ALCW2015
Accelerator Report

K. Yokoya

2015.5.15 LC推進委

	Monday 20-Apr	Tuesday 21-Apr	Tokyo Event Wednesday 22-Apr	Thursday 23-Apr	Friday 24-Apr
9:00	Registration	BDS-II: optics		CFS:ARUP meeting (Tokyo) / Main Linac / BC (TBC)	SRF I
9:30	Opening joint plenary				
10:00					Positron
10:30	*Coffee*			*Coffee*	
11:00	Machine overviews **PLENARY**	CR-2 L* Final Review **PLENARY**		Sources (TBC)	SRF II Positron
12:30	*Lunch*			*Lunch*	
14:00	BDS I/MDI I	CR-4 Tunnel Extension **PLENARY**		Central Region **PLENARY** TDR lattice release status	SRF III Positron
			14:45	Change Register Review	
15:30	*Coffee*			*Coffee*	
16:00	CR-3 CIT report **PLENARY**	Joint Plenary		Closing Plenary	
16:30	MDI-II: Surface & Infr. With CFS				
18:00					

Issues

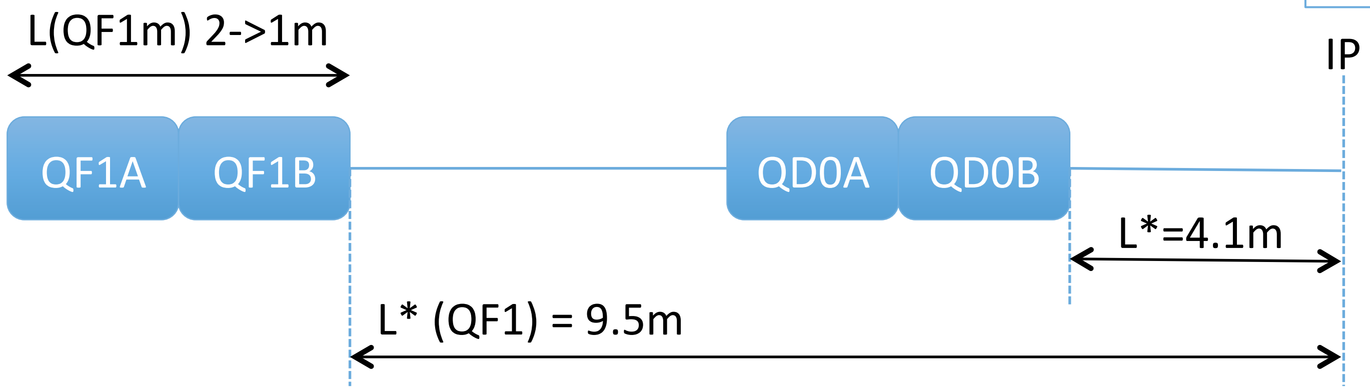
- Design issues
  - CR2: Common L*
  - CR3: Vertical shaft for the detector hall
  - CR4: Extension of the linac tunnel by 2x1.5 km
  - Other possible CR's in the near future
- SRF
  - Recent facility developments
  - EXFEL update
    - Cavities
    - Cryomodules
- R&D issues
  - ATF2
  - Positron

CR2: Common L*

- Change request from accelerator side to make L* common to SiD and ILD for easier commissioning and tuning
- SiD designed with L*=3.5 m can relatively easily accept L* between 2.6 and 4.5 meters.
- ILD designed with L*=4.5 m can accept the minimum L* of 4.1 m by removing the ion pump in front of QD0.
  - Increased pressure seems to be acceptable
  - Backup solution using a distributed NEG system is under consideration. Seems ok.
  - Further modification (e.g., redesign FCAL) needed if L*<4.1m is required
- The difference between L*=4.0 and 4.1m is negligible from the optics and tuning standpoint.
- Once L* decided, there is still a choice for QF1 L* (9.5m in TDR)
  - Shorter QF1 L* leads redesign of QF1 support structure and Packman both on SiD and ILD.
  - But 9.5m and 9.1m do not cause significant difference in optics

Summary of IR Optics for Single L* CR

G.White

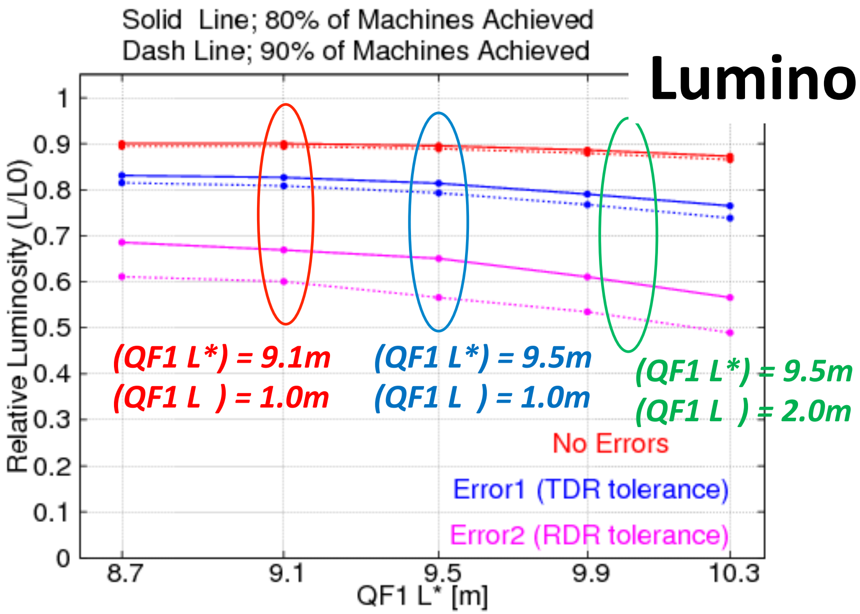


- In general: better performance for shorter L* if free to set both QF1 and QD0 positions.
- QF1 position fixed by push-pull constraints to ~>9m
- Better FFS performance for longer L* (smaller QF1-QD0 distance)
- Optimal L* ~4m. Choose 4.1m to ensure room with ILD design for BPM d/s QD0 for "IPBPM"
- For L*=4.1m considered QF1 position @ 9.5 or 9.1m
- For expected tolerances, negligible tuning performance improvement for 9.1m. Improvements @ 9.1m become a little more pronounced for degraded parameters (e.g. larger than design ε_x)
- Collimation depth optimal @ 9.5m
- No compelling reason to change from 9.5->9.1m, recommend keeping 9.5m distance.

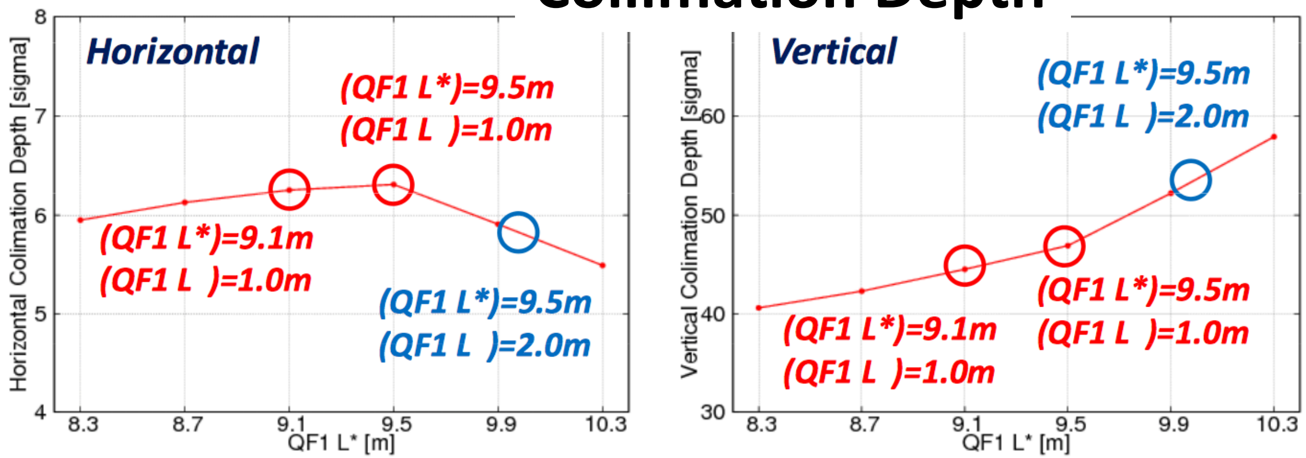
FFS Performance Studies

T. Okugi, KEK

Luminosity



Collimation Depth



Recommendations by CRP (Change Review Panel)

N. Terunuma

- Common L* of 4.1 m

- Taking all currently available information, the CRP recommends that CR-002 being accepted as baseline, with an agreed-upon common L* of 4.1 m.
- As a further corollary to this study, the CRP also recommends that QF1 L* be left at the TDR value of 9.5 m.
- With QD0 L* set at 4.1m, the BDS performance was evaluated for a range of QF1 L* values. A weak dependence is observed when lowering the QF1 L* from 9.5 m, whereas the collimation depth calculations show a preference for an L* of around the TDR design value of 9.5 m.
- Shorter QF1 L* leads redesign of QF1 support structure and Packman both on SiD and ILD.

Recommendations (cont.)

N. Terunuma

- The CRP also makes note of the following related issues that merit further study:
-
- QF1 length:
  - The BDS studies show the more tangible improvements evident for a shorter QF1 of 1 m as opposed to 2 m which they strongly recommend if feasible.
- IPBPM:
  - A BPM located just downstream of QD0 will help the recovery of the beam after the push-pull of detectors and that of after long shutdown, as well as aiding the IP FFBK system.

Final form quite soon !!

CR3: Vertical shaft for the detector hall

- Horizontal access → mainly vertical shaft around IP
- Implementation team named
- V Kuchler, K Buesser, T Markewicz, M Miyahara, J List, B List, (T Sanuki, Support)
- Discuss about

✓ Location of the Overall ILC Alignment to Optimize the Preferred Site Conditions
✓ Path and Configuration of the Horizontal Tunnel Access to the Detector Hall and Damping Ring
✓ Vertical Shafts (2) for Access to the Detector Hall
✓ Footprint and Configuration of the Detector Hall
✓ Crane Requirements for the Detector Hall
✓ Overall Construction and Detector Assembly Schedules
✓ Cost Implications for the Required Changes (~ -5%)

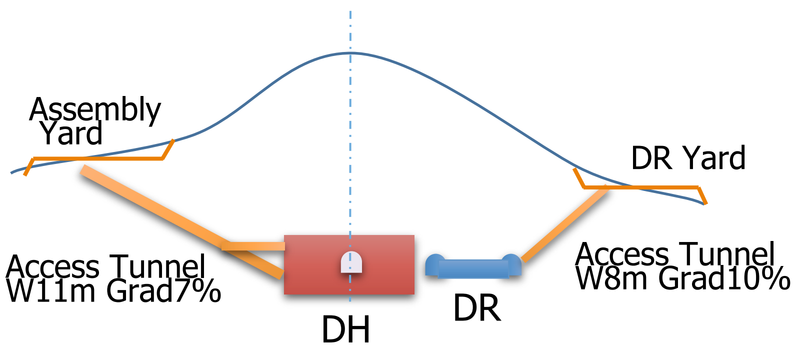
DH with Vertical Shaft Access

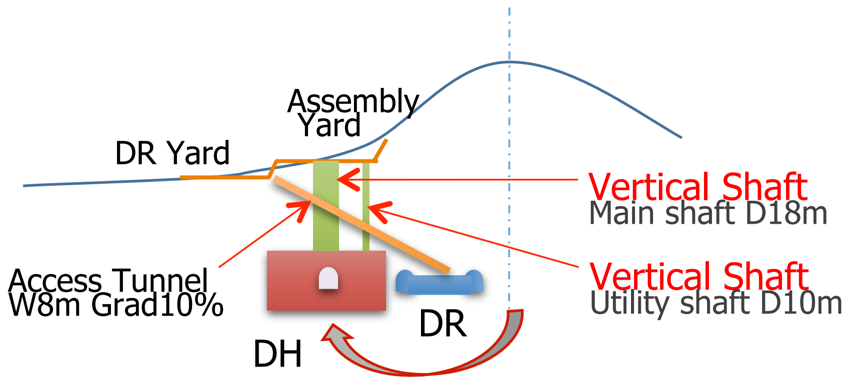
ILC-CR-0003

- Change Review Panel Members: K. Yamamoto, V. Kuchler
- Current Status: Accepted by CMB

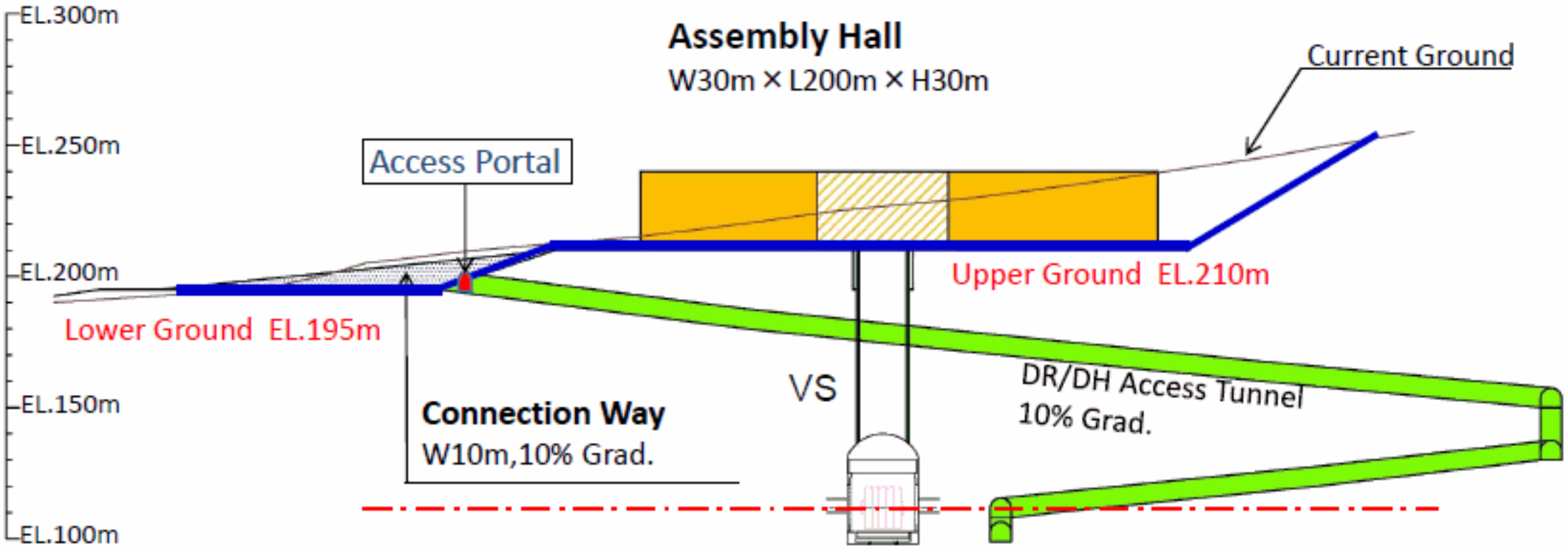
Overview of the Change Request

TDR Baseline	New Baseline
■ Assembly Place: underground/DH	■ Assembly Place: Surface building/AH
■ Access way to DH underground	■ Access way to DH underground
- only horizontal Access Tunnel (AT)	- mainly Vertical Shaft (VS)
- Transport. by special long trailer	- Transport. by Gantry Crane





M. Miyahara

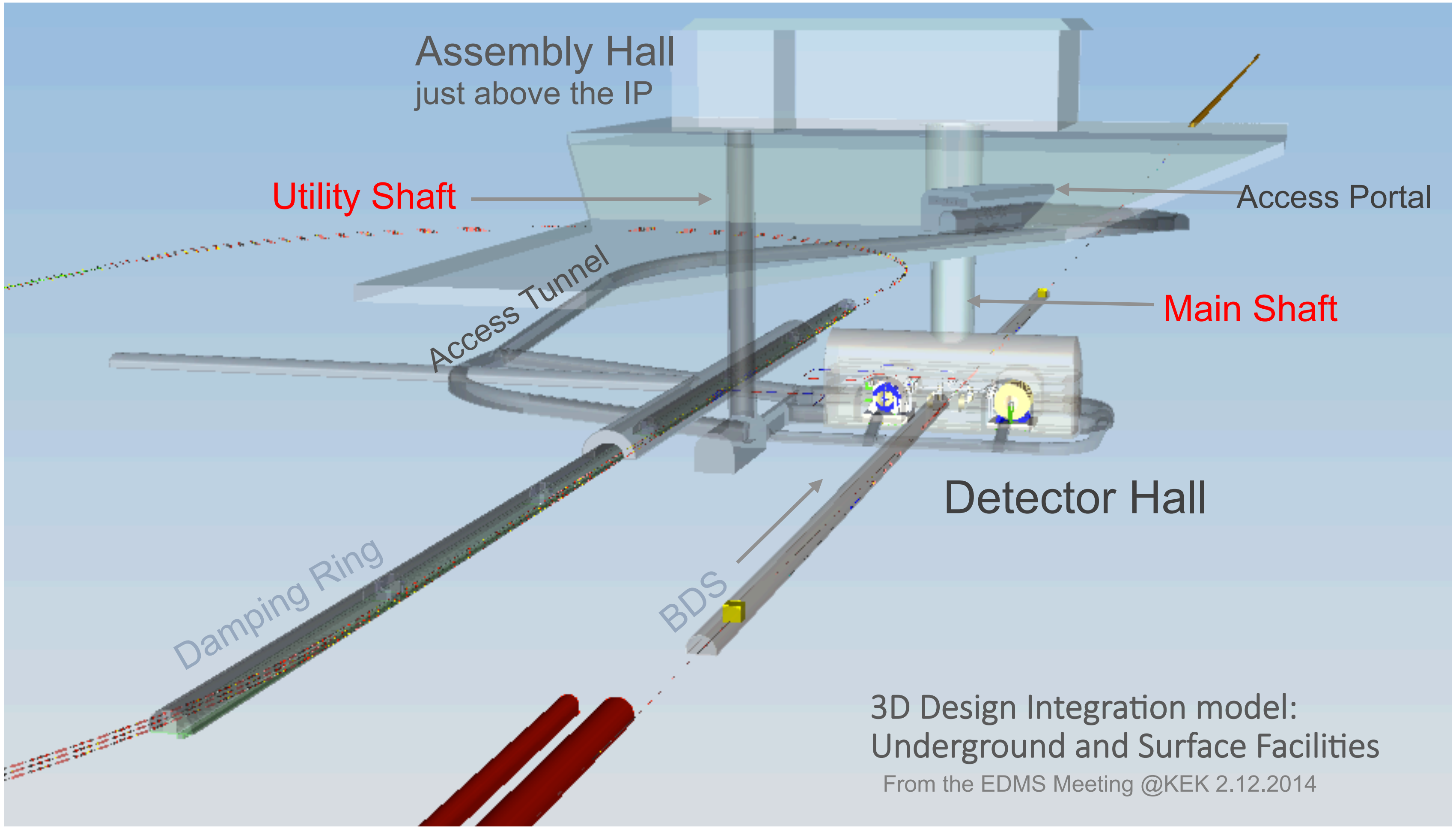


Longitudinal section

New Baseline Layout

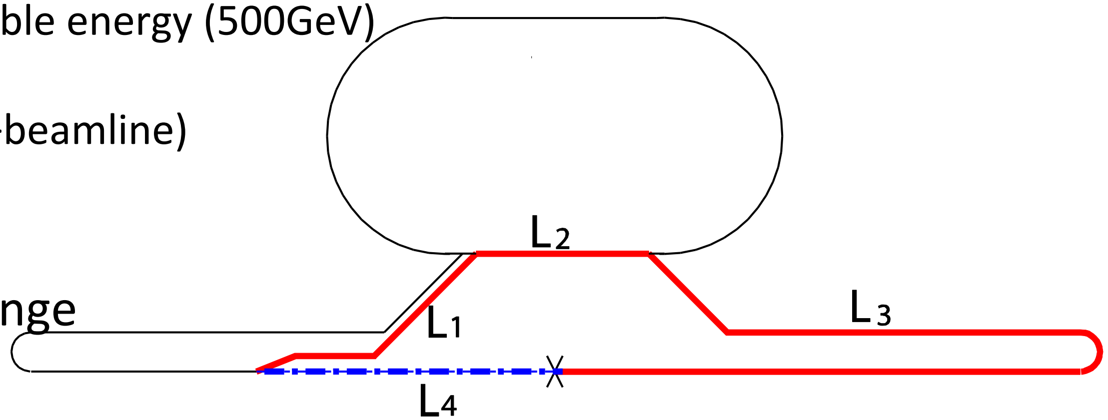
M.Miyahara

DH with Vertical Shaft Access



CR4: Extension of Main Linac Tunnel

- Global timing issue
  - $(L_1 + L_2 + L_3) - L_4 = n \times C_{DR}$
  - Linac (positron) tunnel length discrete by $C_{DR}/2$
  - TDR values $(L_1 + L_2 + L_3) - L_4 = 9 \times C_{DR} + 294\text{m}$
  - Near-TDR solution
    - Decrease BDS by 294m/2
    - Or, increase C_{DR} by ~40m (and increase BDS slightly)
- Perhaps more reasonable solution is to increase the linac tunnel length by 2x1.5km
  - Empty tunnel (with beamline) in the first construction
  - Future margin ~14% for
    - Acceleration gradient (31.5MV/m)
    - Or, maximum reachable energy (500GeV)
  - Cost impact
    - ~100 MILCU (tunnel+beamline)
- Additional equipment
  - Positron chicane in L1
    to adjust 10's of cm range



M. Miyahara

CFS Work for CR

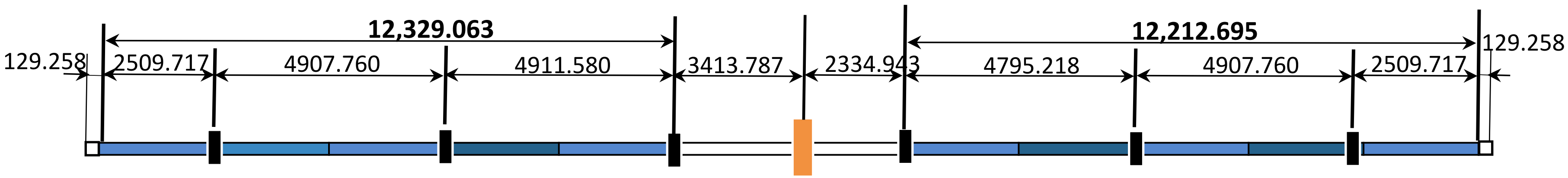
Extension of the ML Tunnel

CR-0004

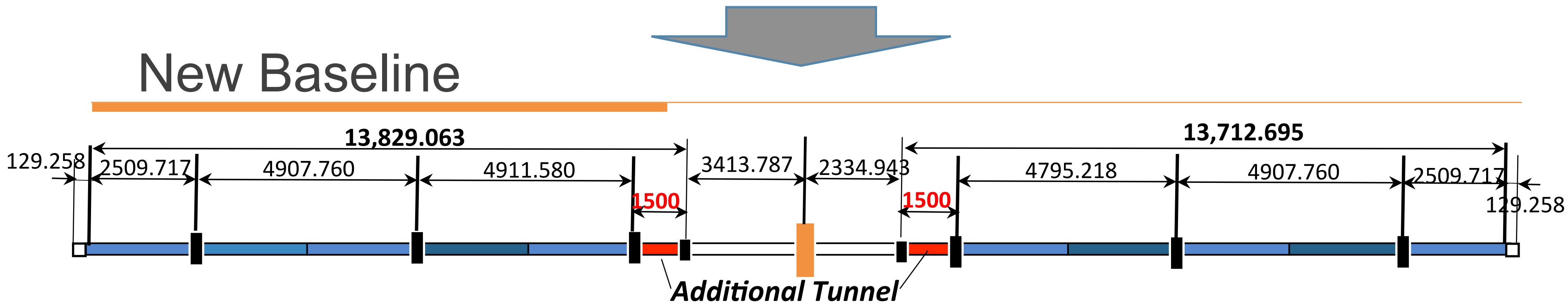
- Change Review Panel Members: V Kuchler (chair), N Waker, H Nakai, T Sanuki, M Miyahara
- Current Status: Under Discussion Change Implementation Team

Under Discussion

TDR Baseline



New Baseline



Expected Change Requests in the Near Future

- Thickness of main linac shielding wall
- BDS tunnel
- Cryogenics layout
- And many more………..

ML Shield wall thickness impact

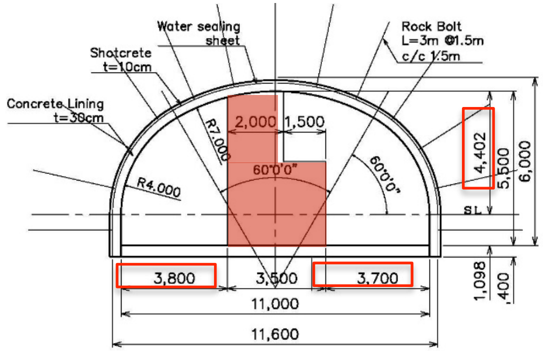
Pre-study

- Radiation shield issue will be decided by necessity of person's access
- Scheme change depends on the management scenario of beam operation.

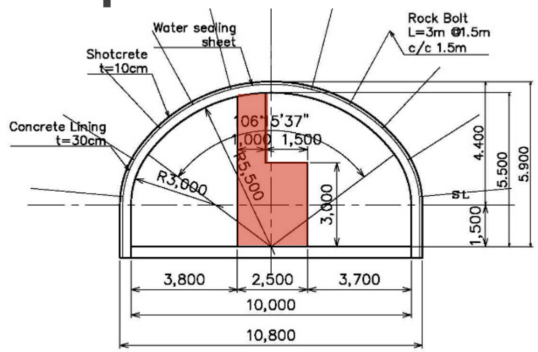
Common Dimensions

- Beam line : Width 3.8m
- Klystron gallery: Width 3.7m
- Tunnel Inner height : 5.5m

Baseline SW3.5m

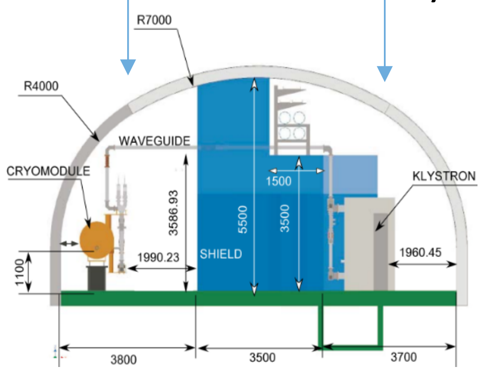


Option-1 SW2.5m

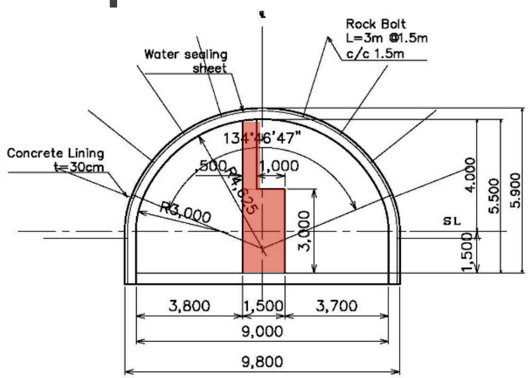


Beam Line

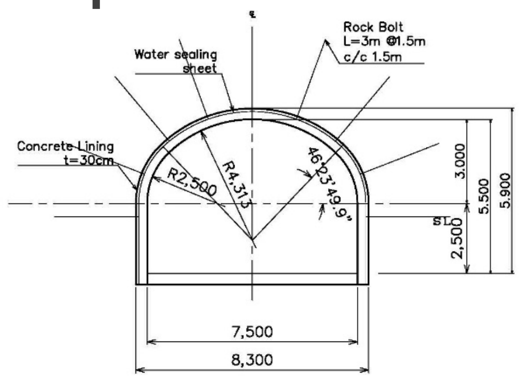
Klystron Gallery



Option-2 SW1.5m

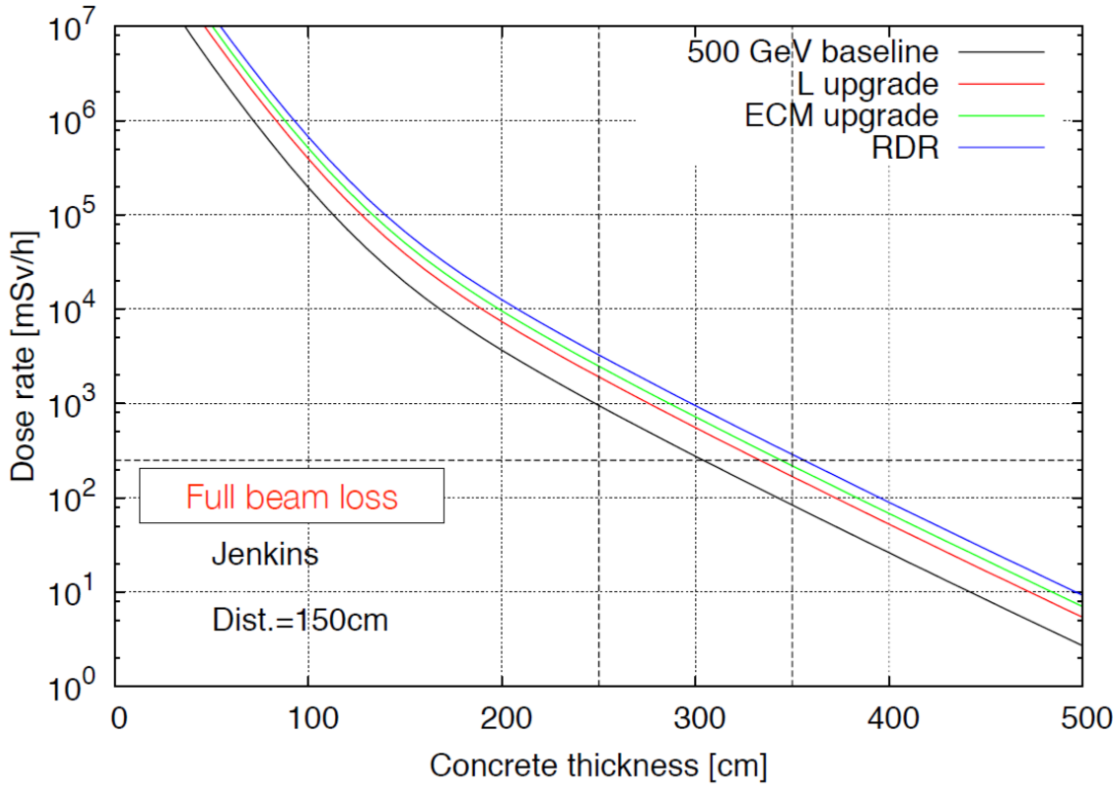


Option-3 No SW



Concrete thickness vs dose rate

Sanami



Several studies presented in this workshop

Failure modes, dark current

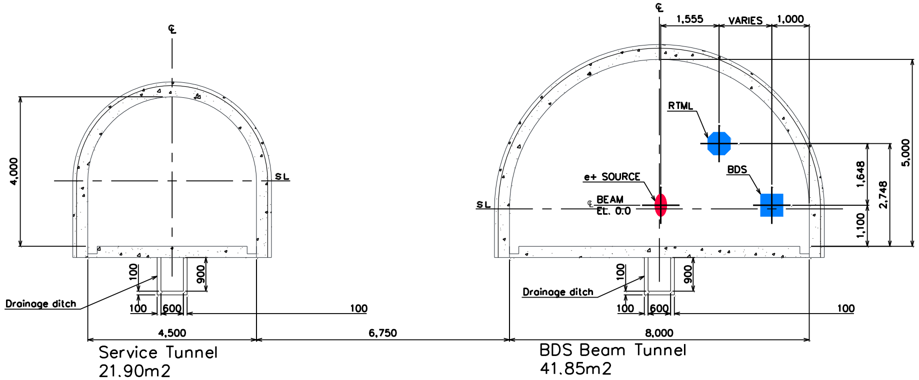
For the wall thikness, the main issue is the policy

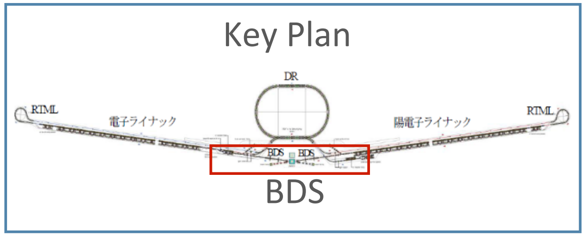
Scheme change – BDS Configuration

Pre-study

- Change to the single tunnel from the twin tunnel in TDR
- BDS group is currently discussing the various layout options

Baseline

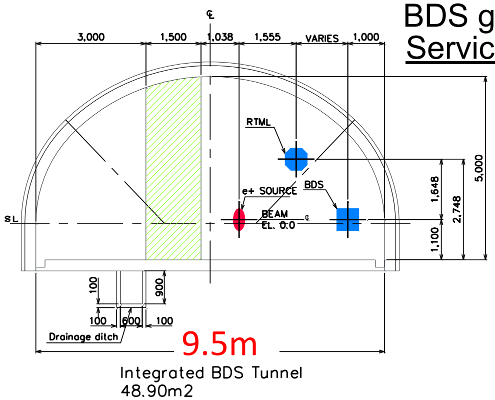




Revision

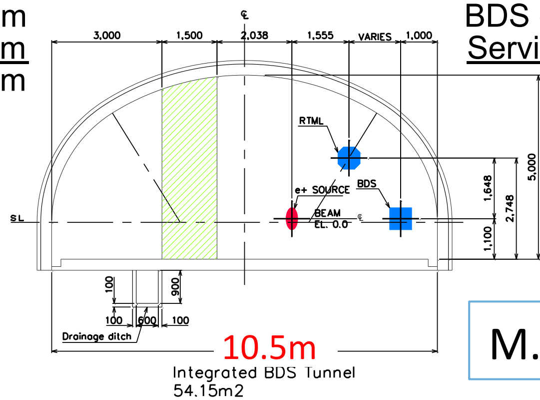
Integrated option_1

Shield wall width :1.5 m
BDS gallery : 5.0 m
Service gallery : 3.0 m
Total 9.5 m



Integrated option_2

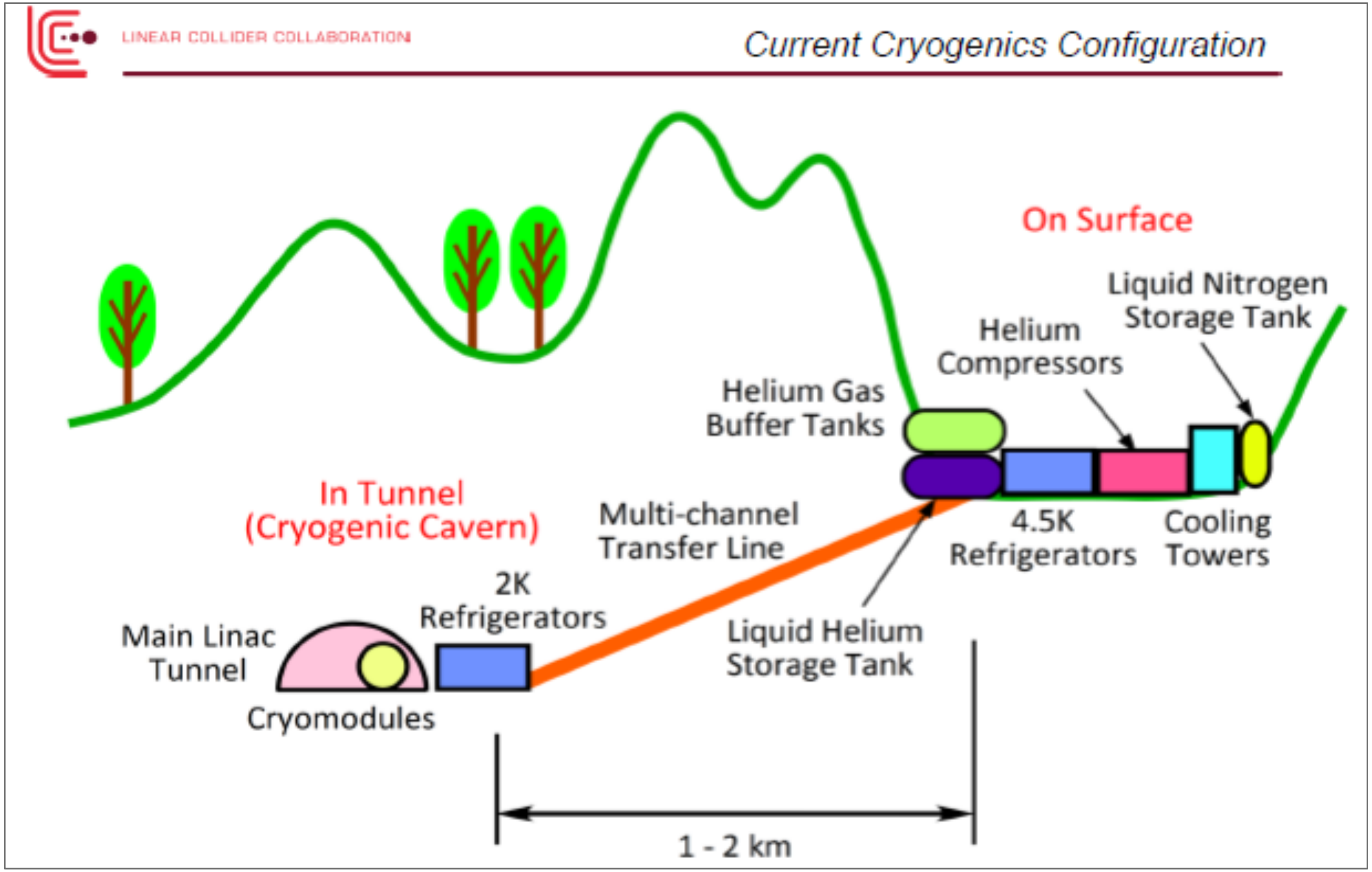
Shield wall width :1.5 m
BDS gallery : 6.0 m
Service gallery : 3.0 m
Total 10.5 m



M. Miyahara

Cryogenics Configuration

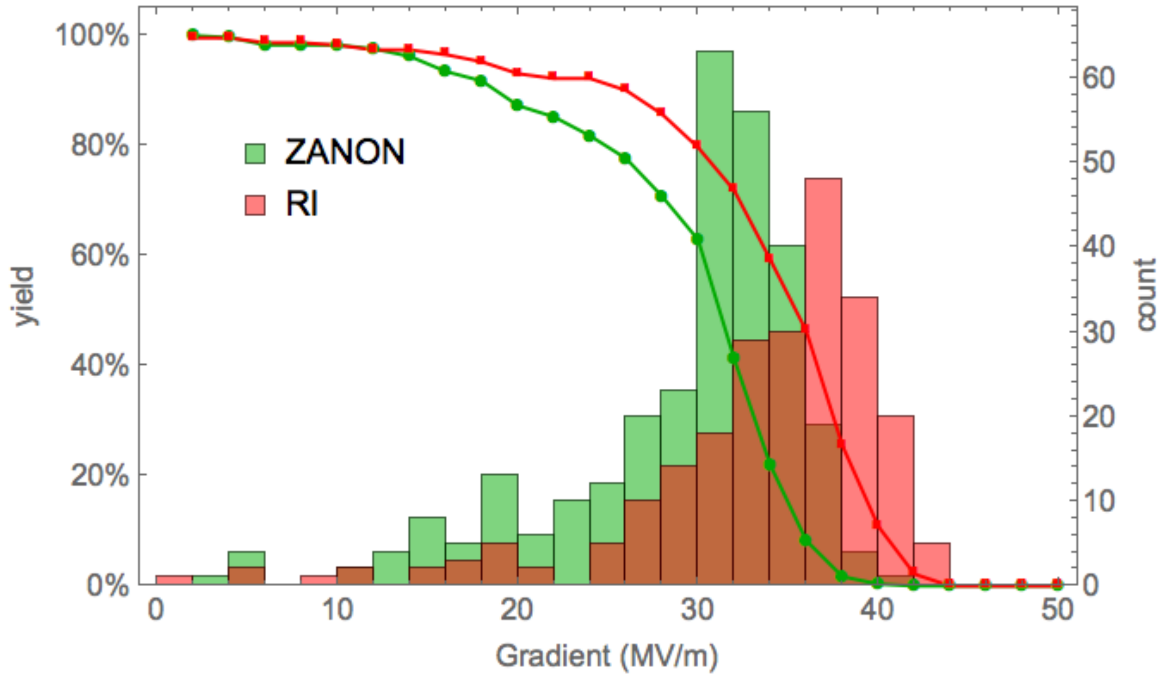
from Nakai-san's report



SRF Issues

- Facility status
  - KEK-STF2
    - CM1+CM2a installation complete
    - RF installation this year
    - Acceleration in 2016
  - FNAL CM2
    - Average grad Reached 31.5 MV/m
- EXFEL
  - Cavities
  - Cryomodules

Test Results: Max Gradient



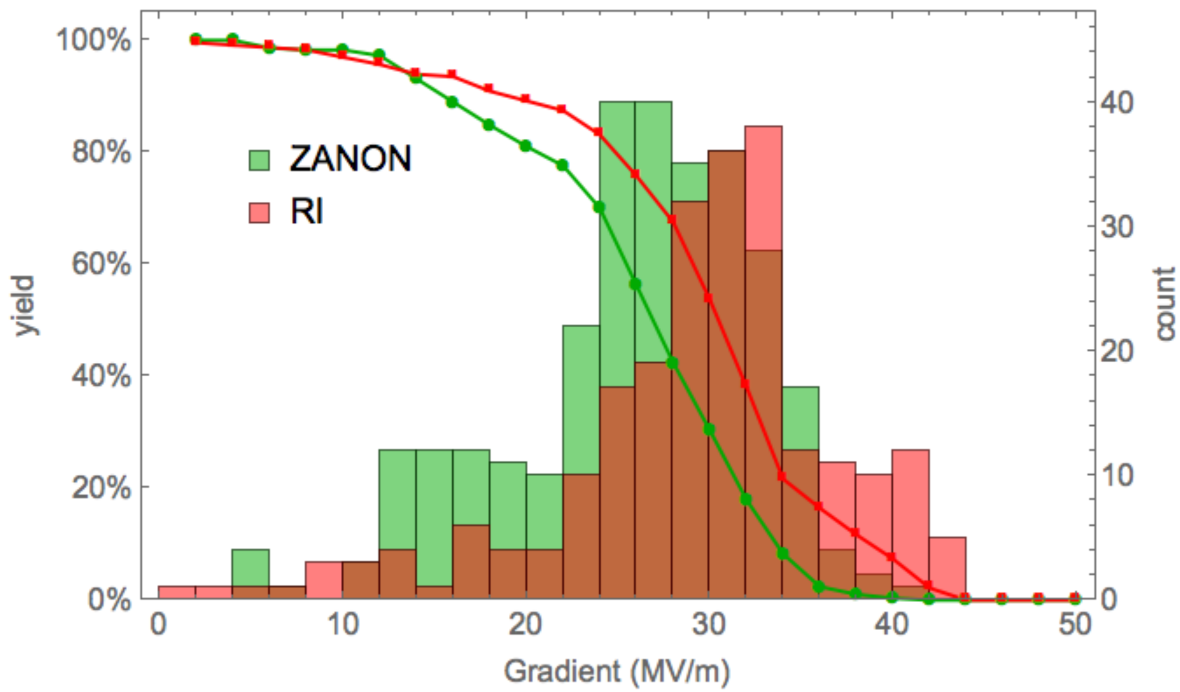
Cavities		(88%)
Tests	522	(63%)

	Tests	Average	RMS	Yield@20	Yield@26	Yield@28
ZANON	291	29.3	6.8	87%	78%	71%
RI	231	33.6	7.	93%	90%	86%
All	522	31.2	7.2	90%	83%	77%

“As received” test

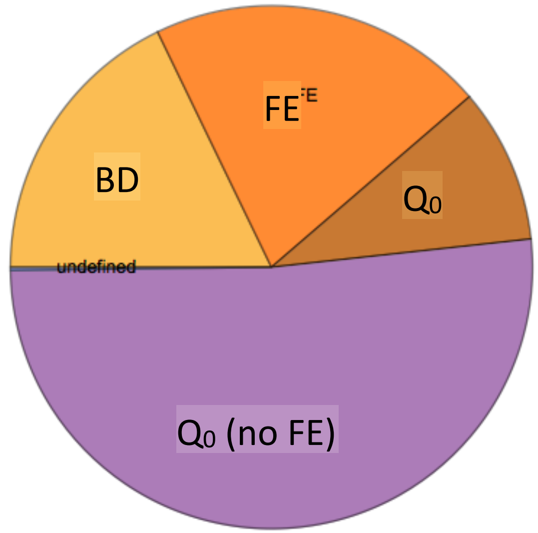
Clearly see difference between RI (EP) and EZ (flash-BCP)

Test Results: USABLE GRADIENT



Cavities	[illegible]	(88%)
Tests	521	(63%)

"As received" test



limiting criterion

	Tests	Average	RMS	Yield@20	Yield@26	Yield@28
ZANON	290	25.9	6.8	81%	56%	42%
RI	231	29.5	7.7	89%	76%	68%
All	521	27.5	7.4	85%	65%	54%

Average loss: ~4 MV/m

Extrapolation to ILC - VT

N. Walker

- ILC TDR assumed VT acceptance > 28MV/m (XFEL >20 MV/m)
  - Average of 35 MV/m (XFEL 26 MV/m)
  - Assumed first-pass yield: 75%
  - 25% cavities retreated to give final yield of 90% >28 MV/m (35 MV/m average)
    - 10% over-production assumed in value estimate

RI results only (ILC recipe)		ILC TDR (assumed)	XFEL max	XFEL usable
First-pass	Yield >28 MV/m	75%	86%	53%
	Average >28 MV/m	35 MV/m	36 MV/m	33.5 MV/m
First+Second pass	Yield >28 MV/m	90%	92%	80% *
	Average >28 MV/m	35 MV/m	36 MV/m	33 MV/m

* based on re-treatment model using XFEL data

but close!

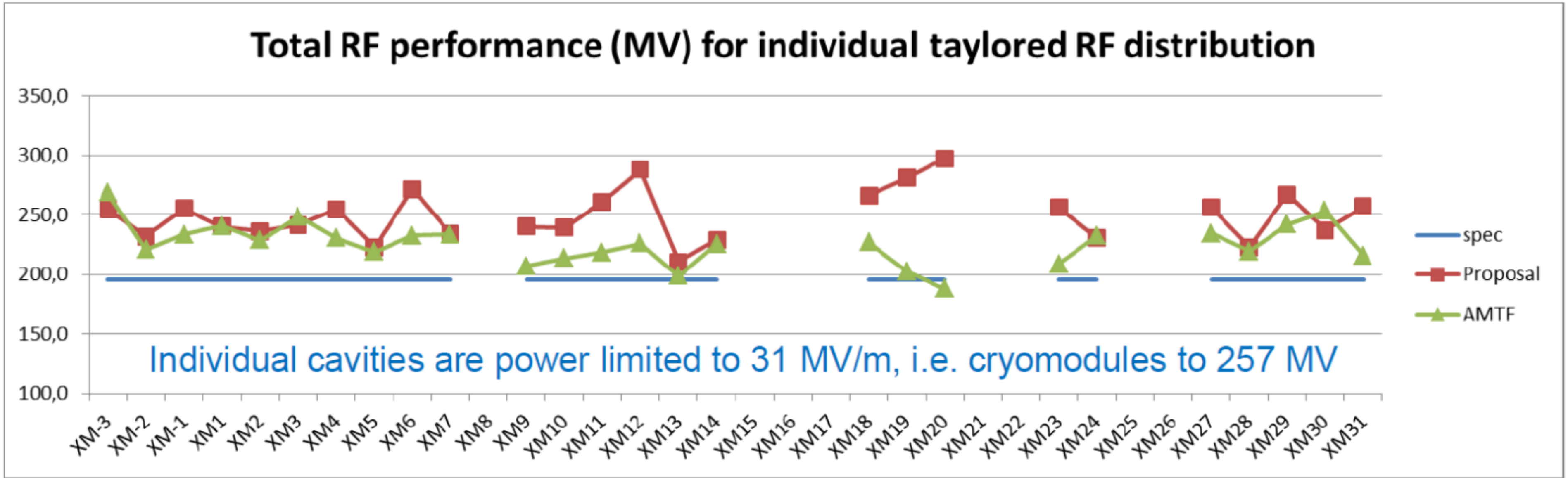
More re-treatments - but only HPR
Number of average tests/cavity increases from 1.25 to 1.46
20% over-production or additional re-treat/test cycles

$$$

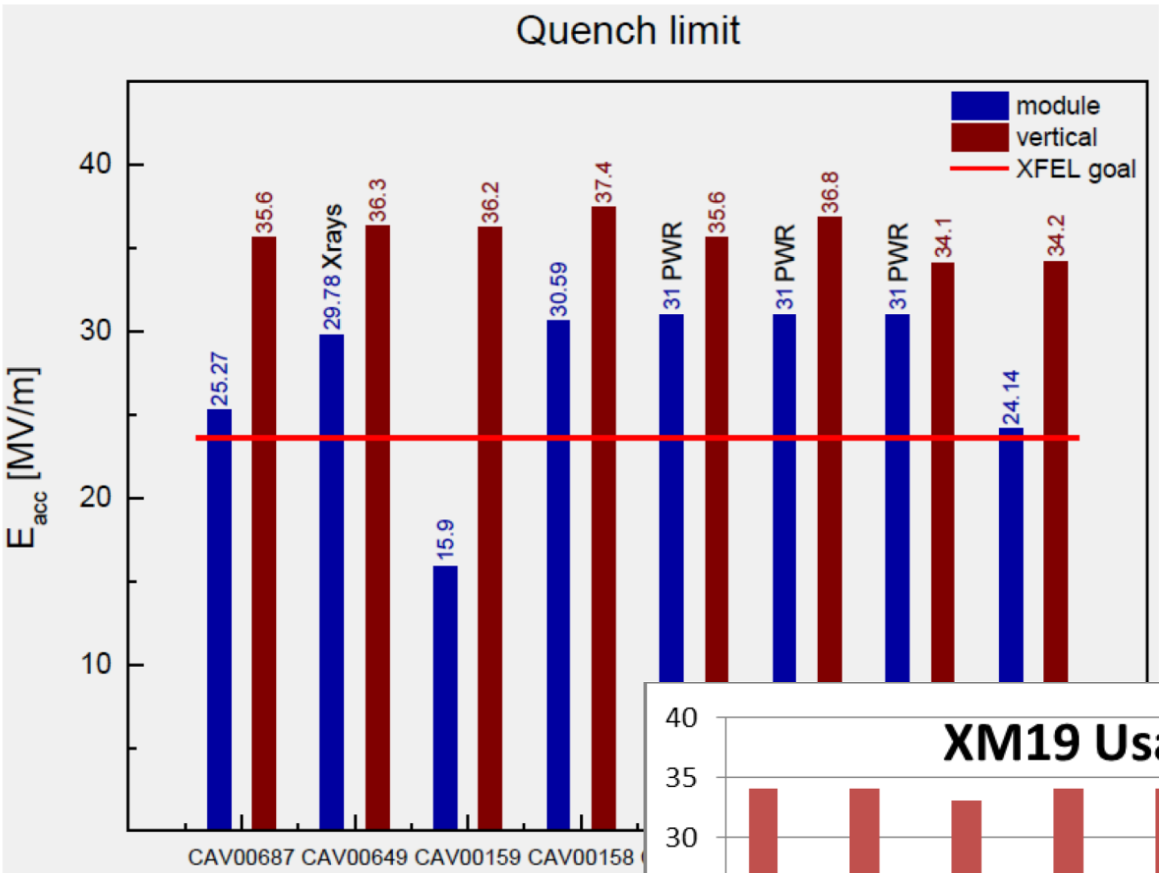
Cryomodule Performance

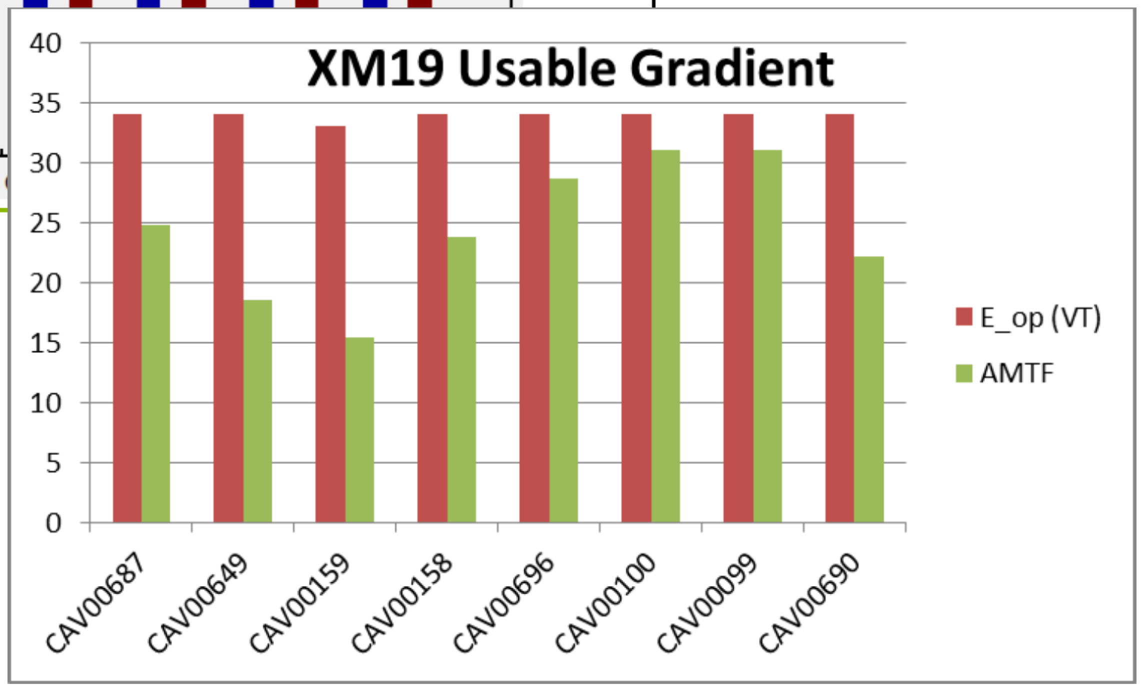
O. Napoly

- All tested modules are on XFEL specs (195 MV per module), on average 15 % above specs (27.2 MV/m).
- Some very important cavity gradient degradation have been recorded, e.g. on XM19. Modules XM-3 and XM30 are the two exceptions.



Cryomodule Performance : XM19





Cryomodule Results–Nick Walker

European XFEL

Extrapolation to ILC - Module Performance

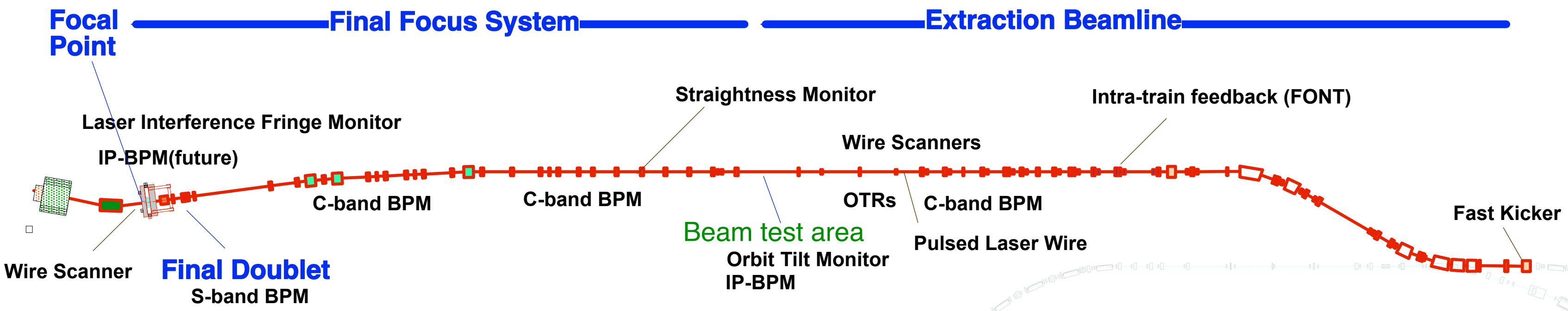
- ILC TDR assumed average operational accelerating gradient of 31.5 MV/m (XFEL 23.6 MV/m)
  - 10% overhead wrt to 35 MV/m average in VT
  - Covers
    - ➡ Performance degradation during module assembly
    - ➡ Waveguide distribution system (WDS) loss
    - ➡ Operations overhead margin (LLRF controls)

- XFEL - so far
  - 39 modules constructed; 20 (22) tested; 100 total
  - Current average degradation ≤10% (3 MV/m, upper limit)
    - ➡ No data above 31 MV/m
  - WDS (not covered here) an addition ~10% on average

Bigger concern. But still early days — Watch this space!

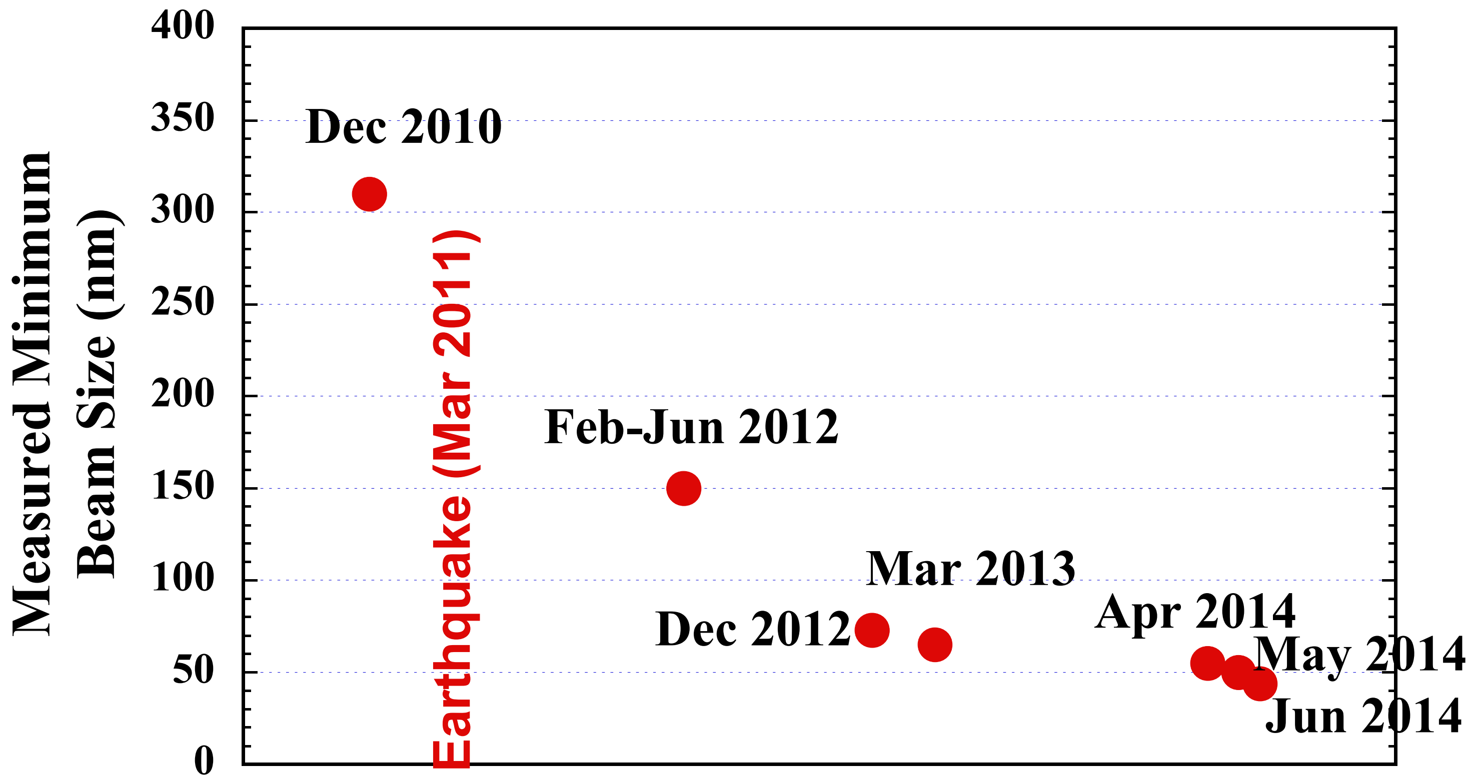
ATF2

- Goal 1
  - Beam size 37nm
  - Maintain the size for long term
- Goal 2
  - Stabilization of the beam position to a few nm
  - Bunch-to-bunch feedback system
- Additional goal
  - Understand the intensity dependence



Presented in IPAC14

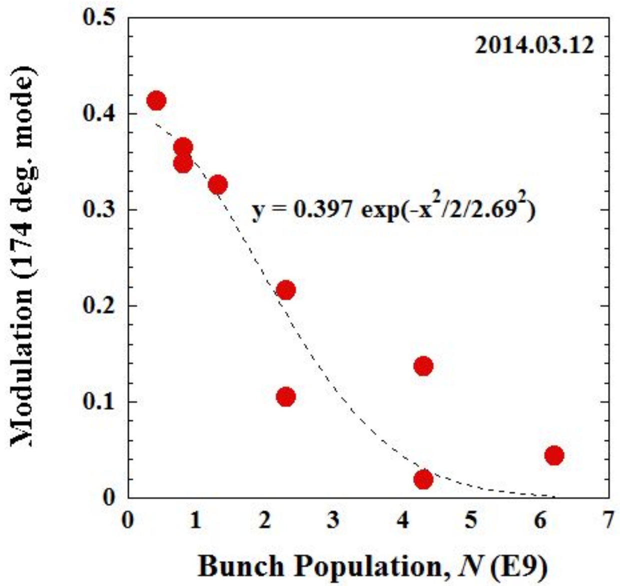
History of measured minimum beam size



- 44nm observed June 2014
- Quick tuning established
- Remaining difference 37nm vs. 44 nm not understood well

Intensity Dependence

- Beam size strongly depends on the beam intensity
  - Already visible at 1/10 of the design intensity
  - Considered to be due to the wakefield
- Various tests and theoretical works done
  - Wake of the OTR monitor turned out to be one of the sources
  - Intensive study still being done
- But the effective is expected to be much smaller in ILC than at ATF2
  - Higher beam energy
  - Shorter bunch

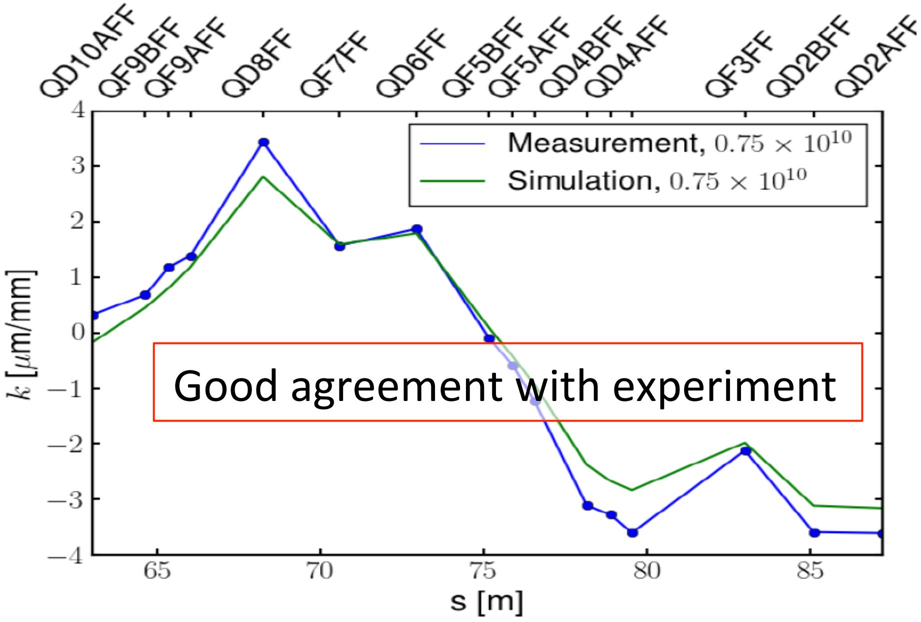


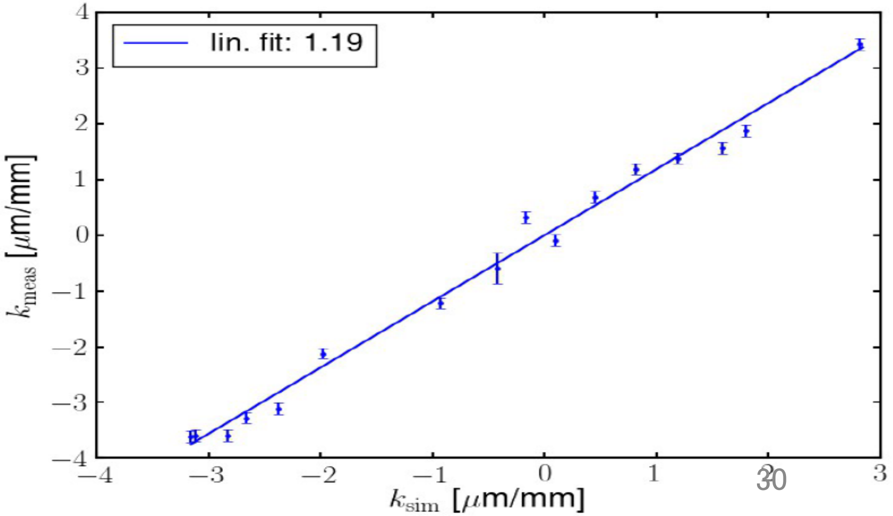
Comparison with simulation

- Measured orbit shape agrees well
- Now about a factor 1.2 larger than simulation

  (numerical calculation + tracking)
- Possible remaining discrepancy might be due to bunch length, charge or (still) underestimation by simulation
- Now within experimental uncertainty:
  - bunch length (about half a mm in DR, effect on wakefield 5-10%)
    - Not measured in extraction line
  - charge

    (ICT calibration error 5-10%)





J. Snuverink, et.al., ATF2 Project Meeting 201502 LAPP

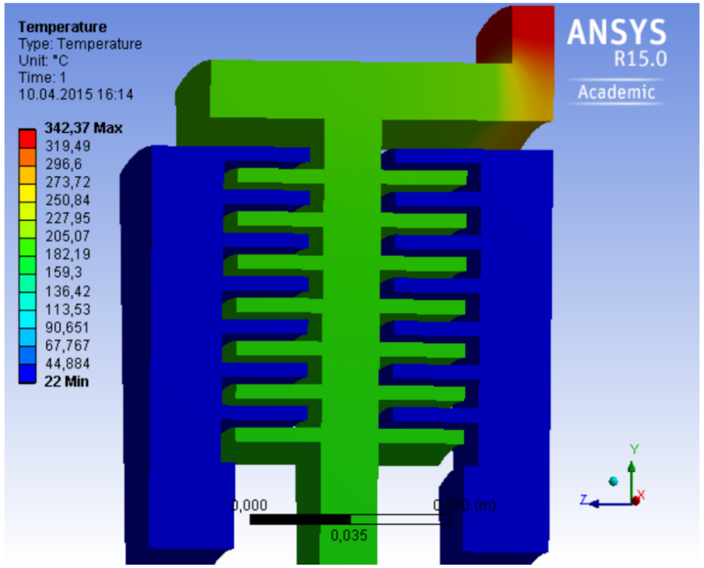
ATF2 Summary

K.Kubo

- Small beam size at IP (Goal 1)
  - 44 nm, confirmed at low intensity. Close to designed 37 nm.
  - Compare with size calculated without chromatic correction, 450 nm. → Local chromatic correction scheme (used at ILC) has been demonstrated.
  - Small size routinely observed with short time (~8 h) tuning.
  - Improvements in beam orbit jitters, etc.
- Intensity dependence
  - Reduced by reducing wakefield. But not yet fully understood. Study continued.
- Near future: Operation with nominal (horizontal) optics and simulation of ILC FF tuning
- Position stabilization at IP (Goal 2)
  - New IPBPM (Low Q for multi bunch) installed and operation started and some preliminary results obtained.
  - Preliminary resolution ~ 50 nm (Should be improved.)
  - Successful feedback (residual jitter ~ BPM resolution)
- Other studies continued

Target for Undulator Positron source

- LLNL experiments
  - Rapidly rotating (100m/s) wheel in vacuum
  - Vacuum seal problem
  - Funding not clear (a few M$)
- Alternatives
  - Radiation cooling
  - Sliding contact cooling
    - Heat conduction with low-friction material
    - Under experiment at IMP (Institute of Moder Physics) China

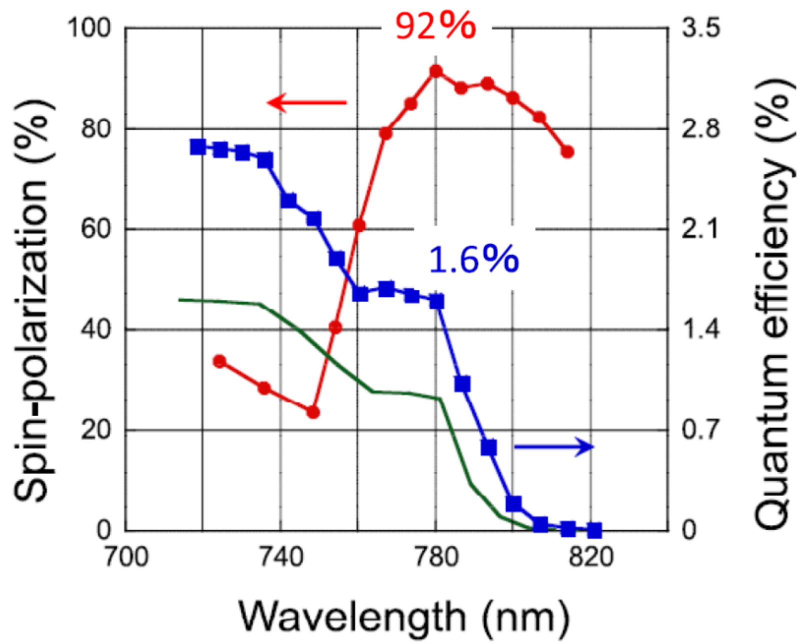


Electron-Driven Source

- Beamline design done
  - Transient beam loading compensation in NC linac
  - Test done at ATF successfully
- Overall simulation complete
- Rotating target ~5m/s required
  - Prototype being designed and to be tested at KEK (FY2015-2016)
  - Radiation dose on the seal estimated
- Housing to tunnel
  - Compatibility with the undulator system
  - Still to be discussed with CFS people
  - Change request needed

Electron source

- Development of polarized electron source at Nagoya U.
  - High polarization ~92%
  - With high Q.E. 1.6%



- To be studied
  - High current (1mA) measurement
  - Life of the photo cathode

Summary

- Several design changes
  - CR3 (vertical shaft) approved
  - CR2 (common L*) to be finalized soon
  - CR4 (linac tunnel extension) under discussion
  - Many more expected
- SRF
  - Cavity data from XFEL >60% obtained.
  - Extrapolation to ILC gives a gradient close to TDR specification
- R&D
  - ATF2 44nm reached. Progress in understanding the intensity dependence
  - Positron
    - Experiment of sliding contact cooling started
    - E-Driven source expects CR in the near future