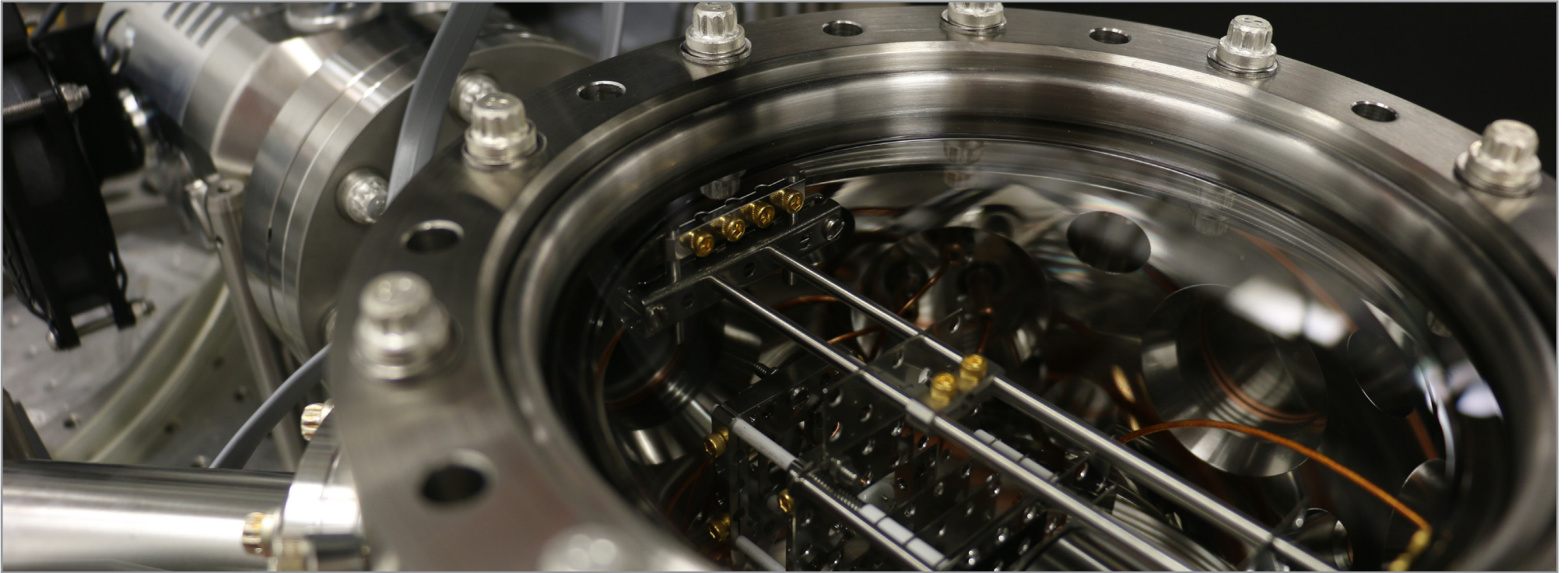


Direct Ion Detection Project Summary



Paul Hockett

femtolab.ca

National Research Council of Canada, Ottawa



femtolab.ca

project overview

- Technology project.
- 2 years @0.3FTE, ~\$20k

Aims

- Colleagues at the University of Oxford (UK) have recently developed a new type of “direct” (on-chip) ion detection.
- In collaboration with them, and starting from their current state-of-the-art prototype detectors [Winter et. al., 2016] we would develop and investigate the use of these detectors for high-sensitivity molecular detection applications.
- This work would be a fusion of new technology with our expertise of the fundamentals of molecular detection and instrument design.



Further project progress details at <http://femtolab.ca?cat=90>

femtolab.ca

- This is an enabling technology for high-pressure (hence portable), rugged and low-cost instruments, and the work so far is a “*stepping stone on the path towards a generic silicon-based ion detector which would remove the need for high voltages and high-vacuum and at the same time greatly reduce detector cost relative to MCP-based detectors.*” [Winter et. al., ibid].
- Early work would be low TRL, make use of existing prototype chips, and involve collaboration with the University of Oxford (UK) and the international PImMS consortium (<http://pimms.chem.ox.ac.uk>).
- This project builds new collaborations with other research institutions. If successful it paves the way for portable, low-cost and high-efficiency ToF mass spectrometers for use in a range of in-situ detection scenarios, e.g. military, industrial, commercial, environmental...



ion detection technology

(1) Gain

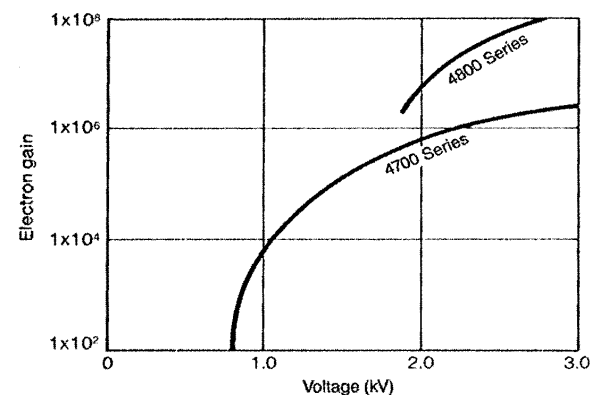
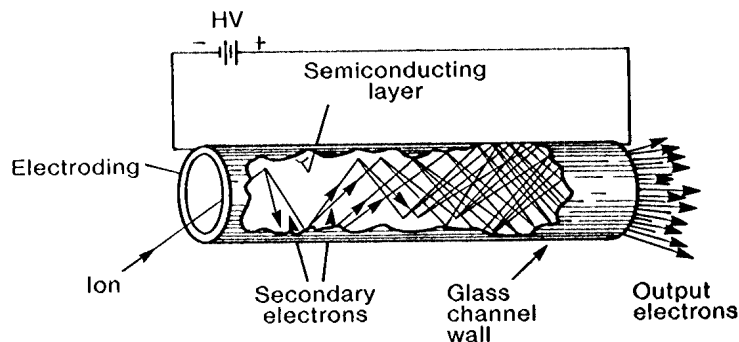
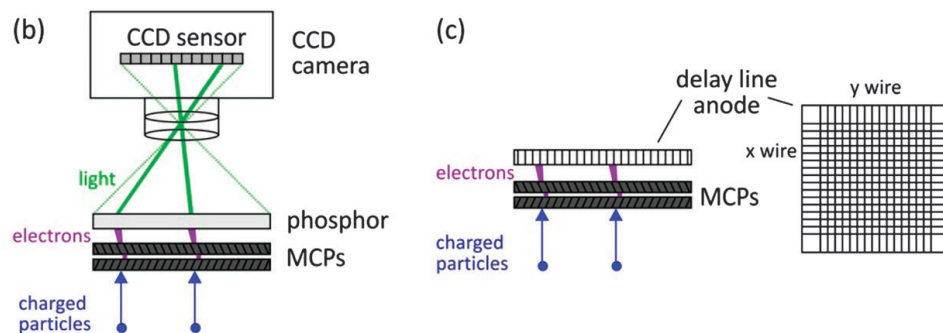


Figure 2-6 Typical Gain Characteristic (4700 and 4800 Series)

Channeltron Handbook (Burle)

(2) Detection



PCCP

PERSPECTIVE

Fast sensors for time-of-flight imaging applications

Cite this: *Phys. Chem. Chem. Phys.*, 2014, 16, 383

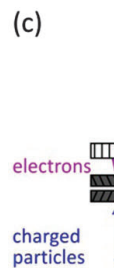
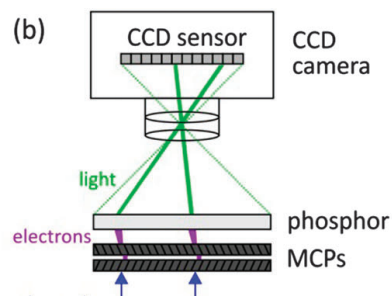
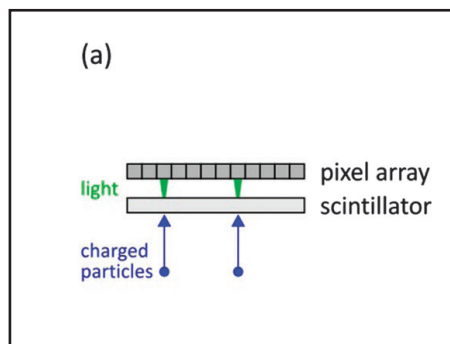
Claire Vallance,^a Mark Brouard,^b Alexandra Lauer,^a Craig S. Slater,^a Edward Halford,^a Benjamin Winter,^a Simon J. King,^a Jason W. L. Lee,^a Daniel E. Pooley,^c Iain Sedgwick,^c Renato Turchetta,^c Andrei Nomerotski,^d Jaya John John^e and Laura Hill^e

ROYAL SOCIETY OF CHEMISTRY

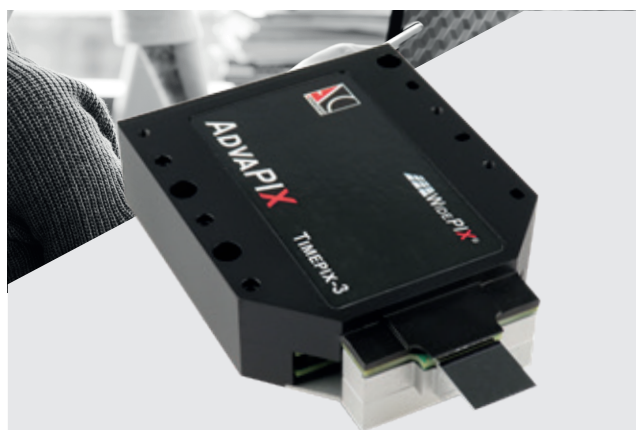
View Article Online
View Journal | View Issue

ion detection technology

Scintillator & sensitive single or array optical detector...?



Advacam
AdvaPix3
(with CERN's
Timepix chip)



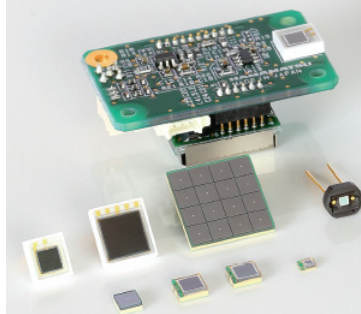
Main Features

• Readout chip type	Timepix3
• Spatial resolution	256 x 256 pixels, 55 μm pitch
• Time resolution	1.6 ns
• Interface	USB 3.0 (Super-Speed)
• Power	External or via second USB 3.0
• Max. readout speed	40 million pixels / s
• Dimensions	125 x 79 x 25.5 mm
• Weight	503g

MPPC[®] and MPPC[®] module for precision measurement

Low-noise MPPC for precision measurement

MPPCs and MPPC modules for precision measurement inherit the high photon detection efficiency of their predecessors and at the same time provide lower crosstalk, lower afterpulse, and lower dark count.

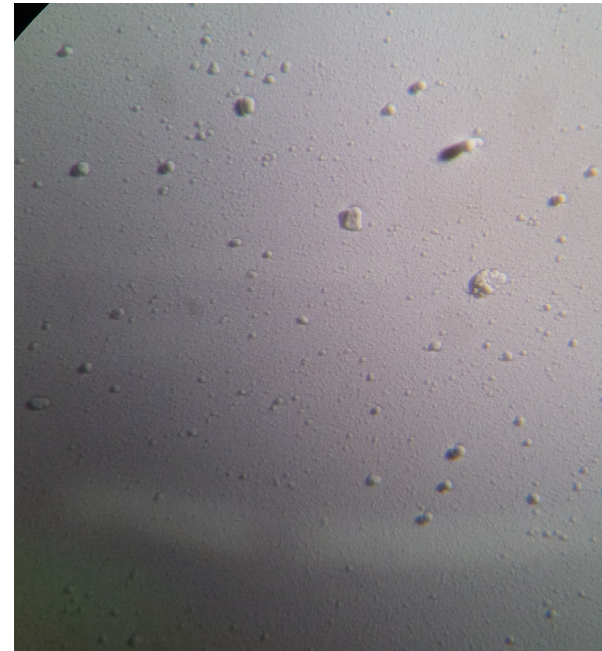
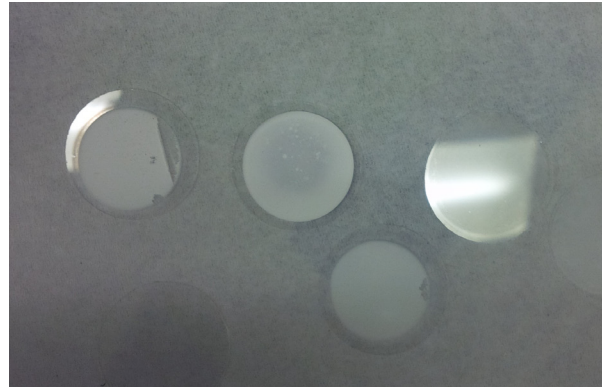


Hamamatsu multi-pixel photon counter (MPPC)



scintillator preparation

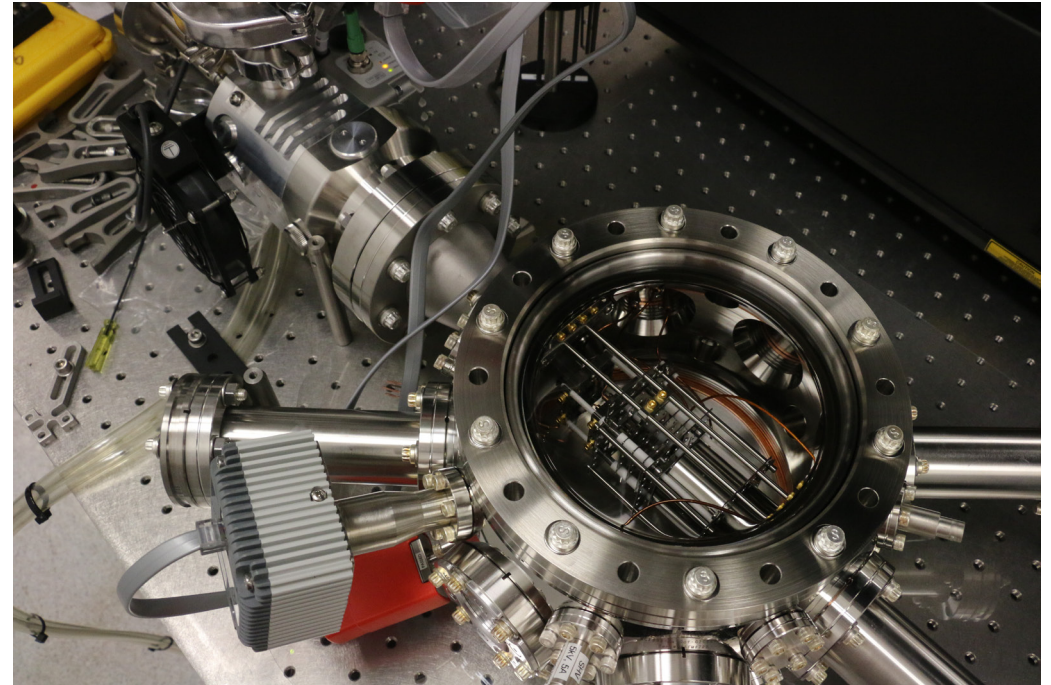
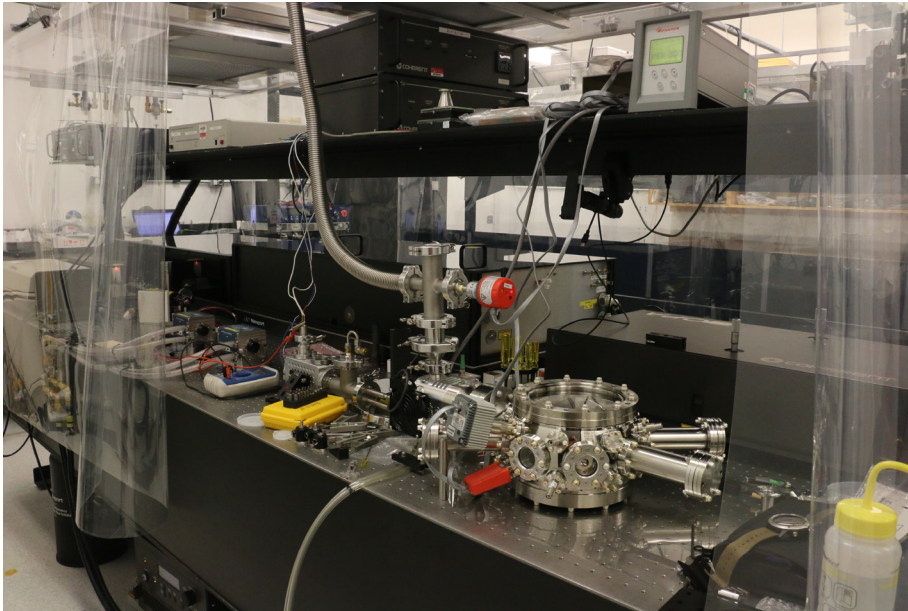
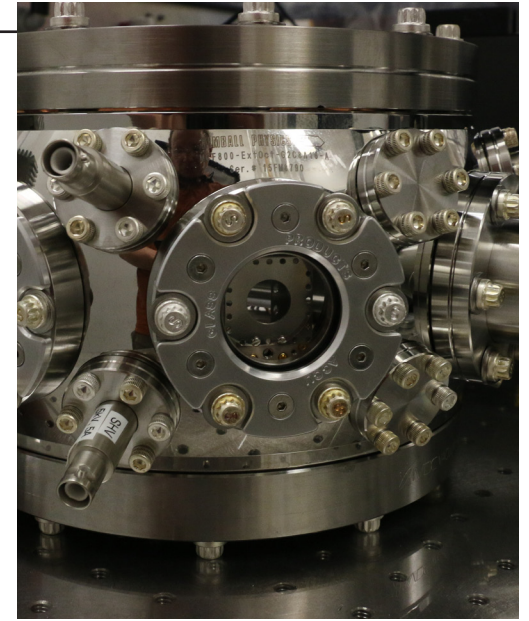
Scintillator screens by vacuum deposition of laser dye.



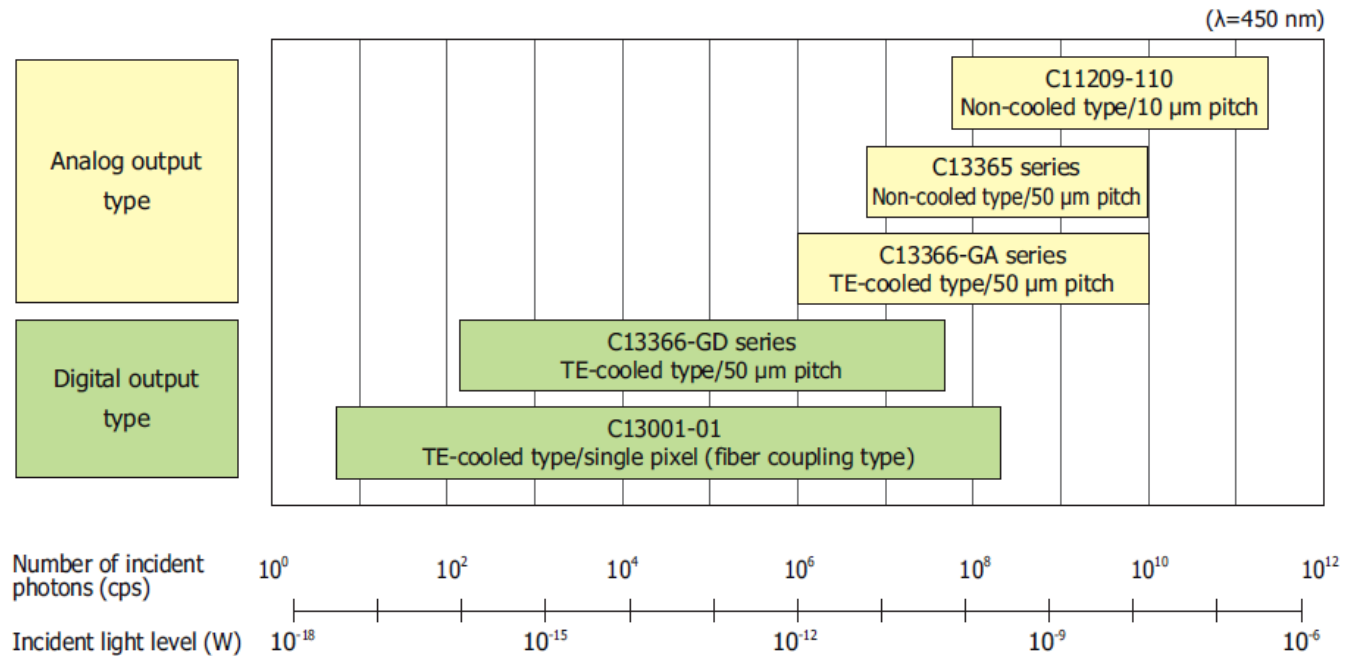
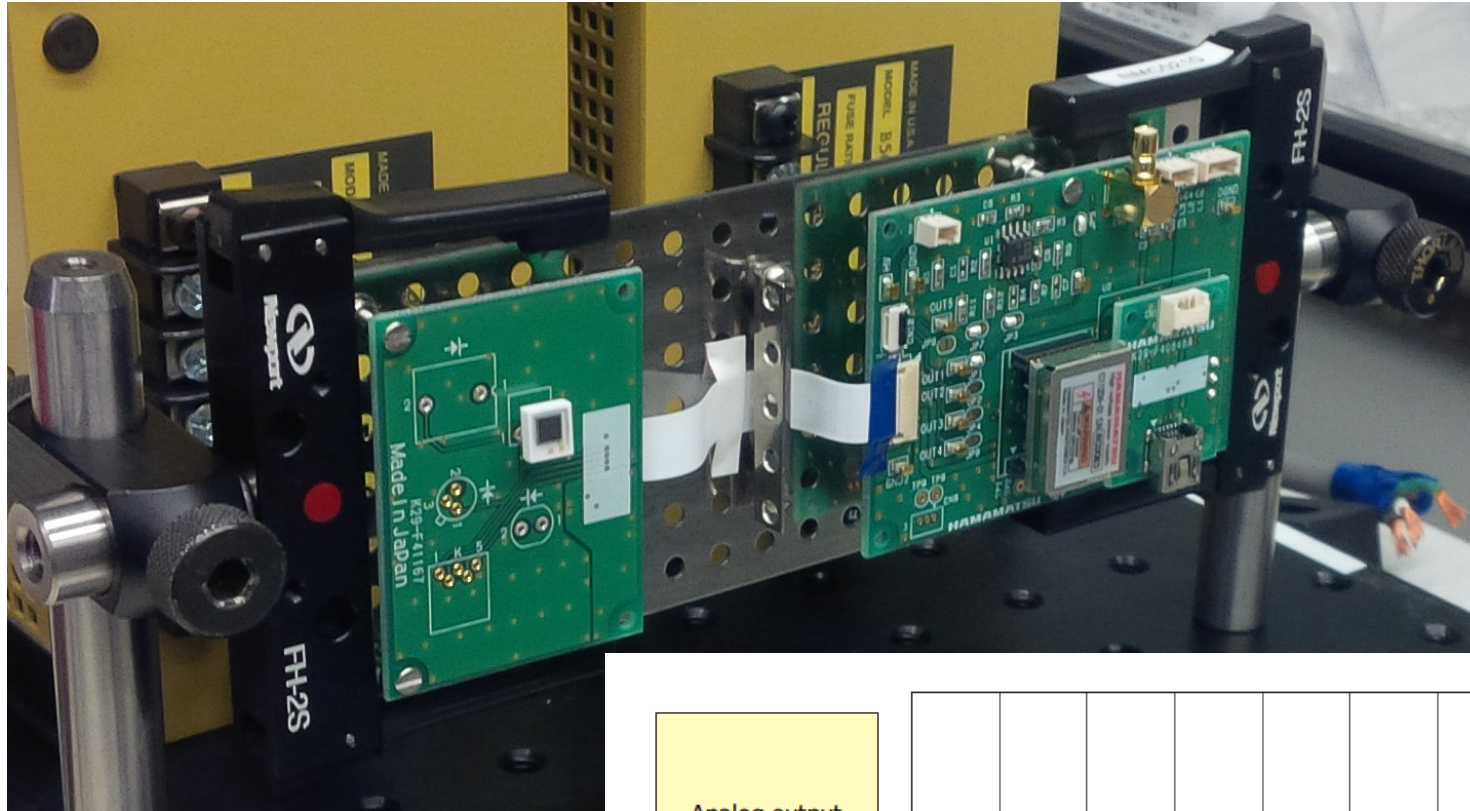
VIRP test chamber

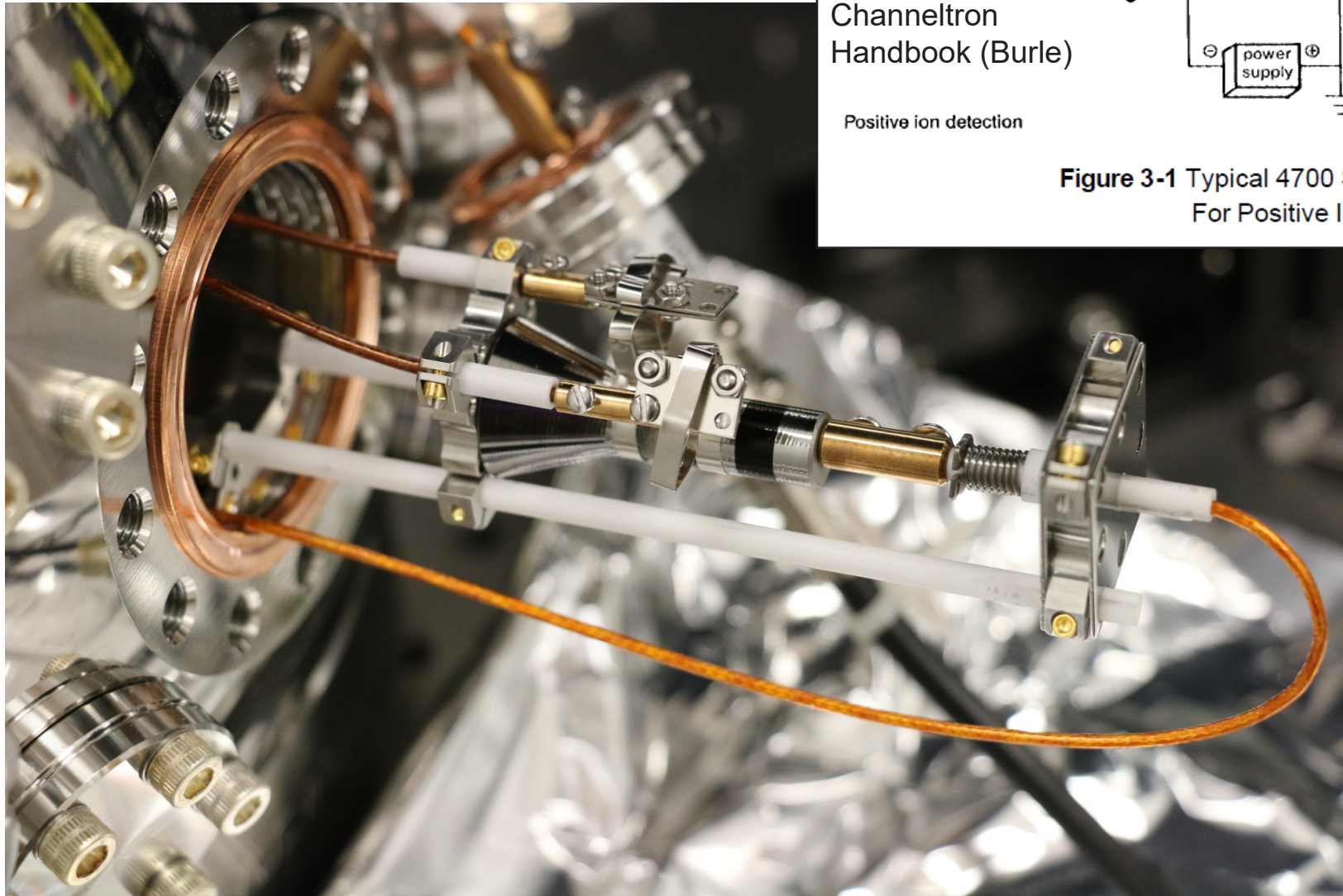
VIRP chamber

- Vacuum Instrument Rapid Prototyping chamber
- Small & efficient
- Test configurations can be constructed and tested on few-hour timescales
- Testing for spectrometer stacks, detectors, new materials... &c &c...



MPPC test board





Channeltron
Handbook (Burle)

Positive ion detection

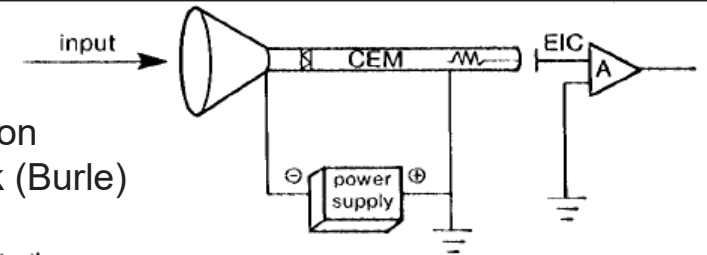
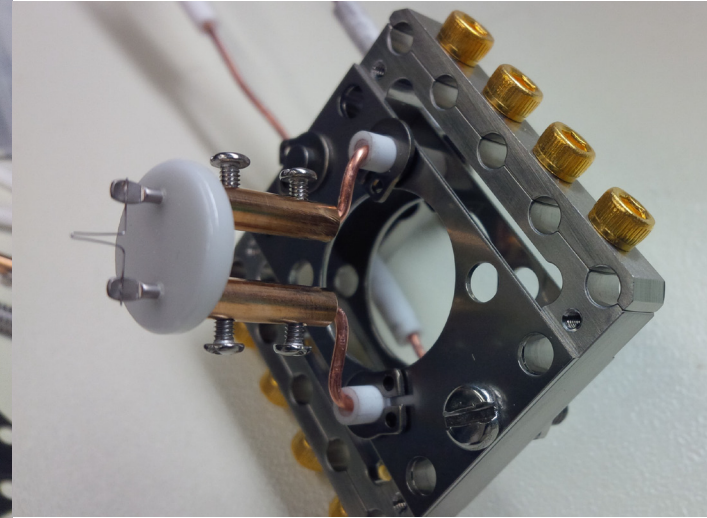
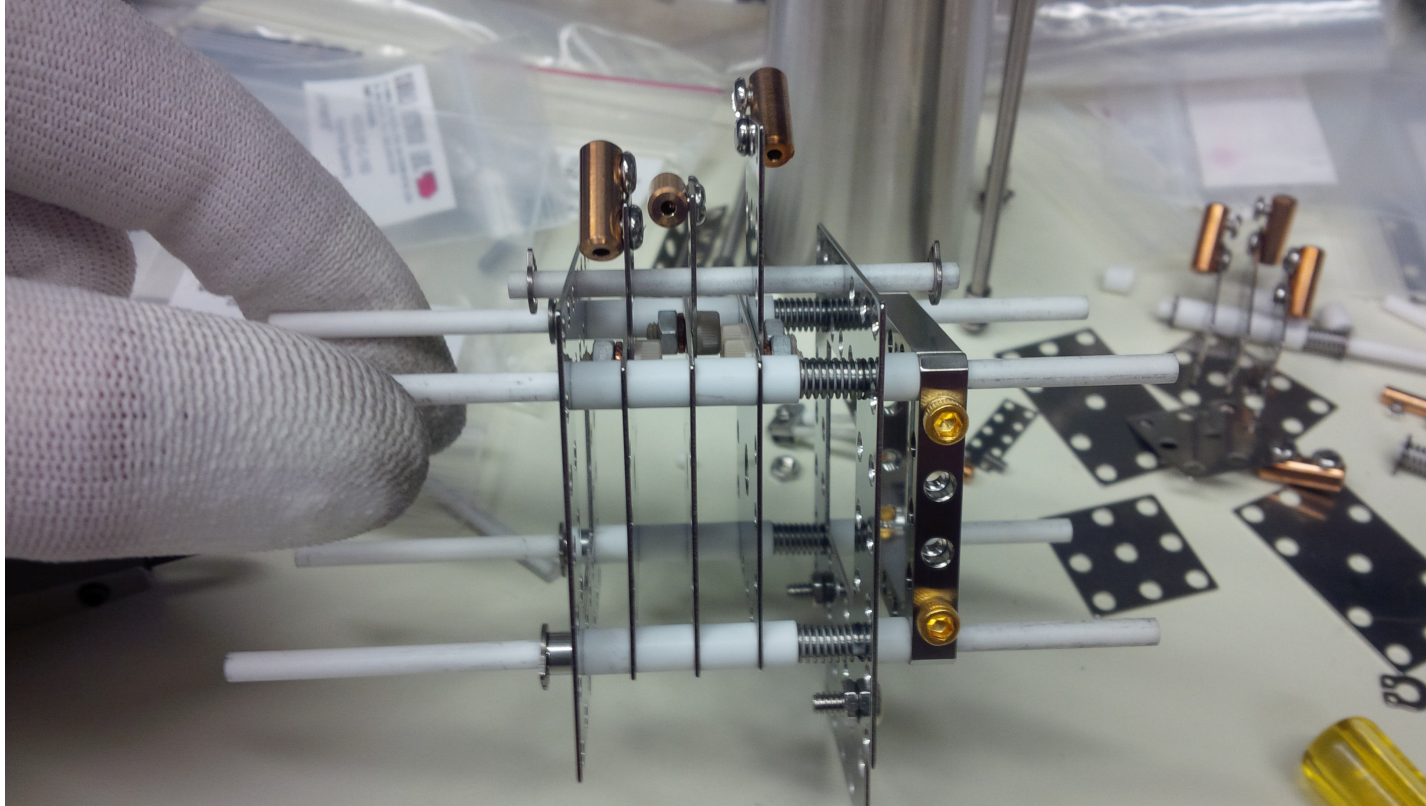


Figure 3-1 Typical 4700 Series Connection
For Positive Ion Detection



Mini e-beam

Time-of-flight Spectrometer stack

- Space-focussing Wiley-MacLaren spectrometer
- Minaturized design
- Rugged
- Optimised for low-energy particles

Successes

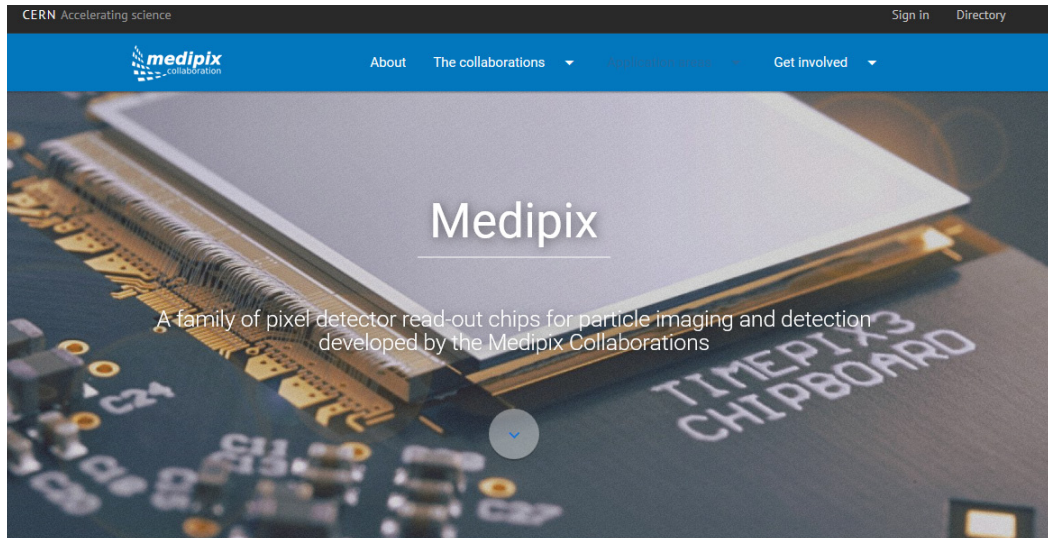
- Entry into new technologies
- Scintillator preparation
- VIRP chamber
- Hardware interfacing, software development
- Prototype operation demonstrated
- PImMS camera also trialled (see later)
- Future directions clear...

Issues & problems

- Tech development requires a lot of person hours
- Full characterisation very time-consuming
- Emerging on-chip detectors from large collaborations (PImMS, CERN) now becoming available...

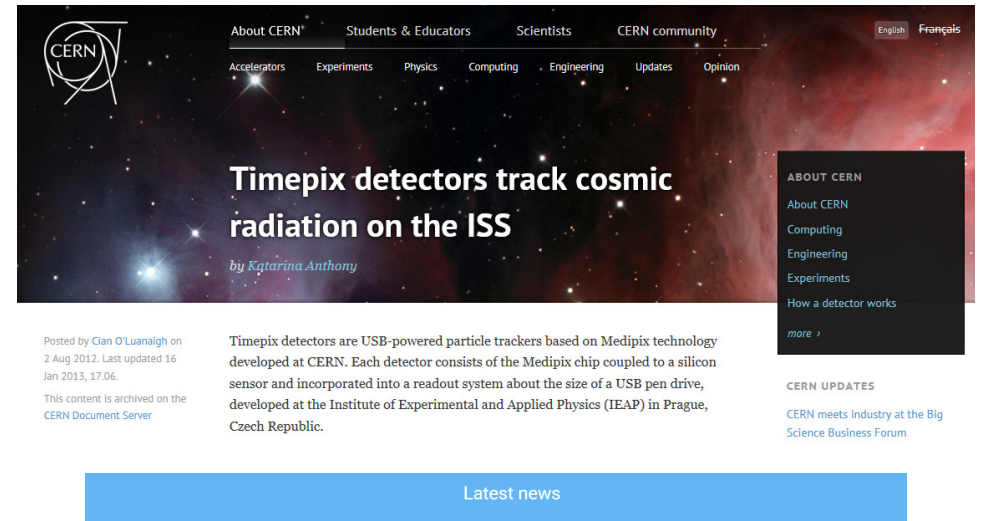


Large collaborations now have chips commercially available, including “direct” and optical versions. In particular, CERN’s Timepix chip...



Medipix is a family of read-out chips for particle imaging and detection developed by the Medipix Collaborations. The original concept of Medipix is that it works like a camera, detecting and counting each individual particle hitting the pixels when its electronic shutter is open. This enables high-resolution, high-contrast, noise hit free images – making it unique for imaging applications.

Hybrid pixel detector technology was initially developed to address the needs of particle tracking at the CERN LHC. The Medipix1 chip, which uses identical front-end circuitry to the Omega3 particle tracking chip, demonstrated the great potential for the technology outside of high-energy physics. To further develop this novel technology and take it into new scientific fields the Medipix2 Collaboration was started in 1999, the Medipix3 collaboration in 2005 and finally the Medipix4 collaboration in 2016.



Posted by Cian O'Luanigh on 2 Aug 2012. Last updated 16 Jan 2013, 17:06.
This content is archived on the CERN Document Server

Timepix detectors are USB-powered particle trackers based on Medipix technology developed at CERN. Each detector consists of the Medipix chip coupled to a silicon sensor and incorporated into a readout system about the size of a USB pen drive, developed at the Institute of Experimental and Applied Physics (IEAP) in Prague, Czech Republic.

ABOUT CERN
About CERN
Computing
Engineering
Experiments
How a detector works
[more >](#)

CERN UPDATES
CERN meets industry at the Big Science Business Forum

Latest news



Timepix3 licence

Published on 25 January 2018

Amsterdam Scientific Instruments (ASI) has acquired a license from CERN for the TIMEPIX3 technology, a core component for ASI's next generation hybrid pixel cameras. With the newly obtained license the company can now deliver the systems commercially.

ASI is a spin-off from Nikhef, the Dutch institute of Particle Physics. Since its foundation in 2005, ASI is a licensee of MEDIPIX technologies and has been collaborating with Nikhef in the development and commercialization of hybrid pixel cameras based on MEDIPIX technology. TIMEPIX3 is the most recent result of a joint research. [Read more](#)

Timepix3



Timepix3 licence

Published on 27 October 2017

CERN as an authorized licensor of Medipix3 collaboration and ADVACAM s.r.o. have signed a Timepix3 license agreement. Timepix3 chip (TPX3) [Read more](#)

Timepix3



The 2017 High Energy Physics Prize awarded to Erik H.M. Heijne, Robert Klanner and Gerhard Lutz

Published on 05 July 2017

The 2017 High Energy Physics Prize was awarded to Erik H.M. Heijne, Robert Klanner and Gerhard Lutz for their pioneering contributions to the development of microstrip detectors that revolutionized high-energy physics.



... and the PImMS camera from the team at Oxford.
We already gained some experience with PImMS as part of the project.

AIP The Journal of Chemical Physics

HOME BROWSE INFO FOR AUTHORS COLLECTIONS SIGN UP FOR ALERTS

Home > The Journal of Chemical Physics > Volume 147, Issue 1 > 10.1063/1.4978923

Published Online: April 2017 Accepted: March 2017

Time-resolved multi-mass ion imaging: Femtosecond UV-VUV pump-probe spectroscopy with the PImMS camera

The Journal of Chemical Physics **147**, 013911 (2017); <https://doi.org/10.1063/1.4978923>

Ruaridh Forbes^{1,2}, Varun Makhija², Kévin Veyrinas², Albert Stolow^{2,3,4}, Jason W. L. Lee⁵, Michael Burt⁵, Mark Brouard⁵, Claire Vallance⁵, Iain Wilkinson^{4,6}, Rune Lausten⁴, and Paul Hockett⁴

AIP Publishing JCP press release!

About Publications Librarians Authors Publishing Partners Advertisers Careers Contact Us

The Inner Lives of Molecules

SHARE THIS      

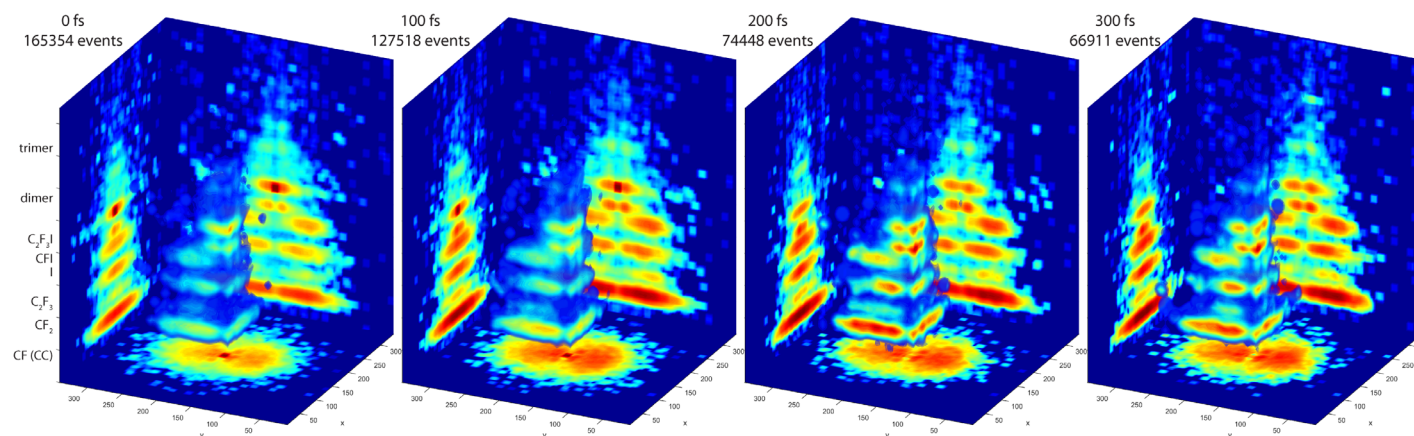
New method takes 3-D images of molecules in action

From the journal: *The Journal of Chemical Physics*

By AIP News Staff

WASHINGTON, D.C., April 4, 2017 -- Quantum mechanics rules. It dictates how particles and forces interact, and thus how atoms and molecules work -- for example, what happens when a molecule goes from a higher-energy state to a lower-energy one. But beyond the simplest molecules, the details become very complex.

"Quantum mechanics describes how all this stuff works," said Paul Hockett of the National Research Council of Canada. "But as soon as you



So...

- Current Direct Ion project to wrap-up this year.
- Ideas, expertise and equipment to roll back into our foundational work (investment so far is not shelved!).
- Bridge-building with Oxford (PIImMS) and CERN (Timepix)...

...new work, with the new chips, to begin FY2019 or FY2020.

