



MAS

(Micro Accelerator Structure center)

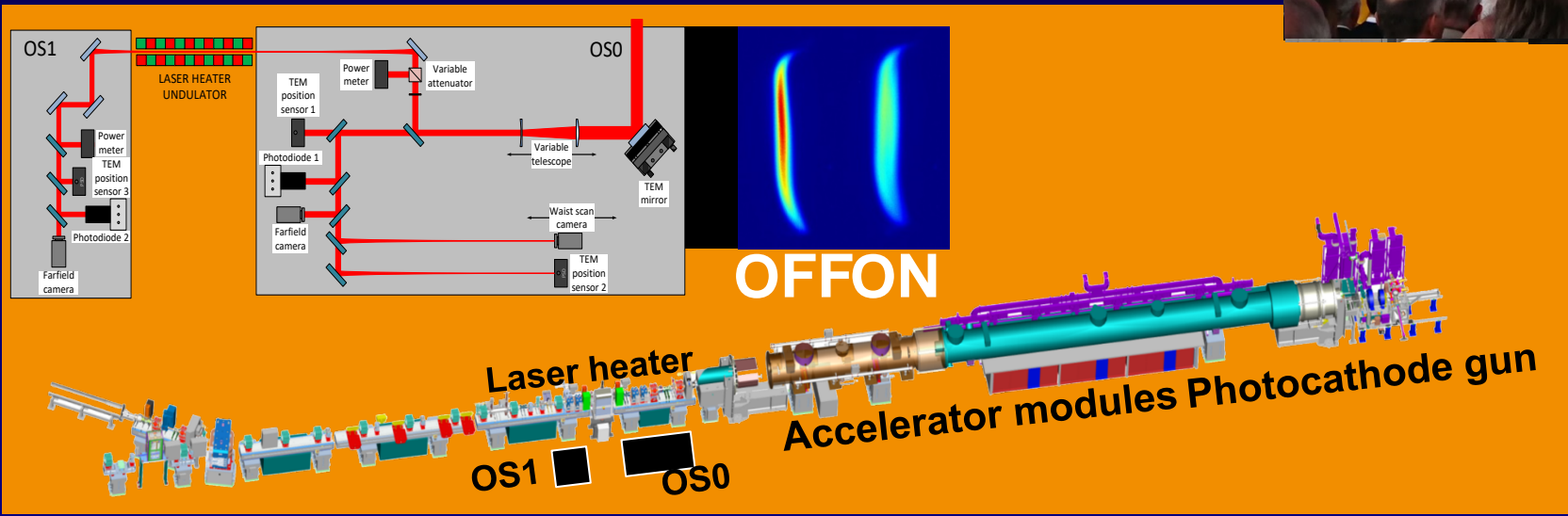
i Uppsala

FREIA Seminar 2018-12-17



MY BACKGROUND = INSTRUMENT DESIGN

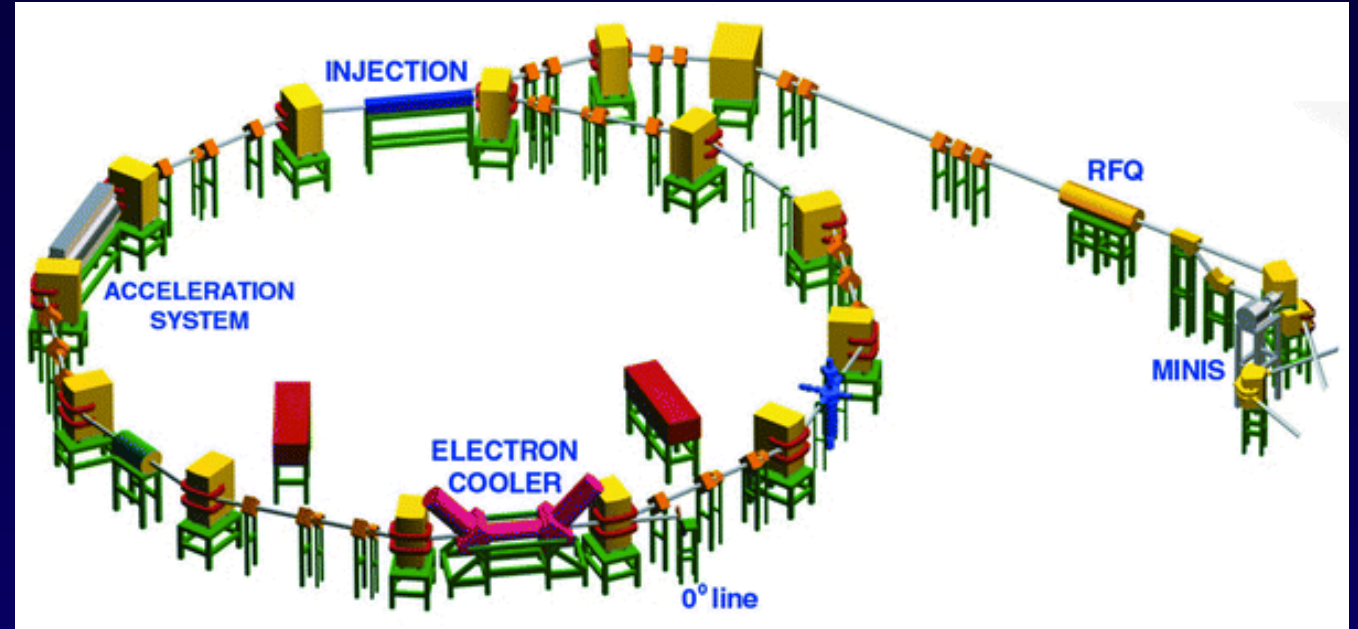
- Laser Heater
- Several Subsystems
- **Extreme Specifications**
- Heating 2016-06-21
- Doubling XFEL Output 2018-03-27
- **ASKED TO LEAD ARIES LH WG**





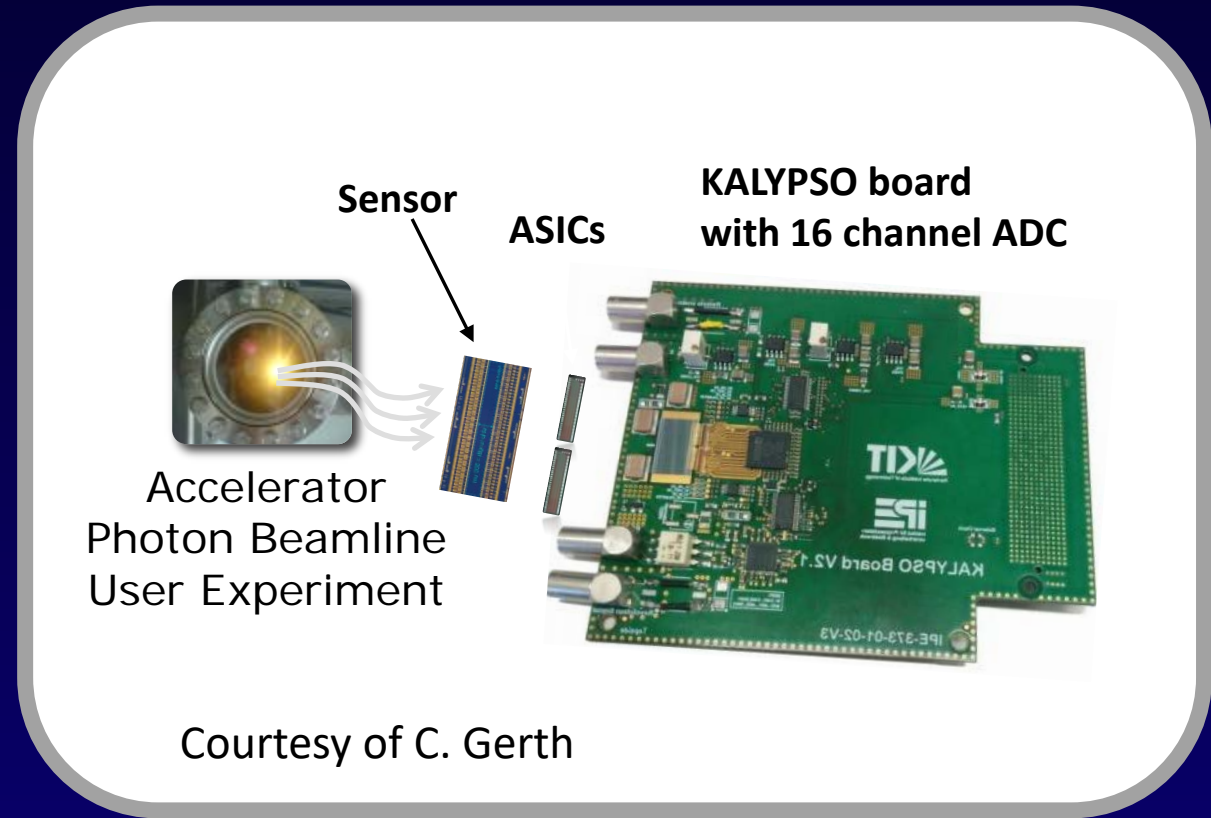
MY BACKGROUND = EXPERIMENTALIST

- STOCKHOLM UNIVERSITY
- CHEMICAL PHYSICS
- ACCELERATOR PHYSICS
- ION SOURCE & DETECTOR RESPONSIBLE
- Dissociative Recombination
- Cooled Trap
- FLASH ORS
- (Crossed Beams)
- (Radio Astronomy)
- 35 ARTICLES

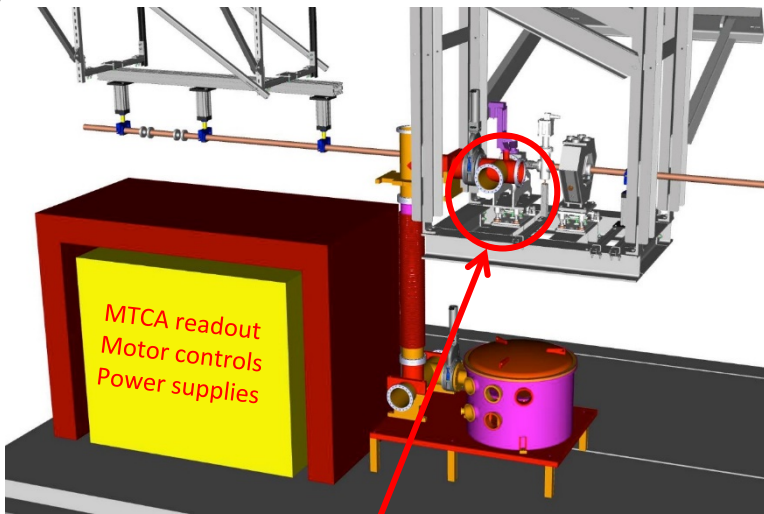


CURRENT ACTIVITIES

- SPECTROMETER AT EU-XFEL
- GOAL: INVESTIGATE LASER HEATER IMPACT ON SPECTRA → LONGITUDINAL DISTRIBUTION → INSTABILITY SUPPRESSION
- NIR (800-1500 nm)
- DIPLOMA WORK: Simon Fahlström
- Christopher Gerth, Nils Lockmann
- INSTALLATION JANUARY 2019
- MEASUREMENTS MARCH 2019
- KALYPSO BASED
- **WORLDS FASTEST >4 MHz @ 14bit**
- CAN BE USED ELSEWHERE

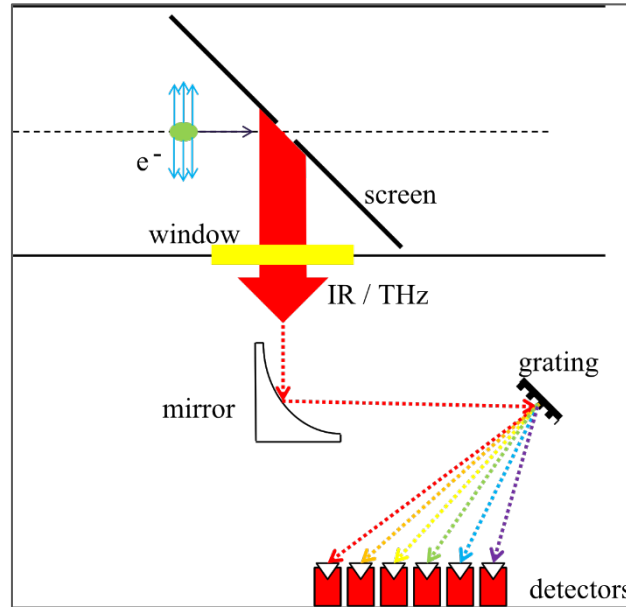


Near Infrared Spectrometer (NISP)



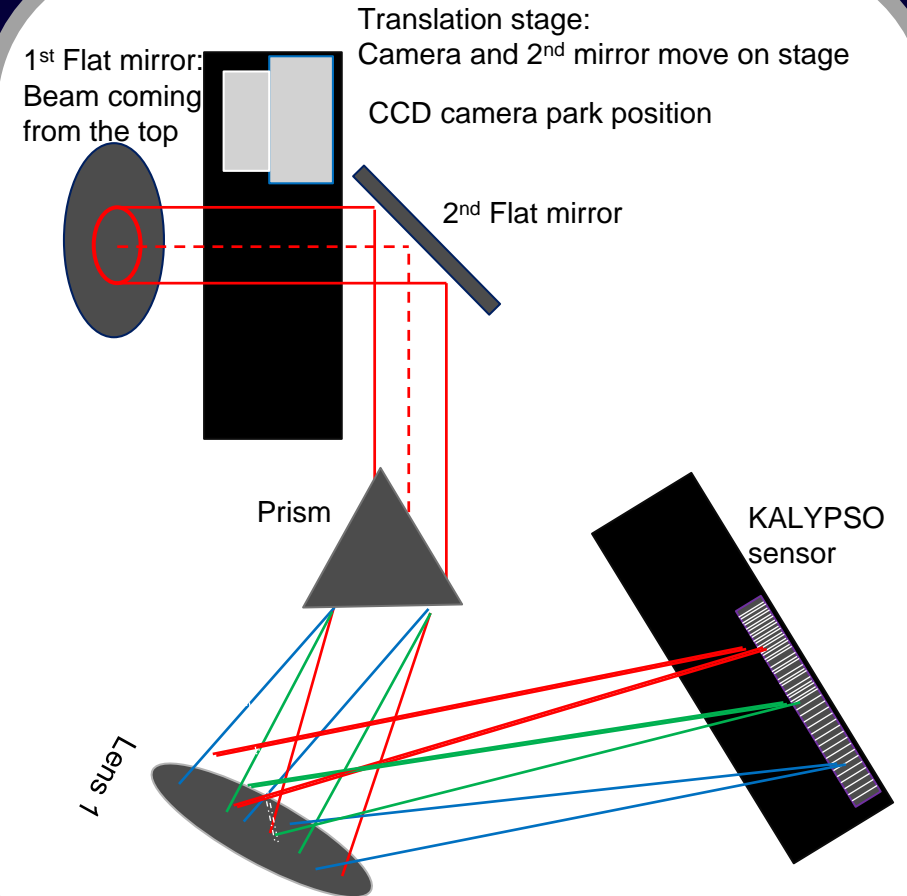
SPECTROMETER INSTALLATION SPACE

→ NEEDS TO BE COMPACT.



DIFRACCTION RADIATION FROM
NON-INVASIVE SCREEN

COURTESY OF C. GERTH





BACKGROUND → FUTURE

- INSTRUMENT DESIGN
- EXPERIMENTAL APPROACH
- ACCELERATOR PHYSICS
- PASSION



BACKGROUND → FUTURE

- ACCELERATOR PHYSICS = LUND
- LARGE ACCELERATOR IN MÄLARDALEN?

- COST LIMITED RESEARCH
 - SLOW SCIENTIFIC PROGRESS
- ONE BOTTLE NECK IS ACCELERATOR CAVITIES
- **What can we expect from future technologies and how do we create them?**



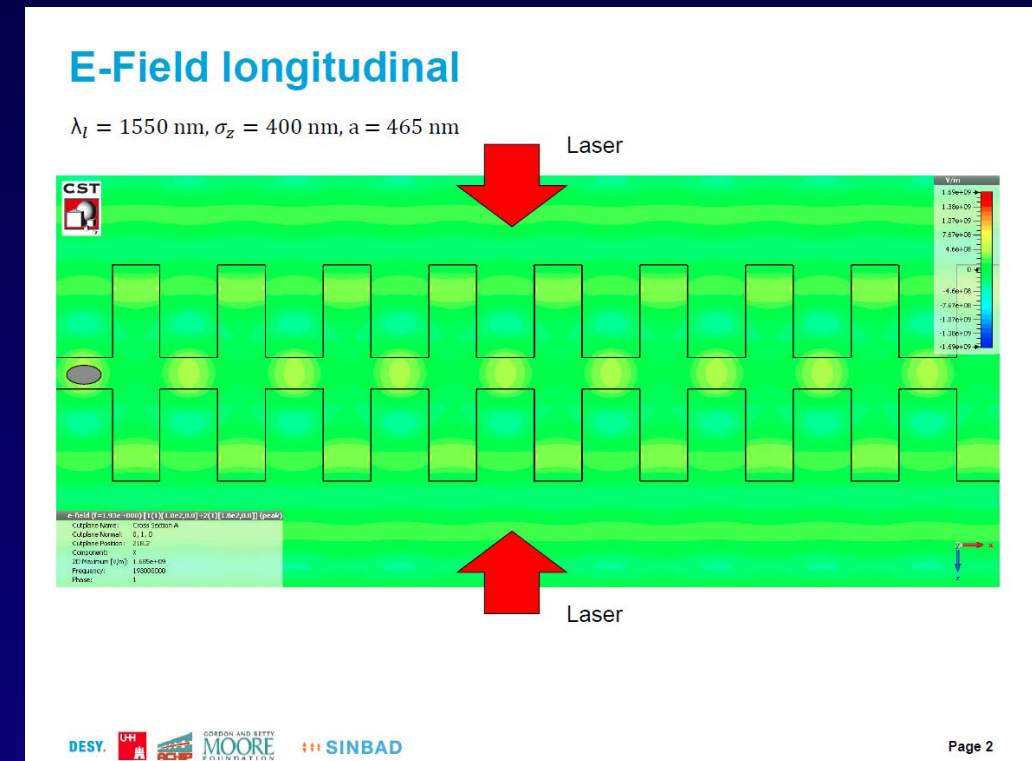
BACKGROUND → FUTURE

NEW ACCELERATION METHODS

- PLASMA ACCELERATION
- DIELECTRIC LASER ACCELERATION
- THz ACCELERATION

APPLICATIONS

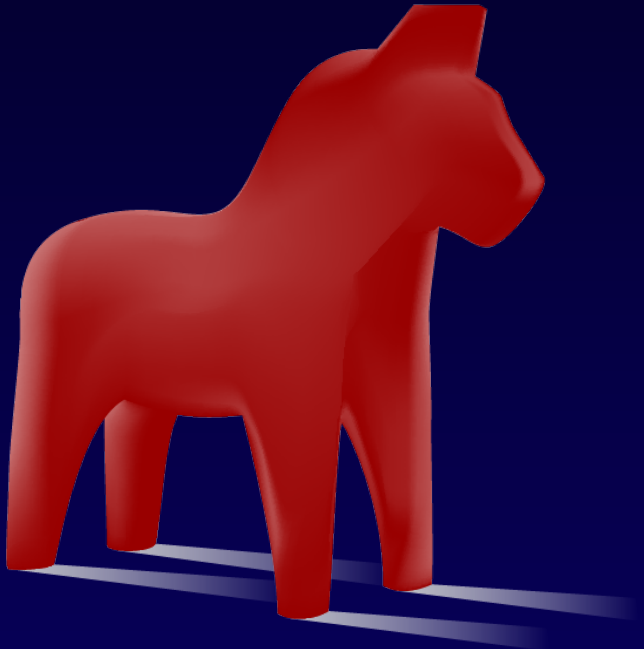
- LIGHT SOURCES?
- ONCOLOGY?





STRATEGY

- NO (KNOWN) GROUP DEDICATED TO MICROACCELERATOR STRUCTURE DEVELOPMENT
- MAKE THE DISADVANTAGES AN ADVANTAGE
- USE WHAT WE HAVE IN UPPSALA
- **EXTREMELY MULTIDISCIPLINARY !!!**
- COLLABORATE WITH THE BEST
- BE BOLD



MAS

MICRO ACCELERATOR STRUCTURE
CENTER IN UPPSALA



MAS: WHEN GROW SOME
BALLS IS TAKEN LITERALLY!



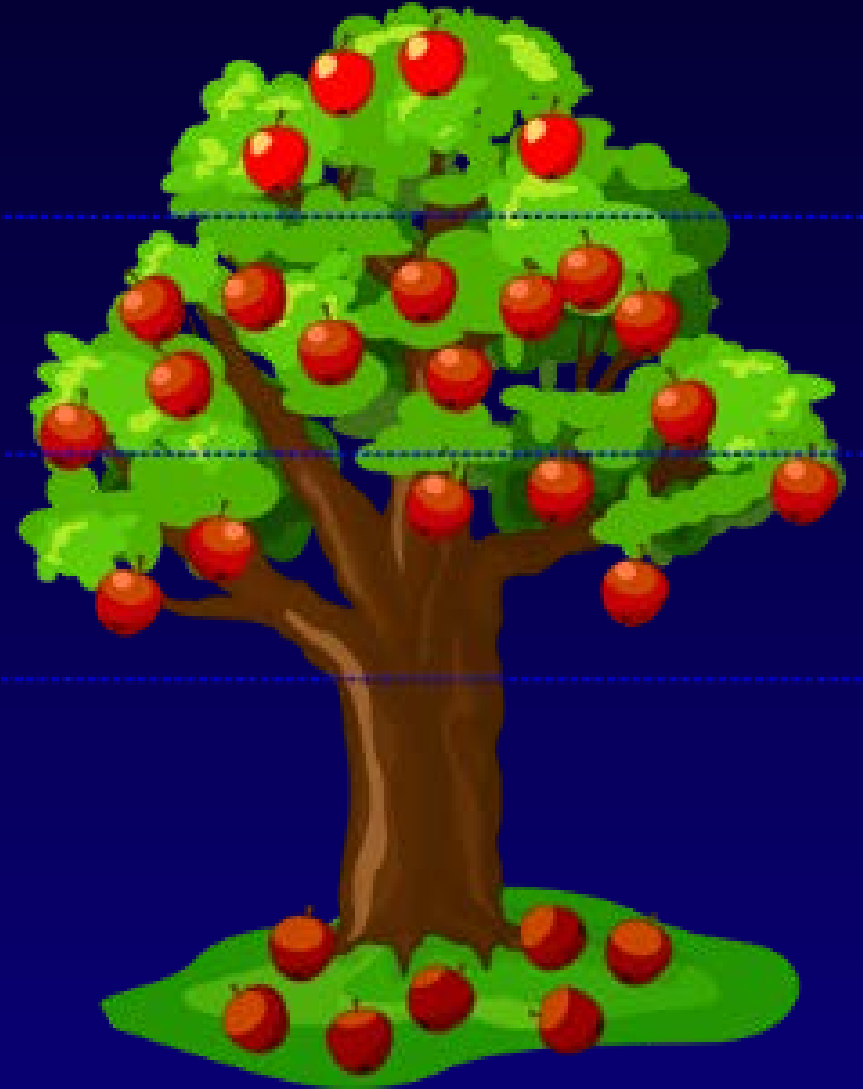
MAS GROUP

- Local Group at Ångström Laboratory Formed in 2015
- Mathias Hamberg
- Mikael Karlsson
- Pontus Forsberg
- Ernesto Vargas Catalan
- Dragos Dancilo
- Anders Rydberg
- Janos Haidu
- Finnish Colleagues Joensuu
- DESY Colleagues
- ERLANGEN and Max-Planck Quantum Optics



GRANTS AIM

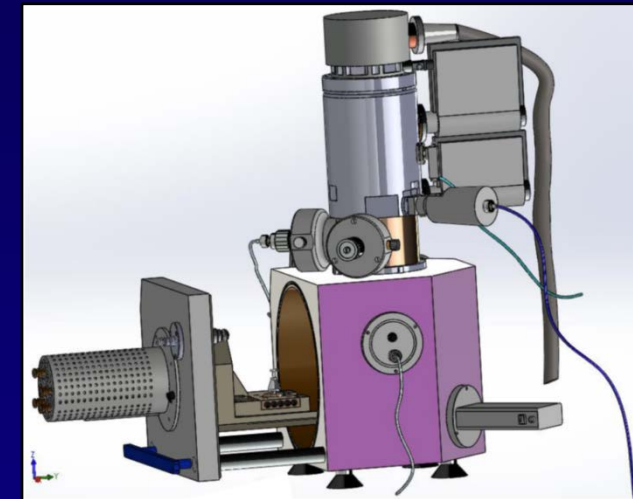
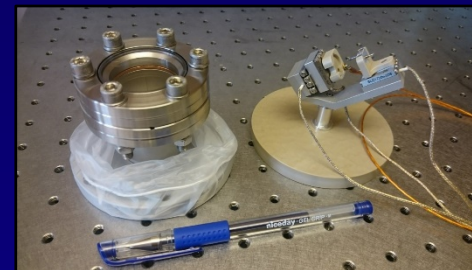
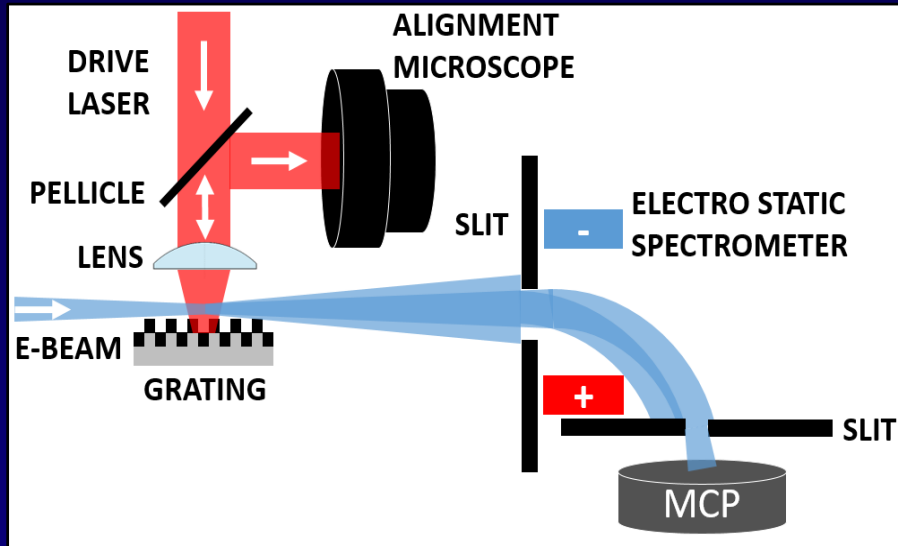
- Σ9 MSEK
- Local Swedish Setup at Ångström Laboratory
- Two PhD's and one Postdoc
- Instrument Design
- PhD1: DLA Focus
- PhD2: THz Focus
- Material Physics
- Postdoc: Manufacturing
- Career Possibilities???





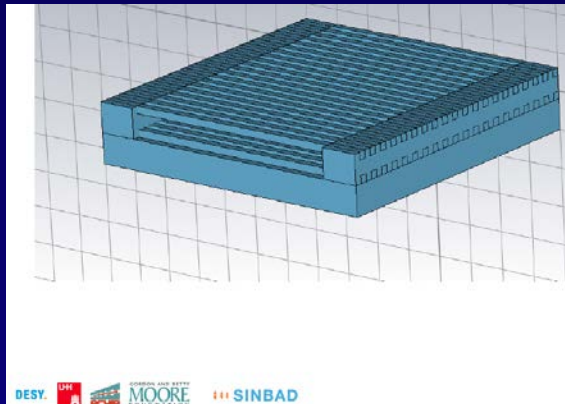
UPPSALA DLA SETUP

- SEM DLA SETUP
- DIPLOMA WORK UPSTARTING
- SIMILAR TO ERLANGEN SETUP



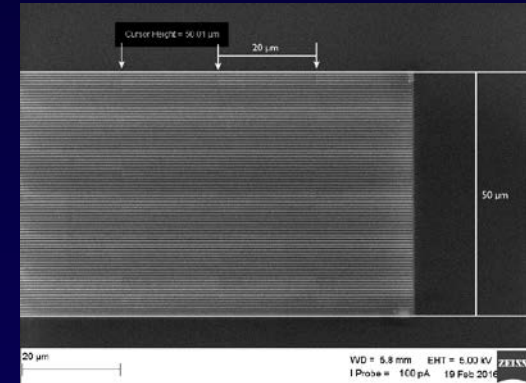
MYFAB

- MICROFABRICATION
- LITHOGRAPHY METHODS
- DIAMOND
- NEW MATERIALS
- VARIOUS STRUCTURES

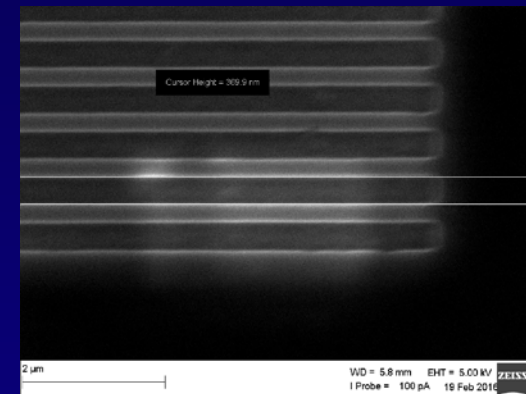


Polycrystalline diamond substrates $\varnothing 10$ mm, 300 μm thick used for grating fabrication. Improved method was demonstrated by Karlsson et al. Nano-replication using SAMIM, and ICP-RIE of Al, Si and diamond.

Diminishable line width differences compared to master pattern. A lower sidewall angle was demonstrated by collaborators. The diamond gratings will be tested at the DLA setup at FAU, Erlangen, Germany.



SEM image of PDMS etching





SINBAD

SINBAD

- 300 m RACE TRACK

ARES

- 100 MeV
- pC CHARGES
- <10 fs RMS ELECTRON BUNCH JITTER
- 50 Hz

- **WE PROVIDE GRATINGS**

AXSIS

- DESY CFEL ARIZONA ERC COLLABORATION
- THz ACCELERATION
- XRAY CREATION



Simulated working point for external injection of single bunches.

Parameter @ IP	Value
Charge [pC]	0.5
Bunch Length [fs, FWHM]	2.1
E [MeV]	99.1
$\Delta E/E$ [%]	0.12
σ_{xy} [μm]	7.8
$\epsilon_{n,xy}$ [nm]	105

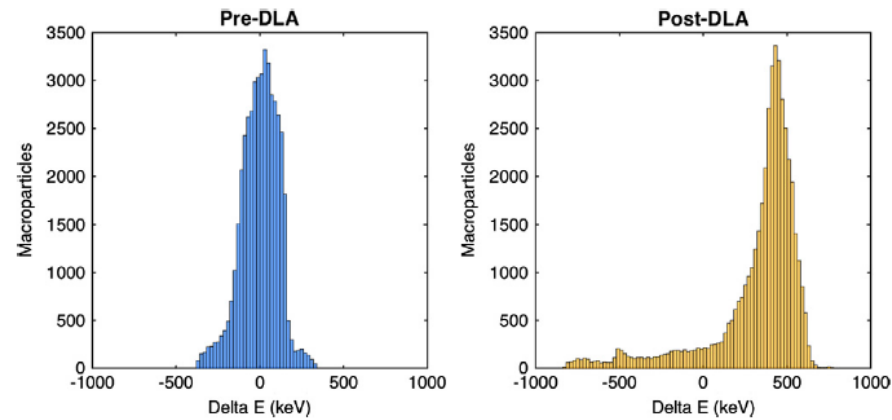
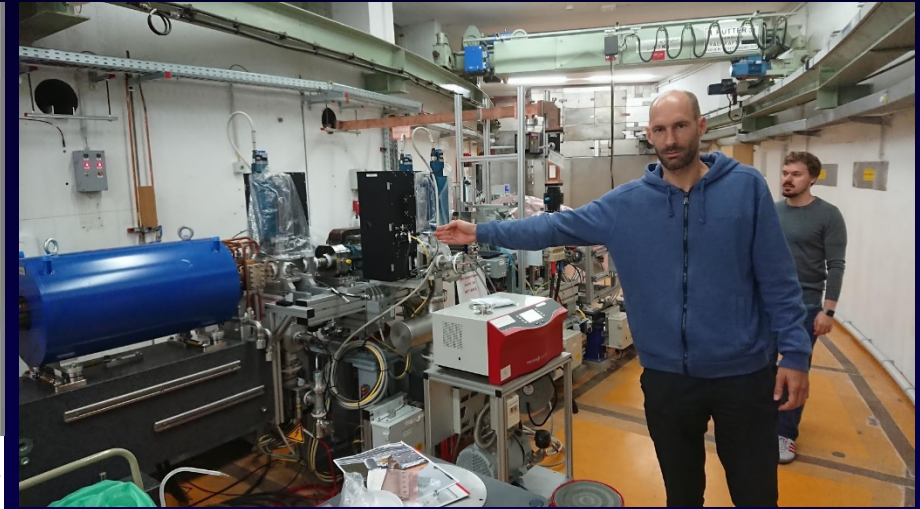


Fig. 4. Simulated energy spectrum of the transmitted part of the bunch before (left) and after (right) the DLA interaction (mean energy gain of ~ 300 keV). The bins are chosen according to the expected minimum energy resolution of the spectrometer ($\sim 10^{-4}$).





SINBAD

ARES

- MICROBUNCH CREATION
- COULD BE AN OPTION FOR THE HAM-UNDULATOR
- MY SIMULATIONS
- SIMONS SIMULATIONS
- DIPLOMA WORK
MECHANICAL ENGINEER
- DESY+KYMA COLLABORATION

F. Mayet et al.

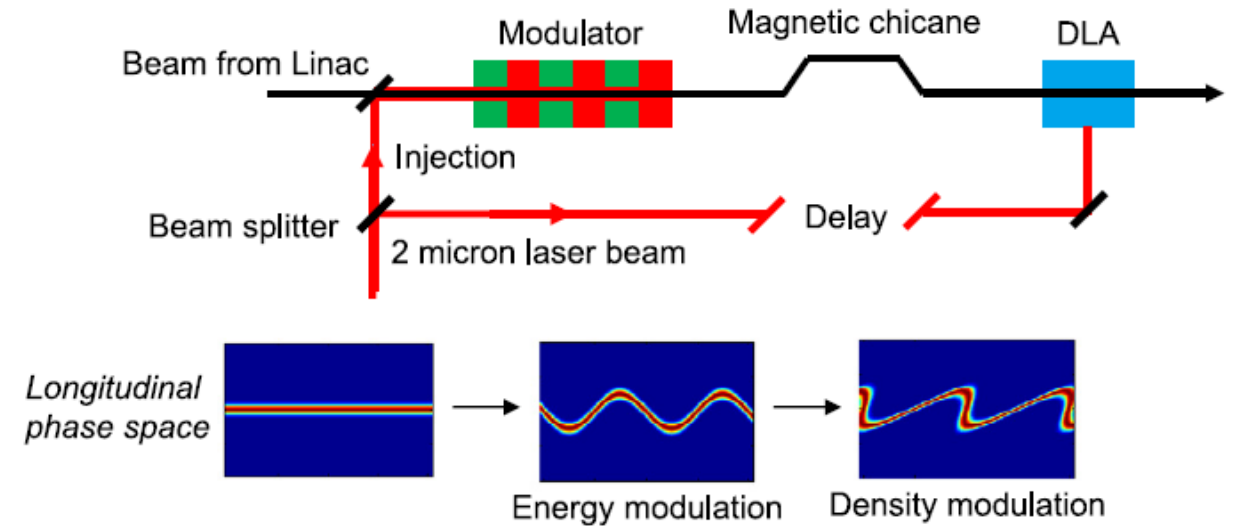
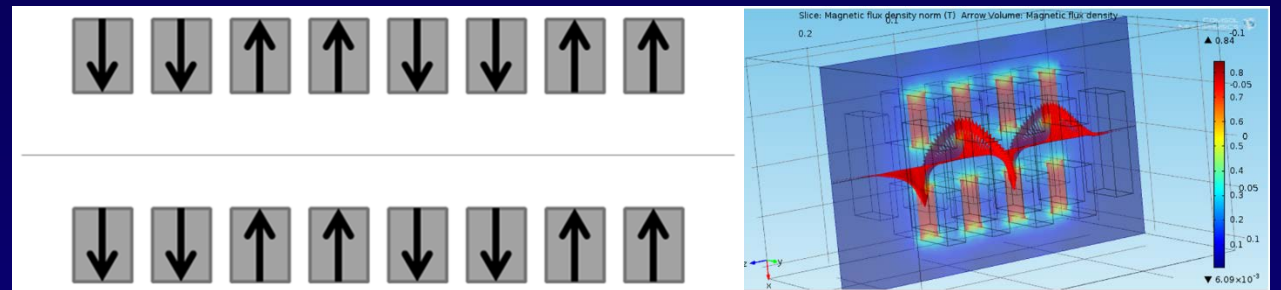
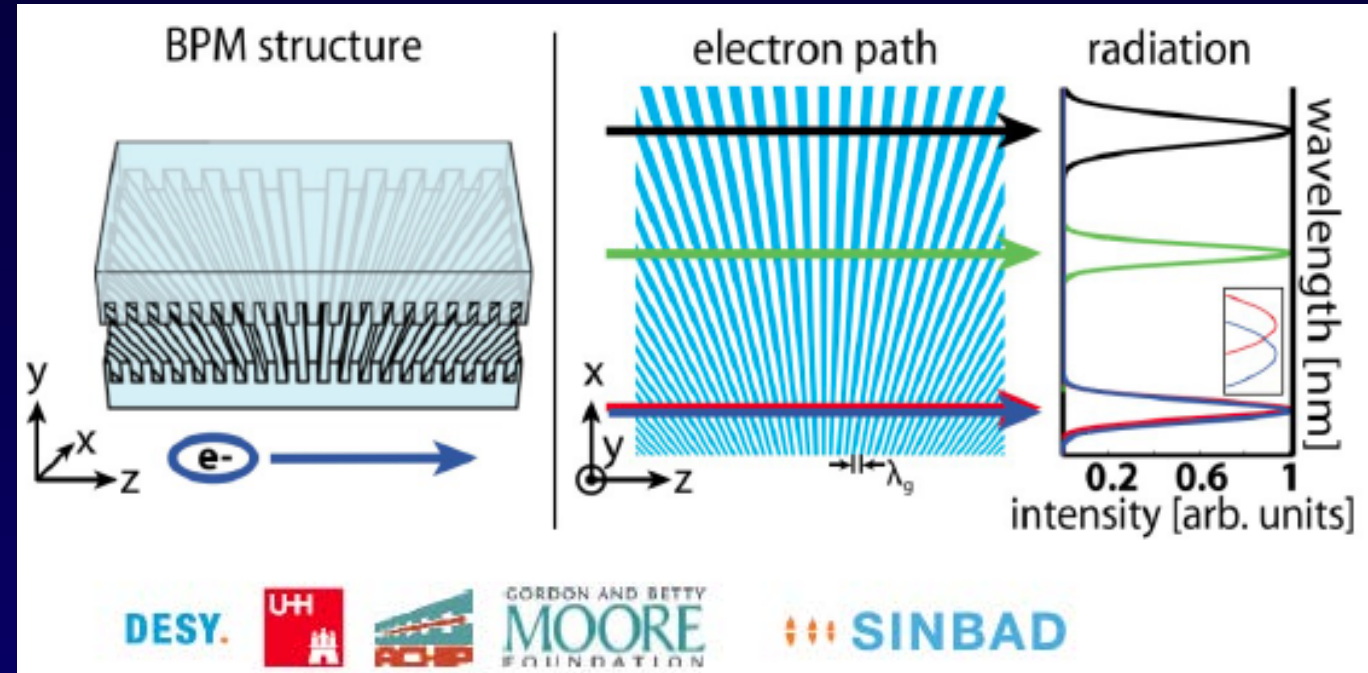


Fig. 5. Basic representation of the microbunching scheme using a modulator and a chicane.



BPM

- MM SIZE
- SUPERIOR RESOLUTION
- SPECTROMETER BASED
- COLOR CHANGE → POSITION CHANGE
- SPECTRAL BROADENING → BEAM BROADENING



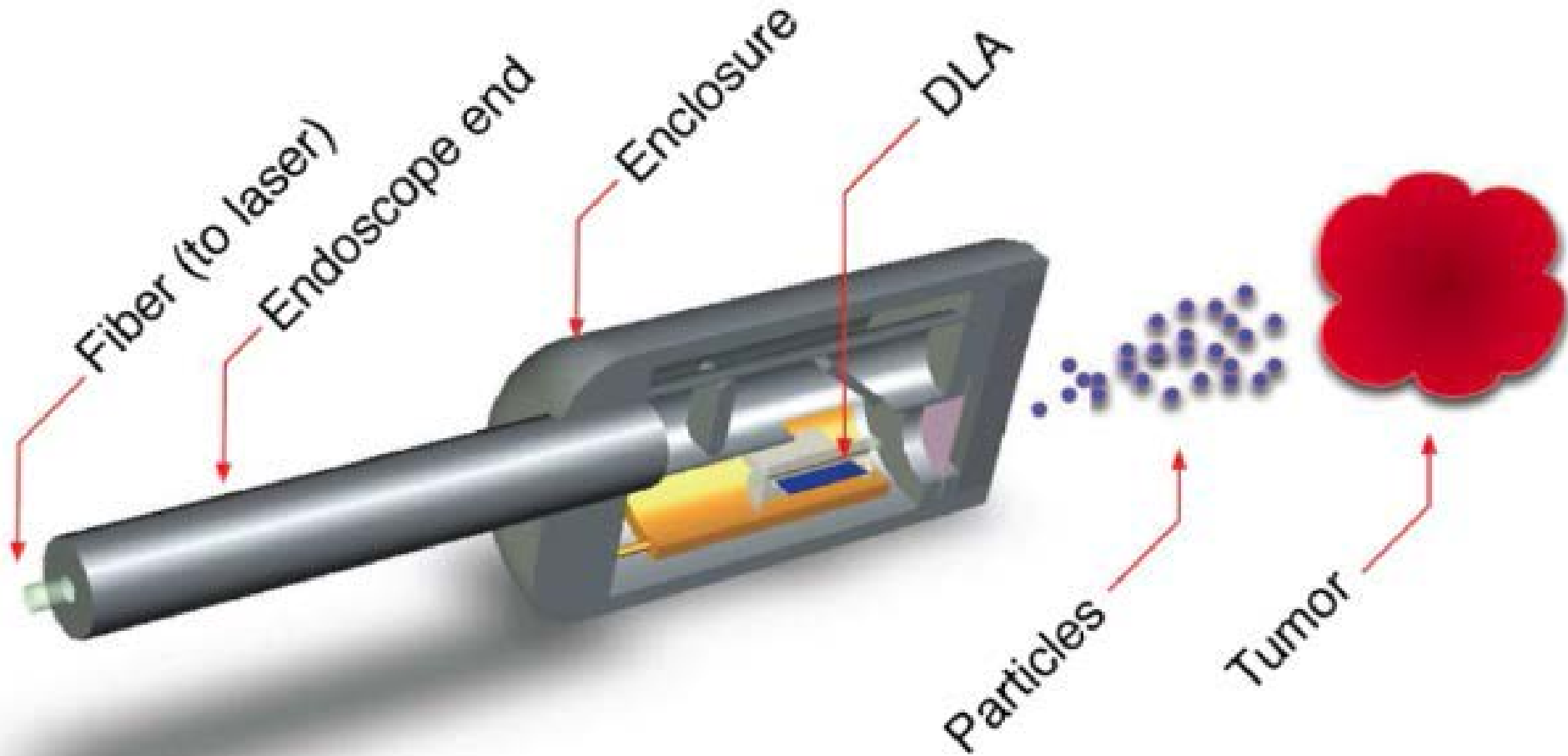


OPTIONS ARE AVAILABLE

- DISCUSSIONS ARE ONGOING
- HARDWARE DESIGN
- VACUUM CHAMBER
- HEXAPOD IMPLEMENTATION
- LASER INCOUPLING
- GRATING CONTROL

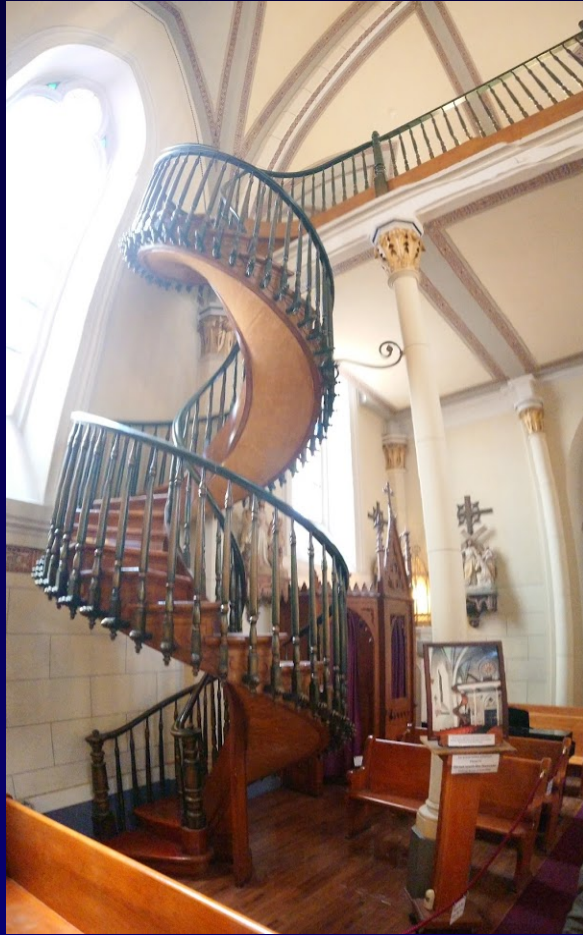


WHAT IS POSSIBLE?





THANK YOU FOR YOUR ATTENTION!





QUESTIONS?

