Snowmass'21

Accelerator Frontier Kick-Off Meeting

June 29, 2020

Welcome and Introduction:

Steve Gourlay, Vladimir Shiltsev and Tor Raubenheimer

https://snowmass21.org/accelerator/start

Accelerator Frontier

Steve Gourlay (LBNL)

Tor Raubenheimer (SLAC)

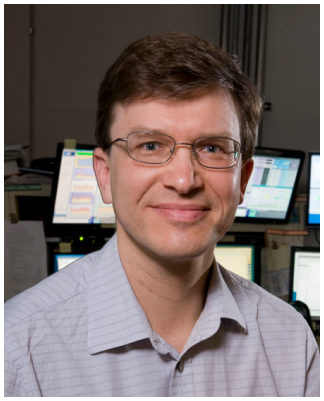
Vladimir Shiltsev (FNAL)

Topical Group		Topical Group co-Conveners			
AF01	Beam Phys & Accel. Education	Z. Huang (Stanford)	M. Bei (GSI)	S. Lund (MSU)	
AF02	Accelerators for Neutrinos	J. Galambos (ORNL)	B. Zwaska (FNAL)	G. Arduini (CERN)	
AF03	Accelerators for EW/Higgs	M. Ross (SLAC)	Q. Qin (IHEP, Beijing)	Georg Hoffstaetter (Cornell)	
AF04	Multi-TeV Colliders	M. Palmer (BNL)	A. Valishev (FNAL)	N. Pastrone (INFN, Torino)	
AF05	Accelerators for PBC and Rare Processes	E. Prebys (UC Davis)	M. Lamont (CERN)	Richard Milner (MIT)	
AF06	Advanced Accelerator Concepts	C. Geddes (LBNL)	M. Hogan (SLAC)	P. Musumeci (UCLA)	R. Assmann (DESY)
AF07	Accelerator Technology R&D				
	Sub-group RF	E. Nanny (SLAC)	S. Posen (FNAL)	H. Weise (DESY)	
	Sub-Group Magnets	G. Sabbi (LBNL)	S. Zlobin (FNAL)	S. Izquierdo Bermudez (CERN)	
	Sub-Group Targets/Sources	C. Barbier (ORNL)	Y. Sun (ANL)	Frederique Pellemoine (FNAL)	

Liaisons

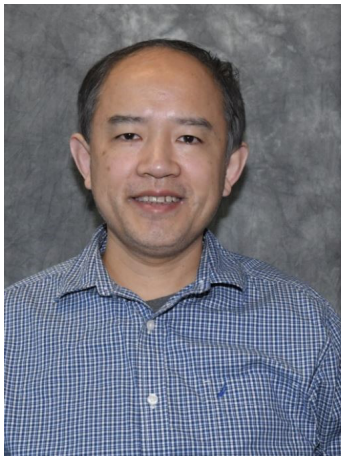
Energy Frontier

Meenakshi Narain
(Brown U)



Dmitri Denisov (BNL)

Theory



Liantao Wang (University of Chicago)

Rare Processes and Precision Measurements

Bob Bernstein (FNAL)

Computational

Jean-Luc Vay (LBNL)

AF Kick-Off

- Brief introduction by each Topical Working Group
  - 5 min talks
  - Submit questions via chat
  - I will go through the questions during the time reserved for Q&A
    - Depending on the time left and the number of questions I may limit the number on the first pass to ensure the last Topic doesn't get left out!
- The intention is to
  - introduce the TWG Conveners
  - engage our community
  - present plans and process for engagement
  - receive input

Your Input

- Letters of Interest (submission : April 1, 2020 – August 31, 2020)
  - Allow conveners to see what proposals to expect and to encourage the community to begin studying them. Help conveners to prepare the Snowmass Planning Meeting (Nov. 4 - 6, 2020 at Fermilab).
  - Letters should give brief descriptions and cite the relevant papers to study.
  - Submission instructions: https://snowmass21.org/loi
  - Authors are encouraged to submit a full writeup as a contributed paper

- Contributed Papers (submission : April 1, 2020 – July 31, 2021)
  - Part of the Snowmass proceedings.
  - White papers on specific scientific areas, technical articles presenting new results on relevant physics topics, and reasoned expressions of physics priorities, including those related to community involvement.
  - These papers and discussions throughout the Snowmass process will help shape the long-term strategy of particle physics in the U.S. Contributed papers will remain part of the permanent record of Snowmass 2021.
  - Submission instructions: https://snowmass21.org/submissions/.

The Final Word

- Outside your day job, participation in the Snowmass planning process is one of the most important things you can do to define your professional future

- The outcome of this process will serve as input for the Particle Physics Project Prioritization Panel (P5)

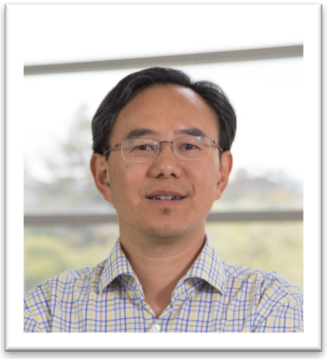
- It will define US priorities for the next 8 – 10 years

AF1
BEAM PHYSICS AND ACCELERATOR EDUCATION

Beam Physics and Accelerator Education

- Co-Conveners

Mai Bai (GSI/U. Bonn)



Zhirong Huang (SLAC/Stanford)

Steve Lund (MSU)

- Beam physics and Accelerator Science & Technology (AST) education are critical to the future of HEP accelerator facilities worldwide. We focus on:
  - Identify ongoing and potential research topics necessary to advance the frontiers of AST for HEP.
  - The relationship of Beam Physics and AST education to the US HEP program, and outreach to the worldwide accelerator communities.
  - The relationship of AST for HEP to other programs within the DOE Office of Science and other international science and research organizations.
- Topics includes
  - Advance accelerator and beam physics (ABP) to push the frontiers of accelerator facilities;
  - Guide and help fully exploit the scientific and technology potential of both HEP GARD facilities and operating accelerators;
  - Controls, AI, computing and data science for improved accelerator performance;
  - Education, training and outreach activities

Beam Physics and Accelerator Education

- Process and Organizational plans, including
  - Part of the organizers for the two GARD ABP workshops identified Four Grand Challenges of ABP and is in the process of developing a research roadmap
  - Two community meetings: GARD ABP open forum and IOTA/FAST collaboration meeting
  - Sent about 50 requests for LoIs covering a wide range of topics. Among them, most of the DOE laboratories were contacted. Major European research centers such as CERN, GSI, PSI, JINR were also contacted to contribute.
  - More than half of 50 requests responded positively
  - One LoI received (extreme bunch compression)

AF2
ACCELERATORS FOR NEUTRINOS

Accelerators for Neutrinos Working Group

- Co-Conveners

Gianluigi Arduini
CERN

Robert Zwaska
FNAL

John Galambos
ORNL

- Short Description

Taking as input the anticipated needs of particle physics and the requirements for neutrino beams in terms of energy, flux, temporal and spatial characteristics, this group will discuss:

- The proton (or other) beam requirements to meet the neutrino physics community needs
- The capability of existing or planned accelerator facilities to satisfy the above requirements, and If not: the necessary upgrades or new facilities.
- Enabling R&D and test facilities necessary to develop upgrades and new facilities.

Working Group

- Process and Organizational plans, including
  - Laura Fields is identified as primary liaison from neutrino physics group
  - Solicited input from relevant existing facilities, programs and projects
    - Requests for LOI have been sent
  - Proposing Oct 5 and or 6 2020 for a virtual workshop

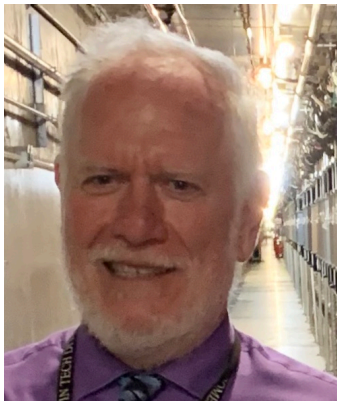
AF3
ACCELERATORS FOR EW/HIGGS

AF 3 Topical Group: Accelerators for EW/Higgs

- Co-Conveners

Georg Hoffstaetter
Cornell

Qing Qin
IHEP



Marc Ross
SLAC

- Short Description

" The Accelerator Frontier Electro-Weak/Higgs Topical Group has been charged with showing how accelerators will do what is needed to advance physics. We will focus on performance, cost-mitigation, (especially for relatively mature technology), and will try to make sure alternative schemes receive adequate attention. Energy Frontier engagement is required for this and we would like to ask you to join us."

European Strategy for Particle Physics
19 June 2020

- "**An electron-positron Higgs factory is the highest priority next collider**. For the longer term, the European particle physics community has the ambition to operate a proton-proton collider at the highest achievable energy. Accomplishing this compelling goal will require innovation and cutting-edge technology."
- **"The timely realisation of the electron-positron International Linear Collider (ILC) in Japan would be compatible with this strategy and, in that case, the European particle physics community would wish to collaborate."**

Working Group Planning

- Enlist Points-of-Contact
  - 24 PoC from 12 project teams
- Develop partnerships with EF (24.06/01.07)
  - Need suggestions
- LOI solicitation and preparation (initial letter 01.06)
  - One received (CEPC)
  - Parameters
  - Performance improvements and challenges/cost savings/energy consumption/schedule advancement
  - 31 July meeting with PoC
- Workshops with the community
  - ….

LOI Solicitation:

The Accelerator Frontier activities in the Snowmass process include discussions on high-energy hadron and lepton colliders, high-intensity beams for neutrino research and for the “Physics Beyond Colliders”, accelerator technologies, science, education and outreach as well as the progress of core accelerator technology, including RF, magnets, targets and sources. Participants will submit Letters of Interest (LoI), contributed papers, take part in corresponding workshops and events, contribute to writing summaries and take part in the general Snowmass'21 events. See https://snowmass21.org/accelerator/start

All members of the community and those in related areas are invited to submit Letters of Interest. Your help is critical for generating a large and diverse pool of ideas.
In formulating an LoI, please consider these (more or less) AF3-specific questions:

1. What EW/Higgs facilities could be available in the next decade (or next to next decade)? (For example: review and update parameter tables used for the European Strategy for Particle Physics, as appropriate.)
2. What are the cost / schedule drivers and what is being done to manage those?
3. What is the potential for improved physics/energy consumption performance? What steps are necessary to realize practical improvements?
4. What are enabling technologies for each approach; what needs to be addressed first? What R&D is specifically needed? (SEE BELOW)
5. What are the time and cost scales of the R&D and of the full facility. What are associated test facilities?
6. How can new technologies be used to provide EW/Higgs physics? (ERL, PWA, muon, and other)?
7. What are potential timelines for new technologies?

Team	First Name	Last Name	email	Sub-topic	Secondary sub-team
ILC	Shin-ichi	Michizono	shinichiro.michizono@kek.jp		
CLIC	Steinar	Stapnes	Steinar.Stapnes@cern.ch	CERN lead	
CLIC	Phil	Burrows	Philip.Burrows@physics.ox.ac.uk	Collaboration Spokesperson	
CLIC	Daniel	Schulte	Daniel.Schulte@cern.ch	Design	muon
CLIC	Walter	Wuensch	Walter.Wuensch@cern.ch	RF	
CLIC	Steffen	Doebert	Steffen.Doebert@cern.ch	Positron	
CLIC	Erik	Adli	erik.adli@fys.nio.no	gamma/gamma	
FCC	Katsunobu	Oide	katsunobu.oide@cern.ch		
FCC	Jorg	Wenninger	jorg.wenninger@cern.ch		
FCC	Frank	Zimmermann	frank.zimmermann@cern.ch	hh	gamma-gamma
ERL-FCCee	Thomas	Roser	roser@bnl.gov		
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CepC	Jie	Gao	gaoj@ihep.ac.cn	Technology	
SppC	Jingyu	Tang	tangjy@ihep.ac.cn	Design	
SppC	Qingjin	Xu	xuqj@ihep.ac.cn	Technology	
EIC	Christoph	Montag	montag@bnl.gov		
Muon	Mark	Palmer	mpalmer@bnl.gov		
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ILC	Akira	Yamamoto	Akira.yamamoto@kek.jp		
ILC	Benno	List	benno.list@desy.de		
ILC	Nikolay	Solyak	solyak@fnal.gov		
C3	Emilio	Nanni	nanni@slac.stanford.edu	Cold Copper Collider	
HE-LHC	Michael	Benedikt	michael.benedikt@cern.ch		
LHeC	Oliver	Bruening	oliver.bruening@cern.ch		

AF4
MULTI-TEV COLLIDERS

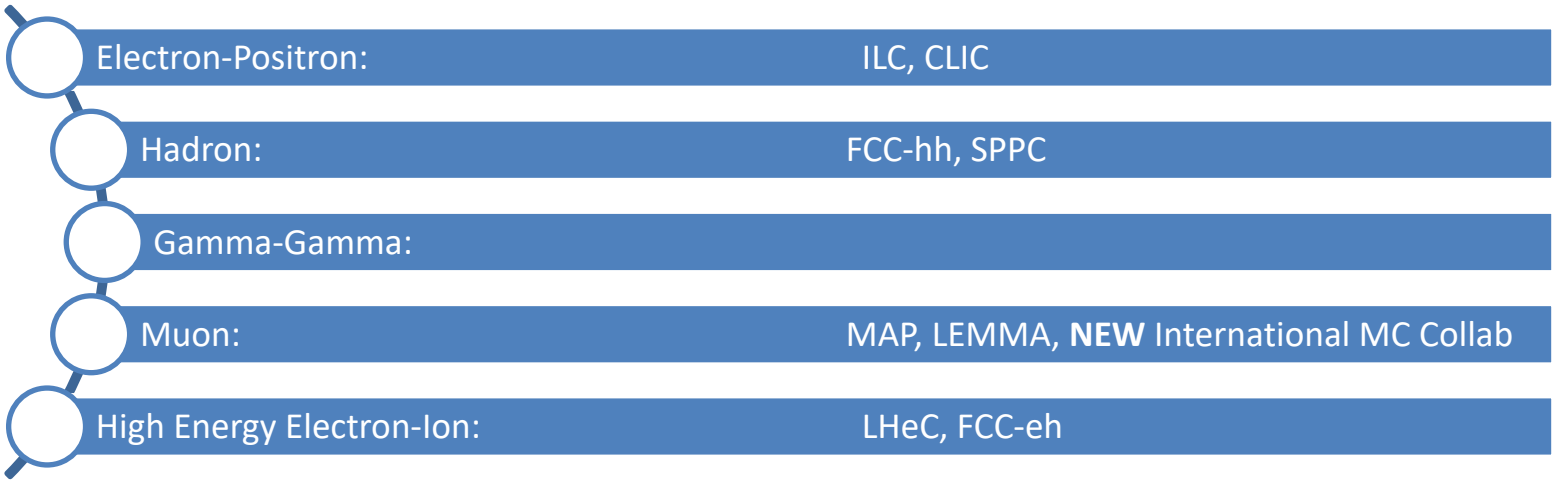
Accelerator Frontier Working Group 4
Multi-TeV Colliders



AF4 Focus: Machines with 1-100 TeV Energy reach – and Beyond...

- This Working Group Will Explore
  - Potential Machine Routes
  - R&D Requirements
  - Potential Readiness Timelines
  - Common Issues at the very high energy scale such as energy efficiency and cost
- It Will Coordinate with the **Energy Frontier Physics Group** to Identify
  - Connections between the physics needs and accelerator types
  - Detailed machine requirements to achieve the community's physics goals

Machines with $E_{cm} \geq 1$ TeV and Collaborations



Other possibilities?

Letters of Intent

- Request for LOIs To Focus On:
  - Machine concept
  - R&D needs to deliver a potential future capability
  - Connections of the technology to existing facilities (e.g. to provide potential facility construction and/or R&D pathways)
- Planning an LOI Town Hall with Collaboration Points of Contact and other interested parties
  - Tentatively July 8, 10AM-Noon US EDT
- An email list has been created: MULTITEV-SNOWMASS21@fnal.gov

Upcoming Meetings

Meeting	Date	Time	Meeting Link
Muon Collider Collaboration Meeting	July 3	14:00-18:00 CEST	https://indico.cern.ch/event/930508/
LOI Town Hall Meeting (Tentative)	July 8	10:00-12:00 EDT	
Future Joint WG Meetings	TBD		

Please visit our Snowmass page for updates:
https://snowmass21.org/accelerator/energy_frontier/start

Or contact us directly:

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AF5
ACCELERATORS FOR PHYSICS BEYOND COLLIDERS AND RARE PROCESSES

Eric Prebys, UC Davis
Mike Lamont, CERN
Robert Milner, MIT

AF5 Areas of Interest

- **Low energy hidden sector searches**
  - Helioscopes (e.g. BabyIAXO/IAXO)
  - Haloscopes using resonant cavities (e.g. ADMX) or other methods (e.g. MADMAX)
  - Light-shining-through-walls experiments (e.g. JURA, STAX)
- **Light Dark Matter searches**
  - Direct detection WIMP searches (primarily addressed by the Cosmic Frontier).
  - Proton beam dump experiment: new proposals (e.g. BDF/SHiP), re-purposed existing experiments (e.g. NA62, MiniBooNE, SeaQuest)
  - Electron beam dump experiments: NA64, LDMX, BDX
  - Long lived particles at colliders (LHC, SuperKEKB)
- **Precision measurements and rare decays**
  - Ultra-rare or forbidden decays/reactions:
    - Kaon sector (NA62, KOTO, KLEVER}
    - Lepton sector (TauFV, Mu3e, MEG,mu2e/mu2e-II)
  - Precision measurements:
    - Permanent EDM
      - in protons/deuterons (CPEDM)
      - in strange/charmed baryons (LHC-FT)
    - Anomalous magnetic moment of muon (g-2)

Activity Since Last Meeting

- Meetings within the group
- Attended EF/RP/AF cross-frontier meeting on June 22
- Held ”AF5 Brainstorming” meeting on June 23rd with representatives from CF,RPP, AF/AF7 (technology)
- Ongoing meetings discussing a number of topics related to muons at FNAL.
- Scheduling meetings with axion people to discuss magnet/RF needs
- Contacting IF9 to discuss test beam needs.
- Reached out to representatives of most of the experiments on the list soliciting LoI suggestions
  - Heard back from some

LoI Plans

- We see LoIs from this focus group falling into two categories
  - LoIs related to specific experiments, eg
    - Hybrid storage ring for proton EDM measurement
    - FFAG for Mu2e-II
    - Induction Linac for future m->eg or m->3e searches
  - Cross-cutting LoIs related to R&D that can benefit multiple areas, eg.
    - Bunch compressor for PIP-II
    - Non-accelerator magnet and RF needs for axion and other searches
    - Electron and proton beam needs for beam dump experiments
      - Energy, intensity, and bunch structure
      - Probably multiple LoIs here
    - *Test Beams*
    - *Quantum coatings, thin film applications for axion searches etc.*
    - *Intermediate users for PIP-III*

Entries in Italics were suggested at brainstorming meeting and are in the beginning of development.

AF6
ADVANCED ACCELERATOR CONCEPTS

Accelerator Frontier 6: Advanced Accelerator Concepts

AF6 "goal":

- Assess potential for new accelerator technologies to revolutionize cost and capability of future accelerators for frontier High Energy Physics
- Capacity for orders of magnitude higher acceleration gradient than conventional systems enabling new types of high energy colliders including energies at/beyond TeV.
- Generation of beams with unprecedented parameters (ultrahigh brightness), enabling novel intermediate applications
- Identify challenges and capability gaps that new acceleration methods could address

AF6 Conveners

Cameron Geddes
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Mark Hogan
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Pietro Musumeci
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Ralph Assmann
Deutsches Elektronen-Sychrotron
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AF6 LOIs Status and Plans

- Invitations sent to mailing lists of conferences:
  - AAC list - US and international (done)
  - EAAC, EuroNNAC lists – Europe (done)
  - LPAW list - Europe and Asia (TBD)
- LOIs to date (AF6) found @ https://www.snowmass21.org/docs/files/?dir=summaries/AF:
  - Ultimate Acceleration in Crystals and Nanostructures
  - Nanostructure Accelerators Novel concept and path to its realization
- LOI solicitation topics/plans: Address path to colliders and intermediate applications such as photon sources (e.g. FELs, MeV gamma rays…)

Technologies including
- PWFA
- LWFA
- Hybrid
- Proton-driven plasma accelerators
- Crystal / nanostructure accelerators
- High frequency metal and dielectric structures
- Dielectric laser-driven accelerators
- High efficiency lasers and drivers

Address path to collider performance, including
- System concepts & luminosity
- Particle injectors - low emittance
- Positron generation & transport
- Efficient acceleration
- 'Staging' of modules to TeV-class energy
- Beam manipulation / cooling / focusing
- Polarization transport
- Diagnostic techniques

AF6 Meetings and Conferences

- Conveners meetings bi-weekly
- Advanced Accelerator Conferences (all postponed):
- AAC 2020 - discussions with organizers started on potential focus sessions
- Linac 2020
- High Gradient Workshop 2020

AF6 Liaisons and PoCs

- Drive accelerator needs from physics frontiers, grounded in accelerator designs
- Energy Frontier - specific for AF6, outreach started, Joint meetings 6/24 & 7/1/20 and more detailed discussions planned for week of July 8th, 2020
- Computational Frontier
- Coordination among accelerator frontiers
- US Accelerator Test Facilities Council – discussions started
- Started outreach to other groups including LaserNetUS, ICFA advanced concepts panel, EuPRAXIA, AWAKE, ALEGRO, AChip

AF6 AOB

- Snowmass Young nominations submitted including Brendan O'Shea, Mike Litos, Spencer Gessner, Marlene Turner

AF7
RF

Accelerator Frontier 7: Accelerator Technology R&D
RF Subgroup

Accelerator Technology is the enabling foundation for accelerator-based HEP.

RF acceleration – primarily divided into SRF and NCRF, plus consideration for regions of overlap, e.g. RF sources

AF7 - RF Conveners

Emilio Nanni
SLAC
nanni@slac.stanford.edu

Sam Posen
Fermilab
sposen@fnal.gov

Hans Weise
DESY
hans.weise@desy.de

Accelerator Frontier 7: Accelerator Technology R&D
RF Subgroup

- Structure discussion around DOE RF Accelerator Roadmap – assess progress and outlook
- In addition **explore new or overlooked concepts/topics**
- Planning for a series of ~monthly zoom meetings
- Overviews of the field / strategy reports
  - First meeting July 2nd 11 am CT / 9 am PT; Jamie Rosenzweig "State of Accelerator: R&D/GARD Update on P5 GARD subpanel recommendations" https://indico.fnal.gov/event/44088/
  - Planned future topics include GARD roadmap, plans in Europe, plans in Asia
- Considering possible satellite meetings at related workshops:
  - TTC Meeting 2021; CLIC Meeting 2021; High Gradient Workshop 2021

AF7
MAGNETS

AF7: Accelerator Technology – Subgroup Magnets

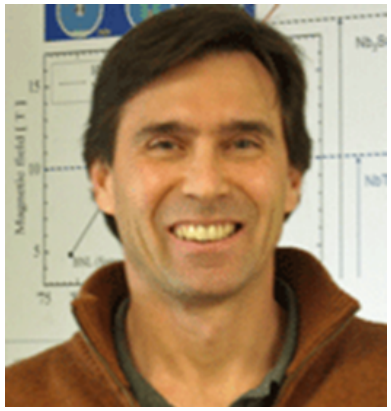
Goal

Address the potential contributions of magnet technology to future HEP facilities, the R&D required to enable these opportunities, the time and cost scales of these efforts, and the needs for associated fabrication infrastructure and test facilities.

Conveners

Susana Izquierdo Bermudez
CERN

GianLuca Sabbi
LBNL



Alexander Zlobin
FNAL

AF7-Magnets: LoIs Status and Plans

- Invitations sent:
  - 81 total; 26 Labs, 13 Univ, 10 companies; 14 countries
  - Personal emails when a connection exists with one of the conveners; undisclosed recipient mailing list otherwise
  - Requesting (and receiving) additional contacts

- LoI status: 3 received, several more expected
  - We plan to reach out more broadly, and especially to young researchers to provide input
  - All our contacts have been invited to this kick-off meeting, please ask questions if something is not clear!

AF7-Magnets: Meetings

- Conveners meeting every 1-2 weeks to discuss status, coordinate plans, compare progress
  - Often attended by one of the AF conveners (Gourlay)
- Short presentations to collaborations/projects where conveners have connections
  - GARD/MDP, AUP, EIC, MAP, HiLumi, FCC, CEPC/SppC
- Based on feedback from LoI invitations, will organize meetings to discuss Snowmass process, next steps

Liaisons and PoCs

- Brainstorming sessions with EF and AF5, identifying needs not covered so far (for example, large bore detector magnets).
- Working on PoC nominations

Status and Plans

We want everyone on board!

- This is an open list, if there are additional needs/ideas, let us know

			Hadron colliders (FCChh, HE-LHC, SppC, etc.)			Linear colliders (ILC, CLIC, etc.)	Muon colliders	Lepton-hadron collider (LHeC, FCCeh, EIC, NICA, etc.)	Others (Dark matter, Gamma-Gamma...)
			Arc	IR	Others				
Conductor	HTS	Wire/Tape	■	■	■	■	■	■	■
		Cable	■	■	■	■	■	■	■
	LTS	Wire	■	■	■	■	■	■	■
		Cable	■	■	■	■	■	■	■
Transverse Techonology		Quench protection	■	■	■	■	■	■	■
		Insulation materials and polymers	■	■	■	■	■	■	■
		Manufacturing techniques	■	■	■	■	■	■	■
		Test facilities	■	■	■	■	■	■	■
		Others (Diagnosis, costs...)	■	■	■	■	■	■	■
Magnets	HTS	Dipoles&Quadrupoles	■	■					
		Correctors							
		Fast ramp magnets			■		■		■
		Wigglers/Undulators				■			
		Kickers/Septum			■				
		Others (Solenoids, dipole detectors...)							
	LTS	Dipoles&Quadrupoles	■	■			■	■	
		Correctors	■						
		Fast ramp magnets							■
		Wigglers/Undulators				■			■
		Kickers/Septum			■				
		Others (Solenoids, dipole detectors...)					■		■
	Warm&Permanent Magnets					■	■	■	

AF7
TARGETS AND SOURCES

Snowmass 2021 AF7: Accelerator Technology R&D Subgroup Targets/Sources

Conveners

Charlotte Barbier
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Yine Sun
ANL
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Targets/Sources: Progress and Plans

- Mass email and personal invites sent out to call for LOIs:
  - 20 confirmed intend to submit a LOI.
- List of topics identified:
  - Target systems:
    - for multi-MW proton beam;
    - for neutrino experiments;
    - for muons production;
    - beam dumps and windows;
  - Sources:
    - High brightness and/or high average current electron sources
      - photocathode, thermionic cathode, field emitters…
      - RF gun, DC gap, plasma-extracted sources … (overlaps with RF subgroup)
    - Polarized electrons/positrons
    - High intensity ions
      - EIC
- Weekly co-convener's zoom meeting on Thursdays.

Identified LOI topics - Targets

- Proton irradiation station
  - (Stora-CERN)
  - (Pellemoine-FNAL)
- Post Irradiation Examination - PIE
  - (Senor-PNNL)
  - (Dai-PSI)
  - (Tomut-GSI)
  - (Densham-STFC)
  - (Pellemoine-FNAL)
- Novel Material
  - (Densham-STFC)
  - (Pellemoine-FNAL)
- Multi-MW targetry development
  - ANL Beam dumps (Dooling-ANL)
  - (Ishida-KEK, Okuno-RIKEN)
  - (Lee-ESS)
  - (CALVIANI-CERN)
  - (Densham-STFC)
- Simulations/validation
  - (WINDER-ORNL)
  - (Densham-STFC)
- Instrumentation
  - (WINDER-ORNL)
- Remote handling
  - (CALVIANI-CERN)
- Robotics development
  - (Yonehara-FNAL)
- TBD
  - (Rosenblad-ORNL)
  - (Bajeat – GANIL)

Identified LOI topics - Sources

- Integrated LOI from LANL-BNL cathode consortium on multiple source technologies and applications (LANL and BNL)
- Superconducting RF gun (BNL)
- Ultra-cold, high average current, polarized electron sources (Arizona state Univ.)
- High average current DC gun electron beams /polarized electron beams (Jlab)
- High field photoemission nano-emitters
  - (FAU)
  - (GAU)
- Polarized H- ion sources
  - (BNL)
- Heavy ion productions
  - (Jlab)
  - (BNL)