
NATIONAL
INSTRUMENTS™

Graphical System Design: Empowering Domain Experts to Enable Innovation and Scientific Discovery

Dr. Stefano Concezzi

Director, Science & Big Physics

National Instruments

NATIONAL INSTRUMENTS

OUTLINE

1. National Instruments
    - Brief presentation on the company
    - What we do
2. Anomalous Heat Generation
    - Non judgmental business approach
    - Why NI is interested in this phenomena
3. National Instruments Contribute
    - Colloboration
    - Conclusion

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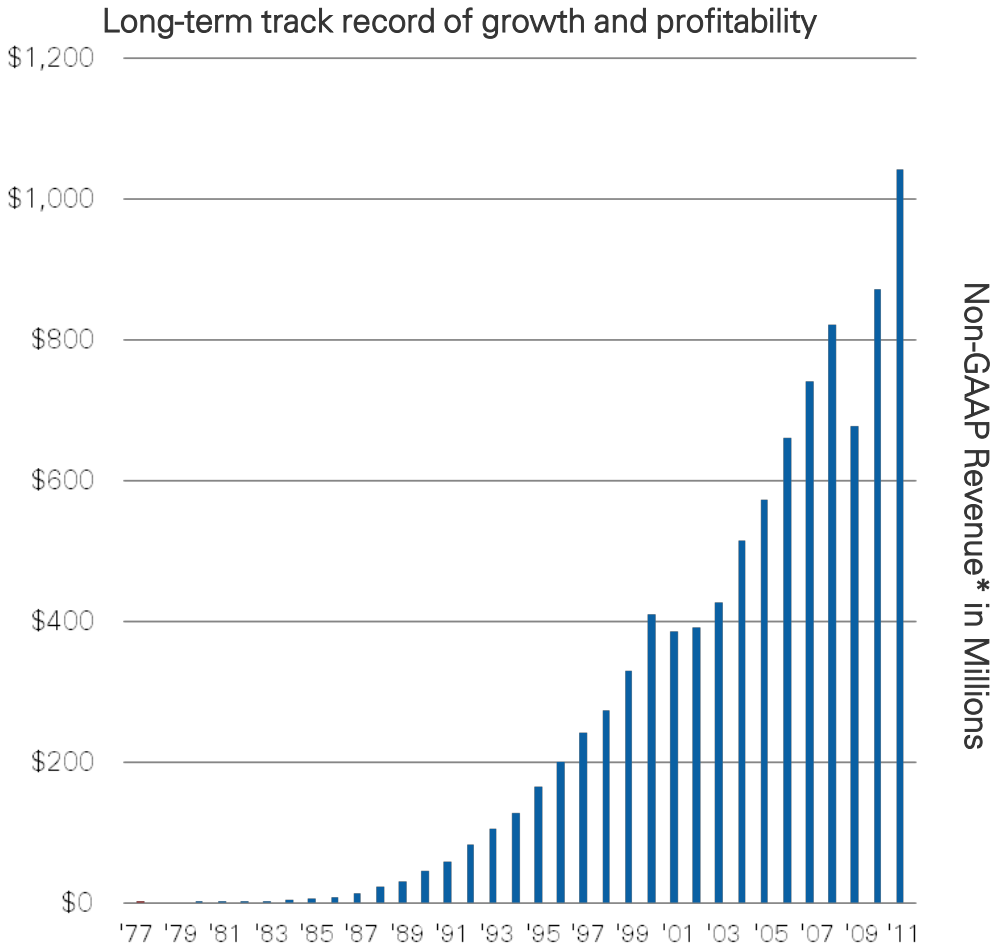
National Instruments

We equip engineers and scientists with tools that accelerate productivity, innovation, and discovery

- **Non-GAAP Revenue:** $262 M in Q1 2012
- **Global Operations:** Approximately 6,300 employees; operations in more than 45 countries
- **Broad customer base**: More than 35,000 companies served annually
- **Diversity**: No industry >15% of revenue
- **Culture**: Ranked among top 25 companies to work for worldwide by the Great Places to Work Institute
- **Strong Cash Position**: Cash and short-term investments of $377M at March 31, 2012

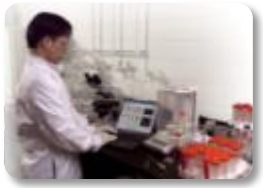


*A reconciliation of GAAP to non-GAAP results is available at investor.ni.com

Diversity of Applications

No Industry >15% of Revenue

Academic



Advanced Research

Automotive

Big Physics

Consumer Electronics

Defense/Aerospace

Energy

Life Sciences

Mobile Devices

Semiconductors

National Instruments

We equip engineers and scientists with tools that accelerate productivity, innovation, and discovery

- NI presence in the EU (about 1,700 employees)

  R&D Centers in Denmark, Hungary, Germany and Romania.

  Manufacturing center in Hungary (1,000+ employees).

  IT Center in Hungary.

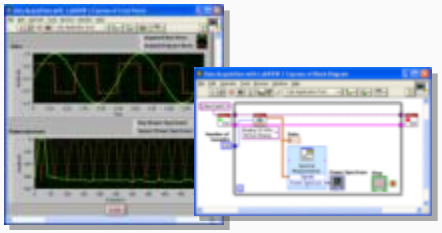
  Sales, Systems Engineering and Customer Support offices in Austria, Belgium, Czech Republic, Denmark, France, Ireland, Italy, Hungary, Germany, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, UK.

What We Do

Graphical system design combines graphical programming software with modular hardware, leveraging the latest technologies

Low-Cost Modular Measurement and Control Hardware

Productive Software Development Tools



Highly Integrated Systems Platforms

Empowering Users Through Software

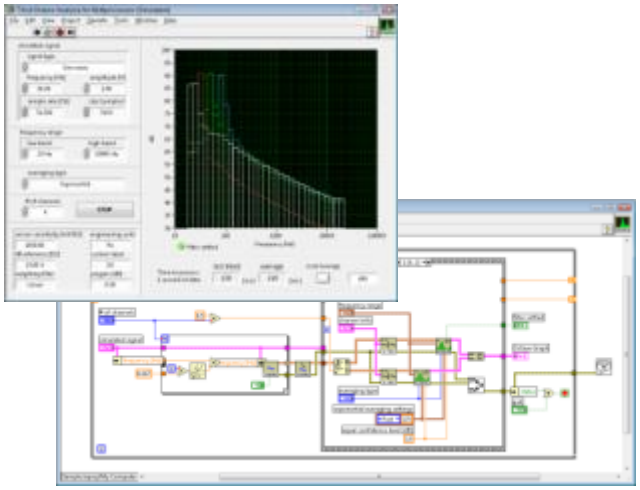
Providing unique differentiation and preserving customer investments

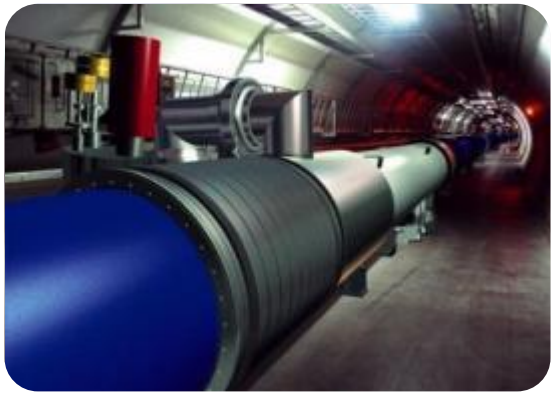
LEGO® MINDSTORMS® NXT

"the smartest, coolest toy of the year"

POWERED BY

NATIONAL INSTRUMENTS LabVIEW™





CERN Large Hadron Collider

"the most powerful instrument on earth"

National Instruments & Innovation





Areas of Innovation

- Energy
- Medical & Life Sciences
- Custom Machines

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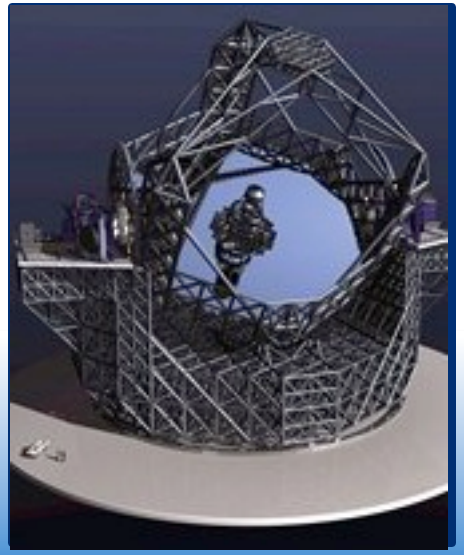
Today's Engineering Challenges

- Doing more with less
- Time to experiment
- Managing global projects
- Adapting to evolving application requirements
- Delivering on increasingly complex initiatives
- Maximizing operational efficiency
- Protecting system and resource investments



Anomalous Heat Generation

- An independent thesis research at the University of Texas at Austin found that from 1989 to 2010 more than 180 experiments around the world reported anomalous high production of excess heat in Pd-D or Ni-H.
- Either there is an unknown physical event or there is a need of better measurements and control tools. In both cases NI can accelerate innovation and discovery.

Anomalous Heat Generation and NI

The Master Plan

1. Find, analyze results and publications of institutions and researchers that are working on these anomalous heat generation phenomena.
2. Meet with the top 10 researchers.
3. Establish a research cooperation.
4. Leverage NI platforms and R&D to accelerate results.

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Collaboration List

Prof. Kim - Purdue University

(Bode-Einstein Condensate)

Prof. Hagelstein – MIT

(Incl. Quantum Field Theory)

Dr. Mace – LANL

(Transfer matrices, QFT)

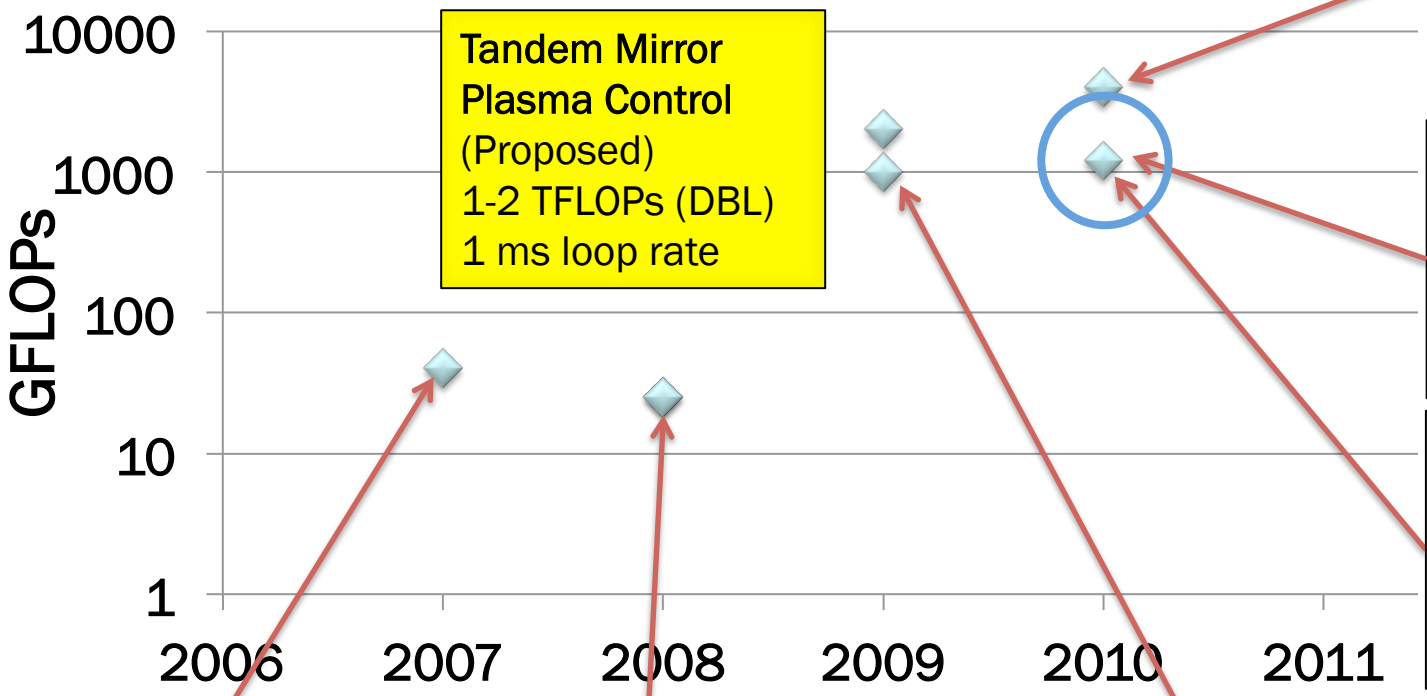
Prof. Duncan - University of Missouri

Prof. Levi – University of Bologna

Prof. Violante – ENEA

Other potential activities with SRI, NRL, INFN, Univ. of Kobe, Univ. of Osaka, UT at Austin, CEA.

Real-Time HPC Trend



Tandem Mirror Plasma Control
(Proposed)
1-2 TFLOPs (DBL)
1 ms loop rate

Synchrotron Tomography
(Proposed)
4 TFLOPs
3D 8k x8kx8k voxels

Tandem Mirror Plasma Control
(Proposed)
1-2 TFLOPs (DBL)
1 ms loop rate

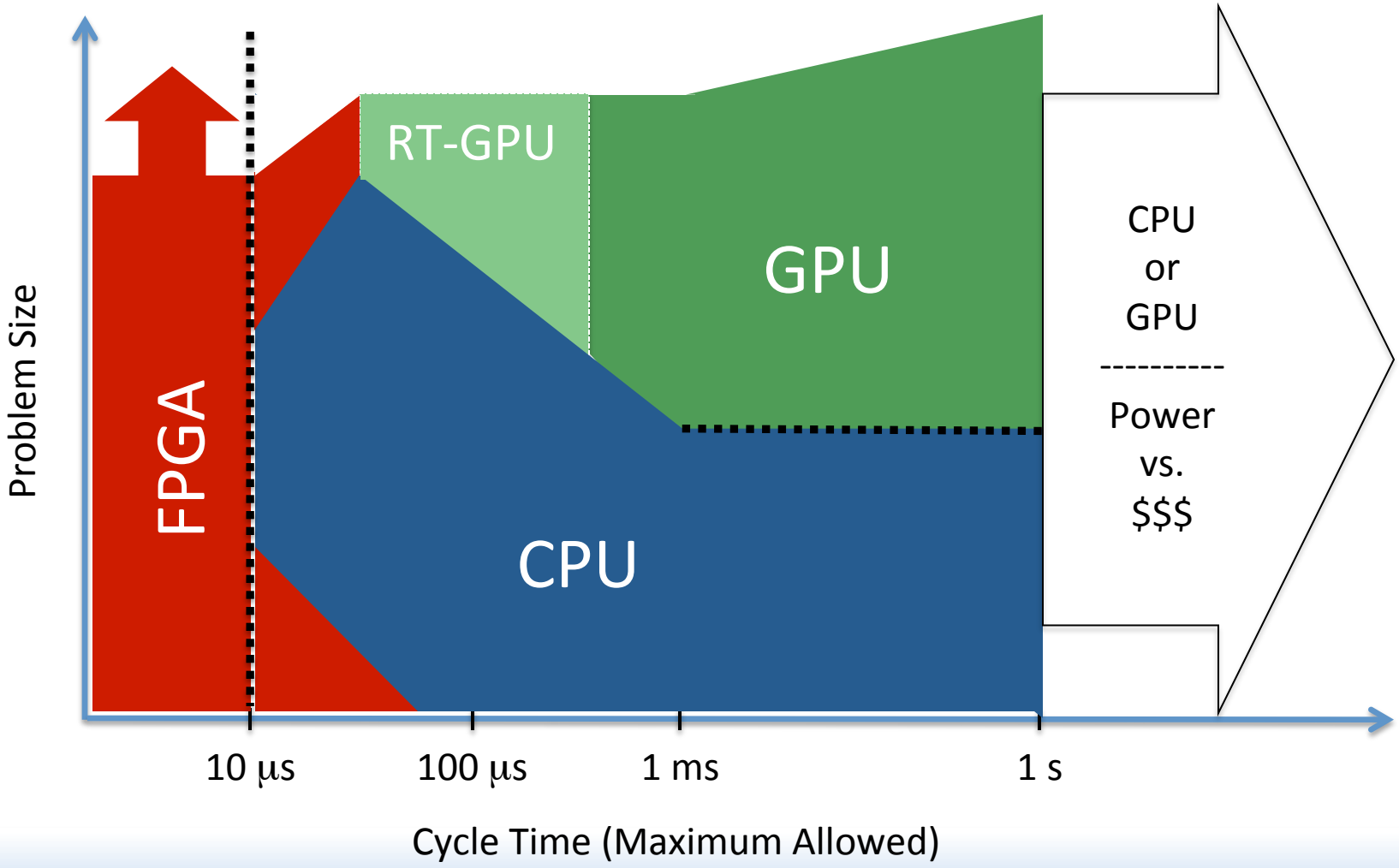
Financial Application
(Proposed)
1.2 TFLOPs
European Options

Tokamak Plasma Diagnostics
40 GFLOPs (DBL)
1 ms loop rate

1M Real FFT/s
1k samples
500k Complex FFT/s
1k samples

ESO E-ELT Mirror Control
M4: 2 TFLOPs, 2 ms loop rate
M1: 1 TFLOPs, 1 ms loop rate

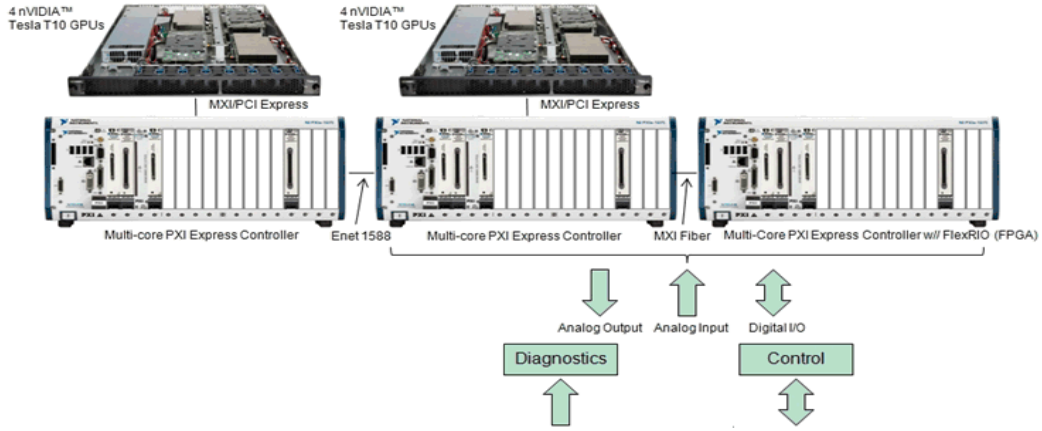
Our View Of The Computational Map

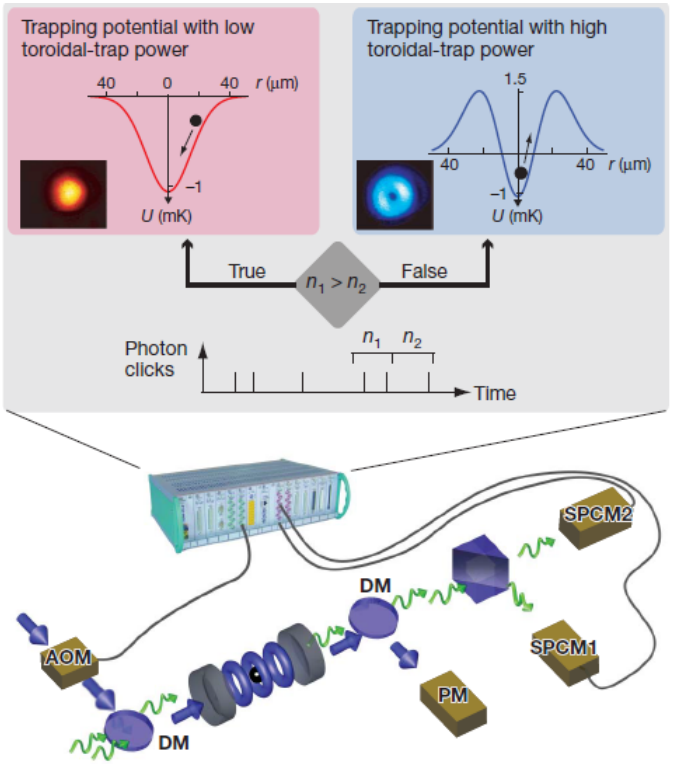


Example 1: FPGA-Based Quantum Optics

Extremely demanding Quantum Optics simulation/HIL/control
Manipulation of trapped atoms/ions
12 European universities + industry
$5M funding (Curie)

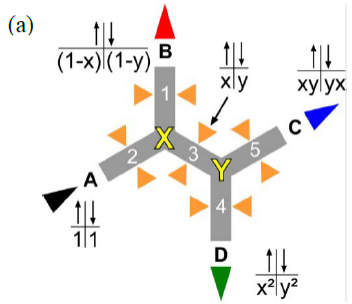
1 MHz-10 MHz controllers → FlexRIO (FPGA)

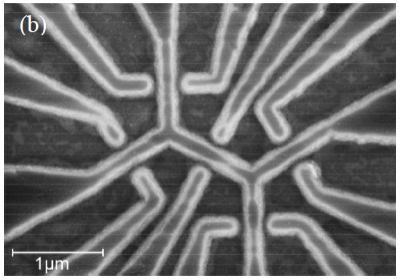




Example 2: Spintronic

Joint-work with Hamburg (Dr. Jacob) and A&M (Prof. Sinova)
Best-Paper Award, ICACSEE'12, 2/2012
Extremely large quantum simulations





Systemsize (N_x=N_y) (sites)	Matrixsize (N_x•N_y) (elements)	GPU Pipelined BT-Solver (seconds)
128	16384	2.463
256	65536	0.691
384	147456	2.936
512	262144	8.887
640	409600	21.255
768	589824	43.610
896	802816	80.244
1024	1048576	136.685
1280	1638400	332.707
1536	2359296	688.338
1792	3211264	1272.800
2048	4194304	2170.260
2560	6553600	5290.440
3072	9437184	10964.600
3584	12845056	20297.700
4096	16777216	34616.500
5120	26214400	84462.700

We are using:
(1) Quantum mechanical equations
(2) HPAL – our new High-Performance Analysis Library
(3) Our new GPU Toolkit

Collaboration With Prof. Kim (Purdue Univ.)

Purdue

Very LENR friendly environment

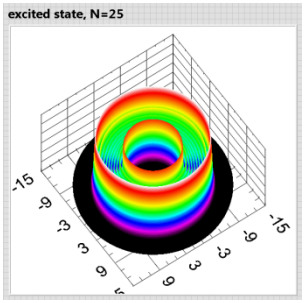
- Several experimentalist, nano-particle, …
- Prof. Koltick, Prof. Reifenberger and Dr. Andres

NI – Prof. Kim cooperation

- Quantum simulations
- Confirm Prof. Kim's ELTB-results
- Potential fusion rates under BEC conditions
- Potential fusion rates under various trapping and external field conditions
- Gross-Pitaevski equation for BEC simulations

Bazhutov-Vereshkov Theory
Chubb (Scott) Theory
Chubb (Talbot) Theory
De Ninno Theory
Fisher Theory
Gareev Theory
Hagelstein Theory
Hora-Miley Theory
Kim-Zubarev Theory
Kirkinskii-Novikov Theory
Kozima Theory
Li Theory
Sinha-Meulenberg Theory
Szpak Theory
Takahashi Theory

Collaboration With Prof. Kim (Purdue Univ.)



Phase I

- We confirmed ELTB results
- Building up a computational framework
- Hartree-Fock, Gross-Pitaevski
- Special solvers for interesting situations,
  - e.g., 2 D+ in trap+repulsion+strong magnetic fields

Phase II

- Numerical experiments using Phase I tools under Prof. Kim's supervision
- Optimize tools, stability, speed, parallelization
- Reusing tools for other projects with other institutions (as ENEA, SRI, NRL, INFN, etc.]

Conclusion

- There is an unknown physical event and there is a need of better measurements and control tools. NI is playing a role in accelerating innovation and discovery.

Appendix

1. NI – Prof. Kim cooperation: screen shot of mathematical simulations.
2. NI – Prof. Kim cooperation, background on existing theories.

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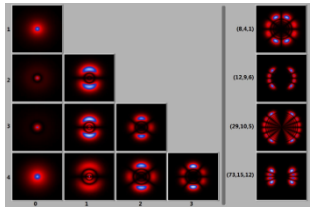
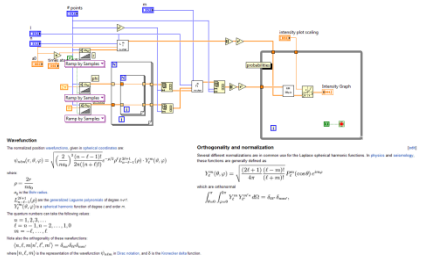
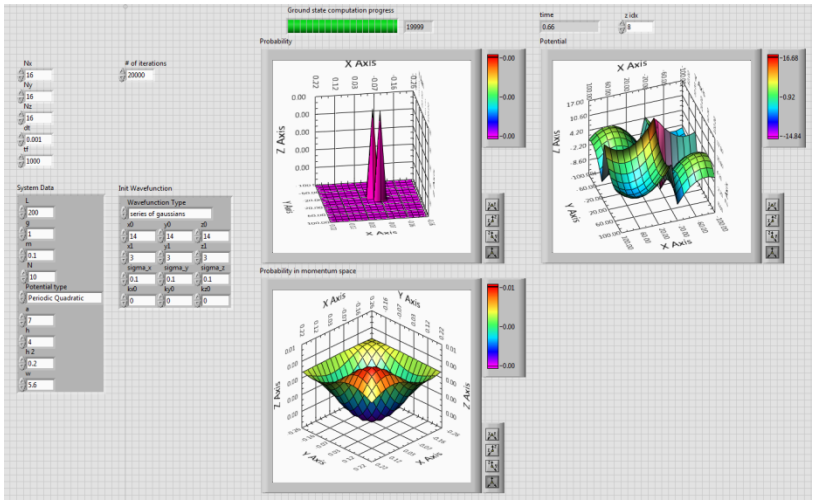
Some Screen Shots

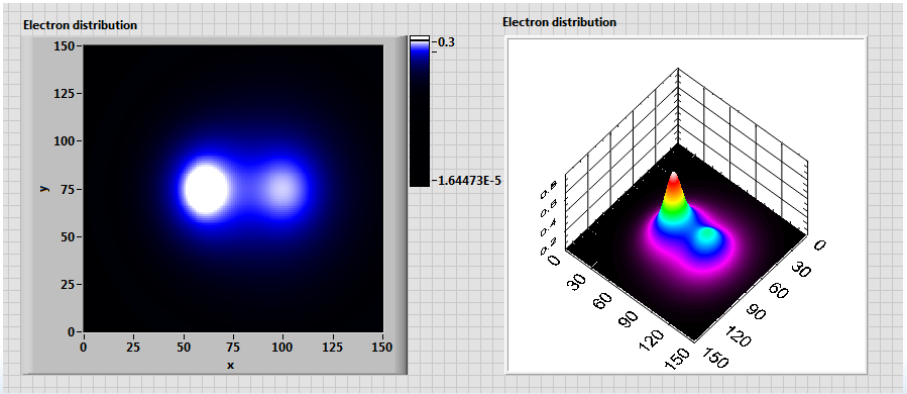
Hydrogen Atom





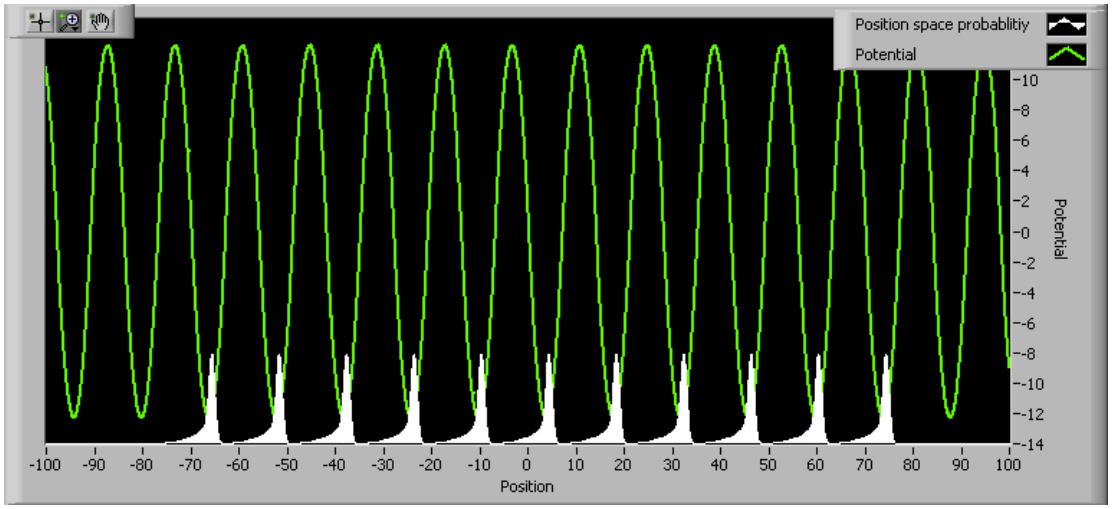
3D Gross-Pitaevski

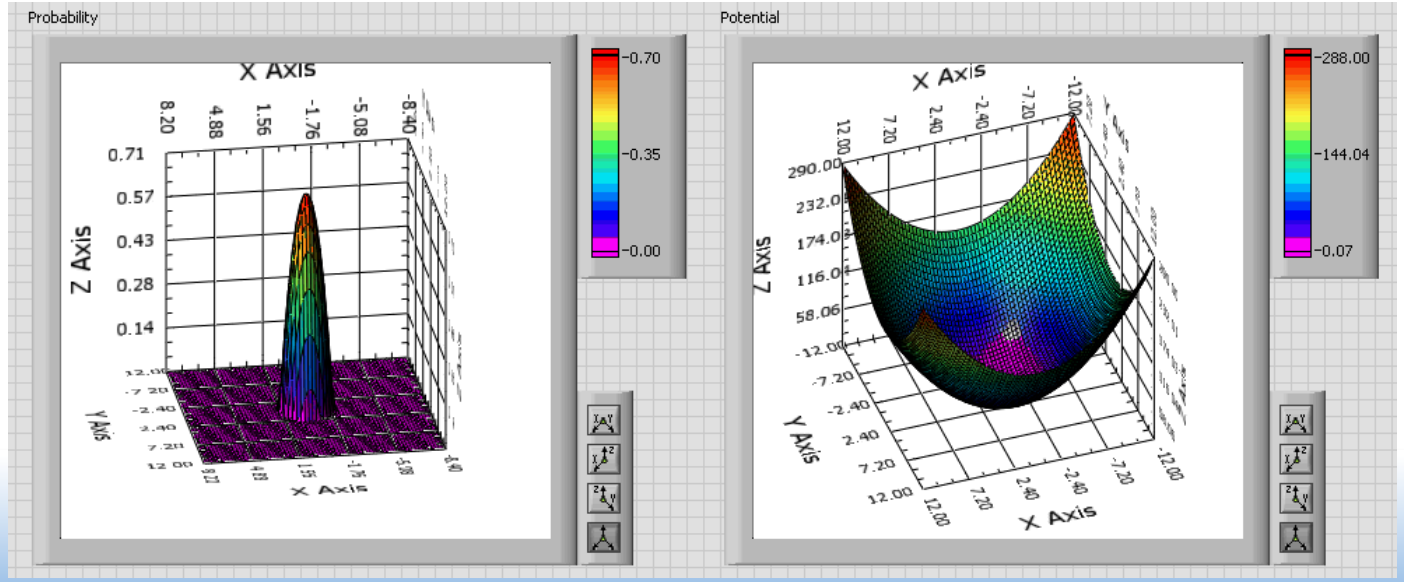




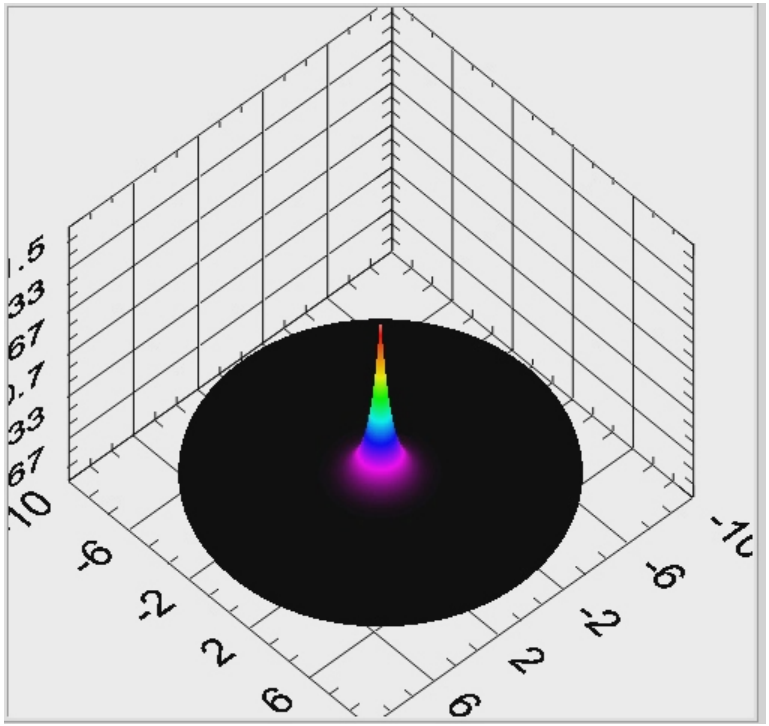
Hartree-Fock (HeH+)

Some Screen Shots

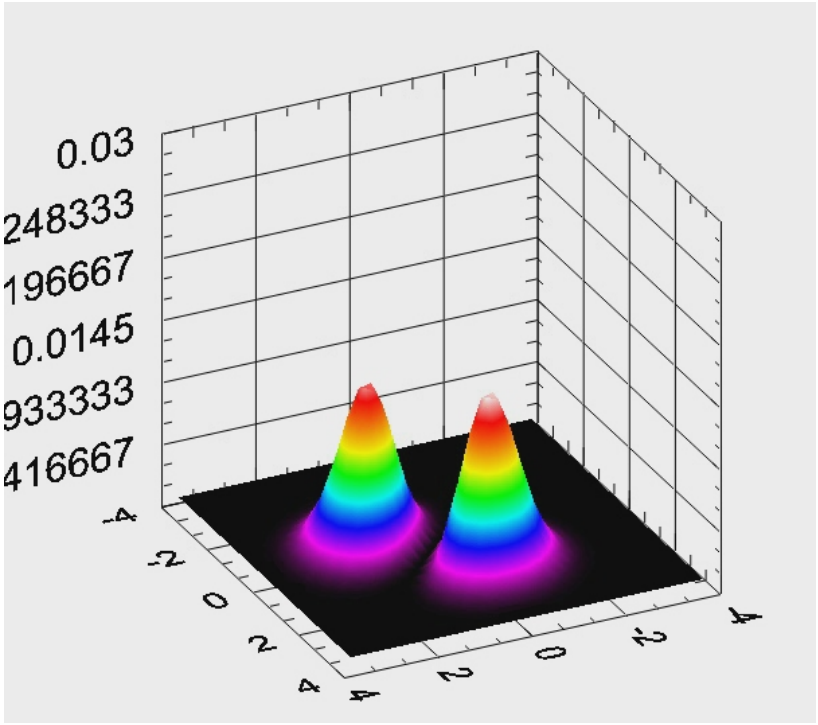




Hydrogen Atom in Electric Field



1D 2-Body in Electric Field



$$\Psi^0_{100} = \frac{1}{\sqrt{\pi}} e^{-r}$$

$$\Psi^0_{100} = \frac{1}{\sqrt{\pi}} e^{-r}$$

$$\Psi^{(1)}_{100} = -F\left(r + \frac{r^2}{2}\right) P_1(\cos\theta)\Psi^0_{100}$$

$\Psi^{(2)}_{100} = F^2(b + cP_2)\Psi^0_{100}$ where $b = \frac{1}{24}\left(r^4 + 6r^3 + 18r^2\right)$ and $c = \frac{1}{24}\left(2r^4 + 10r^3 + 15r^2\right)$.

This allows us to calculate the energy through 5th order or up to F^5.

The third order function is given by $\Psi^{(3)}_{100} = F^3\left(dP_1 + eP_3\right)\Psi^0_{100}$ where

$d = \frac{1}{480}\left(6r^6 + 64r^5 + 344r^4 + 852r^3 + 1590r^2 + 3180r\right)$ and

$e = \frac{1}{240}\left(2r^6 + 18r^5 + 63r^4 + 8r^3\right)$ and allows the energy to be calculated through 7th order or F^7.

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