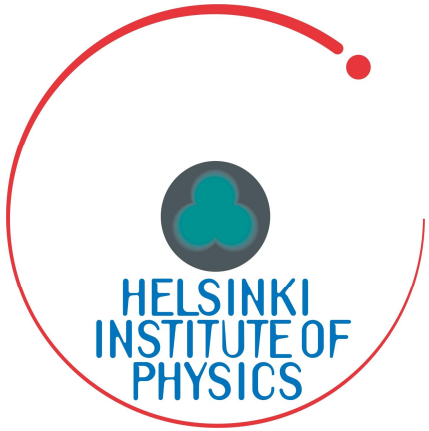
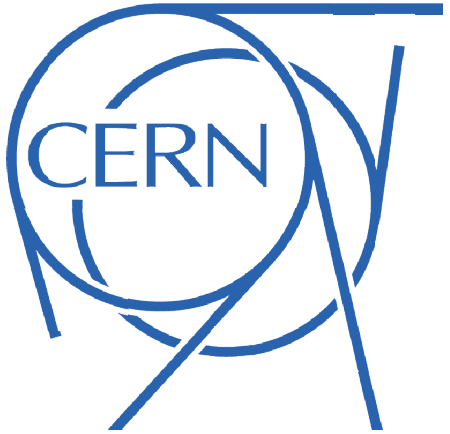
A warm welcome to

IAPP MeChanICs project meeting !!

On behalf of  **&** 

Project meeting agenda

09:00 am Introduction and MeChanICs overview	K. Österberg
09:15 am News from CLIC	H. Schmickler
09:30 am News on CLIC RF structure prod. & test.	G. Riddone
09:50 am RF structure design (WP1 report)	P. Piirainen
10:05 am Coffee	
10:30 am Material test program (WP2 report)	J. Nurminen
10:45 am Modelling of disc machining (WP3 spec. rep.)	J. Turunen
11:00 am Status of validation disc (WP3 report)	T. Niinikoski
11:10 am Brazing (WP4 report)	J. Kallaperä
11:20 am Assembly of CLIC RF structures (WP5 report)	F. Rossi

12:30 am Lunch at Restaurant 2

Management Team

- **Project Coordinator:** Kenneth Österberg, HIP, kenneth.osterberg@helsinki.fi

- **Administrative Manager:** Jukka Väinölä, HIP, jukka.vainola@cern.ch

- **Scientific Coordinator:** Germana Riddone, CERN, germana.riddone@cern.ch

- **Technical Consultant:** Tapio Niinikoski, CERN, tapio.niinikoski@cern.ch

The 7 Partners

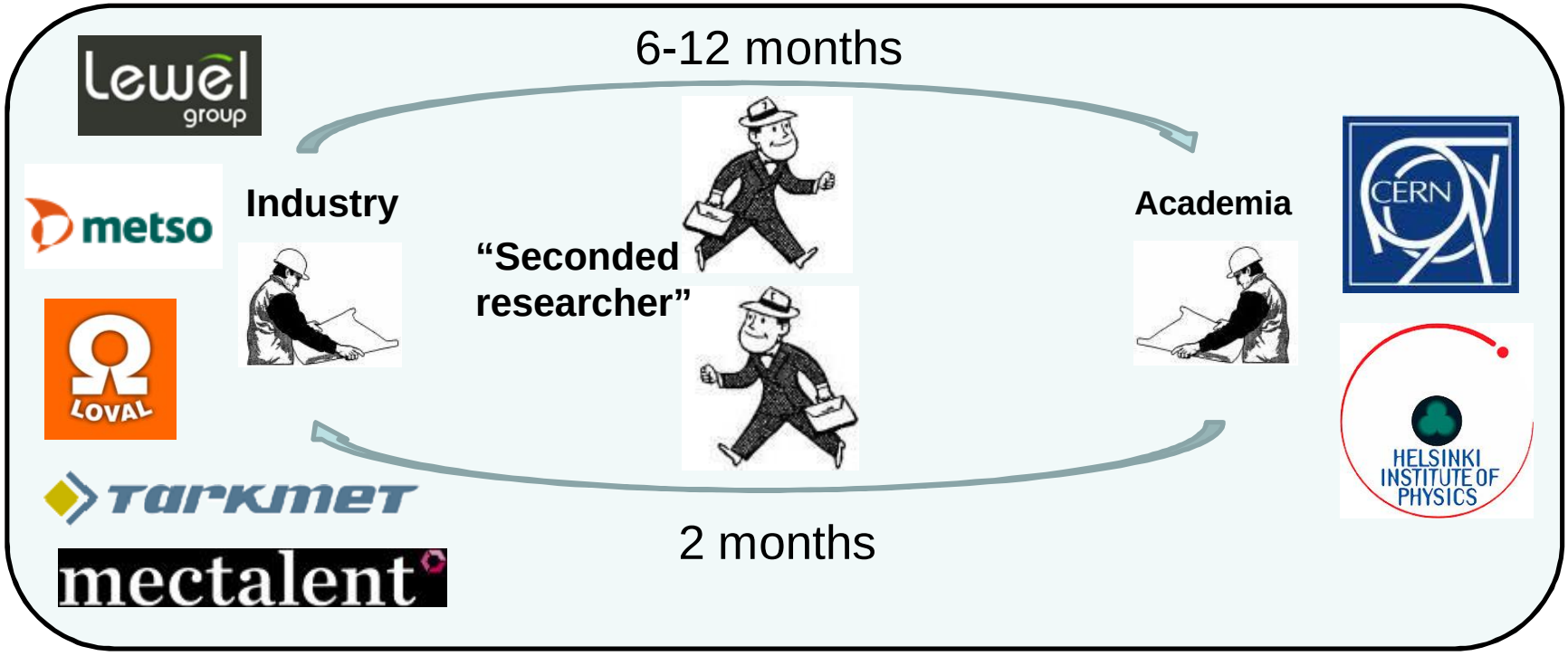
- Coordinator: **Helsinki Institute of Physics** (HIP), University of Helsinki (UH), Helsinki, Finland
- **CERN** European Organization for Nuclear Research
- **Tarkmet** Oy, Vaasa, Finland
- **Mectalent** Oy, Oulu, Finland
- **Loval** Oy, Loviisa, Finland
- **Lewel Group Finland** Oy, Oulu, Finland
- **Metso Materials Technology**, Tampere, Finland

MeChanICs

- **FP7/People/IAPP** (Industry-Academia Partnerships and Pathways) project **MeChanICs**, “Marie Curie linking Industry to CERN”
- start September 1st 2010, 4 year project
- budget: ~ 1 M€
- to enhance knowledge exchange between Partners on precision manufacturing by two-way intersectoral **secondments** and dissemination workshops

MeChanICs

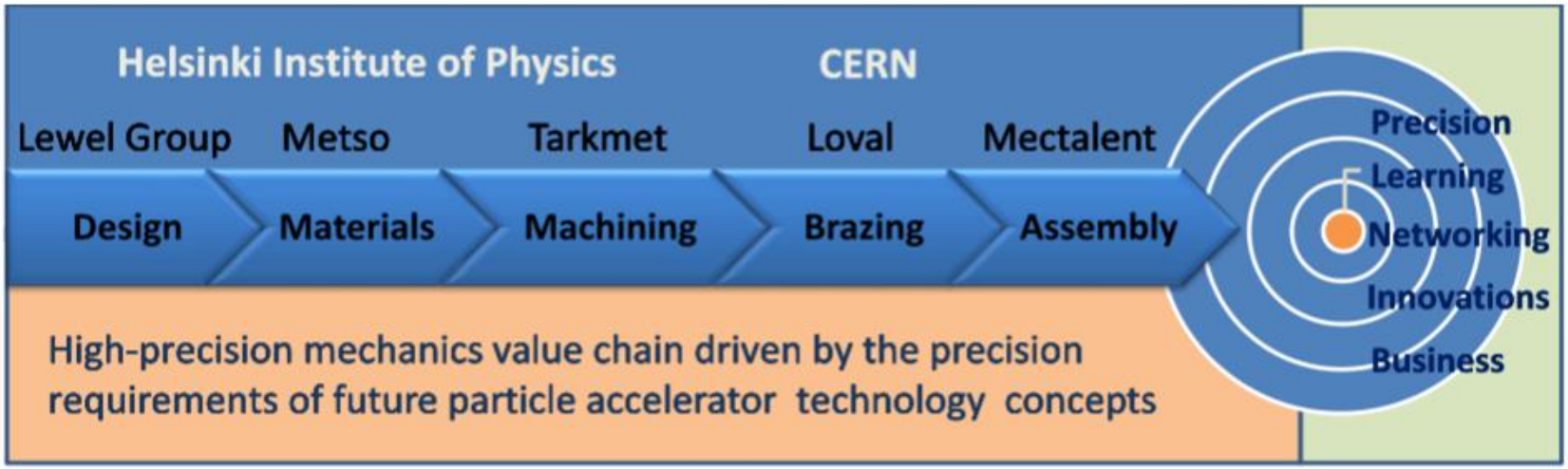
Enhance knowledge exchange by two-way intersectoral
industry-academia researcher secondments
(secondment period 2–12 months)



100 % coverage by EU funds

MeChanICs

- objective: enable & enhance long term industry participation in **CLIC**, Compact LInear Collider, **RF structure R&D**
- participation in each step of RF structure manufacturing

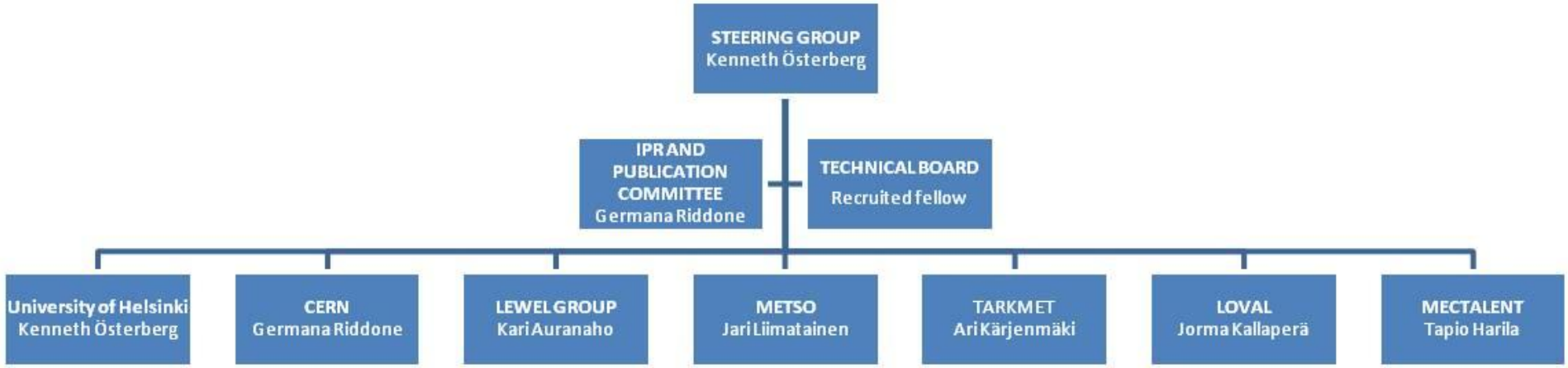


Work Packages

WP no.	Work package title	Lead beneficiary	Start month	End month
WP 1	**Design**	Lewel Group	M2	M25
WP 2	**Materials**	Metso	M14	M21
WP 3	**Machining**	Tarkmet	M8	M22
WP 4	**Brazing**	Loval Oy	M25	M38
WP 5	**Assembly**	Mectalent	M34	M48
WP 6	**Project coordination**	UH	M1	M48

WP6: coordination

- Objective: effective project management & co-ordination, proper execution of exchange of people, effective & timely exploitation, transfer and dissemination of knowledge
- Lead beneficiary: University of Helsinki/Helsinki Institute of Physics, WP coordinator: Kenneth Österberg



+ all interactions with EC (REA) !!

WP6 news

- Kickoff meeting & 1st Steering group meeting Sep 2010 ✓
- Launched procedure to replace Veslatec by Tarkmet Oct 2010: Tarkmet validated Feb 2011, changed DoW (Annex I) approved May 2011, amendment request Jun 2011, EC approval Sep 2011 **?**
- 1st secondment: Pauli Piirainen, Lewel → CERN Oct. 2010 ✓ mid-term report Apr 2011 ✓ end report Sep 2011
- 1st recruitment launched Nov 2010 → Fabrizio Rossi starting at CERN Apr 2011 ✓
- Project status report Feb 2011 & project meeting Mar 2011 ✓
- Dissemination: press release Sep 2010, article Mar 2011 ✓
- 2nd recruitment (Technical Coordinator) launched Mar 2011; to be re-launched Sep 2011 **?**
- Project meeting & 2nd Steering group meeting Sep 2011
- 2nd secondment: Markus Aicheler, CERN → Metso Oct 2011

Dissemination

Article in International Innovation March 2011

MECHANICS

Precision instruments

With physicists already seeking to take the development of particle collision instruments to the next level, **Dr Kenneth Österberg** explains how his new project will support this aim through the collaborative exchange of information

Could you begin by describing the aims and objectives of the Marie Curie linking Industry to CERN (MeChaniCs) initative, and the catalyst for this work?

The aim of MeChaniCs is to enable knowledge exchange between research institutes and industry in the field of high precision manufacturing, especially in view of mass manufacturing of high precision components for large science projects. The catalyst for this work is the requirement for next-generation elementary particle colliders made from high precision metal components that are relatively large in size and needed in very large quantities (millions), for example, 2cm thick and about 8cm diameter copper disks for the Compact Linear Collider (CLIC). High precision is already required in optical devices, but typically speaking, the required pieces are relatively small in size, or the number of pieces required is small. The main objective of MeChaniCs is to enhance long-term industry participation in CLIC component research and technology development.

How would you rate the current levels of knowledge exchange in the precision manufacturing industry? Are there any areas that you have identified which require particularly stringent changes?

There is knowledge in industry about how to make pieces at high precision, but a considerable effort and the right equipment and tooling is needed to achieve this in practice. In addition, making similar pieces at high precision in larger quantities seems to be more difficult; the fraction of pieces that are not up to the specifications seems to increase with the number of pieces. Here, industry and research institutes need to work together and find solutions for the mass manufacturing of high precision components, exploiting both conventional and non-conventional methods to reduce both cost and production time. Assembling up to about 30 of these high precision pieces with micrometer precision is currently done manually, but this is not feasible for mass production. Therefore, high precision machining and assembly are the key areas of MeChaniCs, but they need to be supported by appropriate engineering design, metallurgy and brazing R&D to be able to fulfil the goals. This is why these five areas were chosen as work packages.

Can you elaborate on some of the mechanisms you will be employing to increase knowledge exchange? How they will enhance existing research at the Helsinki Institute of Physics and the European Organisation for Nuclear Research (CERN)? How important is collaboration to the overall success of the project?

Secondments of researchers from industry to research institutes and vice-versa will be the main tool to increase knowledge exchange. Putting people with different backgrounds and knowledge to work together is by far the most efficient way to enhance development. People from industry will come with different ideas and approaches to the problem and will thereby enhance the R&D efforts. Similarly, those individuals from research institutes will be able to provide industry with knowledge about the approaches used at their home institutes. In addition, dissemination workshops will be arranged and used to invite other European SMEs to communicate the results of the project. It is clear that collaboration between partners will be key to the success of the project. The participation of SMEs is important since the technologies and equipment required are so special that only very few specialised supplier SMEs are able to make the required pieces, and they have flexibility to adapt more easily to the challenges of developing components.

What does the work of MeChaniCs mean for European competitiveness and employment?

Novel compact accelerator technology like that of CLIC has the potential to be used for many other applications beyond particle physics research: material, biological and medical research with very bright light sources; so-called X-ray free electron lasers; and cancer tumour treatment with particle beams (so-called hadron therapy), to name a few. The whole area of particle accelerators in non-research use has steadily been growing by 10 per cent each year for the last 10-15 years and it is estimated that the sales of accelerator components will represent a market of 50 billion euros over the next 10 years. If CLIC technology, developed together with European industry, could take over a fraction of that market, then that would increase European competitiveness and employment, while providing significant economic return for the companies involved. In addition, the skills of making high precision components in large quantities has applications far beyond large science projects, and can constitute significant future commercial opportunities for the industries developing such manufacturing technology.

Collision course

As humanity continues to pose questions regarding the nature of the Universe, the **MeChaniCs** collaboration has been set up to assist physicists in developing next generation precision instruments to provide the necessary answers

THE LARGE HADRON COLLIDER (LHC) is the world's largest and highest energy particle collider. Built by the European Organisation for Nuclear Research (CERN), it was developed in an attempt to address some of the fundamental questions in physics and thus advance human understanding of the laws of Nature. The first successful collisions at the LHC took place in late 2009, and in early 2010, LHC set a world record for the highest energy man-made particle collisions, at 7 thousand billion electron volts (TeV). By revealing the existence of very heavy and hitherto unobserved particles, it is hoped that the LHC will shed light on several currently outstanding problems in elementary particle physics, such as the Higgs mechanism – that is, the mechanism for generating the mass of elementary particles. However, while the LHC is designed to reveal the existence of these particles, it cannot be used to make high precision studies of the properties of those particles, once their existence has been established. In order to perform precision measurements and thus reveal the exact nature of any potential new physics, an electron-positron collider in the TeV range is needed. Currently, two global collaboration projects are underway to develop technologies for linear colliders: the International Linear Collider (ILC) collaboration, and the Compact Linear Collider (CLIC) study, which seeks to develop a realistic technology, at affordable cost, ready for the post-LHC era (2020 and beyond). It is to assist the latter of these projects that the Helsinki Institute of Physics (HIP) has conceived the Marie Curie linking Industry to CERN (MeChaniCs) collaboration; a four year project that aims to enhance knowledge exchange in the field of high precision.

COST-EFFECTIVE

The MeChaniCs Industry-Academia Partnerships and Pathways (IAPP) platform for precision manufacturing knowledge exchange is a key ingredient in Finland's involvement in the CLIC R&D programme, and gathers five specialised precision manufacturer companies of excellence – one of which is an SME – to enhance their existing research and technology development (RTD) efforts with HIP and CERN. The mechanisms used for the transfer of knowledge within MeChaniCs are two-way, intersectoral secondments and dissemination workshops. MeChaniCs will be established within HIP's existing research cooperation with the CERN-led CLIC technology development, one of the highlighted topics of the European Strategy for Particle Physics. CLIC is likely to represent the forefront of Particle Physics in the post-Large Hadron Collider era, and its development boosts the competitiveness of its suppliers by pushing the used technologies to their limits. However, after proving technical feasibility, one of the major obstacles is to show that complex components can be made at reasonable cost. Close cooperation with industry in the next few years is vital in devising an industrialisation scheme that enables the mass manufacturing of the required components at an affordable price and according to a stringent timeline. The scientific and technological objective of MeChaniCs is to contribute at the early stage of the next phase – the technical design phase of CLIC. Here, the main focus is to show technically how a multi-TeV CLIC can be built at a reasonable cost.

MULTIPLE COMPONENTS

If built, CLIC will require a very large number of parts and components, but as it is still in the development phase, the number of actual orders has been relatively low and most have been for experimental testing and quality assessments. CLIC is continuously searching for new companies that would be interested and capable to participate in the development and manufacturing of the challenging parts. Currently, there are only a few companies in Europe that have the necessary resources and capabilities to machine the high precision parts. The range of components that are required poses notable challenges concerning affordability and timescales, not least because of the infeasibility of producing them all in-house at research institutes. Owing to their complexity, the design programmes still take years to complete and require unprecedented levels of collaboration between CLIC and leading stakeholders in the European precision manufacturing industry. It is here that MeChaniCs steps into the breach, ensuring effective and sustainable future cooperation in the building of the collider components.

> MeChaniCs will support ongoing international RTD projects in machining and precision assembly, but will also widen the precision manufacturing value chain

MECHANICS

MARIE CURIE LINKING INDUSTRY TO CERN

OBJECTIVES

The main objective of MeChaniCs is to enable and enhance long-term participation of industry in the R&D of Compact Linear Collider (CLIC) technology, a next-generation particle accelerator concept. The project focuses particularly on ultra-precision mechanics and technology required for the CLIC radio frequency accelerating structures.

PARTNERS

European Organization for Nuclear Research (CERN)

Tarkmet Oy
Mectalent Oy
Loval Oy
Lewel Group Finland Oy
VTT
Metso Materials Technology
Bgator Ltd, Finland

FUNDING

EU Seventh Framework Programme (FP7)

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DR KENNETH ÖSTERBERG is a Lecturer and Docent in Experimental Particle Physics at the Department of Physics, University of Helsinki. His research is connected to the inner structure of the proton and to R&D of novel accelerator technologies like the Compact Linear Collider (CLIC) concept. He coordinates the Finnish involvement in CLIC R&D.

AFFORDABLE ASSEMBLY

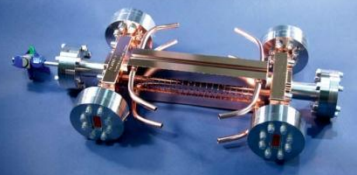
In order to deliver high-end products, companies must also be prepared to provide accurate and reproducible assemblies for CLIC. At present, assemblies are made manually at CERN and brazed or bonded at the final assembly. As this work has been very focused and streamlined only to obtain the required precision, new ideas and experiences from different areas of technology are likely to increase efficiency and decrease the cost of current processes. MeChaniCs will support the ongoing international RTD projects in machining and precision assembly, but will also widen the precision manufacturing value chain by enabling information exchange on manufacturing technologies in design, materials and brazing. Engineering design work in CLIC has always been done in close cooperation between beam dynamics physicists, RF-designers, mechanical designers and manufacturing specialists. MeChaniCs will further assist the process by creating the necessary contact network to determine the boundary conditions that limit the design and elucidate the special fields of science which influence the work.

A STRONG BEGINNING

It is hoped that MeChaniCs will promote the development of the European Research Area through researcher mobility and training. Secondments enable the transfer of personnel between industrial partners and CERN, thereby strengthening European R&D in the field of high precision machining and assembly. Furthermore, the RTD of the CLIC accelerator technology is one of the items of the European Strategy for Particle Physics, as defined by the CERN Council.

Though the project only began in September 2010, Dr Germana Riddone, the CERN link person to the project, acknowledges its initial achievements: "We have successfully completed a new compact design of a key CLIC accelerator component – an accelerating structure prototype that now includes all necessary technical systems for operation with particle beams in the CLIC test facility at CERN. From here, the next step will be to validate the design and then begin producing the parts for a prototype in European industry". From a European industry perspective, CLIC represents major technological challenges, possibilities for long-term RTD collaboration, as well as significant future commercial opportunities, especially as CLIC technologies already show potential beyond particle physics applications.

The setup of MeChaniCs has so far proved a valuable tool for the CLIC study, and is representative of the direction in which RTD is moving, as Österberg elaborates: "New particle accelerator technology very often relies on cutting-edge technologies in materials, machining, electronics etc., so there will be an increasing need for industry participation in R&D activities related to components for new accelerator technologies".



A PROTOTYPE OF A KEY COMPONENT FOR CLIC: AN ACCELERATING STRUCTURE THAT REQUIRES MICROMETRE PRECISION MANUFACTURING (COURTESY SLAC).