ICAN Project News

Design studies for a high average power, high pulse energy laser based on optical fibre technology

ICAN - one year on

After one year, the ICAN project held its second conference in Southampton, on January 21st & 22nd, 2103. The year has seen significant development of the concept of high average power, high pulse energies based on coherent combination of multiple optical fibres. Also, the potential applications of ICAN have expanded, with the possibility of using high average power lasers in nuclear physics, with long-term applications in the reduction of nuclear waste and clean power generation.

Workshops in Jena and Paris

ICAN will run 10 workshops over the course of the project. Over the summer, workshops were held in Jena, at Friedrich-Schiller University, and in Paris, at École Polytechnique, two of the founding institutions of the project. The intention of these workshops has been to build a community in the topic area, and to develop design studies for a potential demonstrator of ICAN technology, to be constructed over the next 5 years.

ICAN/IZEST workshop, Glasgow

In November, the ICAN members contributed to a workshop run by the IZEST project. IZEST is a large consortium looking at laser particle acceleration using some of the world's largest conventional laser source for laser wake field acceleration experiments toward 100 GeV. Highlights of the meeting included a talk by Professor Peter Higgs. The ICAN/IZEST session looked at applications of IZEST's ultrahigh intensity lasers in nuclear medicine, proton therapy, nuclear waste control, detection and transmutation.

ICAN 2nd conference - Southampton, Jan. 2013

January 21st/22nd saw two events at Southampton - workshop WS7, and the second ICAN conference. The workshop & conference were focused on design studies for an ICAN laser suitable for driving a single accelerator stage, using as a target the laser specifications of the ICFA-ICUIL joint task force from 2010 - around 30 J, at a 15 kHz repetition rate. Three different design studies were discussed. Direct combination of many relatively low power fibre lasers was outlined, where the use of production components in the fibre lasers made the fabrication of several thousand fibre lasers at the 10 W, , sub-mJ pulse energy level. A filled aperture techniques, already demonstrated for 64 low-power lasers, & developed by THALES and ONERA was put forward as a beam combination method, and its limitations were discussed. Representatives from industrial operations such as SPI, Amplitude Technologies, and BAe discussed manufacturability of such a large scale system, and how component costs could be reduced.

The second design study presented used a different approach - much higher average power fibre lasers of a more specialized design, but in much lower

ICAN TIMETABLE

Upcoming events:

APRIL 18/19th 2013
WORKSHOP WS9, WS10
University of Jena

JUNE 27th-28th, 2013
FINAL CONFERENCE CS3
CERN, Geneva

Previous events:

FEBRUARY 2012
KICKOFF CONFERENCE CS1
CERN, February 21-22, 2012

APRIL 2012
WORKSHOP WS1,WS2
Southampton, April 16th-17th

JUNE 2012
WORKSHOP WS3, WS8
University of Jena, June 18th-19th

OCTOBER 2012
WORKSHOP WS4,WS5
Ecole Polytechnique, Paris, October 11/12th

NOVEMBER 2012
WORKSHOP WS6
IZEST meeting, Glasgow, November 15th

JANUARY 2013
WORKSHOP WS7 & CONFERENCE CS2
Southampton, UK, January 21/22

numbers. Here the pulse energy was increased by a combination of spatial and temporal stacking, with temporal stacking performed using either divided pulse amplification, or using enhancement cavities - referred to as "stack'n'dump" techniques. These techniques play to the strengths of fibre lasers in that they increase the final pulse energy by

increasing the average power of the fibre lasers.

A third scheme of pulse combination was outlined by Prof. Galvanauskas of University of Michigan. This scheme also used time stacking, but in this case via an elegant pulse synthesis technique using frequency shifting. This radical technique is less developed than the two more mainstream ideas, but continues to be developed at a small scale.

Collaboration with Max-Plank-Institut für Quantenoptik.

One highlight of the development of the ICAN concept has been the close links developed between FSU Jena, one of the world's top fibre labs, and MPQ Garching, whose expertise in the use of very high finesse cavities has led to one of the composite designs for an ICAN laser. The use of cavities can allow many fewer fibre lasers to create high pulse energies. MPQ Garching is one of the world's top labs in high-precision spectroscopy, quantum information, and attoscond science.

ADS - societal applications of ICAN

The ability to produce very high energy laser pulse at high average powers may take ICAN into a new area of great importance. The recent proposal by Prof Tajima of laser acceleration of ions to relativistic velocities makes possible the use of a laser-based proton accelerator as a neutron source, via the process of spallation. At present large conventional accelerators power spallation neutron sources, and laser-based acceleration could reduce the scale and increase the efficiency of these devices significantly. Spallation neutron sources are useful in scientific and medical applications, but may also be used in Accelerator-Driven Reactors (ADR). In an ADR, the nuclear reaction is kept going by the addition of neutrons from the spallation source rather than by a chain reaction, making them inherently very much safer than traditional reactors. This safety factor allows them to be used to 'burn' the minor actinides produced in conventional reactors, which represent the most toxic and longest-lived components of nuclear waste. Half-life reductions from hundreds of thousands of years to tens of years are possible, making nuclear waste problems much more tractable for engineering solutions. A single ADR system could burn waste from about 7 conventional power plants, transforming the energy production landscape worldwide.

Nature Photonics

A review of the ICAN concept will appear in April 2013's edition of Nature Photonics.

Final conference - CERN, June 27/28th, 2013

The ICAN project finishes in July 2013, and its final event will be a conference at CERN, during which the design concepts for ICAN will be reviewed, applications will be discussed, and progress toward funding for a hardware demonstrator of the ICAN concept will be reviewed.

ICAN main partners:
École Polytechnique, Paris
FSU, Jena
University of Southampton
CERN

Industrial participants include:
Southampton Photonics Inc.
Fianium
BAe
Oclaro
Amplitude Systems
THALES R&T
ONERA
Crystal Designs
Horiba
Thales Optronique SA

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Partner labs
CUOS, Univ. of Michigan, USA
LMU / MPQ, Germany
LCFIO, France
ONERA, France
Thales, France
CEA, France
KEK, Japan
Fermi Lab, USA
LULI, France
ILC, Russia
HZDR, Germany
DESY, Germany
University of Strathclyde, UK

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