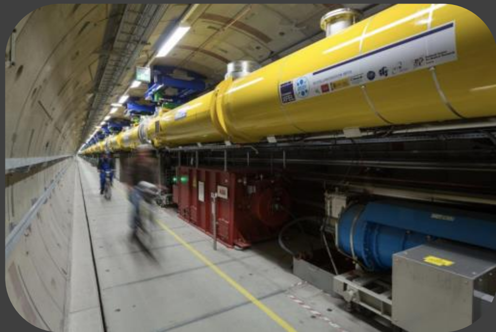


Overall Takeaways from Accelerator Sessions

ILC accelerator technology is **ready for implementation** at the large scale required

Technology for ILC is settled, now exploring some tweaks to reduce costs (with promising results). **Consistency of overall plan** since TDR (and before) shows the strength of the proposal

Long term SRF R&D is underway for cost reduction on the timescale appropriate for a future upgrade beyond 250 GeV

Success of current linear accelerator projects bring confidence as we look forward to scaling up to ILC and CLIC

LCWS accelerator sessions showcase **sophistication of accelerator expertise worldwide** – crucial that these skills exist in all regions for large “international-scale” accelerator projects

Thank you to Accelerator Conveners!

- **ATF**
  Nobuhiro Terunuma (KEK)
  Phil Burrows (Oxford)
  Edu Marin (Alba-Cells)
  Rogelio Tomas (CERN)
  Glen White (SLAC)

- **Damping Rings**
  Nobuhiro Terunuma (KEK)
  Yannis Papaphilippou (CERN)
  Eliana Gianfelice (FNAL)

- **Sources**
  Masao Kuriki (U. Hiroshima)
  Steffen Doebert (CERN)
  Sabine Riemann (DESY)
  Manoel Conde (ANL)

- **Beam Dynamics and RTML**
  Kaoru Yokoya (KEK)
  Andrea Latina (CERN)
  Nikolay Solyak (FNAL)

- **Beam Delivery System**
  Toshiuki Okugi (KEK)

- **CFS (Conventional Facilities and Siting)**
  Hitoshi Hayano (KEK)
  Saeki (KEK)
  John Osborne (CERN) & Matthew Stuart

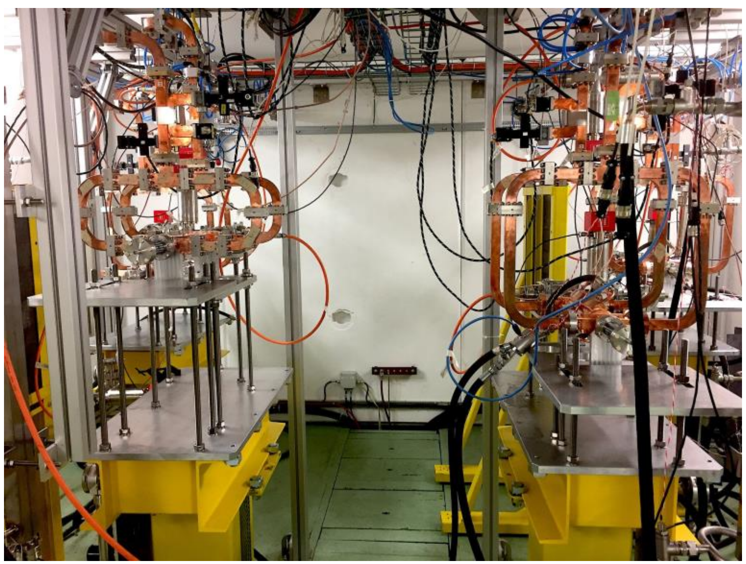
- **(SCRF) Superconducting Radio Frequency**
  Sam Posen (FNAL)
  Yasuchika "Kirk" Yamamoto (KEK)

- **Warm RF**
  Walter Wuensch (CERN)
  Emilio Nanni (SLAC)

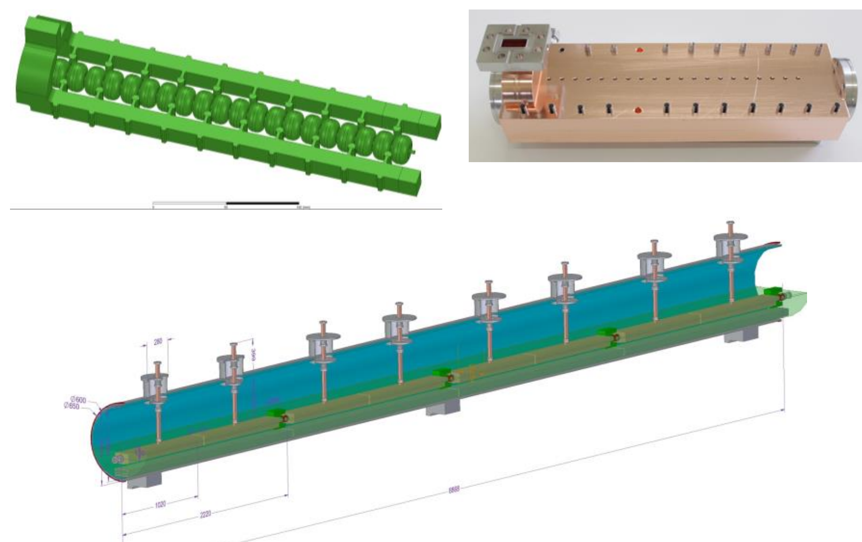
- **Industry**
  Hugh Montgomery (JLab)

Warm rf session – News from CLIC testing program and linac technology development from SLAC, LANL and UCLA.

- Xbox test stand operation and prototype testing – steady operation of structures above 100 MV/m and validation of new components.
- Power source development – High-efficiency X and L-band klystron development for CLIC and ILC, low-cost fabrication concepts and prototype superconducting focusing solenoid.
- New directions for accelerating structures – Manifold-fed structures, LN2 temperature operation (also for low emittance rf gun), dielectric structures and atomic-level high-field simulations.
- Linac development – LN2 alternative for linear collider



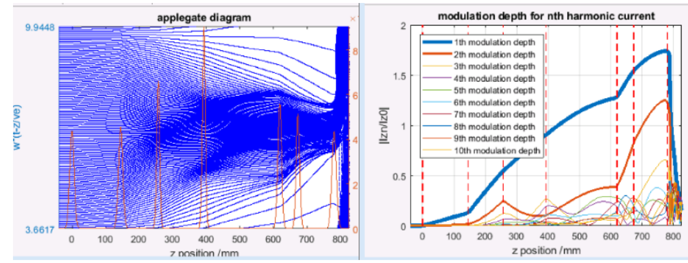
Four prototype CLIC accelerating structures under test in Xbox-3



New structure topologies and cryogenic operation

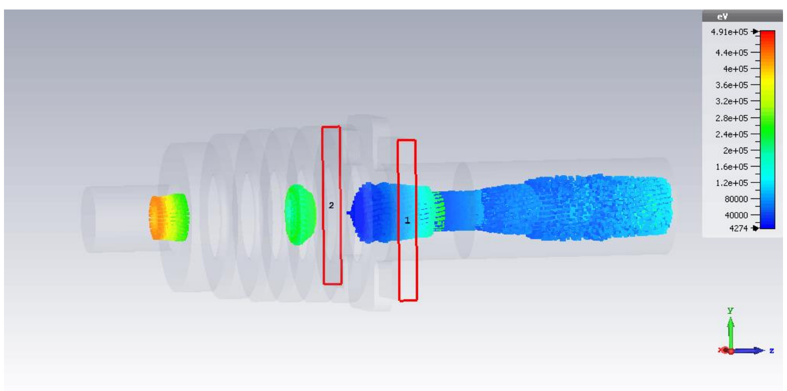
Warm RF

MgB2 superconducting solenoid for X-band klystrons

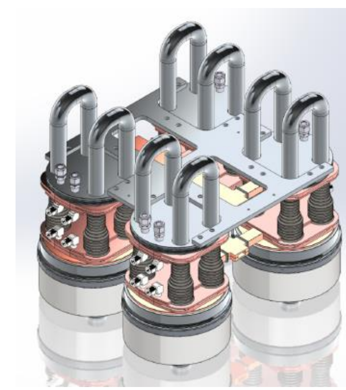


	FCC CSM	ILC CSM MBK	ILC/Thales MBK
Frequency, GHz	0.8	1.3	1.3
Total current, A	12.55	133	130
Voltage, kV	133.6	115	115
N beams	1	7	7
Efficiency,%	**80**	**76.3**	**70**
RF power, MW	1.38	11.7	10
Power gain, dB	38	47.6	47
RF Length, m	1.7	0.8	1.2

High-efficiency klystron design for the ILC courtesy of CLIC.



High-efficiency X-band klystron design for CLIC.



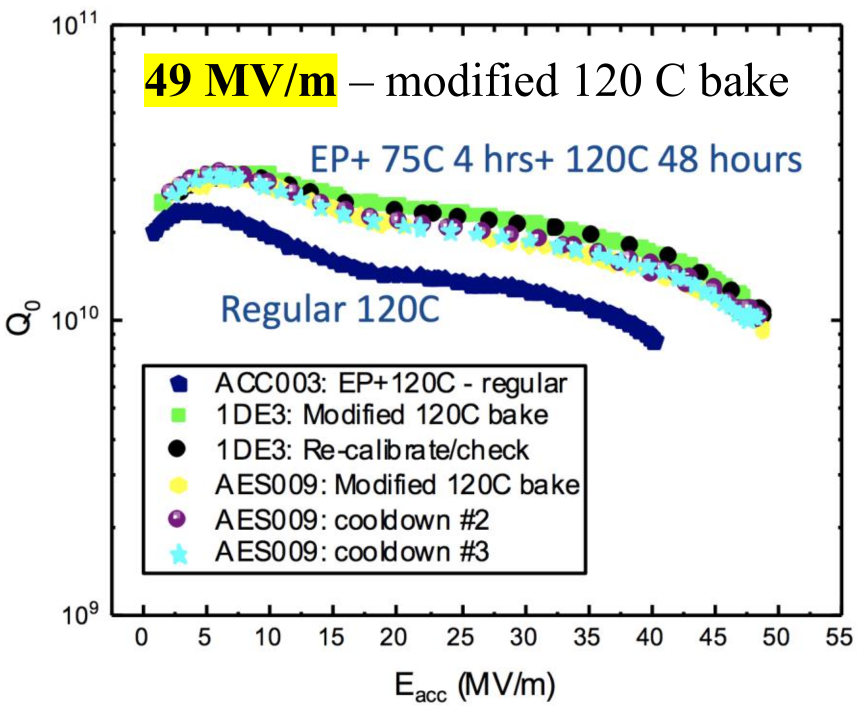
Exploring modular and commoditized source concepts

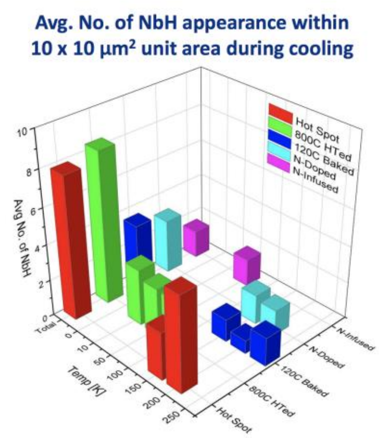
Overall theme – Solidifying the 100 MV/m and higher baseline and investigating new ideas for higher performance, higher efficiency and lower cost!

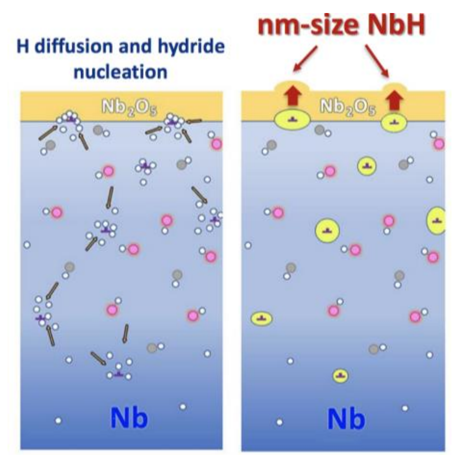
Superconducting RF

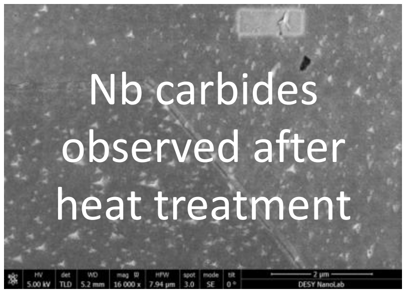
Focus: exciting developments in ILC cost reduction, facilities, R&D for future of SRF

- Cavity treated with “modified 120 C bake” treatment developed this year at Fermilab was sent to Cornell. Measurement by Cornell **confirms achievement of 49 MV/m, a new record for ILC-style single cell cavity** – next reproduce at other labs and multicells – studying possible role of **hydrides** in performance improvement
- While Fermilab has consistent performance in **nitrogen infusion treatment**, success has been intermittent at other labs (see reports from KEK and DESY). It seems that a very clean furnace is needed.



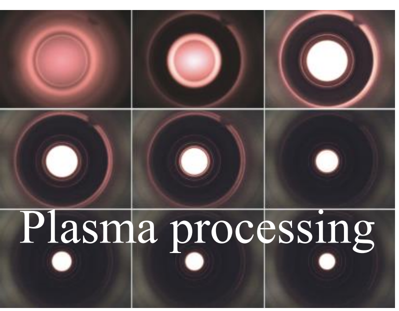


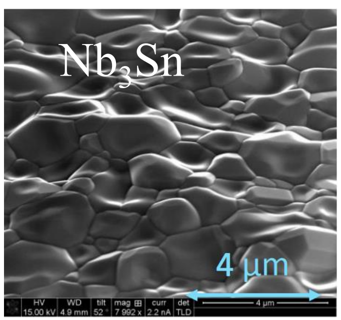


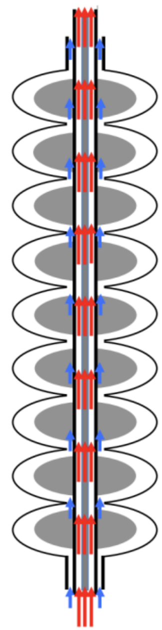


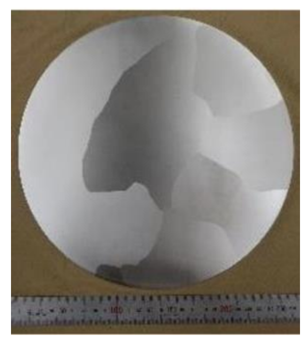
Superconducting RF

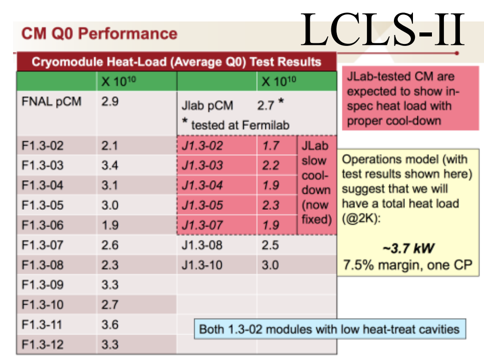
- Updates given on a number of paths towards **high gradient/high Q_0** including low surface field shapes, plasma processing, flux expulsion, and (long term) Nb_3Sn
- **STF upgrades and plans for the future**
- **Reducing costs** in cavity fabrication/processing: large grain material, hydroforming, vertical electropolishing
- Updates on **couplers/tuners** from KEK and LCLS-II, **clean** assembly at KEK
- **<u>Success in large SRF linacs is extremely encouraging as we look forward to ILC. European XFEL is now at design energy! LCLS-II is producing cryomodules meeting all specifications, many with average Q_0>3x10^{10}</u>**





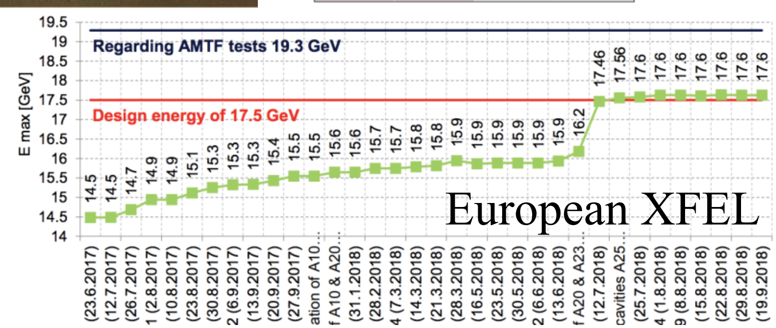




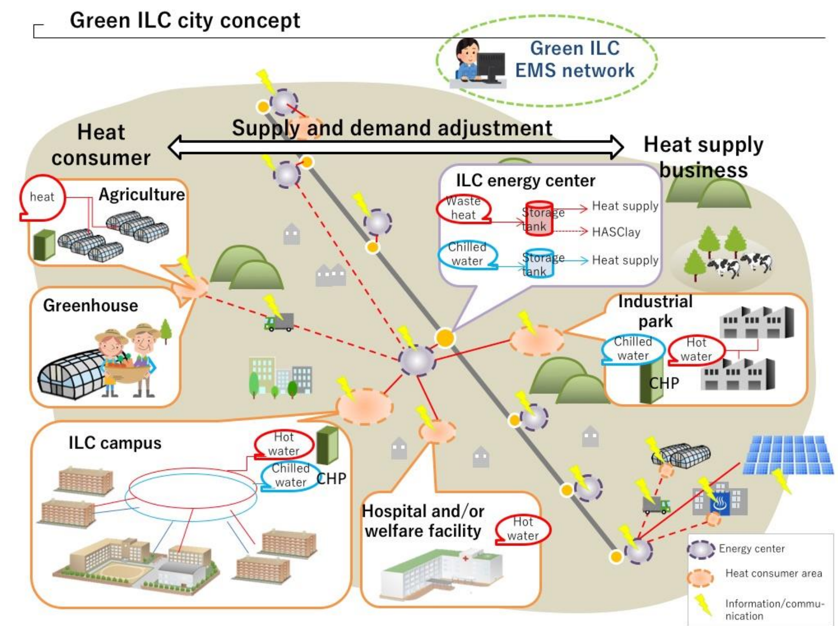


Cryomodule Heat-Load (Average Q0) Test Results

	X 10^{10}		X 10^{10}	
FNAL pCM	2.9	Jlab pCM 2.7 * * tested at Fermilab		
F1.3-02	2.1	J1.3-02	1.7	JLab slow cool-down (now fixed)
F1.3-03	3.4	J1.3-03	2.2	
F1.3-04	3.1	J1.3-04	1.9	
F1.3-05	3.0	J1.3-05	2.3	
F1.3-06	1.9	J1.3-07	1.9	
F1.3-07	2.6	J1.3-08	2.5	
F1.3-08	2.3	J1.3-10	3.0	
F1.3-09	3.3			
F1.3-10	2.7			
F1.3-11	3.6			
F1.3-12	3.3			



Conventional Facilities (CFS)

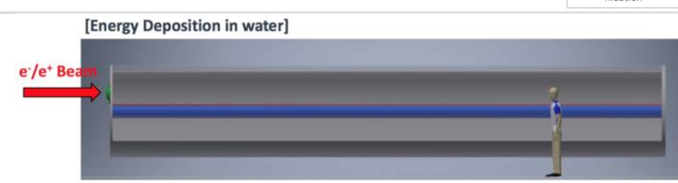


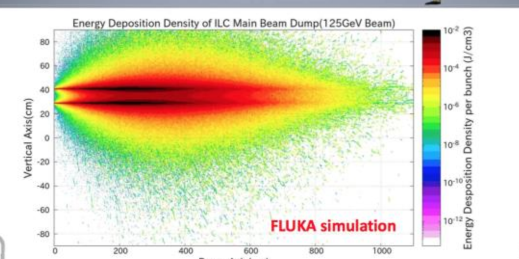
Green-ILC

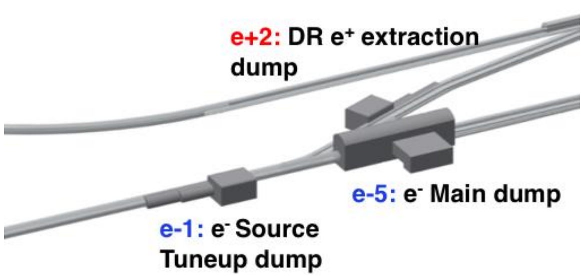
- Energy saving on RF system
  (PM-focus-klystron, Q-switch RF filling, thin-film coating High-Q/High-G)
- Reducing beam energy by strong laser interaction
- Green-ILC activities in Kitakami-site
  Use of ILC waste heat, Use of local wood

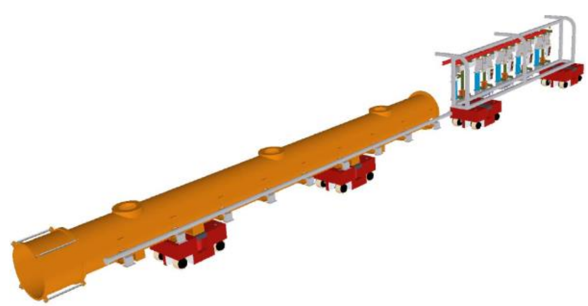
Tunnel Design

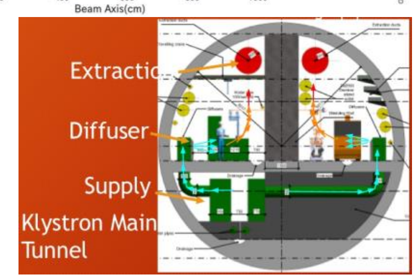
- Design of beam dumps
  (Main beam dump, other dumps)
- Dump-room widening consideration
- Cryomodule Power Distribution System
  cryomodule, PDS, separate installation in the tunnel
- CFS status on CLIC/FCC/HL-LHC







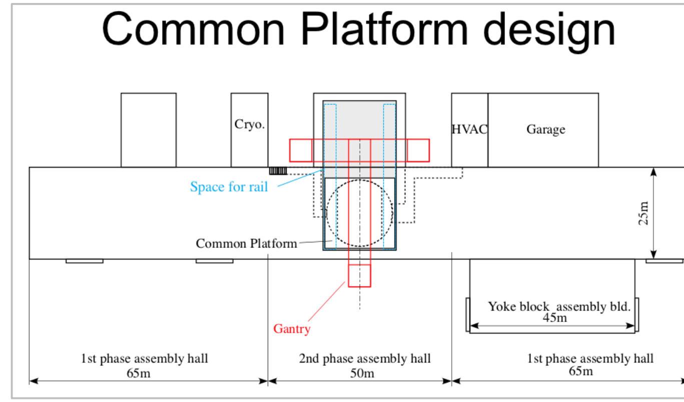


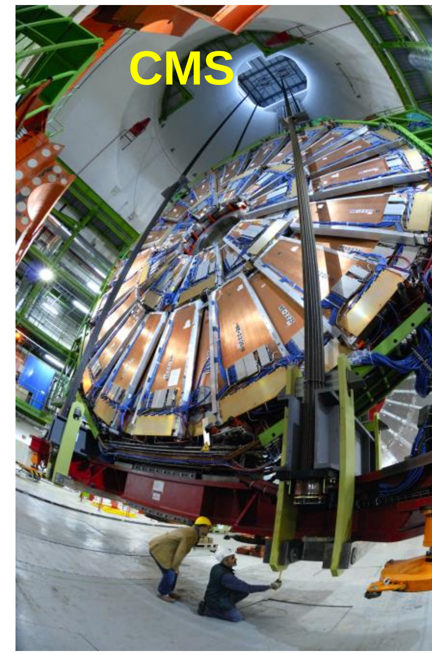


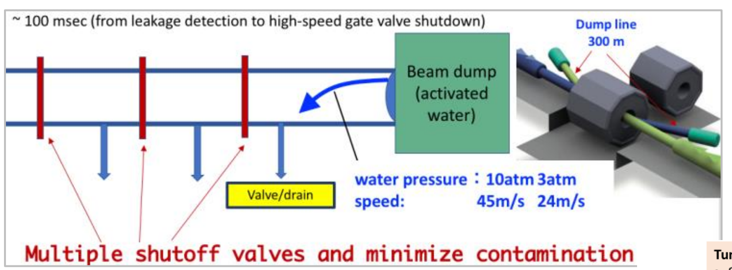
CFS

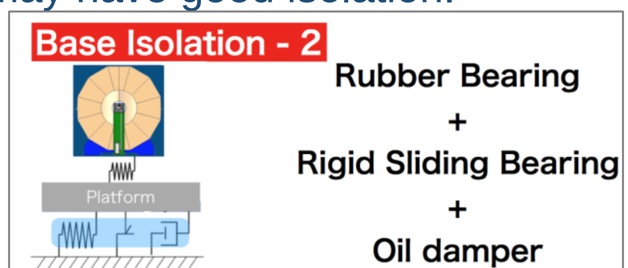
CFS Risks

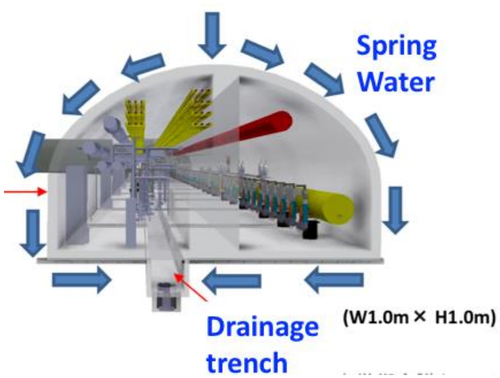
- CFS Risks at Sience-Council-Japan discussion
  (Radiation Safety, AC power black-out,
  Spring-water around tunnel,
  Environmental assessment)
- Gantry crane and Detector Platform
  Cost discussion and Risks during earthquake
- Experience of CMS Gantry crane
  CMS Detector lowering into the tunnel, how was it.
- Base isolation from big earthquake for Detector/Accelerator
  Rubber+rigid-sliding+damper may have good isolation.

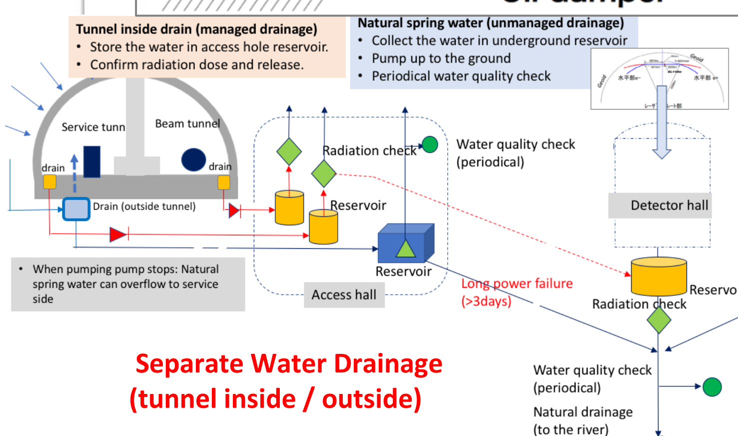












Separate Water Drainage
(tunnel inside / outside)

ATF2 & BD/RTML

ATF2 (Accelerator Test Facility 2) session: Focus on intensity dependent effects and extrapolations to ILC and CLIC

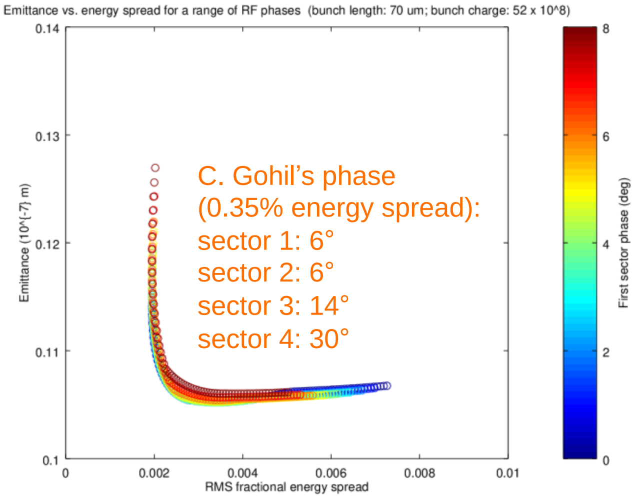
- A dedicated **Report on intensity dependence** is being written
- Progress in the **characterization and understanding of the effects of intensity dependence at ATF2 -**
- **Increasing confidence in the extrapolations to ILC BDS** – simulations of global mitigation strategies are reassuring

Beam Dynamics & RTML (Ring to Main Linac): Performance optimizations; design updates; super-short bunches for LC

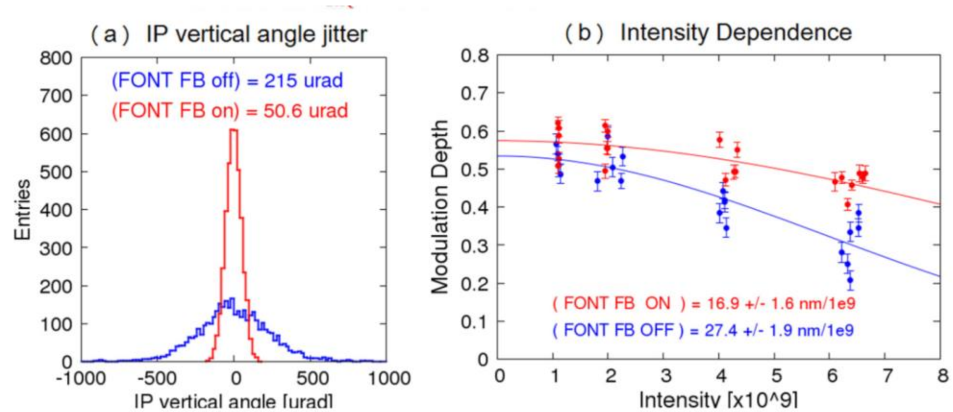
- **ILC 250 GeV CoM lattice decks** – being updated and completed of missing parts
- **LCLS-II Cryomodule performance** – exceeded requirements, e.g. gradients -
- **Stray fields in CLIC** – accurate modeling and countermeasures -
- **Beam performance optimization in CLIC Stage 380 GeV CoM** – energy spread and transverse stability -
- **Ultra-compressed low-power beam parameter options for a future LC** – Non-perturbative strong field QED with linear collider parameters -

Feedback On Nano-Second Timescales

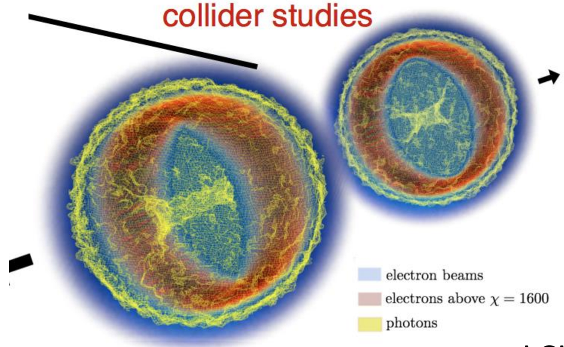
CLIC 380 GeV ML RF phase optimization for emittance and energy spread



IP angle jitter reduction with upstream FONT FB at ATF2



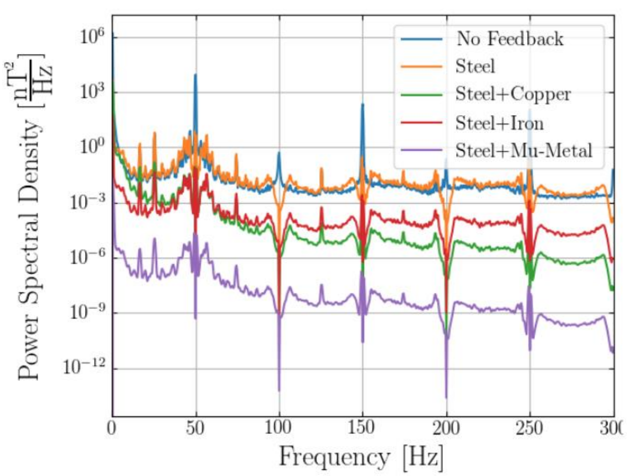
Future ~100GeV collider studies



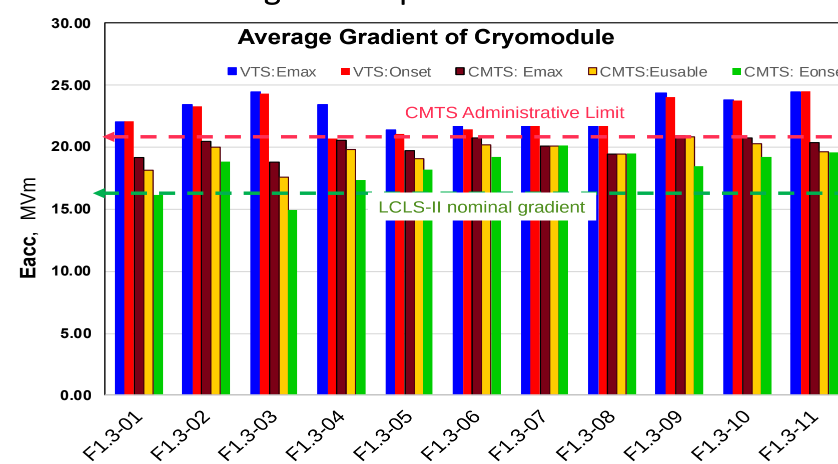
Ultra-short bunches push the limits of QED models

Simulation of spent beams after collision

Suppression of magnetic stray fields



LCLS-II CM gradient performance



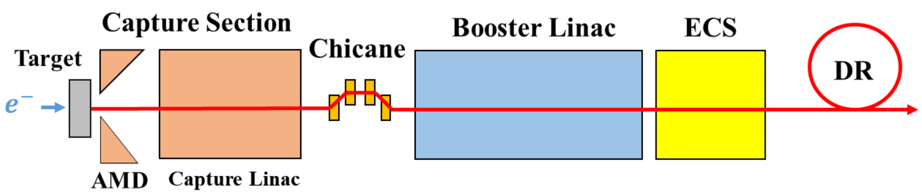
Source **W**orking **G**roup

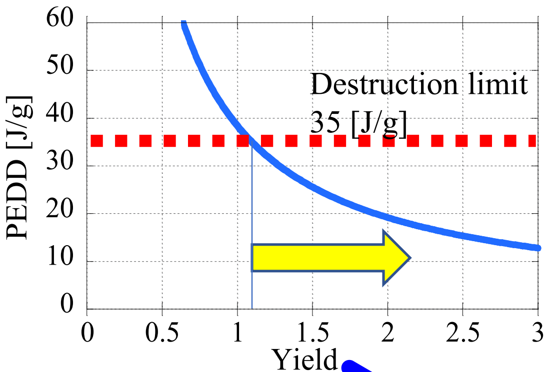
e^+ and e^- are sources changing the world.

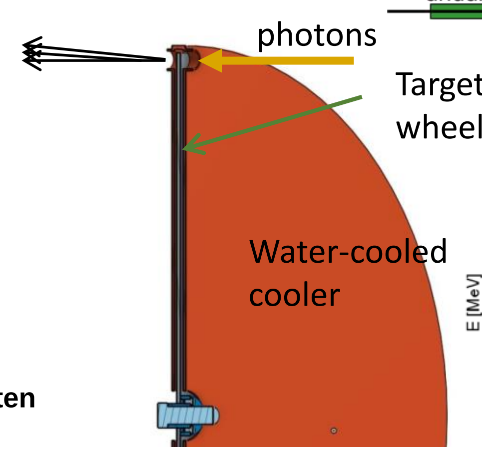
- 6 contributions for E-Driven Positron Source,
- 5 contributions for Undulator Positron Source.

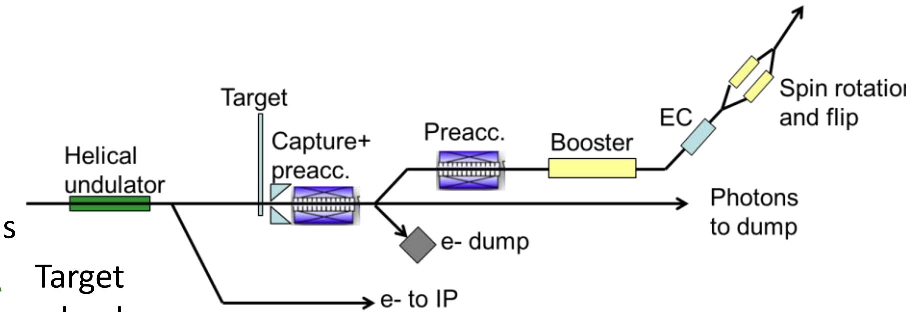
- E-Driven:
  - Confirmation that positrons can be generated without any damage on Target with a realistic AMD (Adiabatic Matching Device) field.
  - Study showing positron yield can be enhanced by improving AMD and solenoid field.
  - Report on the progress of the target prototype. The ferro-fluid seal shows an excellent performance corresponding to 4.0e-9 Pa at accelerator.
  - Estimate that the highest RF detuning of capture linac by beam loss is much less than bandwidth of RF structure determined by Q value.
  - Report that polarized positron can be generated with polarized E-driven method but with low efficiency. Application at ILC requires detailed studies and essential effort

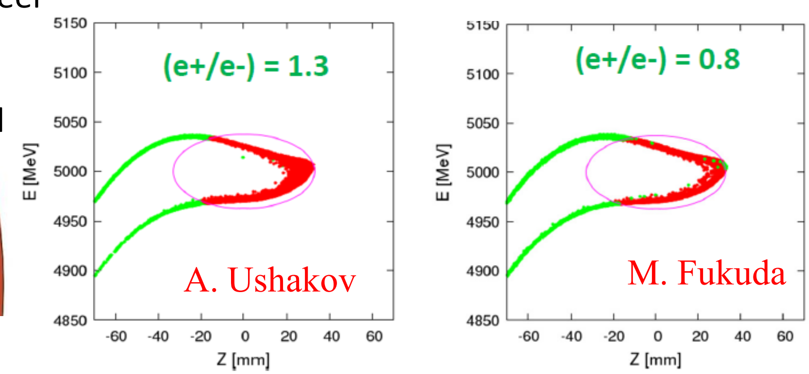
- Undulator
  - A summary of the status of R&D was presented. The stress on the target is manageable.
  - Report on the target damage test at MAMI. There was no significant damage on test pieces even for load exceeding that expected for the ILC.
  - Two independent studies of photon spectra from Undulator.
    - There is a discrepancy on positron yield between two studies - enough positron yield (>1.5) with QWT (quarter wave transformer) should be confirmed with a full tracking simulation.

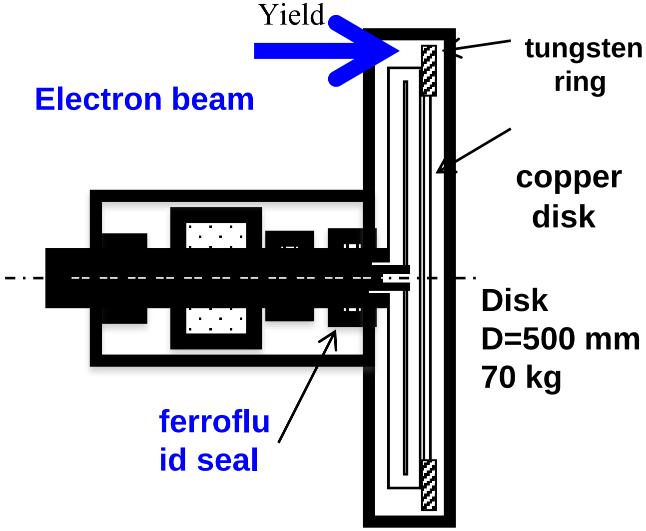


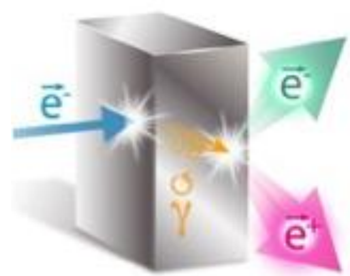












$$\vec{e}^- \to \vec{\gamma} \to \vec{e}^+ \ (+\vec{e}^-)$$

ILC Polarized E-Driven Positron source

E(e+)	N(e+)/N(e-)	<Sz>	P (%)
150 MeV	0.436	0.23	21
350 MeV	0.056	0.41	37

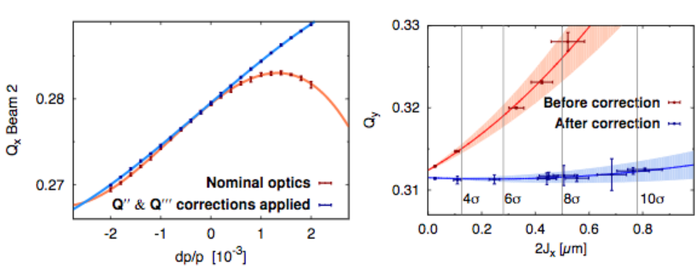
Damping Ring Session.

Focus: Updates, new ideas for low emittance rings and means to preserve it in practice (alignment, knobs for optics correction).

Key takeaways:

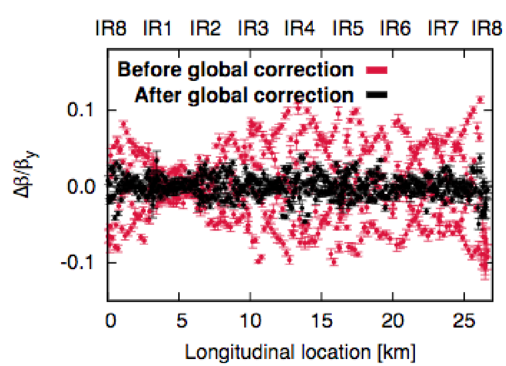
- ILC TDR optics were revisited. It was found that basic checks were okay, but some disagreement on the dynamic aperture. Bending magnet length changed from 3 to 5 m for reducing ε_x from 6 to 4 μm w/o deteriorating DA.
- A study was performed of achieving ultra low emittances ($\varepsilon_x \approx 0.1$ nm, $\varepsilon_y \approx 1$ pm, $\varepsilon_s \approx 5$ KeV m) in the CLIC damping ring using TME arcs and FODO straights with wigglers. Revisions: e- pre-DR eliminated, e+ pre-DR may be replaced by a booster. DRs getting reviewed for new baseline. SC wiggler prototype being tested at ANKA.

▪ LHC at injection had far larger nonlinear errors than expected



▪ Octupole/decapole correction improved nonlinear chromaticity, amplitude detuning, decoherence, and free DA

Measurement of nonlinear observables in the Large Hadron Collider using kicked beams; PRSTAB, 17, 081002



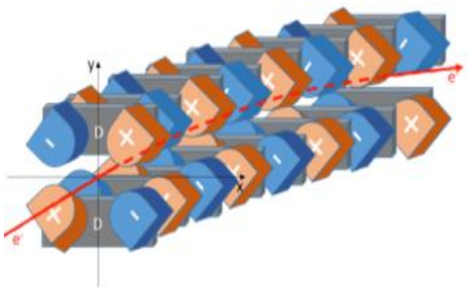
Record low β-beating in the LHC; PRSTAB 15, 091001

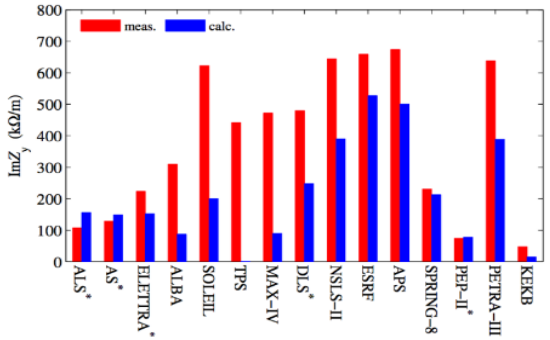
LHC optics commissioning: A journey towards 1% optic

- Methods for correcting LHC optics were shown. Measurements rely on a **AC dipole** and **turn-by-turn capable BPMs**. Beta-beating was corrected below the required 18%. Nonlinear octupole and decapole corrections for chromaticity.

Damping Ring Session – Key takeaways

- To minimize horizontal emittance, a “complex bend” was proposed with possibly SC magnets for strong focusing or by displacing the quads (more compact). A lattice for NSLS-II upgrade is being developed. It needs a special insertion for chromaticity correction.





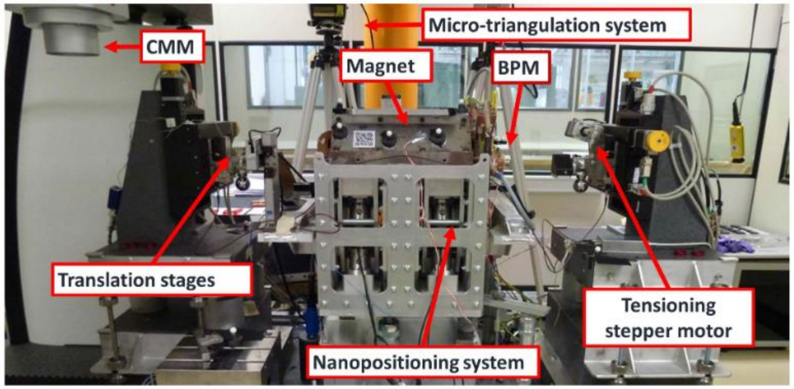
* Z_y is calculated using formula $Z_\perp(\omega) \approx \frac{2c}{b^2\omega} Z_\parallel(\omega)$

- It was shown that with proper instruments, numerical models of machine impedance can be inferred by measurements of beam parameters dependence on intensity. Results were shown for many rings. Reasons were suggested for differences between computation and measurements of machine impedance budget.

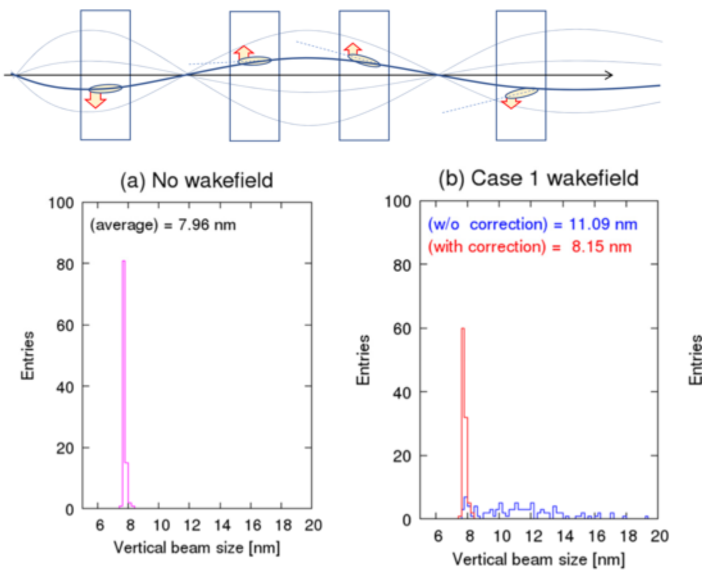
- Advanced Photon Source lattice upgrade aiming to ε_x =42 pm was described. APS results of on-line coupling and chromaticity correction resorting to “brute force” optimization were shown.

- At CLIC, nm beam size at the IP translates in very stringent alignment requirements for emittance preservation ($\approx 14 - 17\ \mu$m over 200 m). The fiducialization process for CLIC quad and cavity BPM was described using the stretched-wire measurement method.

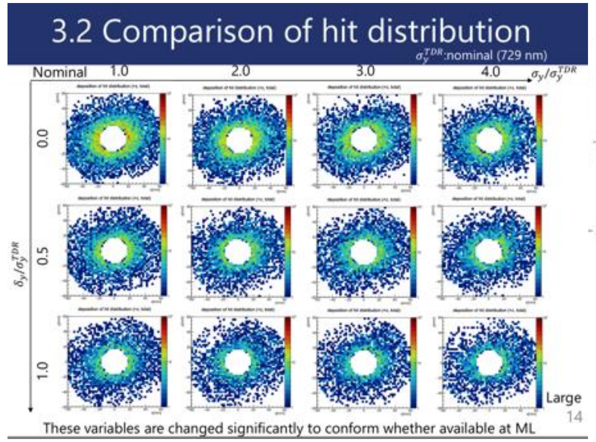
The prototype alignment



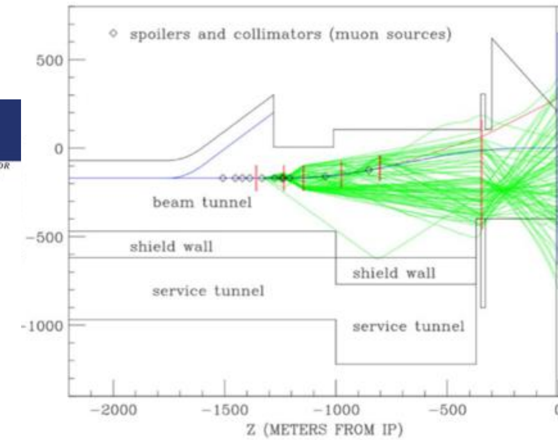
Beam Delivery Systems



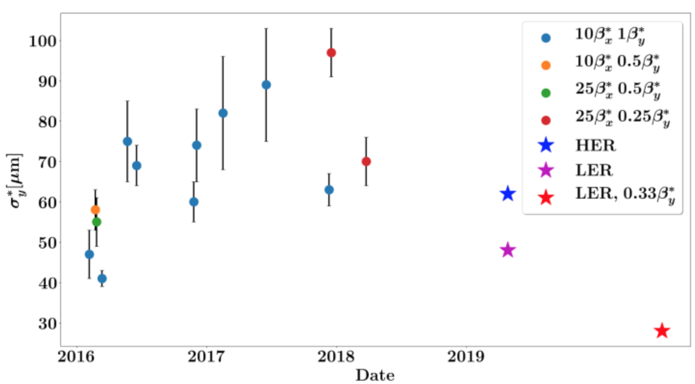
- Wakefields measured & mitigation procedures developed @ ATF2
- Applied to ILC in simulation -> expect 2.4% effect on luminosity



- Machine learning applied to beam parameter reconstruction of ILC beam collision parameters
- Early work shows promise- will be developed further

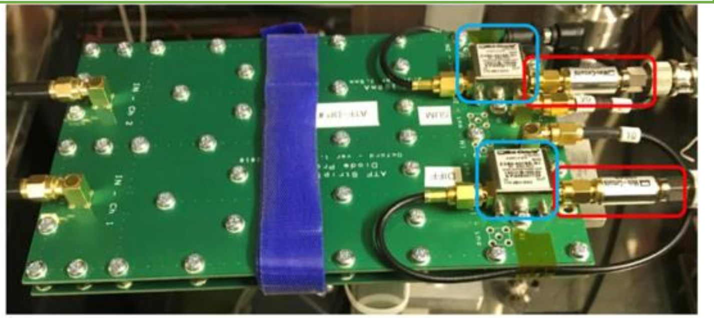


- Muon rates from halo interception in ILC collimation system studied
- Rates low enough that “muon wall” may not be initially required
  - need to consider other background processes carefully

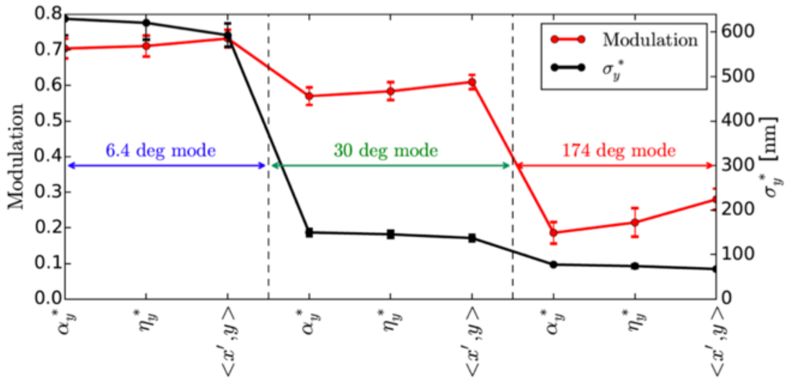


- SuperKEKB has similar FFS optics requirements to ILC & ATF2
- Lots to learn from SuperKEKB tuning -> now looking at β^* measurements

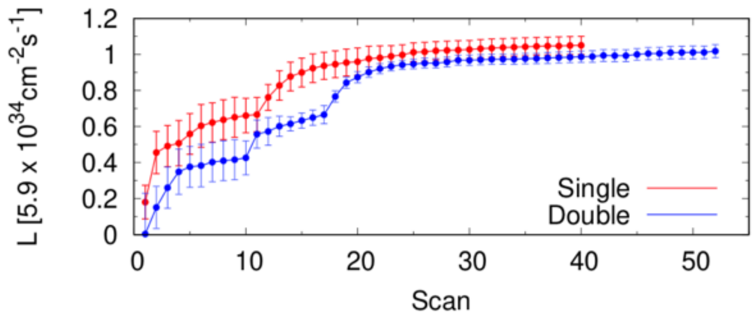
- BPM processing electronics demonstrated @ ATF2
- Capable of ~1ns latency for CLIC, resolution = 325 nm
- Suitable for IP intra-train feedback



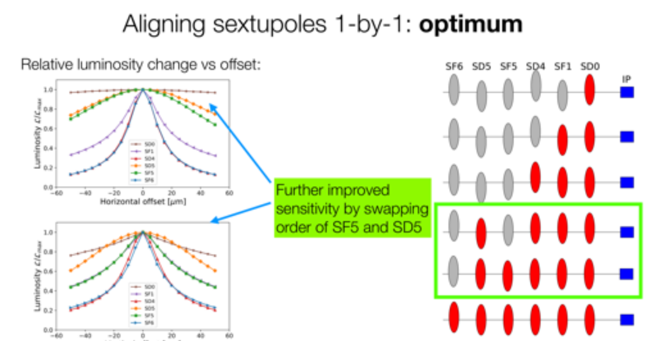
Beam Delivery Systems



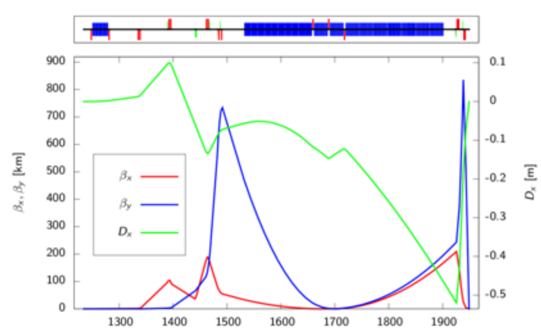
- Study of optics @ ATF2 to reach CLIC-level FFS (final focus system) chromaticity under way
- Ongoing effort to understand systematics and reduce beam size <60 nm - level



- CLIC tuning simulations with static & dynamic show 90% cases > 97% lumi
- Work towards improving realism, reducing tuning time

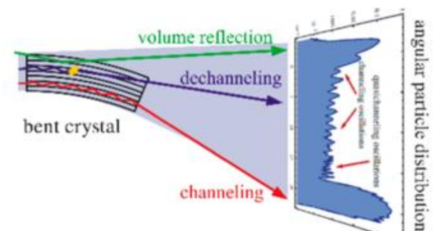


- Improved tuning performance by optimized sextupole alignment



	β_x^* [mm]	β_y^* [μm]	D_x^* [m]	α_x^*	α_y^*
Nominal	8.0	100.0	0.0	-0.005	-0.021
Reduced β_y^*	8.0	70.0	0.0	0.0	0.0

- Smaller IP beta-function studied for L*=6m CLIC optics to reduce non-linear aberration contribution
- Work ongoing to optimize energy bandwidth



- Crystal focusing system considered
- High order aberrations currently significantly limit available luminosity


WOOD FIRST for ILC-related facilities building
ECONOMIC RIPPLE EFFECT BY UTILIZING LOCAL WOOD IN THE CONSTRUCTION OF WOODEN DETECTOR PREPARATION BUILDING FOR THE ILC EXPERIMENT
Hiroyuki Adachi A), Masakazu Yoshioka B), Noboru Sekino B), Shinya Narita B), Hisashi Odaira C)
A) Shelter Co.,Ltd.
B) Iwate University
C) Iwate Prefectural Office
Shelter
Shelter Co.,Ltd.
岩手県
Iwate Prefecture
Iwate University
5. 超高装（中山）科技有限公司
ChaoGao Zhuang (zhongshan) Scientific Technology Co., Ltd.
1.3G SC cavities
CEPC Industrial Pr
6. CEPC18KW@4K Cryogenics and system:
Aims to promote the industrial application of cryogenic technologies coming from TIPC
TIPC
FUHO Capital
Professional Team
Founded in August 2016 with a registered capital of RMB 131 million.
High-tech company based on the cryo-technologies coming from TIPC, CAS
Focus on Cryogenic Engineering
CEPC Industrial Promotion Consortium (CIPC)
INEUSTAR, THE SPANISH SCIENCE INDUSTRY ASSOCIATION:
A PRIVATE AND COLLECTIVE PROMOTION TOOL
Arlington, TX
October 24th, 2018
Business Overview in support of SRF Cavity Capability
ROARK
C.F. Roark Welding & Engineering Co., Inc.
LCWS 2018
Arlington, Texas
Industry Session
Nor-Cal Products, Inc.
Where Technology Takes Shape
North American Experience Working with Labs
Nor-Cal Products
by PFEIFFER VACUUM
CONFIDENTIAL
SIGMAPHI
ACCELERATOR TECHNOLOGIES
LCWS 2018
UNIVERSITY OF TEXAS ARLINGTON
French industry for Large Research Infrastructures
The SIGMAPHI example
Dr Matthieu CAVELLIER – Sigmaphi
Companies in Iwate involved in the accelerator industry
Vertical electropolishing
WING. CO. LTD
Higashi-nihon kidenkaihatsu, Ltd.
Cavities
PROFIT Co., Ltd.
Pulse power supplies
P&A Technologies Inc.
Takizawa
Morioka
Oshu
Candidate site for the ILC
Magnets
Suzuki Kikai Co., Ltd.
Sun Ai Inc.
KAMAISHI electrical machinery factory Co.,Ltd
Active Movers
NEC Platforms, Ltd.
IWATE IRON CO, LTD
Tohotechnos Co., Ltd.
Iwate Industrial Research Institute
MILHOUS COMPANY
LCWS 2018
Industry Session
Joel Meissner

Industry Session - Takeaways

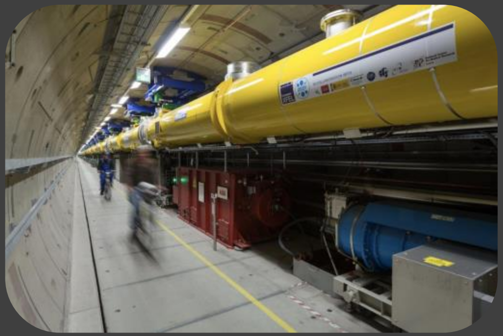
ILC does include numerous challenges for technological industry

Despite explicit funding for ILC being constrained, there are extensive activities in all regions fairly directly related to eventual ILC construction—cost reduction through performance improvement—based on ubiquitous use of SRF technology

Interactions between (scientific) clients and industry demands excellent communications and frequent understanding of goals on both sides

In several countries, organizations encouraging interactions between individual companies prove to be beneficial

Also (in several countries) strong encouragement from labs is bringing industry along at an enormous rate (China)



Overall Takeaways from Accelerator Sessions

ILC accelerator technology is **ready for implementation** at the large scale required

Technology for ILC is settled, now exploring some tweaks to reduce costs (with promising results). **Consistency of overall plan** since TDR (and before) shows the strength of the proposal

Long term SRF R&D is underway for cost reduction on the timescale appropriate for a future upgrade beyond 250 GeV

Success of current linear accelerator projects bring confidence as we look forward to scaling up to ILC and CLIC

LCWS accelerator sessions showcase **sophistication of accelerator expertise worldwide** – crucial that these skills exist in all regions for large "international-scale" accelerator projects