University of Zurich[UZH]

PHYSIK INSTITUT
UNIVERSITÄT ZÜRICH

# Physik - Institut Universität Zürich

(Department of Physics)

Ueli Straumann, 9. March 2016, FV MNF

# Early History

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- University started operation in 1833, Physics and all other sciences were part of Faculty of Philosophy
- First Physics teacher was PD Albert Mousson: was in parallel a teacher at Gymnasium, had no diploma or PhD, but got a Dr. h.c. of his own faculty. Taught physics for medical students. established a collection of physics experiments ("physikalisches Kabinett"). PhD student: Roentgen

Abb. 1 ALBERT MOUSSON. Bild: Archiv der Universität Zürich.

- When Polytechnikum was founded in 1855 (now ETHZ) Mousson became Ordinarius and the first double professor at Uni and ETHZ. Worked on pressure dependance of ice melting point. Meter standard, public gas illumination. Meteorology. Snails collection.
- Rudolf Clausius became 1857 double prof. for "technische und mathematische Physik". Worked on thermodynamics, "Zweiter Hauptsatz", kinetic gas theory. Invented the terms entropy and mean free path.

Abb. 2 RUDOLF J. CLAUSIUS. Bild: Bibliothek ETHZ.

# Physikalisches Institut

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Abb. 3 ALFRED KLEINER. Bild: Archiv der Universität Zürich.

- Alred Kleiner, originally a medical doctor, PD at ETH, prof. 1879 together with PD Hofmeister (Meteorology).
- 1885 new building for Physics and Physiology. Ordinarius and first director of the physikalisches Institut (not double prof.).

- Now real experimental research started: electrical features of capacitors and conductivity of electrodes and ion fluids, dielectrical losses, selfinductance, oscillators, very precise electrometer. Screening of gravitational field, which was proven to be wrong by himself later.

Der Neubau für Physik und Physiologie. (Siehe Seite 14 und 15.)

# Kleiners most famous PhD student

- His most famous PhD student was Albert Einstein (graduated 1905 at UZH, second attempt). Kleiner became rector 1908 of the university and managed to create a new chair for Albert Einstein, who became the first prof. in theoretical physics in 1910.

- Kleiner wrote an excellent evaluation letter, in which he had to defeat the bad teaching rumors about Einstein. He wrote "Ich habe die Ueberzeugung, dass Herr Dr. Einstein auch als Dozent seinen Mann stellen wird, weil er zu gescheit und zu gewissenhaft ist, um allfälliger Belehrung nicht zugänglich zu sein".

# Nobel Laureates

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UZH website lists 12 UZH related Nobel prizes. Of those, 6 are physicists:

- Wilhelm Conrad **Röntgen** (1869): X-rays
- Albert **Einstein** (1909-1911): Photoeffect
- Peter **Debye** (1911-1912): Dipolmoments of molecules (chemistry)
- Max **von Laue** (1912-1914): X ray diffraction on cristalls
- Erwin **Schrödinger** (1921-1927): Schrödinger equation
- K. Alex **Müller** (1967-1974): High temperature superconductivity

(years of employment at UZH)

# period up to 1949

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1919 - 1949 **Edgar Meyer** Ordinarius für Physik, first "physicist by education"
Spectroscopy also in UV, Zeeman effect, Stark effect,
gas discharges,

1928 - 1947 **Gregor Wentzel**. founded a well known school of theoretical physics
Auger effect, formula similar to the "Fermis golden rule"
weak interaction and coupling of mesons to nucleaons
predicted spin and isospin of nucleon resonances
Students: PD E. Stückelberg, became Prof. in Geneva, QFT, e+
Res Jost, PhD, found math-phys. at ETH.

- 1907 - 1924 PD Heinrich Greinacher invented his cascadic HV generator principle (Cockcraft-Walton)
- 1917 - 1928 PD, TP Richard Bär, gifted experimentalist, polarisation of Raman lines, ultra-sound
- 1931 - 1954 (?) PD TP F.W.P. Götz: Meteorology, Ozon measurements, founded the "Lichtklimatisches Observatorium" in Arosa.
- 1907 - 1911 PD Friedrich Alder, more interested in politics, assassinated the Austrian President Graf Stürgkh, later became secretary general of the Labour and Socialist International 1921-1940

# 1949 - 1990

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1949 - 1973 **Hans Staub** Ordinarius für Physik, concentrated on nuclear physics and nuclear magnetic resonance NMR.
1958 New building at Schöngberggasse 9, 5 MeV van de Graaf accelerator. Manz precision experiments in nuclear physics.
first beam-beam scattering experiment (alpha-alpha scattering)

1949 - 1974 **Walter Heitler** Quantum electro dynamics, widht of spectral lines, Renormalization methods.
well known book about "Quantum Theory of Radiation"
many philosophical thoughts, ethical questions of Science

- around **1960 experiment and theory divorced:** "Physik-Institut" and "Institut für theoretische Physik"
- significant growth of our University between 1960 and 1980
- Number of physics professors increased to 7 experimentalits and 4 theoreticians
- strong cooperation with SIN (now PSI) since 1974
- first unix computers connected to internet in the late 1980's

# Physik - Institut as of today

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- 1.1.2014 restructuring of physics. It is now a **patchwork family**

  Institute of theoretical physics dissolved itself

  Half of it joined the Physik - Institut

  Second half became new Institute of Computational Science, Astrophysics and Cosmology.

# Organisation Physik-Institut Universität Zürich

*Stand 2016*

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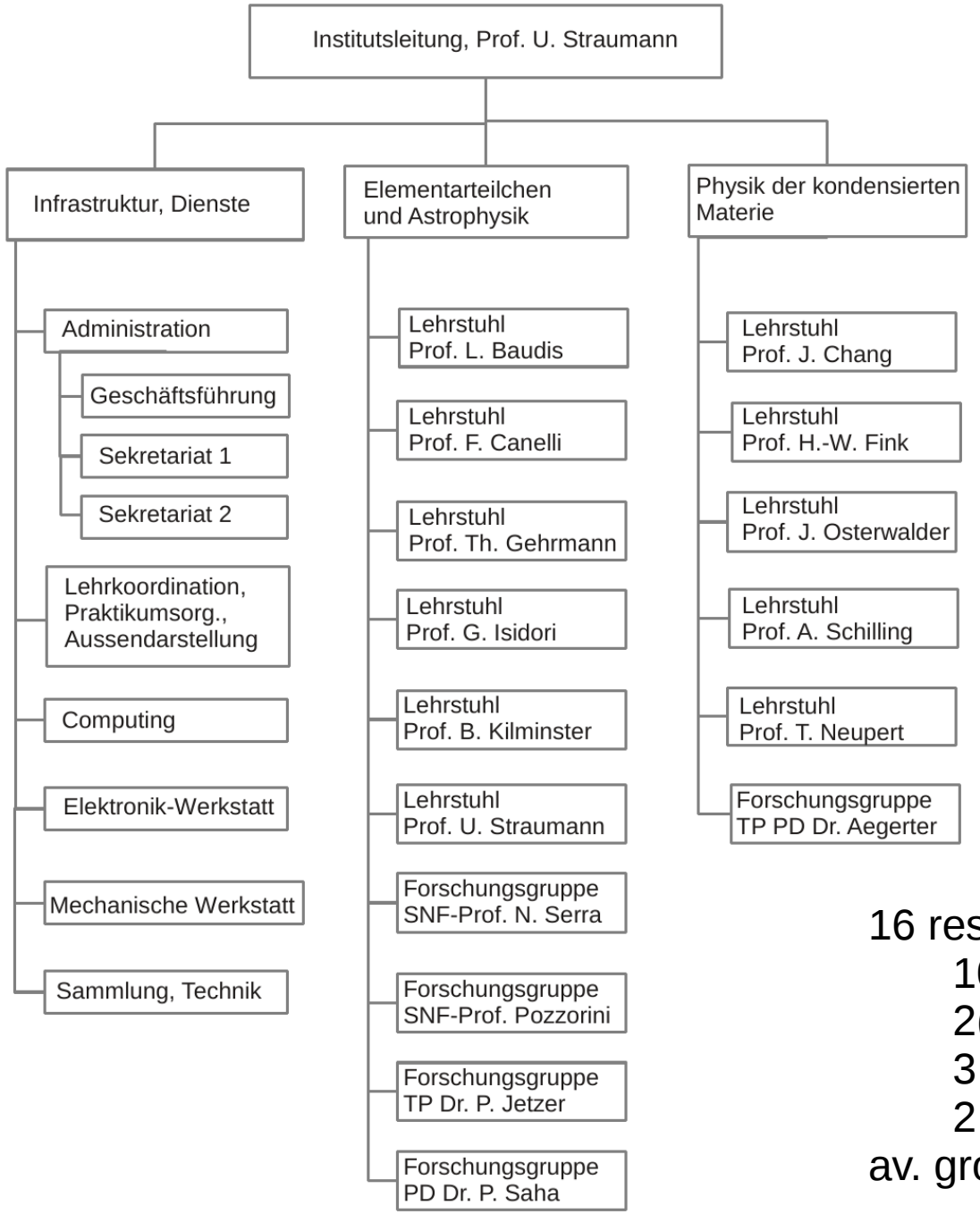


| # persons | |
|---|---|
| 4 | Administration |
| | Geschäftsführung |
| | Sekretariat 1 |
| | Sekretariat 2 |
| 4 | Lehrkoordination, Praktikumsorg., Aussendarstellung |
| 1 -> 2 | Computing |
| 3+1 | Elektronik-Werkstatt |
| 4+3 | Mechanische Werkstatt |
| 3 | Sammlung, Technik |

16 research groups lead by
- 10 full profs.
- 2(3) aoP adP.
- 3 SNF/ERC profs
- 2 PD/TP

av. group size 8 persons.

# Personnel

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Personnel statistics, 1. May 2015

**UZH funded:**

| | |
|---|---|
| services: | 23 |
| independant group leaders: | 3 |
| professors: | 10 |
| attached to groups (technicians, senior scientists): | 22 |

**Third party funded (SNF, EU, ERC, foundations)** 90

**80% of the personnel attached to research groups is third party funded**

# Personnel

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**Positions**:

| | | |
|---|---|---|
| ATP | 29 | |
| assistents | 124 | (incl. PhD students) |
| Prof. | 13 | |

**sex**:

| | | |
|---|---|---|
| male | 126 | |
| female | 40 | 24% |

**country of origin:**

| | | |
|---|---|---|
| CH | 66 | 40% |
| Italy | 27 | |
| Germany | 25 | |
| 26 other countries | 48 | |

# Teaching

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Number of students for HS 2015

| | | |
|---|---|---|
| Physics Major Ba+Ma, all semesters | 165 | |
| Physics Minor Ba+Ma, all semesters | 75 | |

5 separate physics modules tailored to specific needs for basic physics education for students of

| | | |
|---|---|---|
| Chemistry + WC | 115 | |
| Biology | 151 | |
| Biomedicin | 180 | (? FS16) |
| Medicial school | 397 | |
| VetSuisse | 86 | |
| Seklehrer | 15 | |
| **Sum** | **1184** | |

**All physicists by education take part in teaching.**
**Majority of TAs is third-party-financed!**

# Research

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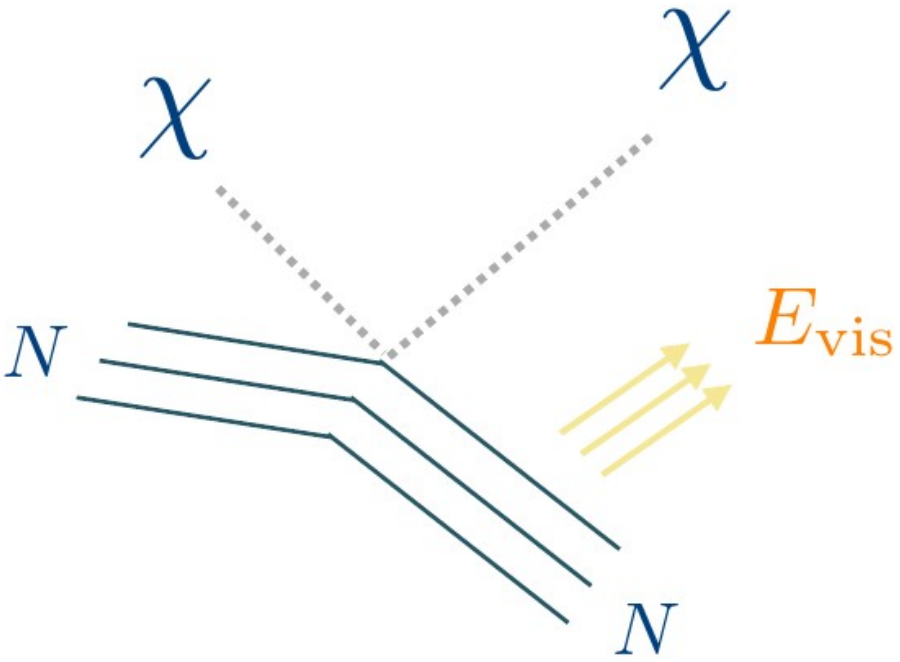
- Diversity
- Synergies between groups
- Synergies between exp. and theory
- Try to have 2 to 3 groups working in a similar field.

# L. Baudis Group

- Direct detection of particle dark matter in xenon time projection chambers
- Via elastic dark matter - nucleus collisions
- Detection: charge and VUV scintillation light

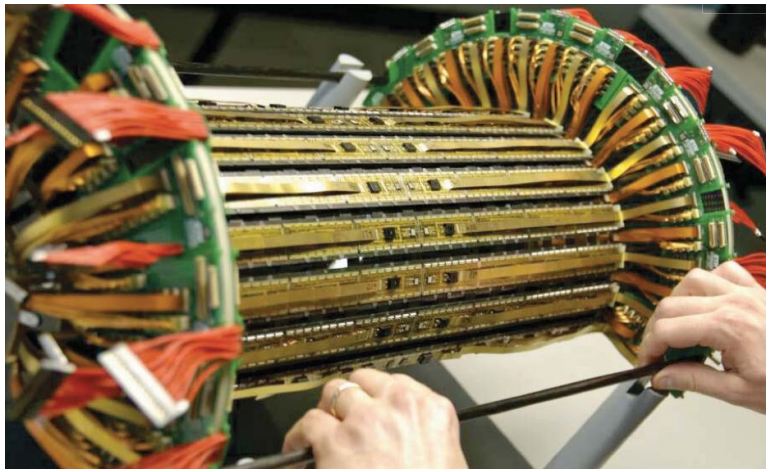
The XENON1T experiment at the Gran Sasso Laboratory

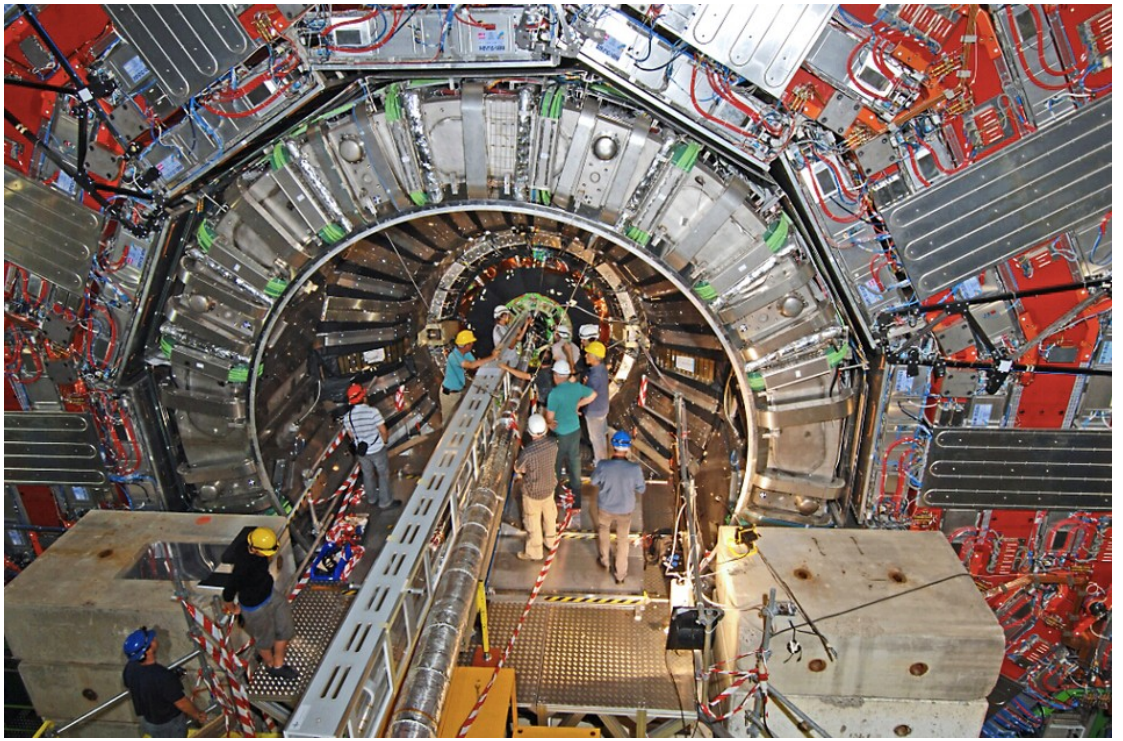


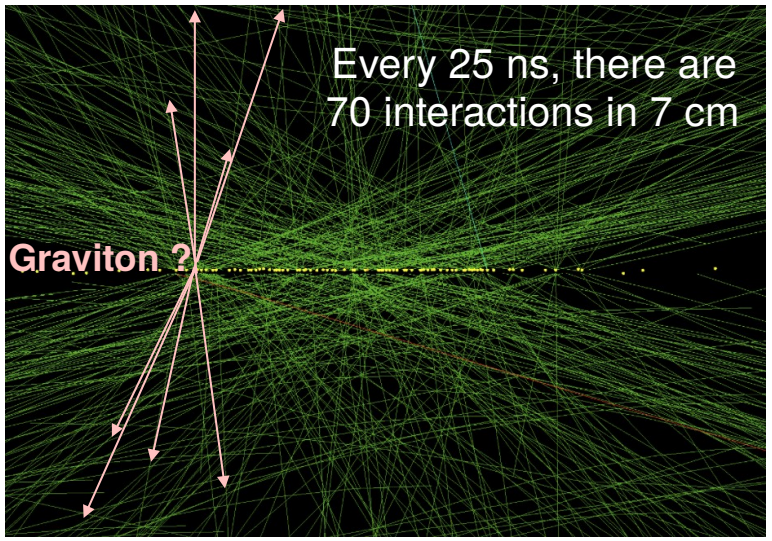
# Group Canelli / Kilminster: CMS @ LHC

**The heart of the CMS detector at the LHC**

Pixel tracker (UZH, ETH, PSI)





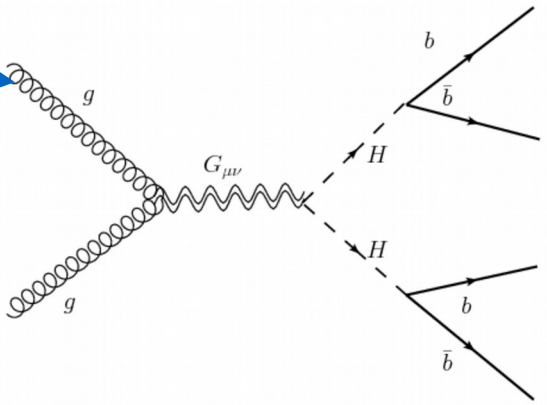



66 million channels read out at 40 MHz to reconstruct 100s of tracks each bunch crossing to produce this image

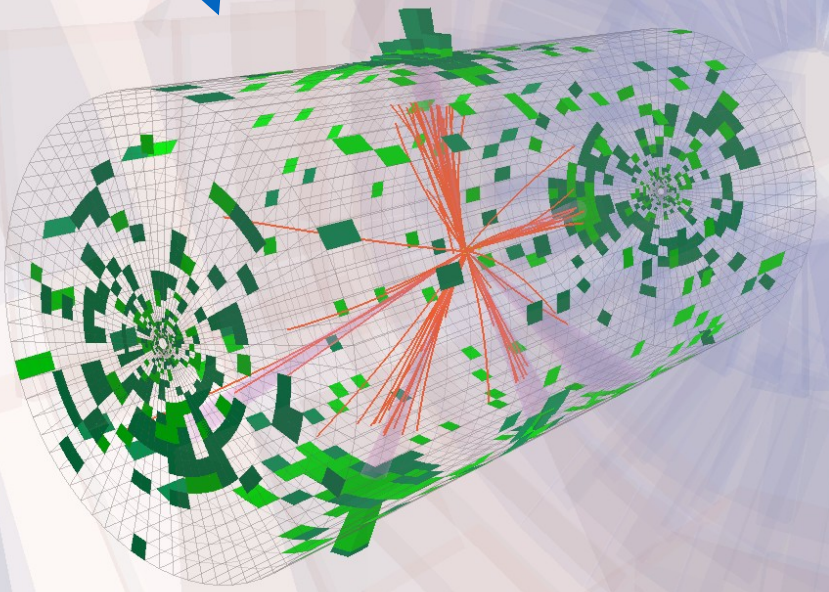
Needs to be precise enough to disentangle & subtract out all interactions except the interesting one

# Group Canelli / Kilminster: CMS @ LHC

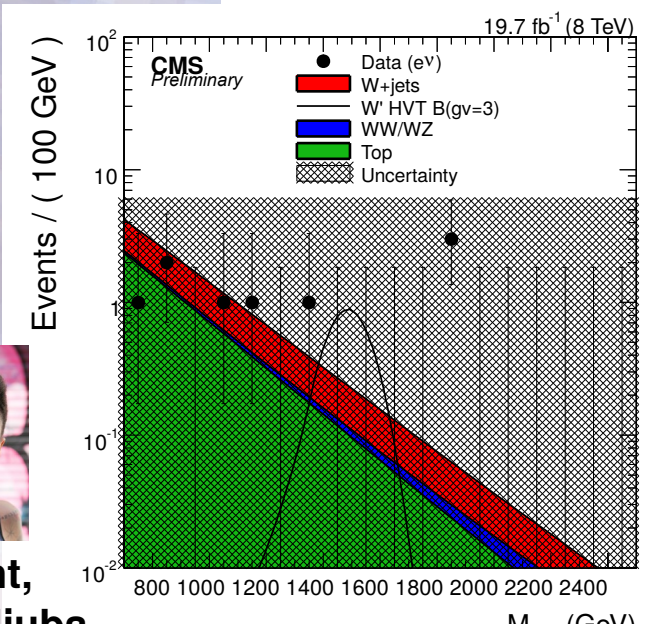
## (1) Theory : Extra dimensions in the universe could cause graviton to be produced at LHC

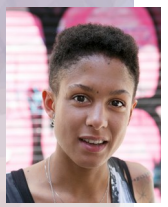



## (2) Experiment : A 3 TeV-mass Graviton would look like this in CMS detector (actual data candidate)



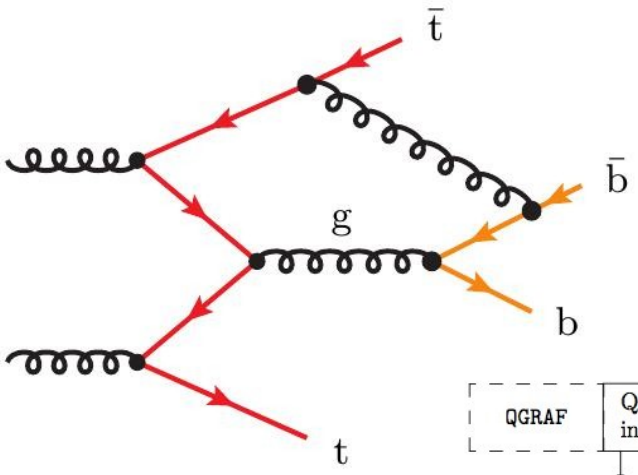
## (3) Analysis : Backgrounds calculated, excess of signal would appear as resonance (or bump)



**PhD student, Jennifer Ngadiuba**

# Particle Theory: Gehrmann, Isidori, Grazzini, Pozzorini

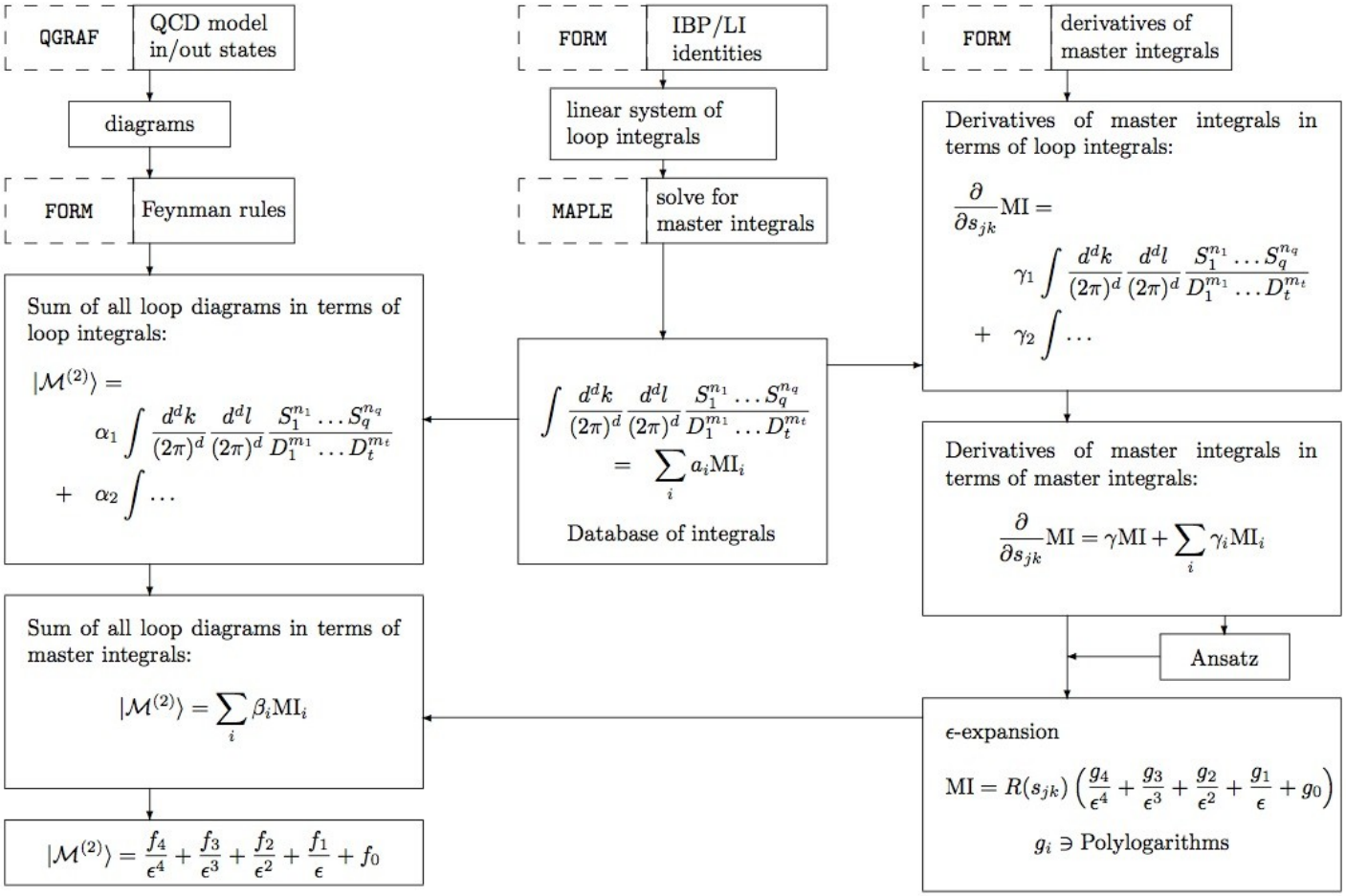



calculate particle physics processes
from known standard model,
as well as from possible new models

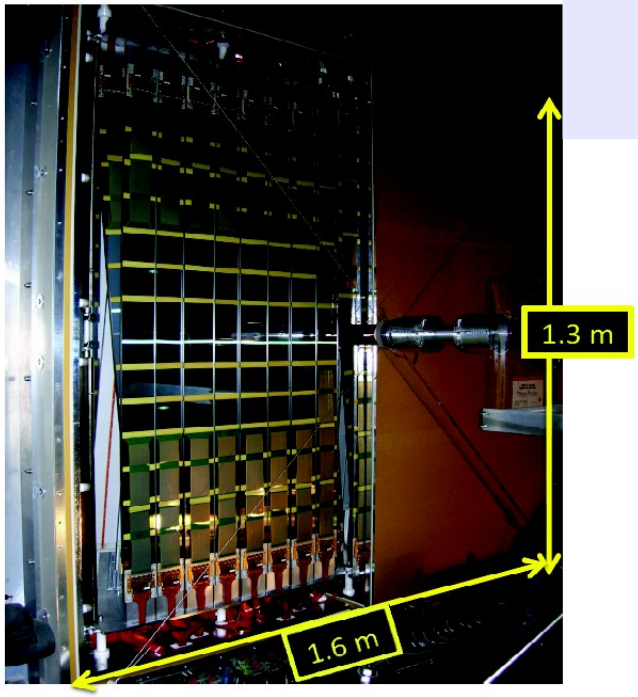
compare with experimental data

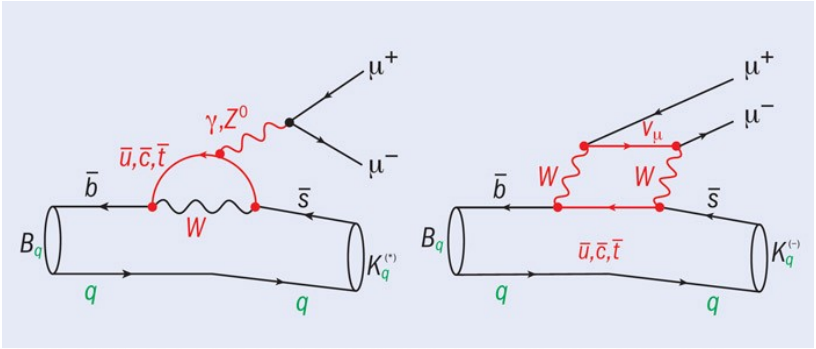
using Monte Carlo methods

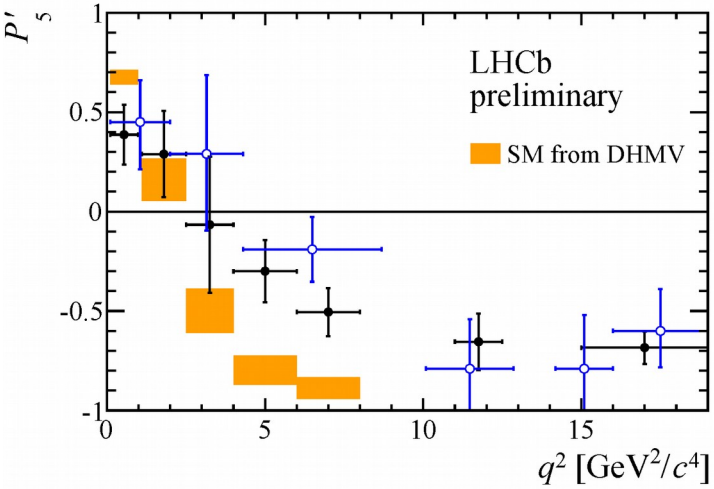
and computer algebra



# Group Serra / Straumann: LHCb @ LHC

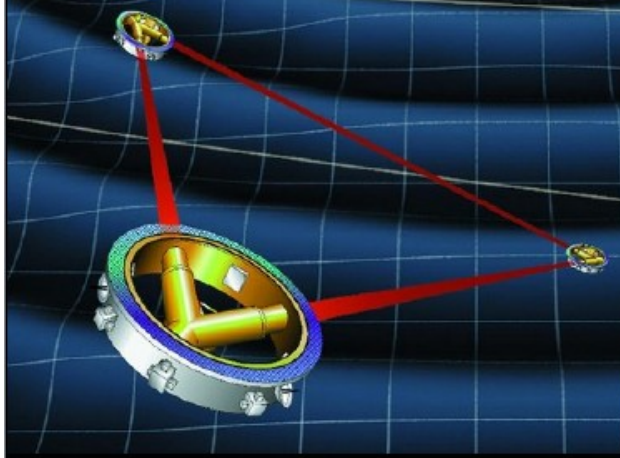


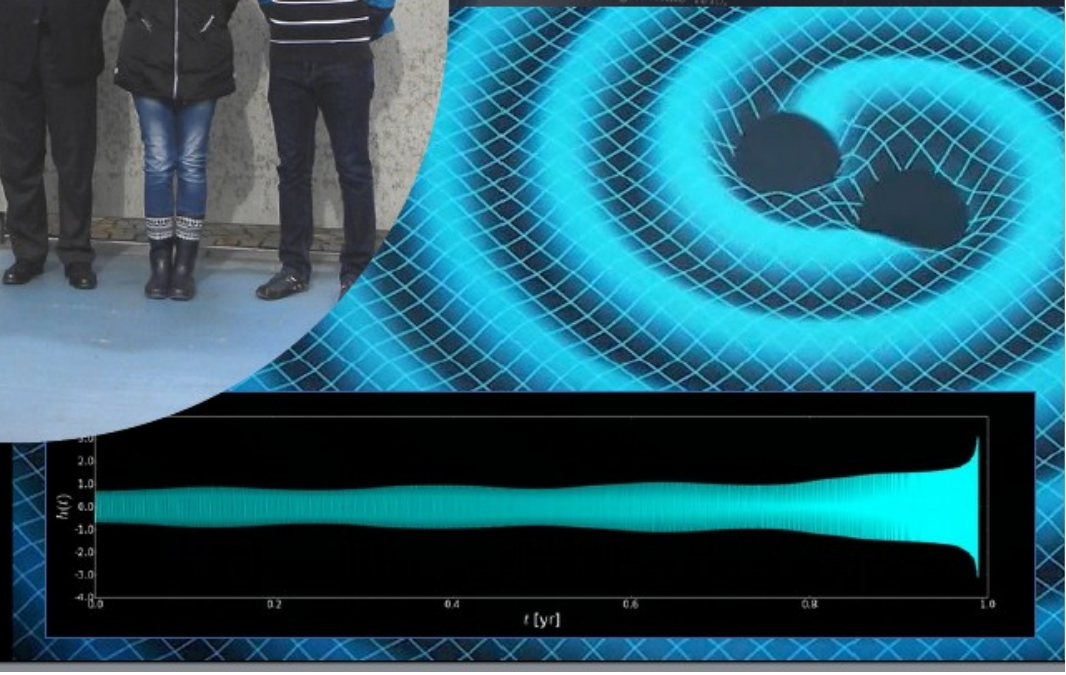




# Gravitation and Astrophysics

## Jetzer Group



$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = \frac{8\pi G}{c^4} T_{\mu\nu}$$





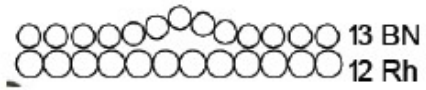

lisa pathfinder

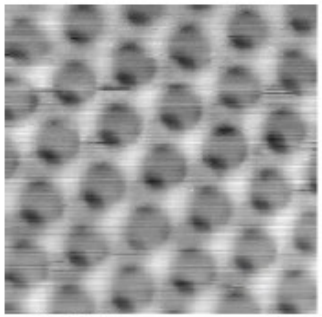
# Surface Physics – Group of Profs. J. Osterwalder / T. Greber

## Single layers of hexagonal boron nitride and graphene


… grown on metal surface

⇒Periodic “superstructure”

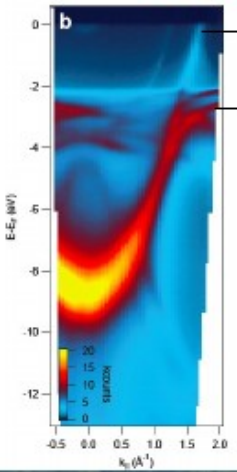


h-BN nanomesh

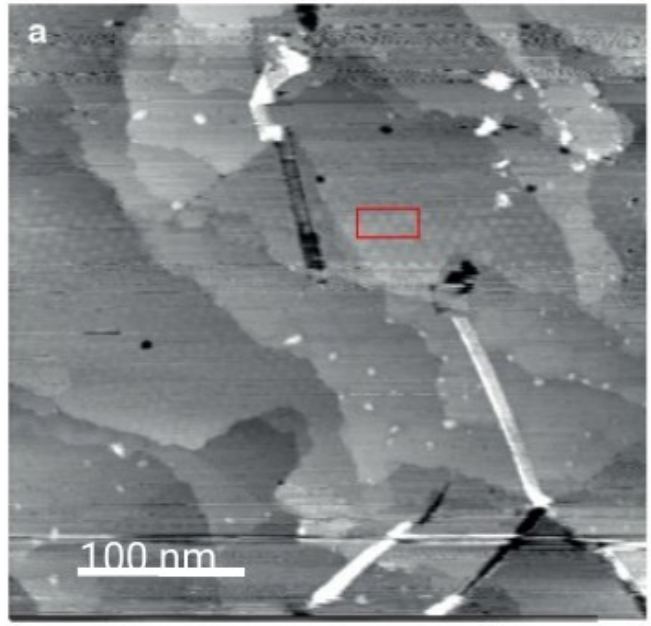
⇒ A nanotemplate for molecules

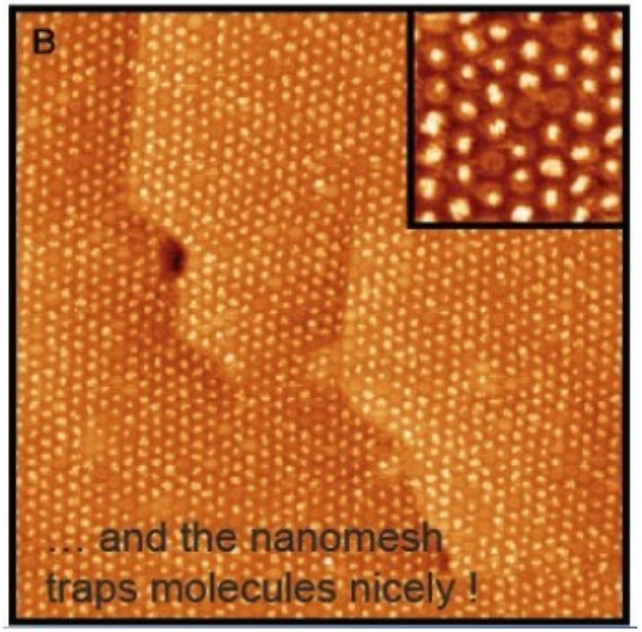
… growth of heterostacks

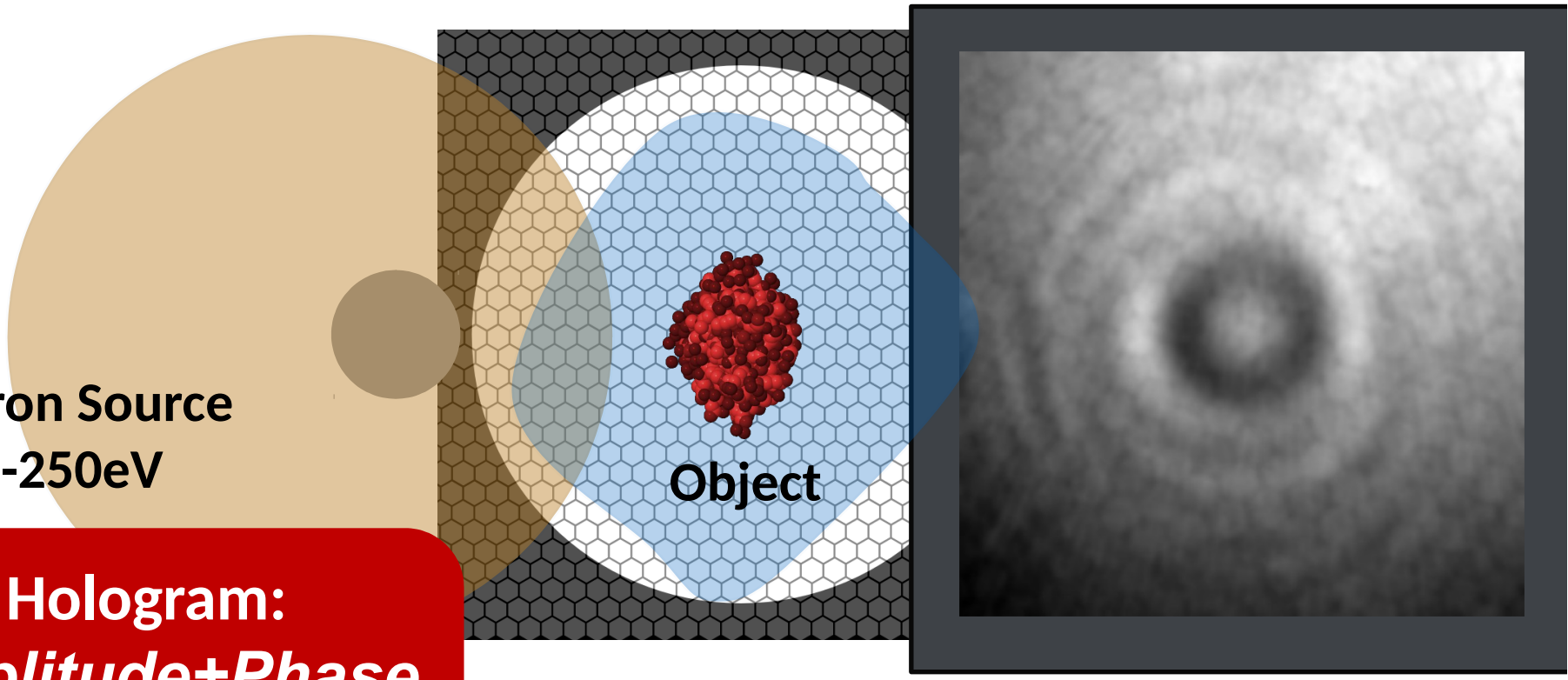

g: Dirac point

h-BN: band gap


## Group Fink: Imaging individual single proteins, using low energy electron holography

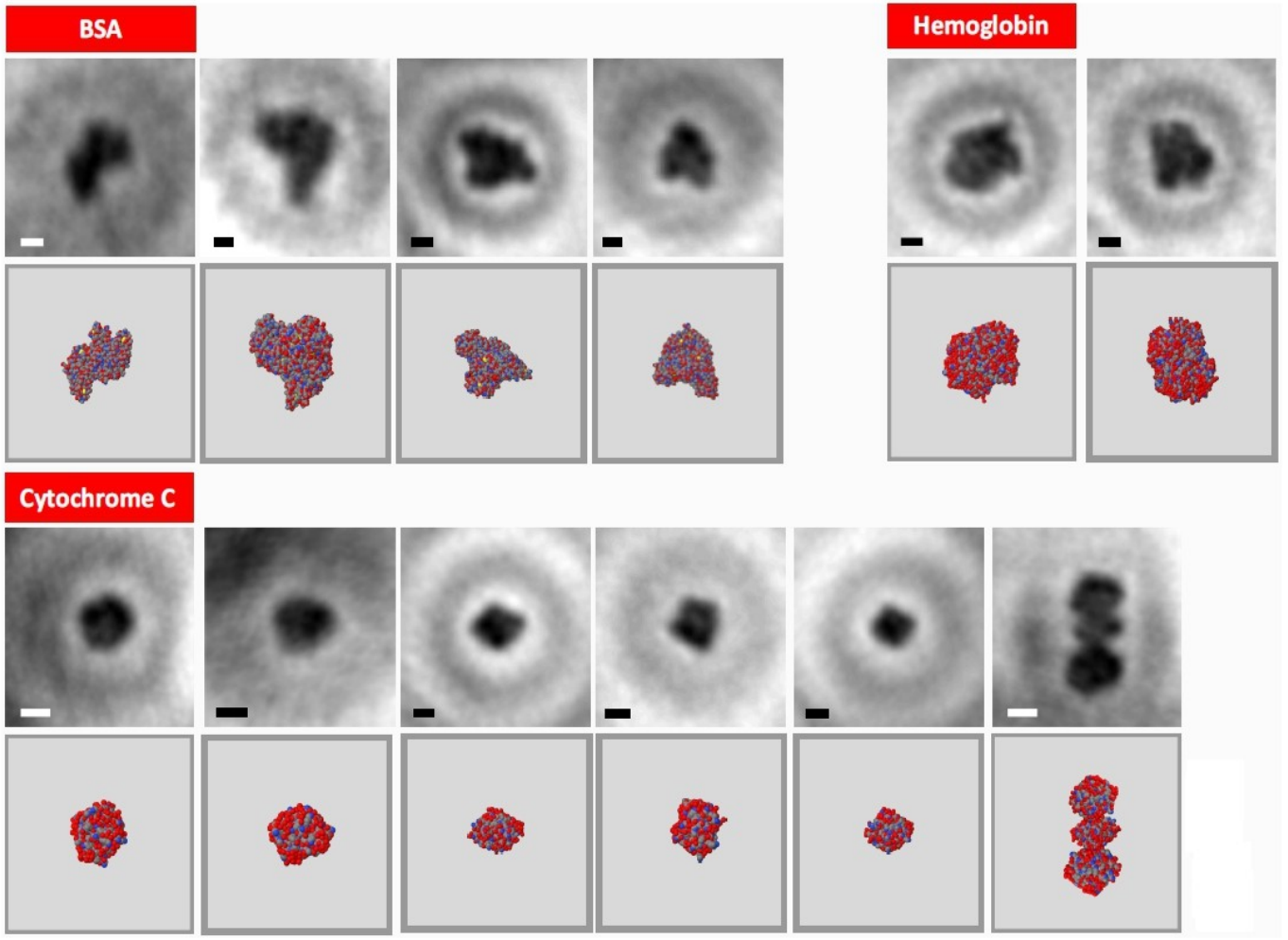



**Hologram:**
***Amplitude+Phase recorded***
***NO "phase problem"***

**Magnification:**
M=Z/z $M>1\times10^6$

**Lensless Scheme ->**
**No Aberrations ->**
**Wavelength Limited Resolution**

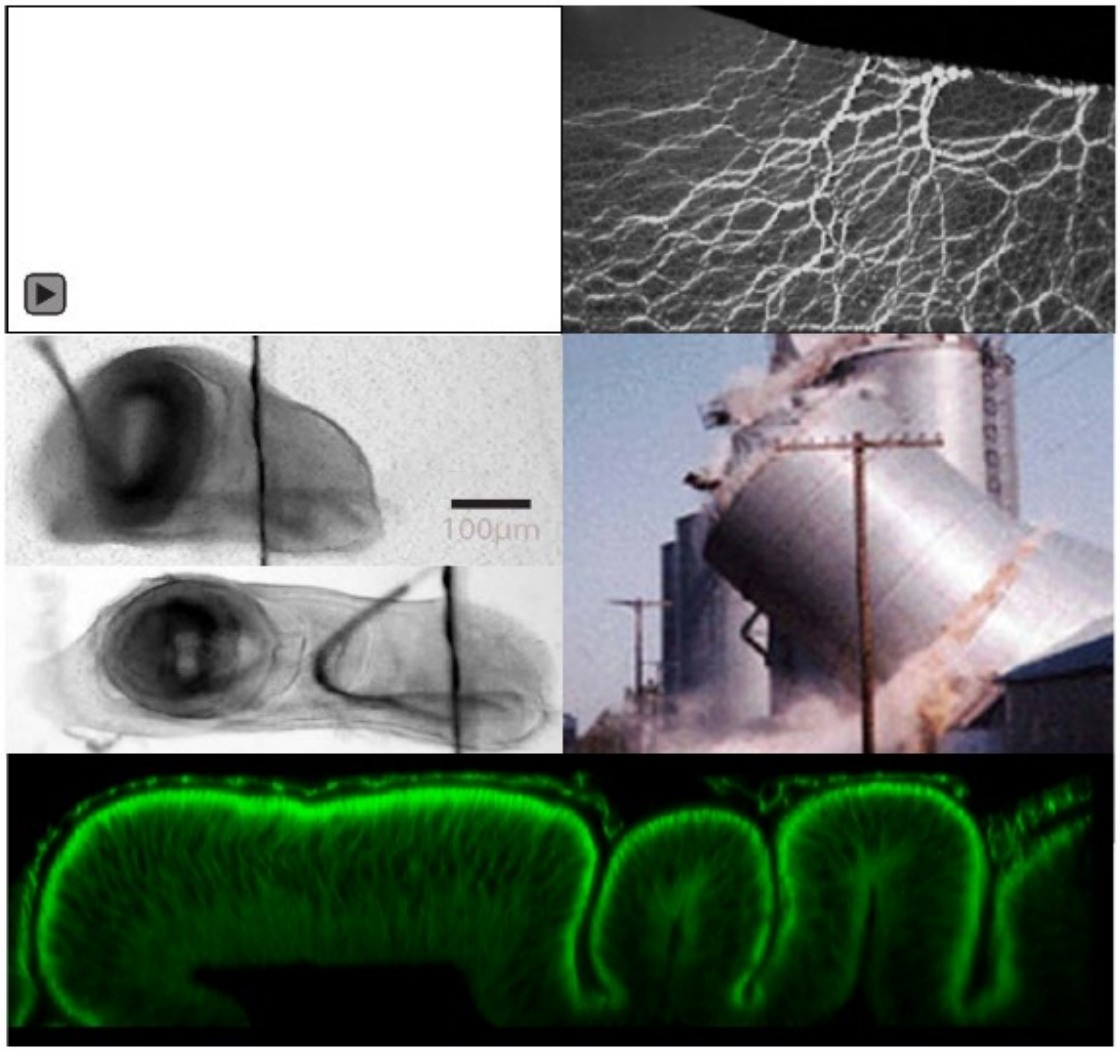
# Group Fink: Imaging individual single proteins, using low energy electron holography




submitted for publication.

# Group Aegerter

## Forces in heterogeneous and biological materials




Universität Zürich[UZH]

In collaboration with:
*DLR Berlin, KIT Karlsruhe*

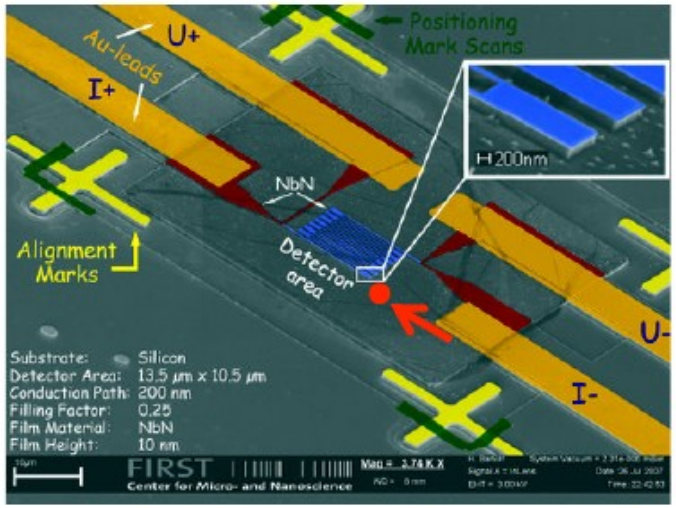
**Physik-Institut**

# Phase Transitions, Materials and Applications

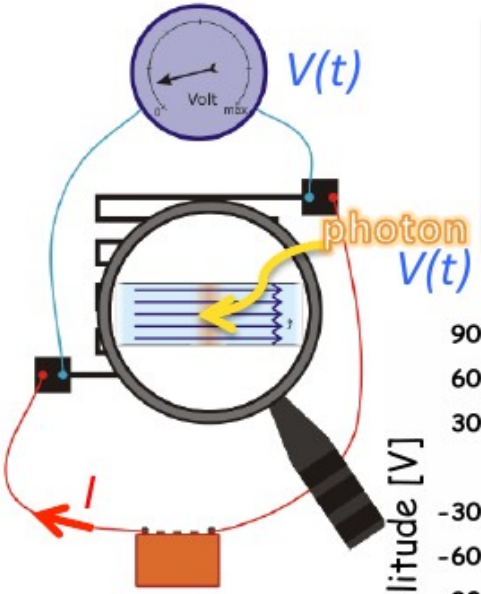
**Prof. Andreas Schilling**

Research Group of Prof. A. Schilling



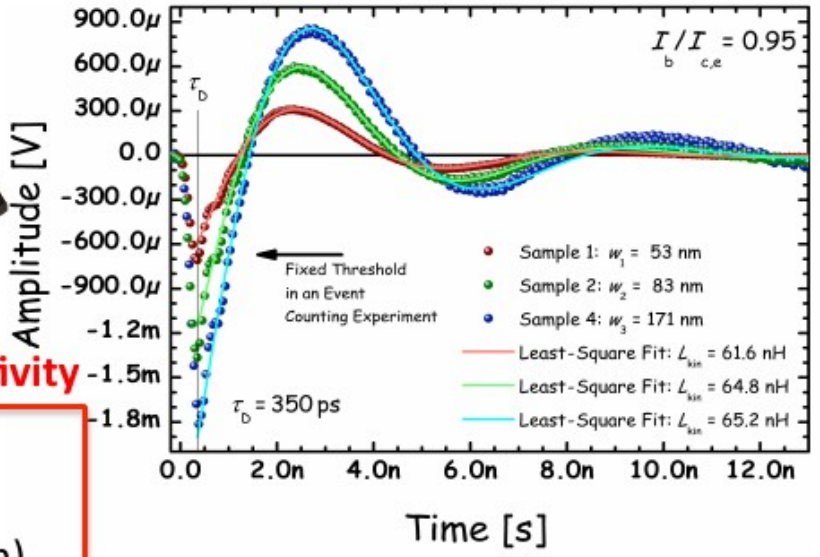



Example: 200 nm wide stripes of superconducting NbN on sapphire, ≈ 10 x 13 µm² detection area




**Fast (Ghz)**
**Singe-photon sensitivity**

Development and physical understanding of superconducting nanostructured ultrafast single-photon detectors for **visible light, infrared and X-ray**



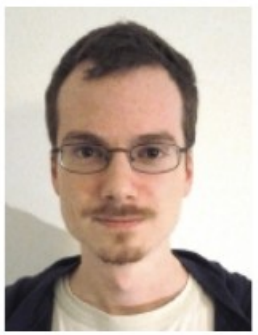

typical reponse after photon absorption (≈ 1-2 nanoseconds)

Some possible applications:

- secure telecommunication (quantum key distribution)
- optical (quantum) computing with single photons
- various detector applications

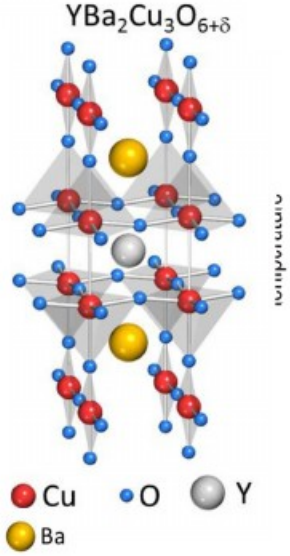
# Group Johan Chang

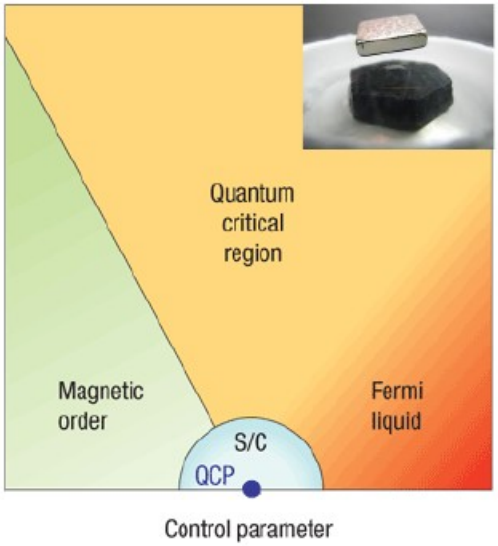
## Laboratory Quantum Matter Research

| Denys Sutter | Oleh Ivashko | Daniel Destraz | Claudia Fatuzzo | Johan Chang |
|---|---|---|---|---|
|  |  |  |  |  |

- **HIGH TEMPERATURE SUPERCONDUCTIVITY**
- **MAGNETISM & CHARGE ORDER**
- **QUANTUM CRITICALITY**

**ELECTRON, NEUTRON & LIGHT SPECTROSCOPIES**
**DIFFRACTION EXPERIMENTS**
**MAGNETO-TRANSPORT MEASUREMENTS**






## EXPERIMENTAL TECHNIQUES

# Events: Kaggle competition winners workshop

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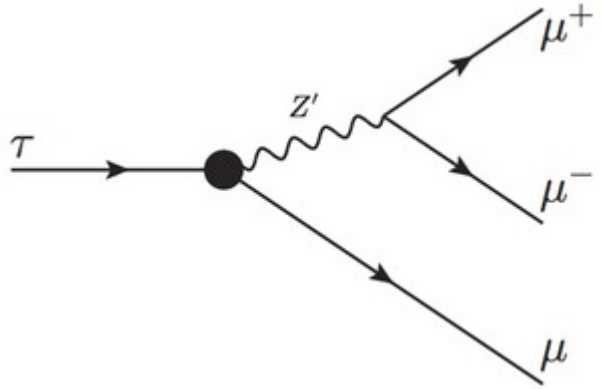
Kaggle competitions are organized by machine learning scientists to solve difficult and interesting challenges in fields with big data.

Marcin took part in this years organisation. 673 teams from all over the world took part.
The final winners workshop took place in Irchel in February 2016.




Prizes sponsored by Yandex and Intel.

# Events:
# International physics olympiad

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July 2016 at Irchel:
see Andrea Schneiders presentation