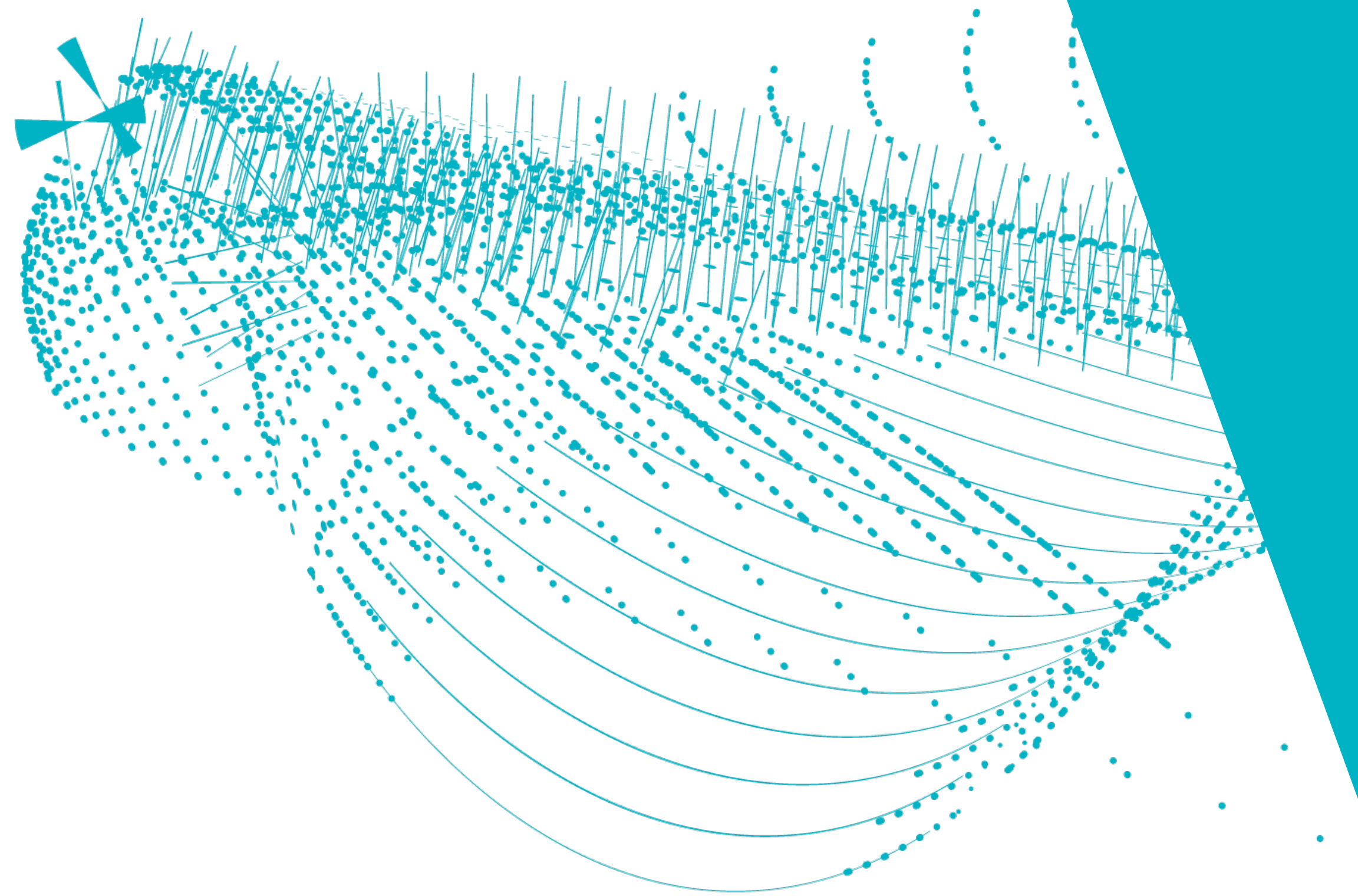




NIKHEF VISTA UPDATE MEETING, 21 OCTOBER 2020

NIKHEF THEORY

Robert Fleischer



THEORETICAL PHYSICS LANDSCAPE

- Mathematical physics
- String theory
- Cosmology/Astro/Gravity
- Model building
- High-energy frontier
- High-precision frontier
- Quark and lepton flavour physics
- Strong interactions
- ...

Fascinating topics & developments

*Impressive expertise
in the Netherlands*

Various interactions

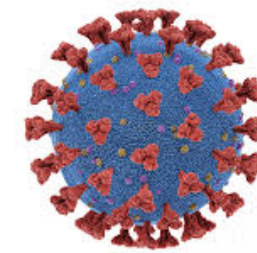
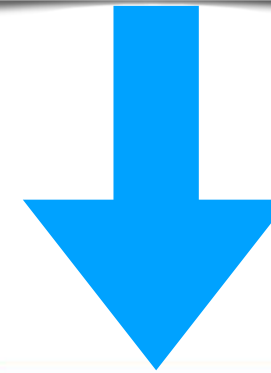
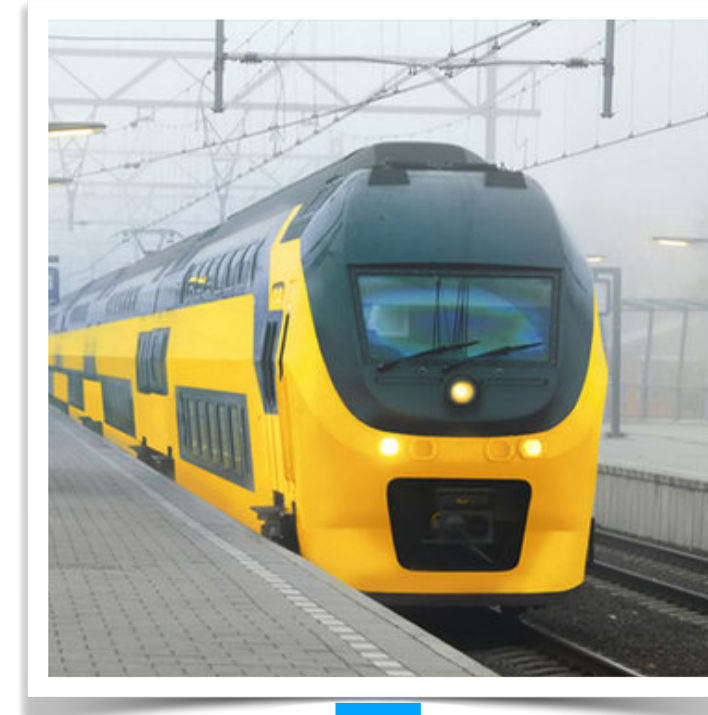
DUTCH THEORETICAL PARTICLE PHYSICS

- Amsterdam: Nikhef, VU, UvA
- Nijmegen: Radboud Universiteit
- Groningen: Rijksuniversiteit
- Utrecht: Universiteit Utrecht
- Leiden: Universiteit Leiden
- Maastricht: Maastricht University

Nikhef Theory Groups

- *Large community:*

- O(45) staff members
- O(60) postdocs
- O(100) PhD students



[No theoretical particle physics at Technical Universities]

NIKHEF THEORY GROUP AMSTERDAM

- Broad spectrum of research topics:
 - Collider, flavour and BSM physics
 - Strong interactions - QCD
 - Cosmology, dark matter...

Synergies with Nikhef programmes

- We serve as a national centre for particle physics phenomenology.
- Interaction with experimental groups:

Exciting opportunities @ Nikhef



["Theory Welcome Meeting" 2019]

THEORY MEETS EXPERIMENT

The screenshot shows the INDI CO website interface. At the top left is the INDI CO logo with the text 'Integrated Digital Conference'. On the top right, there are dropdown menus for 'Europe/Amsterdam' and 'Englisch', and a 'Login' button. Below the logo is a navigation bar with 'Home', 'Create event', 'Room booking', and 'Help'. A breadcrumb trail shows 'Home >> Theory Meets Experiment'. The main heading is 'Theory Meets Experiment'. To the right of the heading are icons for 'Parent category', a calendar, an eye, and a plus sign. The main text describes the events, organized by Robert Fleischer, Tristan du Pree, and Marcel Merk, and provides information on how to join and subscribe. Below the text, there are two event listings: one for June 2020 on 26 Jun and one for May 2020 on 15 May. On the right side, there is a 'Managers' section listing Berger, J., Fleischer, R., Merk, M., and du Pree, T., and a 'Files' section with a 'more information' link.

Home Create event Room booking Help

Home >> Theory Meets Experiment

Theory Meets Experiment

Parent category

Managers

- Berger, J.
- Fleischer, R.
- Merk, M.
- du Pree, T.

Files

more information

The “Theory Meets Experiment” events are organised by Robert Fleischer (Theory), Tristan du Pree (ATLAS) and Marcel Merk (LHCb). These topical Nikhef mini workshops usually take place on a Friday afternoon, sometimes complementing a more general colloquium in the morning, and have the aim to further stimulate interactions and discussions between the theory and ATLAS/LHCb communities. All students (MSc, PhD), postdocs and scientific staff physicists of the corresponding groups are welcome to join. If you would like to receive the announcements of these events by email, please subscribe to the Nikhef colloquium email list by following the link on the right (i.e. right below “Files”). For more information and suggestions of possible topics and speakers, please contact the organisers.

June 2020

26 Jun Mini Nikhef Workshop: Theory Meets Experiment - SMEFT for Higgs and Top

May 2020

15 May Mini Nikhef Workshop: Theory Meets Experiment - High-energetic neutrino scattering processes and interactions of cosmic rays

Suggestions are very welcome!

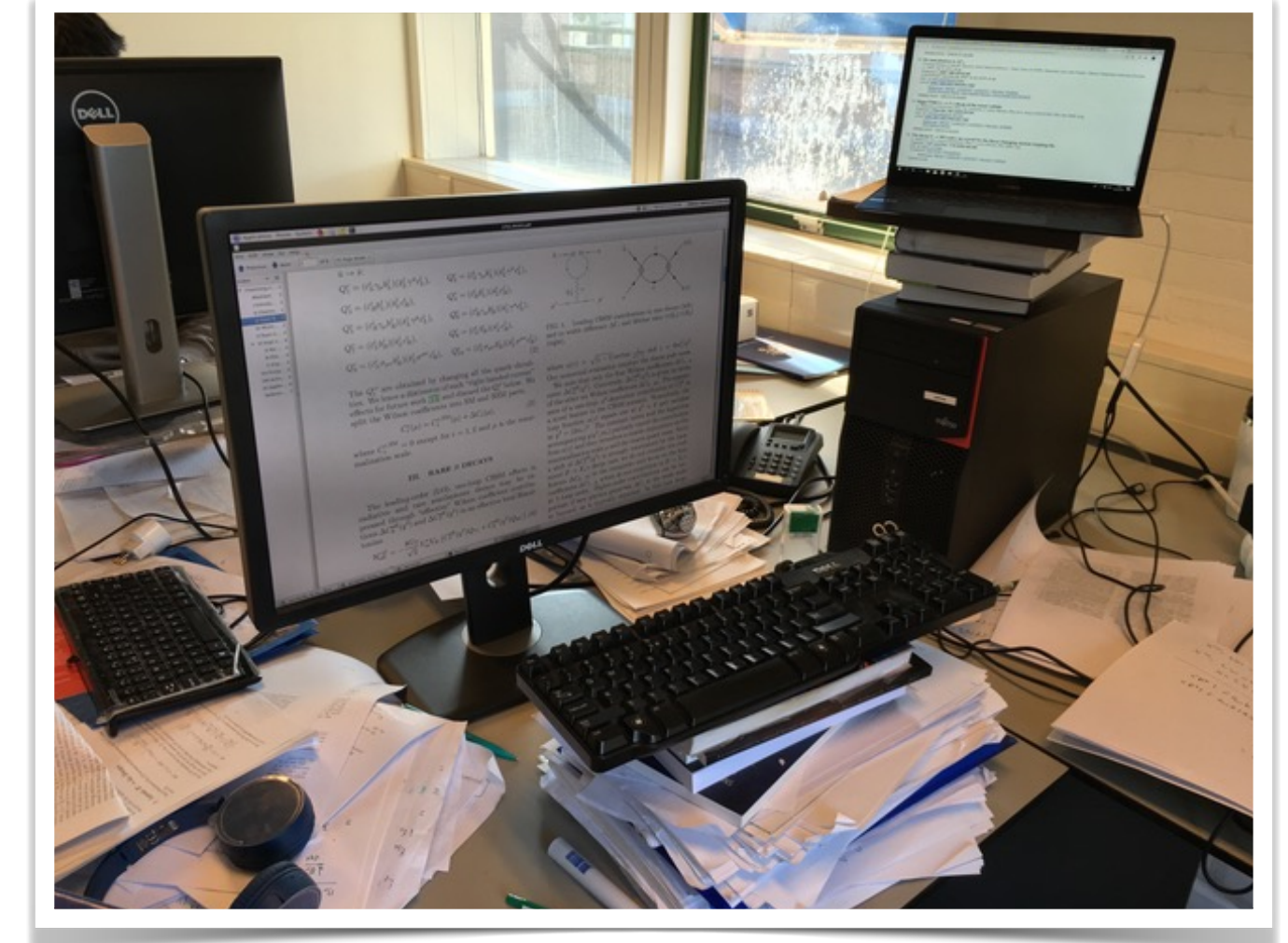
THEORETICAL PHYSICS: “INSTRUMENTATION”



(i) Brainstorming



(ii) Thinking



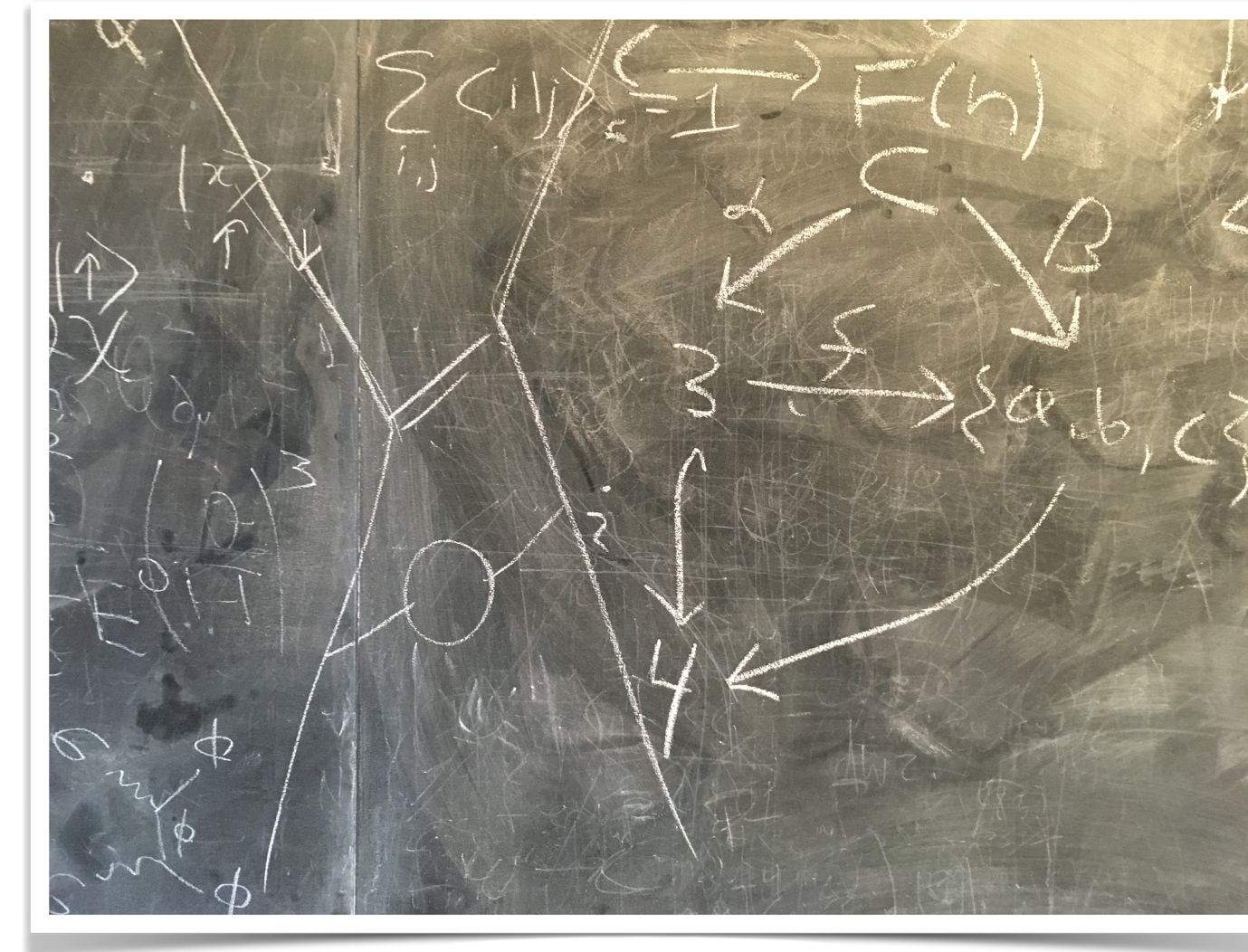
(iii) Calculating

Key investment: positions (junior & senior scientists)

MAJOR RESEARCH TOPIC (2020-2030 + ...!?)

The Quest for a “New Standard Model”

- Standard Model is very successful...
- But not the “final” theory:
 - Dark Matter
 - Baryon asymmetry of the Universe
 - Theoretical “ugliness” + ...

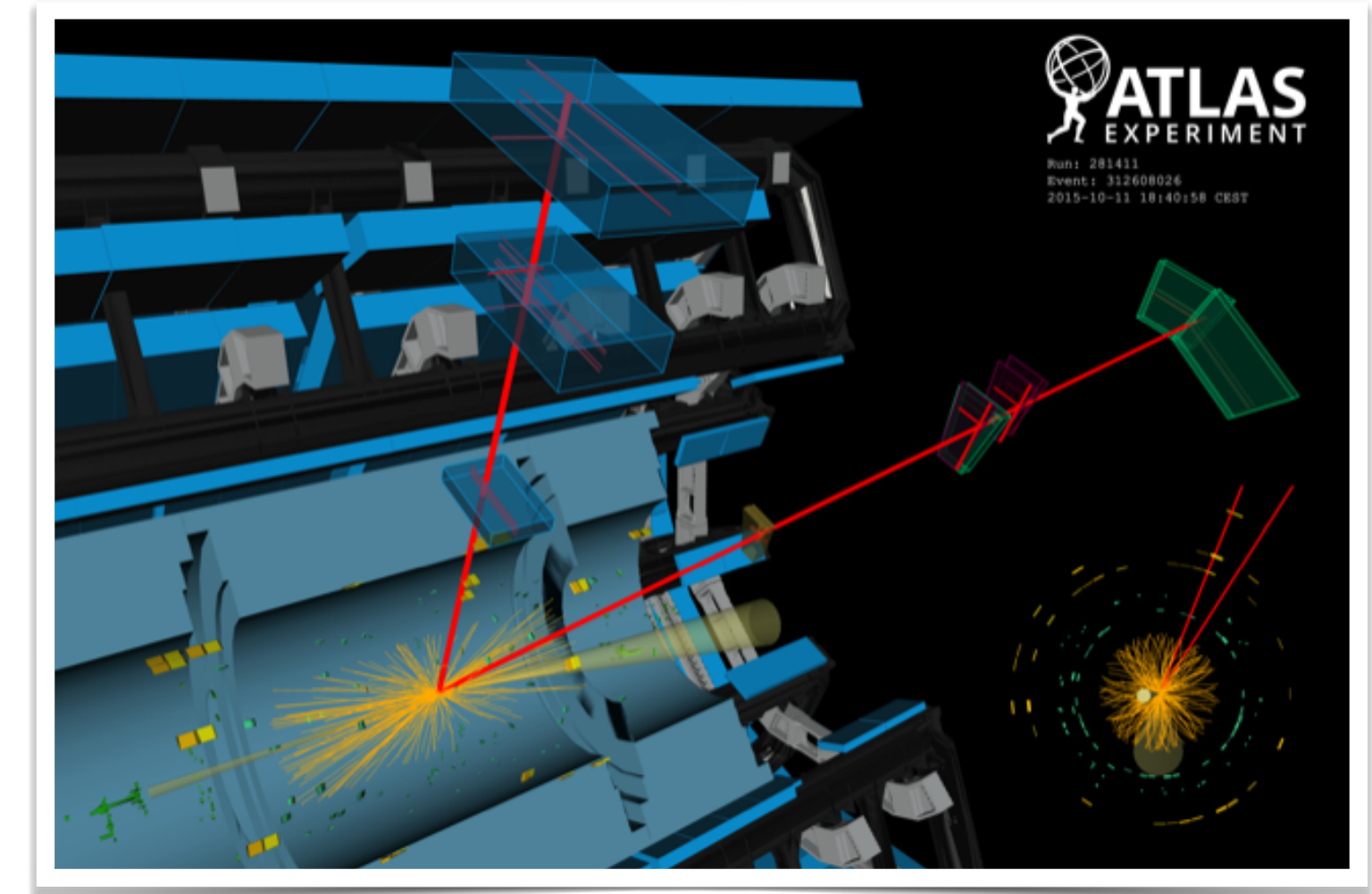


Which physics lies beyond the Standard Model?

THE CURRENT PICTURE IN A NUTSHELL

Lessons from experimental data:

- Higgs boson is well established:
 - Properties being studied at ATLAS (CMS) ...
 - Is it the “minimal” Higgs of the SM?
- Direct searches for new particles at the high-energy frontier, i.e. at the LHC:
 - Unfortunately, no signals (yet?!)...



[Candidate Higgs decay into two muons]

New physics at (much) higher energies?

INDIRECT MANIFESTATIONS OF NEW PHYSICS

Virtual quantum effects

- New particles and interactions may contribute to quantum corrections:

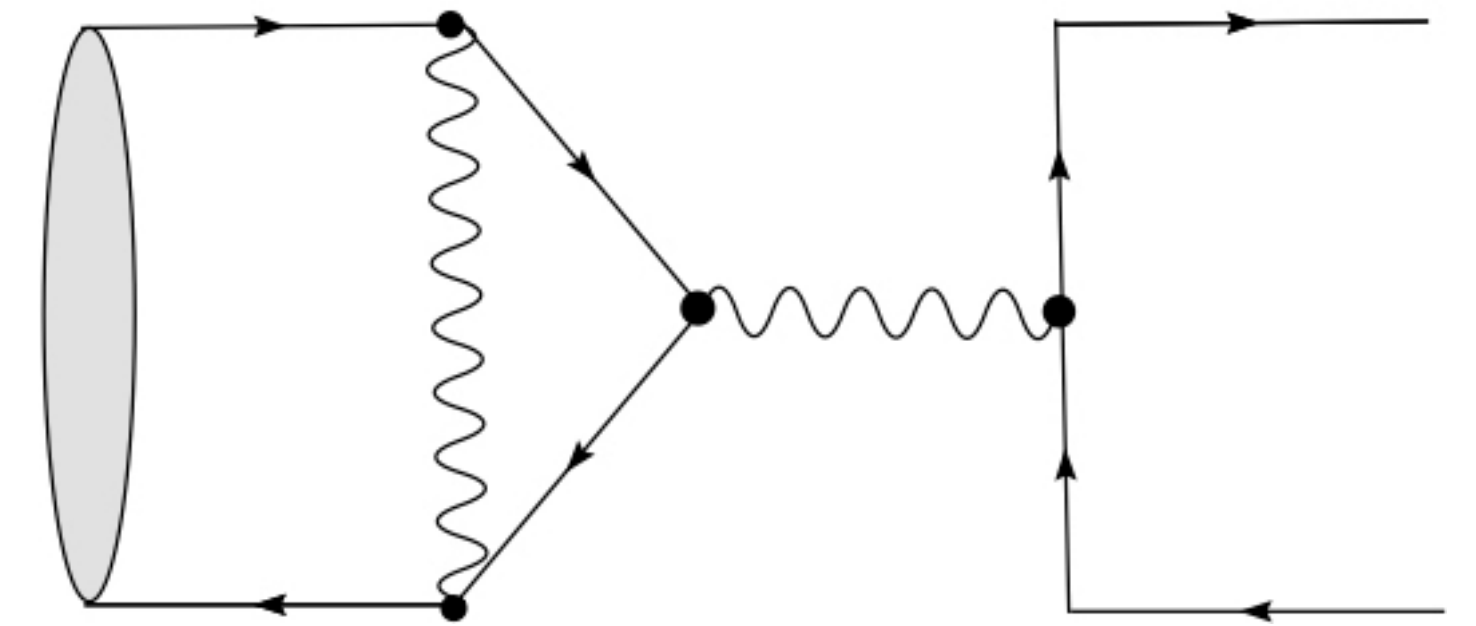
- Loop effects
- Flavour changing neutral currents, ...

Domain of Theory

- Standard Model offers very sensitive probes:

- Strongly suppressed decays.
- CP-violating asymmetries.
- Electric dipole moments, ...

High-precision frontier



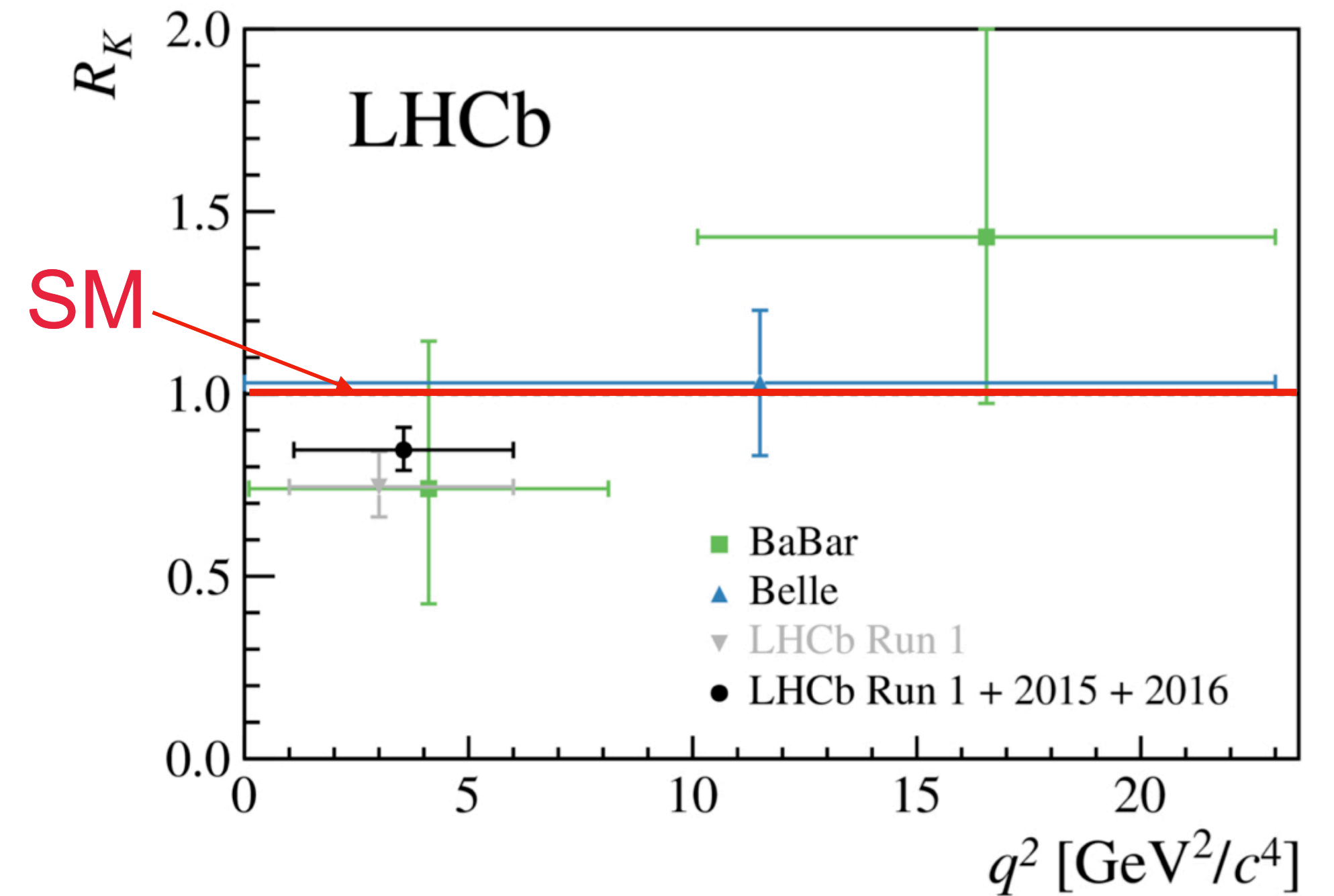
[Penguin topology]

EXCITING TIMES ...

- Puzzling patterns in precision data:
 - Example: R_K anomaly in $B \rightarrow K\ell^+\ell^-$
- A lot of new data in 2020-2030:
 - LHC upgrades
 - Belle II, rare K decays, LFV, EDMs, DM
- Interpretations and implications?

Theory is essential!

Imprint of new particles and interactions?

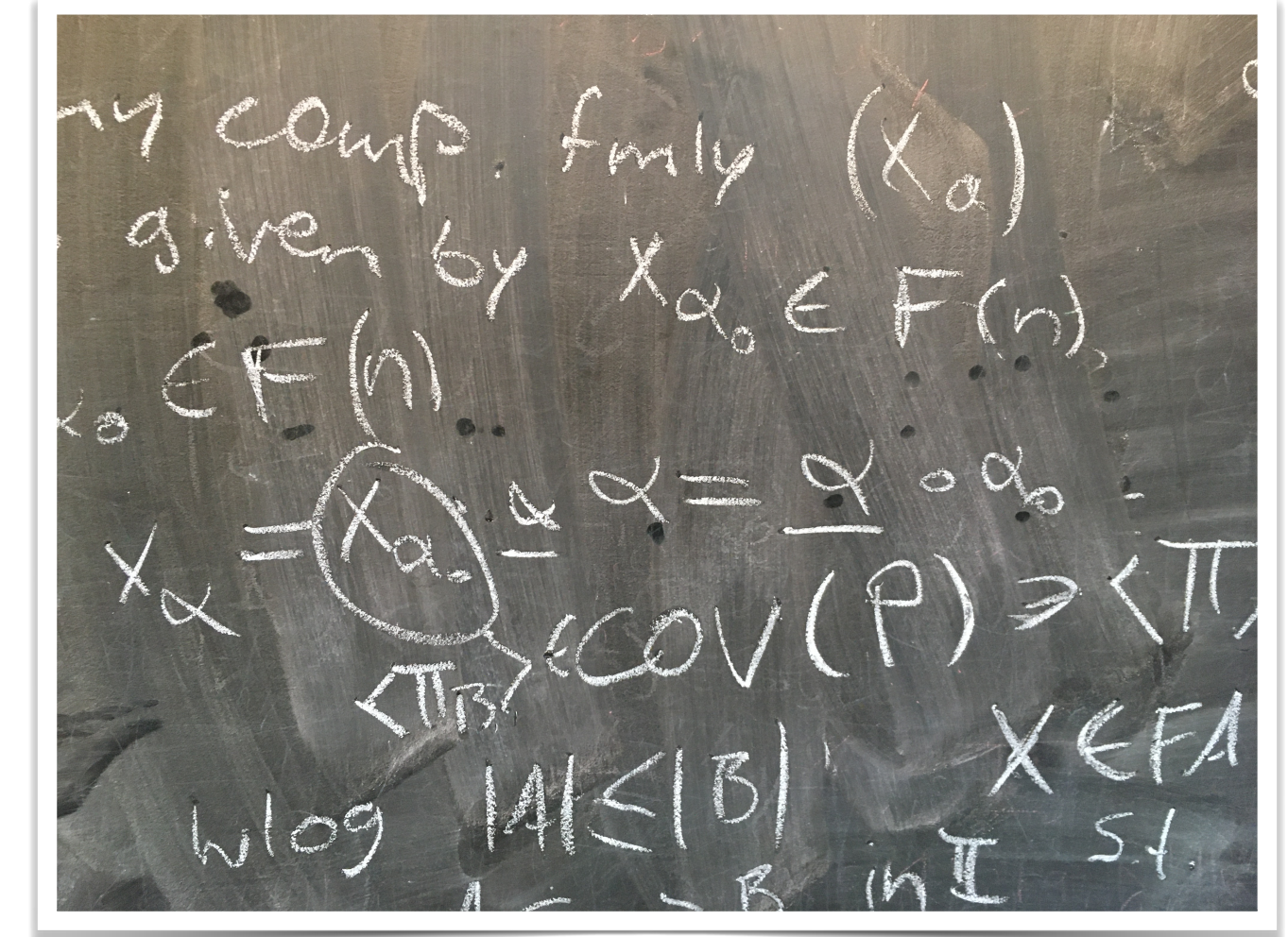


[LHCb public website]

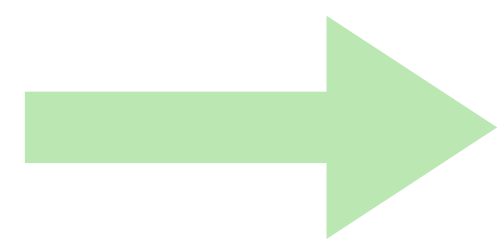
Precision is the key...

THEORETICAL PHYSICS AS “QUANTUM MICROSCOPE”

- Quantum field theory is our main “tool”:
 - New methods (including machine learning).
 - Critical Standard Model analyses: *uncertainties*.
 - Interplay with experimental data...
- Enter a new territory:

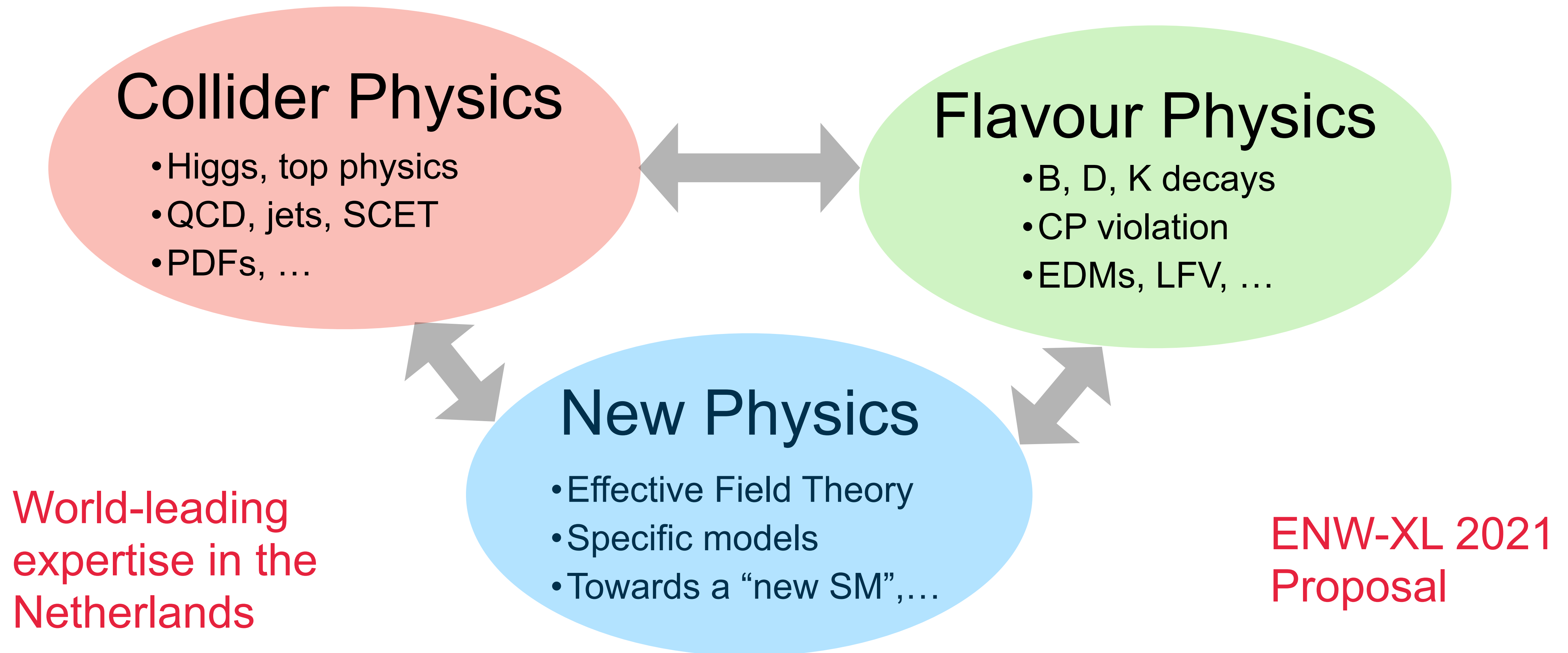


Nature at zeptometre distances \leftrightarrow *PeV energies*
[$10^{-21}m$ (corona virus $\sim 10^{-7}m$)] [$10^{15}eV = 1000 TeV$]



Implications for future colliders!?

LOOKING INTO THE ZEPTOUNIVERSE



FOCUS SESSION AT PHYSICS@VELDHOVEN 2021

Journeys through the Zeptouniverse: Particle Physics and the Quest for a New Standard Model

- Chris Quigg [Fermilab]
- Juan Rojo [VU]
- Keri Vos [Maastricht University]
- Elisabetta Pallante [RUG/VSU]

Physics@Veldhoven

< Events

> ACOS

> Bessensap

> CHAINS

> DutchBiophysics

> ICT.OPEN

> Insight Out 2018

> Life

> Life Sciences with industry

> NAC

> **Physics@Veldhoven**

Abstracts

Archives

Physics@Veldhoven 2021 goes digital and takes place on 18, 19 and 20 January 2021! This year's theme is the Magic of Physics. More information will follow soon on this website.

Physics@Veldhoven 2021

Physics@Veldhoven takes place each year in January. It is a large congress that provides a topical overview of physics in the Netherlands. Traditionally, young researchers are given the chance to present themselves and their work alongside renowned names from the Dutch and international physics community. The programme covers Statistical Physics & Soft condensed matter, Physics of Fluids, Plasma & Fusion Physics, Quantum Physics, Nanoscale Physics, Atomic, Molecular and Optical Physics, Materials Physics, Particle Physics, Astroparticle Physics and Physics for Technology.

FURTHER THEORY GROUP TOPICS

- Links with non-LHC programmes:
 - Cosmic rays (cross sections, ...)
 - Neutrinos
 - Dark matter (UvA/GRAPPA)
 - Electric dipole moments (VSI)
- Gravitational waves:
 - Links with Maastricht University and other theory groups (UvA, UU)
- Cosmology, strings, formal theory:
 - Links with UvA, Leiden, UU, RU, VSI.

Keep close & excellent links with the Dutch theory community

+

Keep close links with the international community

QUESTIONS KEEPING ME BUSY AT NIGHT...

At which scale does
New Physics enter?

Can we make progress to
understand the structure
of the Standard Model?

Is the Higgs the
minimal SM one?

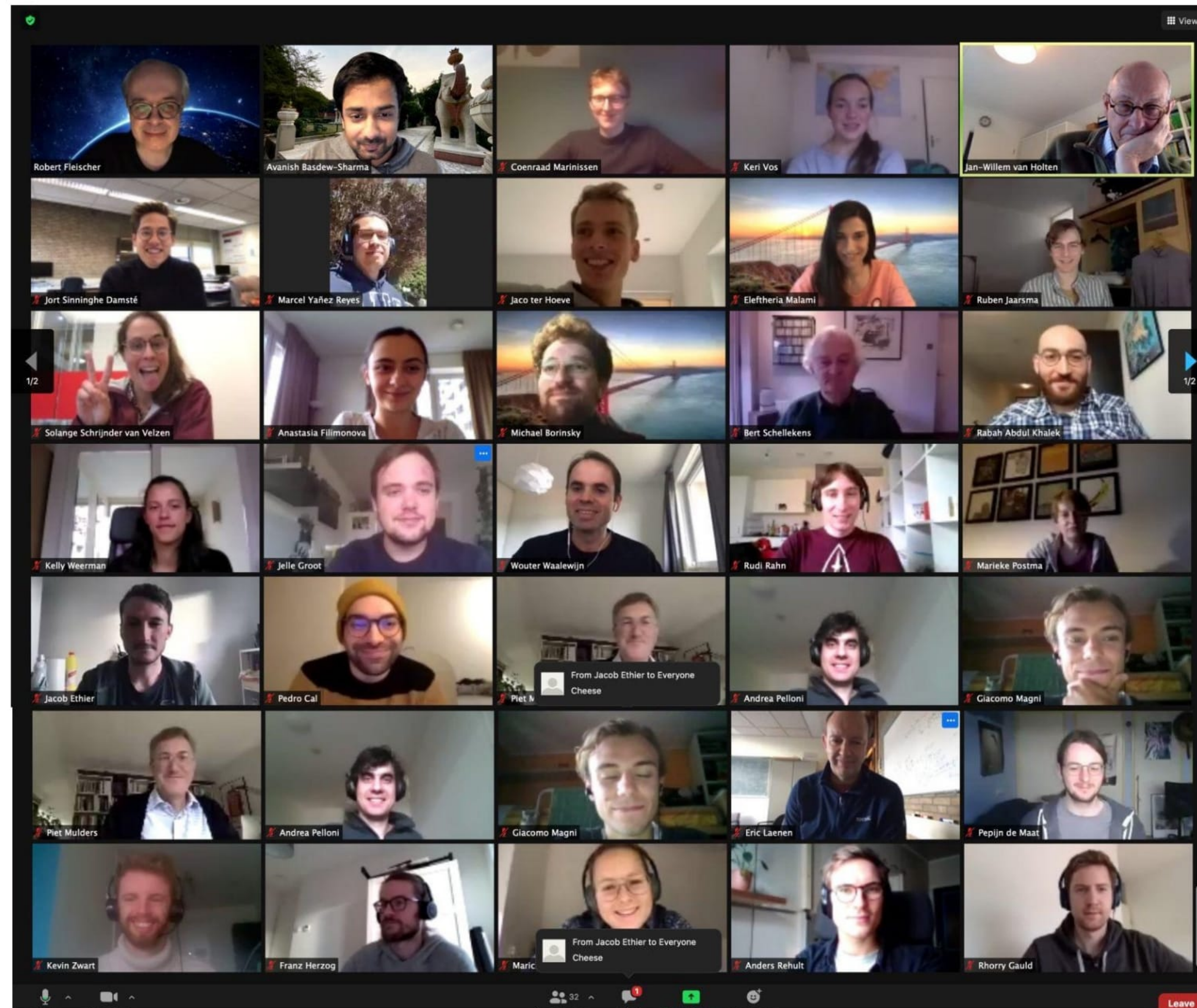
Will we be able to establish
New Physics in this decade?

Will we find new sources of CP violation?

Which mysteries will rare B decays reveal?

Will we find dark matter? Properties? Gravity?

THEORY GROUP IN CORONA TIMES...



Hope to meet you again in person soon...

Stay safe & healthy!

["Theory Welcome Meeting" October 2020]