# CTC Activity Report

| | |
|---|---|
| DR SC Wiggler | P. Ferracin et al. |
| Survey & Alignment | H. Mainaud et al. |
| Quad Stability | K. Artoos et al. |
| Two-Beam module development | G. Riddone et al. |
| Warm Magnet Prototypes | M. Modena et al. |
| Beam Instrumentation | T. Lefevre et al. |
| Collimation, Masks and Beam Dumps | V. Vlachoudis et al. |
| Controls | M. Draper et al. |
| RF Systems (1 GHz klystrons & DB cavities, DR RF) | E. Jensen et al. |
| Powering (Modulators, magnet converters) | D. Nisbet et al. |
| Vacuum Systems | C. Garion et al. |
| Magnetic stray Fields Measurements | S. Russenschuck et al. |
| DR Extraction System | M. Barnes et al. |
| Creation of a “CLIC technology center@CERN" | F. Bertinelli et al. |

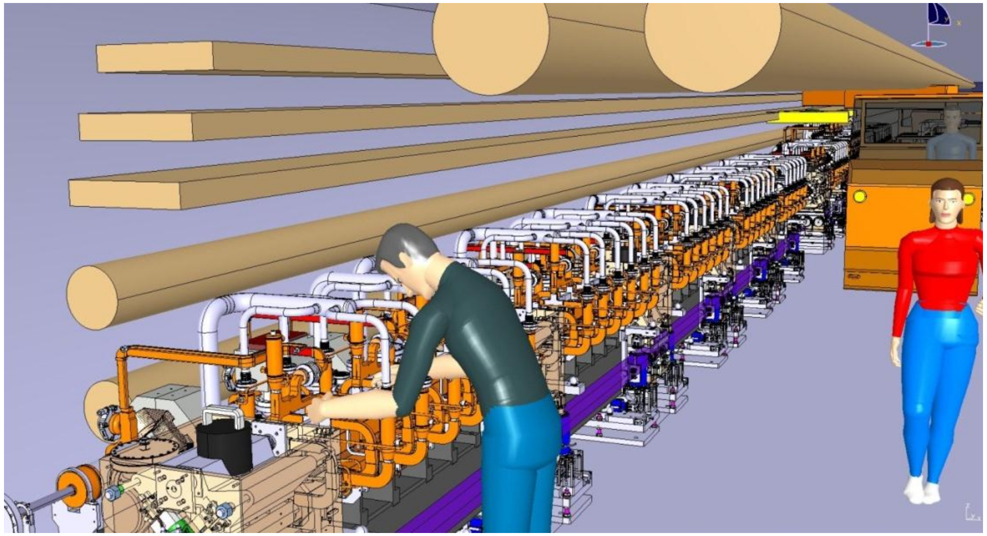
H. Schmickler on behalf of the CLIC Technical committee Members; scientific secretary: Nuria Catalan Lasheras

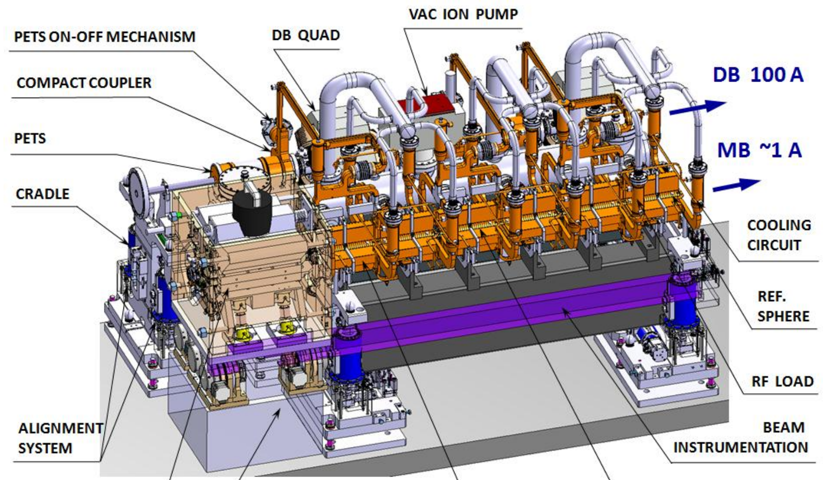
# Two Beam module program

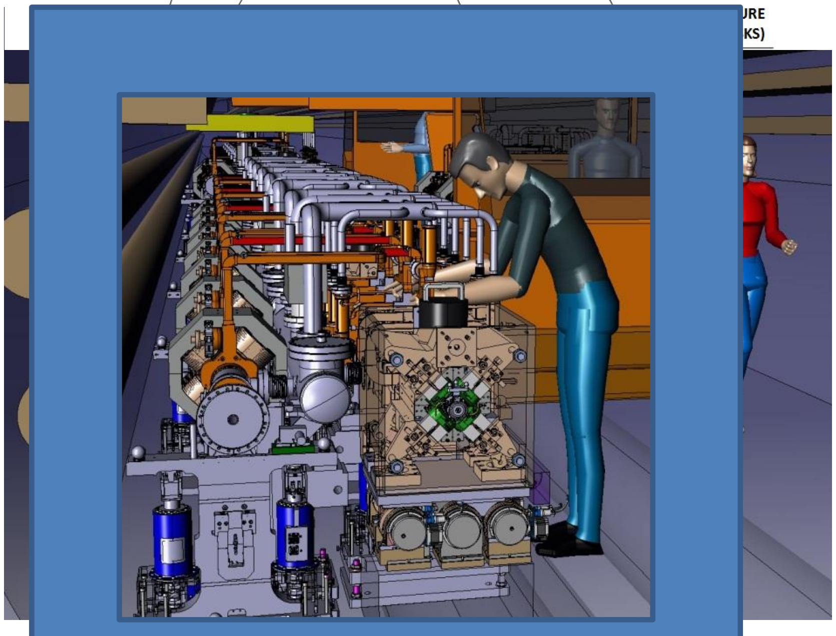
- Objectives
  - assemble a 1-0-0-4 configuration in the lab for:
  a) validation of integration studies; access to components; sequence of installation...
  b) choice of materials and components (girder material...)
  c) metrology before and after a transport
  d) intense measurement program on thermal behaviour
  e) showcase: the present idea is to show during a council week the module assembly in the entry hall of building 60

  f) create a natural deadline for contributions from other activities: (vacuum, alignment, quad stabilization, magnets, instrumentation)

# CLIC two-beam module





**Baseline for**
**C**onceptual
**D**esign
**R**eview

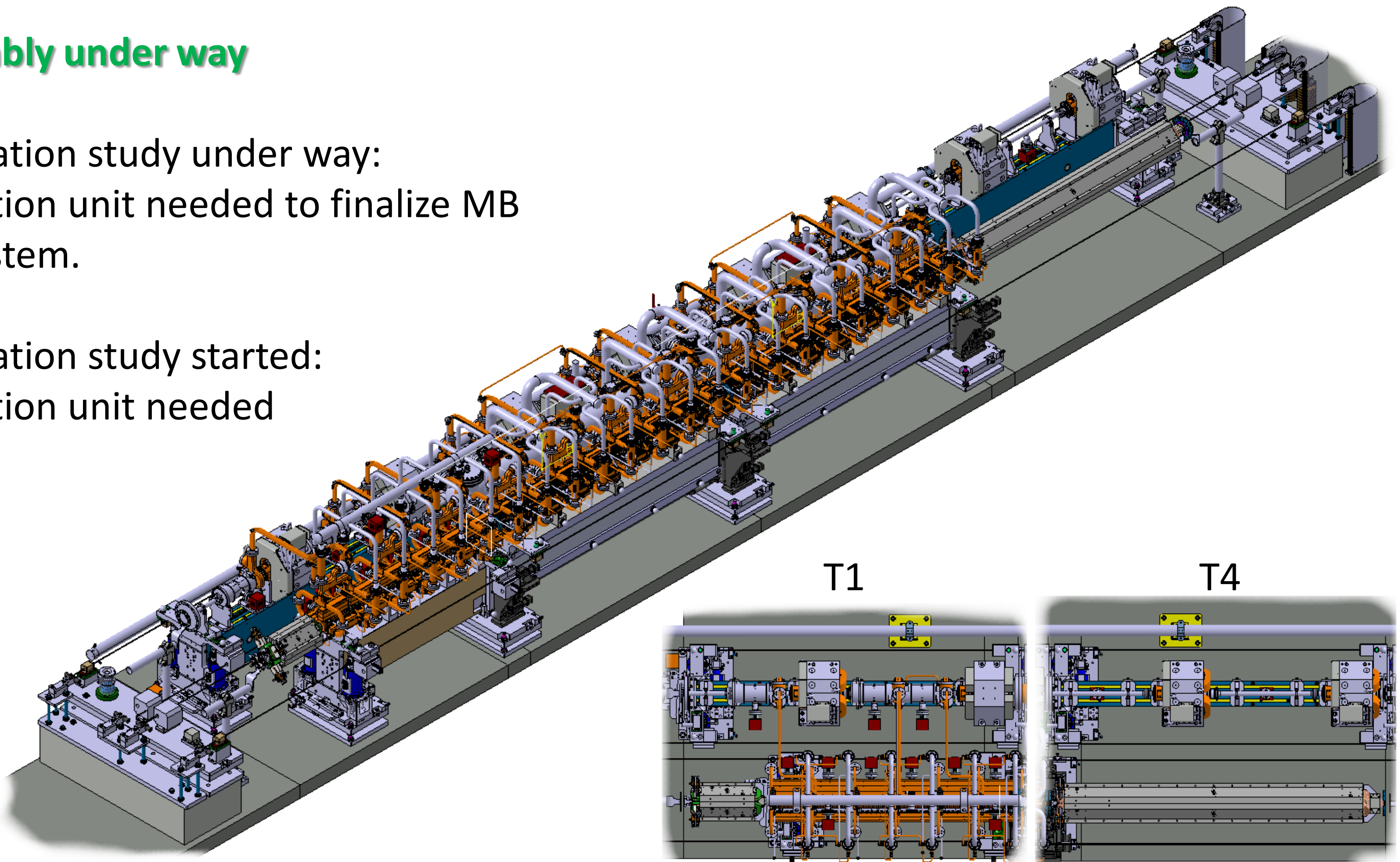
# Two-beam module prototypes (B169) Assembly and Integration

Test modules in the LAB. 4 modules 1-0-0-4:

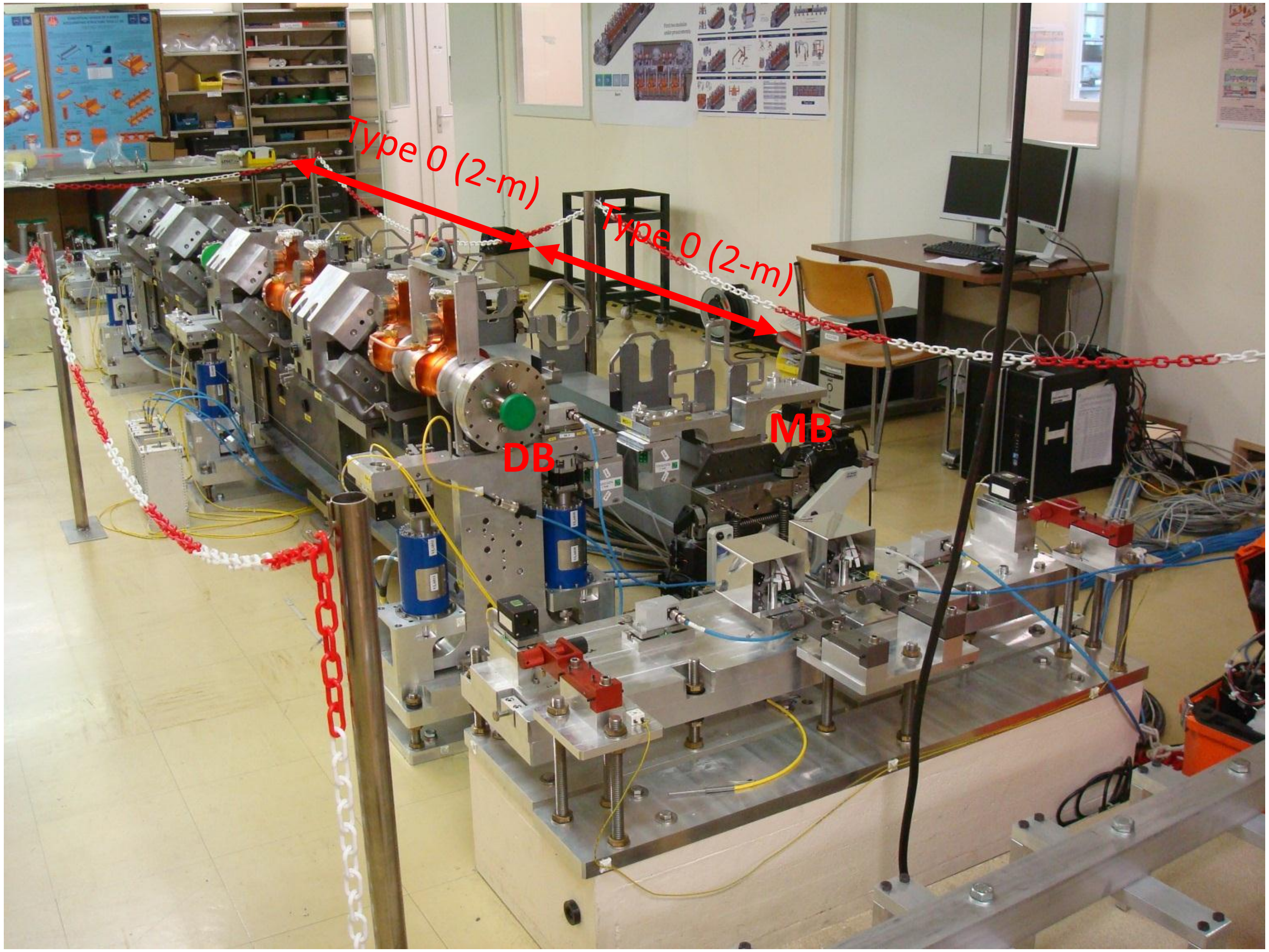
**Type 0: assembly under way**

Type 1: Integration study under way:
MBQ stabilization unit needed to finalize MB supporting system.

Type 4: Integration study started:
MBQ stabilization unit needed



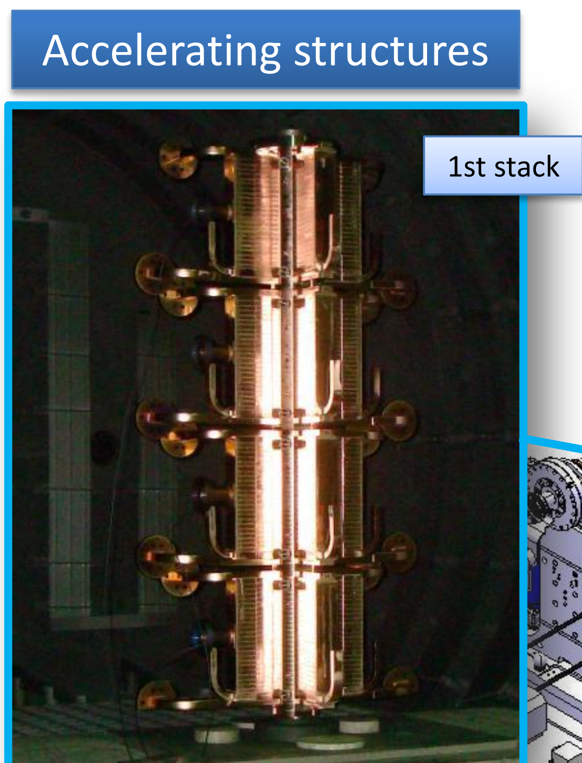
# Two-beam module prototypes (B169)
# Type 0



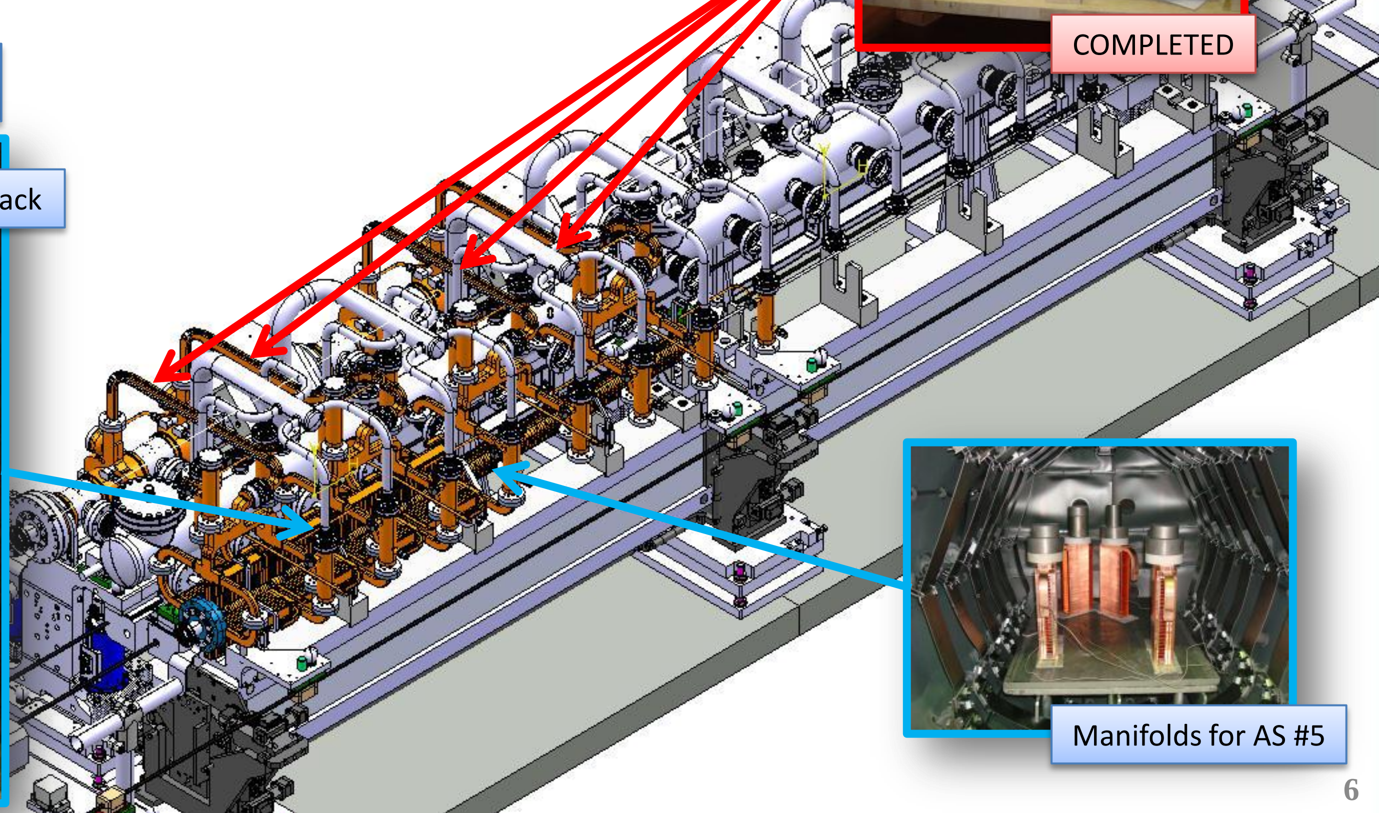
# Two-beam module prototypes (B169) Type 0

Final brazing of:

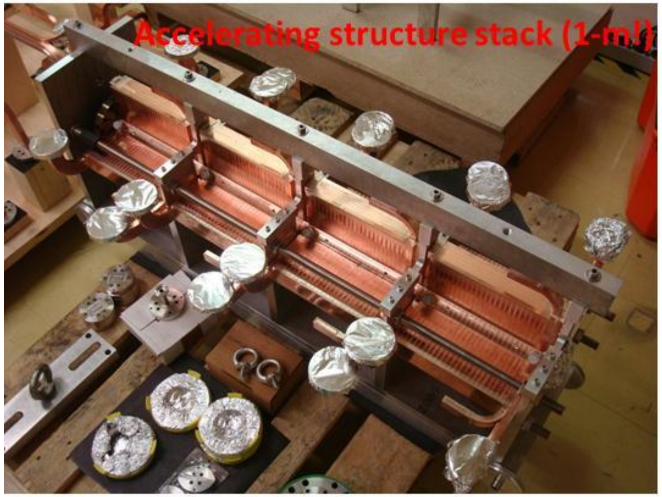
- 1st stack made of 4 AS: completed
- 2+2 RF network for 1st TM0
- Manifolds for AS #5



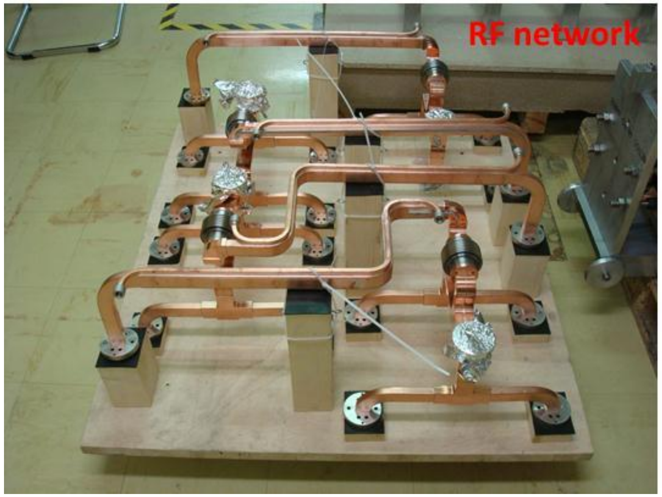


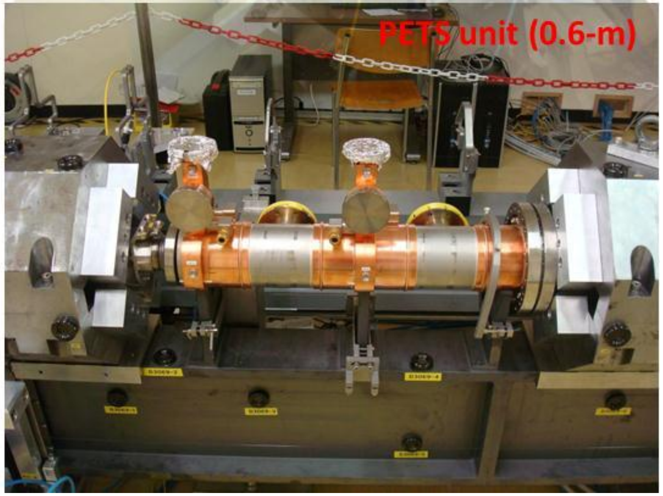


# Two-beam module prototypes (B169) Type 0 RF system

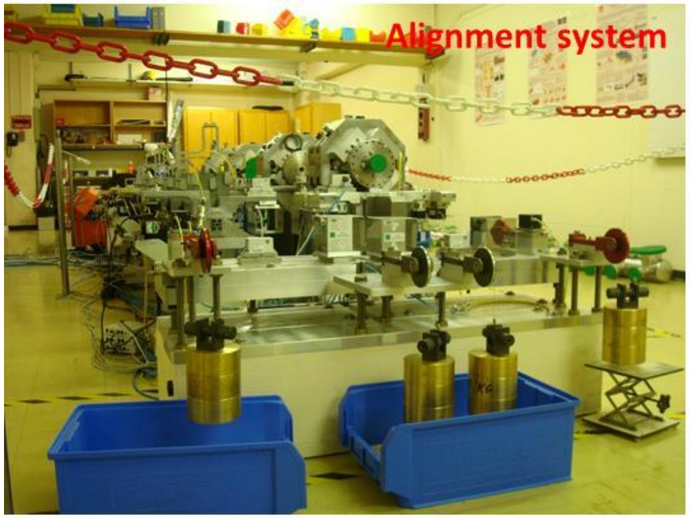


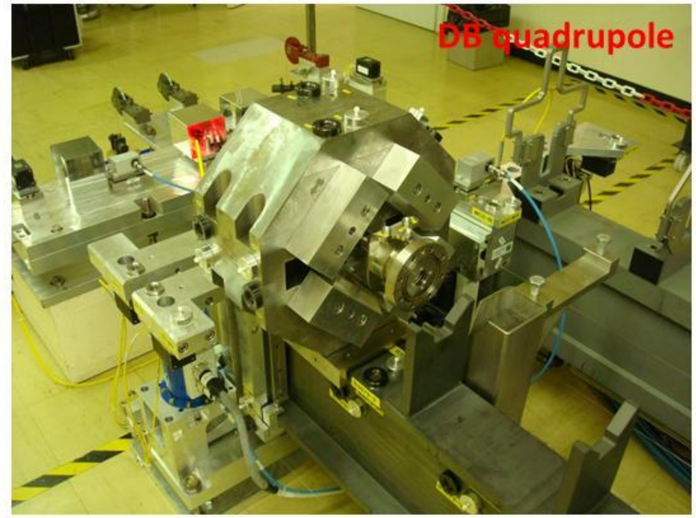


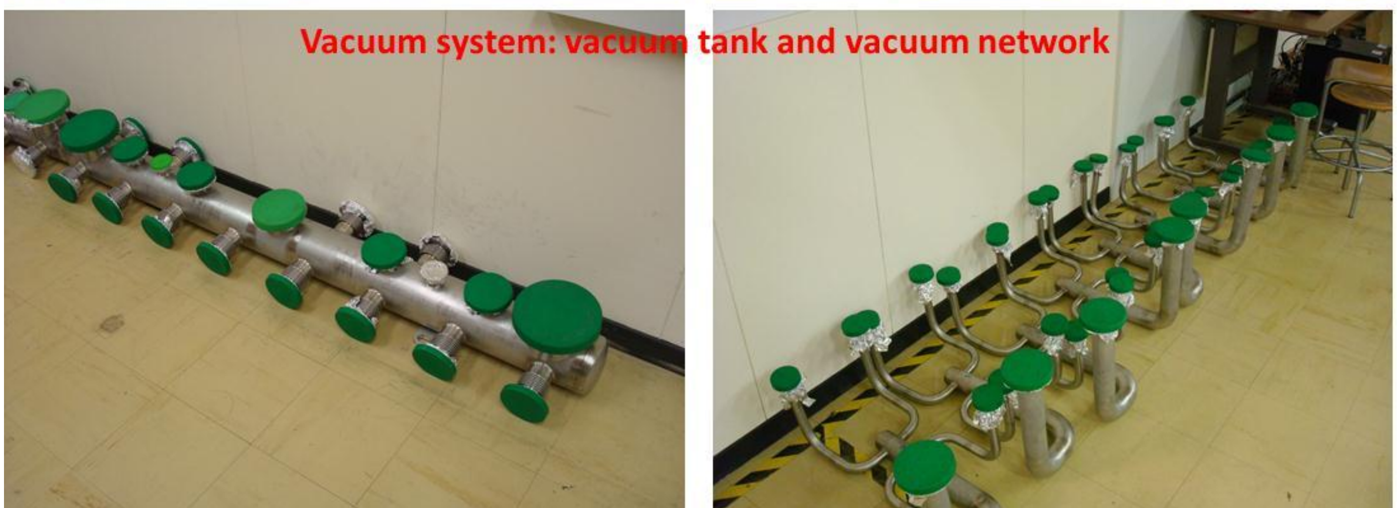


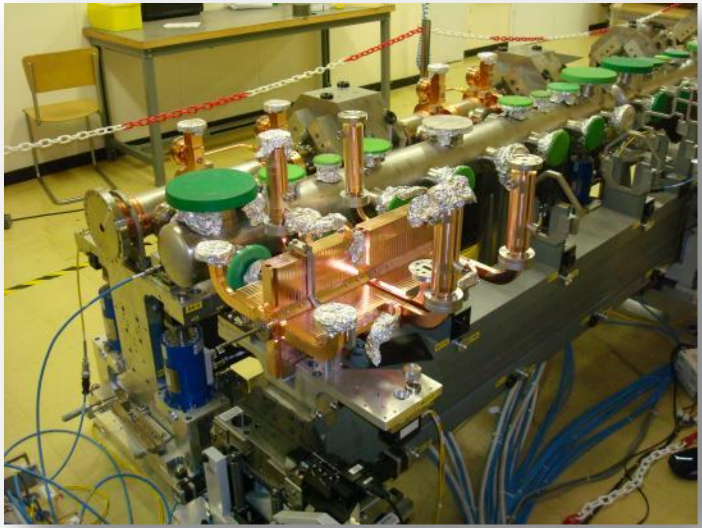
# Two-beam module prototypes (B169) Type 0 technical systems



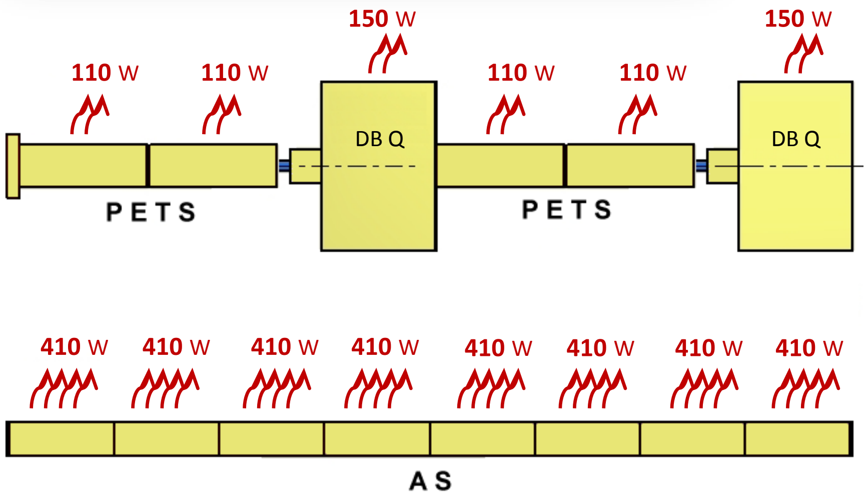
# Two-beam module prototypes (B169) Validation tests

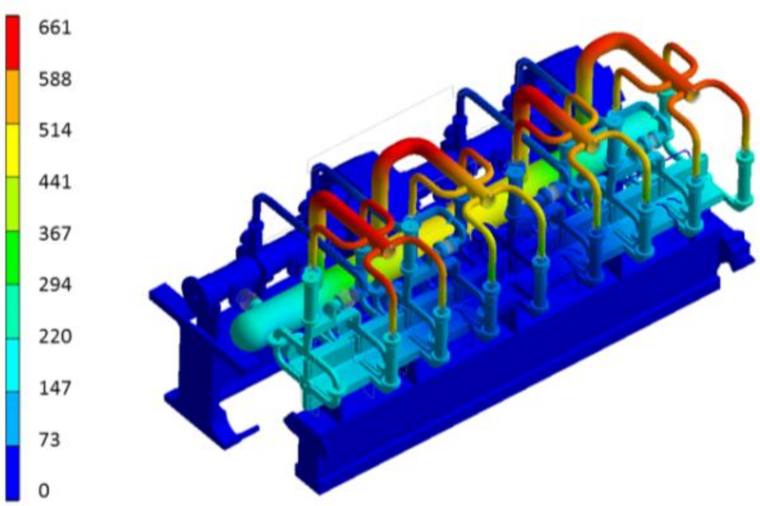


- The aim of prototype modules is to prove the feasibility of the proposed technical solutions for the different systems (pre-alignment, stabilization, cooling and vacuum systems)
- **Alignment tests successfully performed**

- Thermal tests to validate thermo-mechanical models previously developed: heaters will be used to reproduce heat dissipation due to RF power
- **Thermal tests in preparation**

*IPAC12 paper*



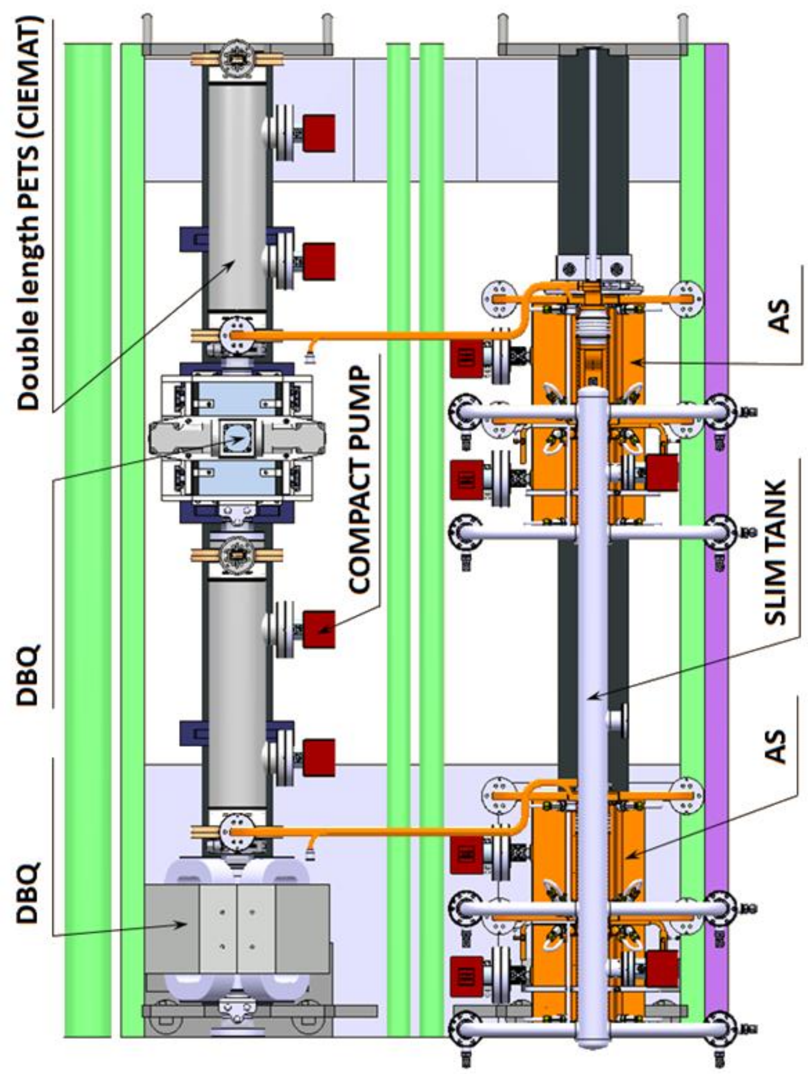



# CLIC: Two-beam module prototype (CLEX) – Integration and procurement

Test modules in the CLEX. Integration of the first T0 is under way. Procurement of main components launched (girders and accelerating structures)

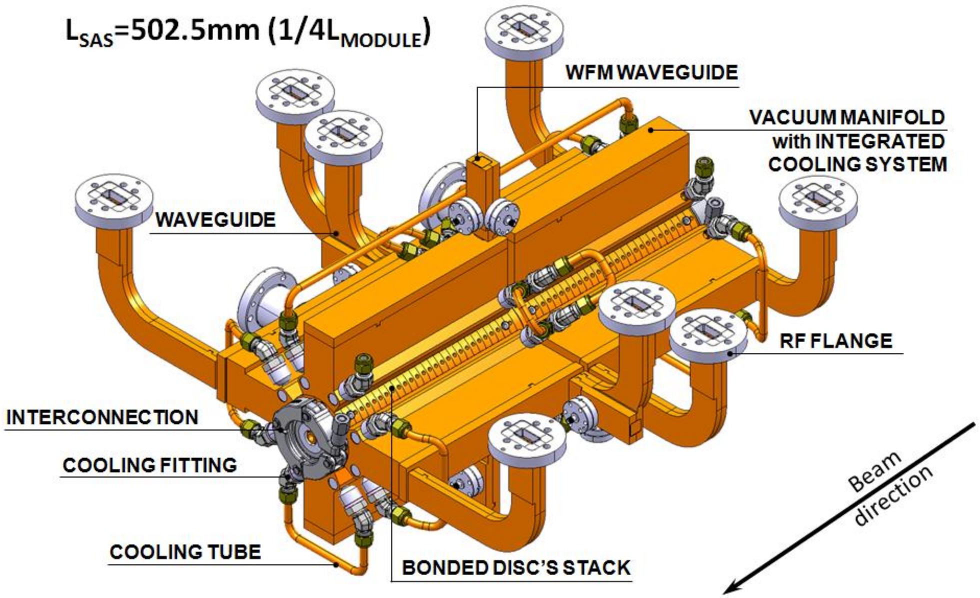
**STATUS:**

- AS: under fabrication
- PETS: under fabrication by CIEMAT
- DBQ: CockCroft of Danfysik, preliminary integration done. Final integration after the design of supporting system
- RF network: design and integration under way
- Slim tank: design and integration under way



# Two-beam module prototype (CLEX) Accelerating structure

TD26 CC SiC (***4 accelerating structures for the module*** to be tested with beam and RF in the CLIC Experimental Area)




Disks (about 30 each ac. structure)

Vacuum manifolds: housing damping material

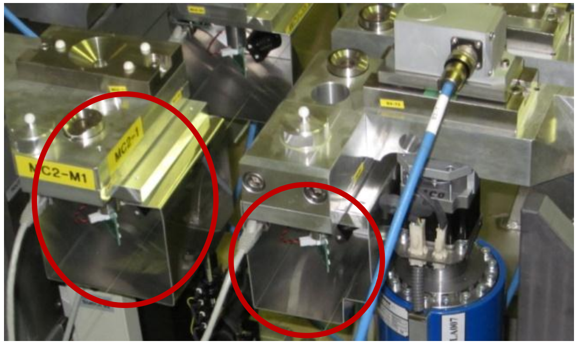
Other technical systems: cooling, alignment integrated

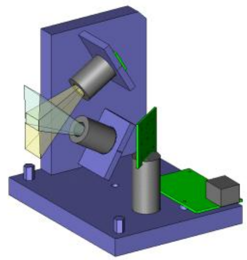
- Metrology and Active Pre-alignment

# CLIC pre-alignment studies

On the two beam modules prototypes…

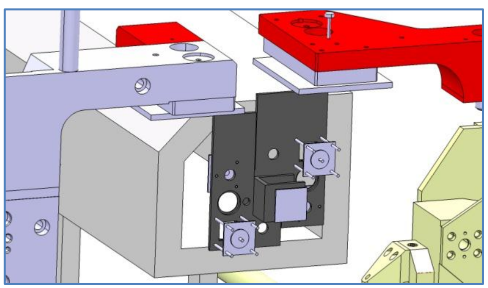
- ✓ cWPS sensors and actuators validated (see next slide)
- ✓ Articulation concept validated for both solutions of supporting (see next slide)
- ✓ 13 oWPS installed, to be validated.
- ✓ Alignment systems developed by NIKHEF (optical based Raschain) integrated (installation foreseen in June 2012)
- ✓ Validation of the fiducialisation strategy under progress
- ✓ Software in order to acquire sensors and pilot actuators developed under labview ok.
- ✓ Control algorithms ready
- ✓ Micro triangulation developed and validated.





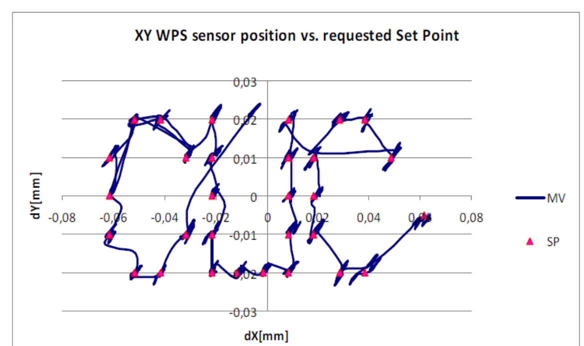
Installation of 13 oWPS

Control software



Integration of NIKHEF alignment systems


Development of micro triangulation

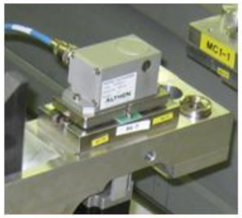



Regulation

# CLIC pre-alignment studies

Latest results on the two beam modules prototypes…

Performance of the sensors



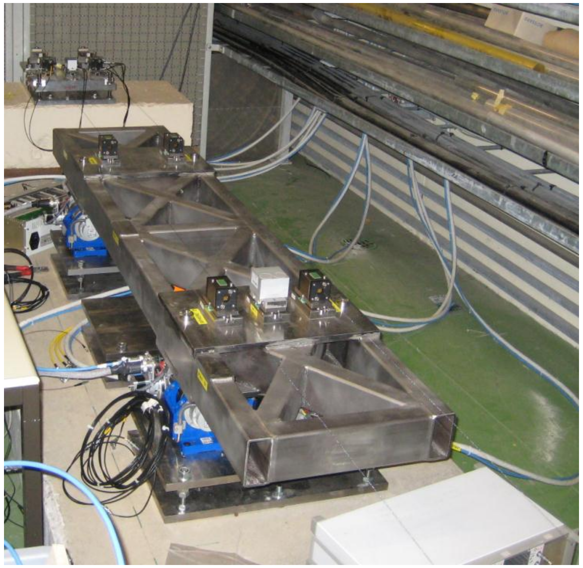
| | WPS | INCLINOMETER |
|---|---|---|
| Noise (peak to peak) | 5 µm | 3 µrad |
| Standard deviation over 15s | 0.6 µm | 1 µrad |
| Repeatability | 1 µm | 2-3µrad |
| Reproductibility | 2-3 µm | 5µrad |
| Interchangeability | 2-3 µm | 4-5 µrad |

Performance of the articulation point

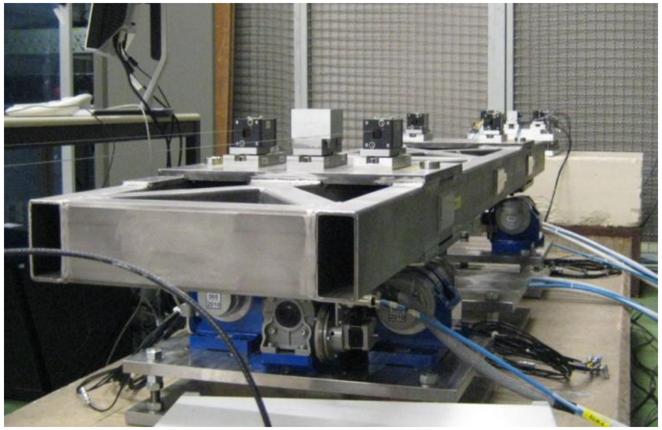
| 3 DOF linkage (Slave versus Master) | Boostec | Micro-Contrôle |
|---|---|---|
| Vertical Translation | 1-2µm | 3-5 µm |
| Horizontal Translation | 1-2 µm | 2-3µm |
| Roll | 1µrad | 2µrad |

CLIC pre-alignment studies

Development of high resolution cam movers…

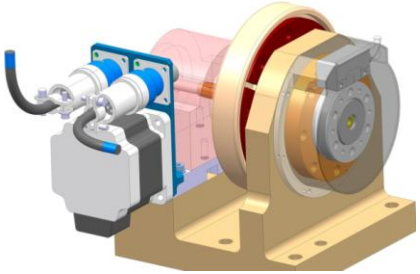


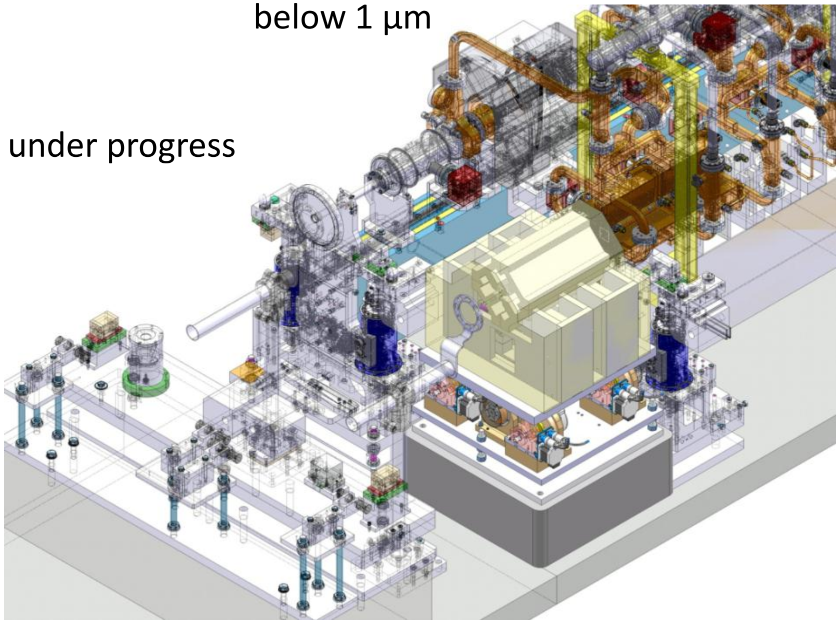
5DOF test bench reinstalled in ISR 8.



5DOF repositioning in less than 3 iterations below 1 µm

Development of a smaller cam mover (for type 1 MB quad) under progress



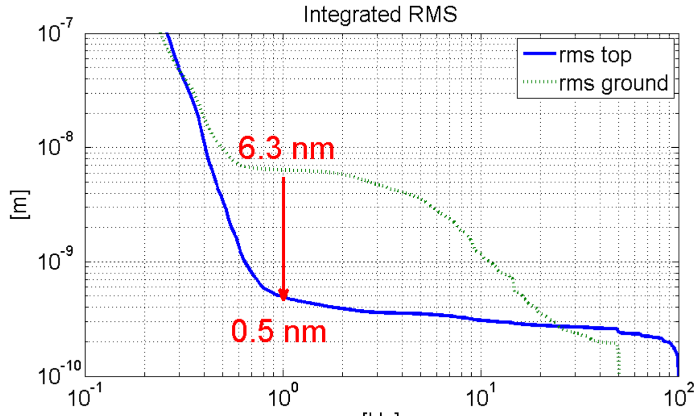


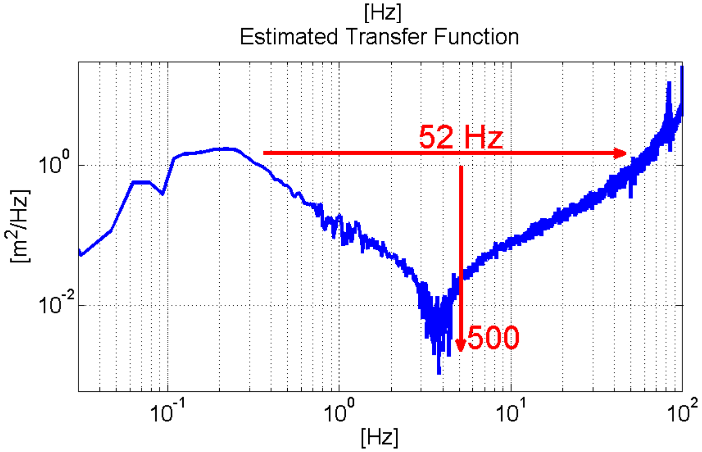
- Quadrupole Stability

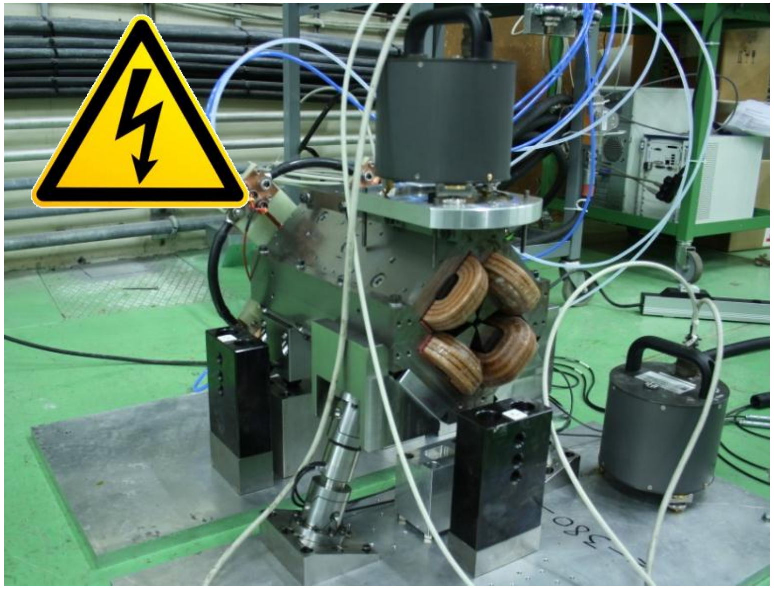
# Stabilization on Type 1 magnet



- Water cooling 4 l/min
- With magnetic field on
- With hybrid circuit



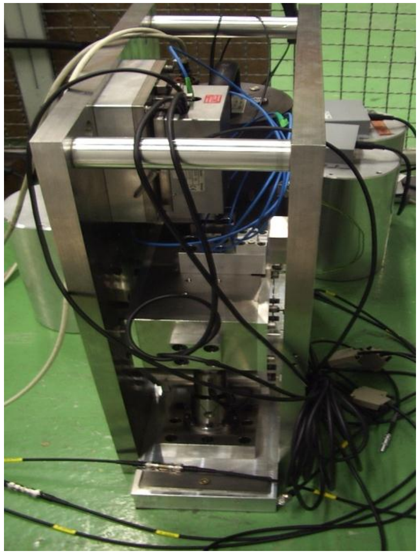



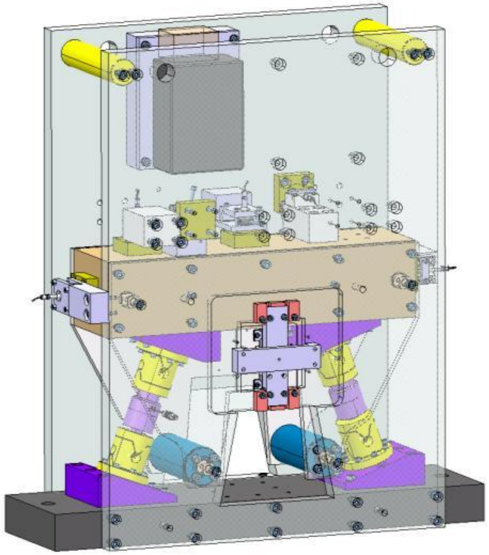
| Figure | Value |
| --- | --- |
| R.m.s @ 1Hz magnet | **0.5 nm** (during the day) |
| R.m.s @ 1Hz ground | 6.3 nm |
| R.m.s. attenuation ratio | ~13 |
| R.m.s @ 1Hz objective | **1.5 nm** |

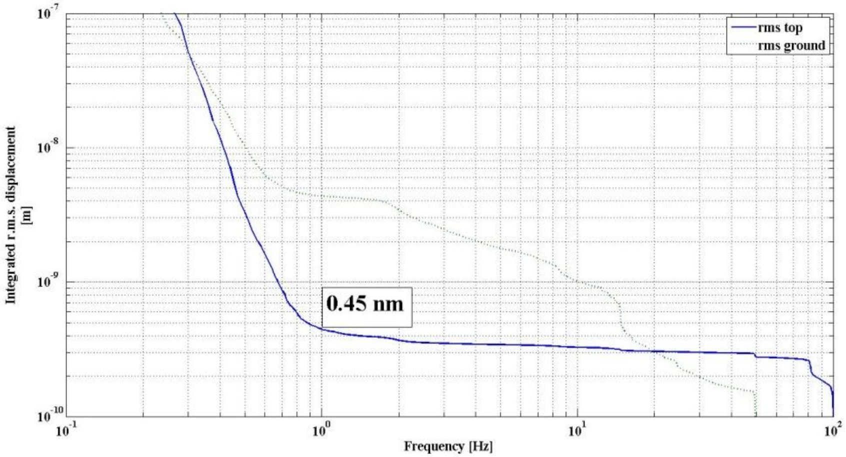
# Positioning + Stab. test bench
# X-y guide prototype operational

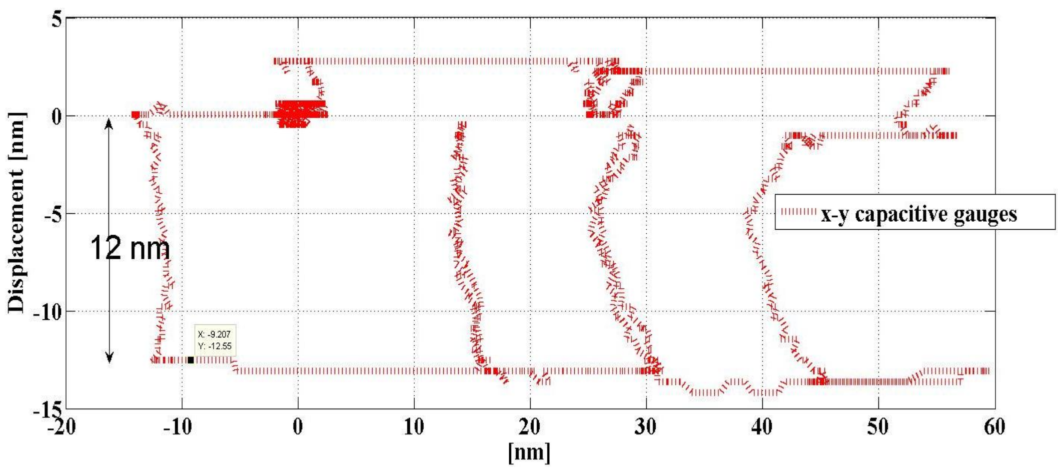




- X-y guide « blocks » roll + longitudinal
- Increases lateral stiffness by factor 500, increases band width without resonances to ~100 Hz
- Introduces a stiff support for nano metrology
- cross check with interferometer

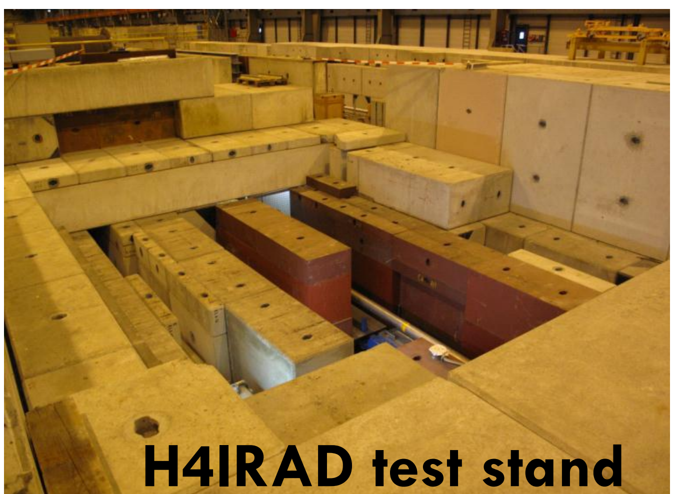


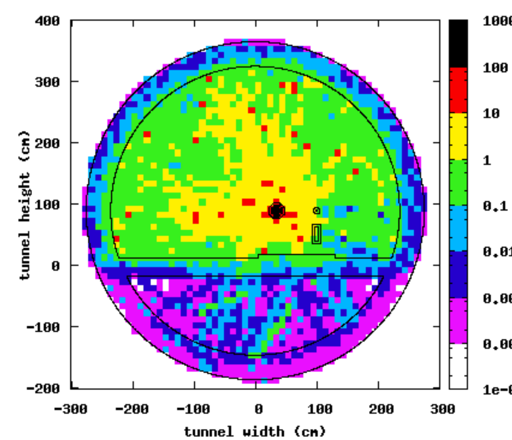


# Stabilisation
# Radiation tests 2012

- Contact with RAD WG
- **SEU tests in the H4IRAD test stand at CERN planned for August**
- Several components under evaluation. Larger community working on same problems
- Sensitivity simulation of controller to changes in the components
- remark from RAD WG: **Essential for CLIC: obtain more complete and sure expected radiation values.**
- Available shielding for electronics in the CLIC tunnel ????


H4IRAD test stand



Courtesy S. Mallows

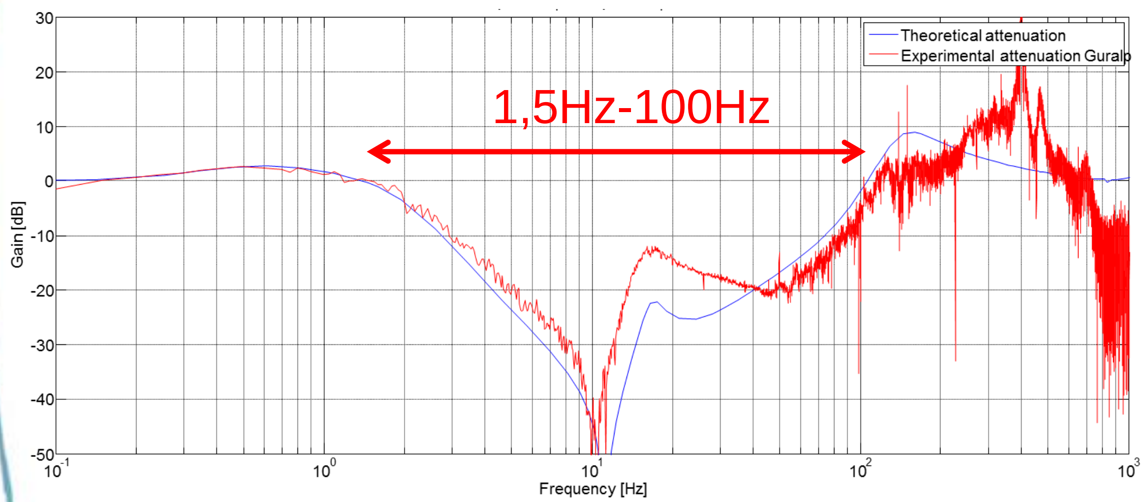
Pablo Fernandez Carmona

# Update on Final Focus stabilisation studies in Annecy

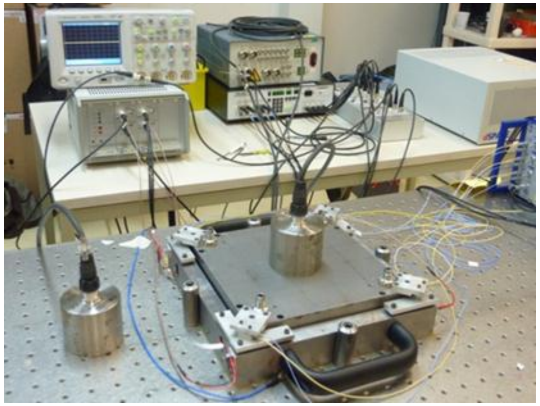
Andrea JEREMIE

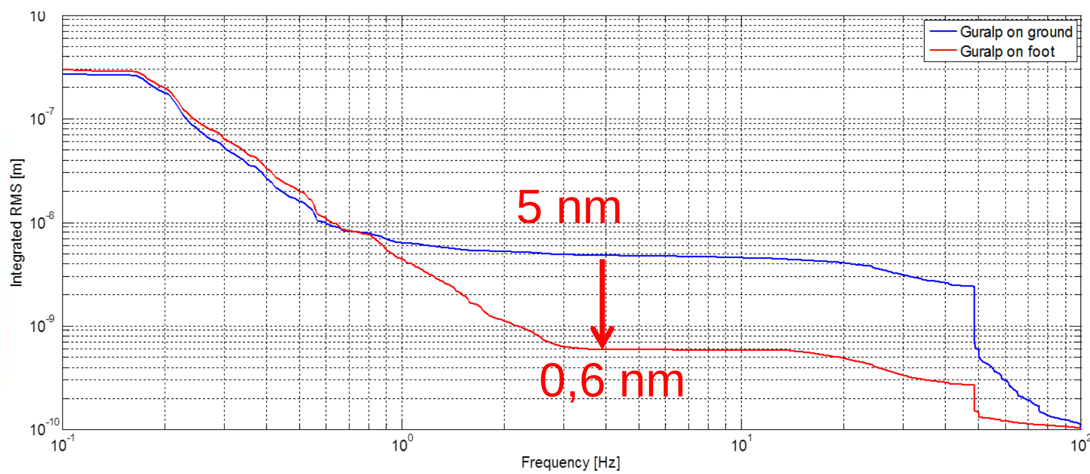
In2p3

# FF stabilisation results



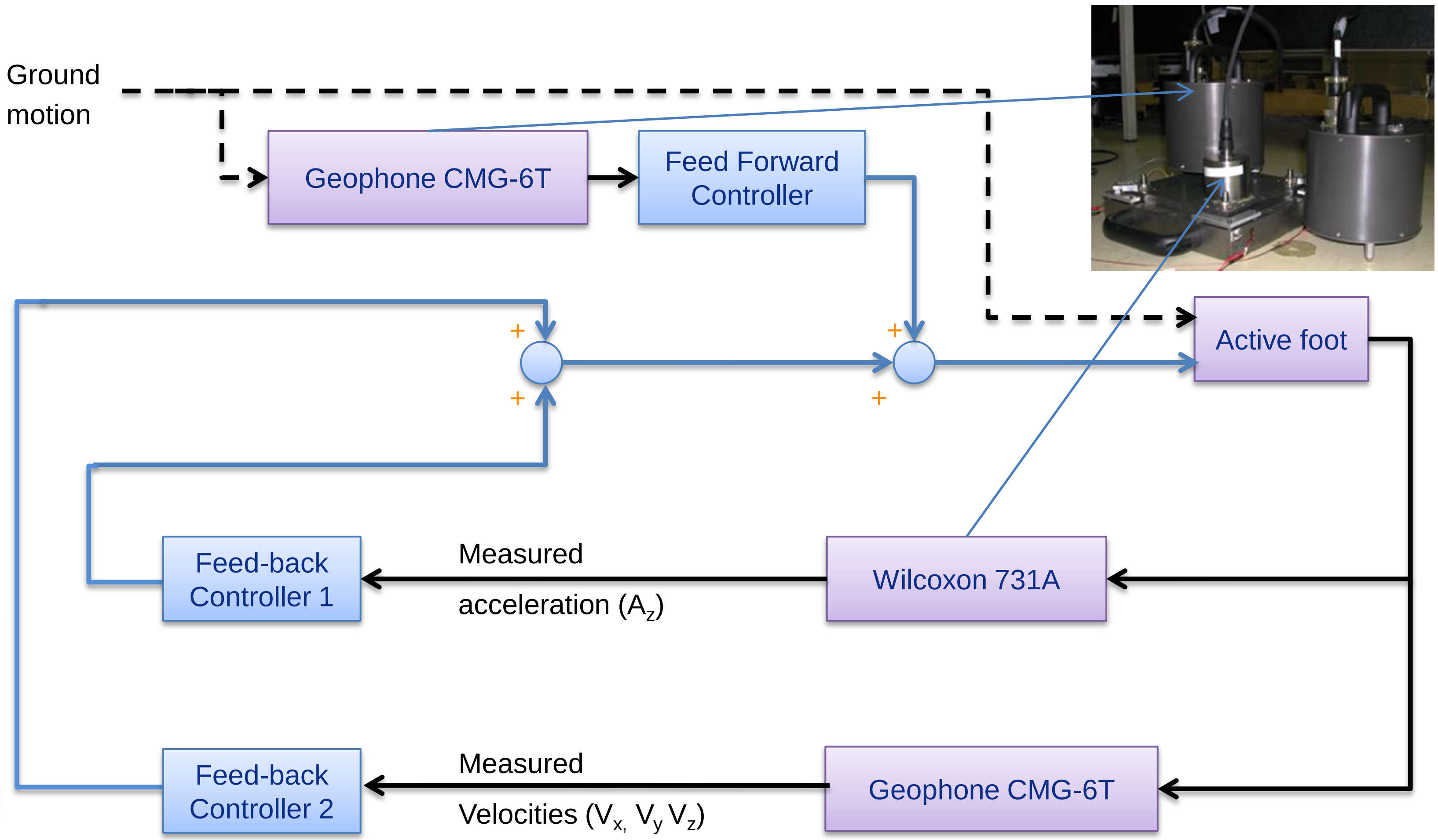

Attenuation up to 50dB between 1,5-100Hz



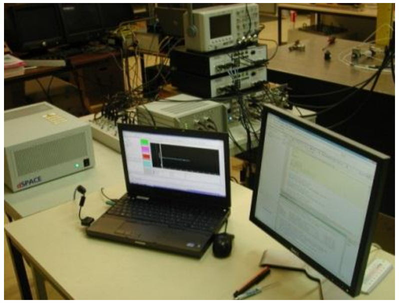



RMS ground at 4 Hz: 5 nm
RMS on foot at 4Hz: 0,6nm
(FF aim: 0,2nm at 4Hz)
RMS ratio: 8,3

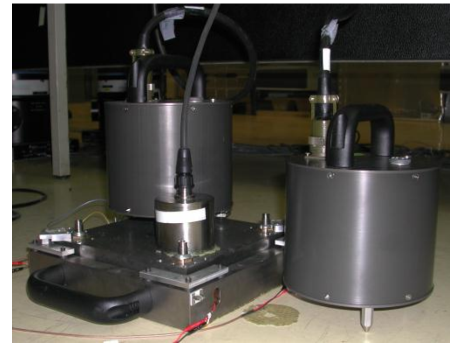
# Control scheme for FF quad stabilisation



# Experimental setup



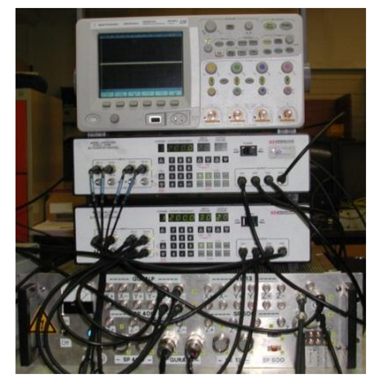
Matlab and dSPACE ControlDesk
For monitoring and analysis



Active foot with sensors

dSPACE
Real time hardware for
Rapid Control Prototyping


| Sensor type | Electromagnetic Geophone | Piezoelectric Accelerometer |
|---|---|---|
| Model | GURALP CMG-6T | Wilcoxon 731A |
| Company | Geosig | MEGGITT |
| Output signal | Velocity (X,Y,Z) | Z Acceleration |
| Sensitivity | 2398 V/m/s | 10 V/g |
| Bandwidth [Hz] | [0.033-100] | [0.05-500] |

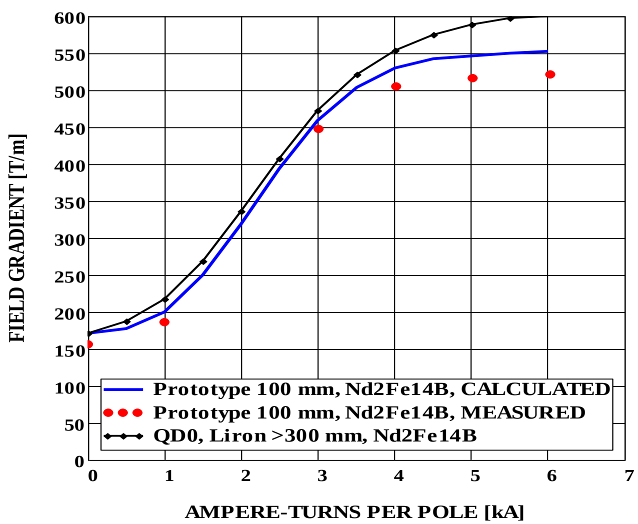


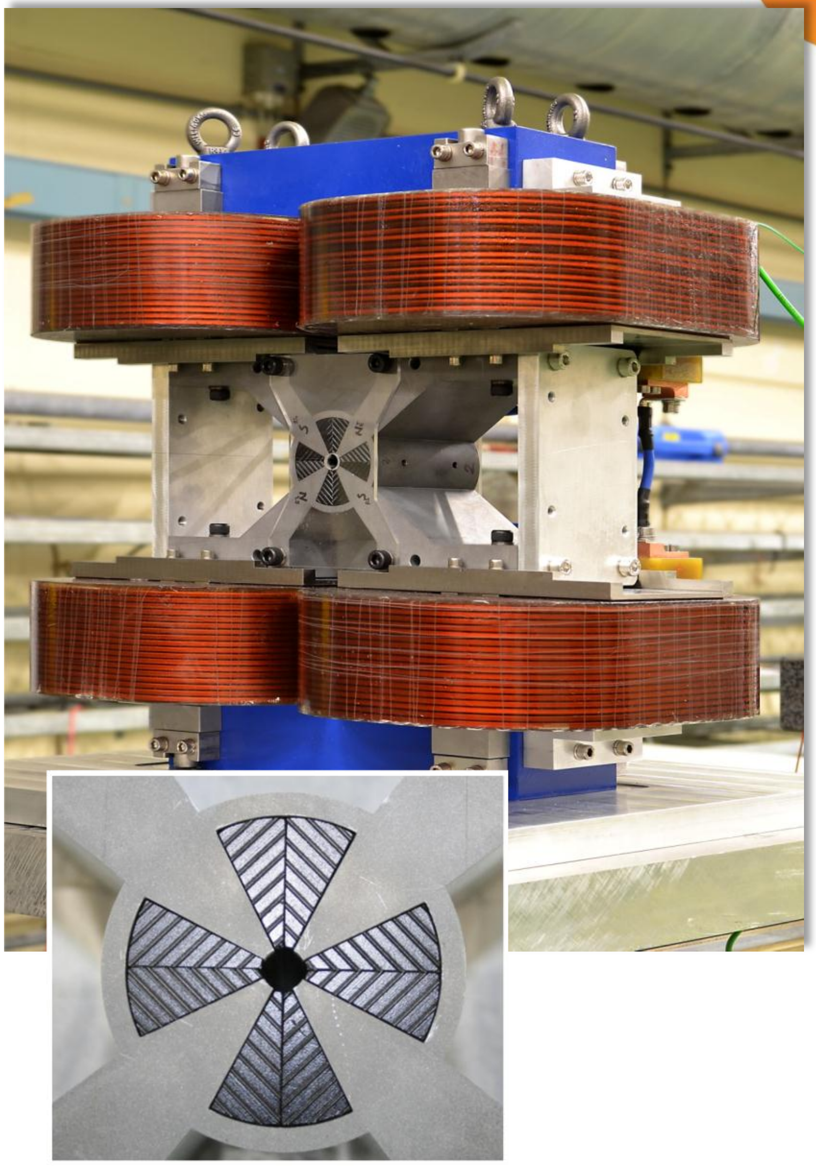
Amplifiers, filters input/output
board for signal conditioning

- Magnets

# Hybrid QD0 short prototype results

| *CLIC QD0 Main Parameters* | | *Prototype (Iron yoke length of 100 mm)* | *Nominal magnet (Iron yoke length of ~ 2500 mm)* |
|---|---|---|---|
| Max. Gradient (computed) | [T/m] | 552 | 615 |
| Magnet aperture | [mm] | 8.25 | 8.25 |
| Tunability | | 32÷100% | 32÷100% |
| ***GEOMETRY*** | | | |
| Total length | [mm] | 273 | 2600 |
| Width | [mm] | 468 | 518 |
| Height | [mm] | 424 | 424 |
| Total mass | kg | ~ 200 | ~2700 |
| ***COILS*** | | | |
| Conductor size | [mm] | 4x4 | 4x4 |
| N. of turns | | 324 (18x18) | 324 (18x18) |
| Average turn length | [m] | 0.586 | 5.786 |
| Total coils (4) mass | [kg] | 107.2 | 1060.8 |
| ***ELECT.PARAMETERS*** | | | |
| Ampereturns per pole | [A] | 5000 | 5000 |
| Current | [A] | 15.4 | 15.4 |
| Current density | [A/mm$^2$] | 1 | 1 |
| Total resistance | [mOhm] | 896 | 8838 |
| Total voltage | [V] | 13.8 | 136.4 |
| Total power | [W] | 213 | 2150 |



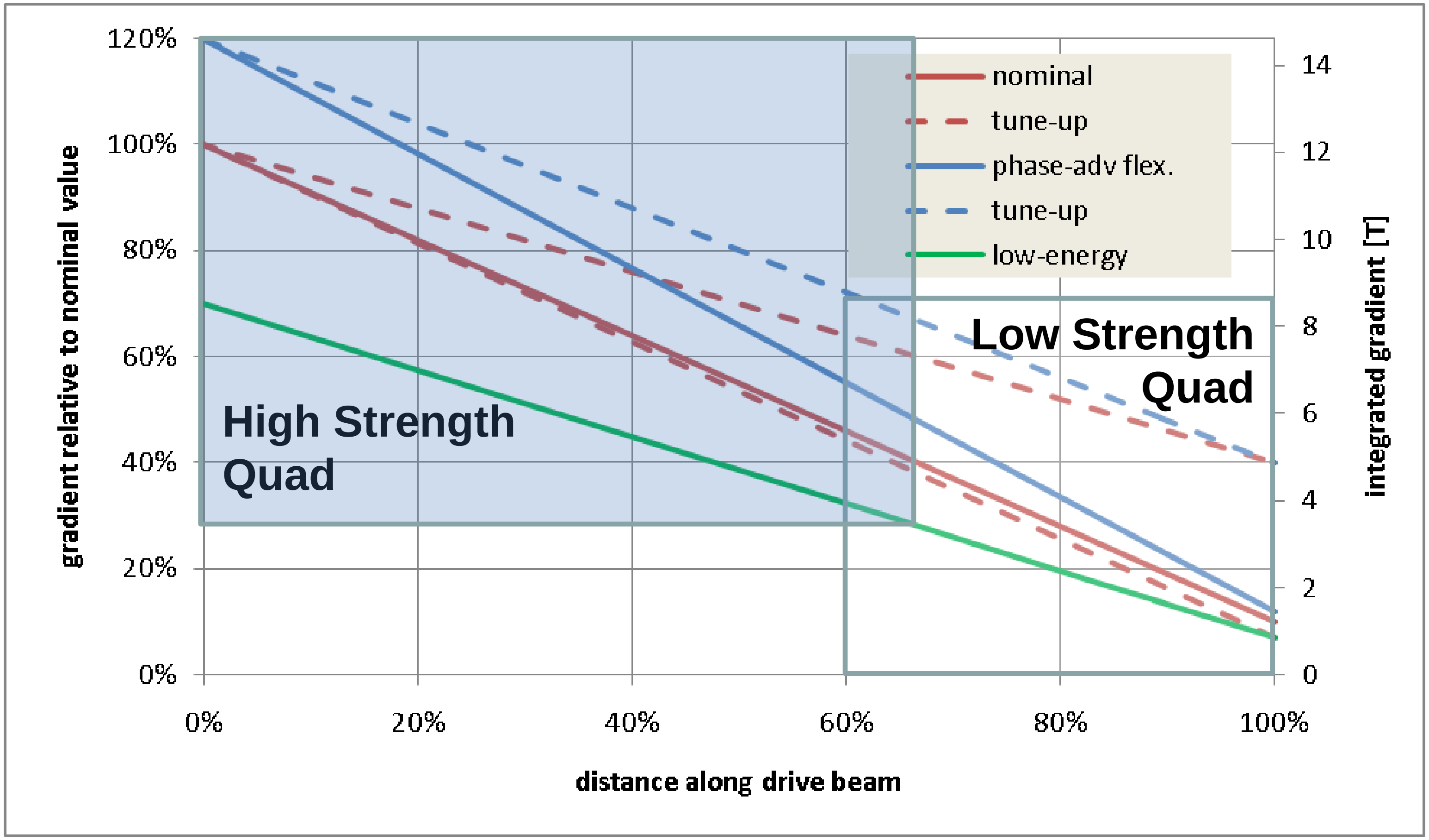
# ASTeC Report for CLIC-UK

**Jim Clarke** on behalf of all ASTeC & Technology Department staff contributing to CLIC-UK

**STFC Daresbury Laboratory, UK**

**CERN-UK Review, 9th May 2012**

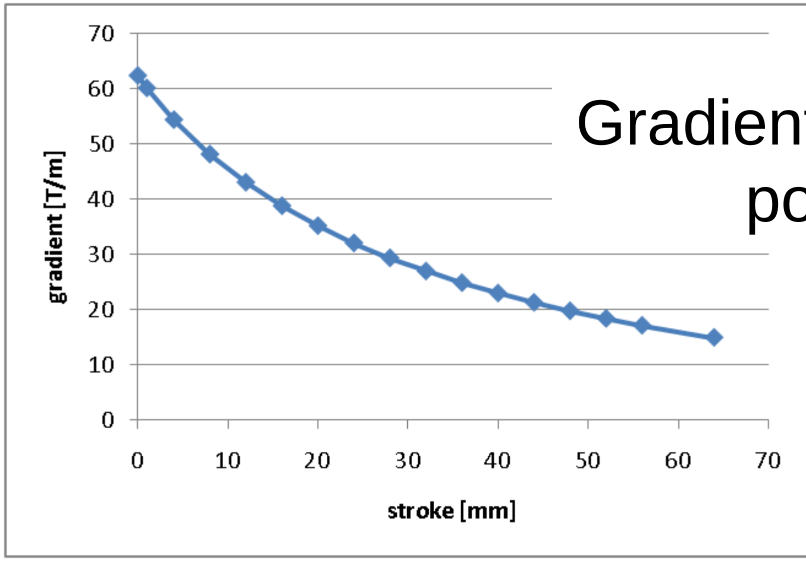
# Tuneability



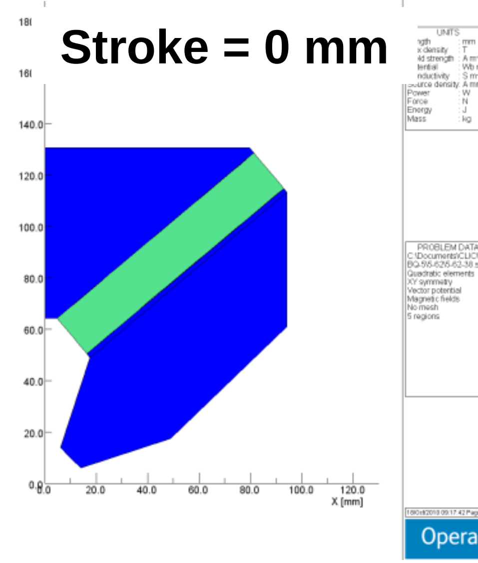

Low energy end more demanding in terms of adjustable range of magnet

# High Strength Quad Design

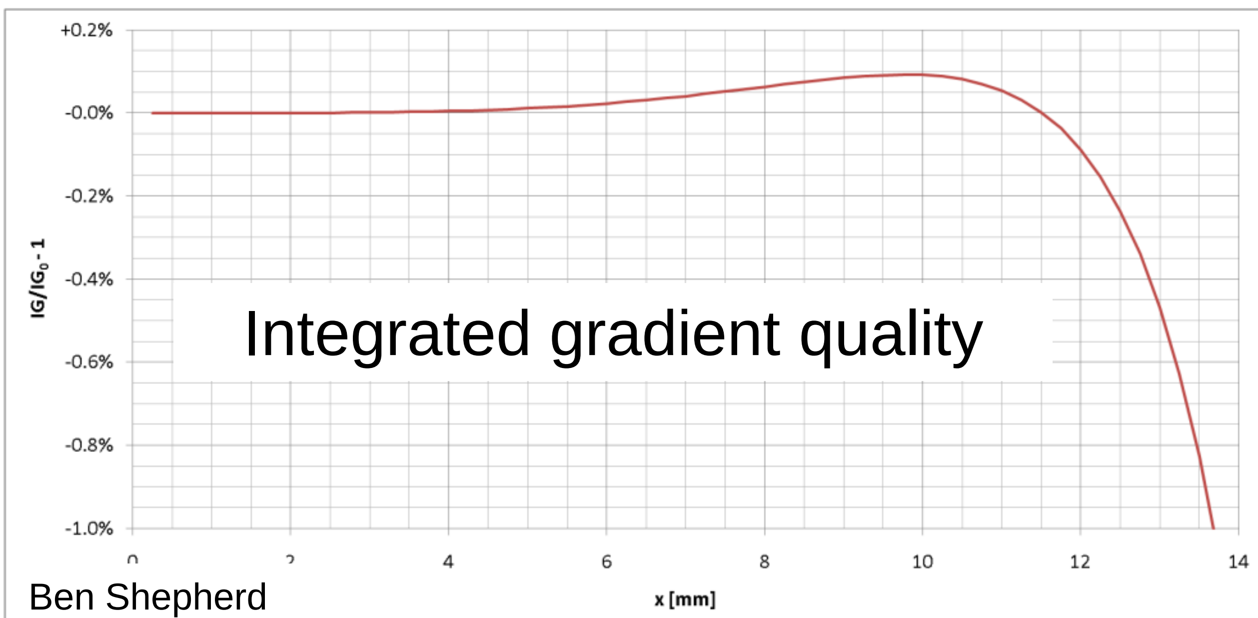
Gradient vs magnet position



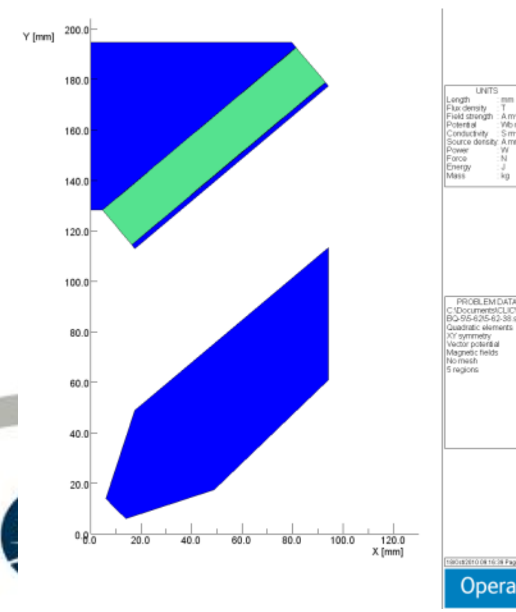

Stroke = 0 mm




Integrated gradient quality

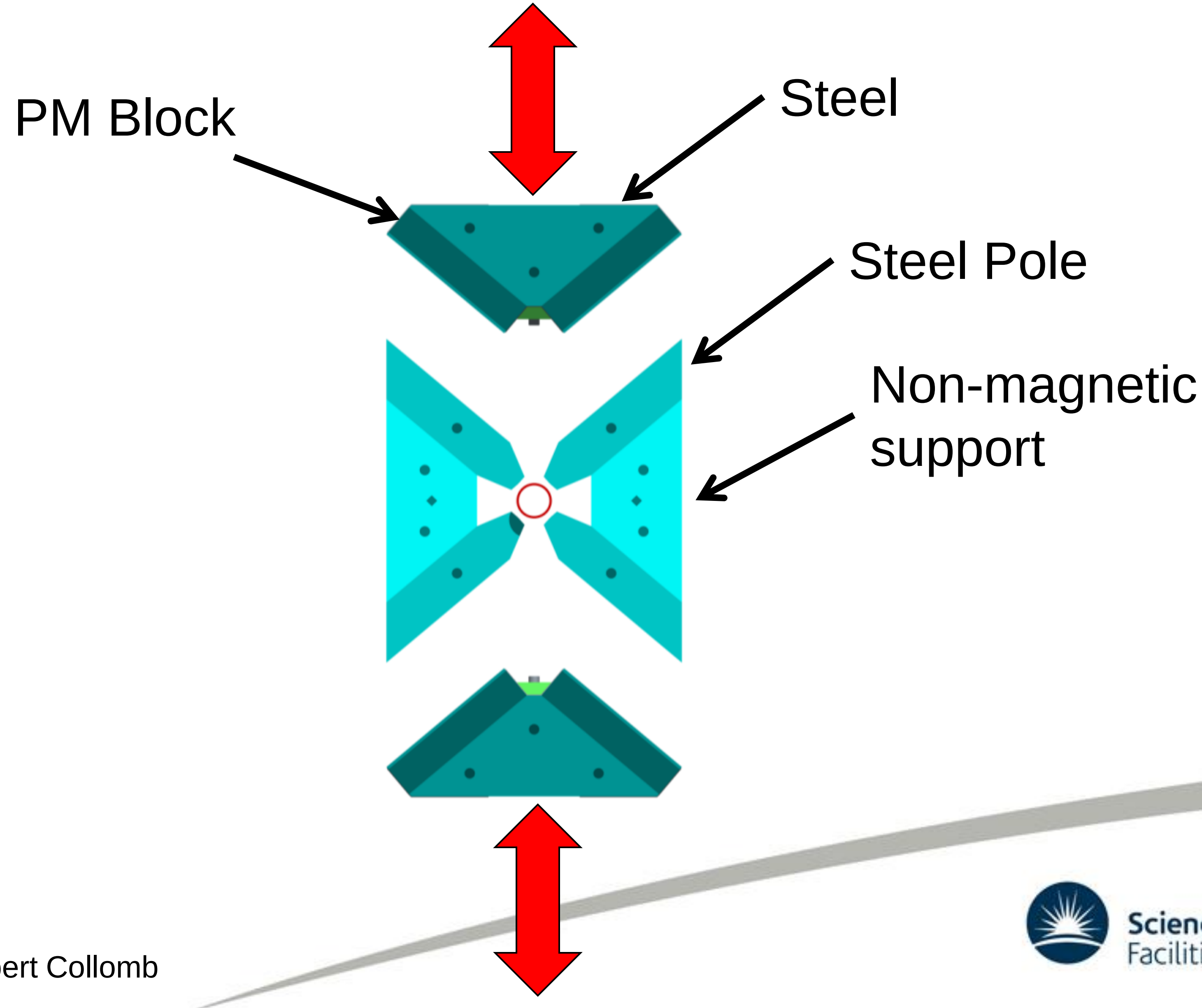



Stroke = 64 mm




Ben Shepherd

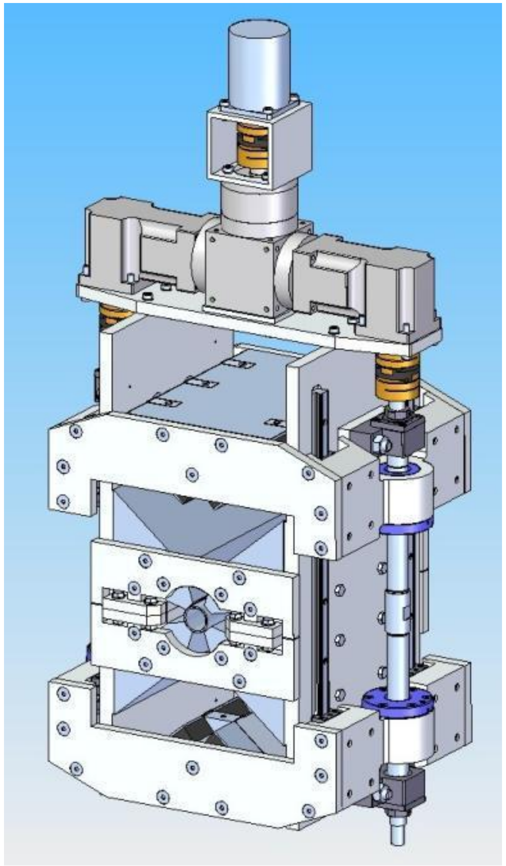
# Basic Engineering Concept



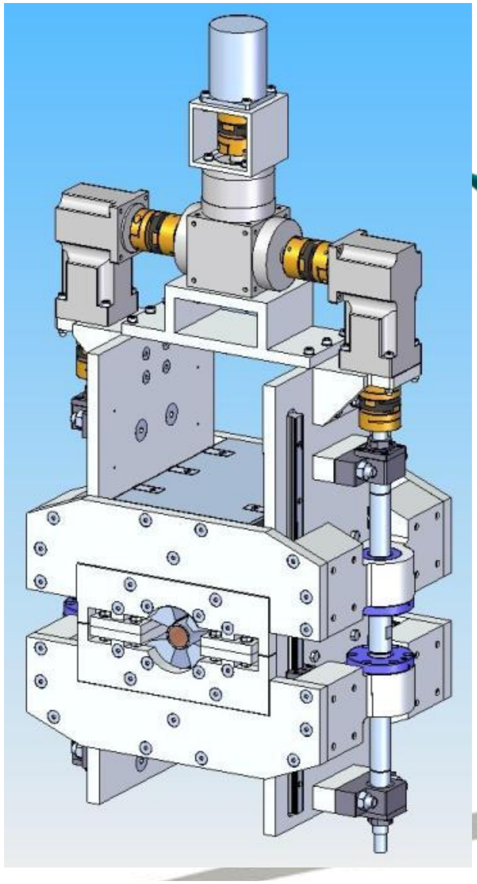

Norbert Collomb

Science & Technology Facilities Council

# Engineering

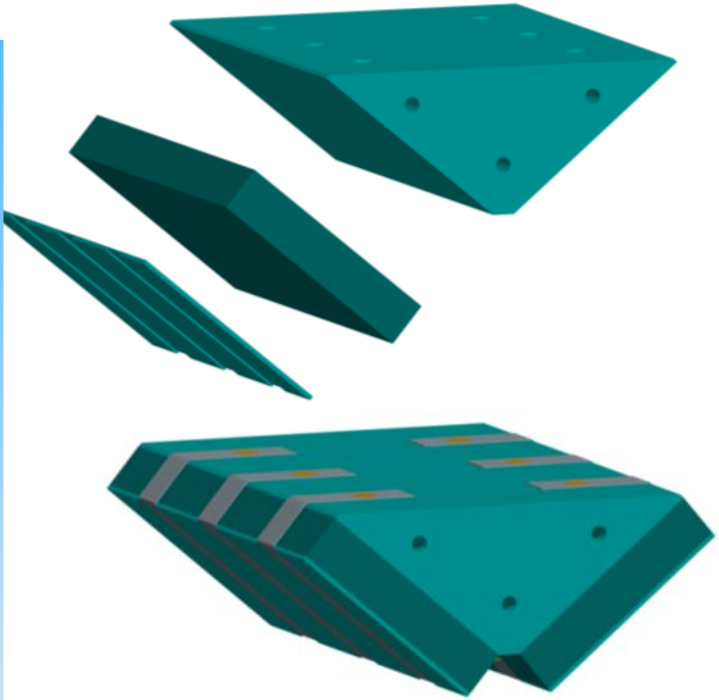


Fully Open



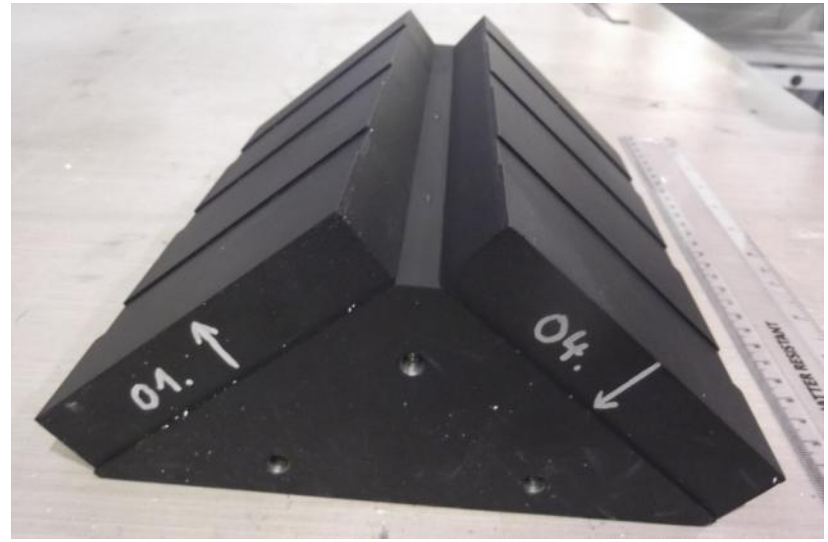
Fully Closed

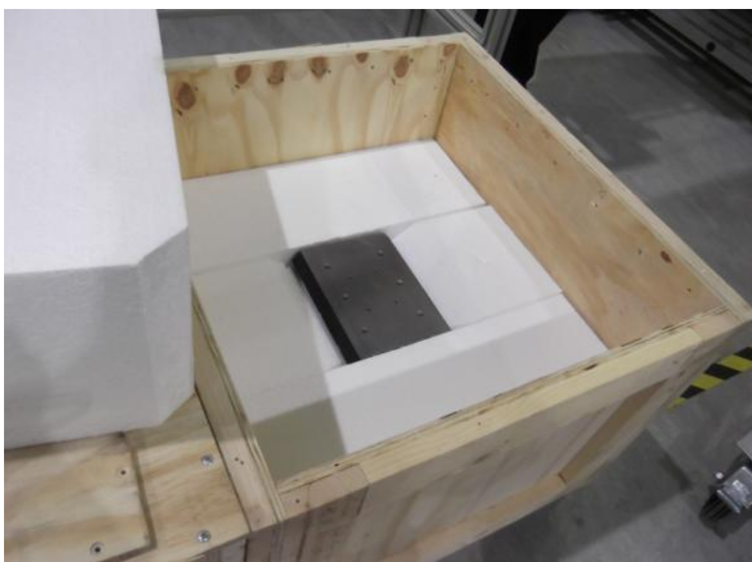
PM Block secured to steel yoke

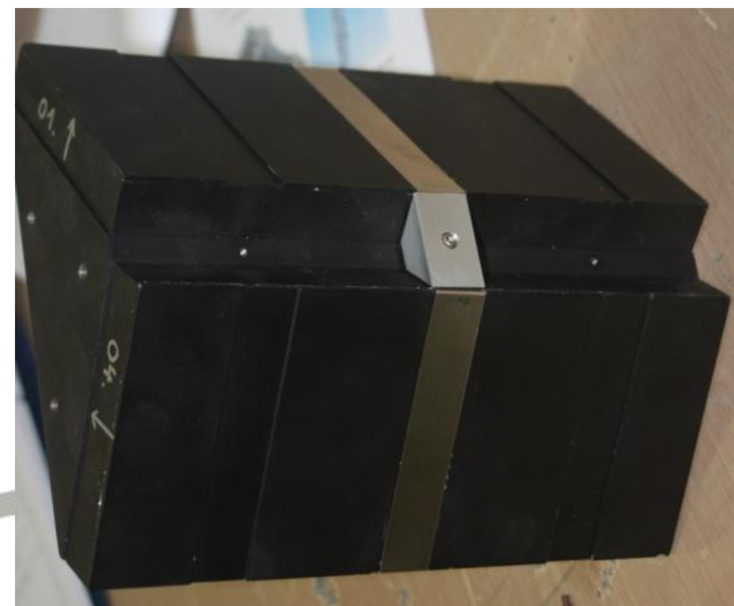


Norbert Collomb

# Permanent Magnets



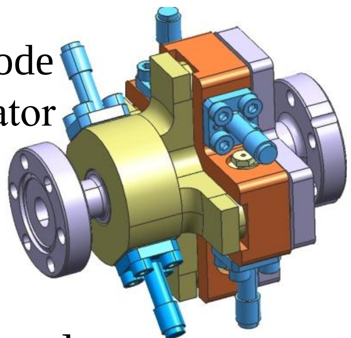





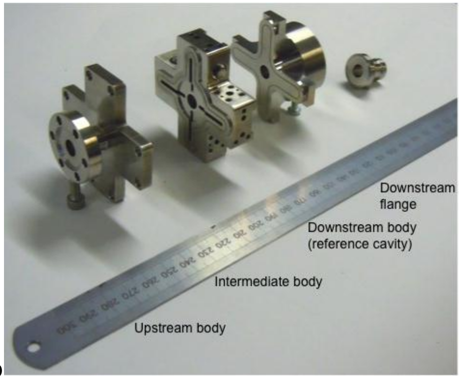
- Instrumentation

# Cold test of the cavity BPM prototype

Monopole-mode "REF" resonator

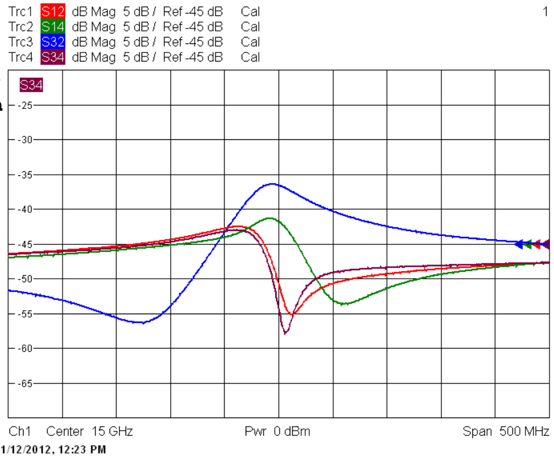


**Dipole-mode "BPM" resonator & waveguide**

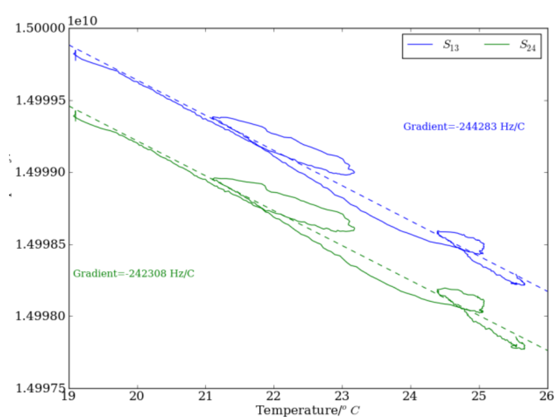



- Stainless steel prototype cavity BPM for CTF3
- Cold test carried out before brazing – mechanical improvement identified
- Dipole mode frequency within 5 MHz of the design value of 15 GHz
- Q-values and coupling close to expected (~250)
- Reference cavity: frequency off by +2 GHz, Reduced the diameter by 0.98 mm to correct it
- Cavity has been **successfully brazed** and leak-tested
- Next steps: vacuum test with feedthroughs, repeat RF measurements
- **Foreseen to be tested in TBTS@CTF3**

Low cross-coupling out of the box: -41 dB average

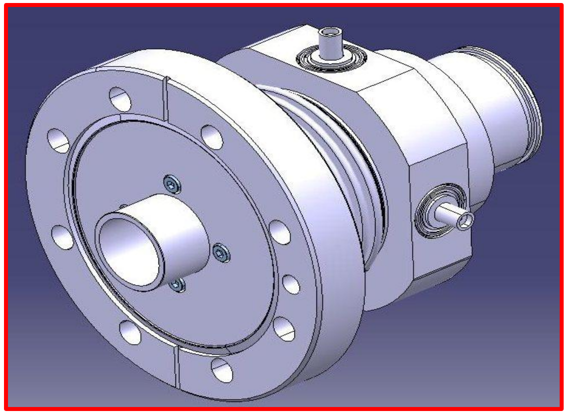



Frequency vs. temperature variation: 250 kHz/K




Royal Holloway University of London

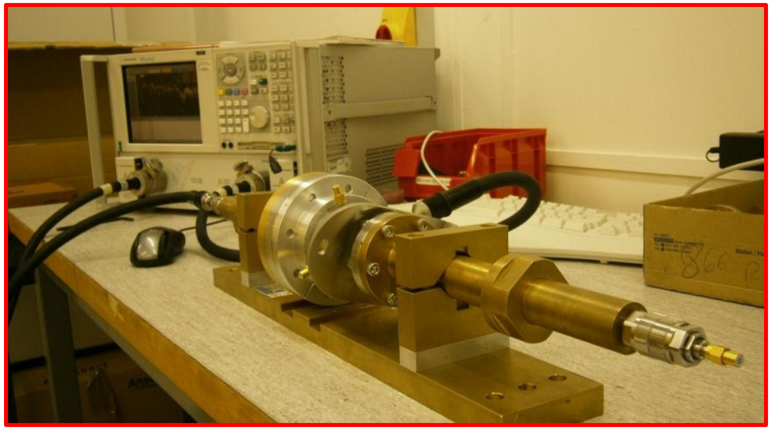
# Cold test of the Stripline BPM prototype



**Striplines BPM for the CLIC decelerator**

- High current 100A – high bunch frequency 12GHz
- In the vicinity of an RF strucutre producing 100MW @12GHz
- Temporal resolution of 10ns
- 2 micron resolution over an aperture of 23mm (accurate calibration)
- Transverse mode damped by SiC absorber

**Stripline BPM has been assembled**

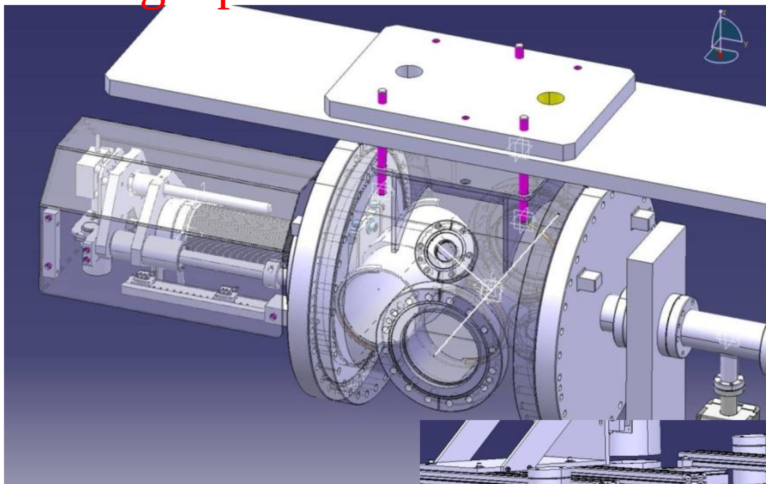


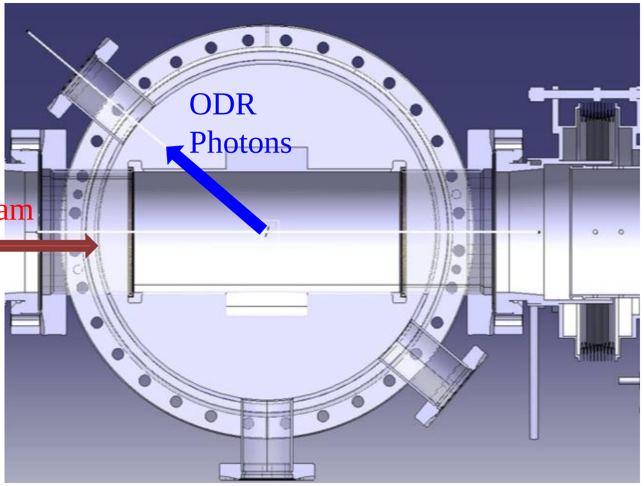
**RF Characterization and linearity checks have started**

**<u>Foreseen to be tested on TBL@CTF3</u>**

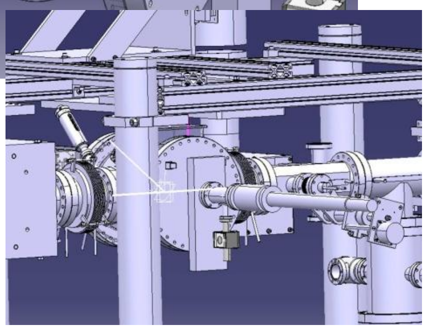
# Design of ODR Chamber for CESRTA

## Observing Optical Diffraction Radiation angular distribution to measure Beam size

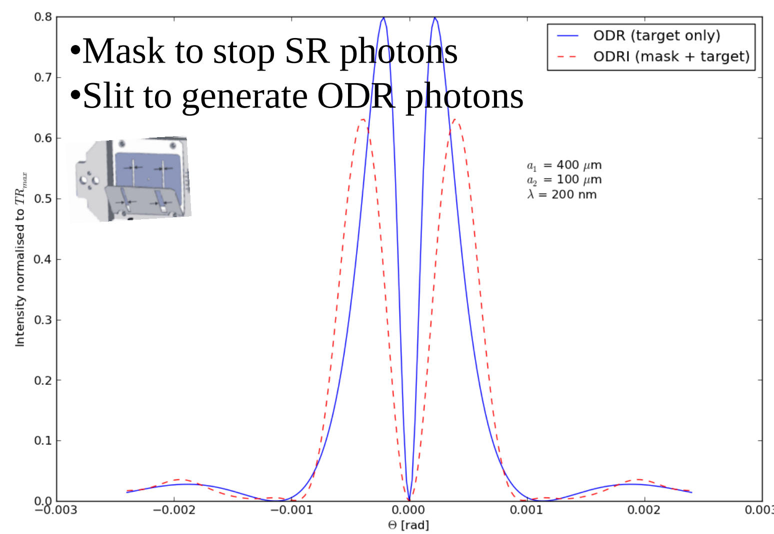


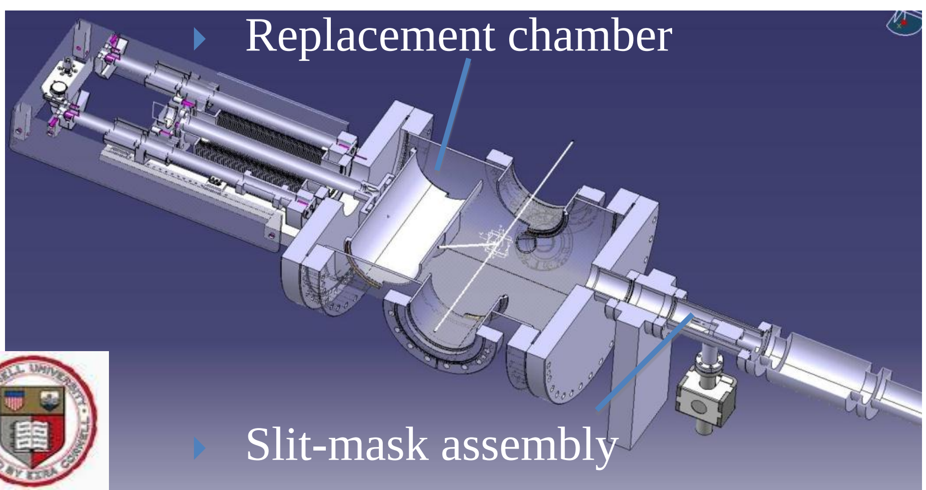



Integration of Chamber
in the L3 straight section
@ CESR-TA



Simulation of the optical distribution

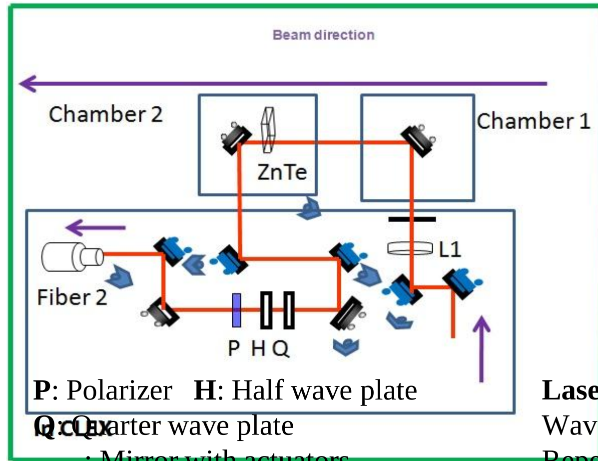


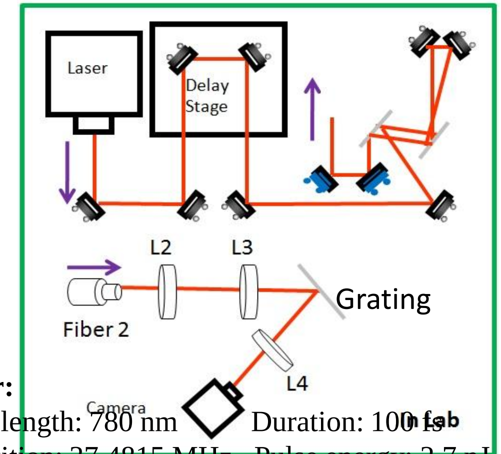
## 1. Califes Facility — E-O Bunch Profile Monitor using spectral decoding

Development of a sub-ps time resolution bunch length monitor

1. Overall EO system for CTF3 is designed
2. Laser system and optics arrived
3. Control system design completed, all cables and optical fibres installed
4. Optical synchronization system designed , transfer lines for laser and OTR designed
5. Laser laboratory under preparation, camera and motors being delivered
6. Two vacuum chambers are being designed




P: Polarizer H: Half wave plate
Q: Quarter wave plate
: Mirror with actuators
: Finger camera




**Laser:**
Wavelength: 780 nm Duration: 100 fs
Repetition: 37.4815 MHz Pulse energy: 2.7 nJ
**Crystal:** Thickness: 1mm Separation: 5-10 mm

## 2. Activities at STFC Daresbury Laboratory

**Spectral Upconversion Techniques -** Convert the far-IR → mid-IR spectrum to an optical spectrum

- Bandwidth reduction 1mm - 10μm → 800nm – 740nm

2011/12 experiments at Daresbury (Manchester Univ collaborating)

**Laser-generated THz pulses as mimic of electron bunch**

- Experiments underway May 2012

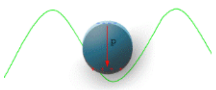
University of Dundee

STFC ASTeC

## 3. Activities at University of Dundee

**EO Detection solution in thin films & 2D structures**

Nano-structured materials



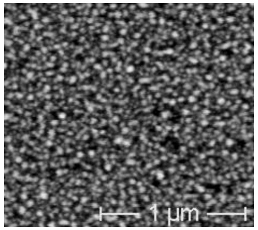
**Materials, Photonics & Smart Systems (MAPS) Group at Dundee**
Fabrication & Applications of Nanocomposites

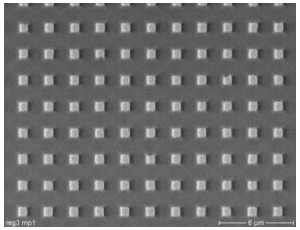
3 separate nanosecond laser systems (wavelengths - 355, 532 and 1064 nm) in place for materials processing, during 2011

Picosecond (Coherent Talisker ULTRA 355-04) system installed May 2012
Operates at same 3 wavelengths

Pulsewidth <15ps with an average power of up to 4W at 355nm, 8W at 532nm, and 16W at 1064nm.

First tests on new system planned for early June 2012



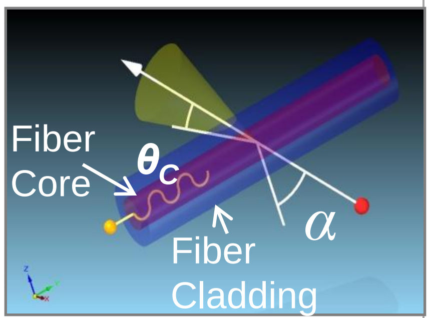



# CLIC Beam loss monitoring

## 1. CDR Baseline Choice: Ionization Chambers

- Adequate (dynamic range, sensitivity), BUT expensive, 1 per quadrupole means >50,000.
- Investigate Alternative Technologies for the Two Beam Modules e.g. Cherenkov Fibers
- *REF: CLIC BI CDR chapter & IPAC 2010 WEPEB074*

## 2. Development of Analytical Model for Cherenkov Light Signal in Fibers




*Must Consider probability of :*

***1.trapping** of produced photons inside the fiber, $P_t$*

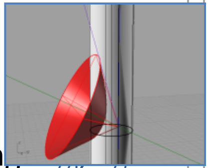
*2.trapped photons exiting the fiber end face, $P_e$*

***3.trapped photons exiting the** end face **within acceptance cone** $P_{e,a}$*

$$P_{e,a} \propto \cos^{-1}\left[\frac{\beta\sqrt{n_{co}^{2} - NA} - \cos\alpha}{\sin\alpha\sqrt{\beta^{2} n_{co}^{2} - 1}}\right] \qquad NA = \sqrt{n_{co}^{2} - n_{cl}^{2}}$$

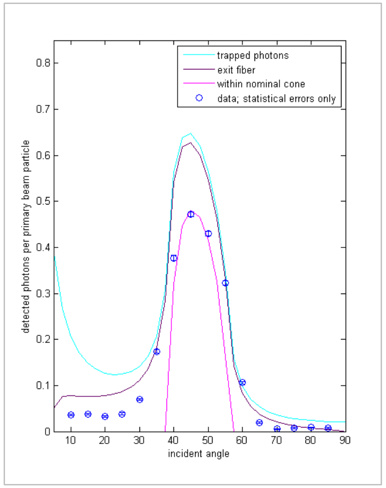
*Several papers already exist (but conflicting theories) →Developed our own model ~ 200 lines code (J. V*

- Signal depends on:
  - Angle of incoming radiation alpha **α,**
  - Velocity of charged particle beta: *β*
  - Refractive indices of fiber core and cladding $n_{co}$, $n_{cl}$
  - Fiber diameter



## 3. Verification of Model for Cherenkov Light Signal in Fibers

- Experiments at CERN Test Beam Lines (T9 East Hall, H6A, SPS North Area)
- Good Agreement between Experimental and Model

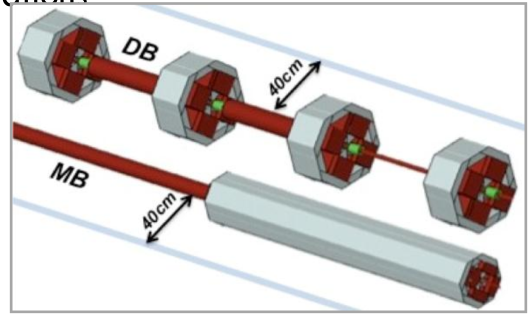



**Left: Results for the angular dependency of the photon yield in a fiber** with:
-d=0.365mm
-NA=0.22

- *(FLUKA simulations for Optical photon production also in good agreement with Model / experimental data )*
- *REF: Masters thesis (May 2012) by J. Van Hoorne,*
- *& Journal papers (hopefully) to be published.*

## 4. Determine Cherenkov Fiber Signal for **CLIC Two Beam Modules**

1. FLUKA to simulate loss scenarios and calculate angular and velocity distribution of secondary particle shower at fiber locations

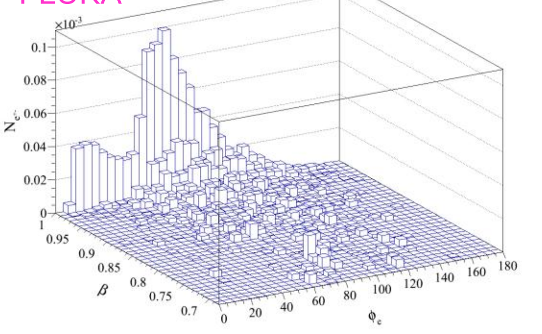



*FLUKA Represnetion of Two Beam Modules Beamlone Components. Charged particle distributions calculated at blue lines.*

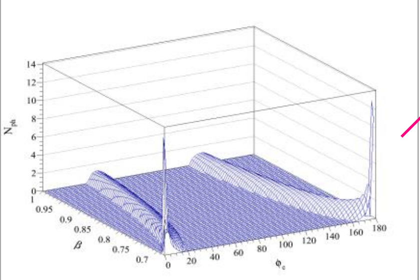
2. Use analytical model to predict signal ( or 'trapped photons') for a given fiber type and various loss scenarios. Determined dynamic range, sensitivity requirements of photon detectors.

***Example : Loss at 2.4 GeV :***

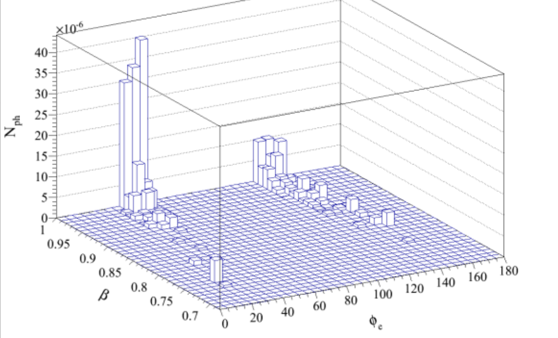
Particle Shower Distribution (from FLUKA



*Model for the angular & veliocity dependency of the photon yield in a fiber with: d=0.365mm, NA=0.22*



Predicted Trapped Photons



- *REF: webpc171, IPAC 2011*

## Longitudinal Position Resolution - Fibers

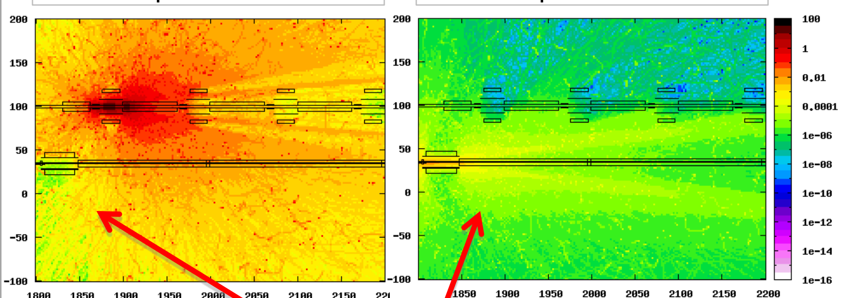
- 100m fibers, Long bunch trains (60m)
  - **NOT a problem for machine protection purposes: Onset of a destructive loss always detected**
  - Location of onset of destructive loss can be found with rise time of photo-detector signal
  - Standard Operational Losses: Some localised detectors per fiber could be used to measure the loss structure over a train and compared with signal from fiber to determine loss structure over 100m accelerator. ..

## Cross Talk (All Monitor Types)

- Desirable to distinguish between a failure loss from each of the beams
- Spatial Distribution of prompt Absorbed Dose (Gy) from FLUKA Simulations:

**Drive Beam:** 1.0% of bunch train hits aperture restriction

**Main Beam:** 0.01% of bunch train hits aperture restriction

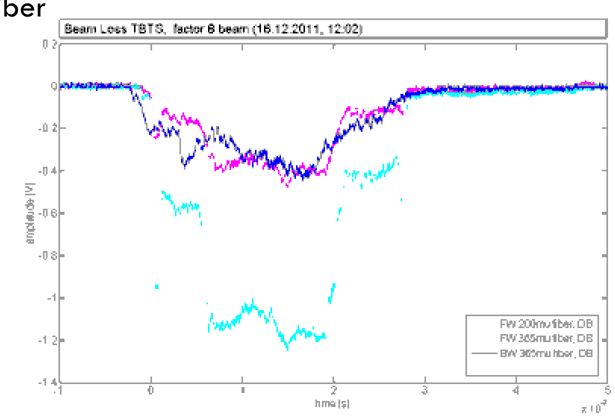



- Loss of 1.0% in DB provokes similar signal as a loss of 0.01% of MB in region close to MB quadrupole.
- **Compare signals from both fibers each side to distinguish Main and Drive Beam losses.**
- In any case: NOT a Machine Protection Issue – **Dangerous loss would never go unnoticed**

## Fibers at CTF3

- *Installation of fiber at TBL (2012)*
  - Achievable longitudinal position resolution, with long bunch trains using 'forward' (downstream) and 'backward' (upstream) trapped photons
  - Comparison of Fiber with localized detectors (ACEMs)
  - Suitability of Silicon Photomultipliers as a photodetector for fibres

- *Preliminary Results at CLEX(TBTS) (in 2011) Used for:*
  - First observation of Cherenkov Signal from Fiber
  - See whether cross talk can be studied at TBTS (it probably can't – probe beam too low instensnity)
  - Decide on diameter for fibers to be used in CLEX Hall. (< 200um suffuiecient)
  - Confirm production of 'upstream' and 'downstream' photons in fiber

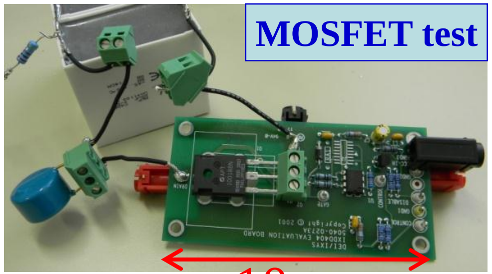


- Damping Ring Extraction Equipment
  - Stripline kickers
  - Pulser (Inductive Adder)

# Present Status of Inductive Adder (IA) Development

- Components and devices ordered for prototyping an IA
- Tests of main components on-going or scheduled:
  - Pulse Capacitors
  - Semiconductor Switches and Gate Drivers
  - Transformer cores (April, by CERN TE/MSC?)
- 3-D modelling of the IA stack commenced
  - Mechanical and electrical design of the IA stack: housing of transformer cores, feedthroughs, PCBs, etc.

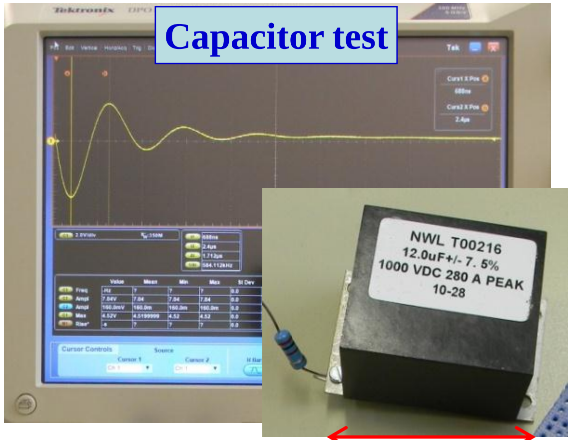
**MOSFET test**




**3D Model of one layer of IA !**

**Sample transformer cores**

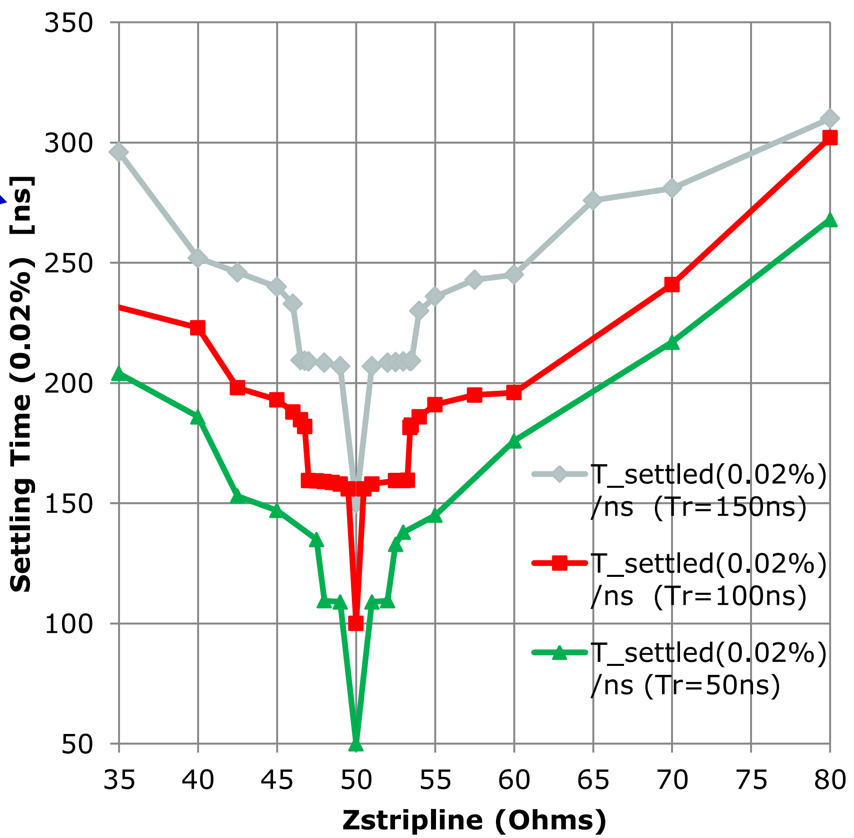

**Capacitor test**



# Present Status of Inductive Adder Development & Planning

- The stripline odd mode characterisitic impedance may not be matched to the impedance of the inductive adder, resulting in increased settling time for ripple and hence increased demands on the IA.
- Also the IA design for the CLIC 1 GHz baseline is more demanding than for the 2 GHz option.
- In addition, although the IA design for CLIC DR is the main goal of the current R&D, **the prototype IA is also being designed to meet the specifications of ATF test facilities** (e.g. increased voltage w.r.t. CLIC DR).
- 2012 goal is to have tested 2 or 3 layers of IA and ordered significant quantity of components for one-stack.
- 2013 goal is to build and test one stack and order components for a 2nd stack.
- **2014 goal is to test in a facility (with beam).**

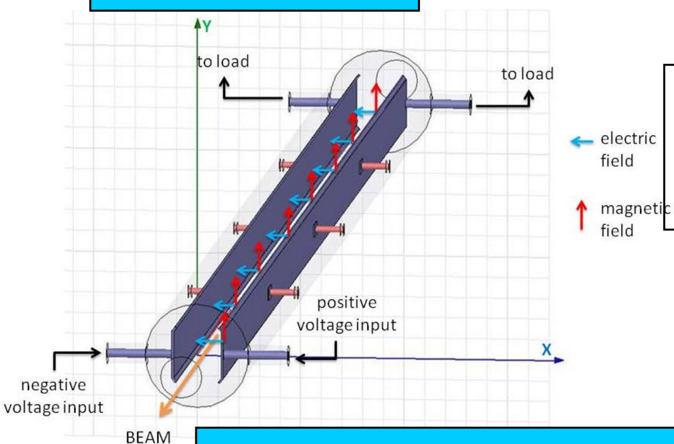
**Settling time of the kicker voltage pulse as function of stripline impedance. IA = CVS, Delay of IA + cable delay = 10 ns; time delay of stripline = 10 ns; load = 50 Ω.**



# Status Of Development of Striplines

- ✓ Cross section of striplines studies to achieve:
  - Characteristic impedance = 50 Ω
  - Excellent field homogeneity
- ✓ **Possibility to test CLIC DR striplines in ATF & ALBA**
  - **ALBA parameters presently being defined**
- ✓ Beam coupling impedance:
  - Presently being studied

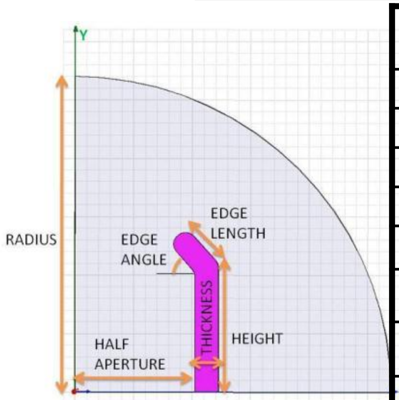
## STRIPLINE KICKER




- **Even mode**: same polarity on electrodes.
- **Odd mode**: opposite polarity on electrodes.

[1]over 1 mm radius
[2]over 3.5 mm radius
[3]over 0.6 mm radius

## GEOMETRIC PARAMETERS OF THE CROSS SECTION




| PARAMETER | CLIC DR | CLIC PDR | ATF2 | ALBA |
|---|---|---|---|---|
| Kicker radius (mm) | 24.6 | 51.1 | 24.6 | |
| Aperture (mm) | 20 | 40 | 20 | |
| Electrode height (mm) | 24.2 | 65.0 | 16.2 | |
| Electrode edge length (mm) | 4.9 | 5.0 | 5.0 | |
| Electrode edge angle (º) | 45 | 45 | 45 | |
| Even mode impedance (Ω) | 50.4 | 50.0 | 69.7 | |
| Odd mode impedance (Ω) | 37.3 | 36.2 | 49.7 | |
| Field homogeneity (%) | ± 0.01[1] ± 0.1[2] | ± 0.08[2] | ± 0.01[3] | |
| Calculated longitudinal beam impedance (Ω) | 20.3 | 24.6 | 38.2 | |

## TABLE OF SPECIFICATIONS FOR CLIC DR & PDR, ATF2 AND ALBA

| PARAMETER | CLIC DR | CLIC PDR | ATF2 | ALBA |
|---|---|---|---|---|
| Beam energy (GeV) | 2.86 | 2.86 | 1.30 | 3.00 |
| Total kick deflection angle (mrad) | 1.5 | 2.0 | 5.0 | |
| Deflection | horizontal | horizontal | horizontal | |
| Minimum aperture (mm) | 20 | 40 | 12 | 12 |
| Beam pipe range (mm) | 20 - 30 | 40 - 50 | 20 - 30 | 20 - 30 |
| Effective length (m) | 1.7 | 3.4 | 1.3 | 1.3 |
| Field rise time (μs)<br>Field fall time (ns) | 0.56[A]/1.0[B]<br>0.56[A]/1.0[B] | 0.43[A]/1.0[B]<br>0.43[A]/1.0[B] | < 160<br>NA | |
| Pulse flat top duration (ns) | 900[A]/160[B] | 900[A]/160[B] | 280 - 300 | |
| Flat top reproducibility (ns) | $\pm 1 \times 10^{-4}$ | $\pm 1 \times 10^{-4}$ | $\pm 1 \times 10^{-4}$ | |
| Injection stability (per system) | $\pm 2 \times 10^{-3}$ | $\pm 2 \times 10^{-2}$ | $\pm 2 \times 10^{-3}$ | |
| Extraction stability (per system) | $\pm 2 \times 10^{-4}$ | $\pm 2 \times 10^{-3}$ | $\pm 2 \times 10^{-4}$ | |
| Injection field inhomogeneity (%) | ± 0.1[2] | ± 0.1[2] | ± 0.01[3] | |
| Extraction field inhomogeneity (%) | ± 0.01[1] | ± 0.1[2] | ± 0.01[3] | |
| Repetition rate (Hz) | 50 | 50 | 50 | |
| Vacuum (mbar) | $10^{-10}$ | $10^{-10}$ | $10^{-10}$ | $10^{-10}$ |
| Pulse voltage per stripline (kV) | ± 12.5 | ± 17.0 | ± 15.0 | |
| Stripline pulse current [50Ω load] (A) | ± 250 | ± 340 | ± 300 | |
| Peak beam current (A) | 110[A]/120[B] | 50[A]/70[B] | | 50 |
| Minimum bunch spacing (ns) | 1.0[A]/0.5[B] | 1.0[A]/0.5[B] | | 2.0 |
| Bunch length (ps) | 6.0[A]/5.3[B] | 1.0[A]/1.4[B] | | 20.0 |
| Mode matched to 50 Ω characteristic impedance | even | even | odd | |
| Longitudinal beam coupling impedance (Ω) | < 0.05n | < 0.05n | < 0.05n | |
| Transverse beam coupling impedance (kΩ/m) | < 200 | < 200 | < 200 | |

[A]1GHz baseline
[B]2GHz baseline

# Present Stripline Planning

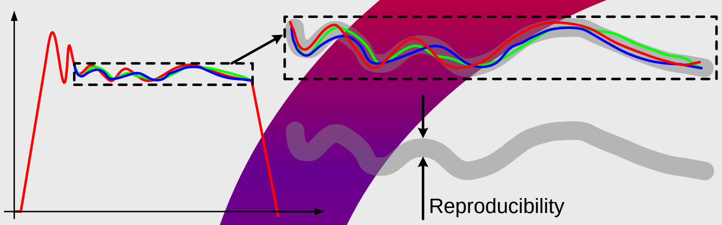
1) Complete the stripline design, by June 2012:
   - **a) 2D kicker design to optimize the cross section of ATF2/ALBA stripline prototype**;
   - b) 3D design to study the integrated field homogeneity and beam coupling impedance.
2) **Beam dynamics study, to analyze the impact of the kicker on the beam behavior (ATF2 and CLIC).**
3) Manufacturing of the stripline kicker, from June to December 2012.
4) Calibration and lab test at CERN, from January to March 2013. It will include:
   - a) Verification of dimensions, including tapering;
   - b) Vacuum compatibility;
   - c) Longitudinal and transverse beam coupling impedance measurements;
   - d) Field homogeneity measurements.
5) Possible installation of striplines at ALBA, from June to September 2013
6) Possible test of stripline at ALBA, from October to December 2013.
7) Installation of striplines at ATF2, from June to September 2014?
8) Test of striplines at ATF2, with inductive adder, from October to December 2014?

- Powering
  - Modulator Development

# CLIC studies & klystron modulators specs

- Technology challenges

**Pulse to pulse reproducibility: 10 to 100ppm**




Modulator and voltage measurement reproducibility **never achieved before**!

**Machine availability**
With more than 1600 modulators, reliability, modularity & redundancy must be optimized for maximum accelerator availability

**Modulator topology selection considering:**
- Efficiency maximization (max. power limited)
- Reproducibility
- Constant power consumption
- Satisfactory accelerator availability

**AC power quality optimization**
More than 1600 modulators pulsing synchronously! Utility grid power fluctuation minimized (~1%) – tough charger design

**Need for a global approach! Different solutions must be explored (transformer based, fully solid state, HV & LV solutions)**

# R&D partners

- Survey of European Universities and institutions

| | Application | | | PFS Development | | | Capacitor Charger Development | |
|---|---|---|---|---|---|---|---|---|
| **Universities** | **HV** | **short pulses** | **Long pulses** | **pulse Transfo** | **bouncer** | **SW stack** | **AFE** | **Resonant topologies** |
| Strathclyde University (UK) | ☑ | ☑ | | | | | | |
| Loughborough University (UK) | ☑ | ☑ | | ☑ | | ☑ | | |
| Ecole Polytechnique Paris | ☑ | ☑ | | | | | | |
| Research Centre Karlsruhe (DE) | ☑ | ☑ | ☑ | | | ☑ | | ☑ |
| Université de Pau (FR) | ☑ | ☑ | | | | ☑ | | |
| Eindhoven (NL) | ☑ | ☑ | | ☑ | | ☑ | | |
| Oxford (UK) | ☑ | | | ☑ | | | | |
| EPFL (CH) | | | | | | | ☑ | ☑ |
| **ETH (CH)** | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ |
| **Nottingham (UK)** | ☑ | | ☑ | ☑ | | ☑ | ☑ | ☑ |
| **Institutions** | **HV** | **short pulses** | **Long pulses** | **pulse Transfo** | **bouncer** | **SW stack** | **AFE** | **Resonant topologies** |
| Desy (DE) | ☑ | ☑ | ☑ | | ☑ | ☑ | | ☑ |
| PSI (CH) | ☑ | ☑ | | | | ☑ | | |
| ESS (SE) | ☑ | | ☑ | | | | | |

Preparation of collaboration agreements with ETHZ, Nottngham, Laval (Canada) and SLAC in preparation

# Summary

- Wide-spread technology development program for CLIC in place.
  Not only paper studies, but to a large fraction targeting real hardware and functional prototypes:
  - Will serve for beam tests (CTF3, ATF, CESR-TA...)
  - are qualified in laboratory measurements
  - will become part of future installations (DB injector)
- Based on a large collaborative efforts
- Major milestone in 2012/2013:
  - achievement of full TBA modules in the lab including measurement programs
  - planned review of TBA modules in spring 2013
- Personal Objective for the rest of 2012:
  - Create additional effort for magnetic measurements and for fs-timing distribution