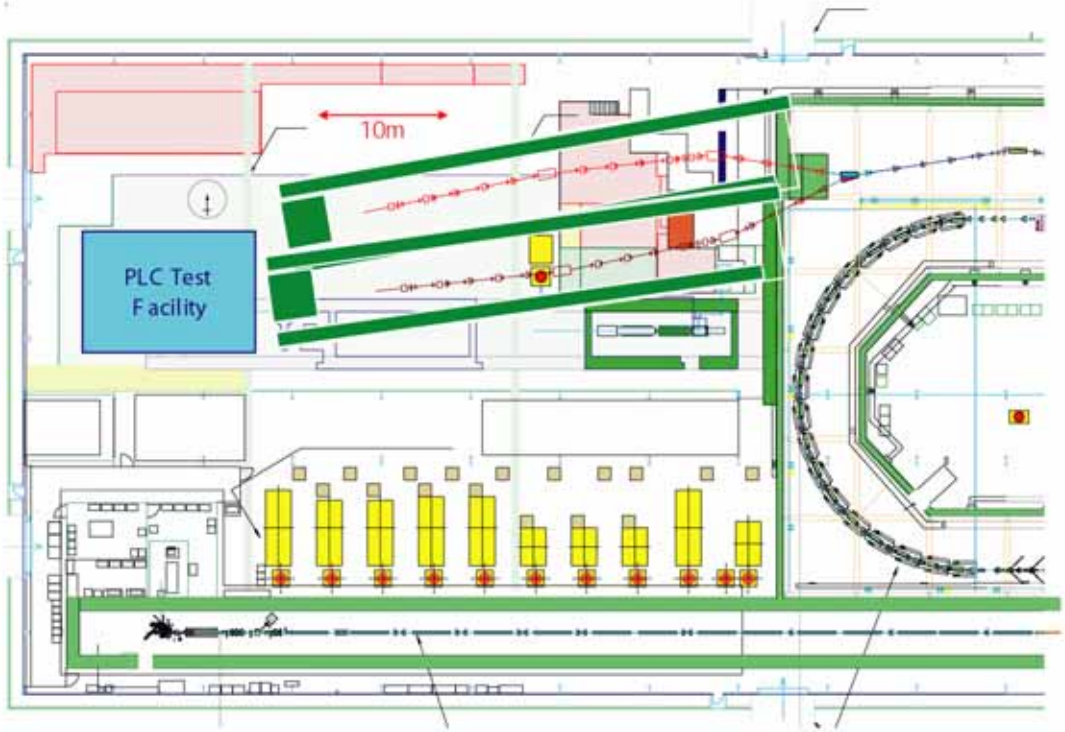
	ATF2@KEK	FFTB@SLAC
Optics	CCS embedded in QC region: β_y*=100μm	Now-traditional, separate CCS : β_y*=100μm
Beam Size (Design)	37nm / 3.4μm w. $\gamma\varepsilon_y$ = 3E-8m	60nm/1.92μm w. $\gamma\varepsilon_y$ = 2E-6m
Achieved	We will see.	~60nm

ATF2 WBS

	JFY2004	JFY2005
Conv Fac inv. Floor refirbishment	0	60,000KY
Magnets+PS	35,000KY	43,000KY
Vaccum System	0	23,000KY
Control sys		21,000KY
Alignment + support	13,000KY	13,000KY
Instrumentation	56,000KY	35,000KY
Sum	104,000KY	195,000KY

Part of this budget will be executed at SLAC to build required components. Details are under discussion.

Contact: J.Urakawa/T.Tauchi/S.Kuroda/R.Sugahara + A.Seryi/M.Ross



Some details to freeze soon:

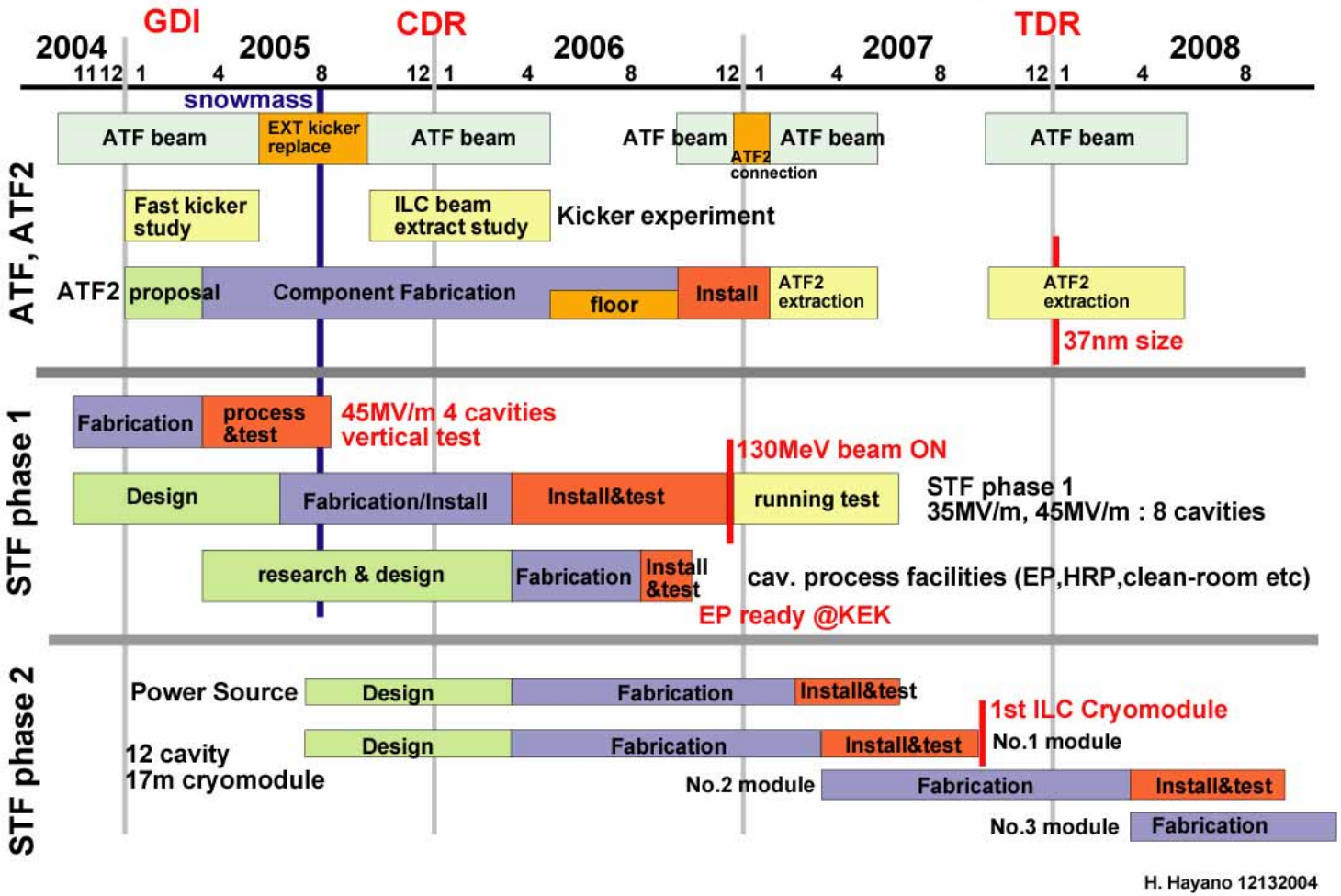
Optics design; Beamline layout; HW geometric specifications;

Job partitions among participating parties.

Other Activities

- ILC Design Efforts
  - SAD computers
  - Calculations
    - Contact: Yokoya/Kubo + Tenenbaum/Raubenheimer + <FNAL>
- Project Engineering
  - Costing
  - Video conferencing
    - Contact: Enomoto/Toge + <SLAC> + <FNAL>
- Alignment R&D
    - Contact: Sugahara + Ross/Seryi

Long-term Plan of KEK ILC-study



In Conclusion,

- JFY2005 marks a pivotal cornerstone in our new launch of SRF-based ILC program in Japan.
- Some Japanese hardware components will be contributed to US programs. Some funds will be sent to US to build components to be used at ATF/ATF2. Strong interests are shown by our US colleagues to collaborate with us in both.
- Yet, a bulk part of the requested Japan-US budget in JFY05 will be spent to build-up the essential HW infrastructure in Japan first,
- Which will eventually benefit the world (inc. US) LC programs.
- As you will see, we are talking about some big money.
- And we seek the support by the Japan-US program committee to carry out our programs in this regard.