



# Summary and overview of HG2021

<https://indico.fnal.gov/event/22025/>

## International Workshop on Breakdown Science and High Gradient Technology (HG2021)

19-21 April 2021  
US/Pacific timezone

Overview

Timetable

Speaker List

Registration

Participant List

Previous Meetings

Support

✉ [traci@slac.stanford.edu](mailto:traci@slac.stanford.edu)

We are pleased to (re)announce the 13th workshop on breakdown science and high gradient accelerator technology\*, HG2021, will be held virtually on Zoom from April 19-21, 2021.

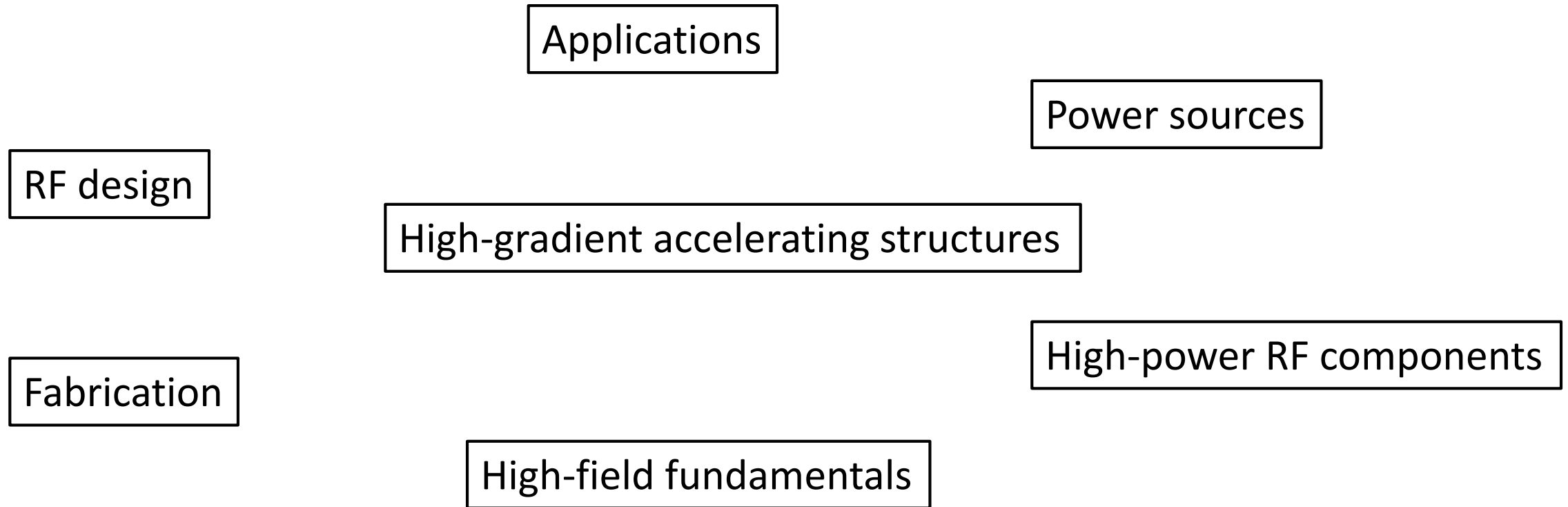
Clearly the identification and advancement of high gradient accelerator technologies for a linear collider have been the main goal since the inception of the High Gradient workshop series. Historically, the workshop has heavily concentrated on progress of X-band accelerator technologies, the area in which the most recent research results have been shared and discussed. The tight collaborations among the participants have pushed practical accelerator technologies to a level that has never been achieved before. Knowledge gained through the HG workshops in the past, like the current depth in understanding RF breakdown, the procedure of fabricating and conditioning high gradient accelerators, and the novel designs of high power rf components, etc., have benefits far beyond the X-band accelerator community.

Besides the intensive focus on X-band high gradient accelerator technologies, the workshop has always made efforts to broaden the spectrum of technologies discussed and attract more talent in related fields. In recent years, the workshop has successfully recruited theorists in material science and experts in accelerator applications, whose participation has significantly enriched the program and generated mutual benefits. HG2021 will continue this journey. The workshop will share the latest advancements in, but not limited to, breakdown science, high efficiency high power RF sources, low breakdown rate high-gradient accelerators, low cost accelerator fabrication technologies, novel accelerator designs, accelerator applications to light source, medical, and industrial technologies etc. While it will be virtual, the format of HG2021 follows the format of preceding workshops, i.e. oral presentations and discussions.

We look forward to seeing you.



# What is the HG (High Gradient) workshop series about?



Fairly complete coverage of high performance linac technology and science from many perspectives – projects, technology etc.



# History



- Started by us in CLIC to build collaboration to develop our accelerating structures.
- Also focus for NLC/JLC colleagues to continue their work after their project was cancelled.
- We expanded to cover high-gradient linac systems more broadly for system-level development.
- Spun off MeVArc in 2010.
- Further expansion to include other applications but with common technology challenges to identify and stimulate cross-project development.

- 13<sup>th</sup> HG workshop 2021 [SLAC and LANL](#)
- 12th HG Workshop 2019 [CERN](#)
- 11th HG Workshop 2018 [SINAP](#)
- 10th HG Workshop 2017 [IFIC](#)
- 9th HG Workshop 2016 [ARGONNE](#)
- 8th HG Workshop 2014 [TSINGHUA UNIVERSITY](#)
- 7th HG Workshop 2013 [TRIESTE](#)
- 6th HG Workshop 2012 [KEK](#)
- 5th HG Workshop 2011 [SLAC](#)
- 4th HG Workshop 2010 [CERN](#)
- 3rd HG Workshop 2009 [SLAC](#)
- 2nd HG Workshop 2008 [KEK](#)
- 1st HG Workshop 2007 [CERN](#)



# HG2021



Turn of North America, co-hosted by SLAC and Los Alamos. Local chair was Emilio Nanni from SLAC.

Was supposed to be held in June 2020 in Lake Tahoe but the in-person meeting was cancelled due to the pandemic. We replaced this with an on-line meeting held 19-21 April 2021.

235 registered participants, with peak participation of over 110. Typical in-person meetings were 70-100 registered participants.

Participation from Asia, Europe and North America.

Session ran from 16:00 to midnight. Toughest on our Asian colleagues!



# Organization



Six sessions:

- Facility Update
- High-gradient structures; design and test
- Industry
- Theory and materials
- Snowmass discussion
- RF sources and pulsed power

45 presentations – I will not try to go through them, nor even give selected highlights, but will try to give a structure of what was presented.

45/15 minutes = 20 s per talk...



# Facility Update and Structure design and tests



Contribution list Timetable

Mon 19/04

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16:00	UCLA High Gradient Cryogenic RF Research Program	James Rosenzweig	16:00 - 16:30
	Design and high-power test of a short prototype of high gradient S-band accelerating structure for the FERMI free electron laser linac upgrade	Nueman Shafiqat	
17:00	Update on CERN X-band activities	Nuria Catalan Lasheras	17:00 - 17:30
	The CompactLight Design Study	Gerardo D'Auria	17:30 - 18:00
18:00	The EuPRAXIA@SPARC_LAB X band LINAC	David Alesini	18:00 - 18:30
	Coffee Break		18:30 - 18:45
	CERF-NM: The C-band Engineering Research Facility in New Mexico	John Lewellen	18:45 - 19:15
19:00	Gyrotron-based High Gradient THz Accelerator Test Facility	Sudheer Jawa	19:15 - 19:45
	RF activities concerning S-band high-gradient applications at PSI	Riccardo Zennaro	19:45 - 20:15
20:00	SmartLight: Current Activities and Future Concepts	Thomas Lucas	20:15 - 20:45
	High Gradient Research Activities at AWA	John Power	20:45 - 21:15
21:00	Lunch Break		21:15 - 21:30
	Update on High Gradient Research at SLAC	Dr Emilio Nanri et al.	21:30 - 22:00
22:00	High Gradient Research at KEK / Nextel	Tetsuo Abe	22:00 - 22:30
	Updates from Tsinghua X-band High power Test Stand (TPOT)	Jieru Shi	22:30 - 23:00
23:00	High Gradient Research Activities at SSRF/SARI	Wencheng Fang	23:00 - 23:30
	Overview of High Gradient Research Activities at IHEP	Jingru Zhang	23:30 - 00:00

Contribution list Timetable

Tue 20/04

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16:00	Design consideration and R&D towards high gradient RFQs	Alexej Grudiev	16:00 - 16:30
	Development of braziless accelerating cavities	Chunguang Jing	16:30 - 17:00
17:00	Welded Cavities	Luigi Fallace	17:00 - 17:30
	A Ka-Band accelerating structure as a linearizer for the Compact Light XLS project	Bruno Spataro	17:30 - 18:00
18:00	High Gradient S-Band experiments at IFIC	Nuria Fuster	18:00 - 18:30
	Coffee Break		18:30 - 18:45
	Development and high power testing of C-band accelerator components	Dr Evgenya Simakov	18:45 - 19:15
19:00	Design, fabrication and cold-testing of DLA structures	Yelong Wei	19:15 - 19:45
	High power test of mm-wave accelerators	Mohamed Othman	19:45 - 20:15
20:00	C-band high gradient cryogenic photoinjector research at UCLA	Atsushi Fukasawa	20:15 - 20:45
	High gradient, short filling-time parallel-coupled structure	Hao Zha	20:45 - 21:15
21:00	Development of an X-band Field Emission RF Gun at Tsinghua University	Liyuan Zhou	21:15 - 21:45



# Facility Update



## Classic X-band:

- Xbox test stand – Nuria Catalan
- CompactLight design study – Gerardo D'Auria
- EuPRAXIA@SPARC\_LAB project and TEX test stand – David Alesini
- Smart\*Light project – Tom Lucas
- KEK/NEXTEF test stand – Testuo Abe
- TPOT test stand – Jiaru Shi

## THz and two-beam:

- MIT gyrotron test stand – Sudheer Jawala
- AWA Argonne two-beam test stand – John Power

## C-band:

- CERF-NM Los Alamos test stand, general – John Lewellen
- CERF-NM, RF system – Evgenya Simakov
- CERF-NM, commissioning – Mark Middendorf
- SSRF/SARI facility – Wencheng Fang (also X-band deflectors)

## S-band:

- FERMI test stand – Nuaman Shafquat
- PSI SLS2 injector, FCCee – Riccardo Zennaro
- IHEP CECP injector – Jingru Zhang
- IFIC test stand – Nuria Fuster

## Cryo and mixed frequency:

- UCLA high-grad – Jamie Rosenzweig
- SLAC high-grad – Emilio Nanni

Trickier to find an organizing principle...

## Development (some combination of design, fabrication and test):

- High-gradient RFQ – CERN, Alexej Grudiev
- Dielectric structure – CERN, Yelong Wei
- mm wave – SLAC, Mohamed Othman

## Design:

- Ka band linearizer – Frascati, Bruno Spataro
- Parallel coupled for short pulses – Tsinghua, Hao Zha

## Fabrication technology:

- Brazeless cavities – Euclid, Chunguang Jing
- Welded cavities – Frascati, Luigi Faillace

## Photoinjectors:

- UCLA cryo photoinjector – Atsushi Fukasawa
- Field emission gun – Tsinghua, Liuyuan Zhou





# Industry session



I was in bed...

☰ Contribution list   **🕒 Timetable**

< Tue 20/04 >

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22:00

	<b>High gradient hadron linacs R&amp;D for medical applications</b>	<i>Sergey Kutsaev</i> <a href="#">📧</a>
		22:30 - 22:45
	<b>High Efficiency, Low Cost, RF Sources for Accelerators and Colliders</b>	<i>R. Lawrence Ives</i> <a href="#">📧</a>
		22:45 - 23:00
23:00	<b>Accelerator-driven radiotherapy methods</b>	<i>Jim Lewandowski</i> <a href="#">📧</a>
		23:00 - 23:15
	<b>High does rate linacs for FlashRT</b>	<i>Arun Ganguly</i> <a href="#">📧</a>
		23:15 - 23:30
	<b>Dielectric Based Compact Accelerator for Industrial Applications</b>	<i>Alexei Kanareykin</i> <a href="#">📧</a>
		23:30 - 23:45
	<b>Sources for high gradient accelerators</b>	<i>Mikael Lindholm</i> <a href="#">📧</a>
		23:45 - 00:00

00:00



# High-field and breakdown theory



< Wed 21/04 >

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16:00	Atomistic approach in understanding of mechanisms leading to vacuum arcing	Prof. Flyura Djurabekova	16:00 - 16:30
	Model and observations linking plastic activity to arc nucleation	Dr Yinon Ashkenazy	16:30 - 17:00
17:00	Atomistic modeling of the coupling between electric fields and bulk plastic deformation in RF structures	Dr Danny Perez	17:00 - 17:30
	Ab initio alloy design for C-band accelerators	Dr Gaoxue Wang	17:30 - 18:00
18:00	Coffee Break		
	Developing Field Emission Models Employing Nanoscale Surface Characterization	Matthew Hopkins	18:30 - 19:00
19:00	Diamond at High Gradients	Prof. Sergey Baryshev	19:00 - 19:30
	Local power coupling as a predictor of high-gradient breakdown performance	Prof. Jan Paszkiewicz	19:30 - 20:00
20:00	Multi-scale multi-physics simulations of vacuum breakdown phenomena	Prof. Andreas Kyritsakis	20:00 - 20:30



MeVArc 'reporting'  
(Sergio next)



Impressive Los Alamos  
start on theory.



Also at MeVArc



# Power sources



<span>☰ Contribution list</span> <span>🕒 Timetable</span>	
<span>&lt;</span> Wed 21/04 <span>&gt;</span>	
<span>🖨️ Print</span> <span>PDF</span> <span>Full screen</span> <span>Detailed view</span> <span>Filter</span>	
21:00	<div style="background-color: #e0f2f1; padding: 5px;"> <p><b>Development of X-band High Power High Efficiency Klystron</b> <span style="float: right;"><i>Jinchi Cai</i> <a href="#">🔗</a></span></p> <p style="text-align: right;">21:30 - 22:00</p> </div>
22:00	<div style="background-color: #e0f2f1; padding: 5px;"> <p><b>A 3MW, 36GHz gyro-klystron for driving a harmonic lineariser for an X-ray FEL</b> <span style="float: right;"><i>Adrian Cross</i> <a href="#">🔗</a></span></p> <p style="text-align: right;">22:00 - 22:30</p> </div>
	<div style="background-color: #e0f2f1; padding: 5px;"> <p><b>The LANL C-Band Engineering Research Facility (CERF-NM) Test Stand Installation, Operation and Initial Conditioning.</b> <span style="float: right;"><a href="#">🔗</a></span></p> <p><i>Mark Middendorf</i></p> </div>
23:00	<div style="background-color: #e0f2f1; padding: 5px;"> <p><b>Development of Compact, Low-Voltage RF Power System Prototypes at SLAC</b> <span style="float: right;"><i>Brandon Weatherford</i> <a href="#">🔗</a></span></p> <p style="text-align: right;">23:00 - 23:30</p> </div>
	<div style="background-color: #e0f2f1; padding: 5px;"> <p><b>Generation of 510 MW of power at X-Band using a metamaterial structure at the Argonne Wakefield Accelerator Facility</b> <span style="float: right;"><a href="#">🔗</a></span></p> <p><i>Julian Picard</i></p> </div>
00:00	

CLIC, high-efficiency

(see facilities)

AWA, two-beam

CompactLight, high-frequency

SLAC, low cost



# Next – under discussion



Strong support for continuing.

Probably something like:

- HG2022 – May or June, Asia, remote
- HG2023 – May or June, Europe, in-person!

n.b. - Not fixed yet.