IIP: Max Planck Institute for Dynamics and Self-Organization

Nathan Wei ‘17

July-August 2015

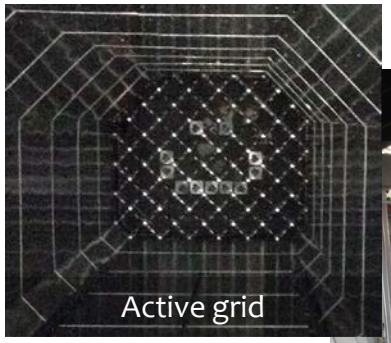
Göttingen, Germany

Presentation of the Project

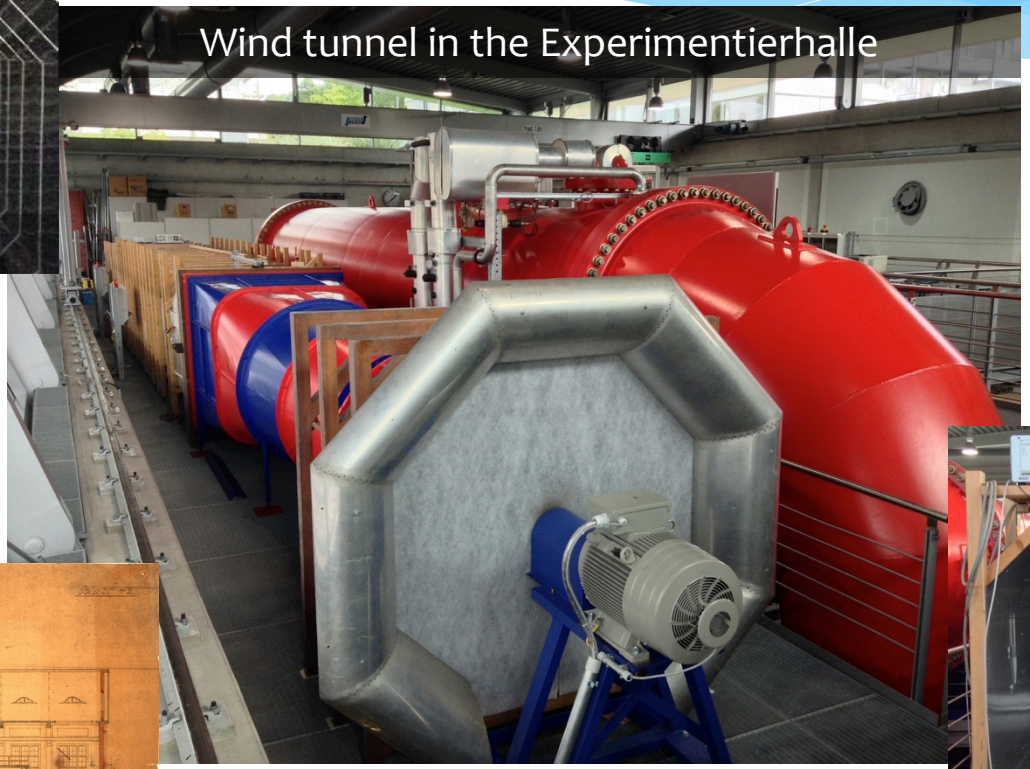
* Turbulence: “the most important unsolved problem of classical physics” – Richard Feynman
* Active grid: 129 independently-moving paddles in air flow
* By changing how the grid moves, can we change how the turbulence downstream behaves?
  * Previous attempts were unable to induce turbulence changes
* Our task: develop new algorithms to correlate grid motions in time, and evaluate their effects on turbulence decay
* Worked with fellow Princetonian Kevin Griffin ‘17
* Advisor: Dr. Greg Bewley, with help from visiting researcher Dr. Willem van de Water


Office setup

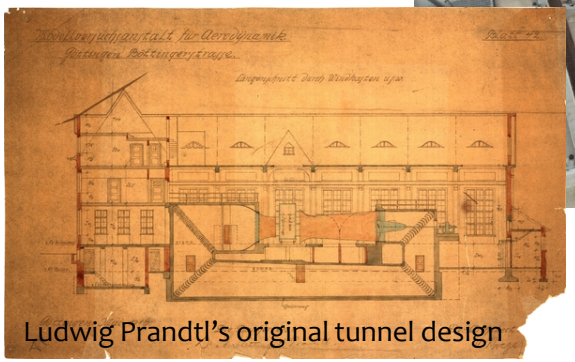
Taking on Turbulence



Active grid



Wind tunnel in the Experimentierhalle

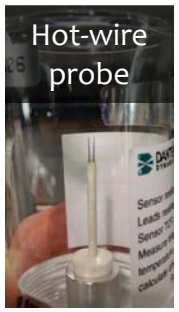


Ludwig Prandtl's original tunnel design

Hot-wire anemometer mounted on traverse, inside the tunnel

Research Responsibilities

* Program new temporal correlations function into existing active grid control code (C++)
  * Debug, refactor, and optimize old code along the way
* Collect data in the wind tunnel using hot-wire probes
* Process data using new and existing MATLAB scripts
* Discuss problems, findings, and possible directions with our advisor



Research Rewards

* Learning about turbulence theory and experimental methods from experts in the field
* Freedom to come up with and test our own ideas
* Experiencing work atmosphere at a purely research-oriented institution in a different country
* Working on a project whose results could significantly impact future active grid turbulence research worldwide

Early morning view from the roof of the Institute

Discovering Deutschland


Room at the Guest House

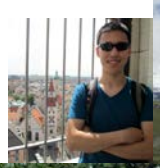
* Accommodations: MPIDS guest house
* City travel by bus, longer trips by train

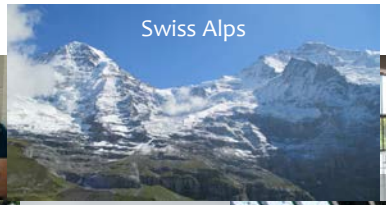
* Göttingen: "Die Stadt der Wissen schafft"
  * Home of several famous intellectuals (such as Gauss, Weber, Planck, Hilbert, Riemann, Barth, and the Brothers Grimm)
  * Produced 47 Nobel laureates

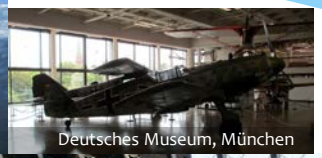

Göttingen Innenstadt, viewed from the top of the Neues Rathaus

Exploring Europe


ICE trains in Göttingen

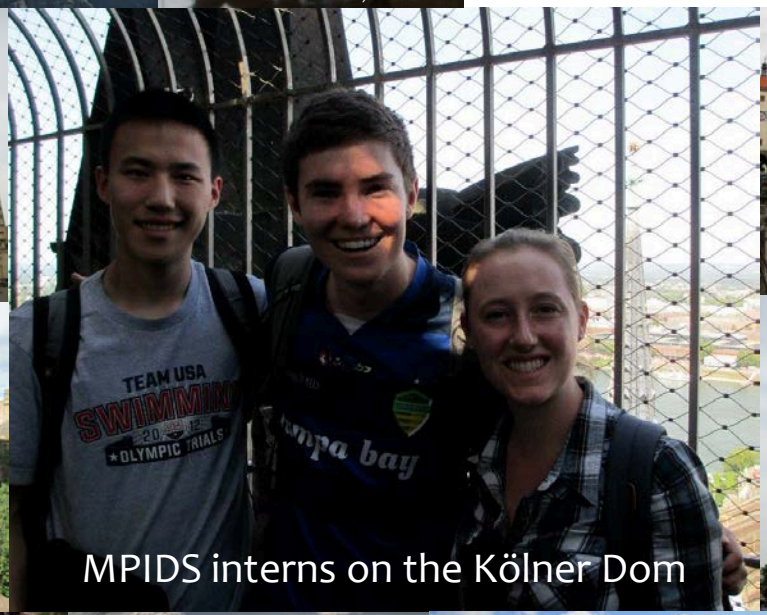



Swiss Alps


Deutsches Museum, München


Vienna


Dresden


MPIDS interns on the Kölner Dom

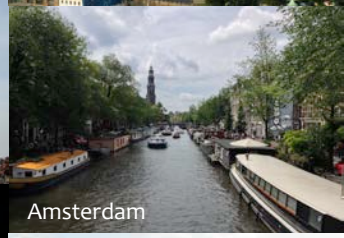

Rothenburg ob der Tauber


Leipzig


Salzburg


Prague


Paris


Amsterdam


Zugspitze


Heidelberg


Standing wave on the Eisbach, München


Mannheim


Strasbourg


Berlin


Lucerne

Conclusions and Contributions

* Our temporal correlation algorithms allow researchers to induce nontrivial changes in turbulence
* New calibration and temperature correction programs significantly reduce experimental error
* Our extensive data sets may yield greater insights into the fundamental nature of turbulence decay
* Organized and documented code and procedures to soften the learning curve for future researchers

Career Consequences

* Learned new programming skills and gained vital experience with experimental work
* Continuing to work on the project through junior independent work (MAE 339, fall 2015)
* Confirmed my inclination to pursue a career in academic research through graduate school
* Sparked an interest in turbulence that may turn into a primary research focus

Personal Progress

* Immersed myself in the rich scientific, philosophical, theological, and technological traditions of Germany
* Grew to appreciate German culture as manifested both in research and in everyday life
* Got to practice my German and meet some local students at a Wednesday night Bible study
* *Vielen Dank* to IIP for such a wonderful summer!


Sunrise over MPIDS


Sunset over MPIDS