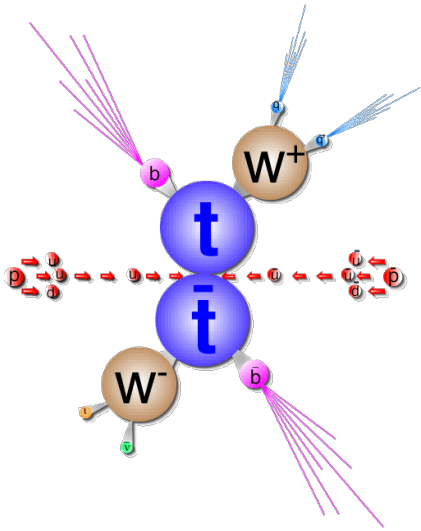


14th International Workshop on Top Quark Physics

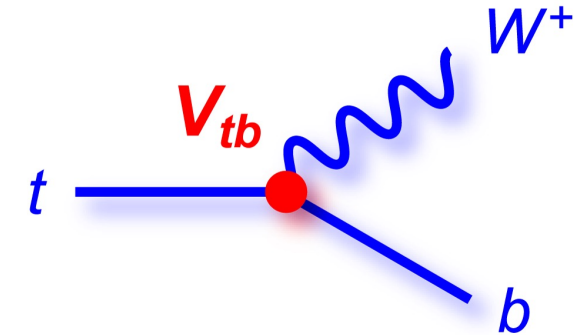
Malgorzata Worek

on behalf of the International Advisory Committee



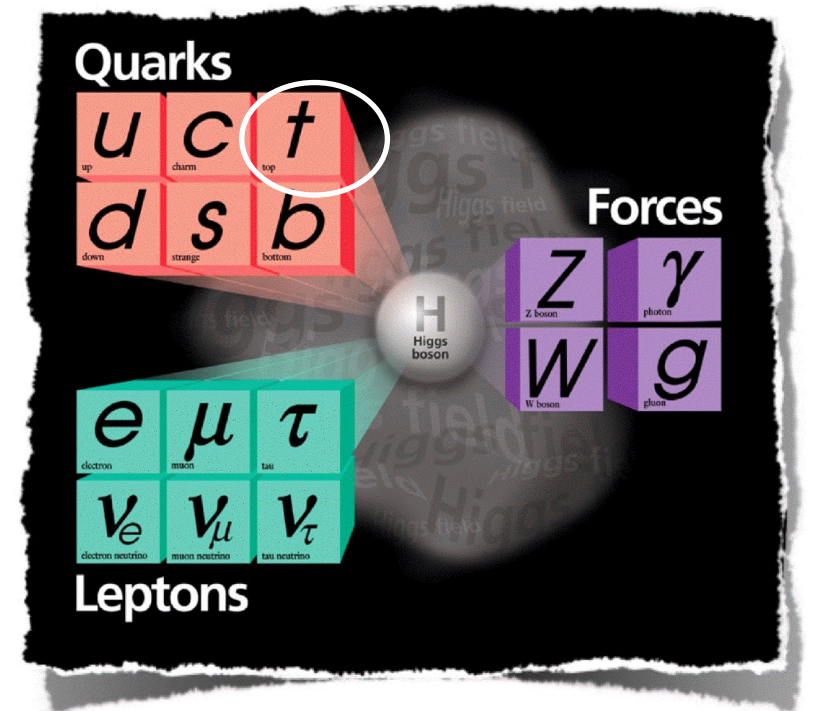
TTK Institute for
Theoretical
Particle Physics
and Cosmology

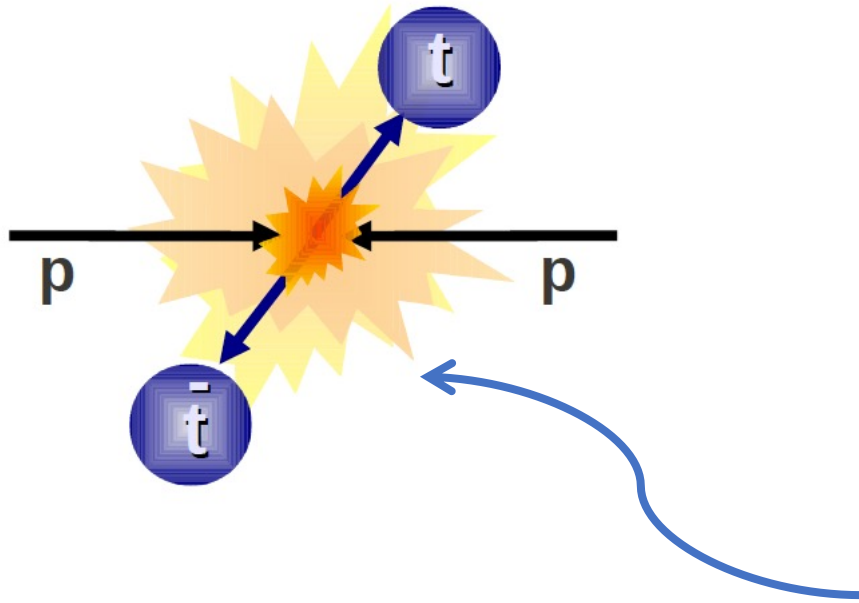
RWTHAACHEN
UNIVERSITY



International Workshop on Top Quark Physics

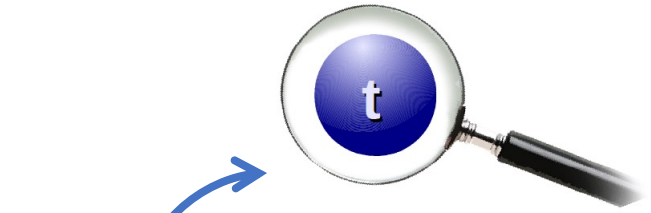
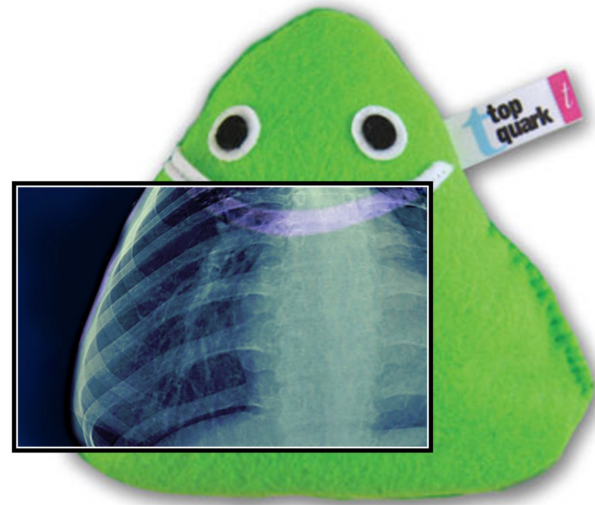
- Platform that brings together experts who work in the field of *experimental & theoretical top-quark physics*
- Focus is placed on *precision predictions* for processes involving top quarks and on the most *recent measurements* from the *LHC experiments* ATLAS & CMS
- Emphasis is also placed on *searches for new physics* with top quarks and the models that predict such processes
- Future projects will be discussed as well \Leftrightarrow Prospects of top-quark physics at the *HL-LHC* or at *next-generation colliders*
- *Topical Theory Mini-workshop*
 - *Top-quark physics @ Future colliders*





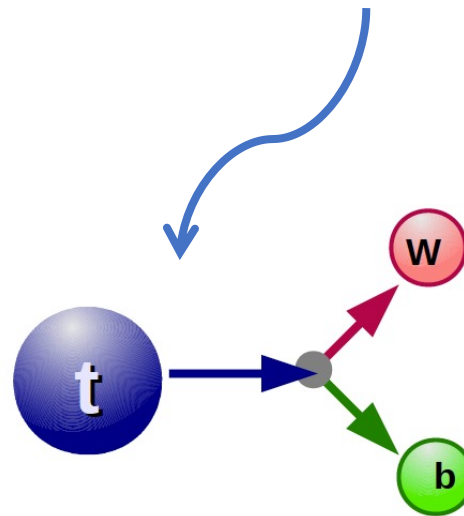
Production:

- Production rate
- Differential distributions
- New production mechanisms
- Single top-quark production
- Top-quark pair production
- Associated production of top quarks with $W, Z, \gamma, H, j, bb, tt, jj, \gamma\gamma \dots$
- ...



Intrinsic properties:

- Mass
- Charge
- Lifetime
- Width
- ...



Decays:

- Various decay channels
- SM & BSM
- Couplings $W, Z, \gamma & H$
- Spin correlations
- ...

TOP Workshop Started in 2006 ...

1st International Workshop on Top Quark Physics (TOP2006)

12-15 January 2006. Coimbra, Portugal (C06-01-12)

Phenomenology-HEP

Experiment-HEP

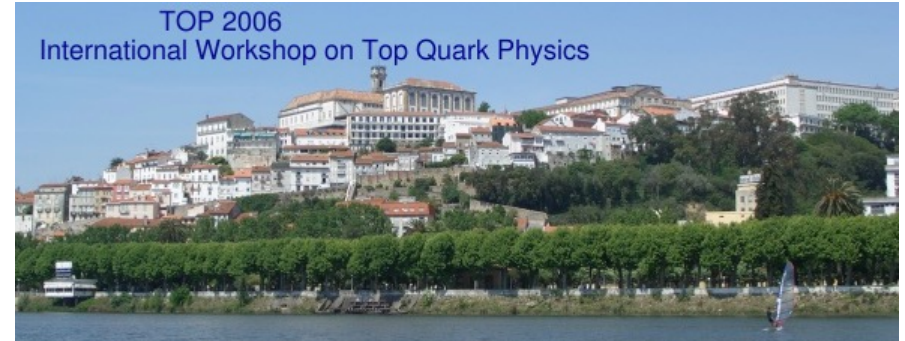
The aim of this workshop is to discuss recent and expected results on the physics of the top quark. In particular we hope to foster current and future research in this area from both the experimental and the theoretical point of view.

1st conference in the [TOP](#) series

Contact: top2006@nautilus.fis.uc.pt

[🔗 website](#) [📄 proceedings](#)

Coimbra, Portugal



Proceedings, 1st International Workshop on Top Quark Physics (TOP2006) : Coimbra, Portugal, January 12-15, 2006

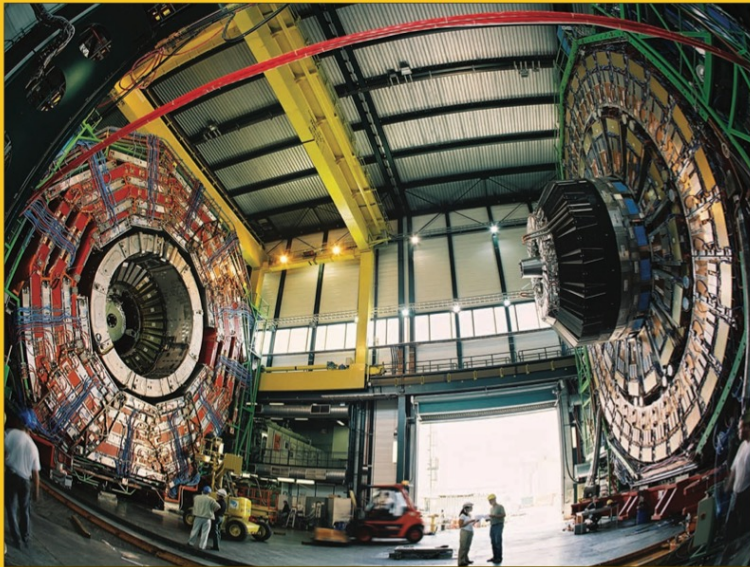
Antonio Onofre(ed.), Werner Bernreuther(ed.), Marina Cobal(ed.), Aurelio Juste(ed.), Michelangelo Mangano(ed.), Takasumi Maruyama(ed.), Joachim Mnich(ed.), Orlando Oliveira(ed.), Lynne Orr(ed.), Dominique Pallin(ed.), Sergey Slabospitsky(ed.), Chris Tully(ed.), P. C. Yuan(ed.)

Published in: *PoS TOP2006* (2006)

Contribution to: [TOP2006](#)

CERN COURIER

VOLUME 46 NUMBER 7 SEPTEMBER 2006



CMS prepares to go underground

COSMIC RAYS

PAMELA goes off in search of antimatter p8

COMPUTING NEWS

Grid aids the fight against avian flu p18

STRATEGY

Europe and US look to the future p29 and p37

TOP2006

Workshop focuses on top-quark physics

More than 80 physicists from all over the world met in January in the ancient Portuguese town of Coimbra to take part in the International Workshop on Top Quark Physics, TOP2006.



Lynne Orr explains the physics of the top quark at future colliders.



The old town of Coimbra is located on a hill on the north bank of the River Mondego, with the university at the summit. The workshop took place in the department of mathematics.

Coimbra, in central Portugal, was the country's capital from 1143 to 1255 and in historical importance ranks behind only Lisbon and Oporto. Its university was founded in 1290 and was the only one in Portugal until the beginning of the 20th century. Its ancient setting contrasted well with the central theme of TOP2006: the top quark, discovered only in 1995 in experiments at Fermilab's Tevatron.

The workshop itself grew from the idea of developing a strong collaboration between theorists and experimentalists who are interested in studying the properties of the top quark. The first properties of this unique particle were measured during Run I of the Tevatron by the CDF and D0 experiments; with Run II more data are now becoming available. Though not yet sufficient to perform the precision tests required to challenge (once again) the Standard Model, the data acquired so far are already providing valuable information on top-quark physics. The knowledge of the physics of the top quark will then enter a totally new phase – the precision era – with the

start-up of the Large Hadron Collider (LHC) at CERN, foreseen towards the end of 2007.

Why is top interesting?

The top quark is the heaviest quark found ($m_t = 172.5 \pm 2.3 \text{ GeV}/c^2$) and is still believed to be a fundamental particle. It completes the third-generation structure of the Standard Model, as the isospin partner of the b (bottom) quark. Why it is so heavy and why its Yukawa coupling to the Higgs field (after spontaneous symmetry breaking) is of the order of 1 is a mystery. Its solution requires an answer to the question: does the top quark play a special role in the electroweak symmetry-breaking mechanism of the Standard Model?

Although mainly produced via the strong interaction at particle colliders (double production via gluon-gluon fusion or $q\bar{q}$ annihilation), the top quark decays through the weak force to a b quark and a W boson with a branching ratio of almost 100%. Because of their large

large mass and decay rate ($\Gamma = 1.42 \text{ GeV}$ at next-to-leading order), top quarks, unlike any other quark, are produced and decay as free particles. With a very short lifetime (around 10^{-25} s), the top quark decays before hadronization can take place. For the same reason no toponium bound states with sharp binding energy are expected in the Standard Model; any evidence of a $t\bar{t}$ bound state would be a sign of physics beyond the model. The flavour-changing neutral-current decays of the top quark are also highly suppressed in the Standard Model, with branching ratios at the level of around 10^{-12} to 10^{-14} ; any evidence of decays such as $t \rightarrow qZ$, $q\gamma$ or qg would therefore constitute a sign of new physics.

Top-quark properties

The first day of the workshop was dedicated to the current theoretical and experimental status of top-quark physics, in the morning and afternoon sessions, respectively. CP Yuan of Michigan State University recalled the need for a precise measurement of the top-quark mass to constrain the Higgs mass when combined with the measurement of the W mass. Within the context of current theoretical knowledge, the day also covered the importance of the rate of single top production at colliders (not yet observed) as a probe for the element V_{tb} in the Cabibbo-Kobayashi-Maskawa matrix. He also stressed the fact that the different channels (s, t and W) that contribute to single top production are important processes for the search for physics beyond the Standard Model.

Aurelio Juste from Fermilab reviewed the current experimental status of the top quark starting from the total cross-section measurement at the Tevatron, with a relative precision of around 25% in Run I, dominated essentially by statistics. In Run II, with a luminosity of 2 fb^{-1} , this error is expected to be reduced to about 10%. The mass is by far the most precisely measured property of the top quark, with a relative error less than 2%. The top charge, anomalous couplings and single top production were also discussed.

The second day examined the experimental methods used to select top quarks at colliders, and the leading-order and next-to-leading-order generators and theoretical methods available for understanding the data. Evelyn Thomson of the University of Pennsylvania presented the experimental methods that are used in the selection and analysis of top-quark decays at hadron colliders. In particular, she discussed the importance of the trigger, the difficult question of the background rejection and estimation (as W+jets and Z+jets), the need for a detailed calibration and determination of the jet energy scale (a major source of systematic error), and b-tagging, a key tool to reduce the background. She stressed the need to fine-tune the available Monte Carlo to reproduce data accurately. Available top-selection tools involve multivariate analysis and different statistical techniques.

Werner Berreuther, of RWTH (Rheinisch-Westfälische Technische Hochschule) Aachen, described spin effects in hadronic top-pair production and polarized top decays, $t\bar{t}$ spin correlations (which are transferred to the decay products), and the possible existence of heavy $t\bar{t}$ resonances. As the top polarization is reliably calculable, it is well suited for experimental checks of the predictions of the Standard Model and its extensions. Berreuther concluded that the top-quark physics is an excellent probe to test electroweak symmetry-breaking and that it provides powerful observations to determine the structure of the $t\bar{t}W$ vertex. Sergey Siabospitsky of the Institute for High Energy Physics, Protvino, and Borut Kersevan of the Josef

Stefan Institute presented the status of the important event generators that are being developed and used at the Tevatron and LHC to simulate top production and decays.

Top prospects

The prospects for top physics on the up-coming colliders were discussed on the third day of the workshop. In the morning, Dominique Pallin of Blaise Pascal University presented the expected performance of the LHC as a top factory. In particular, he showed the work going on for early top-quark studies, such as the measurement of the $t\bar{t}$ production cross-section and the top mass, as well as the determination of the W and top polarizations, in the lepton+jets channel. The top quark is a very useful calibration tool for early data (for the jet energy scale, b-tagging, trigger etc), which can also be used to check detector performance. With the increase of luminosity at the LHC many precision measurements of top-quark properties will be possible.

In the afternoon, Lynne Orr of the University of Rochester gave a talk about top physics at the LHC and a future International Linear Collider (ILC). She described the electroweak symmetry breaking mechanism and the hierarchy problem. She also discussed top-quark physics in models beyond the Standard Model, which are possible solutions to this problem: supersymmetry, little Higgs, technicolour and its descendants, and modified space-time models with extra dimensions. Finally, the sensitivity of different top-quark couplings at the LHC and ILC was reviewed. Brian Foster of Oxford University presented the status of the ILC.

Finally John Womersley, of the CCLRC, Rutherford Appleton Laboratory, presented a lively and appealing workshop summary talk. He also covered the status and the open questions in particle and astroparticle physics. All in all, the workshop was a fruitful opportunity for interesting discussions on the exciting subject of top-quark physics. The participants are looking forward to the next workshop, which will probably take place two years from now, where the latest results of the Tevatron's Run II and the first results from the LHC in top-quark physics will be presented and discussed, and new challenges to the Standard Model will be tested.

Further reading

For more details see <http://nautilus.fis.uc.pt/personal/top2006/>.

Résumé

La physique du quark t au Portugal

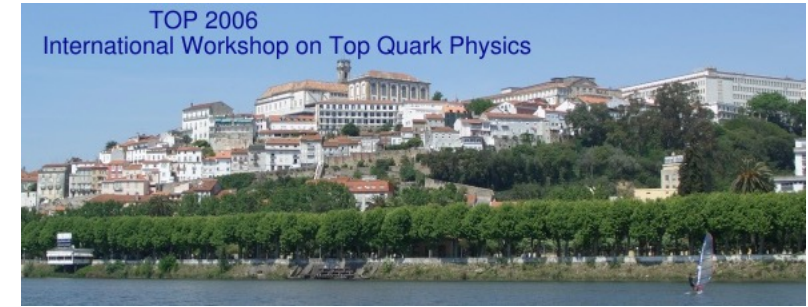
Plus de 80 physiciens du monde entier se sont réunis dans l'ancienne capitale du Portugal, Coimbra, pour TOP2006, un atelier international sur la physique du quark t. Le but visé est de renforcer les relations entre les expérimentateurs et les théoriciens intéressés par l'étude des propriétés du t. La période d'exploitation du Tevatron au Laboratoire Fermi avait permis de mesurer de premières propriétés de cette remarquable particule; la période II apporte aujourd'hui de plus en plus de données. Celles dont on dispose apportent déjà des informations précieuses sur la physique du quark t.

António Onofre, Laboratório de Instrumentação e Física Experimental de Partículas (LIP)/Universidade Católica Portuguesa, and **João Carvalho**, LIP-Coimbra.

TOP2006

1st International Workshop on Top Quark Physics (TOP2006) : Coimbra, Portugal, January 12-15, 2006

Top Quark



- *Why is top interesting?*
 - Why is it so heavy ?
 - Why its Yukawa coupling to the Higgs field is of the order of 1 ?
 - Does the top quark play a special role in the electroweak symmetry-breaking mechanism of the Standard Model?
- *Top-quark properties*
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 - Among others *the expected performance of the LHC as a top factory !*
 - Top-quark physics in models *beyond the Standard Model* \Rightarrow Supersymmetry, Little Higgs, Technicolour and modified space-time models with extra dimensions

TOP Series



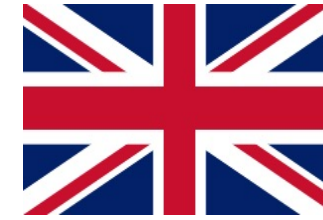
TOP 2008 Italy



TOP 2010 Belgium



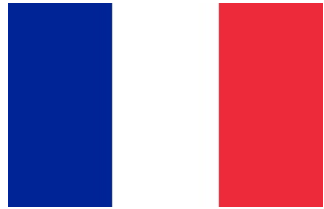
TOP 2011 Spain



TOP 2012 UK



TOP 2013 Germany



TOP 2014 France



TOP 2015 Italy



TOP 2016 Czechia



TOP 2017 Portugal



TOP 2018 Germany



TOP 2019 China



TOP 2020 UK

Online



TOP 2021 USA

Online

5TH ANNIVERSARY

10TH ANNIVERSARY

15TH ANNIVERSARY



TOP 2022 ???

Hopefully not Online





Thank you for connecting !

**It's great to have all of you
here at TOP 2021 !**