



Beam Diagnostics Developments for CLIC in the QUASAR Group

Carsten P. Welsch

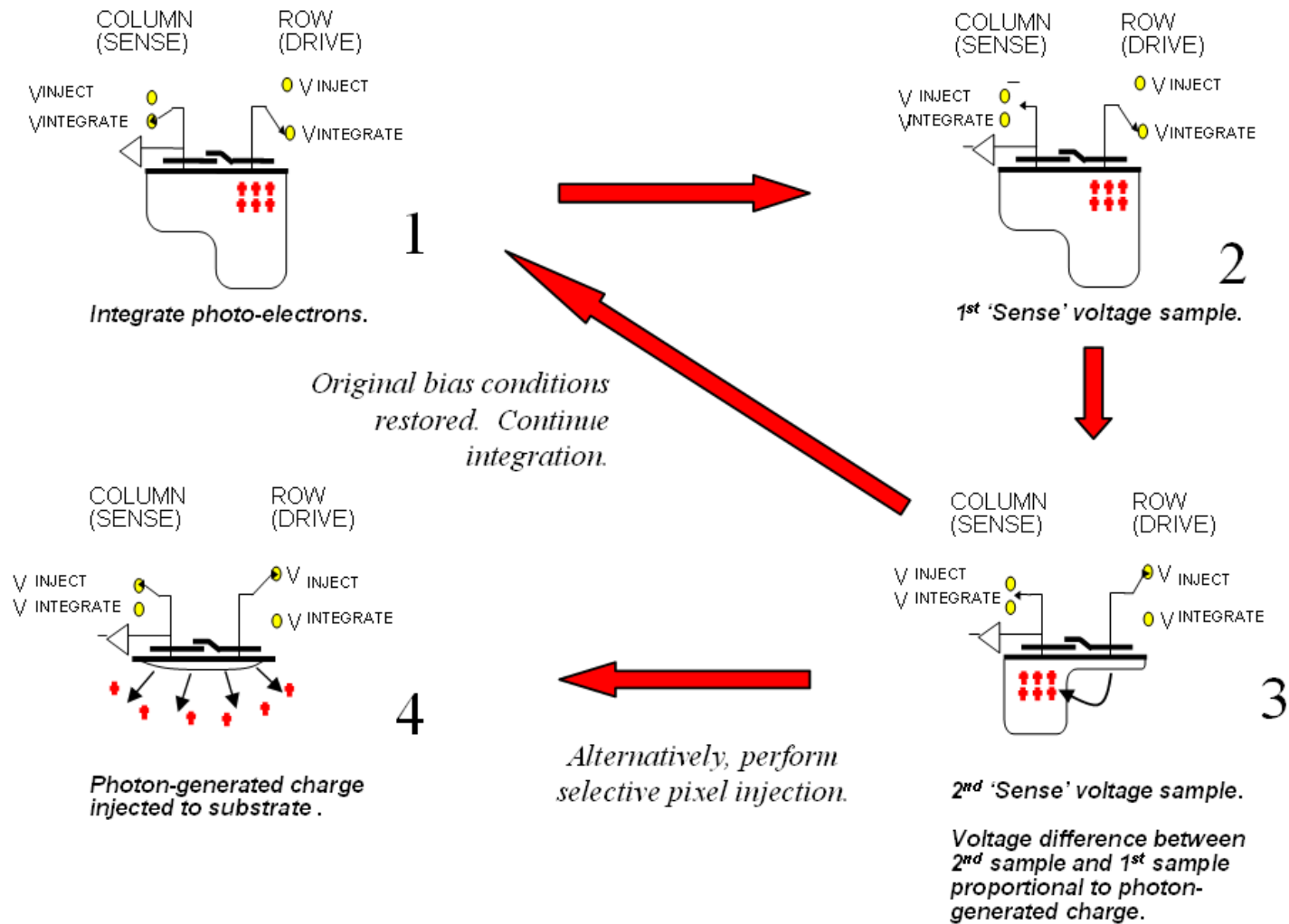
Research Projects

- Transverse beam profile measurements
 - High dynamics range measurements
 - Beam halo monitoring
- Beam loss monitoring
 - Fibre optics-based developments
- Time-resolved energy measurements *(rather CTF3)*
 - Fibre optics-based developments

Beam Halo Monitoring

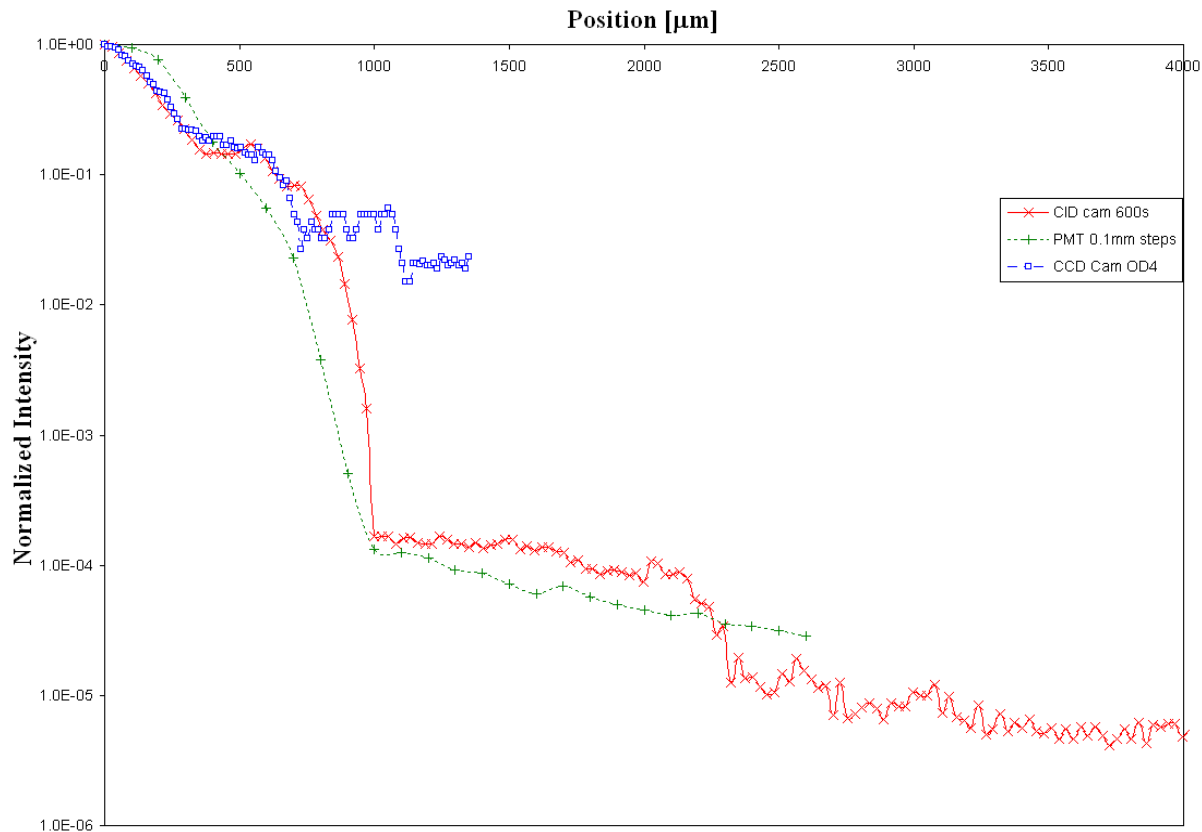
- Studies ongoing since 2004
 - Fixed mask technique
 - CID camera
 - Flexible mask technique
- Requires close interaction with beam dynamics experts (CI ↔ CERN)
- Monitors tested in lab 2008 and 2009, tests with beam will be done at U Maryland.

CID Technology



Source: Thermo Fisher Scientific

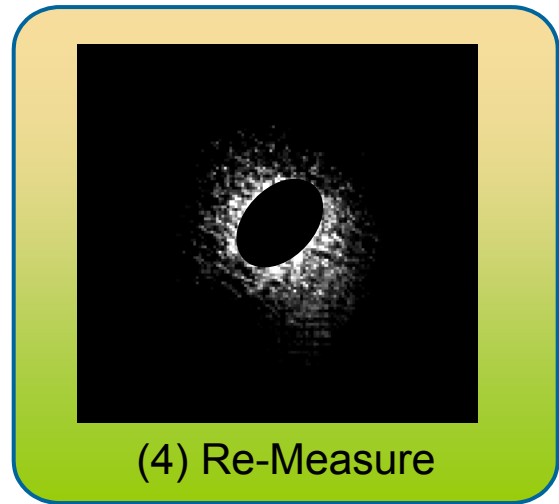
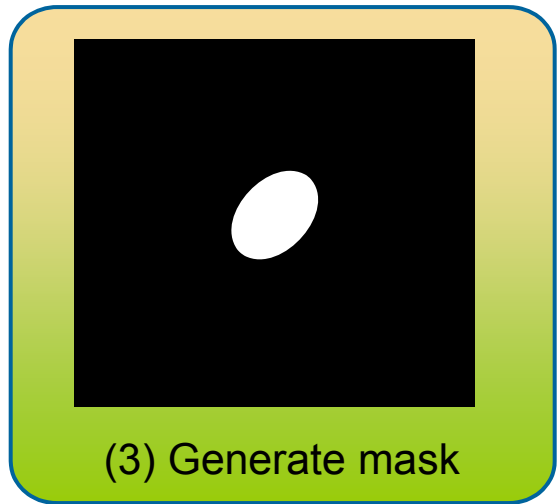
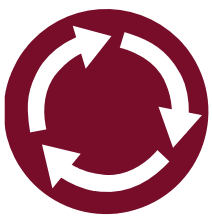
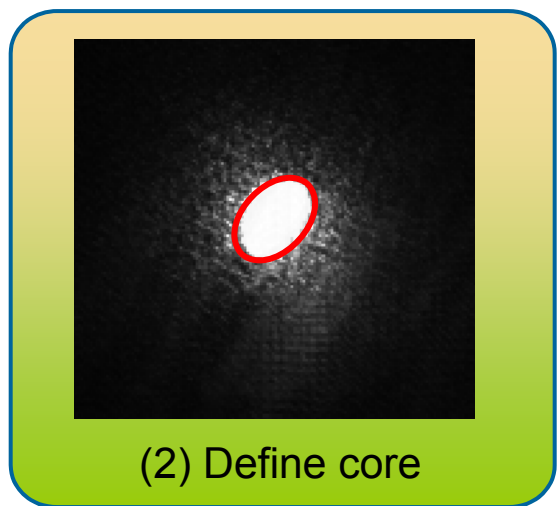
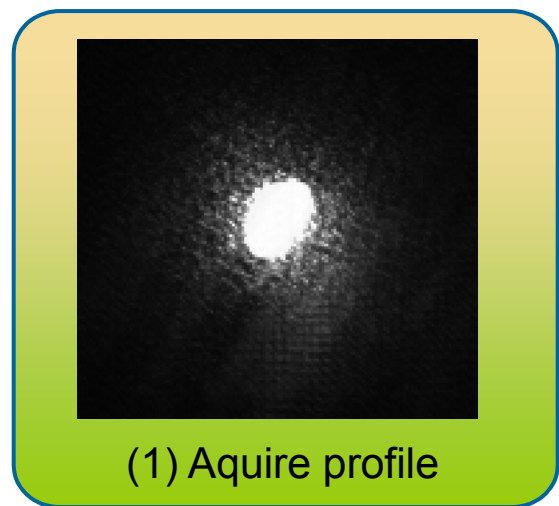
CID Camera Measurements



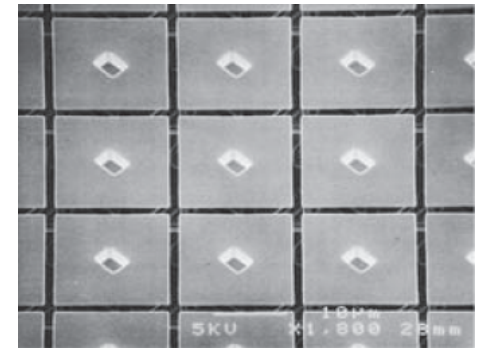
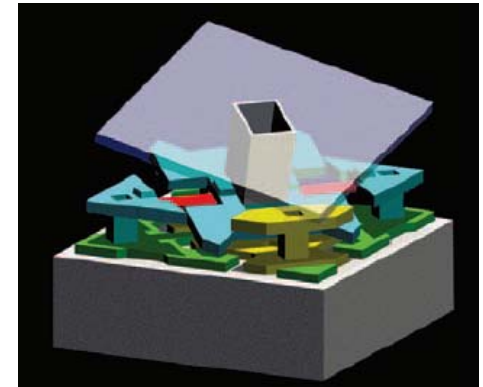
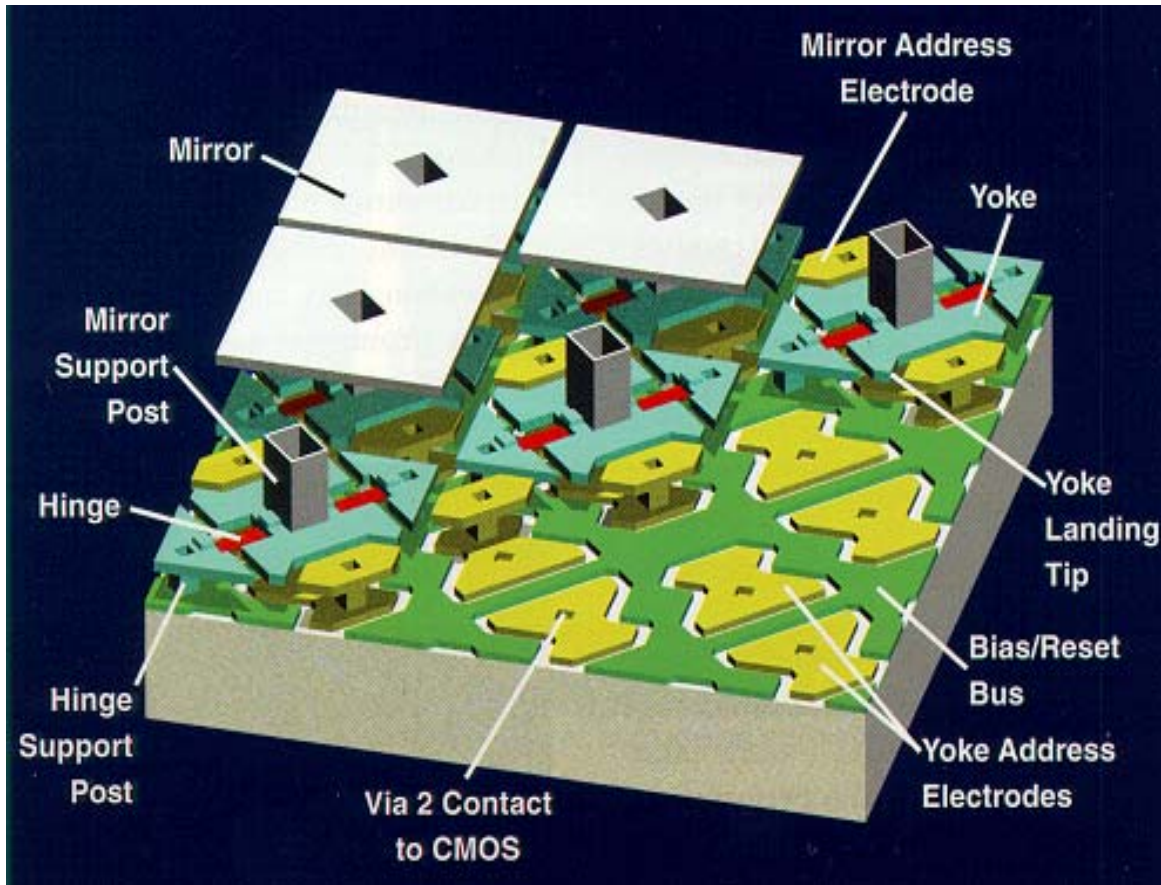
C.P. Welsch et al., Meas. Sci. Technol. **17** (2006) 2035c

- New model (XDR):
Dynamic range of
up to 10^7 in lab
tests.
- Laser beam used
as reference
- Long acquisition
times (10s of min.)
- High costs

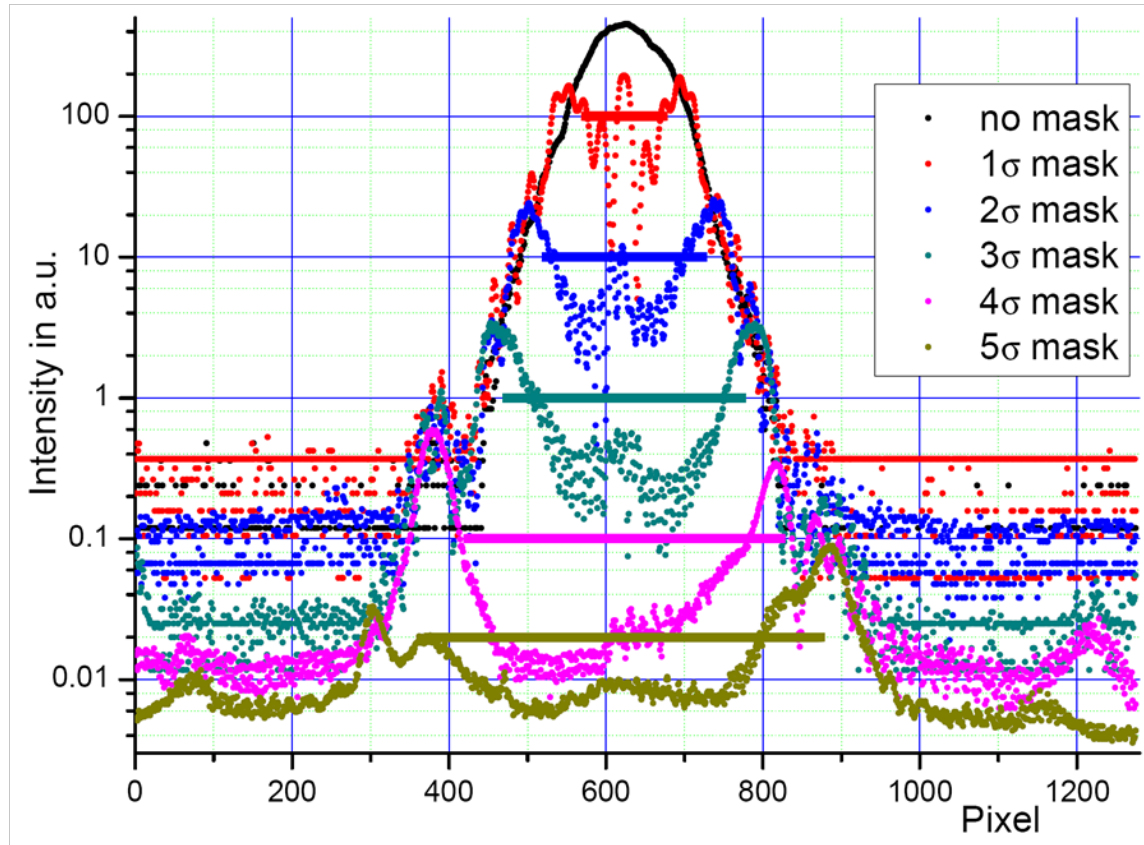
Core Masking Technique: The Idea



Micro Mirror Array



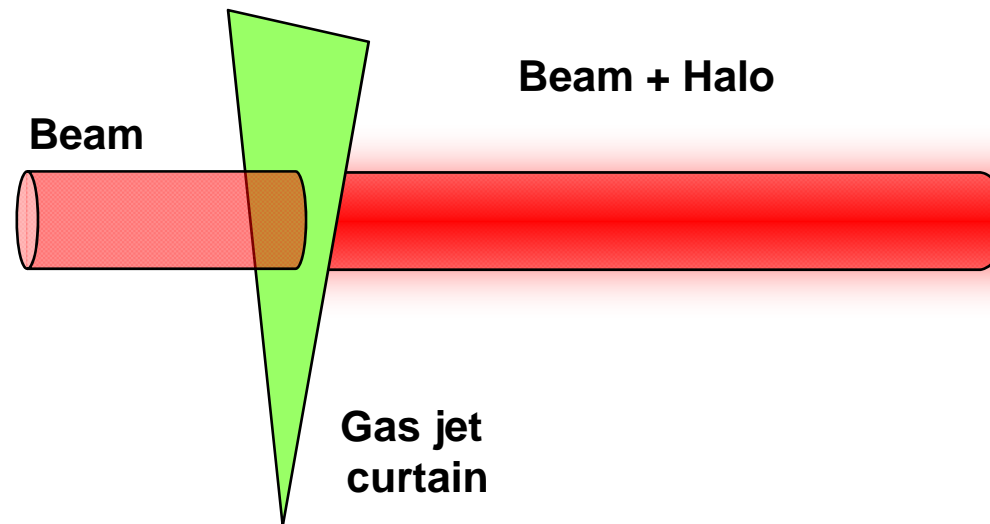
Results from Measurements



- Dynamic range of up to $10^{5.5}$
- Interference in centre
- Automization presently done
- Next step: Apply for accelerator measurements

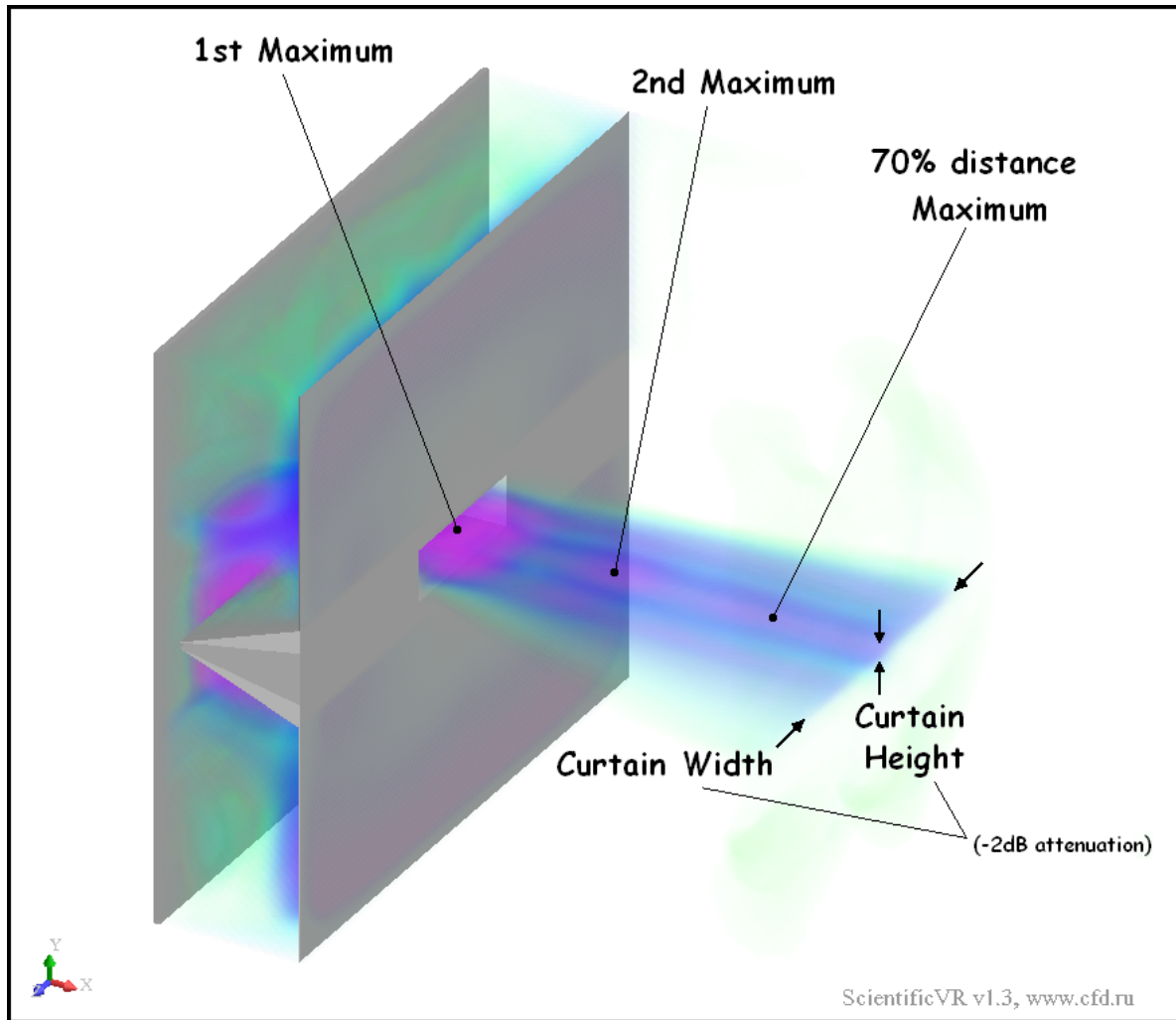
Experiment

Principle:



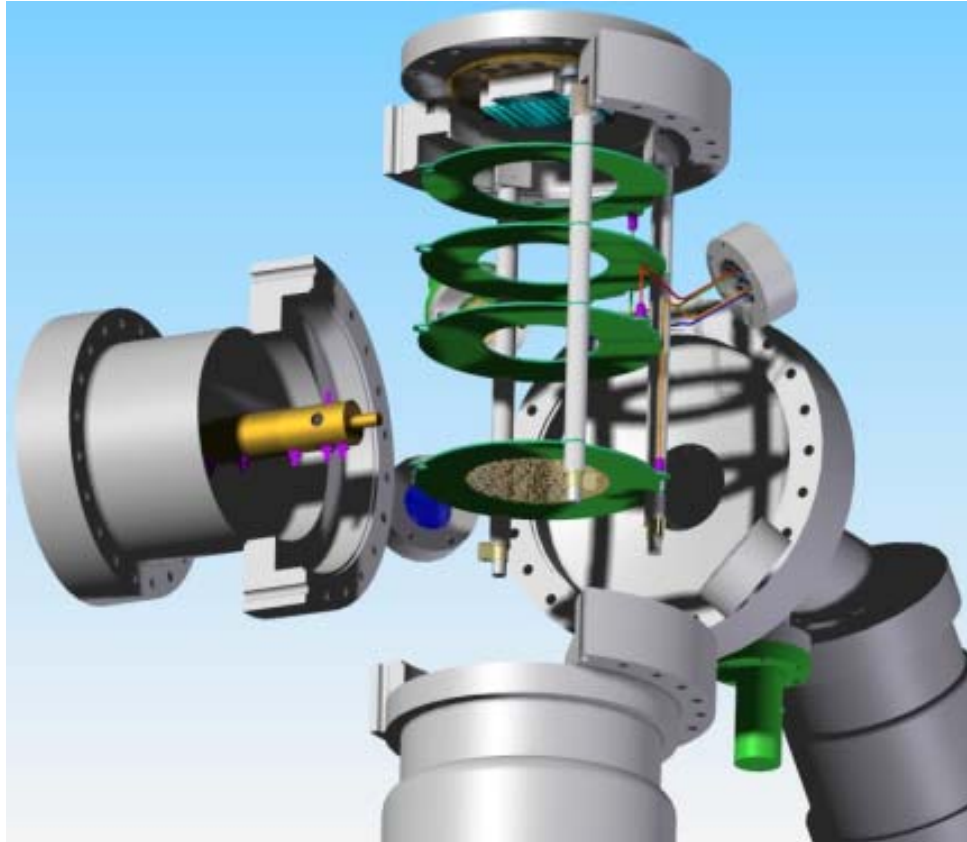
- Development of gas jet with highly flexible geometry (intensity and shape),
- Generation of desired halo distribution,
- Measurements with high dynamic range by curtain (!),
- Goal: Benchmarking and improvement of models.

Numerical Investigations with GDT



M. Putignano

Experimental Setup



M. Putignano

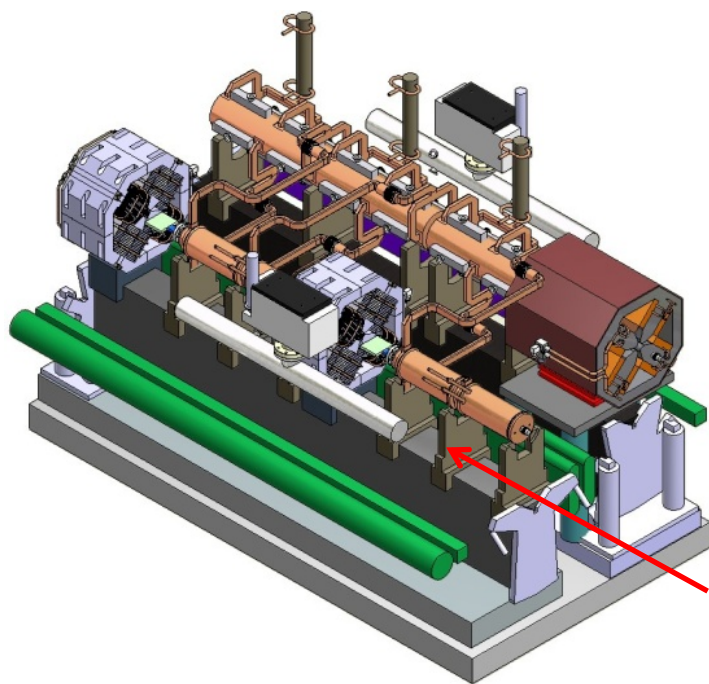
- Jet characterization by e^- beam
- Vacuum chambers presently build up
- First tests 2nd half of 2009
- Close collaboration between CI and MPI-K, Heidelberg.

Theory

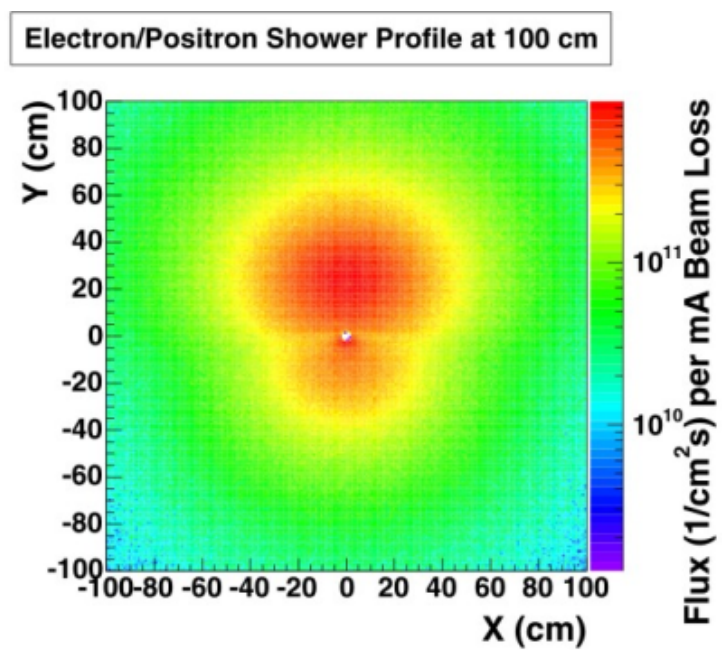
- Looking for a new recruitment (Postdoc) to link between instrumentation and beam dynamics
- Study beam motion in CLIC around critical parts (collimators, aperture limitations, etc.)
- Investigations into losses and look at halo formation mechanisms

Beam loss monitoring

Major complication: Two beams !



100 A, 2.4GeV



M. Wood, T. Lefevre

A. Intermite

The Monitor

- Exploitation of Cherenkov-radiation in optical fibres
 - Based on DESY work
 - 4x2 fibres around vacuum chamber
 - Short individual fibres for true 3D analysis
- Goal: Detect on 10^{-4} level of nominal current
- Steps:
 - Optimization of light capture in fibres
 - Lab tests of fibre coupling/splicing
 - Monte Carlo studies
 - "cross-talk" between losses from both beams

Advantages

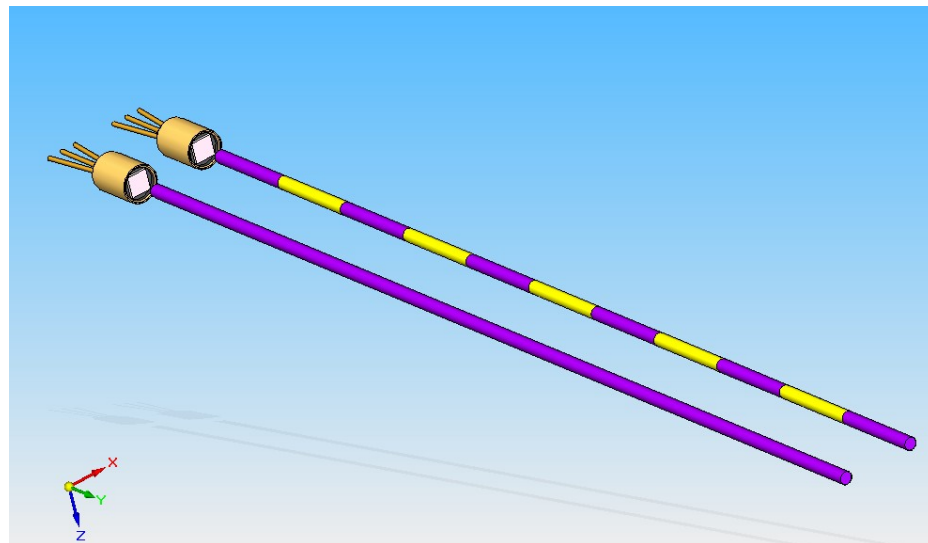
- Fast time response
- Transverse and longitudinal information
- Insensitive against E and B fields
- Radiation hard
- Space requirement of monitor
- Losses can be tuned continuously
- Malfunctions of machine elements can be monitored

Working Principle

- Optical Fiber Sensor based on SiPM composed of SPAD Array.
- Two arms:
 - Reference fiber.
 - Composite fiber.

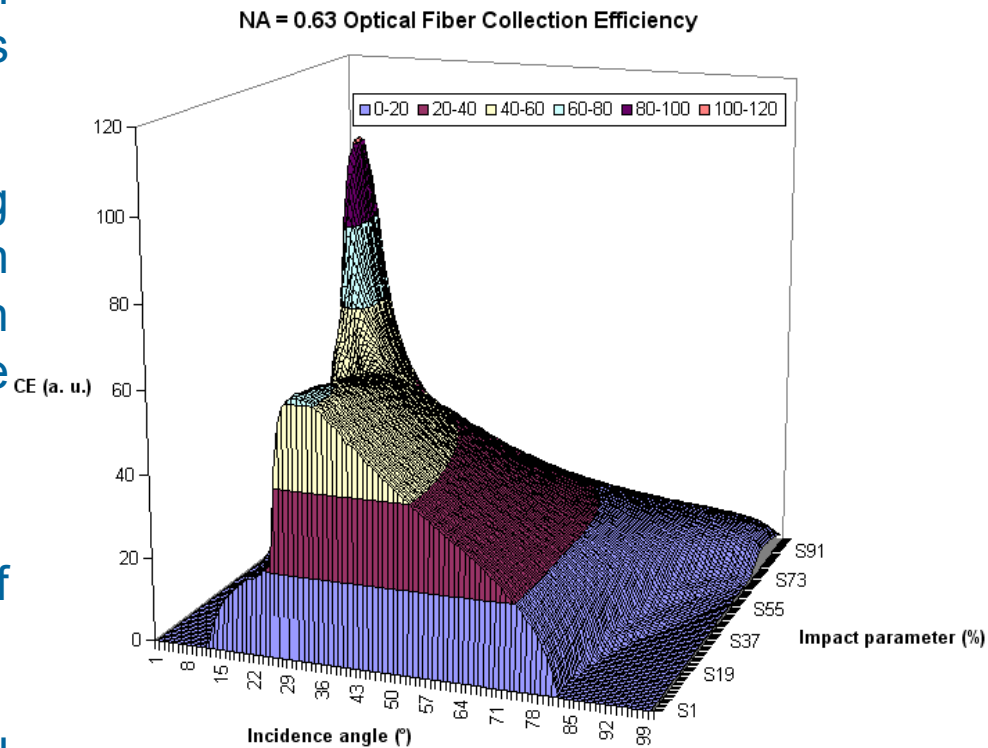
Features:

- Optical fiber diameter: 1mm^2 as the dimensions of SiPM active surface.
- Numerical aperture of fibers between 0.22 and 0.63.
- Pure silica and PMMA multimode step index fibers with $n = 1.46$.
- SiPM recovery time ca. 4 ns.
- SiPM quantum efficiency 15 % in the blue wavelength range



Theory

- Study of Cerenkov effect in optical fibers including both skew rays and meridional rays (*ongoing*).
- C++ code for simulation of coupling efficiency of Cerenkov photons in multimode step index fibers with numerical aperture in the range between 0.22 and 0.63 (*ongoing, see right*).
- To be included until end of summer 2009:
 - Splicing losses
 - Cleaving angle of Optical Fibers
 - Optical Fiber-SiPM Coupling losses



Experiment

- SiPM results on simulating bunches' sequence by a pulsed laser with $\lambda = 450 \text{ nm}$;
- Splicing tests for choosing suitable fibers: about 15 stages with losses between 0.45-0.20 dB;
- Monitor splicing losses for high radiation levels;
- Calibration of the sensor with the SiPMs: 400×400 or 289×289 SPADs for 1 mm² active surface will be used;
- We need (*in collaboration*):

Accurate simulations on losses in the accelerator.

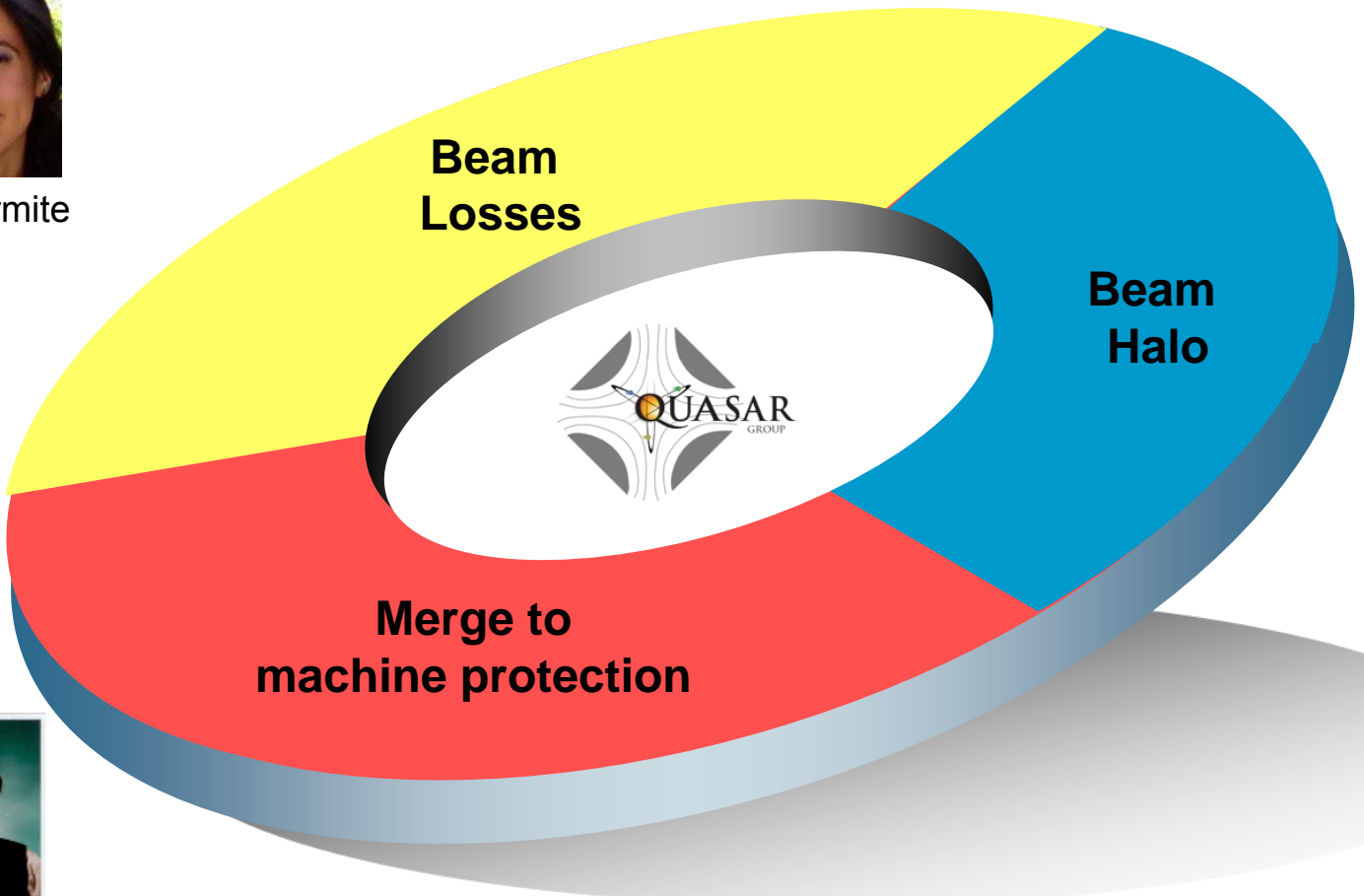
CLIC Diagnostics - Present **Projects**



A. Intermite



J. Egberts



S. Artikova



M. Putignano

Conclusion

- QUASAR group involved in developments related to beam loss and profile measurements for CLIC;
- Envisaged: Collaboration with CERN, RHUL, MPI-K, CI, FZ Karlsruhe, ...

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