March 29, 2022

 1 p.m. Plenaries.

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(CART) is provided in order to facilitate communication

accessibility and may not be a totally verbatim record

of the proceedings."

And I guess we hand over to your

Caterina, I guess. Who is next?

 >> We have conveners Jonathan and Liza.

 >> I'm here on Zoom.

 >> Great. Thank you.

 >> Great. So let me just understand, our first

speaker is online? Maxim.

 >> Yes. Can you hear me.

 >> Maybe I can just start us off. We now have a

session with instrumentation and computation reports.

And I think the talks are 20 plus 10 minutes, is that

correct? Is that okay with you Maxim.

 >> Yes, sure.

 >> Okay. Why don't we give with Maxim Titov, 20

minutes and I'll give you a warning.

 >> Okay. Can you hear my slides, can you see my

slides, sorry?

 >> Yes, we can see them fine, thank you.

 >> Very good. Good afternoon to everyone. It's a

pleasure to give an overview of the instrumentation

frontier contributions which has been submitted and

this talk we prepared together with Caterina and also

with Phil and Petra and Jinlong.

 I apologize because in 20 minutes we can't give a

comprehensive point of view of everything that is

relevant for the energy frontier but we can give you

the status of the contribution and white paper submit

today the instrumentation frontier. There will be some

trends and a few examples which -- of the energy

frontier and they were in the presentations reported

yesterday and others will be later this week.

 Instrumentation frontier is arranged into ten

working groups. Actually, many of the LO Is were

grouped together into white papers and for each white

paper there was an editor that was leading to make sure

all the LOIs is included in the corresponding white

papers.

 This is why the list of white papers is not as

much or comprehensive as the number of LOIs submitted.

Usually up to few and up to six or seven white papers

for one of the working groups.

 This is not the only contribution that is

submitted, in addition to the white paperers which

should accommodate all the -- there was a lot of

relevant papers that were submitted in addition to

this.

 So as I mentioned already, the instrumentation

frontier is arranged in ten working groups and here you

see three of them. The first is related to quantum

sensors. The second is related to photon detectors and

this is of relevance to the energy frontier.

 The two white papers were submitted. One for

photon counting from the vacuum UV to the short

wavelength. And the other one would be a document

which would submit to the white papers with section

relevant to photon detectors. For the silicon tracking

and vertexing, there were a number of submissions and

here you can see the references related to simulation

of silicon radiation and detectors for high energy

physics and novel sensors and four-dimensional trackers

and integration and packaging and mechanics and

monolithics.

 As a working group, four is related to DAQ. And

here, of course, the -- related to the readout

technology for future detectors and fast machine

learning for the dark [inaudible]. Working group five

related to the pattern gaseous detectors. The white

papers are submitted related to recent trends and

neutrino physics for dark matter searches for TPC and

tracking.

 Working group six is related to calorimetry.

Precision pico second timing and particle flow

calorimetry and in addition, what was developed in

advance was in the Snowmass process related to dual

readout calorimetry for future colliders. And

techniques for dark matter detection.

 And working group 7 is electronics and ASIC. This

is a read out for calorimetry, silicon and

photodetectors. Electronics for fast timing, fast

links. Smart sensors which is being developed and

discussed and relevant for the energy frontier as well.

 And finally, there is a noble element detectors,

which will be organized differently. SUSY executive

summaries instead of white papers, I don't want to go

through because it's not of major relevance to the

energy frontier. Nine and ten is a cross cutting and

systems integration and radio detection. And frontier

nine, I would like to point out there was a survey

initiated to test beam and irradiation facilities which

I'm sure is of interest to the energy frontier.

 It's not, this is you see is a list of the white

papers that were submitted as references to the white

papers which were submitted. In addition, there is

much more papers of general interest which has been

submitted to the Snowmass proceedings and the

comprehensive list of these white papers can be found

on this website.

 Of course, several instrumentation frontier

topical groups need to coordinate sections in their

summary reports with topical groups in other frontiers

including energy frontier. There is a plat to organize

topical group level discussion working meeting or maybe

instrumentation frontier wide workshop with other

frontiers.

 This is a summary of where the instrumentation is.

Let me go a little from the point of the white papers

towards requirements which is needed for the future

facilities. Here, of course, I don't need to remind

that the BRM report is a very important document which

addresses a transformative physics goals including the

4 inspiring and distinct directions. Higgs properties

and Higgs self-coupling and Higgs connection to dark

matter and new multi-TeV particles.

 And then priority research for detectors.

 These developments are of up most importance and

it's a cross border between the energy and

instrumentation frontier. It's important also in order

to fulfill the physics goals to create the building

blocks for the system performance. New fabrication

materials and integration. Low mass tracker and of

course, the key element that achieve on-detector

realtime continuous data processing and transmission of

the detectors.

 And the timing detectors is very closely linked

not only to tracking detectors but also the calorimetry

and -- in detectors is very important for the event

separation and also as the development is leading to

the new spatial resolution, high resolution pixel

detectors.

 Going from the BRM to Europe, following the

European strategy update, there was a special process

related to the creation of the ECFA detector R&D

roadmap. I'm sure you heard about this. The idea of

this roadmap was to identify and describe the

diversified detector R&D portfolio and which basically

tried to identify how in the best way to enhance

perform of particle physics future projects in the near

and long-term.

 And this exercise has been done by separating and

trying to find the major milestones and the goals in

nine working groups.

 As you know, the report has been completed and the

final report has been raised in December 2021. And

here you can see the link to this report.

 It should now -- working group or coordinators are

in charge of really developing the implementation of

this detector R&D roadmap. And last week there was a

counsel session and the implementation proposal has

been presented to the scientific policy committee last

week. So the process is quite well advanced. There

are some ideas which need to be discussed with the --

agency. There are different ideas about the

implementations. It might happen that the limitations

will be in a view of the R&D collaborations related to

the different technologies. This is not finalized but

it's a proposal. Something like was done in the past

with the -- committee but it's premature to say what

would be the final structure while it has been present

today the SPC and CERN and waiting for approval from

the council.

 In addition to this, to the -- of course, the goal

of this implementation process is to get some

significant findings for the future detector R&D

activities. As I mentioned that is important to

enhance performance of particle physics in the near and

long-term. This implementation would need to come with

some of the extra funding devoted to the detector R&D.

 In addition to this, last year it was approved

so-called AIDA nova project, which was a continuation

of the successful R&D proposal that was done by AIDA.

This project will provide the funding of the Higgs

scale from 10 million by the European commission and

with respect to some targeted applications like the

Higgs factories and ATLAS and CMS experiments and

accelerator experiences.

 Now coming back from some of the funding

possibilities to some of the general trends. Still

this is very important. For low mass tracking

detectors and vertex and heat -- detectors is a basic

application for different areas of interest. And in

this case you have a completely different optimization

requirements. For PP collisions you require radiation

and hardness and speed. And e+/e-, granularity and

material budget.

 Design includes different technologies which is

proposed for Hadron Colliders but for optimizations for

polarity and power and radiation hardness and data

reduction, et cetera.

 Work is discussed from the instrumentation working

group 3. There is a need to collect requirements from

the different experiments and instrumentation for the

topically group summary would help to make sure the

developments in the community meets the experimental

needs.

 This is one of the important points which is the

gross -- energy frontier.

 In other major trends which is being pursued by

the high luminosity LHC upgrades, this became available

through the -- R&D work on LGAD or crystals or precise

timing. And there is a different options, the high

luminosity LHC is being excluded for 4D pattern

recognition and Snowmass related four dark matter

trackers. PS timing reconstruction is important. The

development of hadron showers in addition to this

triangulate of the primary vertices. And timing has

been used for quite some time at the level of 10s of

pico second.

 The challenge is for huge developments is follow

the radiation hardness with a new type of sensor.

Large scale applications and system aspects of timing

detectors.

 At the end of the day one of the points which is

discussed was the rate of the LHC experiments going

from 4D pattern recognition to 5D reconstruction. You

have space points in pico second time and not just in

calorimetry but a single layer. Each point along the

track. This is the next step.

 Moving from the pico second timing which is very

much used in calorimetry and of course, major

advancement especially for the Higgs factories, has

been done within the CALICE collaboration focused on

the LHC but now widened to include developments for all

imaging calorimeters. And actually, if you look on the

calorimetry, it provides a mixture of very advanced

ideas, some of them are new ones being developed within

the Snowmass process.

 I mentioned technologies related to the SiW-ECAL,

AHCAL and DHCAL.

 The prototypes and the engineering design is

pretty much ready.

 We learned during the Snowmass process not only

there is a new develop., the use of seamless MAPS

sensors and the simulation and developments during the

Snowmass process and with LGAD. And here we need a

more R&D effort to realize as a real detector for the

next generation.

 The image and calorimeters are important. There

is a lot of room for optimization in many aspects.

 Needs to be related more deeply in order to

understand optimal timing accuracy.

 Because it strongly depends from the real goals

physics wise. Includes several aspects. One is

mitigation of pileup, which is important at high rates.

The support of the full 5D particle, and here is real

uncharted territory. Also, there is a possibility to

use calorimetry with time of flight functionality in

the first layers.

 By replacing part of the ECAL with the LGAD, with

10 pico second time resolution that gives you

additional hints for the Pi -- proton simulation up to

5 to 10 GeV. This is additional, very important points

as I mentioned for the physics goals.

 Also was a possibility and also the possibility of

using longitudinally unsegmented fiber calorimeters.

 It's difficult to say what is required. This

needs to be optimized and develops from the -- because

examples today, all these performances is trade off

between the power consumption and timing capabilities

which is better timing capabilities will lead the

higher noise level.

 And timing in calorimeters and energetic showers

need to be understood. To which extent we need to go

down in timing and resolution. Intent reconstruction

using 100 hits and NN can improve a poor single cell

timing.

 This can help to distinguish different particle

types, flavor, long-lived searches which is important

for the physics goals to be addressed. There is a lot

of work to be done. If you want a pico second timing

resolution, the optimal way you have a pico second

timing resolution for the imaging and calorimeters

needs to be time dependent from the performances and

the detector -- elements.

 The added value of timing information is

recognized by everyone. But what is the gain in

scientific return needs to be identified for the

tracking PID, the calorimetry PID, the shower

development. This needs to be a discussion.

 I will not say much about the advanced concepts in

trigger and DAQ. Just what is important related to the

points of general -- is progressive replacement of

complex multistage trigger system with a single layer

trigger system or without trigger. And a large -- for

the final selections.

 Optical readout is important and this is what is

being pursued. Of course, not to say the things about

the intelligent trackers, like a tracker trigger

concept for the high luminosity LHC which allows

the line process and selection of the high PT tracks

and low PT tracks. Or the mini vectors concept for

ILC. One is more precise in special dimension and the

other one has a high granularity and special dimension

but the possibility of timestamping.

 You can get two close bilayers and one provides

more precise specific information and the other timing

information. That is important in addition to the

possibility of including a neural network among the two

layers allows for significant background reduction and

optimization of the physics performance.

 So coming back from the general technology trends

to some of the physics requirements of energy frontier

and instrument frontier interplay, the goals have been

set in October 2020. One of the important benchmarks

is search for a long-lived particle. Especially when

we discuss timing trigger.

 Here are many things that needs to be optimized in

the future such as a pixel size, importance of pixel

tracking, double layers for the background rejections

and one can use a possibility of having double layers,

one with more precision and one with high-speed layer.

In this case, as an example which is shown for LHC but

also for the long-lived particle searches. If you

consider a fully -- trigger-less readout, there is

significant reduction in the pipelines and some of

these may compromise the -- and this is needed to be

addressed and discussed.

 Yesterday Michael addressed the points of jet

substructure and boosted substructure which photon

driver, a huge multi-TeV machines and requires a strong

interest in MIP timing for the jet reconstruction and

the level of tens of pico seconds.

 There is a Snowmass paper submitted for this and I

refer do you the talk given by Michael yesterday.

 >> Two minutes.

 >> There was a talk yesterday by Simon about the

physics requirements and related to several ideas on

the track-based trigger for exotic searches and study

of the granularity calorimeters and some searches were

performed during the Snowmass process. This is another

important element.

 The physics requirements for the future colliders

includes the importance of Higgs couplings to the

strange Quark. You demand enhanced Pi to K separation.

RICH detector for the SiD allows you to separate up to

the 25 GeV and there is a paper include is submitted to

the Snowmass process. As I also mentioned, there was a

development for the dual read out calorimetry in new

types of particle flow algorithms. And this technology

came back and is being discussed now.

 The timing capability is important for the beam

background reduction of the muon colliders to reduce

BIB rejection. It significantly allows and there is a

paper. I'm sure and I have to apologize, this is not a

complete list of topics but I tried to give you a

sketch and some of the things were not present in the

talk, feel free to contact me. Thank you.

 >> Thank you.

 >> Thank you for this lovely talk. I wanted to

make one small clarification about slide 11. The dual

readout calorimeter is part of the other collaboration

idea. Not CALICE. But certainly, they're both very

nice calorimeter collaborations.

 >> Well, thank you, yes. You are fully right. I

just was mentioning that the majority of the

developments were maybe it was appearing on the same

slide, the majority was done within the CALICE and dual

readout is not part of the CALICE, it's a new

development and also the map, MAPs ECAL is not part of

CALICE, it's an extra development which is being

developed now.

 >> There is a question on Zoom.

 >> Please, go ahead.

 >> Andrew has a question.

 >> This is Andy White. I have a comment that just

from parted of the time I work on the SID detector for

the ILC, we're alts interested in CQ. Snowmass is a

U.S., primary a U.S. exercise, I just wanted to

highlight that we have a serious issue. We have a very

small community which we need to build up if indeed the

Higgs factory collider is the thing of the future and I

fully agree with Michael and the other people that

spoke about this.

 We need to build up a community and that requires

a significant investment in the development of the

detectors and physics. People working in that

direction between the e+/e- Higgs factory.

 We tried for a number of years to get that support

from the agencies in the U.S. We're in the process of

a Snowmass process and it will go into P5 at the end of

the year and P5 will make a report in another year.

With the U.S. budget process it takes one or two years

to see funding appear.

 This puts the U.S. community at a significant

disadvantage with respect to some of the things that we

heard in Maxim. I just wanted to put that on the

table. We need to address this with the agencies as a

matter of urgency.

 And Sarah has made a valiant attempt at this with

a paper highlighting the need to move in this

direction. Thank you.

 >> Thank you very much for this comment. I fully

agree with you and I cannot, how do I say, 100 percent

agree.

 This is one of the reasons I mentioned this

detector implementation program which has been started

and is encouraged with the PCMC counsel. I fully agree

there should be in my opinion some discussion within

the U.S. community as well how this R&D, which is

needed in the U.S. part, can be aligned with what is

currently being discussed in the implementation plan in

Europe.

 As I mentioned, one of the possibilities is the

creation of the R&D collaborations. There is a funding

situation and Europe is not very simple, but of course,

it's a discussion for the European community, I think

both Europe and U.S. will benefit in case this process

might be synchronized in the future.

 >> I think during the European discussions, I

asked the question about whether there was going to be

some synchronization between developments and CPAT and

the exercise in the U.S. There is the intention of

will to do that but we have to see that that comes

about.

 >> Exactly. Yes. The discussion is how to

implement it in Europe is being studied with the

funding agency in Europe.

 >> We need a similar discussion here, I agree.

Thanks.

 >> Thank you. Other questions?

 So I see no others in the room. Are there any

online?

 >> No, we're good here.

 >> I was just curious about one statement you made

about the return in physics of timing R&D that you made

in one of the slides towards the end.

 You said that is less clearly quantified than

should be.

 >> Yes.

 >> Okay. I was just wondering if you can

elaborate a second in terms of what you had in mind in

terms of serving, how can I say -- did you have in mind

to try to quantify something in the short-term or was

this more a comment sort of in the longer, in the

longer term.

 >> I think it's more contribution to the future.

Because I didn't stop a lot on this plot which was

probably -- well, it's a very -- plot. We all

discussed about the required time in the resolution and

we all believe it should be at the level of 10, 20, 30,

40, pico seconds. This is how to say, in addition to

this, of course, you have to take a large system

aspects leek globe distribution, et cetera, et cetera.

 Even to intrinsic performance, we understand we

need a performance at the 10 pico second level. But

again, the difference can be depending from the goals

that you optimize, for example, you, for the pileup

mitigation, for the 5G particle flow functionality,

from the time of flight functionality, the fiber

calorimetry which is the easiest one. Here which level

we need to step and to require performance for the

physics goals. This has to be very clearly understood

dependent from the physics requirement. This is my

question. For example, if you relace part of this with

the sensors you can go for good Pi to K separation

which is important for Higgs physics.

 From the other point of view, the timing

resolution, higher power consumption which is important

element.

 This is why I'm saying this optimization in terms

of the pico second timing resolution has to be closely

[inaudible] linked to the needs of the particle flow

and time of flight functionality that comes from the

physics goals. And frankly speaking, what is the type

of resolution that is required for the 5G particle

flow. 10 pico second or 40 pico second which would be

appropriate and not able to now answer as a question.

 Was I clear or no.

 >> Yes. Very clear. Thank you.

 >> Thank you.

 Any other questions?

 Let's thank Maxim again for his talk.

 Now we move onto the computational frontier.

 >> Can you hear me?

 >> Fine. We don't see slides yet.

 >> There we go. Good.

 >> This should be quick. I took a slightly

different tact from the previous slides. Just to

remind you of the computational frontier, the point of

course is that software and computing while being

absolutely key parts of what we do, it's, we in some

sense are surveying the broad HEP community. And what

we're really aiming at is trying to see what

capabilities need to be brought in the time scale of

the next ten years in a way that actually spans the

various frontiers.

 So we're not just focusing on particular solutions

that are in particular areas but trying to see what we

can, what can be brought in the broad sense and the

service sense across the high energy physics.

 It's important that we understand and get funded

for HEP computational capabilities as something that

you need to plan for in advance. It doesn't just

happen when you need them. You need hardware that is

sufficient to do it. You need networking to get the

data from where it's produced to where you need it.

You need software platforms for reconstructing the data

and for the middle ware to distribute your workflows to

various locations for people to analyze the data.

 You need an ecosystem where people with work. And

you have to think about the community effects. There

can be gate keeping effects about people's familiarity

with software or other issues.

 We want to make sure that the work force that is

trained in software and computing is maintained and

cultivated and we have environmental impacts that come

from what we do. In fact, every time we generate a

Monte Carlo events, you are -- the world.

 One thing we do want to emphasize that I think

often isn't really looked at in these discussions is we

have computational needs now for designing facilities

in the far future.

 So there may be questions, there may be

constraints now we can address or now meaning in the

next decade that we can address even if you're talking

about machines with start dates, multi-decades in the

future. But unless we have the capabilities in a

relatively short time scale, we won't necessarily be

able to make the best -- that we can.

 In this context, the thing that for various

reasons, sort of, is probably the best understood and

so actually the most odd and straight rails at the

moment is the HL-LHC needs. These are well understood.

There are design documents for them and going through

various stages of approval.

 So in fact, we started to use that as a starting

point to explore what one can do with other things.

Like the -- is much more on-shelf for these

requirements but there is still flexibility there

compared to the relatively locked-in environment of

HL-LHC.

 Organization for the computing frontier, here are

the conveners, Steve, Daniel, and Ben. The topical

groups that I'm referring to. Seven subgroups.

Slightly different aspects. All have potential

overlaps with other frontiers. The computational

frontier has liaisons with the -- that is why I'm here.

Relatively few of us are pure computing professionals.

Most of us wear the hats of other frontiers as well.

The co-conveners we have energy frontier persons and a

cosmic frontier person and neutrino person.

 Discussions are the usual ways. If you're

interested you check our Slack records and join our

e-mails.

 Challenges that we have, this is the summary of

what is the broad range of topics we're trying to

address on our side: How do we insure sufficient

access to hardware in the future.

 There are various pressures both from funding

agency side and also just various organizational

reasons why just scaling up bigger and bigger things is

not variants of what we've done. The LHC grid is not

necessarily the answer.

 We are being pushed by certain funding agencies in

the direction of supercomputer centers but you can make

the argument for clouds.

 You want environments where you can scale from

single users to the full production needs of an

experiment.

 Heterogeneous architectures are important.

Essentially bringing into production codes that are on

GPUs, on FPGAs and other potential architectures. And

using CPUs better. In fact, a lot of our code runs

very poorly efficiency wise even on CP Us.

 To do that you need framework portability and you

need to flatten the learning curve.

 We have a lot of home-grown solutions for our

problems and one of the main things, main movements at

the moment is seeing what we can do with industry

solutions, especially given the importance of industry

solutions and machine learning. But what we often find

is that there is a reason the home-grown solutions very

well satisfy our use cases in things that weren't gone

in -- don't.

 And so first, what things did we develop that we

should retain opposed to what things should we try to

mold ourselves more into the industry model. And what

things can we contribute to the wider world, for

example, the work that is being done on jagged array

data. The fact that in R&D physics we don't know how

many electrons there are going to be in an event and we

cannot promise a simple nice array. We have to account

for varying length of the data.

 Sustainable support model. How this comes back to

the work force question. How do you maintain key

home-grown packages in an environment that we bias for

novel innovations or novel packages over established

solutions.

 But you also want to encourage the young people to

have a feeling they're not just going to spend their

lives maintaining something that was written before

them.

 We want to make sure we don't stand in the way

between physicists and their work. Friendly

ecosystems, lowering barriers to entry. And patterns

for work that don't, that aren't just what someone came

up with in a study ten years before you do the thing

but are actually responsive to what the real needs are.

 Training and document nation, not just experiment

specific things but also in general how to use common

tools. Version control. Documentation packages and so

on.

 Making the things that we want people to do. For

example, keeping data in a form that can be used later.

And snapshotting and preserving analysis, how to make

it easy and effective and the path of least resistance.

If you do the thing that is easiest to do, everything

is done for you.

 How do you make interfaces between stakeholders.

For example, how do theorists and experimentalists in

both directions and how do you communicate across

frontiers.

 What is next for machine learning. You see at

some level machine learning is such a normal part of

the energy frontier repertoire at this point that we

don't really think about it. But that is in the

classification world, regression is important in some

places. But the question is there are other potential

things where anomaly detection is the thing that people

talk about. And that nice talk by Jesse earlier.

 And then really, what does quantum computing have

to offer.

 So I'm going to focus on the overlapping white

papers between computing frontier and energy frontier.

That is 11 of the 57 that have been submitted to

computing frontier so far.

 There are potential late submissions as well, of

course. So the topics are basically theory

computations, surveys of tools and challenges in those.

So this is meant to be sort of focused on the

nitty-gritty and what libraries and packages are

available. Diversity, equity, and inclusion.

Improving physics sensitivity with machine learning and

some things are that incidentally marked as computing

frontier.

 In terms of the coverage on these white papers and

how they get into the report, for organizing principle

for us, we were concerned over the next decade where

should we focus computing effort. We're trying to make

a recommendation what should funding agencies support.

 Personal, hardware resources, training, R&D,

et cetera is that will best support and HEP program.

 So of course, the physics goals are the motivating

factors behind all this. But we think the details of

those are best covered by the relevant frontiers.

 Where there is probably more bleed through are

comp F6 with quantum computing where things like

quantum sensing is kind of bundled in that world. And

comp F3 with machine learning where indeed, often as

you heard earlier, you can gain insight into

theoretical problems or experimental problems through

clever choices of algorithm.

 So these are somewhat -- this is somewhat

independent of the physics channel but there are

potential places to -- incidentally quite clear, the

white papers are focused on computational issues or not

and the ones that are focused are the ones that we're

concerned about.

 There are cross listings for comp F2. These are

mostly about the calculations and not about the

computational needs or techniques.

 Or they will be in a specific section of the white

paper which we extract. And the other direction we

have things like the HEP software foundation's HL-LHC

is not cross listed with the energy frontier and

doesn't discuss physics. It's important in terms of

planning but it's something worth noting.

 Some themes, computing is fragmented across HEP

frontiers. Neutrino experiments don't have the

equivalent of the standard HEP MC format for exchanging

events between generators and simulation. This was a

surprise to me. Apparently, there is work trying to

standardize this on their stand. If they don't have

standard interfaces to add new models, it's [inaudible]

support for us.

 And collider experiments and that includes B

factories of course have pioneered a lot of the

capabilities that we have now. Partially because they

had lots of personal to attack problems and they

encountered some problems first.

 Energy frontier experiments are not going to be

unique in these challenges in the future but they can

still offer expertise and experience in the sense that

a lot of these problems they experienced first.

Frameworks and data formats and workflows management

across thousands of machines and that sort of thing.

 Just a brief listing of the overlapping white

papers. These aren't all comp F. They are just

overlapping with the energy frontier. For general

interest, software and computing for small HEP

experiments. There can be small experiments, this is

not a contradiction in terms.

 And diversity and equity and inclusion,

surprisingly to me, none in experimental algorithm

optimization and parallelization, given the importance

that has been placed on paralyzing, vectorizing the

codes. But maybe this is more an artifact of the fact

this overlaps are instrumentation and theory.

 Theoretical calculations and simulation. There is

a number of these. I would say most of them are

documentation of theory work and only a couple focus on

the computational aspects.

 Comp F3 machine learning, a number again fewer

than I would have anticipated but I think at some level

machine learning is so common now for us that we just

take it for granted as a thing that you do.

 And then again, somewhat surprising to me not so

much in the other topical groups. And again, I think

some of this is just, it's going to be okay from our

side in that we have energy frontier people working in

all these places but I do think it's worth people

thinking a little bit on the energy frontier side

whether there are things that would be relevant to be

pointed out to people in these topical groups.

 In terms of report writing, both frontiers are

beginning the process of distilling the white papers.

We want to introduce as little noise as possible. But

it's important I think that as people go through their

white papers, they keep a broad mind and say, identify

they think that some information might be relevant to

other conveners in other frontiers.

 And also to take the opportunity to step back for

a minute and think of big integrated picture. It's not

just broken down by frontier. And so I, I'll leave you

with potential prompts for discussion or to think about

as you're going about you day, some cross cutting

topics.

 For example, are we giving up physics capability

because of a lack of computing capability or perhaps

the wrong hardware. This can go both ways. For

example, there are cases where it does seem that super

computers would be a better fit for certain Monte Carlo

integration questions. Whereas we complained about

super computers because they don’t have network access

for processing large numbers of events.

 Are we missing out that we can't at the moment do

higher-order accuracy calculations in a finite amount

of time. Do we better handle the systemics if we had

more capacity and things like that.

 As an aside, what I've looked at, computing

requirements as stated for future experiments, they

tend to be careful to keep themselves within the LH LHC

computing budget which 30 years out doesn't make sense.

That is something that people should consider if

they're constraining themselves.

 Could new techniques improve detector design and

optimization. Differential programming is an up and

coming thing, where you can solve for optimized lots of

steps in a continuous process without doing it chunk by

chunk by chunk. Optimizing things independently.

 Or perhaps you can wander through a large design

space using machine learning techniques.

 And are there elements of the computing

environment that we have now that hinder physicists

productivity. I think we know there are. But the

question is are they real showstoppers or things that

people don't do not because they're impossible but

they're so time consuming that no one can be bothered.

 That is all I have.

 >> Thank you.

 Questions?

 >> We just turn around a little bit one of the

statements you made. I was surprised in a lot of the

topics, sort of topical groups of the computational

frontier you didn't find any submitted paper that sort

of is relevant for the energy frontier.

 >> Let me be careful. It's not that aren't

potentially relevant, they weren't marked as such. At

some point a lot of them are relevant in some degree

but the authors did not explicitly say that.

 >> What I wanted to ask, is given how many places

this is and given as you say that in practice there is

expertise that knows what the -- may need and so on. I

was wondering if this was possible to turn around and

ask the conveners of these groups what are key elements

that they really need input on and they might be

missing. That can be interesting for us, also.

 I mean, looking at just these topics I can think

of many things and you highlighted many in your talk.

I'm trying to understand will these things that you

mentioned not be [inaudible] at all. Or does someone

need the do something.

 >> Like this list?

 >> For instance, yes. I mean, you highlighted a

lot of points that I think are very relevant to many of

these groups.

 >> Yes, I think the answer would be that we have a

pretty good sense of either how they are being

addressed or what, I mean maybe the way I should put it

is, I list these as things that we're trying to discuss

but I think we have a fairly reasonable sense of how

we're going to answer them even if there aren't

explicitly cross listed papers.

 Of course, input on these things is very valuable

and I think in particular, one of the core issues is

that because by definition we're selected as people who

are very comfortable with computing that I think often

we find, we're biased in the sense that we think that

complicated solutions are trivial or something like

that. Where people outside of our community say, of

course, you want to, everyone wants to use Python or

whatever. Right.

 So I do think that kind of input is extremely

valuable. It's pretty much the case that at some level

if you're just thinking from the energy frontier

perspective, you just want the answer. You don't

necessarily want to know if you're running on an

analysis facility or whatever. Whether this is going

through a super computer or not.

 There's a little bit of, you know.

 >> Thanks. Thank you. Maybe just I wanted to

highlight to echo one thing that you said that I think

is very important which is not only sort of the

challenges in running an experiment which of course is

the highest in terms of requirements in the computing

part, but even in the design and sort of in a

collaborative design that we heard a lot about sort of

in a community, et cetera, and you need infrastructure

for the community and one thing you need is a way to

communicate on the computing side. Common resources

and stuff like that. That is often taken for granted

and especially for development so much facilities, it

might not be trivial. I think if we can communicate to

the computing set of, in a way that sort of this

message is highlighted from the energy frontier, I

think it would be very nice overall.

 >> I think that message is the message we need to

enable computing for things that are not specifically

right now ongoing projects that are being constructed

or running.

 I think that message has been taken very

seriously. I think the one thing that is lacking there

is the sense of the scale of that problem.

 If that is something that we can get feedback on,

I think that would be great. What is the scale of the

computing that is needed for example for doing

reasonable muon collider detectors.

 We had a chat about that. It is a meaningful

thing.

 >> As someone who submitted a white paper that was

on that slide today. I think a bunch of papers are

going to come in on a short time scale.

 We submitted it an hour ago.

 So I think I got three of the 8 points or

something. I think there's a few more things in the

pipeline but I think we agree to the scope of what

needs to be done there.

 >> Is there a question online?

 >> Alessandro has a question.

 >> I have a question on the quantum computing. I

was a bit surprised there were no overlapping papers

being submitted to the frontier on quantum computing.

Maybe because the computational frontier is focusing on

a ten-year span. It's difficult for us and I just

wanted to capture the developments of quantum computing

in that time span.

 That is useful for the future. I thought it could

be good potential for application of quantum computing

in the energy frontier both theoretical calculations as

well as for experiments.

 I don't know what your thoughts are.

 >> It's an interesting question. So of course,

there's, I think the most direct is obviously relevant

thing that has been either quantum machine learning or

quantum simulation in certain cases. There are

potential applications to things like tracking as well

with quantum annealing algorithms.

 But I would say that it's really hard to know.

This is the most speculative thing that we're talking

about. It's hard to know where reasonable expectations

of the capabilities, certainly ten years or 20 or 30

years out are going to be.

 (captioning time expired.)