Summary of NCRF

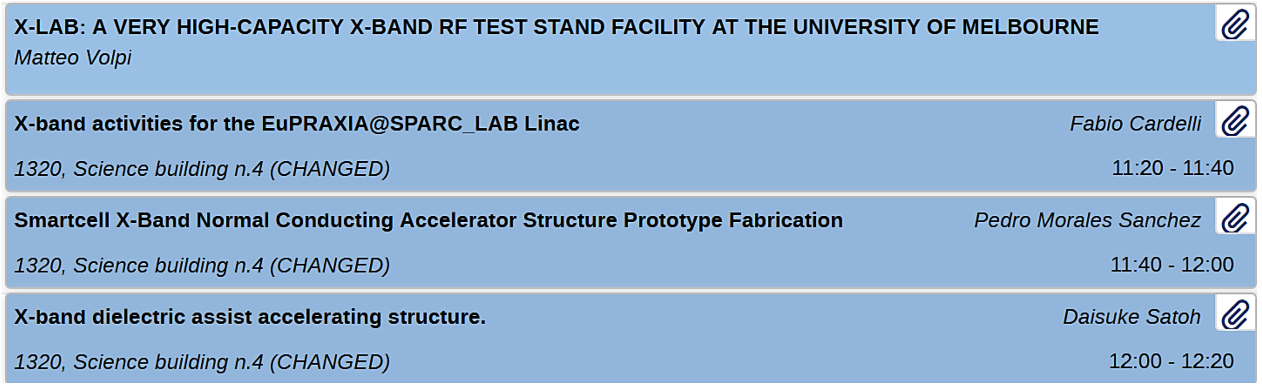
Conveners

Normal conducting RF
Tetsuo Abe (KEK)
Walter Wuensch (CERN)
Ankur Dhar (SLAC)
Evgenya Simakov (LANL)
David Alesini (INFN-LNF)

The 2024 International Workshop on Future Linear Colliders (LCWS2024)

on July 11th, 2024 at the University of Tokyo, Japan

16 presentations in NCRF

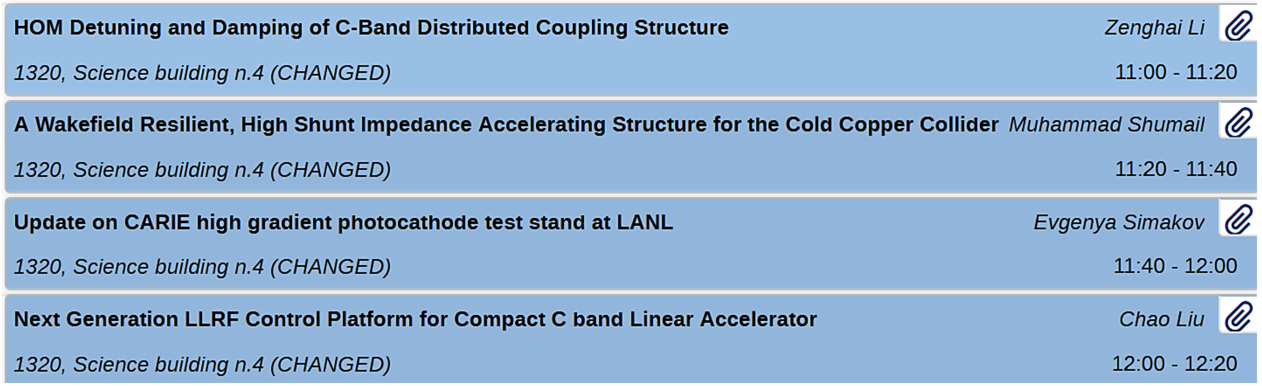


X-LAB: A VERY HIGH-CAPACITY X-BAND RF TEST STAND FACILITY AT THE UNIVERSITY OF MELBOURNE
Matteo Volpi

X-band activities for the EuPRAXIA@SPARC_LAB Linac *Fabio Cardelli*
1320, Science building n.4 (CHANGED) 11:20 - 11:40

Smartcell X-Band Normal Conducting Accelerator Structure Prototype Fabrication *Pedro Morales Sanchez*
1320, Science building n.4 (CHANGED) 11:40 - 12:00

X-band dielectric assist accelerating structure. *Daisuke Satoh*
1320, Science building n.4 (CHANGED) 12:00 - 12:20

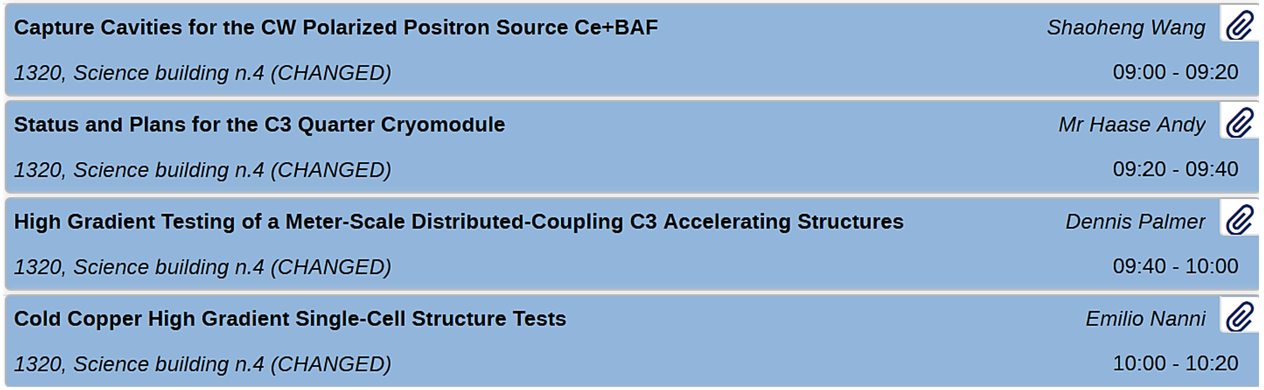


HOM Detuning and Damping of C-Band Distributed Coupling Structure *Zenghai Li*
1320, Science building n.4 (CHANGED) 11:00 - 11:20

A Wakefield Resilient, High Shunt Impedance Accelerating Structure for the Cold Copper Collider *Muhammad Shumail*
1320, Science building n.4 (CHANGED) 11:20 - 11:40

Update on CARIE high gradient photocathode test stand at LANL *Evgenya Simakov*
1320, Science building n.4 (CHANGED) 11:40 - 12:00

Next Generation LLRF Control Platform for Compact C band Linear Accelerator *Chao Liu*
1320, Science building n.4 (CHANGED) 12:00 - 12:20



Capture Cavities for the CW Polarized Positron Source Ce+BAF *Shaoheng Wang*
1320, Science building n.4 (CHANGED) 09:00 - 09:20

Status and Plans for the C3 Quarter Cryomodule *Mr Haase Andy*
1320, Science building n.4 (CHANGED) 09:20 - 09:40

High Gradient Testing of a Meter-Scale Distributed-Coupling C3 Accelerating Structures *Dennis Palmer*
1320, Science building n.4 (CHANGED) 09:40 - 10:00

Cold Copper High Gradient Single-Cell Structure Tests *Emilio Nanni*
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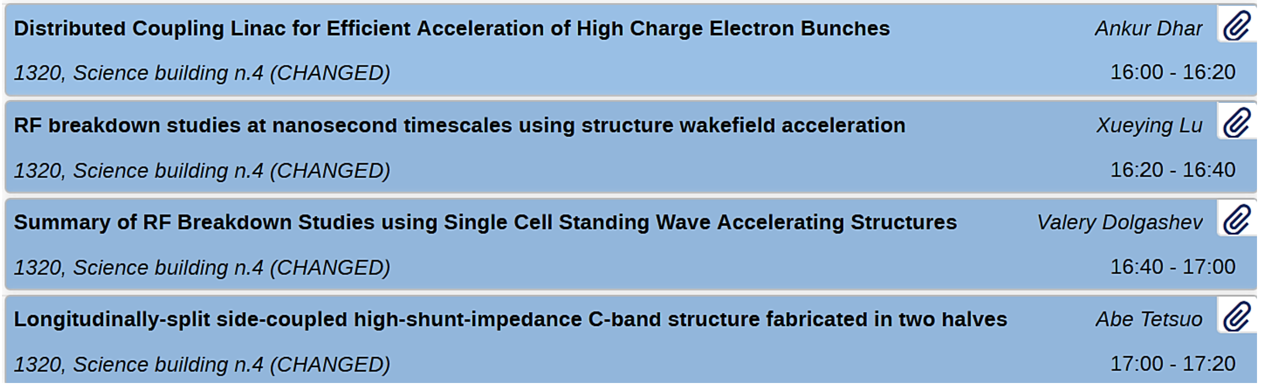


Distributed Coupling Linac for Efficient Acceleration of High Charge Electron Bunches *Ankur Dhar*
1320, Science building n.4 (CHANGED) 16:00 - 16:20

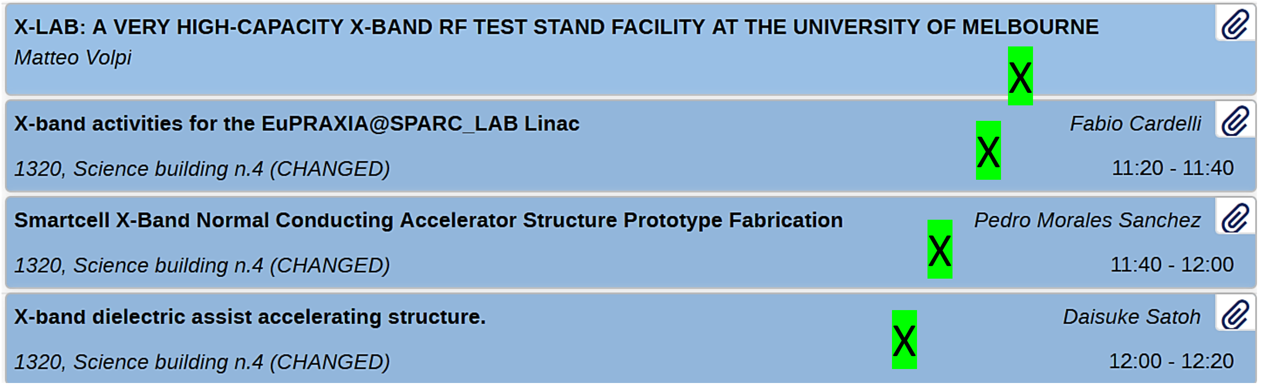
RF breakdown studies at nanosecond timescales using structure wakefield acceleration *Xueying Lu*
1320, Science building n.4 (CHANGED) 16:20 - 16:40

Summary of RF Breakdown Studies using Single Cell Standing Wave Accelerating Structures *Valery Dolgashev*
1320, Science building n.4 (CHANGED) 16:40 - 17:00

Longitudinally-split side-coupled high-shunt-impedance C-band structure fabricated in two halves *Abe Tetsuo*
1320, Science building n.4 (CHANGED) 17:00 - 17:20

16 presentations in NCRF

C-band: 8 **X-band: 6** **L-band: 1** **S-band: 1**



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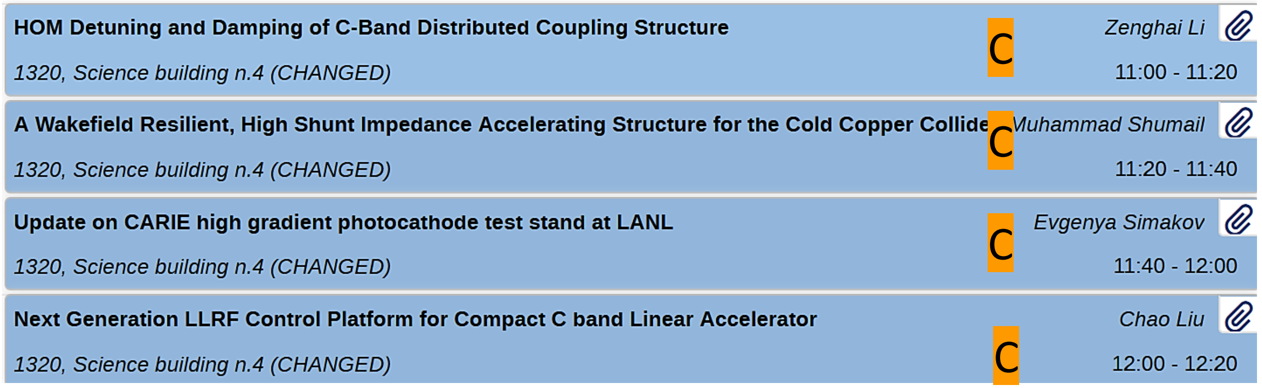

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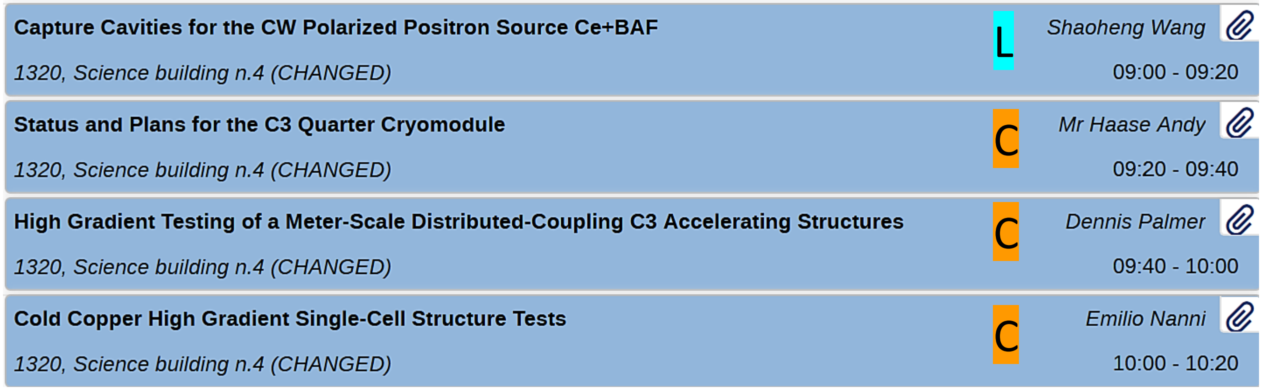

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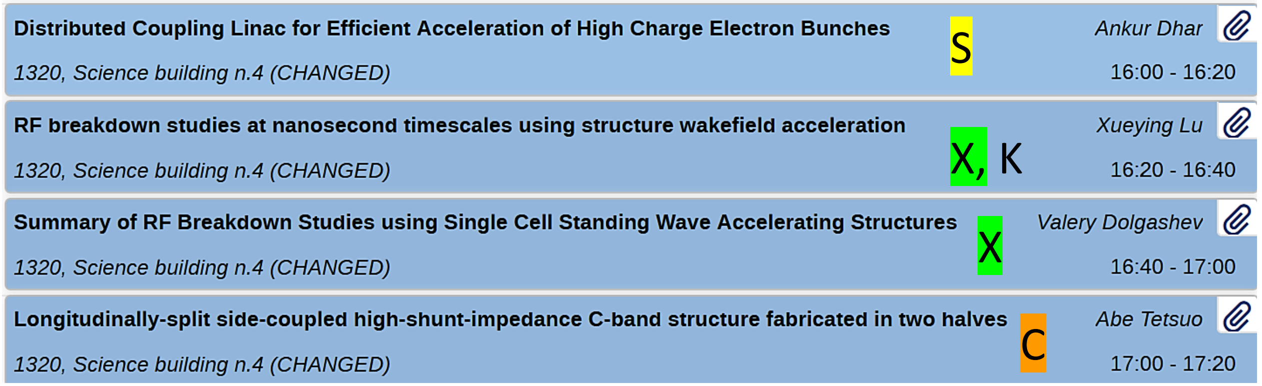

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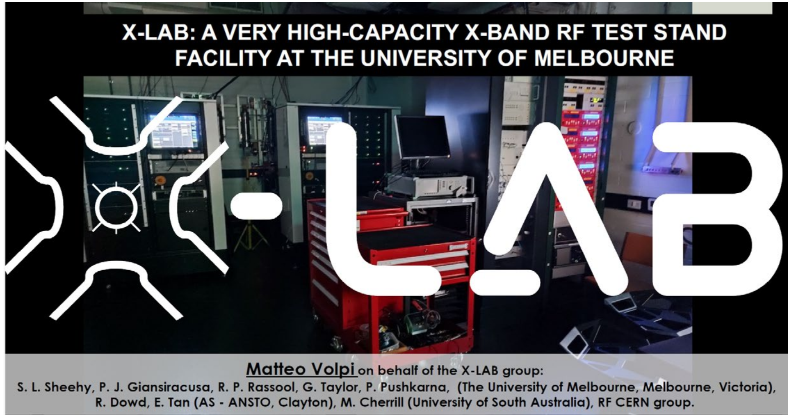
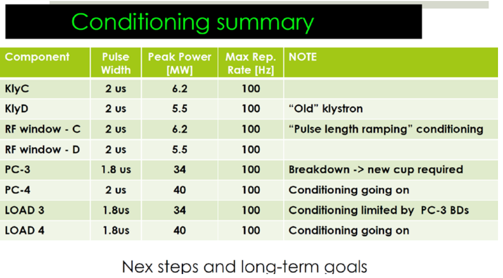
Updates of the High-power test facilities

X



X-LAB: A VERY HIGH-CAPACITY X-BAND RF TEST STAND FACILITY AT THE UNIVERSITY OF MELBOURNE

Matteo Volpi on behalf of the X-LAB group:
S. L. Sheehy, P. J. Giansiracusa, R. P. Rassool, G. Taylor, P. Pushkarna, (The University of Melbourne, Melbourne, Victoria), R. Dowd, E. Tan (AS - ANSTO, Clayton), M. Cherrill (University of South Australia), RF CERN group.

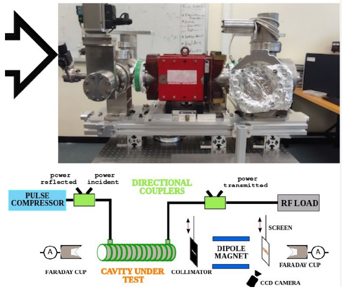


Conditioning summary

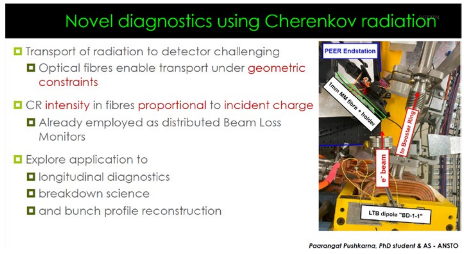
Component	Pulse Width	Peak Power [MW]	Max Rep. Rate [Hz]	NOTE
KlyC	2 us	6.2	100	
KlyD	2 us	5.5	100	“Old” klystron
RF window - C	2 us	6.2	100	“Pulse length ramping” conditioning
RF window - D	2 us	5.5	100	
PC-3	1.8 us	34	100	Breakdown -> new cup required
PC-4	2 us	40	100	Conditioning going on
LOAD 3	1.8us	34	100	Conditioning limited by PC-3 BDs
LOAD 4	1.8us	40	100	Conditioning going on

Nex steps and long-term goals

Started the reassembling in MELBOURNE



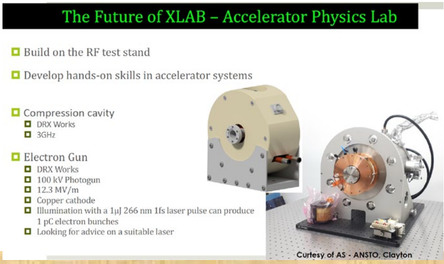
- ✓ Has been constructing and commissioning an X-band test facility.
- ✓ Various components have been conditioned.
- ✓ Also developing beam diagnostic systems.
- ✓ So that they will develop the facility to an accelerator physics lab.



Novel diagnostics using Cherenkov radiation

- ☐ Transport of radiation to detector challenging
  - ☐ Optical fibres enable transport under geometric constraints
- ☐ CR intensity in fibres proportional to incident charge
  - ☐ Already employed as distributed Beam Loss Monitors
- ☐ Explore application to
  - ☐ longitudinal diagnostics
  - ☐ breakdown science
  - ☐ and bunch profile reconstruction

Paarangat Pushkarna, PhD student & AS - ANSTO

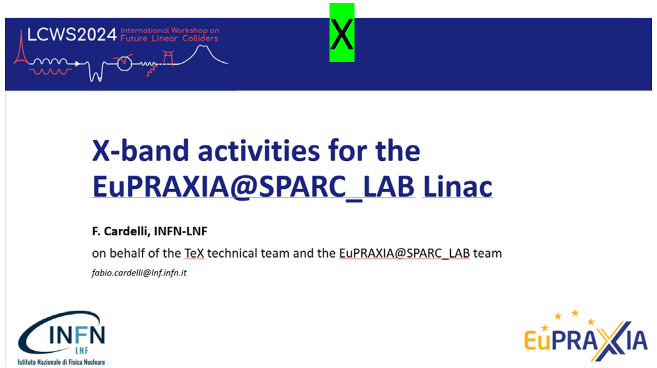


The Future of XLAB – Accelerator Physics Lab

- ☐ Build on the RF test stand
- ☐ Develop hands-on skills in accelerator systems
- ☐ Compression cavity
  - ☐ DRX Works
  - ☐ 3GHz
- ☐ Electron Gun
  - ☐ DRX Works
  - ☐ 100 kV Photogun
  - ☐ 12.3 MV/m
  - ☐ Copper cathode
  - ☐ Illumination with a 1μJ 266 nm 1fs laser pulse can produce 1 pC electron bunches
  - ☐ Looking for advice on a suitable laser

Curtesy of AS - ANSTO, Clayton

X



LCWS2024 International Workshop on Future Linear Colliders

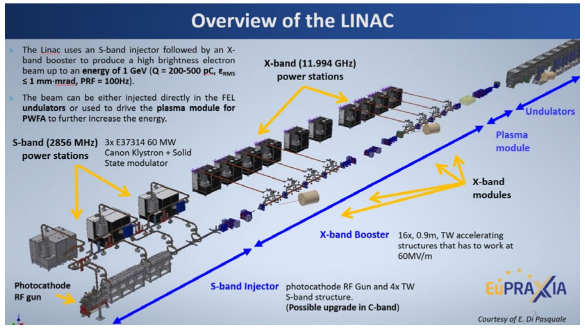
X-band activities for the EuPRAXIA@SPARC_LAB Linac

F. Cardelli, INFN-LNF

on behalf of the TeX technical team and the EuPRAXIA@SPARC_LAB team

fabio.cardelli@lnf.infn.it

- ✓ Has been developing an X-band test facility.
- ✓ Various components fabricated, purchased, and HP tested.
- ✓ 20 cells structure under high power testing
- ✓ A full-scale 0.9m prototype for high power test in production



Overview of the LINAC

- » The Linac uses an S-band injector followed by an X-band booster to produce a high brightness electron beam up to an **energy of 1 GeV (Q = 200-500 pC, $\varepsilon_{RMS} \leq 1$ mm·mrad, PRF = 100Hz)**.
- » The beam can be either injected directly in the FEL **undulators** or used to drive the **plasma module for PWFA** to further increase the energy.

Courtesy of E. Di Pasquale

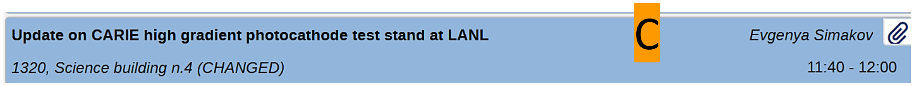
Full-Scale Mechanical Prototype Brazing

2x Full scale mechanical prototype for brazing optimization and test

To maintain the alignment and cell to cell straightness during and after the brazing process, **each cell is fixed to the next one by means of screws** and mounted on a very precise **granite support**. This ease also the cells assembly

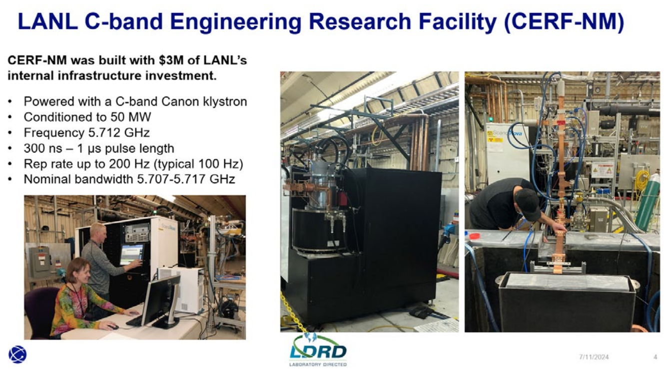
Results on the brazed structure

- **Vacuum test OK** (except one coupler for a miss-positioning of the brazing alloy)
- **Straightness <±15 μm** obtained after brazing on both the prototypes (±30 μm required by BD)



Update on CARIE high gradient photocathode test stand at LANL C *Evgenya Simakov*

1320, Science building n.4 (CHANGED) 11:40 - 12:00



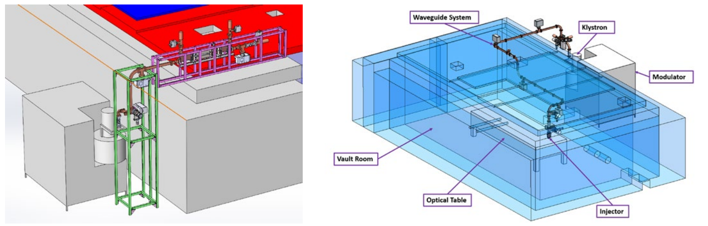
LANL C-band Engineering Research Facility (CERF-NM)

CERF-NM was built with $3M of LANL’s internal infrastructure investment.

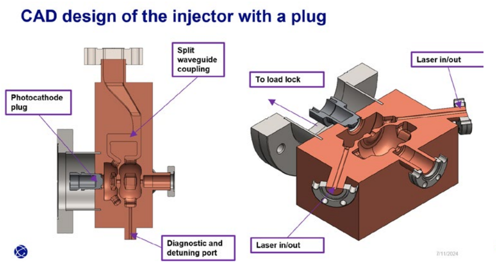
- Powered with a C-band Canon klystron
- Conditioned to 50 MW
- Frequency 5.712 GHz
- 300 ns – 1 μs pulse length
- Rep rate up to 200 Hz (typical 100 Hz)
- Nominal bandwidth 5.707-5.717 GHz

LDRD LABORATORY DIRECTED

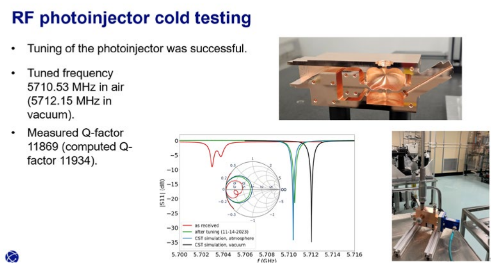
7/11/2024 4



- ✓ Has been developing an C-band test facility
- ✓ To build a HG RF breakdown study facility
- ✓ To build a cryo-cooled photoinjector study facility
- ✓ To conduct material studies
- ✓ To demonstrate high-quantum-efficiency cathodes in a HG RF injector



CAD design of the injector with a plug



RF photoinjector cold testing

- Tuning of the photoinjector was successful.
- Tuned frequency 5710.53 MHz in air (5712.15 MHz in vacuum).
- Measured Q-factor 11869 (computed Q-factor 11934).

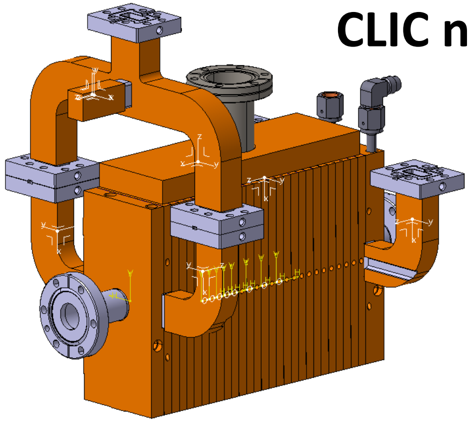
(Other test facilities not included this time: X-box at CERN, XTA at SLAC, Nextef2 at KEK, etc.)

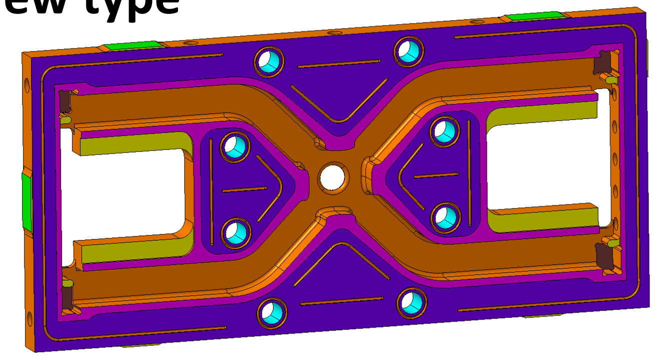
Structure fabrication


Smartcell X-Band Normal Conducting Accelerator Structure Prototype Fabrication *Pedro Morales Sanchez*

1320, Science building n.4 (CHANGED) 11:40 - 12:00

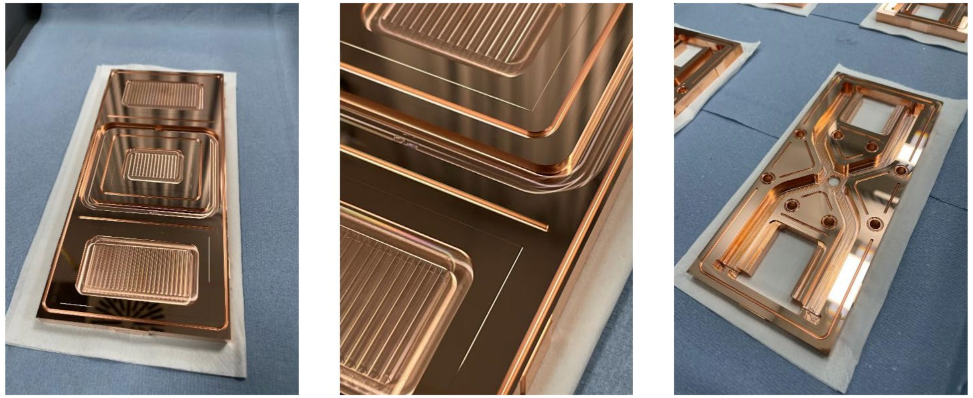
CLIC new type



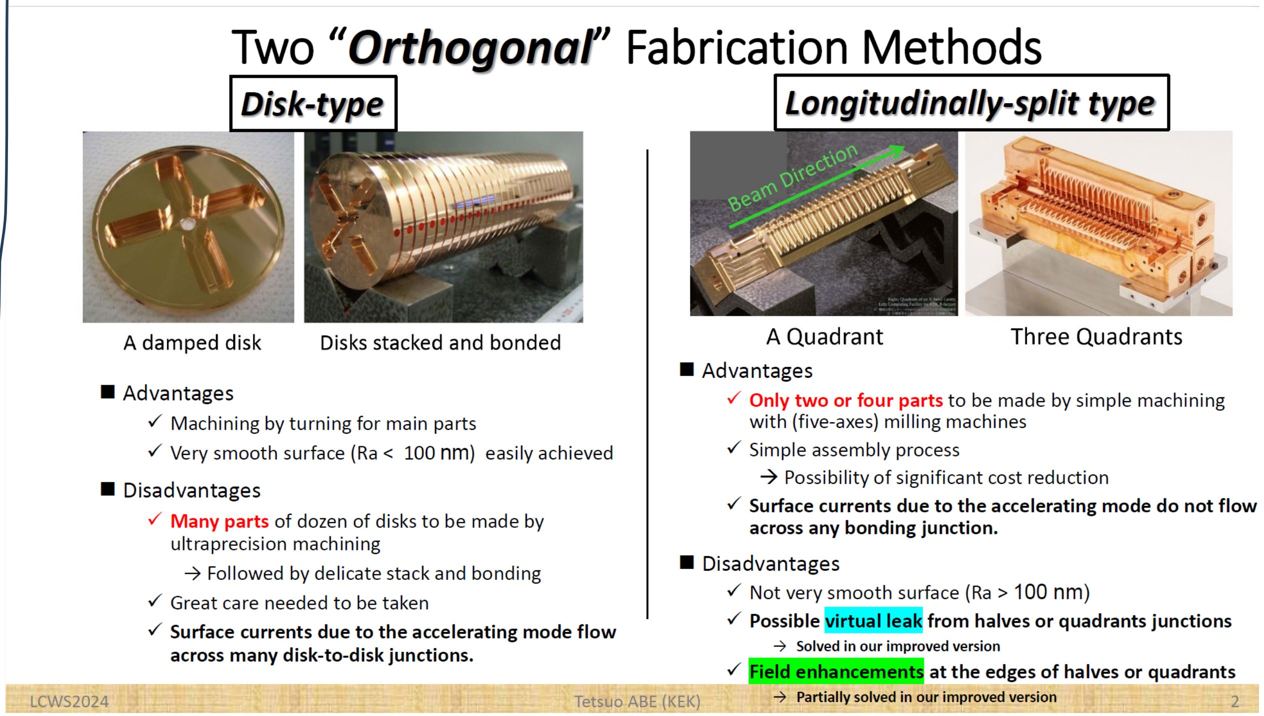


- ✓ New type of CLIC accelerating structure: smartcell
- ✓ The production of a full prototype is ongoing together with a deep analysis about the bonding technique.
- ✓ The prototype production will start before the end of the year

Brazing Mock-up



- Pre-machining done at CERN by MME, metrology OK.
- All cells with UP-Machining at external company.



Two "***Orthogonal***" Fabrication Methods

Disk-type

A damped disk

Disks stacked and bonded

- Advantages
  - ✓ Machining by turning for main parts
  - ✓ Very smooth surface (Ra < 100 nm) easily achieved
- Disadvantages
  - ✓ Many parts of dozen of disks to be made by ultraprecision machining
    - → Followed by delicate stack and bonding
  - ✓ Great care needed to be taken
  - ✓ **Surface currents due to the accelerating mode flow across many disk-to-disk junctions.**

Longitudinally-split type

A Quadrant

Three Quadrants

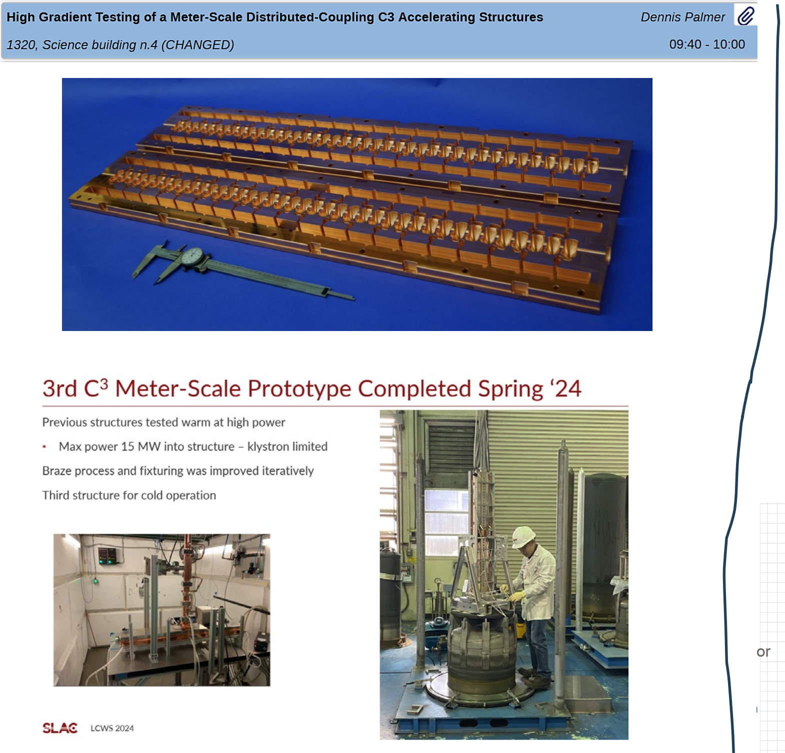
- Advantages
  - ✓ Only two or four parts to be made by simple machining with (five-axes) milling machines
  - ✓ Simple assembly process
    - → Possibility of significant cost reduction
  - ✓ **Surface currents due to the accelerating mode do not flow across any bonding junction.**
- Disadvantages
  - ✓ Not very smooth surface (Ra > 100 nm)
  - ✓ **Possible virtual leak from halves or quadrants junctions**
    - → **Solved in our improved version**
  - ✓ **Field enhancements at the edges of halves or quadrants**
    - → **Partially solved in our improved version**

LCWS2024 Tetsuo ABE (KEK) 2

Application to Compact Medical Linac (C-band: 5.71 GHz)

- ✓ Relatively new fabrication method: split-type
- ✓ Adopted in the C3 accelerating structure fabrication
- ✓ Mentioned later

Various developments for C^3 (hardware)



High Gradient Testing of a Meter-Scale Distributed-Coupling C3 Accelerating Structures *Dennis Palmer*

1320, Science building n.4 (CHANGED) 09:40 - 10:00

3rd C^3 Meter-Scale Prototype Completed Spring '24

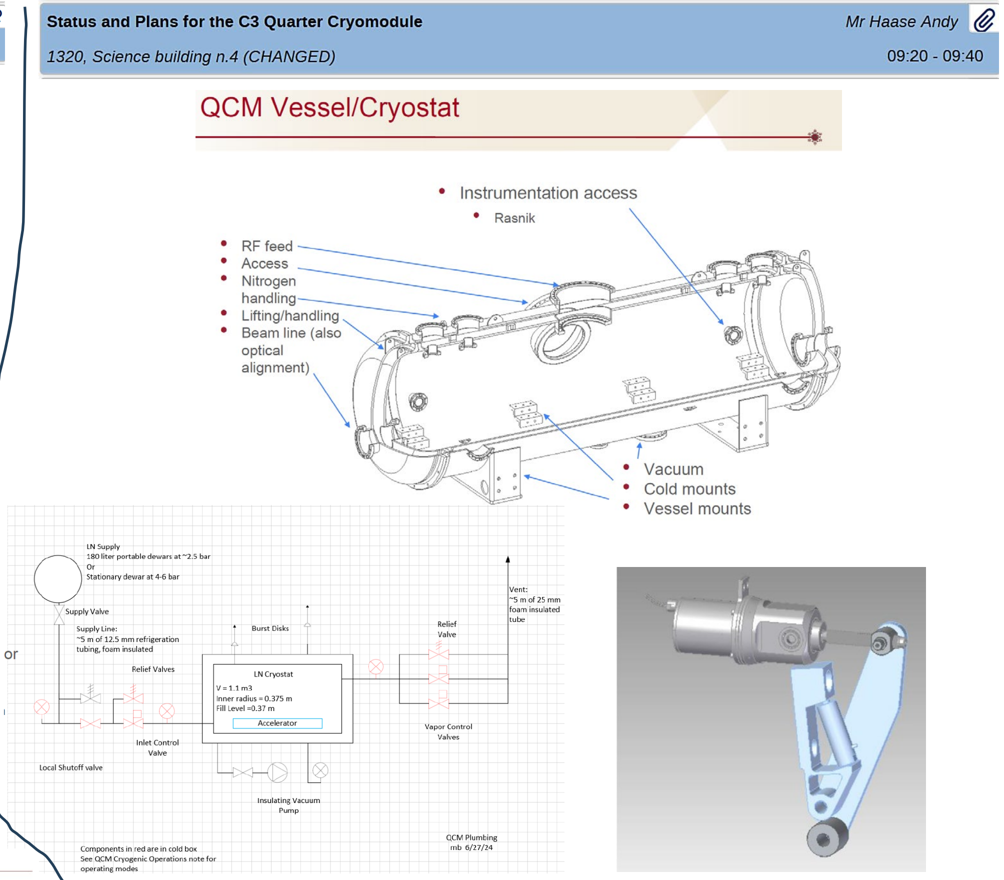
Previous structures tested warm at high power

- Max power 15 MW into structure – klystron limited

Braze process and fixturing was improved iteratively

Third structure for cold operation

SLAC LCWS 2024

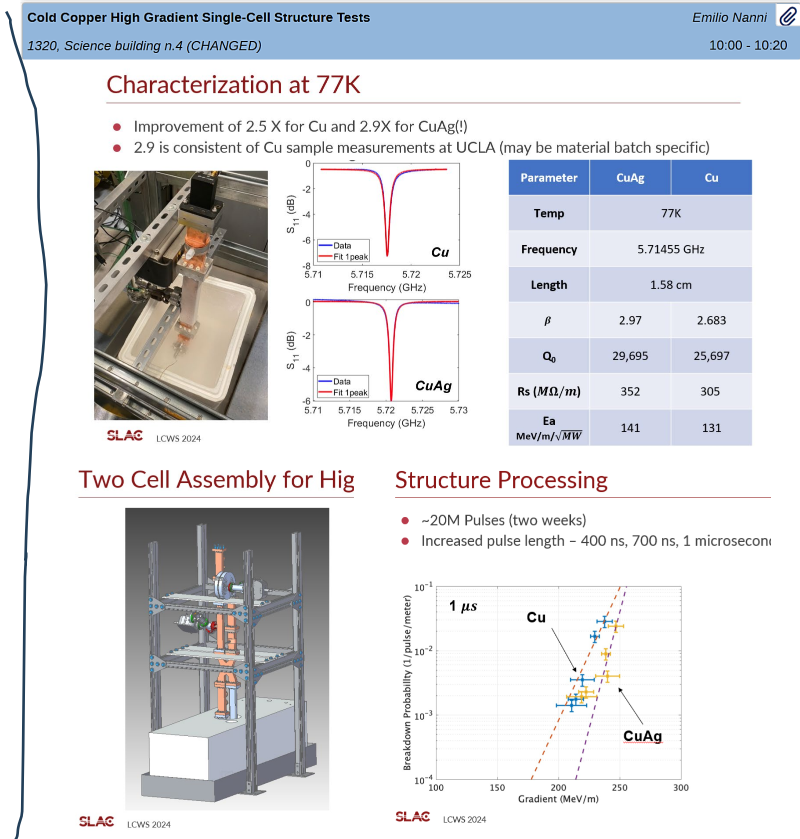


Status and Plans for the C3 Quarter Cryomodule *Mr Haase Andy*

1320, Science building n.4 (CHANGED) 09:20 - 09:40

QCM Vessel/Cryostat

- Instrumentation access
  - Rasnik
- RF feed
- Access
- Nitrogen handling
- Lifting/handling
- Beam line (also optical alignment)
- Vacuum
- Cold mounts
- Vessel mounts



Cold Copper High Gradient Single-Cell Structure Tests *Emilio Nanni*

1320, Science building n.4 (CHANGED) 10:00 - 10:20

Characterization at 77K

- Improvement of 2.5 X for Cu and 2.9X for CuAg(!)
- 2.9 is consistent of Cu sample measurements at UCLA (may be material batch specific)

Parameter	CuAg	Cu
Temp	77K	
Frequency	5.71455 GHz	
Length	1.58 cm	
β	2.97	2.683
Q_0	29,695	25,697
Rs ($M\Omega/m$)	352	305
Ea MeV/m/$\sqrt{MW}$	141	131

SLAC LCWS 2024

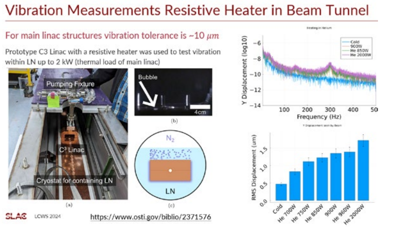
Two Cell Assembly for Hig

SLAC LCWS 2024

Structure Processing

- ~20M Pulses (two weeks)
- Increased pulse length – 400 ns, 700 ns, 1 microsecon

SLAC LCWS 2024



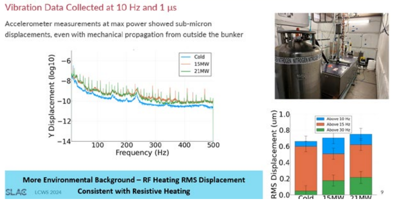
Vibration Measurements Resistive Heater in Beam Tunnel

For main linac structures vibration tolerance is ~10 μm

Prototype C3 Linac with a resistive heater was used to test vibration within LN up to 2 kW (thermal load of main linac)

SLAC LCWS 2024 https://www.osti.gov/biblio/2371576

Vibration Measurements with RF Heating



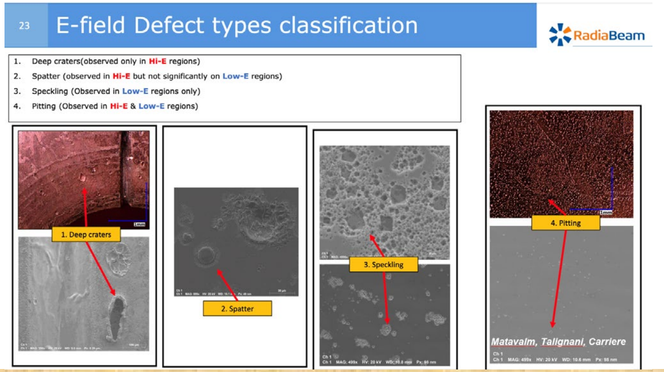
Vibration Data Collected at 10 Hz and 1 µs

Accelerometer measurements at max power showed sub-micron displacements, even with mechanical propagation from outside the bunker

More Environmental Background – RF Heating RMS Displacement Consistent with Resistive Heating

SLAC LCWS 2024 9

- ✓ Hardware developments for C3 have been performed vigorously.
- ✓ Fabricated full-scale accelerating structures based on the DC scheme, and perform LP/HP RF tests.
- ✓ Measured vibrations due to bubbling in LN
- ✓ Designing the Quarter Cryomodule is on-going .
- ✓ HPT of single-cell DCS is also on-going at Los Alamos at LN temperature together with microscopic investigations



E-field Defect types classification

23

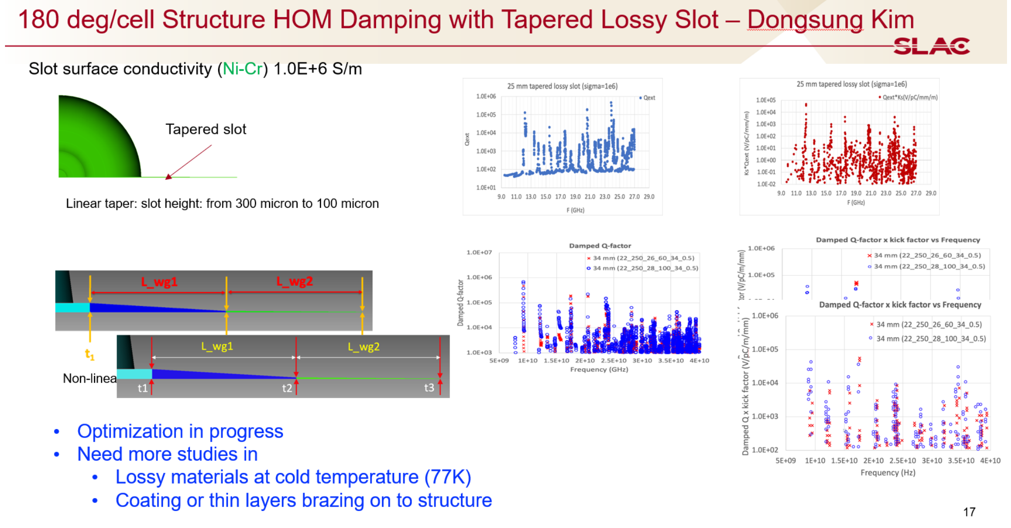
1. Deep craters(observed only in **Hi-E** regions)
2. Spatter (observed in **Hi-E** but not significantly on **Low-E** regions)
3. Speckling (Observed in **Low-E** regions only)
4. Pitting (Observed in **Hi-E** & **Low-E** regions)

Matavalm, Talignani, Carriere

Various developments for C^3 (designing)

HOM Detuning and Damping of C-Band Distributed Coupling Structure *Zenghai Li*

1320, Science building n.4 (CHANGED) 11:00 - 11:20



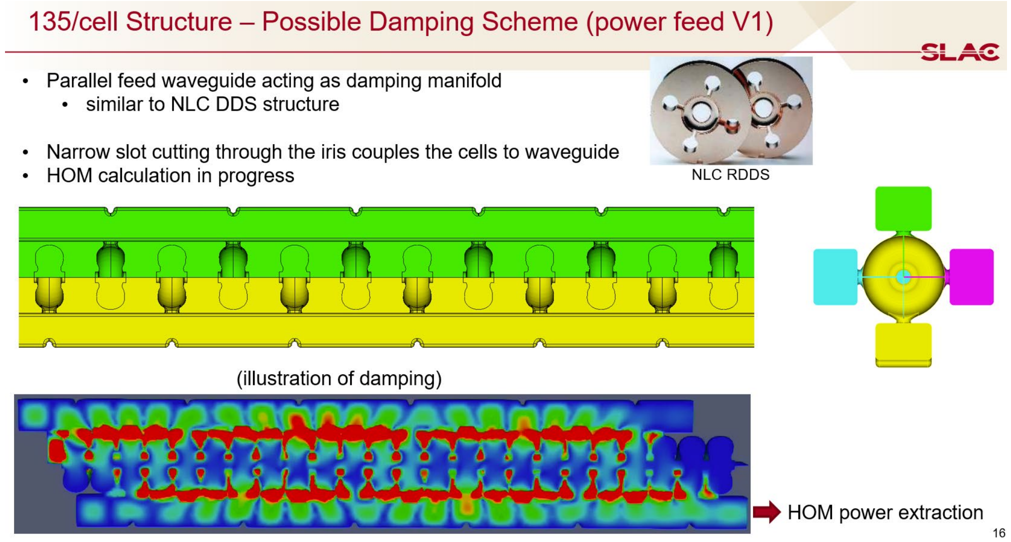
180 deg/cell Structure HOM Damping with Tapered Lossy Slot – Dongsung Kim

Slot surface conductivity (Ni-Cr) 1.0E+6 S/m

Linear taper: slot height: from 300 micron to 100 micron

- Optimization in progress
- Need more studies in
  - Lossy materials at cold temperature (77K)
  - Coating or thin layers brazing on to structure

17



135/cell Structure – Possible Damping Scheme (power feed V1)

- Parallel feed waveguide acting as damping manifold
  - similar to NLC DDS structure
- Narrow slot cutting through the iris couples the cells to waveguide
- HOM calculation in progress

NLC RDDS

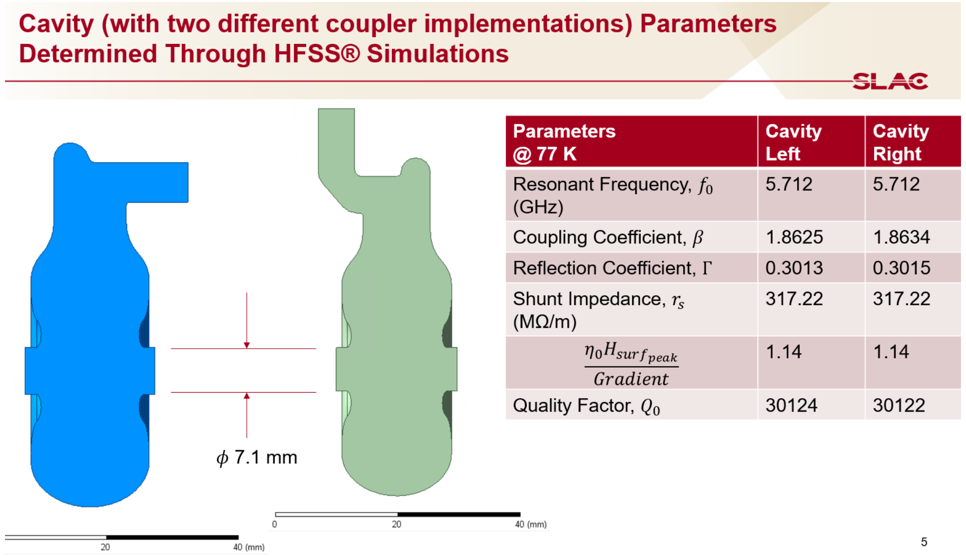
(illustration of damping)

HOM power extraction

16

A Wakefield Resilient, High Shunt Impedance Accelerating Structure for the Cold Copper Collider *Muhammad Shumail*

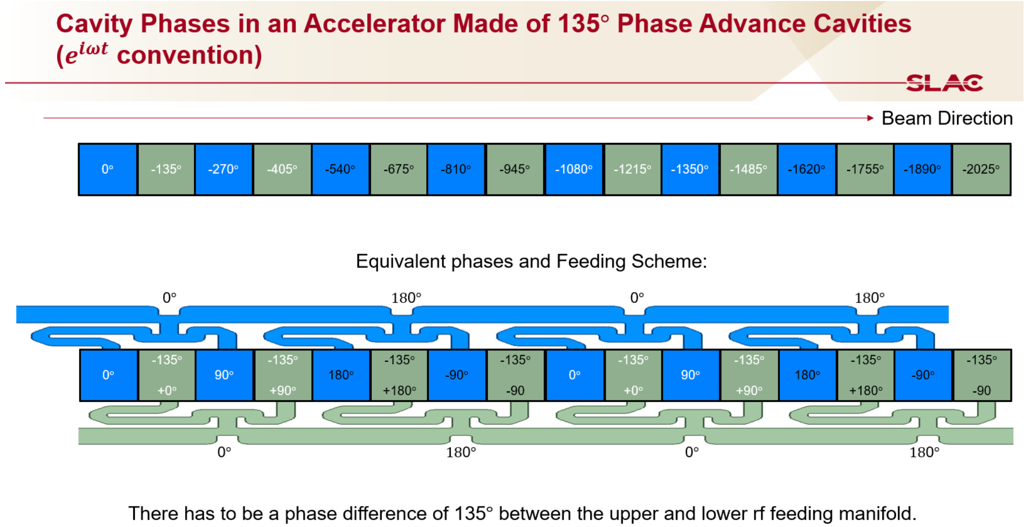
1320, Science building n.4 (CHANGED) 11:20 - 11:40



Cavity (with two different coupler implementations) Parameters Determined Through HFSS® Simulations

Parameters @ 77 K	Cavity Left	Cavity Right
Resonant Frequency, f_0 (GHz)	5.712	5.712
Coupling Coefficient, β	1.8625	1.8634
Reflection Coefficient, Γ	0.3013	0.3015
Shunt Impedance, r_s (MΩ/m)	317.22	317.22
$\frac{\eta_0 H_{surf\,peak}}{Gradient}$	1.14	1.14
Quality Factor, Q_0	30124	30122

5



Cavity Phases in an Accelerator Made of 135° Phase Advance Cavities ($e^{i\omega t}$ convention)

Beam Direction

0°	-135°	-270°	-405°	-540°	-675°	-810°	-945°	-1080°	-1215°	-1350°	-1485°	-1620°	-1755°	-1890°	-2025°

Equivalent phases and Feeding Scheme:

0°	-135° +0°	90°	-135° +90°	180°	-135° +180°	-90°	-135° -90	0°	-135° +0°	90°	-135° +90°	180°	-135° +180°	-90°	-135° -90

There has to be a phase difference of 135° between the upper and lower rf feeding manifold.

Applications

Distributed Coupling Linac for Efficient Acceleration of High Charge Electron Bunches *Ankur Dhar*

1320, Science building n.4 (CHANGED) 16:00 - 16:20

Distributed Coupling as applied to Injector Linac Design

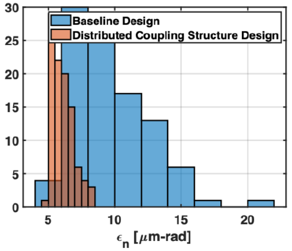
Design balances shunt impedance with aperture size

- S-band cavities designed with aperture ratio a/λ=0.135

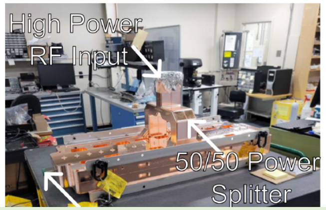
Better output emittance compared to baseline traveling wave structures with 14 nC bunches

- Emittance calculated for a/λ=0.125 cavities
- Baseline design informed by EIC specs

Linac Properties			
Freq (GHz)	2.856	E_{max}/E_{acc}	2.63
a (mm)	14.12	E_{acc}/Z_0H_{max}	0.995
a/λ	0.135	R_s (MΩ/m)	58
P_{diss} (MW)	5	E_{acc} (MV/m)	18



SLAC



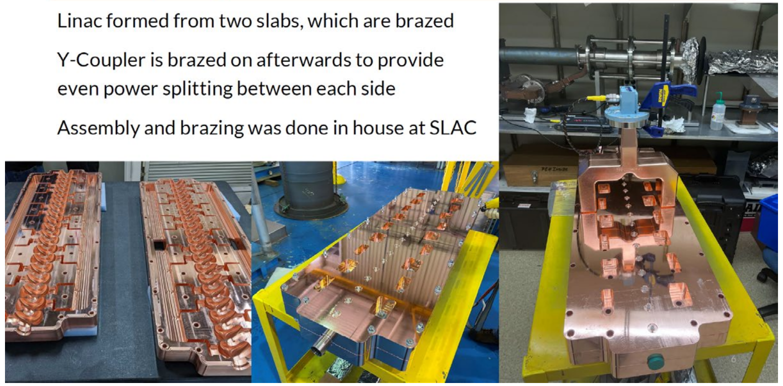
- ✓ Based on the C3 technology applied to Injector Linac
- ✓ Large Aperture distributed coupled Linac in S-band.
- ✓ The assembly and brazing performed in SLAC.
- ✓ Proposals for testing the structure

Assembly of Injector Linac

Linac formed from two slabs, which are brazed

Y-Coupler is brazed on afterwards to provide even power splitting between each side

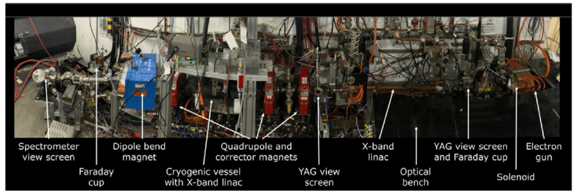
Assembly and brazing was done in house at SLAC



Future Test Plans

Various proposals to testing the structure are in preparation:

- High power test measuring breakdown rate with 35 MW klystron at Station S-band at NLCTA
- ASSET-style wakefield measurement without high power at FACET-II
  - Also potentially at XTA within NLCTA
- Full power + beam tests at CLEAR and/or APS
- Open to further suggestions for test sites



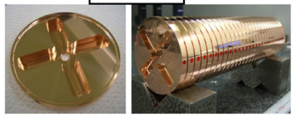
SLAC

Longitudinally-split side-coupled high-shunt-impedance C-band structure fabricated in two halves *Abe Tetsuo*

1320, Science building n.4 (CHANGED) 17:00 - 17:20

Two "***Orthogonal***" Fabrication Methods

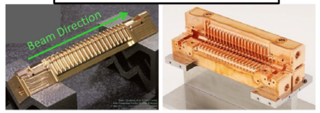
Disk-type



A damped disk Disks stacked and bonded

- Advantages
  - ✓ Machining by turning for main parts
  - ✓ Very smooth surface (Ra < 100 nm) easily achieved
- Disadvantages
  - ✓ **Many parts** of dozen of disks to be made by ultraprecision machining
    - → Followed by delicate stack and bonding
  - ✓ Great care needed to be taken
  - ✓ **Surface currents due to the accelerating mode flow across many disk-to-disk junctions.**

Longitudinally-split type



A Quadrant Three Quadrants

- Advantages
  - ✓ **Only two or four parts** to be made by simple machining with (five-axes) milling machines
  - ✓ Simple assembly process
    - → Possibility of significant cost reduction
  - ✓ **Surface currents due to the accelerating mode do not flow across any bonding junction.**
- Disadvantages
  - ✓ Not very smooth surface (Ra > 100 nm)
  - ✓ **Possible virtual leak from halves or quadrants junctions**
    - → **Solved in our improved version**
  - ✓ **Field enhancements at the edges of halves or quadrants**
    - → **Partially solved in our improved version**

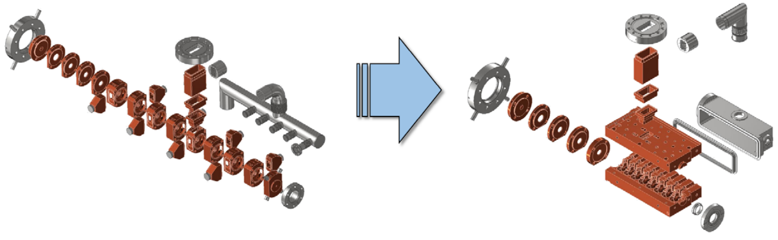
LCWS2024 Tetsuo ABE (KEK) 2

Application to Compact Medical Linac (C-band: 5.71 GHz)

Conventional-versus-New

Conventional disk type structure consisting of 59 parts

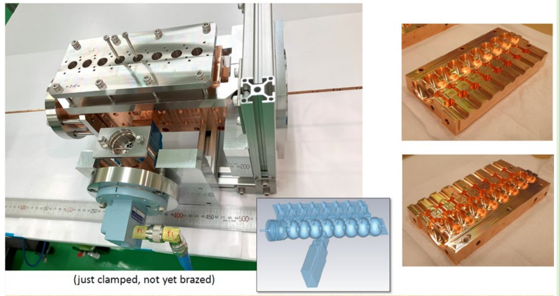
Longitudinally-split type structure consisting of 25 parts



Brazed into one through two steps

To be brazed into one in a single step

Fabrication of a full-scale prototype (2024)



(just clamped, not yet brazed)

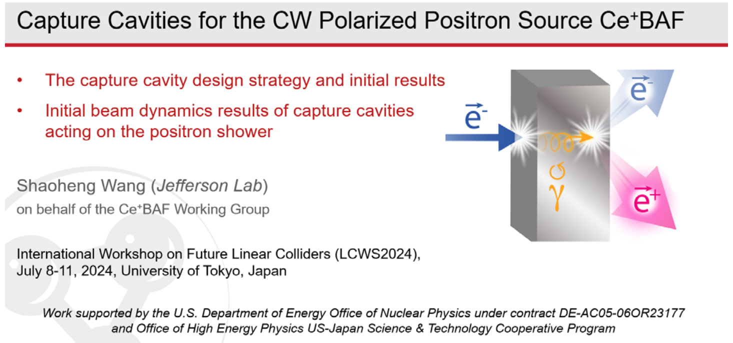
LCWS2024 Tetsuo ABE (KEK)

Quantitative comparison of cost-effectiveness between the longitudinally-split and disk-type fabrication methods for the linac with (almost) the same specifications to estimate sustainability effects

Capture cavity, LLRF

Capture Cavities for the CW Polarized Positron Source Ce+BAF *Shaoheng Wang*

1320, Science building n.4 (CHANGED) 09:00 - 09:20



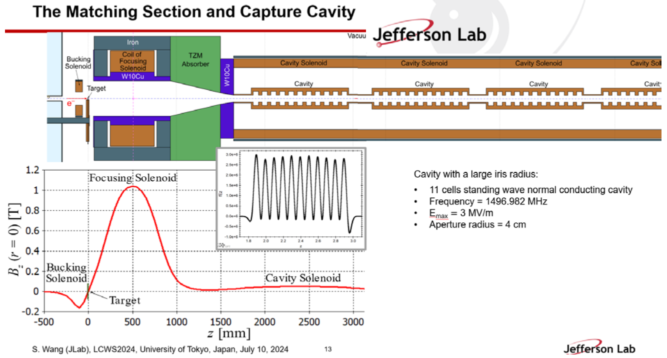
Capture Cavities for the CW Polarized Positron Source Ce⁺BAF

- The capture cavity design strategy and initial results
- Initial beam dynamics results of capture cavities acting on the positron shower

Shaoheng Wang (*Jefferson Lab*)
on behalf of the Ce⁺BAF Working Group

International Workshop on Future Linear Colliders (LCWS2024),
July 8-11, 2024, University of Tokyo, Japan

Work supported by the U.S. Department of Energy Office of Nuclear Physics under contract DE-AC05-06OR23177 and Office of High Energy Physics US-Japan Science & Technology Cooperative Program



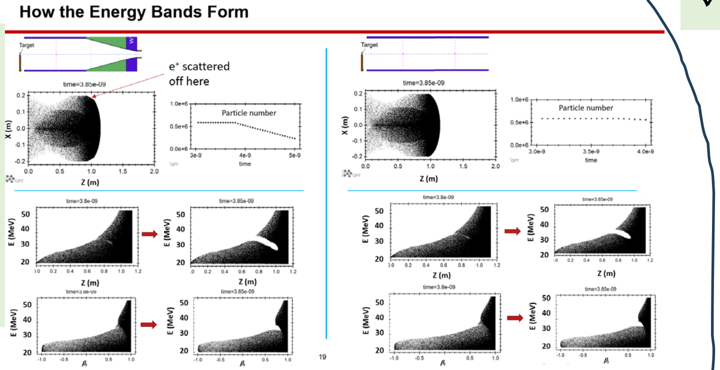
The Matching Section and Capture Cavity

Cavity with a large iris radius:

- 11 cells standing wave normal conducting cavity
- Frequency = 1496.982 MHz
- E_{max} = 3 MV/m
- Aperture radius = 4 cm

S. Wang (JLab), LCWS2024, University of Tokyo, Japan, July 10, 2024 13

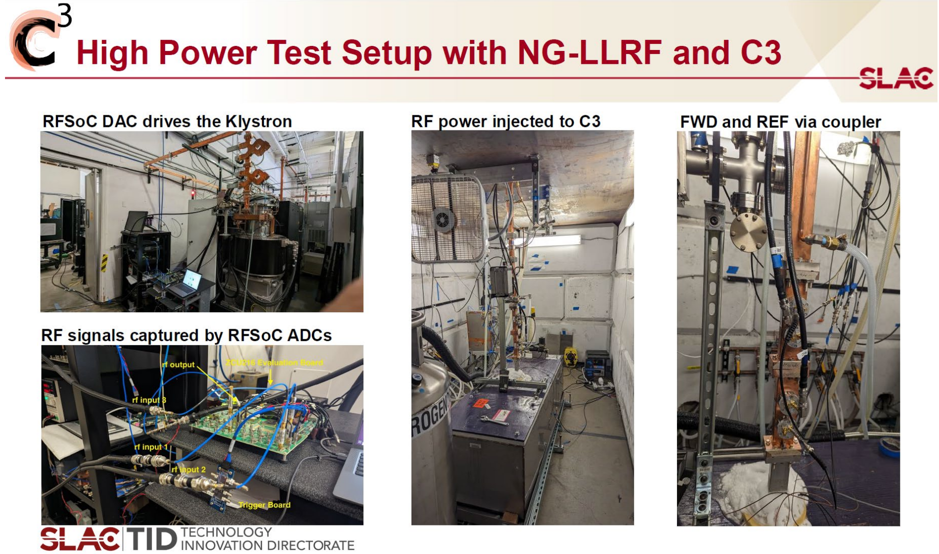
- ✓ The design and related simulated results were shown.
- ✓ Particularly, the influence of solenoid magnetic field to the e+ transportation before entering cavity,
- ✓ Including an Initial studies of the action of RF field of cavities on 20, 60 MeV positrons



How the Energy Bands Form

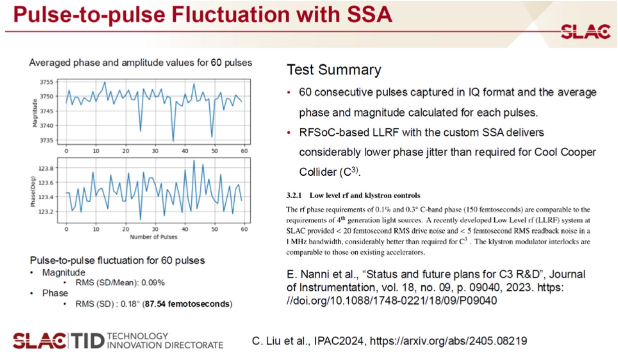
Next Generation LLRF Control Platform for Compact C band Linear Accelerator *Chao Liu*

1320, Science building n.4 (CHANGED) 12:00 - 12:20



C³ High Power Test Setup with NG-LLRF and C3

- ✓ New LLRF system is presented based on RFSoC.
- ✓ RFSoC is an Rf system-on-chip technology which integrates all the essential components including programmable logic, and processors
- ✓ RFSoC based LLRF significantly reduces hardware complexity and enables more flexibility in operation
- ✓ They fabricated the LLRF based on RFSoC, and test it on pulse-to-pulse fluctuation, etc.



Pulse-to-pulse Fluctuation with SSA

Pulse-to-pulse fluctuation for 60 pulses

- Magnitude
  - RMS (SD/Mean): 0.09%
- Phase
  - RMS (SD) : 0.18° (**87.54 femotoseconds**)

Test Summary

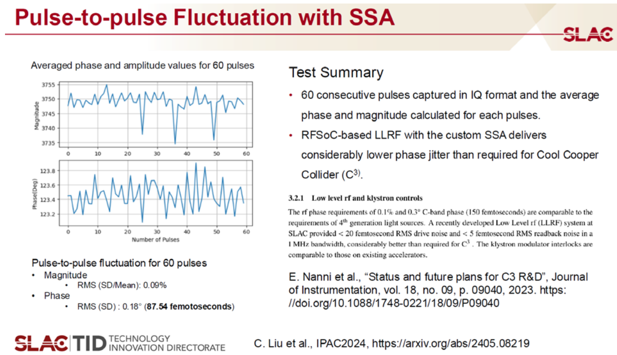
- 60 consecutive pulses captured in IQ format and the average phase and magnitude calculated for each pulses.
- RFSoC-based LLRF with the custom SSA delivers considerably lower phase jitter than required for Cool Cooper Collider (C^3).

3.2.1 Low level rf and klystron controls

The rf phase requirements of 0.1% and 0.3° C-band phase (150 femtoseconds) are comparable to the requirements of 4th generation light sources. A recently developed Low Level rf (LLRF) system at SLAC provided < 20 femtosecond RMS drive noise and < 5 femtosecond RMS readback noise in a 1 MHz bandwidth, considerably better than required for C^3 . The klystron modulator interlocks are comparable to those on existing accelerators.

E. Nanni et al., "Status and future plans for C3 R&D", Journal of Instrumentation, vol. 18, no. 09, p. 09040, 2023. https://doi.org/10.1088/1748-0221/18/09/P09040

SLAC TID TECHNOLOGY INNOVATION DIRECTORATE C. Liu et al., IPAC2024, https://arxiv.org/abs/2405.08219



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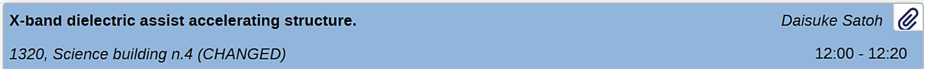
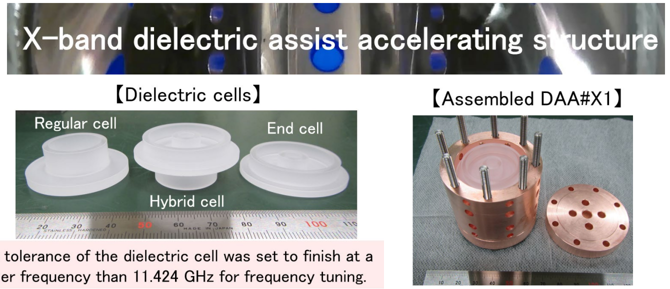
SLAC TID TECHNOLOGY INNOVATION DIRECTORATE C. Liu et al., IPAC2024, https://arxiv.org/abs/2405.08219

Basic studies



X-band dielectric assist accelerating structure. *Daisuke Satoh*
1320, Science building n.4 (CHANGED) 12:00 - 12:20



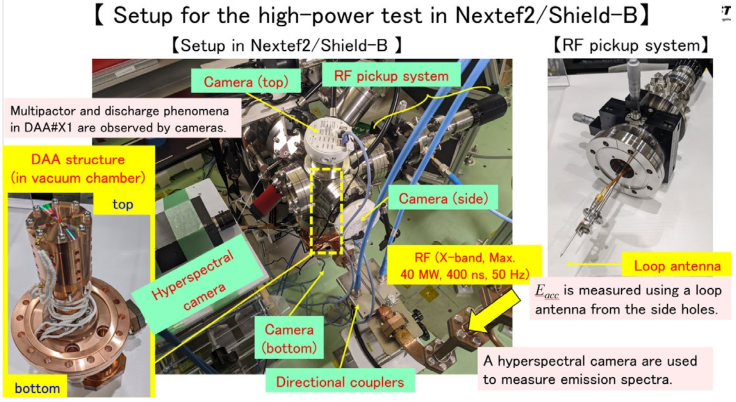
X−band dielectric assist accelerating structure

【Dielectric cells】

The tolerance of the dielectric cell was set to finish at a higher frequency than 11.424 GHz for frequency tuning.

【Assembled DAA#X1】

- ✓ Very high R_{sh}
- ✓ E_{acc} < ~10 MV/m
- ✓ Understand the physics
- ✓ Beak the E_{acc} limit



【 Setup for the high−power test in Nextef2/Shield−B】

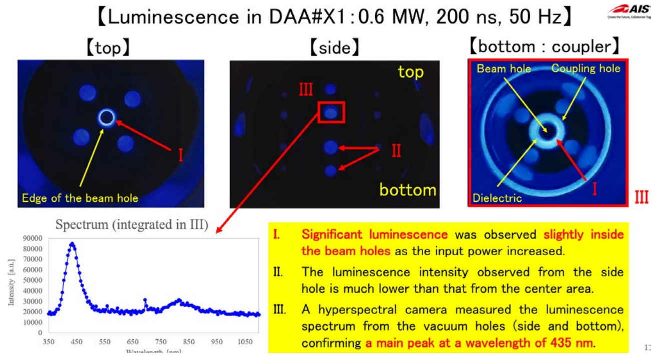
【Setup in Nextef2/Shield−B 】

【RF pickup system】

Multipactor and discharge phenomena in DAA#X1 are observed by cameras.

E_{acc} is measured using a loop antenna from the side holes.

A hyperspectral camera are used to measure emission spectra.



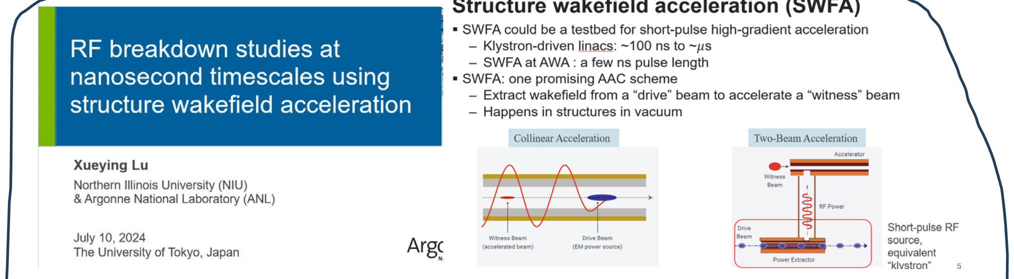
【Luminescence in DAA#X1 : 0.6 MW, 200 ns, 50 Hz】

【top】 【side】 【bottom : coupler】

I. Significant luminescence was observed slightly inside the beam holes as the input power increased.

II. The luminescence intensity observed from the side hole is much lower than that from the center area.

III. A hyperspectral camera measured the luminescence spectrum from the vacuum holes (side and bottom), confirming a main peak at a wavelength of 435 nm.



RF breakdown studies at nanosecond timescales using structure wakefield acceleration

Xueying Lu
Northern Illinois University (NIU)
& Argonne National Laboratory (ANL)

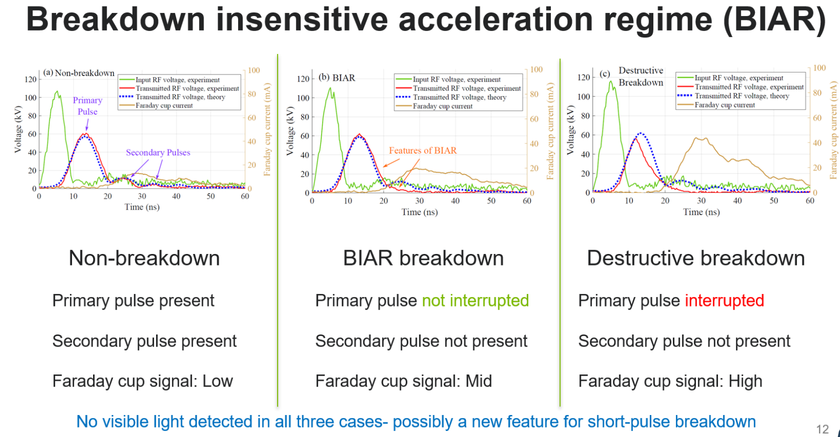
July 10, 2024
The University of Tokyo, Japan

Structure wakefield acceleration (SWFA)

- SWFA could be a testbed for short-pulse high-gradient acceleration
  - Klystron-driven linacs: ~100 ns to ~μs
  - SWFA at AWA : a few ns pulse length
- SWFA: one promising AAC scheme
  - Extract wakefield from a "drive" beam to accelerate a "witness" beam
  - Happens in structures in vacuum

Short-pulse RF source, equivalent "klystron"

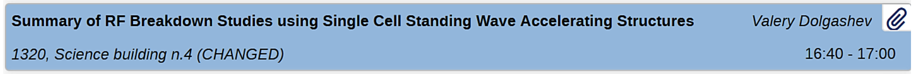
- ✓ Significant point is that they are developing BIAR with a very short RF pulse.
- ✓ In this example, there is a big Faraday cut signal, so BD occurred, but transmission was not affected due to a non-zero grow time of vacuum arcing or discharge.
- ✓ Understanding of this phenomenon
- ✓ We could accelerate beam bunches even when BD occurs?
- ✓ We will be freed from BD limit?



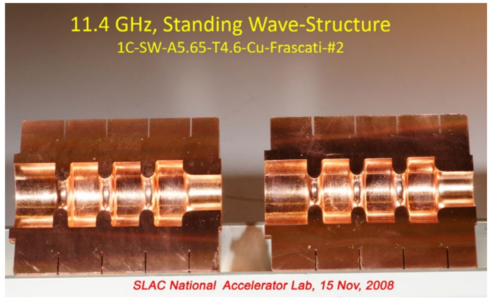
Breakdown insensitive acceleration regime (BIAR)

Non-breakdown	BIAR breakdown	Destructive breakdown
Primary pulse present	Primary pulse not interrupted	Primary pulse interrupted
Secondary pulse present	Secondary pulse not present	Secondary pulse not present
Faraday cup signal: Low	Faraday cup signal: Mid	Faraday cup signal: High

No visible light detected in all three cases- possibly a new feature for short-pulse breakdown

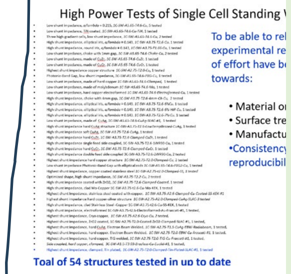


Summary of RF Breakdown Studies using Single Cell Standing Wave Accelerating Structures *Valery Dolgashev*
1320, Science building n.4 (CHANGED) 16:40 - 17:00



11.4 GHz, Standing Wave-Structure
1C-SW-A5.65-T4.6-Cu-Frascati-#2

SLAC National Accelerator Lab, 15 Nov, 2008



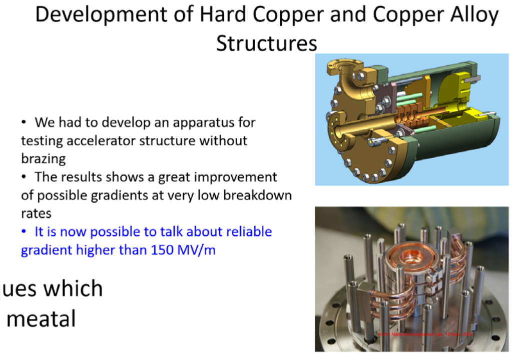
High Power Tests of Single Cell Standing

To be able to rel experimental re of effort have be towards:

- Material o
- Surface tre
- Manufactu
- Consistency reproducibil

Toal of 54 structures tested in up to date

- ✓ At SLAC, many single cell cavities were tested, more than 50.
- ✓ A lot of data has been accumulated, that is very useful to understand new HGT results.
- ✓ Recently we found hard copper and copper alloy have good HG performance.
- ✓ We will investigate such materials in the near future.



Development of Hard Copper and Copper Alloy Structures

- We had to develop an apparatus for testing accelerator structure without brazing
- The results shows a great improvement of possible gradients at very low breakdown rates
- It is now possible to talk about reliable gradient higher than 150 MV/m

News construction techniques which preserve hardens of the meatal

- Electron Beam Welding
- Tungsten Inert Gas Welding
- Clamping