

International
UON Collider
Collaboration



SL Report

D. Schulte



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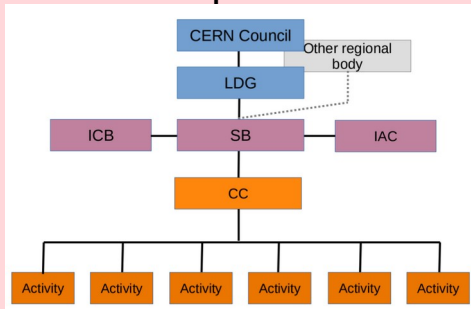


CERN
March 2023

Muon Collider Community



Formed **collaboration** to implement and R&D Roadmap for CERN Council

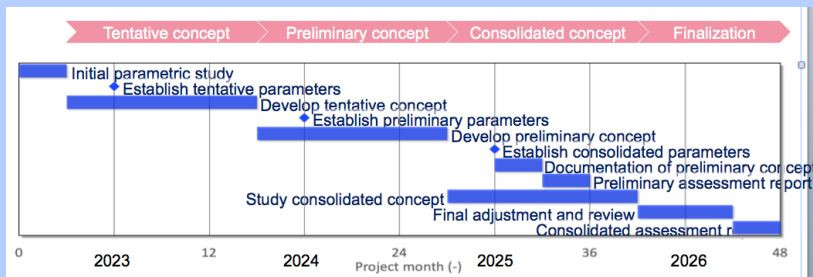


50+ partner institutions
30+ already signed formal agreement

Plan to apply in 2024 for **HORIZON-INFRA-2024-TECH**

Goal: prepare experimental programme, e.g. **demonstrator, prototypes, ...**

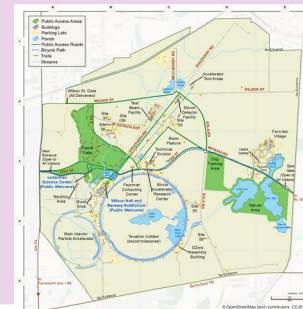
EU Design Study just started, 32 partners, O(3+4 MEUR)
(EU+Switzerland+UK and partners)



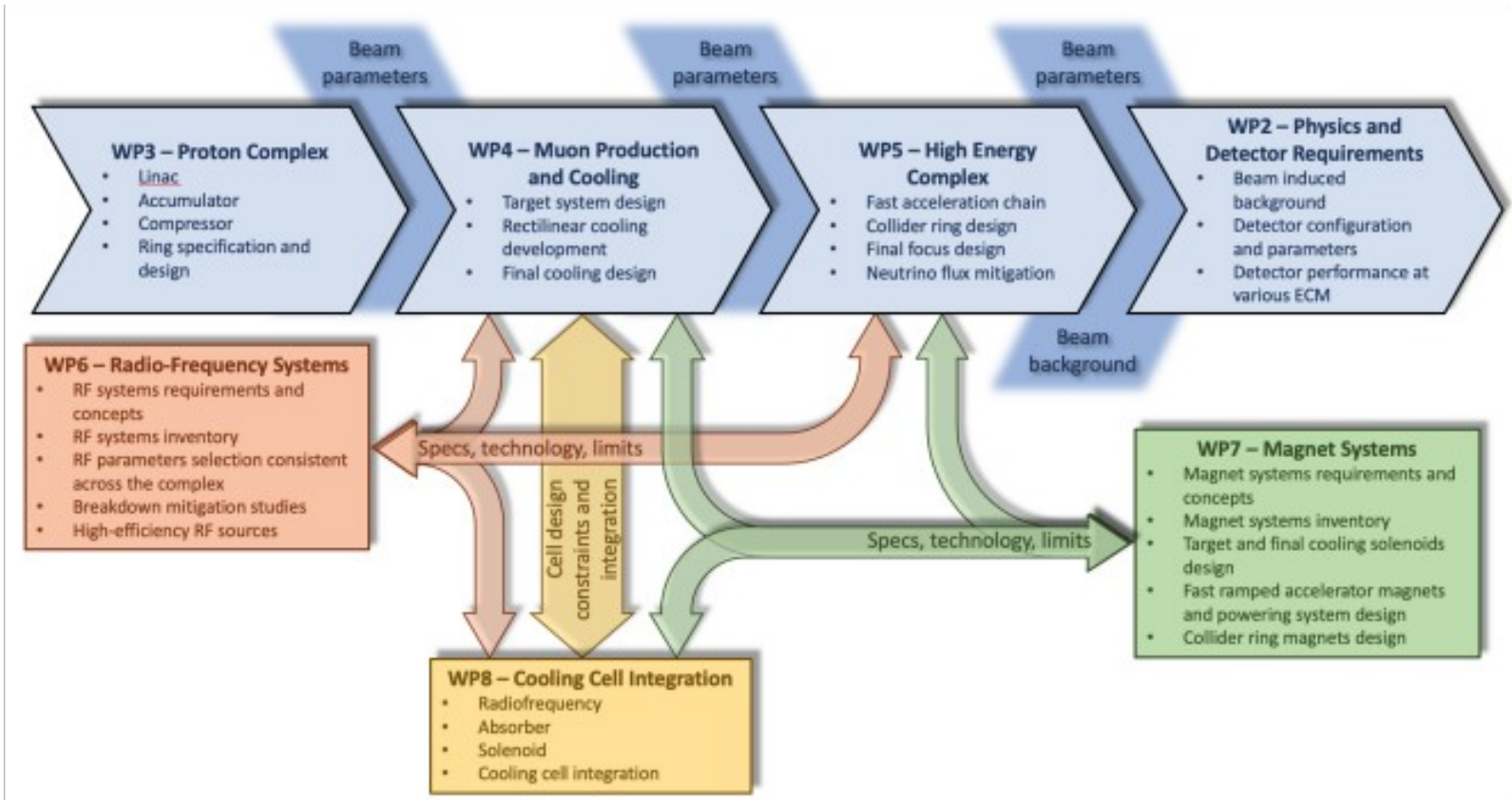
US Snowmass has strong support

- to contribute to R&D
- as a collider in the US

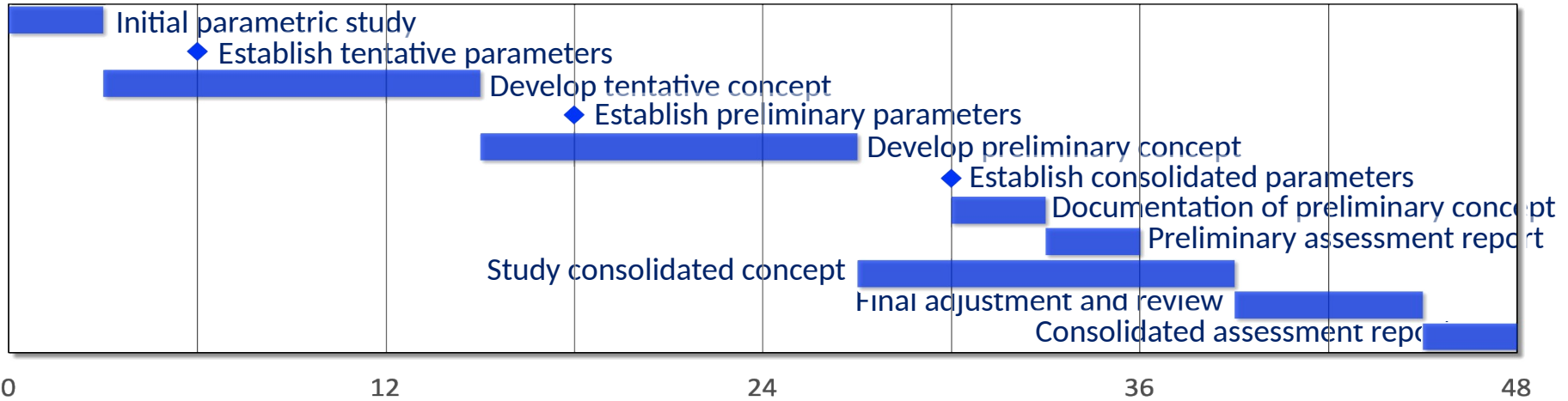
Now P5 and EPP2024 are ongoing
Planning potential contributions



MuCol



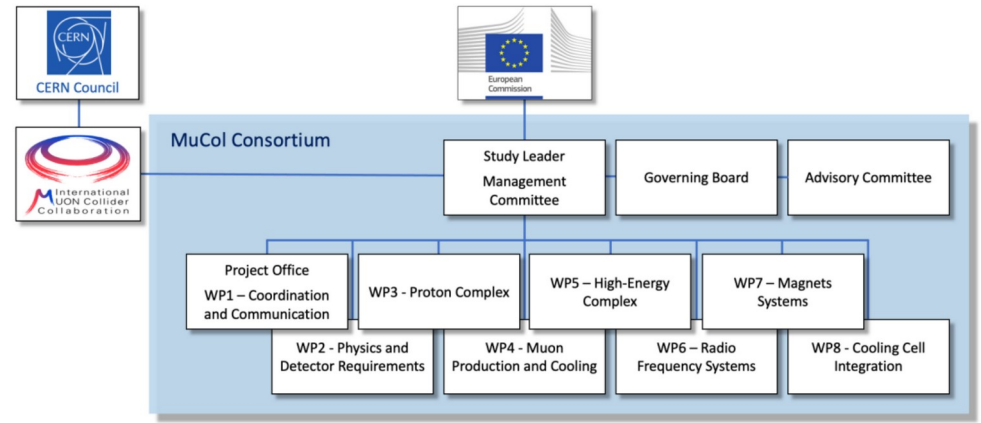
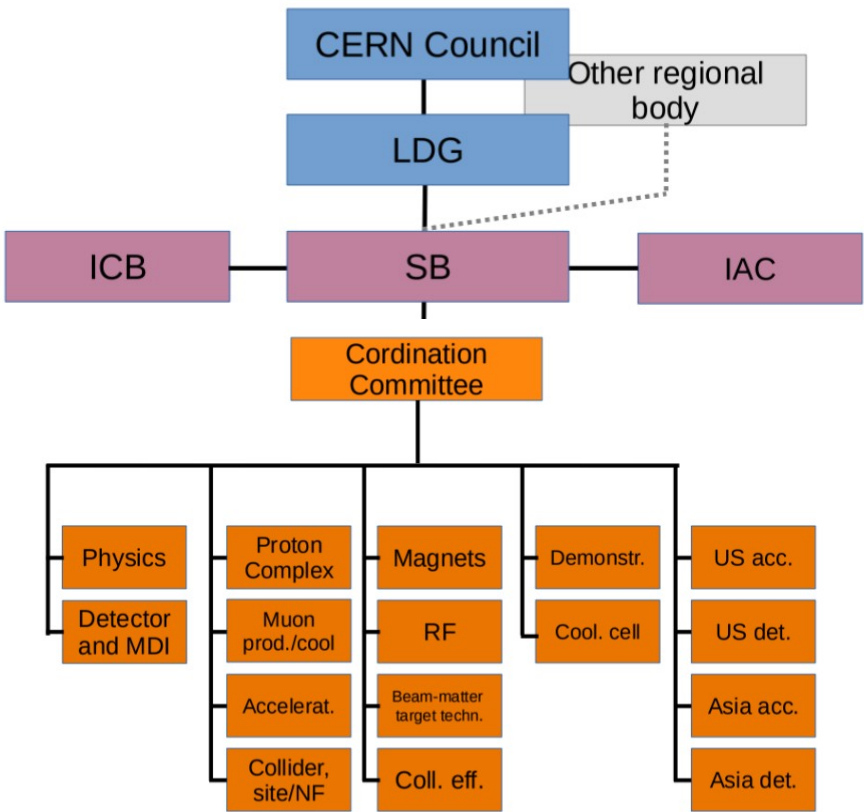
MuCol Timeline



Next ESPPU ?

Representative of overall workplan, now shifted by 2 months

IMCC and MuCol Organisation



- Collaboration Board (ICB) and Governing Board (GB)**
- Steering Board (SB) is unique**
- Coordination Committee (CC) and Management Committee (MC)**
- International Advisory Committee and Advisory Committee**

MuCol and Collaboration Integration

Main executive body of MuCol is Management Committee (MC)

- a subset of the Coordination Committee of the collaboration (CC)

Foresee to have all meetings combined

- e.g. annual meeting, CC+MC, ICB+GB
- may need some specific effort to document meetings for MuCol

Dissemination and publication of reports should be synchronised

- Task in MuCol to ensure quality and publication of reports
- In part use tentative Conference Preparation Team, installed by Interim Study Leader
- Need to define clear procedures and review organisation, task for MC, CC and MuCol task 1.3
- Will be presented to SB, GB and ICB once ready

Proposed that MuCol Governing Board to rely on International Advisory Committee of IMCC

- Steering Board will propose a composition

Coordination Committee Members



Physics	Andrea Wulzer
Detector and MDI	Donatella Lucchesi

Protons	Natalia Milas
Muon production and cooling	Chris Rogers
Muon acceleration	Antoine Chance
Collider	Christian Carli

Magnets	Luca Bottura
RF	Alexej Grudiev, Claude Marchand
Beam-matter int. target systems	Anton Lechner
Collective effects	Elias Metral

Cooling cell design	Lucio Rossi
Demonstrator	Roberto Losito

US (detector)	Sergo Jindariani
US (accelerator)	Mark Palmer
Asia (China)	Jingyu Tang
Asia (Japan)	tbd

The proposed MuCol WP coordinators are CC members

essentially all activities are integrated in MuCol

Resources and Collaboration



MuCol is a very important increase in resources

- 3 MEUR = 530 pm from EC, UK, Switzerland, 4 MEUR = O(600 pm) from partners
- Additional 1.5 MEUR = 180 pm from CERN

Many new members, many from INFN

- Need to make sure that new partners are in contact with CC, which should establish collaborations and coordinate resources

Interim Study Leader appointed Resource Task Force in June 2022 to facilitate this task and to prepare input for September Council

- Need to improve this process to make it work and to ensure CC is fully informed
- Luca Bottura will support effort on the accelerator side

Representation in ECFA Roadmap needs to be improved

Agreement with J. Mnich and M. Lamont to include IMCC in the grey book, need some follow up

MuCol and IMCC Partners



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der
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IEIO	CERN*
FR	CEA-IRFU*
	CNRS-LNCMI
DE	DESY*
	Technical University of Darmstadt*
	University of Rostock*
	KIT
IT	INFN*
	INFN, Univ., Polit. Torino
	INFN, Univ. Milano*
	INFN, Univ. Padova*
	INFN, Univ. Pavia
	INFN, Univ. Bologna
	INFN Trieste
	INFN, Univ. Bari
	INFN, Univ. Roma 1
	ENEA
PT	LIP*

UK	RAL+
	University of Lancaster
	University of Southampton
	University of Strathclyde
	University of Sussex
	Imperial College London+
	Royal Holloway
	University of Huddersfield
	University of Oxford
	University of Warwick
	University of Durham+
SE	ESS*
	University of Uppsala*
NL	University of Twente*+
EST	Tartu University
LAT	Riga Technical Univers.
AU	HEPHY
	TU Wien

FI	Tampere University
ES	I3M+
	ICMAB
CH	PSI
	University of Geneva+
	EPFL
BE	Louvain
IT	INFN Frascati
	INFN, Univ. Ferrara
	INFN, Univ. Roma 3
	INFN Legnaro
	INFN, Univ. Milano Bicocca
	INFN Genova
	INFN Laboratori del Sud
	INFN Napoli
	INFN Catania

Blue: MuCol Participant
* MuCol beneficiary
+ new MoC signatory

US	Iowa State University
	Wisconsin-Madison
	Pittsburg University
	Florida State U.
	U. of Tennessee
	Old Dominion U.+
	BNL
China	Sun Yat-sen University
	IHEP
	Peking University
India	CHEP
Korea	KNU+
US	FNAL
	LBL
	JLAB
	Chicago
Japan	Akira Yamamoto, Akira Sato, T. Ogitsu

Key Recent Workshops



- **Muon Collider Physics and Detector workshop**, FNAL, December 14-16, 2022
 - To foster detector collaboration
 - Detector software training attached
- **EPP2024**, December 2022
 - Organised in the US by the National Academies to determine the long-term future of particle physics
- **KITP** meeting in Santa Barbara
 - Started discussion of P5 input preparation
 - Started discussion of CO2 footprint with Patrick Meade, making link to linear collider efforts
 - Panel with proponents and opponents
 - Early Career Panel

Key Future Meetings



Annual meeting June 19-22, 2023 at IJCLab in Orsay
Organised by CEA-IRFU, Christian Carli and Luca Bottura

Synergy workshop June 22-23 2023 at IJCLab in Orsay
Organised by CEA-IRFU, Chris Rogers

Other Relevant Meetings



P5 Townhall meeting, April 12-15, BNL

Energy, Instrumentation, Computational Frontier

<https://www.bnl.gov/p5meeting/>

P5 Townhall meeting, May 3-5, SLAC

Underground, Accelerator, Theory Frontiers, Community Engagement

IPAC, Venice, May 7-12

<https://www.ipac23.org/>

Muons4Future, Venice, May 29-31

<https://www.pd.infn.it/events/muon4future-workshop/>

EPS-HEP, Hamburg, August 21-25

<https://indico.desy.de/event/34916/>

EPJC Publication



European Physics Journal C (EPJC) showed interest in paper summarising all our 5 Snowmass contributions on physics, detectors and accelerator

Produced a paper with important updates in several areas.

Currently In review.

Many thanks to main editors Andrea Wulzer and Federico Maltoni and chapter editors J. de Blas, R. Franceschini, F. Maltoni, F. Meloni, C. Rogers, D. Schulte and A. Wulzer.

Many thanks to all editors and authors of original white papers and the others that contributed to the work document in them

US Snowmass



International
Muon Collider

Original from ESG by UB
Updated July 25, 2022 by MN

Strong interest in the US community in muon collider

- want funding for R&D
- like to **host** a muon collider

Task forces to prepare P5 bids:

- lead by FNAL (Sergo Jindiriani, D. Stratakys)

Detector and physics

Accelerator

- Goal is 40-50 FTE, similar to Europe
- Would bring resources close to full R&D Roadmap programme

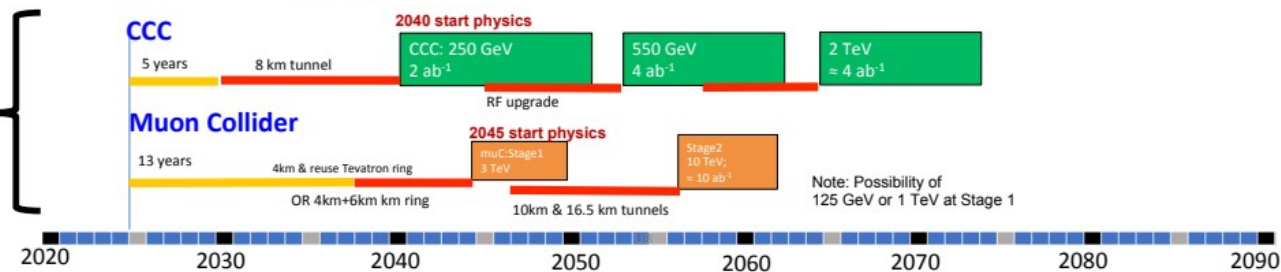
European contact members:

Chris Rogers, Federico Meloni, Donatella Lucchesi, Daniel Schulte

Possible scenarios of future colliders



Proposals emerging from this Snowmass for a US based collider



- Timelines technologically limited**
- Uncertainties to be sorted out
 - Find a contact lab(s)
 - Successful R&D and feasibility demonstration for CCC and Muon Collider
 - Evaluate CCC progress in the international context, and consider proposing an ILC/CCC [ie CCC used as an upgrade of ILC] or a CCC only option in the US.



proposing hosting ILC in the US.

Meenakshi Narain: **Energy Frontier / Large Experiments**,
Snowmass Community Summer Study July 17-26, 2022

US Preparation for P5



Goal:

- US would like to participate to collaboration
- Contribution should roughly match European effort (40-50 FTE)
- European effort approaches minimal plan
 - hope to further increase it
- Equivalent US contribution would allow us to start approaching full programme
 - with some delay compared to Roadmap
- Charge from FNAL directorate to S. Jinariani (FNAL), D. Stratakys (FNAL) and S. Dasu (Wisconsin)

Plan:

- Will install task force to prepare integration of US efforts into the collaboration
 - based on current US experts by adding several experts from collaboration
 - mandate until decision in the US
 - allows to follow developments and prepare smooth collaboration
 - will also consider other new efforts outside Europe
 - currently preparing mandate and choice of experts

US Preparation for P5



Accelerator R&D Focus Areas:

- Muon source: Mary Convery (Fermilab), Jeff Eldred (Fermilab), Sergei Nagaitsev (JLAB), Eric Prebys (UC Davis)
- Machine design: Frederique Pellemoine (Fermilab), Scott Berg (BNL), Katsuya Yonehara (Fermilab)
- Magnet systems: Steve Gourlay (Fermilab), Giorgio Apollinari (Fermilab), Soren Prestemon (LBNL)
- RF systems: Sergey Belomestnykh (Fermilab), Spencer Gessner (SLAC), Tianhuan Luo (LBNL)

International Liaisons: Daniel Schulte (CERN), Chris Rogers (RAL), Donatella Lucchesi (INFN), Federico Meloni (DESY)

Detector R&D Focus Areas:

- Tracking Detectors: Maurice Garcia-Sciveres (LBNL), Tova Holmes (Tennessee)
- Calorimeter Systems: Chris Tully (Princeton), Rachel Yohay (FSU)
- Muon Detectors: Melissa Franklin (Harvard), Darien Wood (Northeastern)
- Electronics/TDAQ: Darin Acosta (Rice), Isobel Ojalvo (Princeton), Michael Begel (BNL)
- MDI+Forward Detectors: Kevin Black (Wisconsin), Karri DiPetrillo (Chicago), Nikolai Mokhov (Fermilab)
- Detector Software and Simulations: Liz Sexton-Kennedy (Fermilab), Simone Pagan Griso (LBNL)

Conclusion



- MuCol has helped to kickstart the collaboration
 - Smooth integration into collaboration starting
- Promising developments in the US
 - Need to get a good understanding of resources including requests
- Need to foster progress on several organisational items
- And do the work

Reserve



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Collaboration

US Snowmass



International

Implementation Task Force

T. Roser et al.

Muon Collider is a viable option for the HEP future

- same risk tier as FCC-hh

They made cost, power, risk and schedule estimates

- Also for muon collider

Take it *cum grano salis*



ITF's Look Beyond Higgs Factories

ITF Report – T. Roser, et al, arXiv:2208.06030

	CME (TeV)	Lumi per IP (10^{34})	Years, pre-project R&D	Years to 1 st Physics	Cost Range (2021 B\$)	Electric Power (MW)
FCCee-0.24	0.24	8.5	0-2	13-18	12-18	290
ILC-0.25	0.25	2.7	0-2	<12	7-12	140
CLIC-0.38	0.38	2.3	0-2	13-18	7-12	110
HELEN-0.25	0.25	1.4	5-10	13-18	7-12	110
CCC-0.25	0.25	1.3	3-5	13-18	7-12	150
CERC(ERL)	0.24	78	5-10	19-24	12-30	90
CLIC-3	3	5.9	3-5	19-24	18-30	~550
ILC-3	3	6.1	5-10	19-24	18-30	~400
MC-3	3	2.3	>10	19-24	7-12	~230
MC-10-IMCC	10-14	20	>10	>25	12-18	O(300)
FCChh-100	100	30	>10	>25	30-50	~560
Collider-in-Sea	500	50	>10	>25	>80	»1000

Thomas Roser et al

EPP-2024



Organised in the US by the National Academies to determine the long-term future of particle physics

Committee: Co-Chairs: Maria Spiropulu, Michael S. Turner,

Nima Arkani-Hamed, Barry C. Barish, John F. Beacom, Philip H. Bucksbaum, Marcela Carena, Bonnie Fleming, Fabiola Gianotti, David J. Gross, Salman Habib, Young-Kee Kim, Piermaria J. Oddone, J. R. Patterson, Fulvia Pilat, Chanda Prescod-Weinstein, Natalie Roe, Tim Tait

Presentations:

Shiltsev: What are the scope and drivers of a national collider R&D program?

Cousineau: How do we best leverage non-HEP national facilities and resources? How do we best coordinate among US agencies and leverage support from non-HEP scientific communities?

Rivkin: What are the scope and drivers of the Accelerator R&D Roadmap in the framework of the 2020 European Strategy for Particle Physics?

Roser: What has the Snowmass Collider Implementation Task Force identified as the major technical hurdles and as a realistic timeline to establish feasibility for a muon collider project as compared to other future collider proposals?

Schulte: What are the scope and drivers of the International Muon collaboration?

Palmer: What can we learn from the previous US Muon Collider Collaboration and how can we frame a new collaboration?