Institut für Experimentelle Kernphysik:
Prof. Dr. Michael Feindt, Dr. Thomas Kuhr, Dr. Michal Kreps et al.
Experimental studies with the CDF II and Belle experiments:
Specialised in reconstruction software and complex analyses.
B mixing, Bs mixing and CP violation, D mixing,
beauty, charm and charmonium spectroscopy.
Close cooperation with industry (Phi-T GmbH, NeuroBayes neural computing,
multivariate statistical analysis)

Institut für Theoretische Teilchenphysik, Prof. Dr. Ulrich Nierste et al.:
Theoretical studies on flavour physics,
implications from new physics on CKM parameters, CP violation etc.

Close collaboration between experiment and theory
(e.g. weekly b physics lunch seminar)
Some recent highlights of our work at CDF II:

$B_s$ oscillations: from evidence (3 sigma) to observation (5 sigma)
by improved signal selection using neural network
and improved opposite site flavour tagging using neural network
and inclusion of partially reconstructed decays

$\Delta m_s = 17.77 \pm 0.10\text{(stat)} \pm 0.07\text{(sys)} \text{ ps}^{-1}$

$|V_{td}| / |V_{ts}| = 0.2060 \pm 0.0007\text{(exp)}^{+0.0081}_{-0.0060} \text{ (theor)}$
Some recent highlights of our work at CDF II:

Implications to unitarity triangle: Measurement of upper right side length

Standard model prediction works very well.
Sets stringent constraint on flavour structure of new physics scenarios.
Close connection between experiment and theory in KIT useful
Some recent highlights of our work at CDF II:

Measurement of lifetime difference of $B_s$ mass eigenstates and a possible CP violating phase in $B_s \rightarrow J/\psi \Phi$ (Theory: Nierste et al)

- left: without flavour tag ($P(SM)=22\%$)
- right: with flavour tag ($P(SM)=8\%$)

Hint for long-awaited new physics? Too early yet....
Some recent highlights of our work at CDF II:

**Heavy flavour spectroscopy**

First observation of $B_{s1}^*$, most precise of $B_{s2}^*$

$J^{PC}$ of $X(3872)$ is $1^{++}$ or $2^{--}$

Most precise mass & width of $B_1$ and $B_2^*$

$X$ splitting larger than 3.6 MeV as predicted by 4q models excluded

Most precise mass meas: Mass very near – but below D*D threshold. Precision now limited by $D^0$ mass.
Theoretical work on flavour physics:

- Flavour aspects of the Standard Model
- Flavour physics signatures of new physics scenarios (e.g. supersymmetry)
- Interplay between high energy (LHC) and high precision (flavour physics) results in the interpretation w.r.t. new physics
- Link between quark and lepton flavour sector in Grand Unified Theories
- Close connection to experimental groups
- Proposals for experimental analyses at Tevatron, LHCb and B factories
Some recent highlights of our theoretical work:

Flavour aspects of the Standard Model:

e.g. most precise theoretical prediction of $B_s$ oscillation parameters in SM,
    CP-violation in $B^0$ and $B_s$ decays,
    semileptonic decays $B \rightarrow D \tau \nu$,
    rare decays $B \rightarrow s \gamma$ to NNLO accuracy
    electroweak corrections to $K \rightarrow \pi \nu \nu$

Flavour physics signatures of new physics scenarios:

e.g. semileptonic decays $B \rightarrow D \tau \nu$ in multi-Higgs doublet models
    first constraints on supersymmetric flavour parameters from charged-current processes
    dominant supersymmetric two-loop corrections to the anomalous magnetic moment of the muon
Alternative Flavour Physics
Belle

- B-factory experiment at KEKB accelerator in Japan
- Competitor of BaBar experiment
- KEKB accelerator holds world record in instantaneous \(=1.7 \times 10^{-34} \text{ s}^{-1} \text{ cm}^{-2}\) and integrated luminosity \((850 \text{ fb}^{-1})\)
- Belle has about 900 million B-meson pairs on tape
- Upgrade to Super Flavour Factory (luminosity times 50) planned
Physics

Precision measurements of fundamental SM parameters (CKM matrix)

Search for physics beyond the SM

Discovery of new particles

Difference in direct charge-parity violation between charged and neutral B meson decays

The Belle Collaboration

Equal amounts of matter and antimatter are predicted to have been produced in the Big Bang, but our observable Universe is clearly matter-dominated. One of the prerequisites for understanding CP violation is that CP violation may arise from the interference between these two amplitudes, similar to two waves interfering with each other to produce a combined wave. However, this still depends...
(1/2) Nobel price 2008

Makoto Kobayashi       Toshihide Maskawa
"for the discovery of the origin of the broken symmetry which predicts the existence of at least three families of quarks in nature"

Final experimental proof:
CP-violation in B system by experiments BaBar and Belle

With all those who have been engaged in the KEKB / Belle experiment. Hope in the success of the upgrade project, too.

Oct. 9th, 2008

Makoto Kobayashi

KEKB と Belle に携わった全ての人とともに、アップグレード計画の成功を祈念した。
- Upgrade of KEKB accelerator and Belle detector from 2009 to 2012
- Aim for ~50 times more data (50 ab⁻¹ integrated luminosity) up to 2020
- Complementary to LHC program
Since July 2008:
IEKP of University Karlsruhe is official member of the Belle Collaboration
and one of the founding institutions of the SuperBelle Collaboration

Motivations:
Access to beautiful clean Belle data – many interesting and noteworthy thesis
topics up to SuperBelle startup
NeuroBayes® technology transfer to a B factory and future superB experiment
Risk and culture diversification of a large institute (not only LHC)

First contributions to Belle:
NeuroBayes®-based optimisations of full reconstruction (huge improvement
expected), flavour tagging and continuum suppression
Planned: MC production using (compared to LHC moderate) Grid resources
Planned: Physics analysis on CP violation, B→ tau, new spectroscopy
Karlsruhe plans for KEKB/SKEKB:
Exploratory study of possible applications of NeuroBayes technology for optimizing the performance of a particle accelerator (started)

Karlsruhe plans for SBelle:
(Fuzzy logic) reconstruction software on neural probabilistic basis

Substantial contribution to planning and construction of the DEPFET silicon pixel detector

Running already: radiation studies of chips with X ray station
Germany @ Belle

Belle Collaboration: 359 scientists from 59 institutes in 14 countries

In July 2008, KIT (Thomas Müller, M.F. et al.) joined the Belle Collaboration. (also MPI Munich (Christian Kiesling, Hans-Günther Moser et al.))

Oct 31/ Nov 1, 2008: Workshop at MPI Munich on Potential and Prospects for Super Flavour Factories

More than 50 participants: Convincing physics case presented

Large interest in SuperBelle expressed: MPI, KIT, Bonn (Norbert Wermes et al.), Göttingen (Ariane Frey et al.), Giessen (Sören Lange et al.) will start now.

Others interested but currently too heavily engaged in LHCb.

Asked for DFG Kosselek project for developing neural computing for Belle
Will ask BMBF to fund German DEPFET pixel detector for SuperBelle