

# Organization of Seminar Talks for Higgs Physics

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- As announced we will have a paper **seminar at the end of this lecture**.
- This seminar will take place at the following dates:
  - 09. July 11:30 – 13:00 ([Gilbert]SR 12-1 / [Berger]SR 9-1)
  - 09. July 14:00 – 15:30 ([Gilbert]kl. HS B / [Berger]SR 8-2)
  - 16. July 14:00 – 15:30 ([Gilbert]kl. HS B / [Berger]SR 8-2) **NB:** short re-gather in kl. HS B afterwards
- It will be **split by the exercise groups**. In both groups the same presentations will be offered.
- We plan **one presentation per student**.
- Presentations should aim at a length of **20-30min (including discussion)**.
- **We offer 10 topics**. If we have higher demand, we might have two students preparing a longer talk or provide another topic. Let me know in this case!

- We have a **great team of supervisors**. All of them celebrated 4. July 2012 as their personal success since they had their own hands on the analyses that you will be talking about.
- The discussion you will have/the stuff you can learn is not only from primary literature, you can also have this literature **explained/discussed from FIRST HAND**, i.e. from the guys whose hands actually made this results!
- This is especially (and literally) true for all  $H \rightarrow \tau\tau$  results and for the analysis of the coupling structure.
- You might have a **hard time to get ever closer than this to a genuine Nobel Prize measurement in physics**.
- We offer access to parts of the first text book in that depth on the topic that will be available on the market only this summer.

# ...Our Wish List to You

- Try to **really understand the papers** as far as you can.
- In general what you do not understand you should be able to formulate in a question. **Discuss your questions** with us!
- In the presentation do **not just reproduce** what you have read. Try to reflect on it, to **focus on points that you have learned** and that you found interesting. Your supervisors will help you with the selection.
- Don't be shy. This is a **discussion seminar!** It will become better the more good discussion we have. Make use of the close contact to your supervisors and lecturers. This is a unique chance which is not a matter of course.

# ToDo List for Students

- Check this presentation. **Make up your mind** on the topic that you are most interested in. Best agree on this with your fellow students before the official distribution of topics.
- Topics will be **distributed in your exercises groups** during the next exercises meeting (→ 28.05.).
- After you have received your seminar topic:
  - **Make yourself familiar** with the literature.
  - Arrange a **first meeting with your supervisor** (best per mail, do this as early as possible).
  - Try to **understand the paper** as complete as possible. If needed make more arrangements with your supervisor to clarify remaining questions.
  - Set up your talk and make a **second arrangement with your supervisor to discuss your presentation** (best do this well in advance of your presentation).

# Order and Dates of Seminar Talks

- Session – 1 (09.07. 11:30 – 13:00):
  - Evidence in the  $H \rightarrow WW$  decay channel ( $\rightarrow$  Quast).
  - Discovery in the  $H \rightarrow \gamma\gamma$  decay channel ( $\rightarrow$  Quast).
  - Search in the  $VH \rightarrow b\bar{b}$  decay channel ( $\rightarrow$  Berger).
- Session – 2 (09.07. 14:00 – 15:30):
  - Evidence in the  $H \rightarrow \tau\tau$  decay channel (event selection and categorization) ( $\rightarrow$  Berger/Gilbert).
  - Evidence in the  $H \rightarrow \tau\tau$  decay channel (signal extraction & results) ( $\rightarrow$  Berger/Gilbert).
  - Search for additional neutral Higgs bosons in the  $H \rightarrow \tau\tau$  decay channel ( $\rightarrow$  Wayand).
- Session – 3 (16.07. 14:00 – 15:30):
  - Discovery in the  $H \rightarrow ZZ$  decay channel ( $\rightarrow$  Wolf).
  - Studies of the CP structure of the Higgs boson in the  $H \rightarrow ZZ$  decay channel ( $\rightarrow$  Wolf).
  - Check of the Higgs boson decay width in the  $H \rightarrow ZZ$  decay channel ( $\rightarrow$  Frensch).
  - Check of the coupling structure of the Higgs boson from an analysis of all decay channels ( $\rightarrow$  Gilbert).

- Literature:
  - *Search for the standard model Higgs boson decaying to a W pair in the fully leptonic final state in pp collisions at  $\sqrt{s} = 8$  TeV (CMS-PAS-HIG-12-017).*
  - *Public TWiki* page.
  - *The Higgs Boson Discovery at the Large Hadron Collider (Section 4.3).*
- Expected content of the talk:
  - Characteristics of the decay (i.e. BR, specialty of the final state, mass resolution, ...).
  - Event selection, special role of normal SM diboson production (WW), special role of spin configurations of W-bosons in the selection, signal extraction.
  - Significance as function of the tested Higgs boson mass. Role of this result in the overall context.

Günter Quast ([guenter.quast@kit.edu](mailto:guenter.quast@kit.edu))

- Literature:
  - *Evidence for a new state decaying into photons in the search for the standard model Higgs boson in pp collisions* ([CMS-PAS-HIG-12-015](#)).
  - [Public TWiki](#) page.
  - *The Higgs Boson Discovery at the Large Hadron Collider* ([Section 4.3](#)).
- Expected content of the talk:
  - Characteristics of the decay (i.e. BR, specialty of the final state, mass resolution, large background, ...).
  - Event selection, different validation procedures (e.g. with  $Z \rightarrow ee$ ), special role of ECAL energy resolution and proper selection of vertex, signal extraction.
  - Significance as function of the tested Higgs boson mass. Role of this result in the overall context.

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- Literature:
  - *Search for the standard model Higgs boson produced in association with W or Z bosons, and decaying to bottom quarks for ICHEP 2012 (CMS-PAS-HIG-12-019).*
  - [Public TWiki](#) page.
  - *The Higgs Boson Discovery at the Large Hadron Collider (Section 4.4).*
- Expected content of the talk:
  - Characteristics of the decay (i.e. BR, mass resolution, problem of QCD background...).
  - Event selection, special role of diboson production (e.g.  $Z(\ell\ell)Z(b\bar{b})$ ), extensive use of MVA discriminators.
  - Significance as function of the tested Higgs boson mass. Role of this result in the overall context.

Joram Berger ([joram.berger@cern.ch](mailto:joram.berger@cern.ch))

# Evidence in $H \rightarrow \tau\tau$ (Event Selection)

- Literature:
  - *Evidence for the 125 GeV Higgs boson decaying to a pair of  $\tau$  leptons* ([arXiv:1401.5041](https://arxiv.org/abs/1401.5041)).
  - *Public TWiki* page.
  - *The Higgs Boson Discovery at the Large Hadron Collider* ([Section 4.4](#)).
- Expected content of the talk:
  - Characteristics of the decay (i.e. BR, problem of mass reconstruction, main background of  $Z \rightarrow \tau\tau$  events...).
  - Event selection, background estimates, event categorization.
  - Invariant di- $\tau$  reconstruction.

- Literature:
  - *Evidence for the 125 GeV Higgs boson decaying to a pair of  $\tau$  leptons* ([arXiv:1401.5041](#)).
  - *Public TWiki* page.
  - *The Higgs Boson Discovery at the Large Hadron Collider* ([Section 4.4](#)).
  - *Bestimmung der Kopplung des Higgs Bosons an das  $\tau$ -Lepton durch statistische Kombination verschiedener Produktions- und Zerfallskanäle mit Daten des CMS Experiments am LHC* ([IEKP-KA/2014-07](#)).
- Expected content of the talk:
  - Combination of all decay channels for the statistical inference, likelihood model for signal extraction, incorporation of uncertainties.
  - Significance as function of the tested Higgs boson mass. Role of this result in the overall context.

- Literature:
  - *Search for neutral MSSM Higgs bosons decaying to a pair of tau leptons in pp collisions* ([arXiv:1408.3316](https://arxiv.org/abs/1408.3316)).
  - *Public TWiki* page.
- Expected content of the talk:
  - Extensions of the SM in the Higgs sector, enhancements of couplings, modification of the search for the SM Higgs boson in the same decay channel.
  - Statistical model, signal extraction, meaning of the results, prospects for the future.

Stefan Wayand ([stefan.wayand@cern.ch](mailto:stefan.wayand@cern.ch))

# Discovery in $H \rightarrow ZZ$ (Evidence/Discovery)

- Literature:
  - *Measurement of the properties of a Higgs boson in the four-lepton final state* ([arXiv:1312.5353](#)).
  - *Public TWiki* page.
  - *The Higgs Boson Discovery at the Large Hadron Collider* ([Section 4.3](#)).
- Expected content of the talk:
  - Characteristics of the decay (i.e. BR, mass resolution, requirement of high selection efficiency, high purity, high mass resolution...).
  - Event selection, event categorization, likelihood model for signal extraction.
  - Significance as function of the tested Higgs boson mass. Role of this result in the overall context.

Roger Wolf ([roger.wolf@cern.ch](mailto:roger.wolf@cern.ch))

# Higgs Properties in $H \rightarrow ZZ$ (CP-studies)

- Literature:
  - *Measurement of the properties of a Higgs boson in the four-lepton final state* ([arXiv:1312.5353](#)).
  - *Public TWiki* page.
  - *The Higgs Boson Discovery at the Large Hadron Collider* ([Chapter 5](#)).
- Expected content of the talk:
  - General overview of CP, how can this measurement be done?
  - Modification of event selection and signal extraction for CP studies.
  - Results and role of these results in the overall context.

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# Higgs Properties in $H \rightarrow ZZ$ (Decay width)

- Literature:
  - *Constraints on the Higgs boson width from off-shell production and decay to Z-boson pairs* ([arXiv:1405.3455](#)).
  - *Public TWiki* page.
  - *Measurement of the properties of a Higgs boson in the four-lepton final state* ([arXiv:1312.5353](#)).
  - *Public TWiki* page.
  - *The Higgs Boson Discovery at the Large Hadron Collider* ([Chapter 5](#)).
- Expected content of the talk:
  - Results of naive line shape measurements. Measurement principle of off-shell method.
  - Modification of event selection and signal extraction.
  - Result and role of this result in the overall context.

Felix Frensch ([felix.frensch@cern.ch](mailto:felix.frensch@cern.ch))

- Literature:
  - *Precise determination of the mass of the Higgs boson and tests of compatibility of its couplings with the standard model predictions using proton collisions at 7 and 8 TeV* ([arXiv:1412.8662](#)).
  - *Public TWiki* page.
  - *The Higgs Boson Discovery at the Large Hadron Collider* ([Chapter 5](#)).
- Expected content of the talk:
  - Likelihood model for statistical inference, preliminary studies.
  - Results of an over all test of the couplings and of selected dedicated tests and role of these results in the overall context.

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