Concluding Remarks

We reached the end of

the third BCD School

High Energy Physics!

Concluding Remarks

- A rich scientific program

- Standard Model and Flavour Physics as the Foundations.

- The properties of the 125 GeV boson and of the top quark.

- Cosmology on its own and the intimate relations with particle questions.

- And next: BSM and future experimental programs.

Concluding Remarks

The Standard Model Foundations:

- The SM is a beautiful model. Elementary interactions follow from symmetries and local gauge invariance dogma

Concluding Remarks

The Standard Model Foundations:

- The SM is a beautiful model. Elementary interactions follow from symmetries and local gauge invariance dogma

Gudrun

Concluding Remarks

The Standard Model Foundations:

- The SM is a beautiful model. Elementary interactions follow from symmetries and local gauge invariance dogma

Gudrun

- It works so far ...
- We could predict the Higgs mass.

Concluding Remarks

The Standard Model Foundations:

- The SM is a beautiful model. Elementary interactions follow from symmetries and local gauge invariance dogma

Gudrun

- It works so far ...
- We could predict the Higgs mass.

Stephane

Concluding Remarks

The Standard Model Foundations:

- The SM is a beautiful model. Elementary interactions follow from symmetries and local gauge invariance dogma

Gudrun

- It works so far ...
- We could predict the Higgs mass.

Stephane

Concluding Remarks

The Higgs quest

- A continuum of 50 years of experimental and theoretical research efforts

Concluding Remarks

The Higgs quest

- A continuum of 50 years of experimental and theoretical research efforts

$$\begin{aligned}
\mathcal{L}_H \;\rightarrow\; & (D_\mu\phi)^\dagger((D_\mu\phi)) \\
= \; & \frac{1}{2}\partial_\mu H\partial^\mu H + \frac{g_W^2}{4}(v+H)^2[W_\mu^\dagger W^\mu + \frac{1}{\cos^2\theta_W}Z_\mu^\dagger Z^\mu] \\
\rightarrow\; & \frac{g_W^2 v^2}{4}[W_\mu^\dagger W^\mu + \frac{1}{\cos^2\theta_W}Z_\mu^\dagger Z^\mu]
\end{aligned}$$

Concluding Remarks

The Higgs quest

- A continuum of 50 years of experimental and theoretical research efforts

$$
\begin{aligned}
\mathcal{L}_H \quad &\rightarrow \quad (D_\mu \phi)^\dagger ((D_\mu \phi)) \\
&= \quad \frac{1}{2} \partial_\mu H \partial^\mu H + \frac{g_W^2}{4} (v + H)^2 [W_\mu^\dagger W^\mu + \frac{1}{\cos^2 \theta_W} Z_\mu^\dagger Z^\mu] \\
&\rightarrow \quad \frac{g_W^2 v^2}{4} [W_\mu^\dagger W^\mu + \frac{1}{\cos^2 \theta_W} Z_\mu^\dagger Z^\mu]
\end{aligned}
$$

Concluding Remarks

The Higgs quest

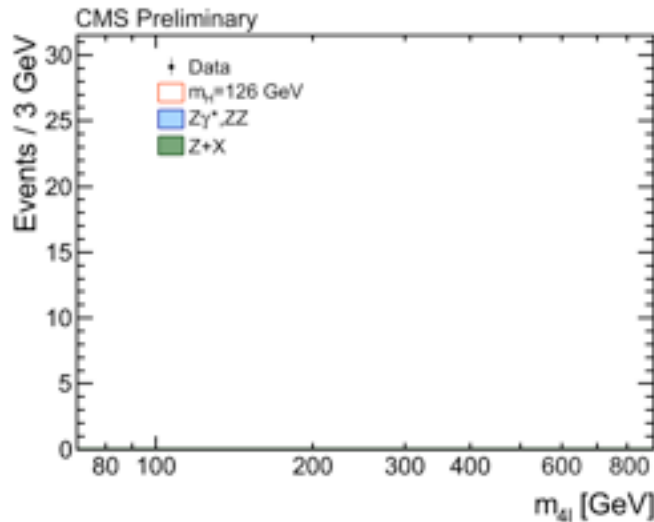- A continuum of 50 years of experimental and theoretical research efforts

$$
\begin{aligned}
\mathcal{L}_H \quad \rightarrow \quad & (D_\mu \phi)^\dagger ((D_\mu \phi)) \\
= \quad & \frac{1}{2} \partial_\mu H \partial^\mu H + \frac{g_W^2}{4} (v + H)^2 [W_\mu^\dagger W^\mu + \frac{1}{\cos^2 \theta_W} Z_\mu^\dagger Z^\mu] \\
\rightarrow \quad & \frac{g_W^2 v^2}{4} [W_\mu^\dagger W^\mu + \frac{1}{\cos^2 \theta_W} Z_\mu^\dagger Z^\mu]
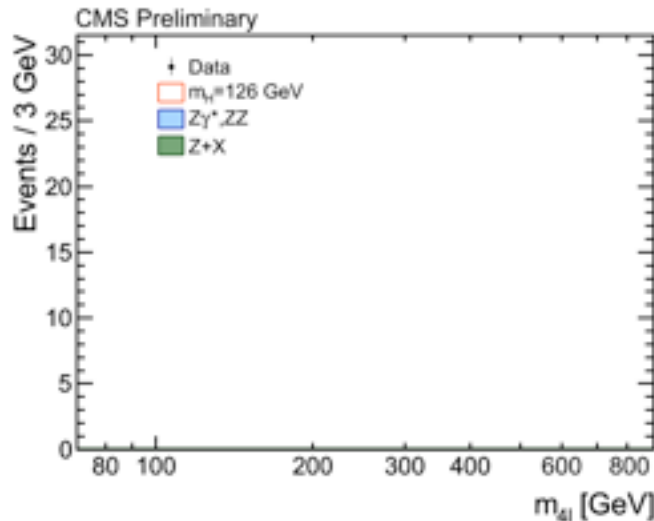\end{aligned}
$$

Concluding Remarks

The Higgs quest

- A continuum of 50 years of experimental and theoretical research efforts

$$\mathcal{L}_H \rightarrow (D_\mu \phi)^\dagger ((D_\mu \phi))$$

$$= \frac{1}{2}\partial_\mu H \partial^\mu H + \frac{g_W^2}{4}(v + H)^2 [W_\mu^\dagger W^\mu + \frac{1}{\cos^2 \theta_W} Z_\mu^\dagger Z^\mu]$$

$$\rightarrow \frac{g_W^2 v^2}{4}[W_\mu^\dagger W^\mu + \frac{1}{\cos^2 \theta_W} Z_\mu^\dagger Z^\mu]$$

Concluding Remarks

The Higgs quest

- A continuum of 50 years of experimental and theoretical research efforts

$$\mathcal{L}_H \quad \rightarrow \quad (D_\mu \phi)^\dagger ((D_\mu \phi))$$
$$= \quad \frac{1}{2} \partial_\mu H \partial^\mu H + \frac{g_W^2}{4} (v + H)^2 [W_\mu^\dagger W^\mu + \frac{1}{\cos^2 \theta_W} Z_\mu^\dagger Z^\mu]$$
$$\rightarrow \quad \frac{g_W^2 v^2}{4} [W_\mu^\dagger W^\mu + \frac{1}{\cos^2 \theta_W} Z_\mu^\dagger Z^\mu]$$

- LHC: the Lord of the Rings is a fantastic Science success
- There seem to be a fundamental scalar in the Nature.   Looks pretty standard though, so far ...
- This is just the beginning of the journey.

Concluding Remarks

The Standard Model Foundations are solid.

- The SM owns a single phase allowing from *CP* violation.
- Angelo introduced us with the Flavour Physics observables, which are eventually telling ...

Concluding Remarks

The Standard Model Foundations are solid.

- The SM owns a single phase allowing from *CP* violation.
- Angelo introduced us with the Flavour Physics observables, which are eventually telling ...

Concluding Remarks

The Standard Model Foundations are solid.

- The SM owns a single phase allowing from *CP* violation.
- Angelo introduced us with the Flavour Physics observables, which are eventually telling ...

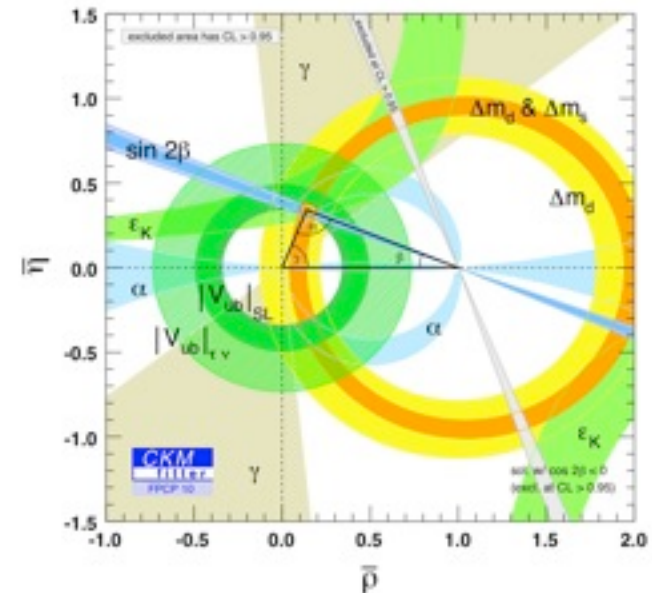

- ... that SM works there as well.

Concluding Remarks

The Standard Model Foundations are solid.

- The SM owns a single phase allowing from *CP* violation.
- Angelo introduced us with the Flavour Physics observables, which are eventually telling ...

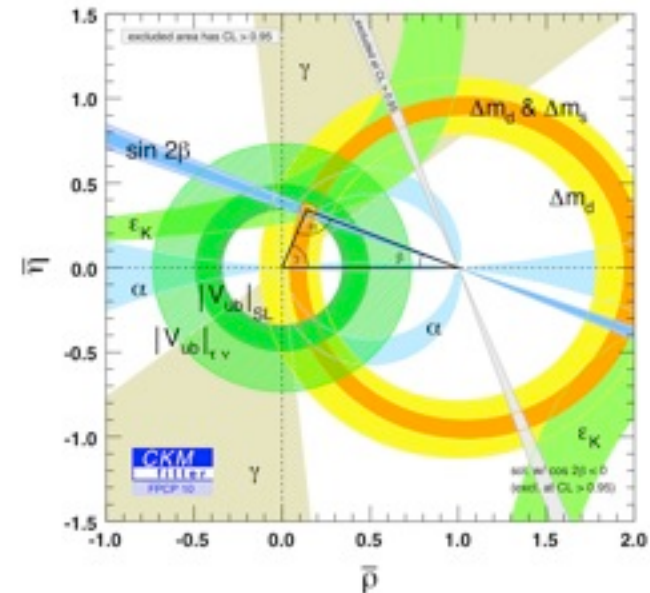- ... that SM works there as well.

Concluding Remarks

The Standard Model Foundations are solid.

- The SM owns a single phase allowing from *CP* violation.
- Angelo introduced us with the Flavour Physics observables, which are eventually telling ...

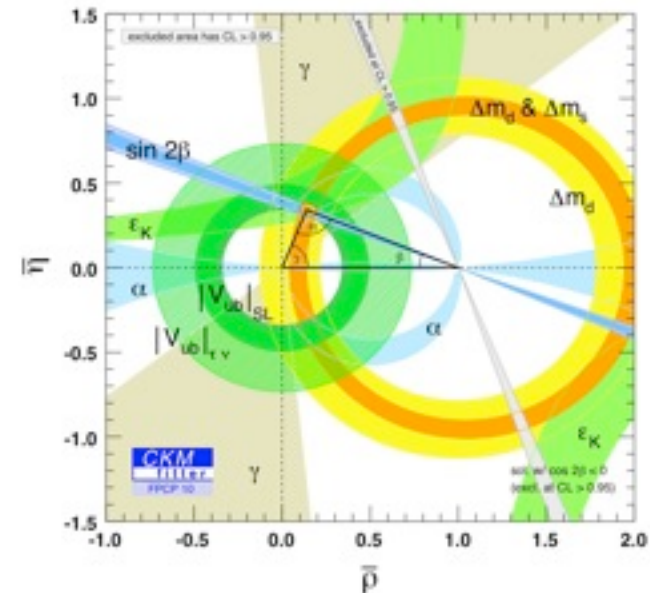- ... that SM works there as well.

Concluding Remarks

The Standard Model Foundations are solid.

- The SM owns a single phase allowing from *CP* violation.
- Angelo introduced us with the Flavour Physics observables, which are eventually telling ...

San Angelo

- ... that SM works there as well.
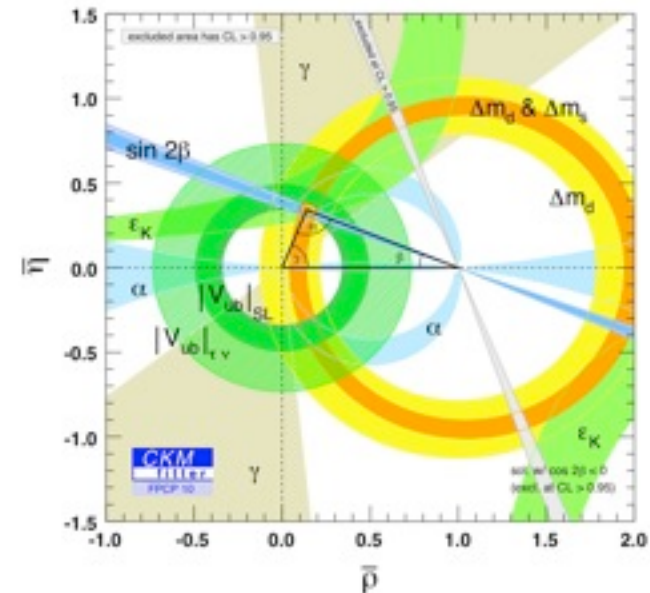
Concluding Remarks

The Standard Model Foundations are solid.

- The SM owns a single phase allowing from *CP* violation.
- Angelo introduced us with the Flavour Physics observables, which are eventually telling ...

San Angelo

- ... that SM works there as well.

- ... Is it really ?

Concluding Remarks

The Standard Model Foundations might be shivering ...

- This comes mostly from rare decays of b-hadrons ($b \rightarrow s$ transitions) and challenges the SM predictions in several respects. The lepton universality might be an appealing case for BSM.

Concluding Remarks

The Standard Model Foundations might be shivering ...

- This comes mostly from rare decays of b-hadrons ($b \rightarrow s$ transitions) and challenges the SM predictions in several respects. The lepton universality might be an appealing case for BSM.

- ... get excited! But keep calm ...

Concluding Remarks

The Standard Model Foundations might be shivering ...

- This comes mostly from rare decays of b-hadrons ($b \to s$ transitions) and challenges the SM predictions in several respects. The lepton universality might be an appealing case for BSM.

San Angelo ready to fish for BSM

- ... get excited! But keep calm ...

Concluding Remarks

The Standard Model Foundations might be shivering ...

- This comes mostly from rare decays of b-hadrons ($b \rightarrow s$ transitions) and challenges the SM predictions in several respects. The lepton universality might be an appealing case for BSM.

San Angelo ready to fish for BSM

Joachim knows some of the possible ways

- ... get excited! But keep calm ...

Concluding Remarks

The Standard Model Foundations might be shivering ...

Concluding Remarks

The Standard Model Foundations might be shivering ...

Concluding Remarks

The Standard Model Foundations might be shivering ...

Model building ...

Concluding Remarks

The Standard Model Foundations might be shivering ...

Concluding Remarks

The Standard Model Foundations might be shivering ...

NP could be here. How to reach there?

Concluding Remarks

The Standard Model Foundations might be shivering ...

NP could be here. How to reach there?

Concluding Remarks

Aparté: we had several clever ways to measure the distance to the rock:

There was a consensus on triangulation method requiring the knowledge of the size of the rock.

A special mention to Joachim Brod having estimated the size of the rock to be around 15 meters. He also estimated the distance to be 1.5 km with few kilometers uncertainty which will improve with luminosity. Invincible but ...

... the best solution received was from the students:

$$d_{\mathrm{rock}} = 2.413 \pm 0.162 \ \mathrm{m}$$

Concluding Remarks

The top is the Lord of the fermions.

- We are starting to study its characteristics.
- It couples to the Higgs with the maximum strength in the SM. In the Nature?

Concluding Remarks

The top is the Lord of the fermions.

- We are starting to study its characteristics.
- It couples to the Higgs with the maximum strength in the SM. In the Nature?

Johannes

Concluding Remarks

The top is the Lord of the fermions.

- We are starting to study its characteristics.
- It couples to the Higgs with the maximum strength in the SM. In the Nature?

- Smart and educated ... Physics

- The top offers a unique window on BSM.

Concluding Remarks

Beyond Standard Model

- Some reasons to think that there must be something new close to our current energy frontier
- Naturalness? Challenged ...

Concluding Remarks

Beyond Standard Model

- Some reasons to think that there must be something new close to our current energy frontier
- Naturalness? Challenged ...

Concluding Remarks

Beyond Standard Model

- Some reasons to think that there must be something new close to our current energy frontier
- Naturalness? Challenged ...

Concluding Remarks

Beyond Standard Model

- Some reasons to think that there must be something new close to our current energy frontier
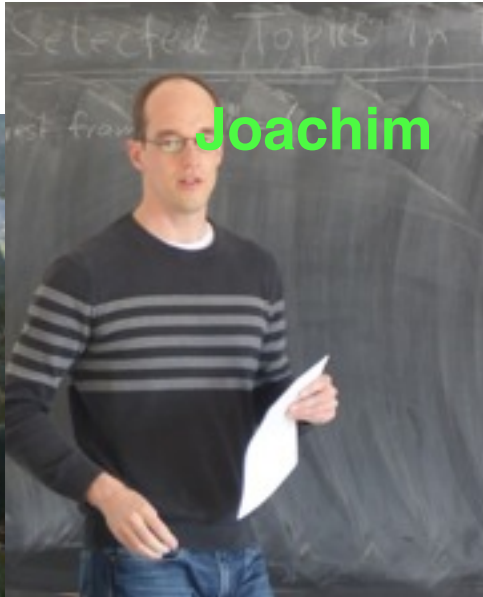- Naturalness? Challenged ...

Extra dimensions?

Concluding Remarks

Beyond Standard Model

- Some reasons to think that there must be something new close to our current energy frontier
- Naturalness? Challenged ...

Extra dimensions?

- And cosmology ... What the Hell is the Dark Energy?

Concluding Remarks

Beyond Standard Model

- Some reasons to think that there must be something new close to our current energy frontier
- Naturalness? Challenged ...

Joachim
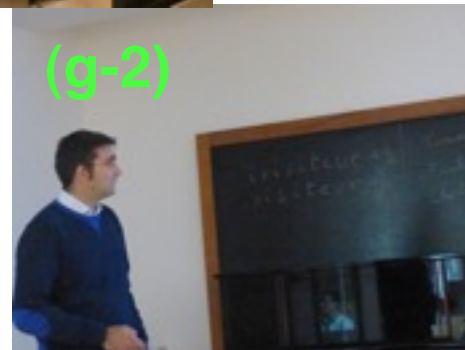
Extra dimensions?

- And cosmology ... What the Hell is the Dark Energy?

Concluding Remarks

Future Projects:

- A very attractive fundamental Science journey
- With very determined proponents

Dark Matters

Sterile Neutrals

Grav. waves

CLFV

Future Colliders

(g-2)

Concluding Remarks

Future Projects:

- A very attractive fundamental Science journey
- With very determined proponents

This field is more lively than ever. Large scale projects but many fascinating smaller scale with high potential Physics outcome: LFV experiments, Dark matter searches ...
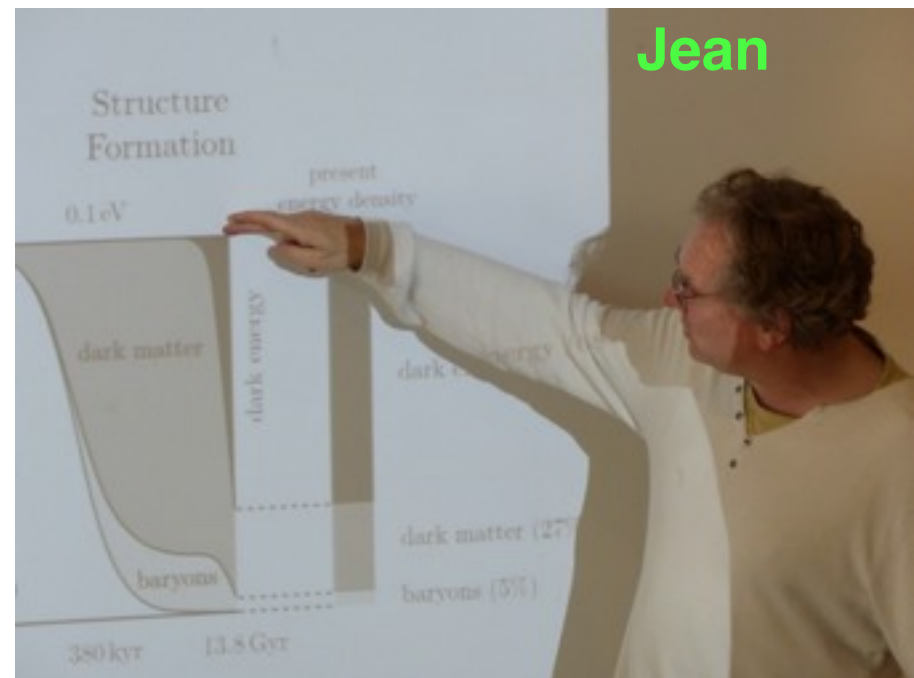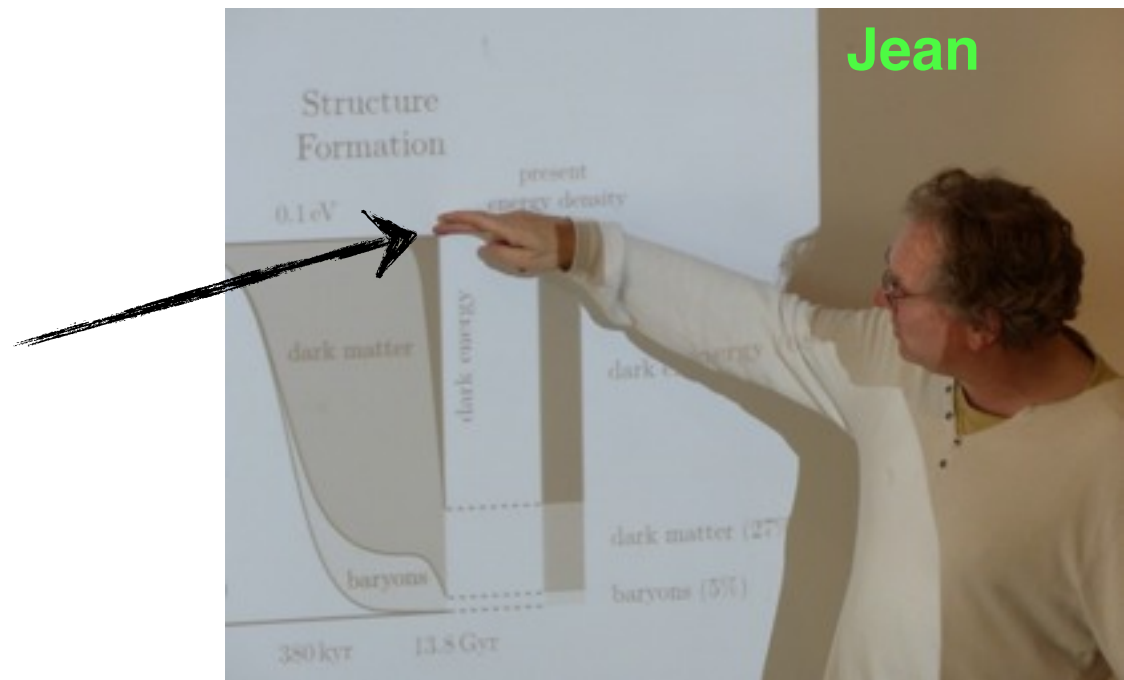
Concluding Remarks

Cosmology

- Relativity, Relativity, Relativity ...
- Particle Physics brings elementary ingredients to our Universe. But what is its faith?

Concluding Remarks

Cosmology

- Relativity, Relativity, Relativity ...
- Particle Physics brings elementary ingredients to our Universe. But what is its faith?

Concluding Remarks

Cosmology

- Relativity, Relativity, Relativity ...
- Particle Physics brings elementary ingredients to our Universe. But what is its faith?
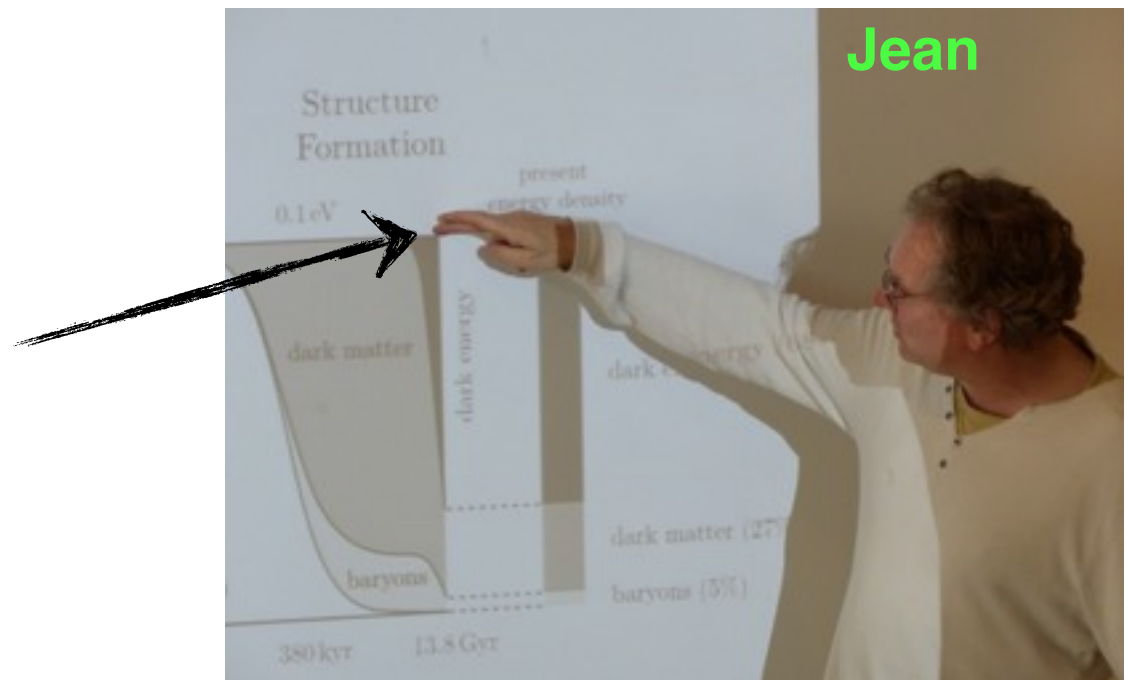
Concluding Remarks

Cosmology

- Relativity, Relativity, Relativity ...
- Particle Physics brings elementary ingredients to our Universe. But what is its faith?

We are exactly here!

Concluding Remarks

Neutrino Physics:

- The light way to Beyond Standard Model Physics.

- Looking at you straight in the eyes ...

Concluding Remarks

Neutrino Physics:

- The light way to Beyond Standard Model Physics.

- Looking at you straight in the eyes ...

Maximiliano

Concluding Remarks

Neutrino Physics:

- The light way to Beyond Standard Model Physics.

- Looking at you straight in the eyes ...

Maximiliano

Concluding Remarks -

The wednesday's session:

- It was alike a mini High Energy Physics Conference.

- We enjoyed it very much and consider that you have delivered high quality presentations.

- The election of the best presentation has been a hard and long task. We, professors, fought a lot, twisted complicated electoral mathematics and came with the following results:

Concluding Remarks -

Concluding Remarks -

The wednesday's session:

- Best Student Presentation

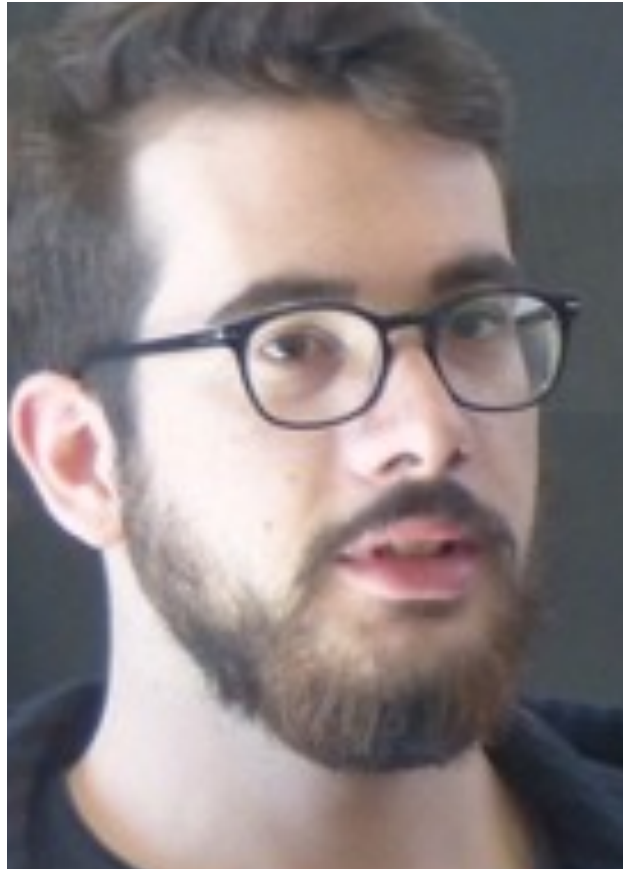# Concluding Remarks -

Concluding Remarks -

Concluding Remarks -

Paolo

Paolo

Concluding Remarks -

Concluding Remarks -

Some of you went very far in the contest, and we'd like to mention their contributions:
Dominik Döring, Fatih Ertas, Stella Oppermann, Vlad Fabbri, Cornelius Grunwald and Torben Peters.

All of you made an excellent job.

Concluding Remarks -

Concluding Remarks -

Medical summary from the professor's team:

- Gudrun collided w/ a (giant, I've been told) jellyfish.

- Jean been beaten by a *Latrodectus tredecimguttatus*, also known as the black widow of Corsica.

- Max been sworded by a seabass fishbone, also known as El Orata de Corsica.

- Joachim's finger cut by a white shark, also known as *le petit squale d'aiacciu*, while swimming towards the rock.

Angelo, Johannes and Stephane? Already beyond Standard Model.

Concluding Remarks -

Concluding Remarks -

Concluding Remarks -

Best Session: another tough competition

Concluding Remarks -

Concluding Remarks -

Gudrun

Concluding Remarks -

Gudrun

Concluding Remarks

Concluding Remarks

- We had a rich week of Science.

Concluding Remarks

- We had a rich week of Science.

- We had also nice outwork moments

Concluding Remarks

- We had a rich week of Science.

- We had also nice outwork moments

- Volleyball, Dinner, Music session, the sea ...
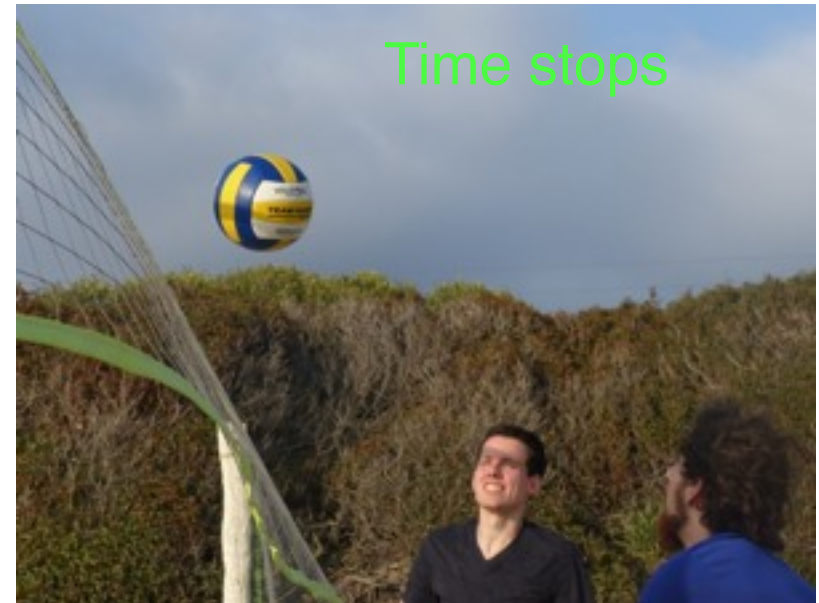
Concluding Remarks: Volleyball

- Five sympathical, international and maximally gender mixed teams:

Where is the ball?

Time stops

- Several strategies at work but ...

Concluding Remarks: Volleyball

- Five sympathical, international and maximally gender mixed teams:

Where is the ball?

Time stops

- Several strategies at work but ...
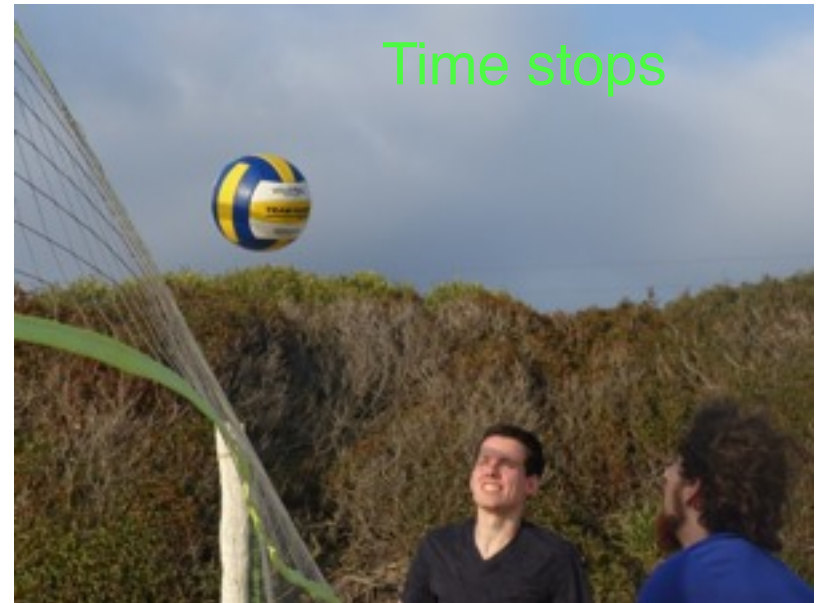
Concluding Remarks: Volleyball

- Five sympathical, international and maximally gender mixed teams:

Where is the ball?

Time stops

- Several strategies at work but ...

Concluding Remarks: Volleyball

A clear, unambiguous outcome:

- A modest triumph for the professor's team.

Concluding Remarks: Volleyball

A clear, unambiguous outcome:

- A modest triumph for the professor's team.

Concluding Remarks

- And very nice moments:

I know what she will talk about ...

Concluding Remarks

- And very nice moments:

A rare and happy classroom ...

Concluding Remarks

- And very nice moments:

A collaborative and happy classroom ...

Concluding Remarks

- And very nice moments:

A collaborative and happy classroom ...

A happy teacher!

Concluding Remarks

- And very nice moments:

A collaborative and happy classroom ...

A happy teacher!

Concluding Remarks

- And very nice moments:

A collaborative and happy classroom ...
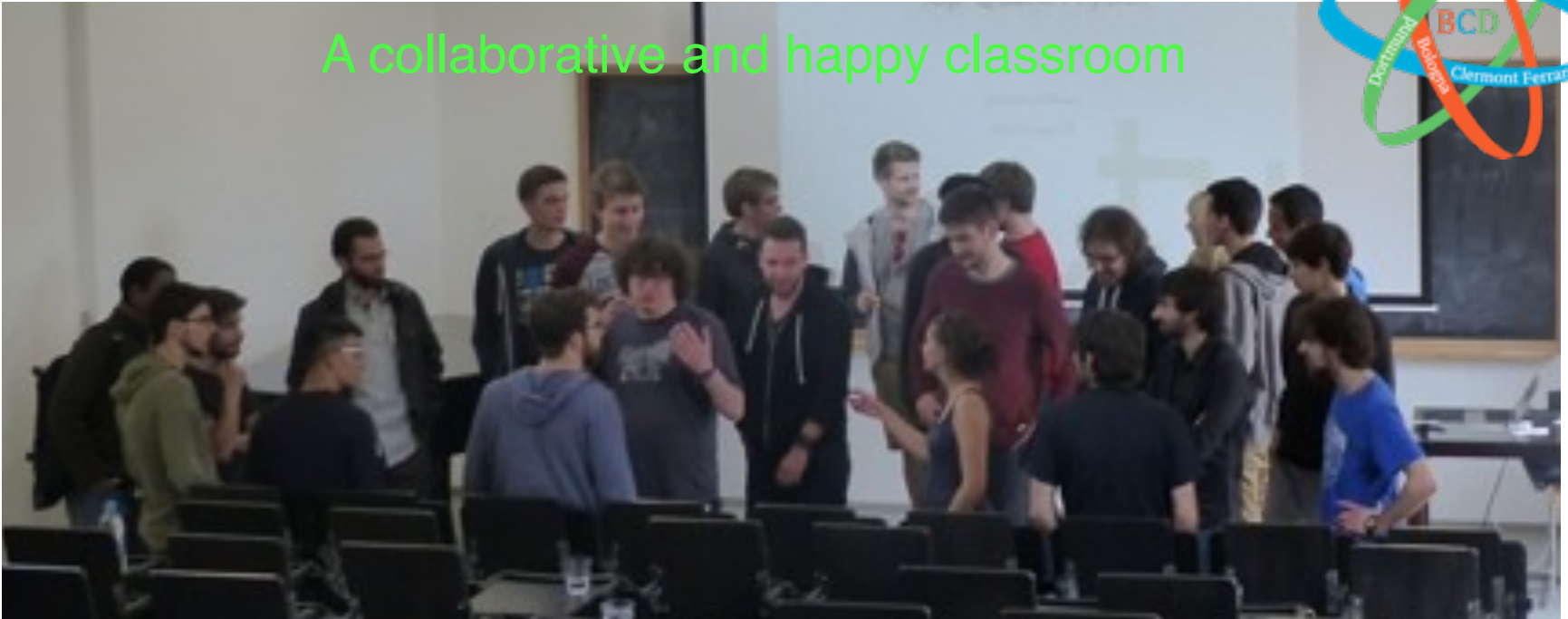
A happy teacher!

Concluding Remarks

- And very nice moments:

A collaborative and happy classroom

- Gathering intelligence and curiosity irrespective of nationalities to look at the same direction. Keep the momentum ...

Concluding Remarks

- A big Thank to our best organiser who made everyone'es life simpler the entire week.

Concluding Remarks

- We had a rich week of Science.

- You are entering in or studying this field in a fascinating time! which has discovered a bosonic state (LHC) so far consistent with the BEH boson, got the Cosmological Microwave Background asymptotically measured (Planck) and identify the first gravitational waves.

- We don't know what's next. You can be part of inventing the paths.

- We enjoyed this week with you. We hope that you'll get lovely memories of it in turn. Have a safe trip back.

Concluding Remarks

BCD 2017.