INSTRUMENTATION FRONTIER LOI HIGH-LEVEL SUMMARY

Phil Barbeau (Duke) , Petra Merkel (FNAL), Jinlong Zhang (ANL)
for the full IF topical group conveners

Overview

- ~340 LOIs submitted to Instrumentation Frontier
- Split up among 9 (now 10) Topical groups
  - IF1: Quantum Sensors
  - IF2: Photon Detectors
  - IF3: Solid State Detectors and Tracking
  - IF4: Trigger and DAQ
  - IF5: Micro Pattern Gas Detectors (MPGDs)
  - IF6: Calorimetry
  - IF7: Electronics/ASICs
  - IF8: Noble Elements
  - IF9: Cross Cutting and Systems Integration
  - IF10: Radio Detection

Digesting the LOIs

- Topical group conveners have broken down the submissions into themes
- Will use this to help push for coordinated contributed papers
- Have also identified LOIs that might not belong (mistakes, misunderstandings)
- We are actively working on including LOIs that should be cross-listed with IF, but may have been missed
  - Please assist TG conveners if you see such cases
  - I will shamelessly share the slides that they have produced

QUANTUM SENSORS

Thomas Cecil (ANL), Kent Irwin (SLAC), Reina Maruyama (Yale), Matt Pyle (Berkeley)

Quantum Sensors LOIs

- 72 LOIs submitted
- Split into 3 broad technology categories
  - Superconducting sensors (18)
  - Quantum Ensembles (Interferometers and clocks (9), Spins, Defects, and NMR (7), and Electro-mechanical systems (4))
  - Quantum calorimeters (16)
- Strong overlap with photon detectors (IF2) and magnet / RF cavity development (AF5)
  - Will move LOIs with focus on these topics (and not ‘quantum’ nature of technology) to the respective topical group

Quantum Sensors Science

- Dark Matter: particle-like (CF1)
- Dark Matter: wave-like (CF2)
- Gravitational waves (CF7)
- EDM (RF3)
- Neutrino mass (NF5)

IF02: PHOTODETECTORS

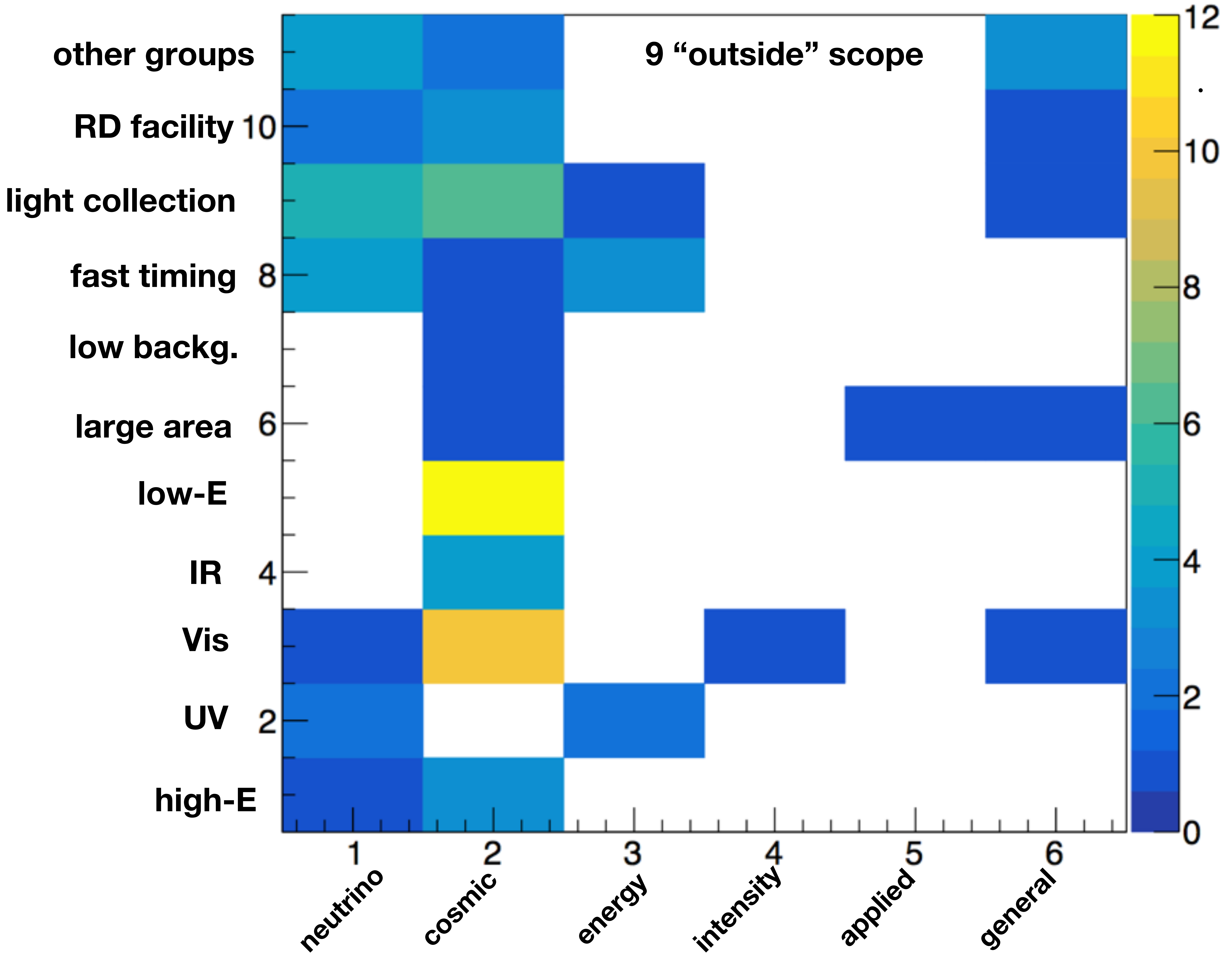
Juan Estrada (Fermilab)
Mayly Sanchez (Iowa State University)

BEFORE THE LOI FLOOD

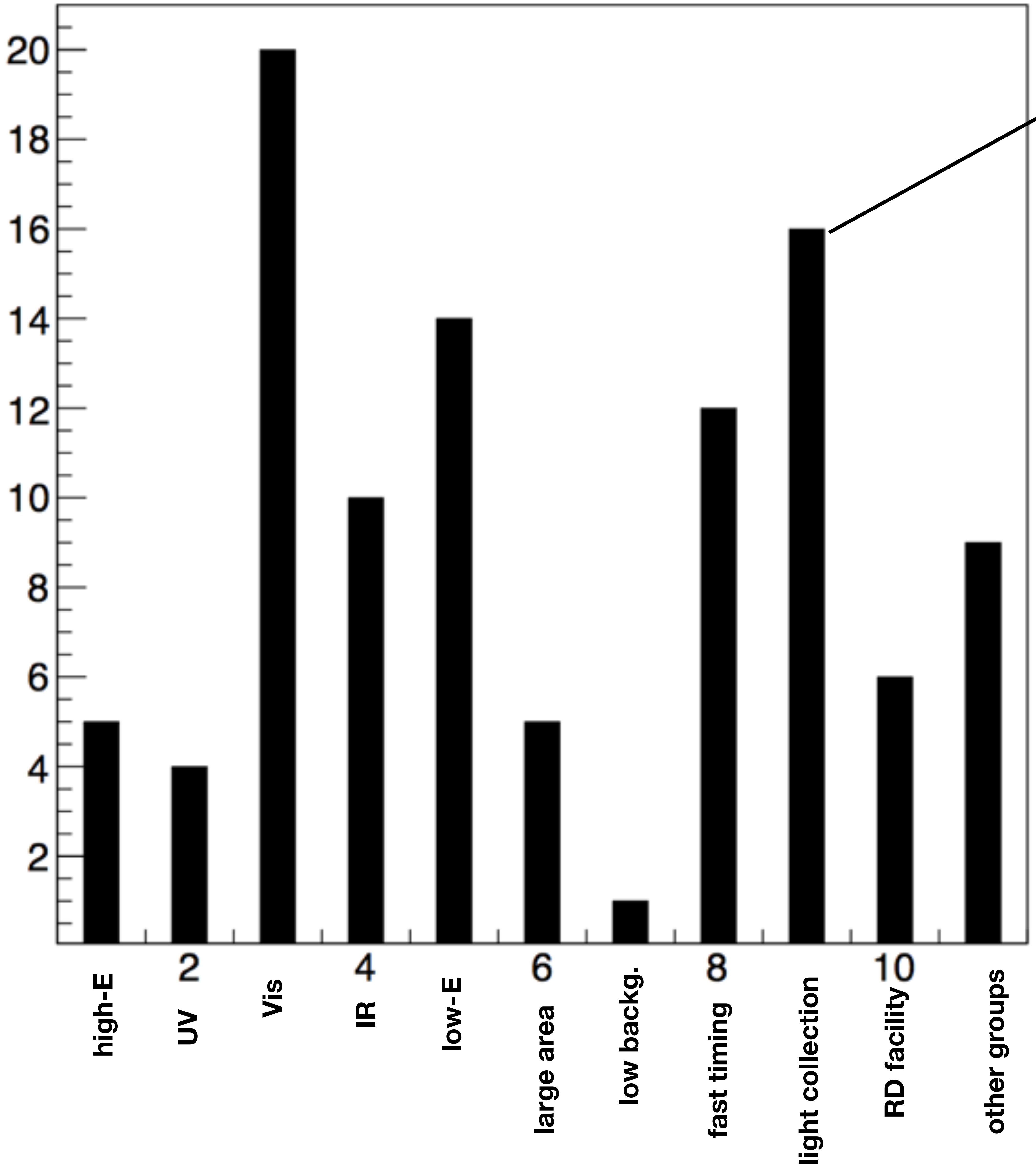
- We had defined the following categories where

	Neutrino Frontier 1	Cosmic Frontier 2	Energy Frontier 3	Rare & Precision 4
Sensors hiE(1)		●		
Sensors UV (2)	●	●		●
Sensors VIS (3)	●	●	●	●
Sensors IR (4)		●		
Sensors µwave/Radio (5)		●		
Large Area (6)	●			●
Low Background (7)				●
Fast Timing (8)	●	●	●	
Light collection (9)	●	●		●
RD facility (10)				

77 LOIS IN IF02



up to 2 technology thrusts per LOI



includes:

- telescopes
- spectrographs
- scintillators
- filters

(need more though)

THE AFTERMATH

- In some cases LOI authors used very loosely associated categories. In a few cases we could not guess what was the photodetector technology being used.
- Received a number of LOIs on facilities where some photodetector (but also other) technologies will be tested.
- We tagged 5 LOIs as Quantum Sensors according to our previously discussed interface.
- One category we had considered: “Light Collectors”, we will be expanding to include target materials such as liquid scintillators.
- It is possible that we have missed developments in the Energy and Intensity Frontiers. We seem to be predominantly Cosmic and Neutrinos.
- Need to also look into how to bring industry into the conversation.

IF03: Solid State Detectors and Tracking

Artur Apresyan, Lucie Linssen, Tony Affolder

September 15, 2020
Conveners Meeting

IF03: Solid State Detectors and Tracking

	Experiments	Title	contact
3	IF0_IF0-RF0_RF0_Daniel_Ambrose-094.pdf	Mu2e-II Tracker	ambr0028@umn.edu
4	IF10_IF3_David_R_Winn-093.pdf	Forward 3<eta<6 lepton-photon-jet system	winn@fairfield.edu
5	IF2_IF7_IF3_IF4_IF5_IF6-056.pdf	Belle II detector upgrades	sevahsen@hawaii.edu
6	IF3_IF0_Oskar_Hartbrich-192.pdf	STOPGAP - a Time-of-Flight extension. for the TOF	ohartbri@hawaii.edu
7	IF3_IF0_Zhijun_Liang-169.pdf	Silicon vertex detector for CEPC	zhijun.liang@cern.ch
8	IF3_IF6_Mathieu_Benoit-188.pdf	Detector optimisation and detector technology R&D	mbenoit@bnl.gov
9	IF3_IF6-112.pdf	Detector optimisation and detector technology R&D	mbenoit@bnl.gov
10	IF3_IF6-EF1_EF4_Andy_White,_Marcel_Stanitzki-027.pdf	SiD	A.White
11	IF3_IF7_CEPC-190.pdf	Time of Flight detector for CEPC	zhijun.liang@cern.ch
12	IF3_IF8-NF2_NF9_Jing_Liu-095.pdf	COHERENT: Instrumentation development	jing.liu@usd.edu
13	IF5_IF3-015.pdf	A time projection chamber using advanced technol	A. Bellerive (Carleton)
14	IF	Dual-readout calorimeter for future Electron-Ion Co	hdyoo@yonsei.ac.kr
15	Cl	Potential future uses of the Rubin Observatory facil	skahn@slac.stanford.edu
16	IF	Muon collider experiment: requirements for new de	D.Lucchhesi (Padova)
17	EF1_EF2-IF3_IF0_Valentina_Maria_Martina_Cairo-047.pdf	Strange quark as a probe for new physics in the Hi	V.M.M. Cairo (SLAC)
18	EF1_EF4-IF3_IF6-096.pdf	IDEA detector	F.Bedeschi
19	EF3_EF0-RF1_RF0-IF3_IF6-077.pdf	Searching for Bs-->PhiNuNu and other b-->sNuNu	manqi.ruan@ihep.ac.cn
20	EF3_EF4-IF3_IF5-031.pdf	The IDEA drift chamber for a Lepton Collider	franco.grancagnolo@le.infn.it
21	EF4_EF0-AF3_AF0-IF3_IF5_GrahamWilson-119.pdf	Exploring precision electroweak physics measurem	gwwilson@ku.edu
22	EF5_EF7-TF7_TF0-IF6_IF3-CompF3_CompF0_Ben_Nachı	Jets and jet substructure at future colliders	bpnachman@lbl.gov
23	EF9_EF10-NF3_NF0-RF6_RF0-AF5_AF0-IF3_IF7_MATHU	Recent progress and next steps for the MATHUSLA	dcurtin@physics.utoronto.ca
24	NF2_NF0-IF3_IF0_Susanne_Mertens-197.pdf	Prospects for keV sterile neutrino searches with KA	mertens@mpp.mpg.de
25	RF2_RF6-IF6_IF3_REDTOP_Collaboration_-_new-083.pdf	The REDTOP experiment: an eta/eta' factory	gatto@na.infn.it
26	RF2_RF6-IF6_IF3_REDTOP_Collaboration-035.pdf	The REDTOP experiment: an eta/eta' factory	gatto@na.infn.it

A Time Projection Chamb...
snowmass21.org

- Grouped into two categories: Experiments and Technology
  - Total of 24 LOIs in the Experiments category
  - A lot of those in Experiments are really proposals for experiments
  - About 10 of the above proposals have tracker-related R&D

IF03: Solid State Detectors and Tracking

30	Technology	Title	contact
31	IF3_IF0_N._Fourches-107.pdf	Beyond CMOS sensors, submicron pixels for the ve	N.T.Fourches (Saclay)
32	IF3_IF9_David_R_Winn-032.pdf	High precision timing and high rate detectors	winn@fairfield.edu
33	IF3_IF9_Jessica_Metcalfe-161.pdf	Thin film detectors	jmetcalfe@anl.gov
34	IF3_IF0_H_Kagan-130.pdf	3D diamond detectors	kagan.1@osu.edu
35	IF3_IF0_Jung-118.pdf	Light-weight and highly thermally conductive suppo	anjung@purdue.edu
36	IF1_IF2-CF1_CF0-147.pdf	Superconducting nanowire single-photon detectors	berggren@mit.edu
37	IF2_IF3_Jean-Francois_Pratte-114.pdf	The particle/photon to digital converters	J.F.Pratte (Sherbrooke)
38	IF2_IF3_Laktineh-PICMIC-066.pdf	PICosecond-sub-MICron (PICMIC) concept for 4D	laktineh@in2p3.fr
39	IF2_IF3_Perez-120.pdf	Large-area, low-cost Si(Li) detectors for cosmic par	kmperez@mit.edu
40	IF2_IF4_Charles_C._Young-115.pdf	Front-end electronics and DAQ for large scintillator	young@slac.stanford.edu
41	IF3_IF0_Pavel_Murat-129.pdf	Exploration of charged particle tracking using InAs	murat@fnal.gov
42	IF3_IF0_Ronald_Lipton-080.pdf	3D integration of sensors and electronics	lipton@fnal.gov
43	IF3_IF0_University_of_California_Santa_Cruz-018.pdf	Use of extremely thin 'LGAD' ultra-fast silicon detec	H. Sadrozinski
44	IF3_IF2_Jessica_Metcalfe-154.pdf	Silicon pixel detectors in space	jmetcalfe@anl.gov
45	IF3_IF2_Mazziotta-100.pdf	Gamma-ray scintillator fiber tracker	mazziotta@ba.infn.it
46	IF3_IF4_Garcia-Sciveres-019.pdf	Wavelength division multiplexed high speed optical	mgs@lbl.gov
47	IF3_IF4-189.pdf	Muon scintillator R&D	xiaolong@fudan.edu.cn
48	IF3_IF5_Simone_Mazza-175.pdf	High density 3D integration of LGAD sensors throu	simazza@ucsc.edu
49	IF3_IF5-EF1_EF4-183.pdf	Time projection chamber R&D	qihr@ihep.ac.cn
50	IF3_IF6_David_R_Winn-033.pdf	Novel low workfunction semiconductors for dark ma	winn@fairfield.edu
51	IF3_IF6_David_R_Winn-034.pdf	Novel low workfunction semiconductors for dark ma	winn@fairfield.edu
52	IF3_IF7_Karri_DiPetrillo-142.pdf	Precision timing detectors for future colliders	kdipetri@fnal.gov
53	IF3_IF7_Martin_Breidenbach-113.pdf	Large area CMOS monolithic active pixel sensors f	M.Breitenbach (SLAC)
54	IF3_IF7_Timon_Heim-104.pdf	28nm CMOS for 4D tracker readout chips	theim@lbl.gov
55	IF3_IF7-131.pdf	4-dimensional trackers	sch@slac.stanford.edu
56	IF6_IF3_Hwidong_Yoo-059.pdf	Feasibility study of combining a MIP timing detecto	hdyoo@yonsei.ac.kr
57	IF6_IF3_Hwidong_Yoo-061.pdf	Heavy flavour tagging using machine learning techi	hdyoo@yonsei.ac.kr
58	IF6_IF3-078.pdf	Novel silicon sensors for high-precision 5D calorim	suehara@phys.kyushu-u.ac.jp
59	IF7_IF3_Leo_Greiner-160.pdf	Monolithic active pixel sensors for high performanc	L.Greiner (LBNL)
60	CF1_CF0-NF10_NF4-IF3_IF0_Ethan_Brown-034.pdf	Paleo detectors	browne7@rpi.edu
61	CF1_CF2-NF10_NF0-IF2_IF3_Kurinsky-101.pdf	Cryogenic carbon detectors for dark matter searche	kurinsky@fnal.gov
62	CF2-IF2-002.pdf	Tunable plasma holoscope	katherine.dunne@fysik.su.se
63	CF3_CF4-IF2_IF7_Tyson-050.pdf	Low earth orbit satellites and the DOE HEP prograr	tyson@physics.ucdavis.edu
64	CF4_CF3-IF2_IF0_David_Erskine-009.pdf	Cosmology and dark matter at a cm/s	erskine1@llnl.gov
65	CF4_CF6-IF2_IF0_Juan_Estrada-081.pdf	Development of R&D platform for astronomical inst	estrada@fnal.gov
66	CompF3_CompF2-NF1_NF5-CF1_CF2-IF8_IF3_Monzani-0	The future of machine learning in rare event search	monzani@stanford.edu
67	UF4_UF3-NF5_NF6-CF1_CF0-IF3_IF0-CommF3_CommF5	Advanced Germanium detectors and technologies	Dongming.Mei@usd.edu
68	UF4_UF3-NF5_NF6-CF1_CF0-IF3_IF0-CompF2_CompF3-	Advanced Germanium detectors and technologies	Dongming.Mei@usd.edu

- Grouped into two categories: Experiments and Technology
  - Total of 38 LOIs in the technology area
  - About 15 of these definitely fall into trackers area
  - Many detectors are “Solid State” but belong to Calorimeters, Dark Matter, quantum, or cosmic, not really MIP tracking kind of detectors

IF03: Solid State Detectors and Tracking

- Some common themes:
  - Studies focusing on physics motivations for a particular technology
  - 4D trackers, precision time + position measurements
  - Monolithic integrated silicon detectors, CMOS, 3D integration
  - High rad tolerant sensors, radiation hardness
  - Mechanics and hybridization, integration aspects, light weight materials
  - Gaseous trackers, scintillating fibers, some detectors fit more into MPGD
  - Several CEPC oriented proposals

Snowmass TDAQ Subgroup LOI Brief Summary

Darin Acosta (Florida), Wes Ketchum (FNAL), and Stephanie Majewski (Oregon)

15 Sep 2020

Real-time processing hardware

- System on chip/readout-integrated ASICs for triggering, feature extraction, self-calibration, etc. (Mostafanezhad et al., Miryala et al., Miller et al 132)
    - Miryala discusses some specific issues, like non-volatile memory and co-design
    - Miller highlights need for Multi-Processor SoC and FPGA for DL/AI needs

- FPGAs for ML inference (Miller et al 132, Herbst et al)

Triggering techniques/algorithms

- Charged-particle track trigger algorithm in FPGA (Kotwal)
- *Self-driving triggers* for automated/adaptive data selection (Miller et al. 72)
- Extending scalable readout systems (SRS) for better/more programmable triggering (Muller et al.)
- Asynchronous L1 triggers for Colliders (Acosta et al.)
    - Requires precise/synchronized/stable timing

Data links/readout

- Wireless
  - Data transfer for Colliders (Zhang et al. 4)
- Rad-hard links
  - Photonics-based links (Zhang et al. 7)
- Wavelength division multiplexing (Garcia-Sciveres et al)
  - Also with photonics chips in detector

Experiment/detector-specific DAQ needs

- Project 8 DAQ (Oblath)
  - Real-time spectral analysis and tracking for trigger/data reduction (compute-intensive)
- Low-energy events in DUNE (Karagiorgi et al.)
  - Largely improved algorithms and data compression to extend low-energy sensitivity
- Belle-II upgrades (Vahsen et al)
  - DAQ upgrades underway for increased rates, timing upgrades envisioned for long-lived particle triggers(?)
- Optical instrumentation for EM calorimeters (Rutchi et al)
- Muon Scintillator R&D for Higgs factory/long-lived particle searches (Wang et al)
- Large Scintillator Arrays (Young et al)
  - Signal coincidence and >100 ps timing resolution (for position reco)

IF5: Micro-Pattern Gaseous Detectors (MPGDs)

Conveners: Bernd Surrow, Maxim Titov, Sven Vahsen

Submitted LOIs

primarily submitted to:	all IF	IF01	IF02	IF03	IF04	IF05	IF06	IF07	IF08	IF09	IF10
IF	7	37	50	41	18	**23**	52	25	26	31	2
AF	1	1	0	0	0	**0**	0	1	0	2	0
CF	1	21	24	7	4	**1**	1	5	5	3	6
CommF	0	0	1	0	0	**0**	0	0	0	2	0
CompF	0	0	1	1	2	**0**	0	2	3	0	0
EF	2	0	0	7	1	**2**	5	1	0	1	0
NF	4	4	11	1	1	**0**	6	0	17	10	3
RF	3	4	1	2	5	**0**	2	0	0	0	0
UF	0	1	0	2	0	**0**	0	0	2	2	0
TF	0	0	0	0	0	**0**	1	0	0	0	0
TOTAL per TG	18	68	88	61	31	**26**	67	34	53	51	11

- 26 LOIs in Petra's spreadsheet
- 3 duplicates
- 4 belong in other groups
- 2 are general overviews

➔**17 LOIs describing specific MPGD plans or needs**

Observations:

- LOIs don't comprehensively cover MPGD technology landscape. "Overview LOIs" help in this regard.
- U.S. MPGD future needs also not fully represented; e.g. no IF5 LOIs on neutrino detectors with LEMS

Possible ways to categorize

- By MPGD technology
- By Snowmass Frontier
- By Experiment
- By MPGD role
- Better ideas? – suggestions welcome

Done via LOI naming process

Preliminary categorization

redacted

See current version on next page. We will keep updating at the link above.

			More suitable for other TG?	overview LOI?	type of experiment / physics			MPGD application / role					
File	Title	contact			future HEP collider experiments	nuclear physics experiments	low rate / low background experiment	electronic TPC readout	optical TPC readout	photon detection	tracking layers	timing layers, order 10 ps timing	calorimeter preshower, other colorimetry
IF2_IF7_IF3_IF4_IF5_IF6-056	Belle II detector upgrades	sevahsen@hawaii.edu			x (SuperKEKB)			x					
IF3_IF5_Simone_Mazza-175.	High density 3D integration of LGAD sensors through wafer to wafer bonding	simazza@ucsc.edu	Suggest IF3 handles		x (HL-LHC)			x				x	
IF3_IF5-EF1_EF4-183.pdf	Time projection chamber R&D	qihr@ihep.ac.cn			x (CEPC)			x					
IF5_CF2_AF5_Ferrer-Ribas-0	The International Axion Observatory (IAXO): MPGD development	E. Ferrer Ribas (Irfu, CEA)					x (IAXO)	x					
IF5_IF0_Brunbauer-096.pdf	Advanced micro-pattern gas detectors for tracking at the Electron Ion Collider	florian.brunbauer@cern.ch					x (CYGNO)	/	x				
IF5_IF0_C.Lampoudis-098.pd	High precision timing with the PICOSEC micromegas detector	Christos.Lampoudis@cern.ch				x (EIC)						x	
IF5_IF0_Gnanvo_Hohlmann_	Advanced Micro-Pattern Gas Detectors for Tracking at the Electron Ion Collider	hohlmann@fit.edu				x (EIC)					x		
IF5_IF0_Kondo_Gnanvo-159.	Development of large micro pattern gaseous detectors for high rate tracking at Jefferson Lab	kgnanvo@virginia.edu				x (CBAF)		x			x		
IF5_IF0_M_Hohlmann-040.pd	MPGDs for tracking and muon detection: progress review and updated R&D roadmap	hohlmann@fit.edu		x									
IF5_IF0_Marco_Cortesi-103.p	LOI from NSCL	cortesi@nscl.msu.edu				low-energy NF, rare isotope beams (RIBs)		x		x			
IF5_IF0-057.pdf	Pixelated resistive MicroMegas for high-rates environment	massimo.della.pietra@cern.ch			x (HL-LHC, FCC-ee/hh, EIC, Muon Collider)	x		x			x		x
IF5_IF0-184.pdf	A high-gain, low ion-backflow double micro-mesh gaseous structure	zhzhy@ustc.edu.cn			x (CEPC)			x	?	x			
IF5_IF3-015.pdf	A time projection chamber using advanced technology for the International Large Detector at the International Linear Collider	A. Bellerive (Carleton)			x (ILC)			x					
IF5_IF6-EF4_EF0_COLALEO	Advanced GEM detectors for future collider experiments	A.Colaleo (Bari)			x (HL-LHC, FCC-ee/hh, Muon Collider)	x		x			x	/	x
IF5_IF9-EF0_EF0-168.pdf	Development of the Micro-Pattern gaseous detector technologies: an overview of the CERN-RD51 collaboration	Silvia.DallaTorre@ts.infn.it		x									
IF5-005.pdf	The role of MPGD-based photon detectors in RICH technologies	S. Dalla Torre (Trieste)				x (EIC)			/	x			
IF5-EF4-007.pdf	micro-RWELL detector	G. Bencivenni			x (FCC-ee, CEPC)	x					?		
IF6_IF5_Laktineh-Calice-050.	Timing semi-digital hadronic calorimeter (T-SDHCAL)	laktineh@in2p3.fr			x (ILC)							?	x
IF7_IF5_H.MULLER-101.pdf	Trigger extensions for the scalable readout system SRS	Hans.Muller@cern.ch	Important for IF5, but more about readout than MPGDs themthelves. Handle jointly w/ IF7, IF4 ?		x	x	x						
IF8_IF5-NF10_NF0_Ben_Jon	Scintillating and quenched gas mixtures for HPGTPCs	ben.jones@uta.edu	Focused on scintillation and gas physics. Let other groups take the lead.				x (DUNE, NEXT)	x	x	x (primary scintillation)			
CF1_CF0-NF10_NF4-IF5_IF4	CYGNUS: a nuclear recoil observatory with directional sensitivity to dark matter and neutrinos	sevahsen@hawaii.edu					x (CYGNUS)	x					
EF3_EF4-IF3_IF5-031.pdf	The IDEA drift chamber for a Lepton Collider	franco.grancagnolo@le.infn.it	Suggest IF3. IDEA drift chamber. Tracking.		x (FCC-ee, CEPC)								
EF4_EF0-AF3_AF0-IF3_IF5_(	Exploring precision electroweak physics measurement potential of e+e- colliders	gwwilson@ku.edu	Focused on physics, not MPGDs										

- **One possible way to organize MPGD write-up would be by:**
- **MPGD role**
  → performance required
  → suggested R&D directions

- **Gaseous tracking will be jointly discussed and written with IF3 - solid state tracking.**

IF06: Calorimetry

Andy White,[1] Minfang Yeh,[2] Rachel Yohay[3]
[1]University of Texas at Arlington, [2]Brookhaven National Laboratory,
[3]Florida State University

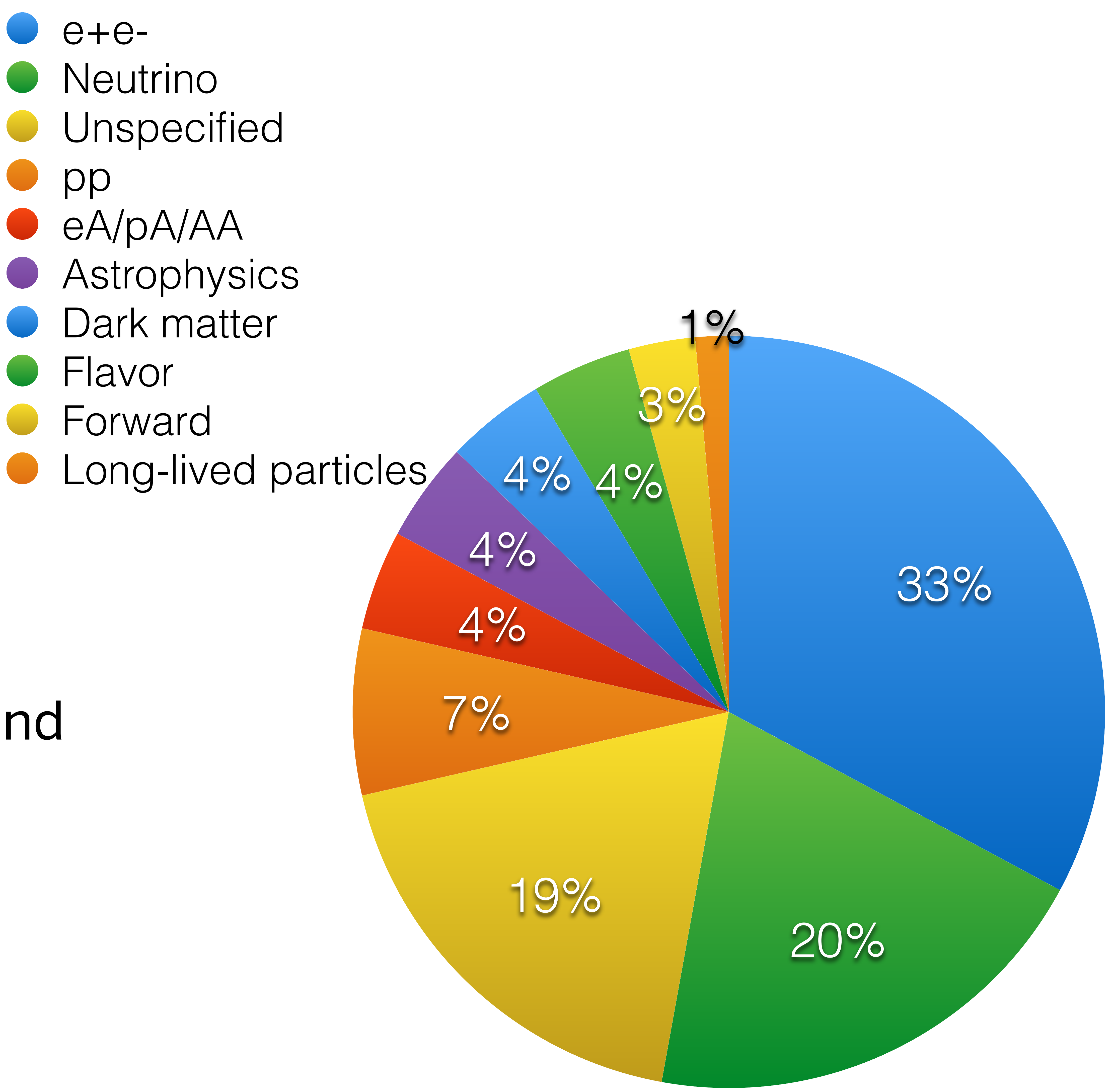
Snowmass Instrumentation Frontier conveners meeting

September 15, 2020

Overall

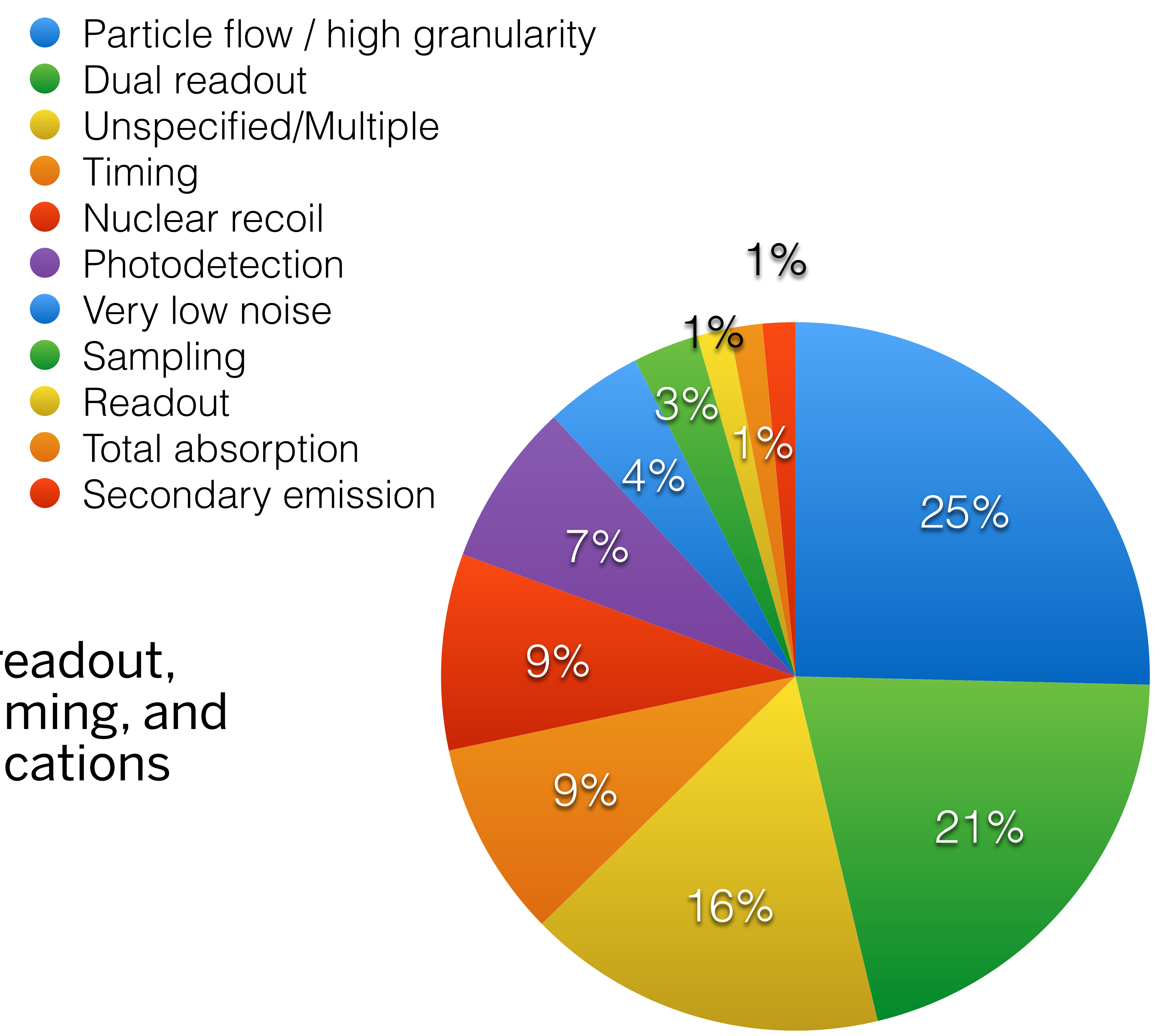
- 65 LoIs
  - +1 duplicate: https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF3_IF6_David_R_Winn-034.pdf
  - +3 broken links
    - https://www.snowmass21.org/docs/files/summaries/RF/SNOWMASS21-RF2_RF6-IF6_IF3_REDTOP_Collaboration-035.pdf
    - https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF3_IF6-112.pdf
    - https://www.snowmass21.org/docs/files/summaries/EF/SNOWMASS21-EF5_EF7-TF7_TF0-IF6_IF3-CompF3_CompF0_Ben_Nachman_(bpnachman@lbl.gov)-035.pdf

Physics topics



- e^+e^-, generalized R&D, and neutrino applications dominate

Techniques



- Particle flow, dual readout, generalized R&D, timing, and nuclear recoil applications dominate

IF 7 LOI summaries

Gabriella Carini
Mitch Newcomer
John Parsons
Sept 15, 2020

Submissions Directed to IF07 topic as Primary

IF 7 LOI Summary September 15, 2020

PDF Reference	Contact					Description
SNOWMASS21-IF7_IF0-073	SMU (Jingbo)	X				Optical Link HS (xtreme environment)
SNOWMASS21-IF7_IF0_Frank_Krennrich-173	F. Krennerich			X		Quality Control Cryogenic Detector FE Readout
SNOWMASS21-IF7_IF1_Carl_Grace-109	Carl Grace LBL		X			Low Temp SiGe heterogenus bipolar
SNOWMASS21-IF7_IF2-NF10_NF0_Analog_Photon_Processor-052	Josh Klein				X	Analog Processor with parametric feature Extraction
SNOWMASS21-IF7_IF3_Leo_Greiner-160	Leo Greiner		X			BNL & LBL MAPs
SNOWMASS21-IF7_IF4_Sandeep_Miryala-180	Sandeep		X			AI ASICs for front end processing
SNOWMASS21-IF7_IF4-132	NALU scientific		X			ML and AI data inferential reduction
SNOWMASS21-IF7_IF5_H.MULLER-101	Hans Muller Bonn Univ.	X				ART for Scaleable Readout System
SNOWMASS21-IF7_IF8-NF10_NF0_Jonathan_Asaadi-079	Jonathan Asaadi Q-Pix				X	Pixelated LAR_TPC Readout Technique
SNOWMASS21-IF7_IF8-NF10_NF0-UF3_UF0_Dan_Dwyer-171	Dan Dwyer				X	Pixelated LAR_TPC Readout Technique
SNOWMASS21-IF7_IF9-CF2_CF4_Austin_Minnich-117	Austin Minnich (Caltech)		X			Quantum-limited transist uwave amplifiers
	Totals	2	5	1	2	

Technology Specificic Near Term Continued Development

Technogy Specific Long Term Investigation

Quality Control technique for Extreme Environments

Existing F E Electronics Tech to implement novel detector readout

IF07 second choice

IF3-IF7

Time of Flight Detector for circular electron positron collider
PRECISION TIMING DETECTORS FOR FUTURE COLLIDERS
Large area CMOS monolithic active pixel sensors for future colliders
28nm CMOS for 4D Tracker Readout Chips
4-Dimensional Trackers

IF4-IF7

FPGA Based Artificial Intelligence Inference In Triggered Detectors
Radiation-hard high-speed fiber-optical data links for HEP experiments
Self-driving data trigger, filtering, and acquisition systems for high-throughput physics facilities
Real-time adaptive deep-learning with embedded systems for discovery science

IF08 LOI report

Eric Dahl
Roxanne Guenette
Jen Raaf

LOI received

- 53 LOIs received (19 IF8 primary)

- Themes covered:
  ➡ Generic overview of large-scale detectors and future possibilities
  ➡ Detector instrumentation R&D (low and ultra low thresholds, pixels, charge gain, light collection, magnetized TPC, HV, Ba tagging)
  ➡ Detector instrumentation with science goals (neutrinos, $0\nu\beta\beta$, dark matter, directional DM)
  ➡ Radiopurity (impurity removal, materials, underground argon)
  ➡ Sourcing and procurement of noble element
  ➡ Computing (microphysics simulations, machine learning and event reconstruction)
  ➡ Calibration
  ➡ Facilities (infrastructure, sources, calibration)

Low-threshold TPCs (electron counting)

CF1_CF0-IF8_IF0_Guillaume_Gi	Search for low mass WIMPs with spherical proportional counters
IF8_IF0_Shawn_Westerdale_anc	R&D for low-threshold noble liquid detectors
NF7_NF9-IF8_IF0_Kaixuan_Ni-0	Noble liquids for the detection of CEvNS from artificial neutrino sources

Ultra-low-threshold (cryogenic) detectors w/ quasi-particle sensing

IF1_IF8-CF1_CF0_Hertel-158.pd	Calorimetric readout of a superfluid 4He target mass
CF1_CF2-IF1_IF8-120.pdf	The TESSERACT dark matter project
IF8_IF0-CF1_CF0_sorensen-053	A crystalline future for dual phase xenon direct detection instruments

Metastable fluids

IF8_IF0_Eric_Dahl-135.pdf	Enabling the next generation of bubble-chamber experiments for dark matter. and neutrino physics
CF1_CF0-NF10_NF6-IF8_IF6_M	Metastable water: breakthrough technology for dark matter & neutrinos

New TPC Physics Applications

CF7_CF1-NF7_NF10-IF8_IF0_Sl	A next-generation LAr TPC-based MeV Gamma ray instrument
NF7_NF9-IF8_IF0_Kaixuan_Ni-0	Noble liquids for the detection of CEvNS from artificial neutrino sources
NF6_NF4-IF2_IF8-139.pdf	Inelastic neutrino-nucleus interaction measurements with COHERENT
NF10_NF3-IF2_IF8-UF1_UF3_Ze	Searches for proton-decay with additional signatures from nuclear deexitations and with precise timin

Facilities

UF0_UF0-NF0_NF0-RF4_RF3-C	The Sanford underground research facility
UF6_UF0-NF10_NF0-RF4_RF0-I	Solution-mined dalt caverns as sites for underground physics experiments
NF9_NF5-CF1_CF0-IF8_IF0_JNI	ORNL neutrino sources for future experiments
NF6_NF9-CF1_CF0-TF11_TF0-II	Neutrino opportunities at the ORNL second target station

Global Calibration Needs

IF8_IF6_Michael_Mooney-192.pc	Precision calibration of large LArTPC detectors
IF8_IF0-NF5_NF10-CF1_CF0-Cc	NEST, The Noble Element Simulation Technique: a multi-disciplinary monte carlo tool and framework
IF6_IF8-NF4_NF9-CF1_CF2_Ric	Nuclear recoil calibration techniques for dark matter and neutrino experiments
IF8_IF9-042.pdf	Investigations of fundamental parameters of liquid argon for particle detection

Pixels

IF2_IF8-NF10_NF0_Gramellini-1	Multi-modal pixels for noble element time projection chambers
IF7_IF8-NF10_NF0_Jonathan_As	Q-Pix: kiloton-scale pixelated liquid noble TPCs
IF7_IF8-NF10_NF0-UF3_UF0_D	An R&D collaboration for scalable pixelated detector systems

Charge Gain

CF1_CF0-IF8_IF0_Guillaume_Gi	Search for low mass WIMPs with spherical proportional counters
IF8_IF0-NF0_NF0-016.pdf	Electron multiplication in liquid argon TPC detectors for low energy rare event physics
IF8_IF5-NF10_NF0_Ben_Jones-I	Scintillating and quenched gas mixtures for HPGTPCs

Sourcing / purifying noble gasses

IF8_IF0-CF1_CF0_Dongqing_Hu	Charcoal-based radon reduction systems for ultra-clean rare-event detectors
IF8_IF0-UF3_UF0_Brian_Mong-1	Using metal organic frameworks for Krypton and Radon removal in low-background Xenon detectors
IF8_IF9_Giovanetti-163.pdf	Applications for underground Argon
NF5_NF3-RF4_RF0-IF8_IF0_Mo	Kilotonne-scale Xe TPCs for 0vbb searches at 10^30 yr half-life sensitivity
NF5_NF10-IF8_IF0_Zennamo-17	DUNE-Beta: searching for neutrinoless double beta decay with a large LArTPC

Directionality / micron-precision spatial reconstruction

IF9_IF8-NF3_NF10-CF1	Dual-readout time projection chamber: exploring sub-millimeter pitch for directional dark matter and tau identification in vtCC interact
IF8_IF0-NF10_NF6_Jac	Towards directional nuclear recoil detectors: tracking of nuclear recoils in gas Argon TPCs
IF8_IF1_C._J._Martoff-(	Instrumentation and R&D for the Global Argon Dark Matter collaboration

Increasing Light Collection

IF8_IF2_RGuenette-084	Cost-effective solution for increased light collection in noble-element detectors with metalenses
IF8_IF2_Andrzej_Szelc-	Wavelength-shifting relfector foils in liquid Argon neutrino detectors
IF3_IF8-NF2_NF9_Jing	COHERENT: Instrumentation development
IF8_IF0_Eric_Dahl-135.	Enabling the next generation of bubble-chamber experiments for dark matter. and neutrino physics
IF8_IF9_Westerdale-14	Instrumentation and R&D for the Global Argon Dark Matter collaboration
NF10_NF0-IF8_IF0_Zer	Improving large LArTPC performance through the use of photo-ionizing dopants

TPC with magnetic field

IF8_IF9-153.pdf	Magnetizing the liquid Argon TPC
NF2_NF6-CF1_CF0-IF8	ICARUS in the next decade

Barium Tagging

NF5_NF3-RF4_RF0-IF8	Barium tagging for a nEXO upgrade and future 136Xe 0vbb detectors
NF5_NF10-RF4_RF0-IF	Barium tagging in Xenon gas for neutrinoless double beta decay

Lowering Backgrounds (aside from radioactive nobles)

IF8_IF0-NF5_NF0-RF4	High-pressure xenon gas time-projection chambers for neutrinoless double-beta decay searches
NF10_NF4-CF1_CF0-IF	Low background kTon-scale liquid Argon time projection chambers
CF1_CF2-NF5_NF4-IF8	The exploitation of Xe large scale detector technology for a range of future rare event physics searches

Computing

CompF1-NF10-IF8-002.	Wire-cell toolkit
CompF2_CompF1-NF1	Fast simulations for noble liquid experiments
CompF3_CompF2-NF1	The future of machine learning in rare event searches
IF8_IF0-NF5_NF10-CF1	NEST, The Noble Element Simulation Technique: a multi-disciplinary monte carlo tool and framework for noble elements

High Voltage

IF8_IF0-031.pdf	High voltage cable feed-through
NF10_NF0-IF9_IF8_Xin	Development of LArTPC vertical drift solutions with PCB anode readouts for DUNE

High-level summaries of R&D needs by experiment

NF10_NF6-IF8_IF9_DU	DUNE near detector
IF8_IF9_Westerdale-14	Instrumentation and R&D for the Global Argon Dark Matter collaboration
IF8_IF0_Eric_Dahl-135.	Enabling the next generation of bubble-chamber experiments for dark matter. and neutrino physics
CF1_CF2-NF5_NF4-IF8	The exploitation of Xe large scale detector technology for a range of future rare event physics searches

CROSS-CUTTING AND SYSTEMS INTEGRATION

Jim Fast (JLAB), Maurice Garcia-Sciveres (LBNL), Ian Shipsey (Oxford)

IF9 LOI's

- Received LOI's: 44 with "IF9" somewhere in the file name
  - 5 w/o IF9 in file name passed along to us (total 49)
  - We know for sure there >5 w/o IF9 in file name. >>5?
  - 14/49 deemed true cross-cutting; 18 belonged in other IF's, rest are "maybe" or not x-cut, but have no other home.
  - 7 yes + 2 maybe are related to facilities (irradiation, test beam, semiconductor fab, ...)
- Missing from LOI's
  - More complete picture of facilities (expanding content in BRN)
    - Remedy: survey link
      (we asked all conveners to forward us LOIs submitted elsewhere but got very few)
  - More multi-disciplinary activities
    - Remedy: Multihep2020 Nov 10-12 2020 link
      (we asked all conveners to forward us LOIs submitted elsewhere but got none)

IF 10 – Radio Detection

Abby Vieregg and Jim Beatty

LOIs Received in IF10

- 12 LOIs were received that tagged IF10.
- Another 6 were received in the IF that plausibly belong in IF10 also.
- Some LOIs were also submitted to the NF or CF (not IF) that are related to the science that some instrumentation IF10 enables.
- The LOIs that were received in IF10 fall in a few main groups: radio detection of ultra-high energy neutrinos and cosmic rays, radio detection of axions, and technology related to mm-wave observations.
- There are a few areas that are not well represented: technology related to 21cm observations, possible radio detection of gamma ray air showers are two examples.

Summary of the Summary

- TG conveners are busy organizing into larger themes
- Many are using the regular TG meetings to confer with the field
  - Please join if you want to contribute
- If you see something off or missing, please say something