

Snowmass Theory Frontier: Introduction

Nathaniel Craig, Csaba Csaki, and Aida El-Khadra
and
Theory Frontier Topical Group Conveners

Snowmass Community Planning Meeting
05-08 October 2020

DPF Core Principles and Community Guidelines (CP&CG)

- By participating in this meeting, you agree to adhere to the CP&CG
 - **Respect and support community members**
 - **Commit to constructive dialogue and take initiative**
 - Details of what this means, expectations for behavior, and accountability procedures are provided in the CP&CG document linked at:
<https://snowmass21.org/cpcg/start>
- Everyone is invited to invoke the CP&CG as needed to encourage constructive and supportive collaboration
- The conveners of this meeting are your recommended first point of contact for reports of CP&CG violations occurring here
 - The conveners have received training in the CP&CG and how to handle reports
 - The CP&CG accountability procedure is designed to encourage early intervention and is flexible enough to appropriately address issues ranging from the discourteous to the egregious
 - Please do not hesitate to contact us!
- Snowmass is most successful when everyone's voice can be heard!

Theory Frontier Structure



Nathaniel Craig
UCSB



Csaba Csaki
Cornell



Aida El-Khadra
UIUC

Topical Group		Topical Group Conveners			
TF01	String theory, quantum gravity, black holes	Daniel Harlow	Shamit Kachru	Juan Maldacena	
TF02	Effective field theory techniques	Patrick Draper	Ira Rothstein		
TF03	CFT and formal QFT	David Poland	Leonardo Rastelli		
TF04	Scattering amplitudes	Zvi Bern	Jaroslav Trnka		
TF05	Lattice gauge theory	Zohreh Davoudi	Taku Izubuchi	Ethan Neil	
TF06	Theory techniques for precision physics	Radja Boughezal	Zoltan Ligeti		
TF07	Collider phenomenology	Fabio Maltoni	Shufang Su	Jesse Thaler	
TF08	BSM model building	Patrick Fox	Graham Kribs	Hitoshi Murayama	
TF09	Astro-particle physics and cosmology	Dan Green	Joshua Ruderman	Ben Safdi	Jessie Shelton
TF10	Quantum information science	Simon Catterall	Roni Harnik	Veronika Hubeny	
TF11	Theory of Neutrino Physics	André de Gouvêa	Irina Mocioiu	Saori Pastore	Louis Strigari

TF Liaisons to Other Frontiers

Energy Laura Reina (Florida State U)	Neutrino Physics Irina Mociouiu (Penn State U) & Kaladi S. Babu (Oklahoma State U)
Rare Processes and Precision Alexey Petrov (Wayne State)	Cosmic Flip Tanedo (UC Riverside)
Theory	Accelerator Lian-Tao Wang (U Chicago)
Instrumentation	Computational Steven Gottlieb (Indiana U)
Underground Facilities	Community Engagement Devin Walker (Dartmouth)

Theory Frontier By the Numbers

● People:

- 41 TF TG conveners and liaisons with other frontiers
- ~ 100 theorists as conveners across all frontiers and TGs
- Snowmass TF community mailing list: ~860 subscribers
- ~380/295 CPM participants listing TF as primary/secondary
- >70 White Papers that are actively being solicited

● LOIs:

- TF primary: 93
- TF secondary: 218
- total: 311

● Sessions @ the CPM

- 26 inter-frontier breakout sessions co-organized by TF TGs
- 2 cross TF breakout sessions + this TF Intro

Past Meetings

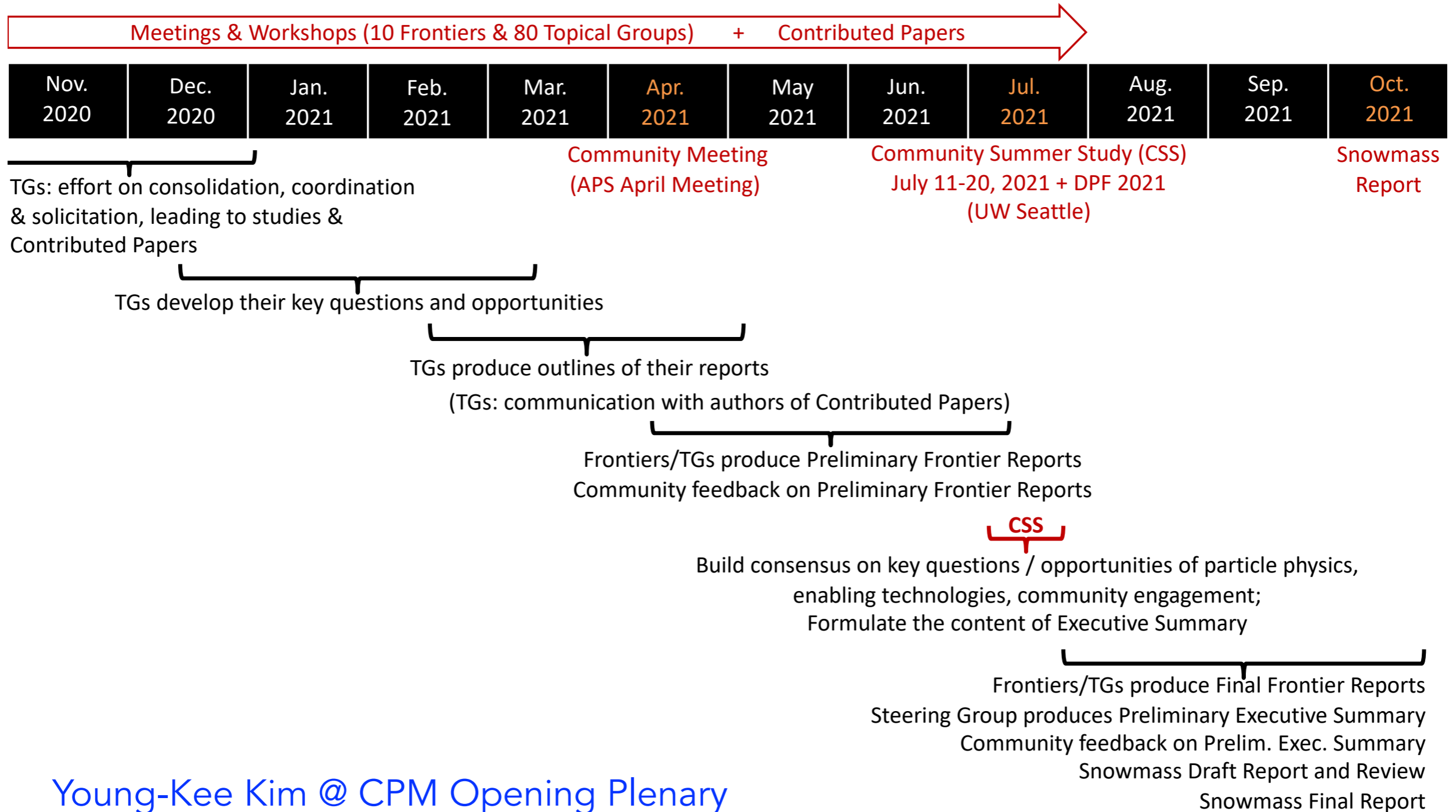
- Theory Frontier Kick-Off Town Hall: 30 July 2020
<https://indico.fnal.gov/event/44512/>
- EW Effects at High Energy: 15 Sep 2020
organized by TF07 (Maltoni, Su, Thaler)
<https://indico.fnal.gov/event/45400/>
- Mini Workshop on Neutrino Theory: 21-23 Sep 2020
organized by TF11 (de Gouvea, Mocioiu, Pastore, Strigari)
<https://indico.fnal.gov/event/45039/>

CPM CSS and the Final Reports: Meetings

- Joint RPF1/TF05/TF06 Meeting on $|V_{cb}|$ and $|V_{ub}|$ planned for November
- plans for further inter-frontier workshops will be developed during or after the CPM
- WP planning meetings in late 2020/early 2021 envisioned by several TF TGs
- Theory Frontier Conference @ KITP: 17-19 March 2021
 - Highlight theoretical developments
 - Consolidate TF White Papers and other activities
 - Coordinate theory activities across frontiers

CPM → CSS and the Final Reports: Plans

● Snowmass timeline: Now → July 2021 → Oct 2021



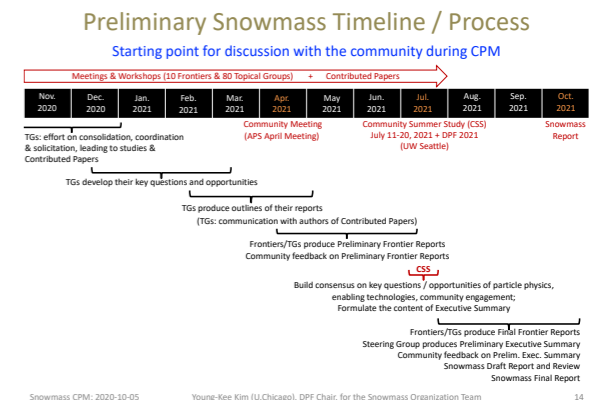
Young-Kee Kim @ CPM Opening Plenary

CPM → CSS and the Final Reports: Plans

● Snowmass timeline: Now → July 2021 → Oct 2021

● Community Input @ heart of Snowmass process

- LOIs → WPs (aka “Contributed Papers”)
 - not all LOIs will turn into WPs, not all WPs are based on LOIs
- use CPM to develop inter-frontier WPs based on LOIs and discussions
- identify theory contributions to project frontiers
- each TG is developing processes for soliciting/developing/including WPs and receiving community input
- communication channels include email lists, slack channels, workshops, targeted WP meetings
 - see [Snowmass Theory Frontier wiki page](#)



CPM → CSS and the Final Reports: Plans

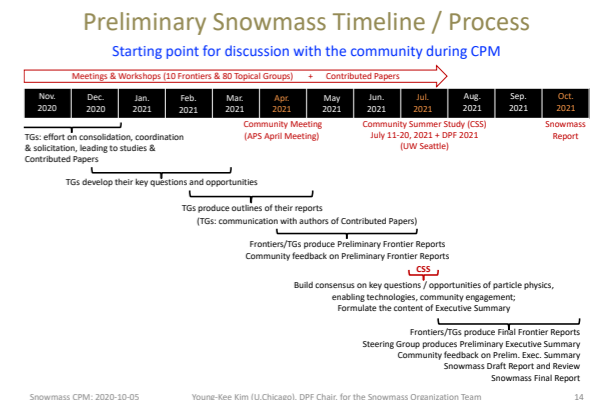
● Snowmass timeline: Now → July 2021 → Oct 2021

● TG reports will be based on the WPs and LOIs

- TGs will communicate with WP, LOI authors, may ask for WP outlines, status, feedback on TG report outlines,...

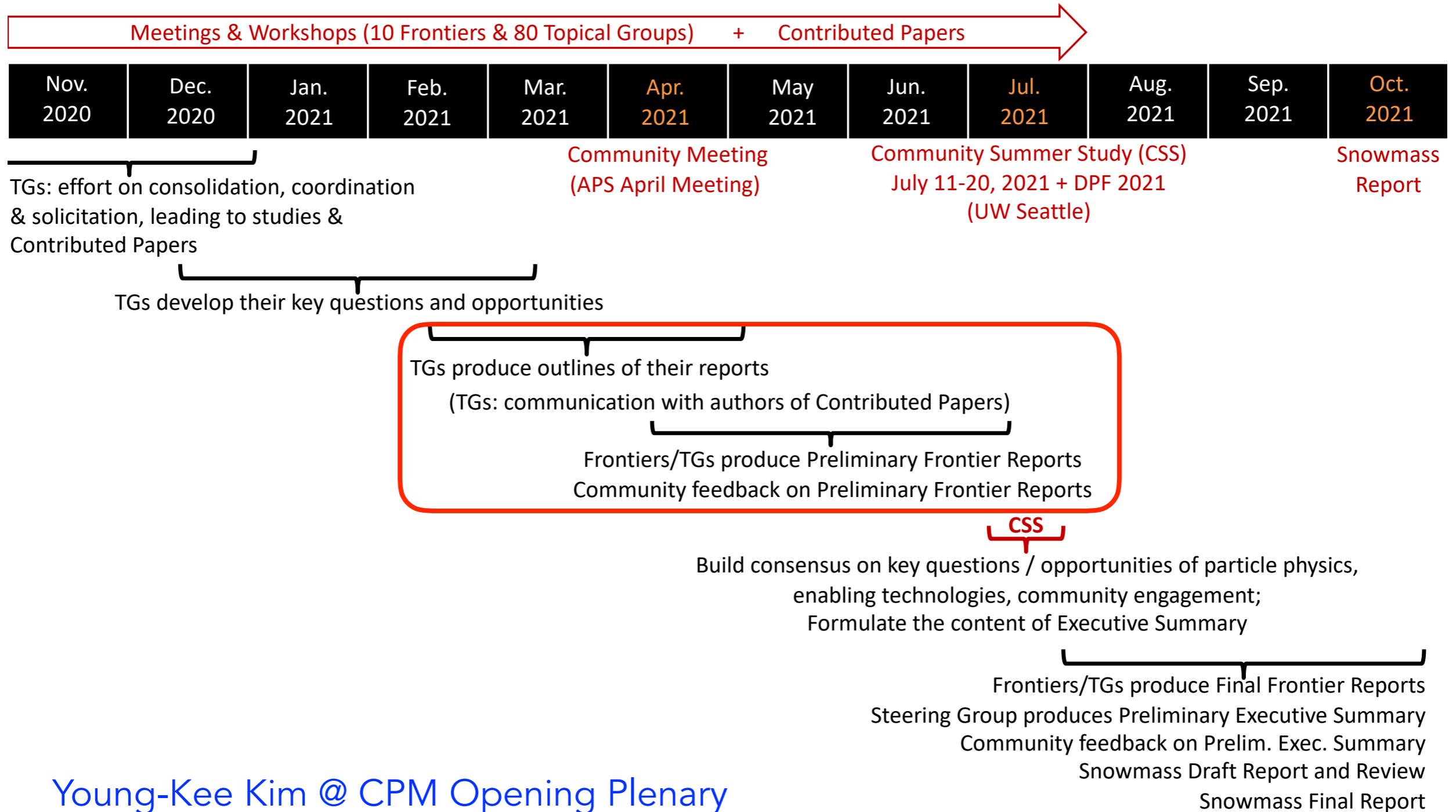
● TF report will be based on the TG reports. Goals are to

- cover all aspects of high energy theory and connections to other fields
- summarize theoretical developments and their impacts
- highlight developments in formal theory not (currently) directly related to experimental efforts
- highlight theoretical contributions to project oriented frontiers
→ coordinate with theorists participating in other frontier efforts
- plan to solicit community input along the way:
solicit feedback at various stages before finalizing reports



CPM → CSS and the Final Reports: Plans

● Snowmass timeline: Now → July 2021 → Oct 2021



Young-Kee Kim @ CPM Opening Plenary

Theory Frontier @ the CPM

- Report from the Theory Frontier Thursday plenary talk (Nathaniel Craig)
highlight promising theoretical developments
- Session timeline view (with zoom room info)
- Guide to breakout sessions co-organized by TF TGs

#	Breakout Sessions Session Title	Session Start Time (US CDT)	length minutes	Theory Frontier Topical Groups											Other Frontiers									
				all	TF01	TF02	TF03	TF04	TF05	TF06	TF07	TF08	TF09	TF10	TF11	EF	NF	CF	AF	RF	CompF	IF	UF	CEF
6	TF Intro	Tuesday 11:00	30	all																				
72	Dark Energy, Origins (Inflation), and Light Relics	Tuesday 11:30	60											TF09			y	y						
77	Quantum Sensors for Wave and Particle Detection	Tuesday 11:30	60											TF09	TF10		y	y					y	y
92	Non-perturbative QCD dynamics at colliders	Tuesday 11:30	60			TF02		TF04	TF05	TF06	TF07					y								
108	Accelerator Probes of Light Dark Matter (keV-GeV)	Tuesday 11:30	120											TF09		y	y	y		y				
109	Determining the Masses and Nature of Neutrinos	Tuesday 11:30	120												TF11	y				y				
125	EFTs for new physics sensitivity studies	Tuesday 11:30	105			TF02				TF06						y				y	y			
129	Higgs Factories	Tuesday 11:30	90								TF07	TF08				y			y					
131	Physics requirements for HEP detectors at colliders	Tuesday 12:30	60								TF07					y				y		y		
139	Testing LambdaCDM cosmology at low and high redshifts	Tuesday 12:30	30											TF09				y						
74	Atomic to Cosmic: Wave Dark Matter and Beyond	Tuesday 13:00	90											TF09				y						
102	The Roles of QIS in HEP	Tuesday 13:00	90	all	TF01		TF03		TF05						TF10				y	y	y	y	y	
124	Lattice Gauge Theory for High Energy Physics	Tuesday 13:00	90				TF03		TF05		TF07					y				y	y			
126	BSM: direct and indirect searches	Tuesday 13:00	90											TF08		y				y				
128	From Amplitudes to Precision Theory for Future Colliders	Tuesday 13:30	105					TF04		TF06						y					y			
127	Searches for dark sectors	Tuesday 14:00	120											TF09		y		y	y	y				
132	Collider Data Analyses Strategies	Tuesday 14:30	90									TF07				y		y		y	y			
29	Low-energy precision experiments	Tuesday 15:00	60						TF05	TF06	TF07					y	y			y				
40	Exotic Hadron Spectroscopy and Interpretation	Tuesday 15:00	60						TF05							y				y				
97	Neutrinos as Probes of Standard and BSM Particle Physics	Tuesday 15:00	60						TF05					TF09	TF11	y	y				y			
101	Higgs as a probe of new physics	Tuesday 15:00	60								TF07	TF08				y				y				
183	Intermediate lepton collision energies between 500 GeV and 1 TeV	Tuesday 15:00	60	all							TF07					y			y					
141	Gravitational wave source modelling	Tuesday 15:30	30			TF02		TF04						TF09				y						
150	Dark Matter Complementarity	Wednesday 12:15	45	all										TF09		y	y	y	y	y		y		
84	Computing Requirements & Opportunities in Theory	Wednesday 12:45	60				TF03		TF05							y					y			
26	Energy Frontier discovery machines	Wednesday 13:00	90									TF07	TF08			y			y			y		
28	Theory Challenges in Precision Measurements	Wednesday 13:00	90	all												y				y	y			
41	Anomalies in Flavor Physics	Wednesday 13:00	60						TF05	TF06										y				
75	Cosmic Probes of Dark Matter Physics	Wednesday 13:00	90											TF09				y						
99	Advances in Event Generation and Detector Simulation	Wednesday 13:00	90									TF07				y				y	y	y		
119	HEP Workforce Careers and Training	Wednesday 13:00	90	all												y	y	y	y	y	y	y	y	y
137	High and ultrahigh energy neutrino experiments	Wednesday 13:00	60											TF09	TF11	y	y					y		
105	The Reach of Formal Theory	Wednesday 13:45	60	all	TF01	TF02	TF03	TF04						TF09										
188	Plasma acc for fixed target experiments	Wednesday 14:00	30																y					
206	TF Planning	Wednesday 15:00	60	all																				

organizing TF TGs indicated in red boldface

Theory Frontier @ the CPM

Guide to breakout sessions co-organized by TF TGs

all TF

105	<u>The Reach of Formal Theory</u>	Wednesday 13:45	TF01	TF02	TF03	TF04	TF09
206	<u>TF Planning</u>	Wednesday 15:00	All TF TGs				

TF01: String theory, quantum gravity, black holes

102	<u>The Roles of QIS in HEP</u>	Tuesday 13:00	TF01	TF10	AF/IF/RPF/CompF		
105	<u>The Reach of Formal Theory</u>	Wednesday 13:45	TF01	TF02	TF03	TF04	TF09

TF02: Effective field theory techniques

125	<u>EFTs for new physics sensitivity studie</u>	Tuesday 11:30	TF02	TF06	EF/RPF/CompF		
141	<u>Gravitational wave source modelling</u>	Tuesday 15:30	TF02	TF04	CF		
105	<u>The Reach of Formal Theory</u>	Wednesday 13:45	TF01	TF02	TF03	TF04	TF09

TF03: CFT and formal QFT

84	<u>Computing Requirements & Opportunities in Theory</u>	Wednesday 12:45	TF03	TF05	CompF		
105	<u>The Reach of Formal Theory</u>	Wednesday 13:45	TF01	TF02	TF03	TF04	TF09

Theory Frontier @ the CPM

Guide to breakout sessions co-organized by TF TGs

TF04: Scattering amplitudes

128	<u>From Amplitudes to Precision Theory</u>	Tuesday 13:30	TF04	TF06	EF/RPF/CompF
141	<u>Gravitational wave source modelling</u>	Tuesday 15:30	TF02	TF04	CF
105	<u>The Reach of Formal Theory</u>	Wednesday 13:45	TF01	TF02	TF03 TF04 TF09

TF05: Lattice gauge theory

124	<u>Lattice Gauge Theory for High Energy Theor</u>	Tuesday 13:00	TF05	TF03	EF/RPF/CompF
40	<u>Exotic Hadron Spectroscopy and Interpretati</u>	Tuesday 15:00	TF05		EF/RPF
84	<u>Computing Requirements & Opportunities in Theory</u>	Wednesday 12:45	TF03	TF05	CompF
41	<u>Anomalies in Flavor Physics</u>	Wednesday 13:00	TF05	TF06	RPF

TF06: Theory techniques for precision physics

125	<u>EFTs for new physics sensitivity studies</u>	Tuesday 11:30	TF02	TF06	EF/RPF/CompF
128	<u>From Amplitudes to Precision Theory for Futu</u>	Tuesday 13:30	TF04	TF06	EF/RPF/CompF
41	<u>Anomalies in Flavor Physics</u>	Wednesday 13:00	TF05	TF06	RPF

Theory Frontier @ the CPM

Guide to breakout sessions co-organized by TF TGs

TF07: Collider phenomenology

92	<u>Non-perturbative QCD dynamics at col</u>	Tuesday 11:30	TF07	EF	
129	<u>Higgs Factories</u>	Tuesday 11:30	TF07	AF/EF	
126	<u>BSM: direct and indirect searches</u>	Tuesday 13:00	TF07	TF08	EF/RPF
132	<u>Collider Data Analyses Strategies</u>	Tuesday 14:30	TF07	EF/CF/RPF/CompF	
26	<u>Energy Frontier discovery machines</u>	Wednesday 13:00	TF07	AF/EF/IF	
99	<u>Advances in Event Generation and Detecto</u>	Wednesday 13:00	TF07	EF/RPF/CompF	

TF08: BSM model building

126	<u>BSM: direct and indirect searches</u>	Tuesday 13:00	TF07	TF08	EF/RPF
101	<u>Higgs as a probe of new physics</u>	Tuesday 14:30	TF07	EF/CF/RPF/CompF	

Theory Frontier @ the CPM

Guide to breakout sessions co-organized by TF TGs

TF09: Astro-particle physics & cosmology

72	<u>Dark Energy, Origins (Inflation), and Light Relics</u>	Tuesday 11:30	TF09	CF/NF
108	<u>Accelerator Probes of Light Dark Matter (keV-GeV)</u>	Tuesday 11:30	TF09	EF/CF/NF/RPF
74	<u>Atomic to Cosmic: Wave Dark Matter and Beyond</u>	Tuesday 13:00	TF09	CF
127	<u>Searches for dark sectors</u>	Tuesday 14:00	TF09	AF/EF/CF/RPF
75	<u>Cosmic Probes of Dark Matter Physics</u>	Wednesday 13:00	TF09	CF
105	<u>The Reach of Formal Theory</u>	Wednesday 13:45	TF01	TF02 TF03 TF04 TF09

TF10: Quantum Information Science

77	<u>Quantum Sensors for Wave and</u>	Tuesday 11:30	TF10	NF/CF/IF/UF
102	<u>The Roles of QIS in HEP</u>	Tuesday 13:00	TF01	TF10 AF/IF/RPF/CompF

TF11: Theory of neutrino physics

109	<u>Determining the Masses and Nature of Neutrinos</u>	Tuesday 11:30	TF11	NF/RPF
97	<u>Neutrinos as Probes of Standard and BSM Particle I</u>	Tuesday 15:00	TF11	NF/CF/CompF
137	<u>High and ultrahigh energy neutrino experiments</u>	Wednesday 13:00	TF11	NF/CF

Questions, comments,
or suggestions?

Questions, comments, or suggestions?

...continue the discussion in the Slack channel
`#cpm_tf_intro_planning`