

Charged leptons at Snowmass

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CHARGED LEPTON GROUP

- This is a group that was formed for the Rockville workshop Fundamental Physics at the Intensity Frontier last Fall.
- Everyone who registered for that meeting and said they were interested in charged leptons was put on a mailing list
 - [charged-leptons @ googlegroups.com](mailto:charged-leptons@googlegroups.com)
- The charged lepton group is everyone on that list.
 - Please let me know if you want to be on the list
- We had a web page last time
 - <http://www.lepp.cornell.edu/~yuvalg/ifw/emt.html>
- We will be using the Snowmass twiki this time
 - <http://www.snowmass2013.org/tiki-index.php?page=Charged+Lepton+Processes>

- Today the charged lepton group is trying to define the scope of the working group
 - What are the physics topics the group will cover?
- Begin discussing how this group will interact with the different groups
- Begin discussing how this group will use the time we have at Snowmass

INTENSITY FRONTIER CHARGE

The American Physical Society's Division of Particles and Fields is initiating a long-term planning exercise for the high-energy physics community. Its goal is to develop the community's long-term physics aspirations. Its narrative will communicate the opportunities for discovery in high-energy physics to the broader scientific community and to the government.

- At **CPM2012**, the groups will present the scientific issues to be emphasized, experiments to be discussed, and strategies for implementation both in national and global terms. The meeting will include opportunities for contributed presentations and discussions.

- After **CPM2012**, subgroup conveners will formulate specific charges for their areas. These charges will clarify the physics questions to be discussed and the experiments to be given most attention. They will also detail choices made in treating areas-overlapping subgroups or linking high energy physics to other areas. In principle, these charges could evolve over the year in response to continued research, new physics results, and new proposals.

- **CSS2013** will provide an opportunity for discussion, analysis, and arrive at conclusions for each area of the study. By the end of this meeting, each

We anticipate that this long-term planning process will trigger an independent process of review and prioritization solicited by the funding agencies.

DRAFT CHARGE

This subgroup will summarize current knowledge and identify future opportunities using precision measurements of muon and tau lepton properties and searches for new decay modes.

The detailed charge, topics and goals for this subgroup will be developed in coordination with the subgroup conveners and based on community feedback.

FROM THE DOE

To that end, a planning process that carefully considers the science opportunities and trade-offs involved, and can clearly elucidate the pros and cons of the various options, would be extremely valuable input for updating the HEP strategic plan.

Jim Siegrist,
Associate Director, Office of High Energy Physics

The focus at Rockville was on the science opportunities
We covered the pros and cons were covered at some level
Trade-offs were not really covered.

The sub-groups are not being asked to prioritize.
We are being asked to provide useful information to the prioritization process.

QUESTION I: WHAT DO WE WANT TO COVER?

- Covered at Rockville by charged lepton group:
 - $\mu N \rightarrow e N, \mu \rightarrow e \gamma, \mu \rightarrow e e e, \mu e \rightarrow e \mu,$
 - LFV τ
 - CPV in τ decay
 - $(g-2)_\mu, (g-2)_\tau$
 - $\mu EDM, \tau EDM$
 - $\sin^2 \theta_W$ in $e^+ e^- \rightarrow e^+ e^-, e^+ e^- \rightarrow \mu^+ \mu^-, e^+ e^- \rightarrow \tau^+ \tau^-$
- In general, significant focus on “New Physics”
 - That was part of the Rockville charge

QUESTION I: WHAT DO WE WANT TO COVER?

- Topics not covered at Rockville:
 - μ lifetime
 - μ capture
 - μ decay parameters
 - Muonic atom spectroscopy
 - μ SR
 - τ spectral functions and BFs
 - V_{us} measurement
 - LFV @ LHCb
 - LFV decays of hadrons
- Charged leptons doesn't have to cover everything but it would be good to have a better balance between:
 - Measurements that define the SM
 - Searches for physics beyond the SM
- Things covered at Rockville by other groups:
 - Electron EDM
 - $e \rightarrow \tau$ LFV
 - Leptonic decays of hadrons
- There should be time to have joint sessions this time around

QUESTION I: WHAT DO WE WANT TO COVER?

- This doesn't have to be decided now
- But the group needs an appropriate charge
- Propose to have monthly meetings with talks from the different experiments
 - What needs updating since Rockville
 - What was not covered at Rockville

WORKING WITH OTHER GROUPS

Now 7 frontiers with a matrix of liaisons

- **Energy Frontier**
 - Chip Brock (Michigan State), Michael Peskin (SLAC)
- **Intensity Frontier**
 - JoAnne Hewett (SLAC), Harry Weerts (Argonne)
- **Cosmic Frontier**
 - Jonathan Feng (UC Irvine), Steve Ritz (UC Santa Cruz)
- **Frontier Capabilities**
 - William Barletta (MIT), Murdock Gilchriese (LBNL)
- **Instrumentation Frontier**
 - Marcel Demarteau (ANL), Howard Nicholson (Mt. Holyoke), Ron Lipton (Fermilab)
- **Computing Frontier**
 - Lothar Bauerdick (Fermilab) and Steven Gottlieb (Indiana)
- **Education and Outreach**
 - Marge Bardeen (Fermilab), Dan Cronin-Hennessy (U of M)

LIAISON MATRIX EXAMPLE

Instrumentation frontier

	Energy	Intensity	Cosmic	Facilities
Sensors				
<i>Marina Artuso</i>	Daniela Bortoletto (Purdue)	Matt Wetstein (Chicago)	Andrei Nomerotksi (BNL)	Carsten Hast
<i>Abe Seiden</i>	Sally Seidel (New Mexico)	Jerry Va'vra (SLAC)	Clarence Chang (Chicago)	
			Jim Fast (PNNL)	
Gaseous Detectors				
<i>Gil Gilchriese</i>	Andy White (UTA)	James White (Texas A&M)	David Nygren (LBL)	
<i>Bob Wagner</i>	Marcus Hohlmann (FIT)	Brendan Casey (FNAL)	Dan Akerib (Case Western)	
	Vinnie Polychronakos (BNL)		Greg Tarle (Michigan)	
Detector Systems				
<i>Ed Blucher</i>	Roger Rusack (Minnesota)	Bonnie Fleming (Yale)	Karen Byrum (ANL)	Erik Ramberg
<i>David Lissauer</i>	Adam Para (FNAL)	Bob Svoboda (UC Davis)	Peter Gorham (Hawaii)	Jae Yu
			Erik Gottschalk (FNAL)	
Electronics/DAQ/Trigger				
<i>Ulrich Heintz</i>	Dong Su (SLAC)	Gary Varner (Hawaii)	Günther Haller (SLAC)	
<i>Ron Lipton</i>	Wesley Smith (Wisconsin)		Frank Krennrich (Iowa State)	
	Maurice Garcia-Sciveres (LBNL)			
Novel/Emerging Technologies				
<i>Jim Alexander</i>	Ted Liu (FNAL)	Steve Ahlen (BU)	Juan Estrada (FNAL)	
<i>David MacFarlane</i>	Julia Thom (Cornell)			
Software				
<i>Norman Graf</i>	Erich Varnes (Arizona)	Robert Kutschke (FNAL)	Salman Habib (ANL)	
<i>NN</i>				

TECHNICAL GROUPS

- The charged lepton group should spell out requirements and challenges for each group
 - Computing, instrumentation, facilities
- This can be done for all planned experiments
 - It would be good to have contacts on experiments to do this between now and the summer
- More importantly, the group can do this for future needs
 - This could be a byproduct of the Snowmass meeting this summer

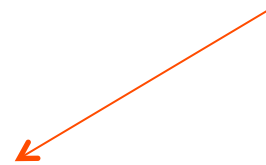
- This is an opportunity to educate our colleagues on the importance of charged lepton physics
- One idea:
 - Spell this out in white papers before Snowmass and submit them to the appropriate groups
- The charged lepton group could also appoint liaisons:
 - But I like the white paper idea better

Low energy constraints on properties



- HE1: The Higgs Boson
- HE2: Precision Study of Electroweak Interactions
- HE3: Fully Understanding the Top Quark
- HE4: The Path Beyond the Standard Model - New Particles, Forces, and Dimensions
- HE5: Quantum Chromodynamics and the Strong Force
- HE6: Flavor Mixing and CP Violation at High Energy

Low energy precision electroweak



Low energy searches/constraints
(we have already been approached
by this subgroup)



Low energy constraints

Constraints on dark forces

- CF1: WIMP Dark Matter Direct Detection (Priscilla Cusl
- CF2: WIMP Dark Matter Indirect Detection (Jim Buckle
- CF3: Non-WIMP Dark Matter (Alex Kusenko, Leslie Ro
- CF4: Dark Matter Complementarity (Dan Hooper, Man
- CF5: Dark Energy and CMB (Sarah Church, Scott Dode
- CF6: Cosmic Particle Probes of Fundamental Physics (C

LFV

IDEAS FOR JOINT TOPICS

- The charged lepton group is supposed to spell out topics that have significant overlap with other physics groups
- Some ideas:
 - All EDMs
 - Joint with Nucleons, nuclei, atoms
 - Specifically storage ring EDMs
 - Joint with Nucleons, nuclei, atoms
 - Y(4S) physics
 - Joint with quark flavor physics
 - LHC physics
 - Joint with flavor mixing and CPV at high energy
- At a minimum, the groups should agree on common parameters and assumptions about future facilities etc.

WHAT TO DO AT SNOWMASS?

- Snowmass has typically been a real working meeting
- It would be nice to do something like
 - Sketch out the next ‘project’ or ‘projects’
 - Sketch out the next facility
 - Now have ~\$300M in charged lepton projects/facilities in US budget profile ending in 2019
- There can be multiple sub-groups doing multiple things
- This also doesn’t have to be decided now but people should start thinking about it.
 - There are issues related to what tools we would need to do this work.

MOVING FORWARD

- **At the end of this meeting:**
 - Charged lepton conveners will have a draft charge based on discussion at this meeting.
 - The group should have a preliminary list of the topics/experiments we plan to include
 - The group should have a preliminary list of topics where we need close collaboration with other groups
- **In the next few weeks:**
 - The conveners will compile a list of contact people for each topic / experiment / region / facility
 - The conveners will set up a doodle poll for a regular monthly meeting time