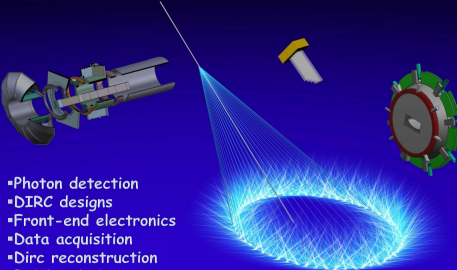


Front-end Electronics for the ATLAS FP

- **ATLAS FP:** *fast timing with QUARTIC (fused silica) bars*
- **Electronics:** *Amplifier → CFD → HPTDC*
- **Reference timing:** *LHC clock → optical pulses sent to left and right detectors*

Workshop on fast Cherenkov detectors
Photon detection, DIRC design and DAQ
May 11-13, 2009
Justus-Liebig-Universität Giessen



- Photon detection
- DIRC designs
- Front-end electronics
- Data acquisition
- Dirac reconstruction
- PANDA-DirC

The workshop will focus on the design of fast DIRC Cherenkov detectors as they are currently being planned for the PANDA experiment at FAIR. Common issues like the fast detection of single photons, the light propagation in radiator material and the fast data acquisition of arrival times and photon amplitudes make the subject interesting for other projects in PANDA and also for ATLAS, WASA and other experiments. We will try to make the workshop effective and inspiring as well for experts as for students.

Local organizers:
Anatoli Astvatsatourov, Michael Düren, Klaus Föhl, Avetik Hayrapetyan, Wolfgang Kühn, Sören Lange, Volker Metag, Rainer Novotny, Wolfgang Plaß, Christof Scheidenberger, Hasko Stenzel

European Graduate School
Complex Systems
of
Hadrons and Nuclei

Copenhagen
Giessen
Helsinki
Jyväskylä

JUSTUS-LIEBIG-
UNIVERSITÄT
GIESSEN

Workshop on fast Cherenkov detectors

Gießen, 11-13 May 2009

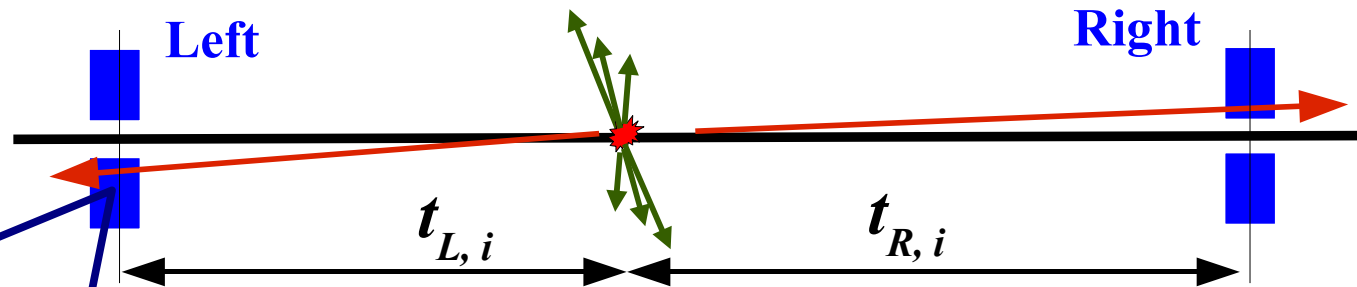
Anatoli Astvatsatourov

JUSTUS-LIEBIG-
UNIVERSITÄT
GIESSEN

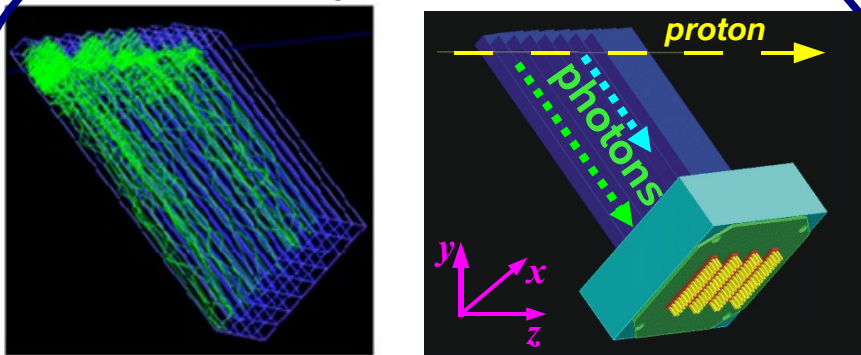


ATLAS FP Cherenkov Detectors

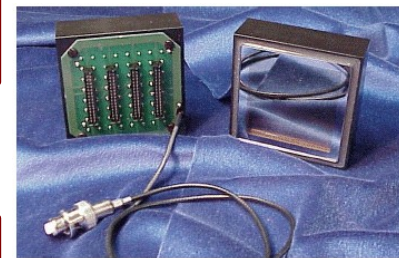
“Combinative”
timing resolution
GOAL: 10 ps
(10 ps → 3 mm)



QUARTIC



Forward Protons at 420m and 220m
LHC upgrade in year 2012



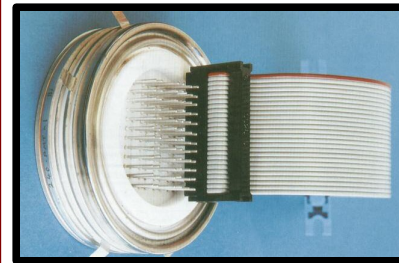
MCP-PMT

Burle 10

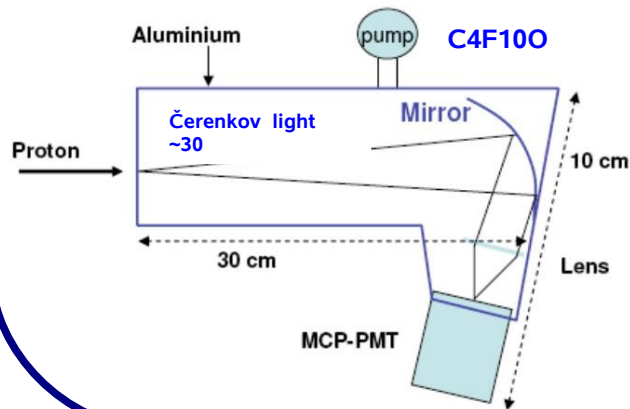
Photek 3-10 μm

Hamamatsu 6 μm

Expected Rates:
5 – 10 MHz

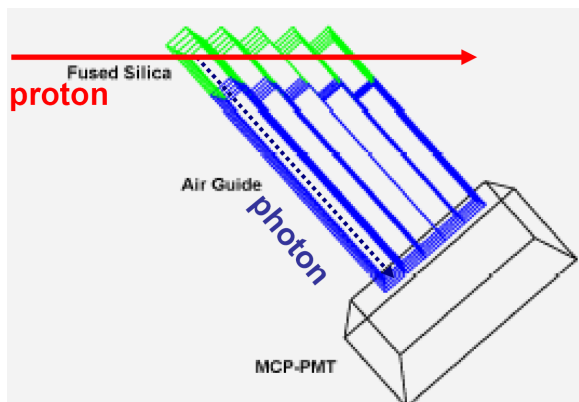
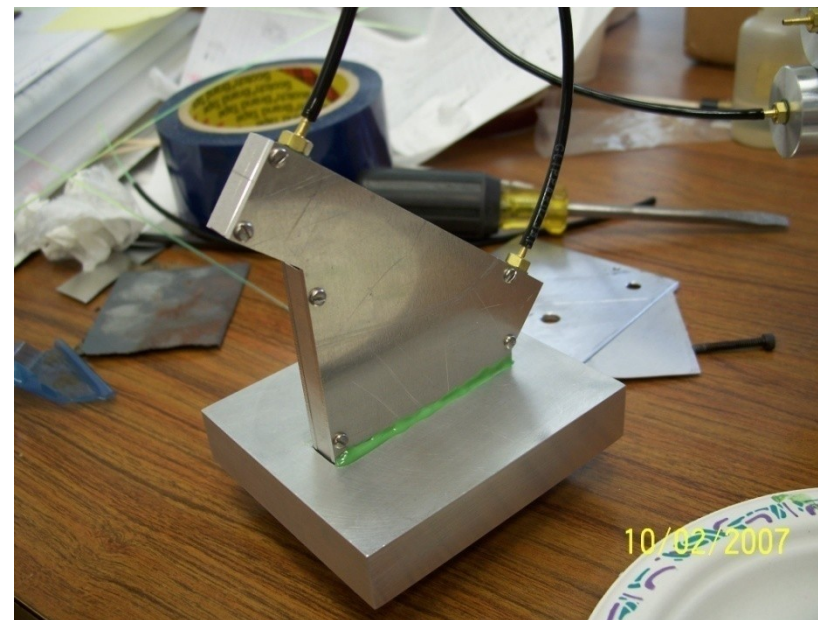
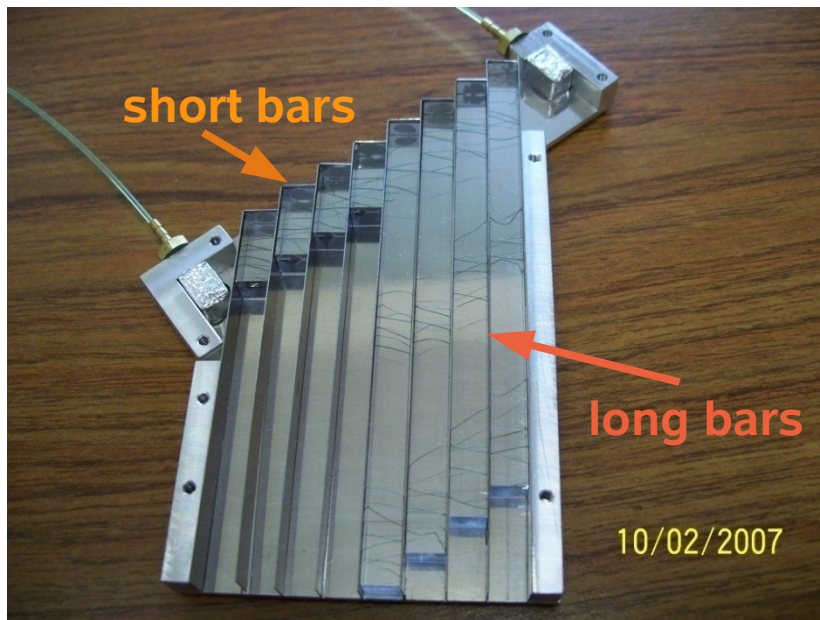


gastoF™



- 1) fused silica bars: QUARTIC
- 2) gas-filled tube: GASTOF

QUARTIC Prototype



Testing **long bars 90 mm** and **mini bars 15 mm**

Simulations show that long bars have more light from total internal reflection vs losses from reflection in air light guide, but more time dispersion due to $n(\lambda)$

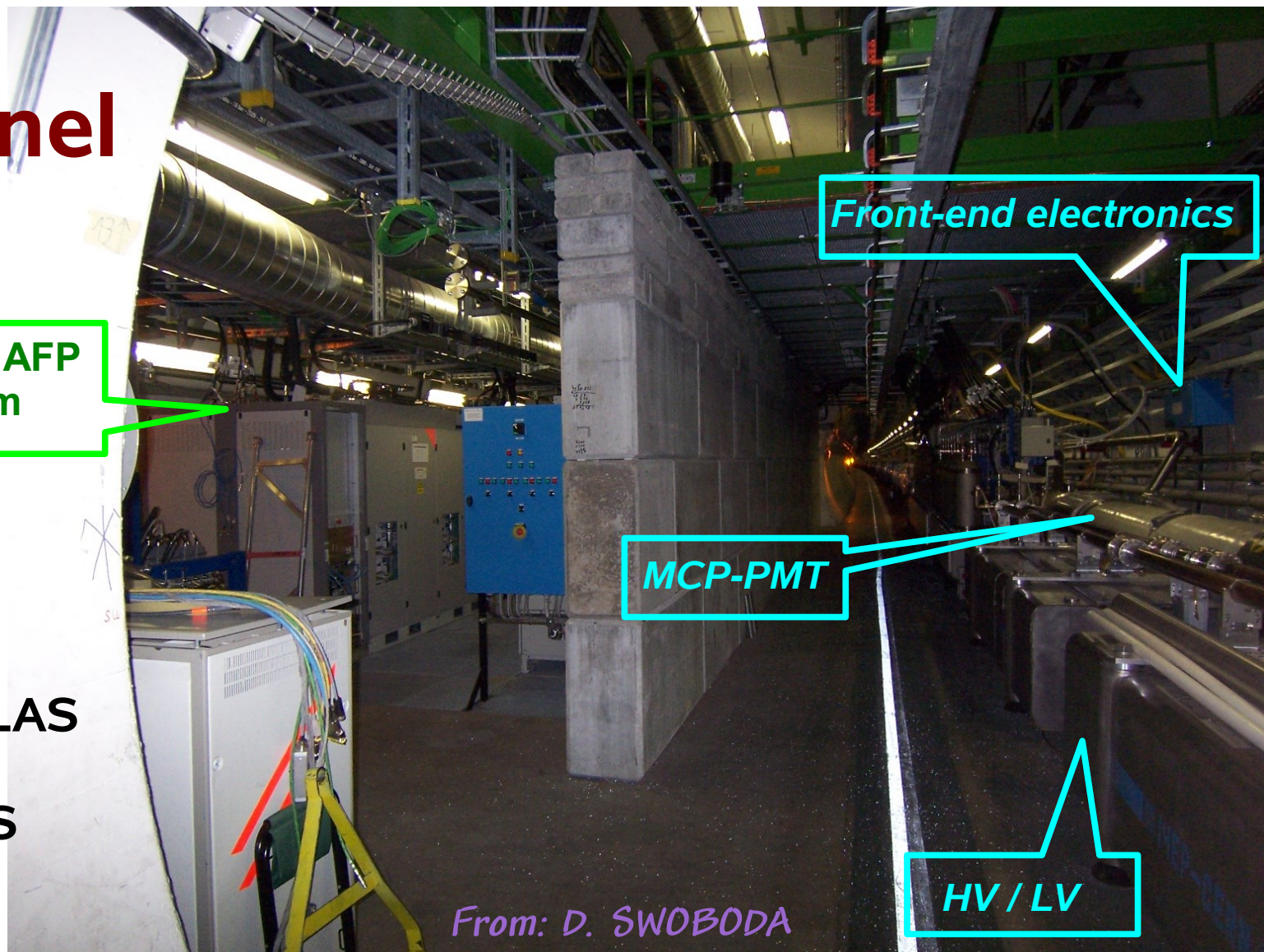
Time resolution goal: 40 ps / bar

LHC Tunnel

Possible place for AFP electronics at 220 m

Tunnel Sectors:

RR17/13 for ATLAS
&
RR57/53 for CMS



Electronics Development

FP-420 readout electronics responsibility: Alberta and Louvain groups

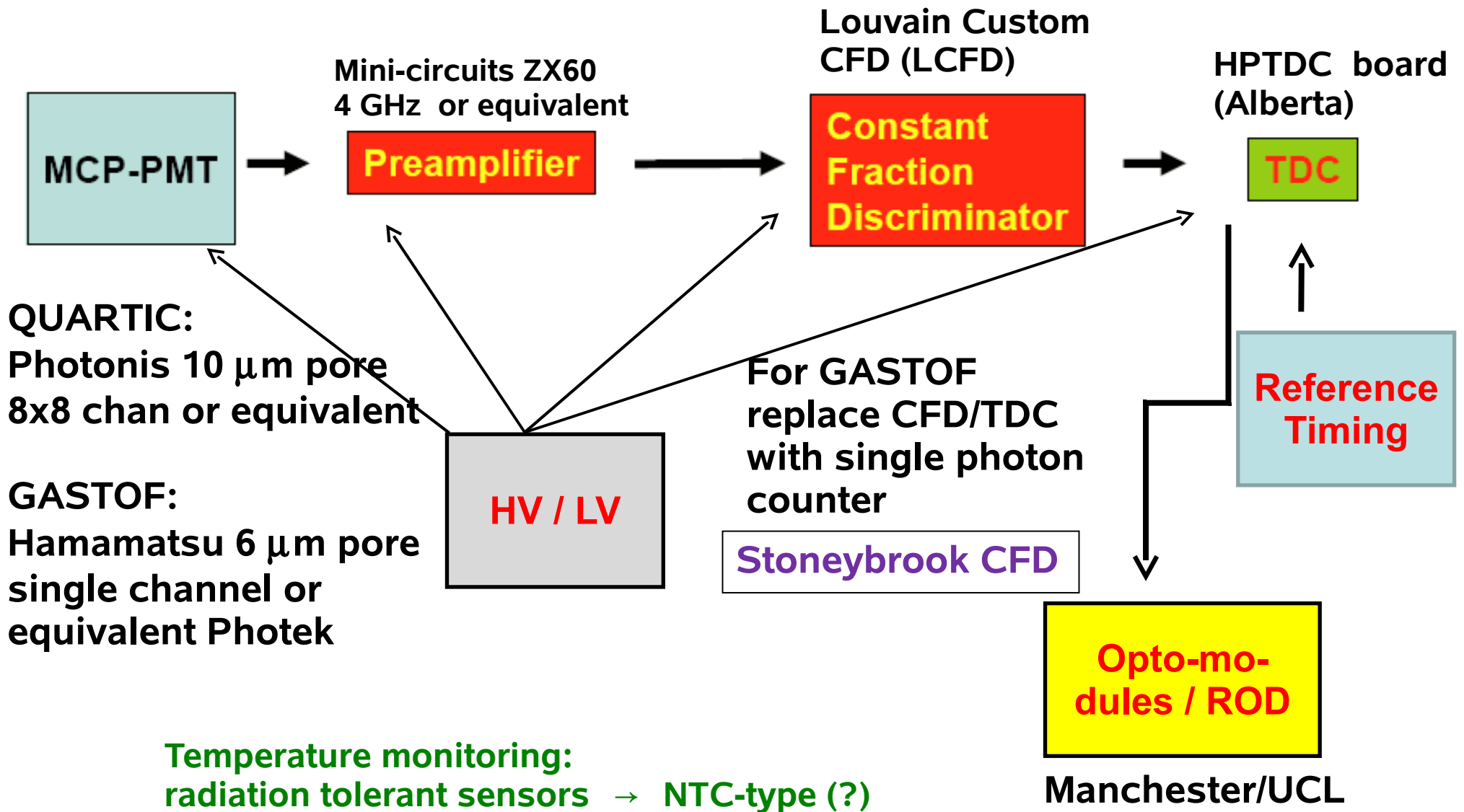
Developed: fast amplifier & CFD boards

- 1) Louvain CFD = LCFD and separately developed amplifier
 - * rise time ~ 150 ps for Hamamatsu , ~ 400 ps for Burle
 - * low sensitivity to the non-linearity and saturation of the amplifier

- 2) Alberta board = ACFD: integrated amplifier and CFD
 - * amplifier based on Phillips BGA2717 chip
 - * CFD developed by Alberta originally for the GlueX experiment

*looking for more groups
to be involved in tdr phase*

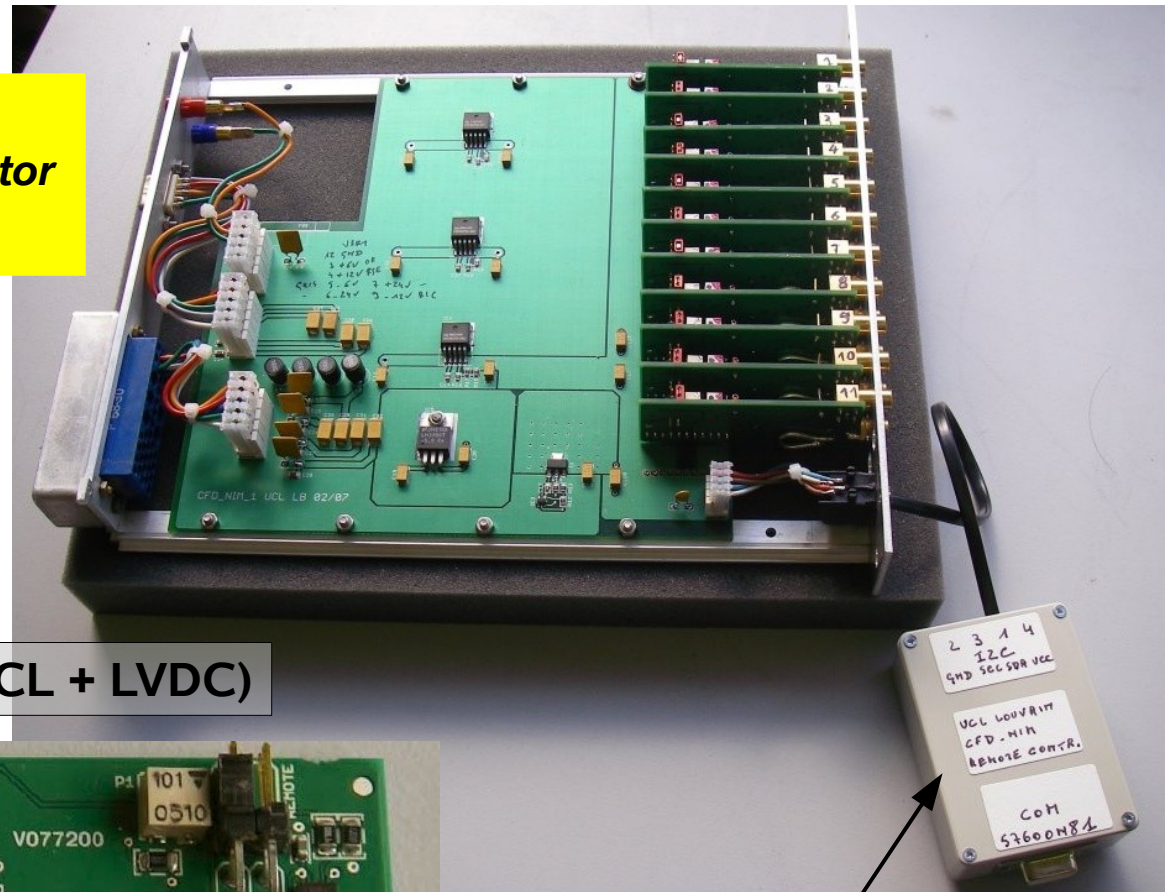
Components of Fast Timing System



LCFD: *Louvain Constant Fraction Discriminator*

Louvain group developed LCFD:
Louvain Constant Fraction Discriminator
(engineer Luc Bonnet)

tuned LCFD mini-module
to Burle and Hamamatsu rise
times; 12 channel NIM unit

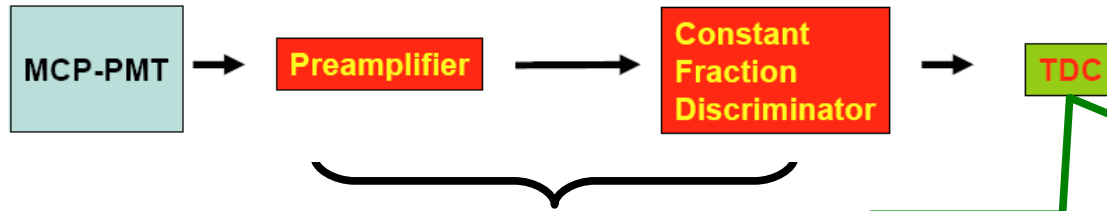


Lemo (to replace later with LVPECL + LVDC)



Remote control
for threshold

Alberta High Precision TDC board (HPTDC)

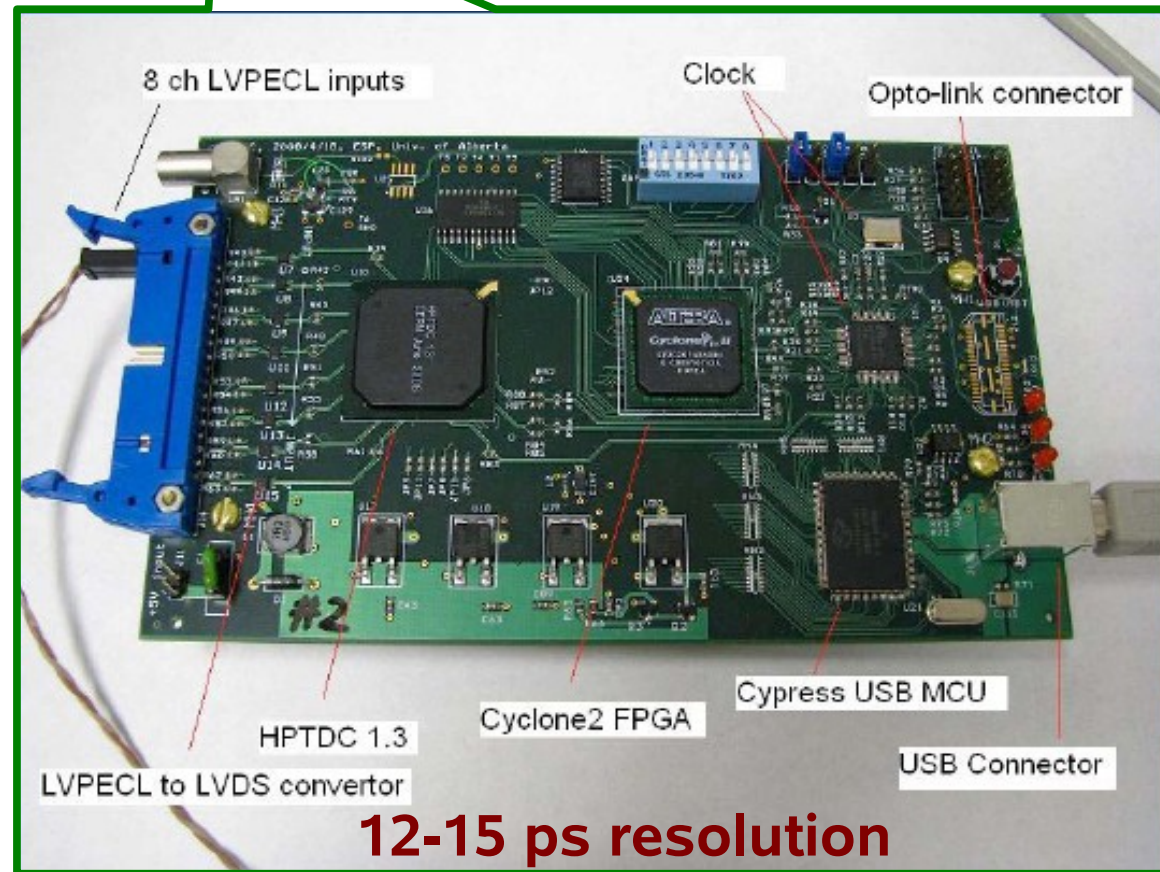


HPTDC has been tested with:
CAEN 1290 VME boards
Burle 10 μm tube, ZX60 amplifier,
LCFD, 6 GHz scope

ACFD / LCFD:

previous tests show that custom made ACFD & LCFD boards have comparable performance to the commercial boards, more compact, less expensive.

amplifier / CFD / TDC units would be located close to the detector in a shielding compartment and connected via SMA 18 GHz cable



Reference timing

Signal from LHC RF converted to optical pulse is split and sent to both left and right detectors for each bunch crossing. Control the signal differences by splitting signal at the detectors and sending back to comparator.

Goal: ≤ 5 ps rms jitter

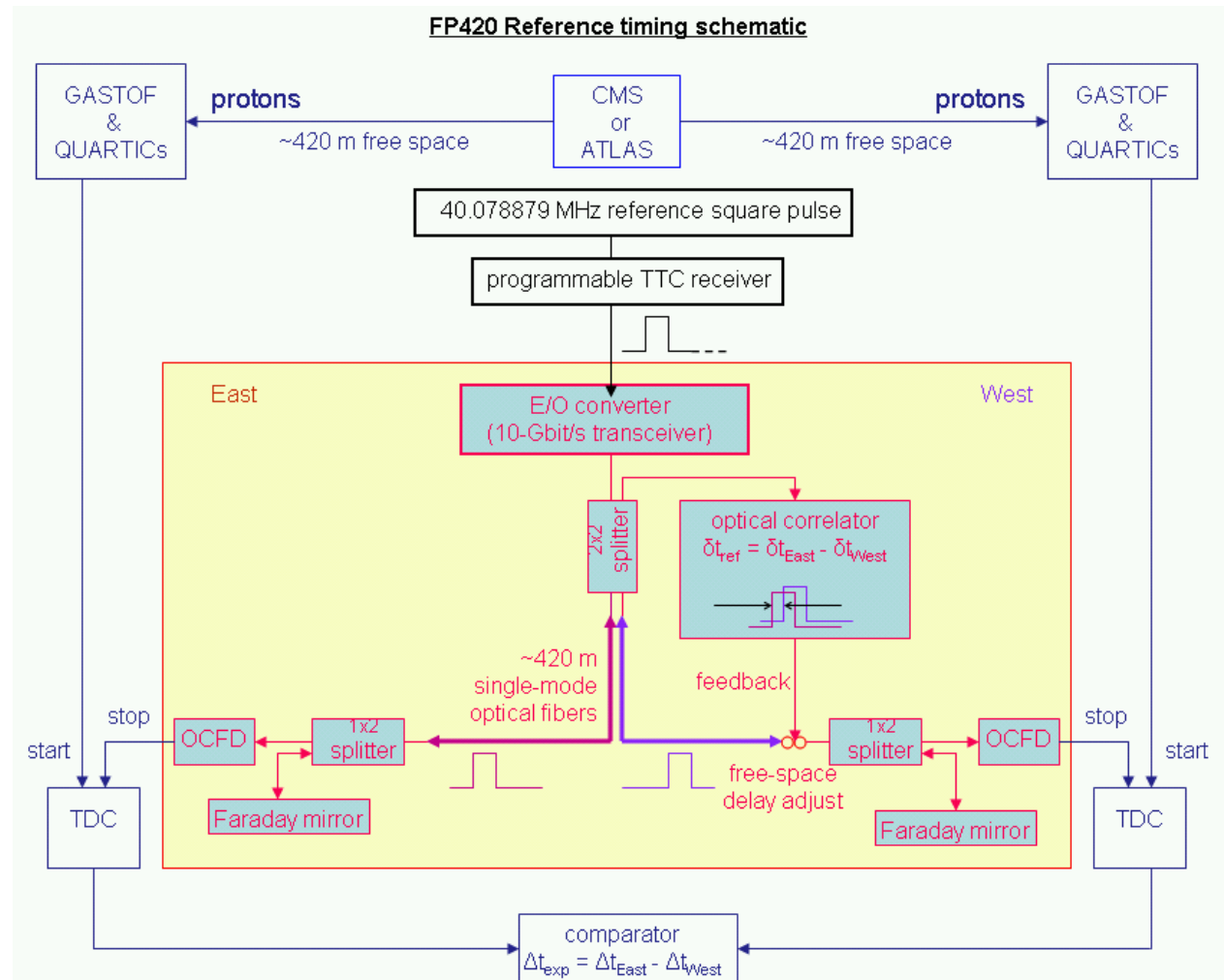
* use LHC clock (40 MHz)
LHC Timing Trigger and Control (TTC)

■ tdc measurement of drift between arms

■ feedback loop based on optical correlator

S. White has specified system still in conceptual design phase

Provides average time as well for central event comparison



Summary

- The FP-420 project for ATLAS → AFP
- Time of Flight with Cherenkov detectors
 - * pile-up background rejection for $pp \rightarrow pXp$ events
 - ``The FP420 R&D Project: Higgs and New Physics with Forward Protons at the LHC," FP420 R&D, arXiv:0806.0302 [hep-ex].
 - ``Letter of Intent for ATLAS FP: A project to install forward proton detectors at 220 m and 420 m upstream and downstream of the ATLAS detector" A. Brandt, B. Cox, C. Royon *et al.*, AFP Collaboration
- R&D Plans for AFP fast timing detectors
 - * continue laser tests
 - * electronics optimization: Amplifier --> CFD --> TDC

Back Up

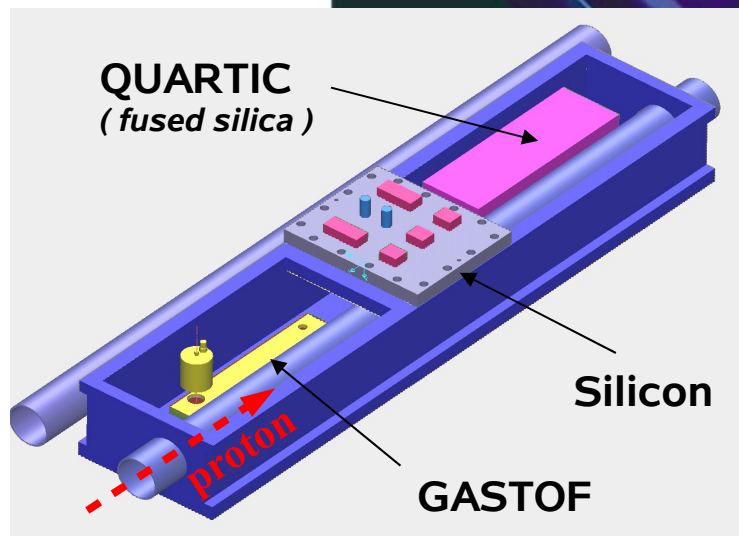
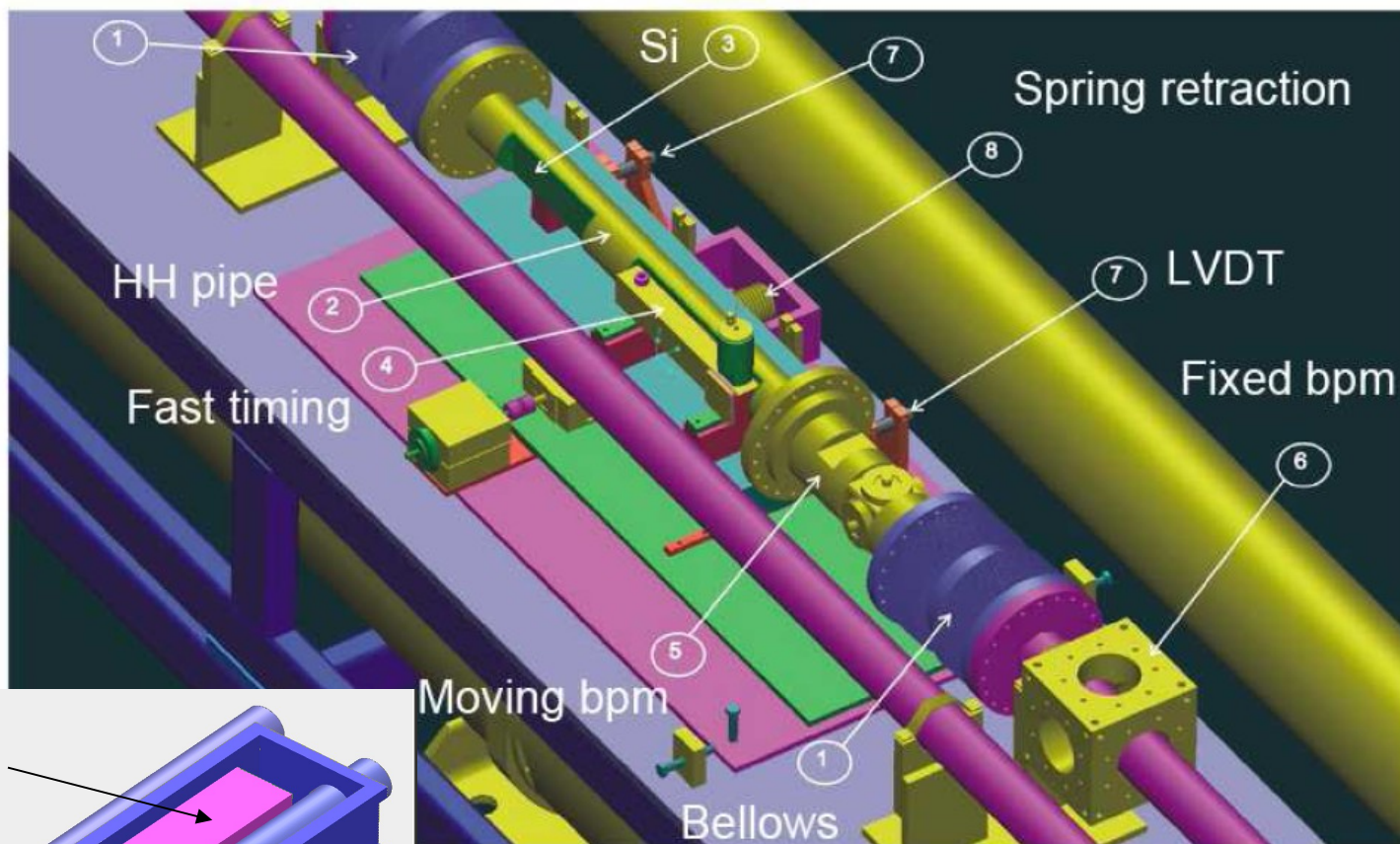
Moving "Hamburg pipe"

Moveable detector:

- parking position
- measuring position

Distance to the beam:

- beam conditions
- acceptance



Spectrometer/ToF inbetween beam magnets

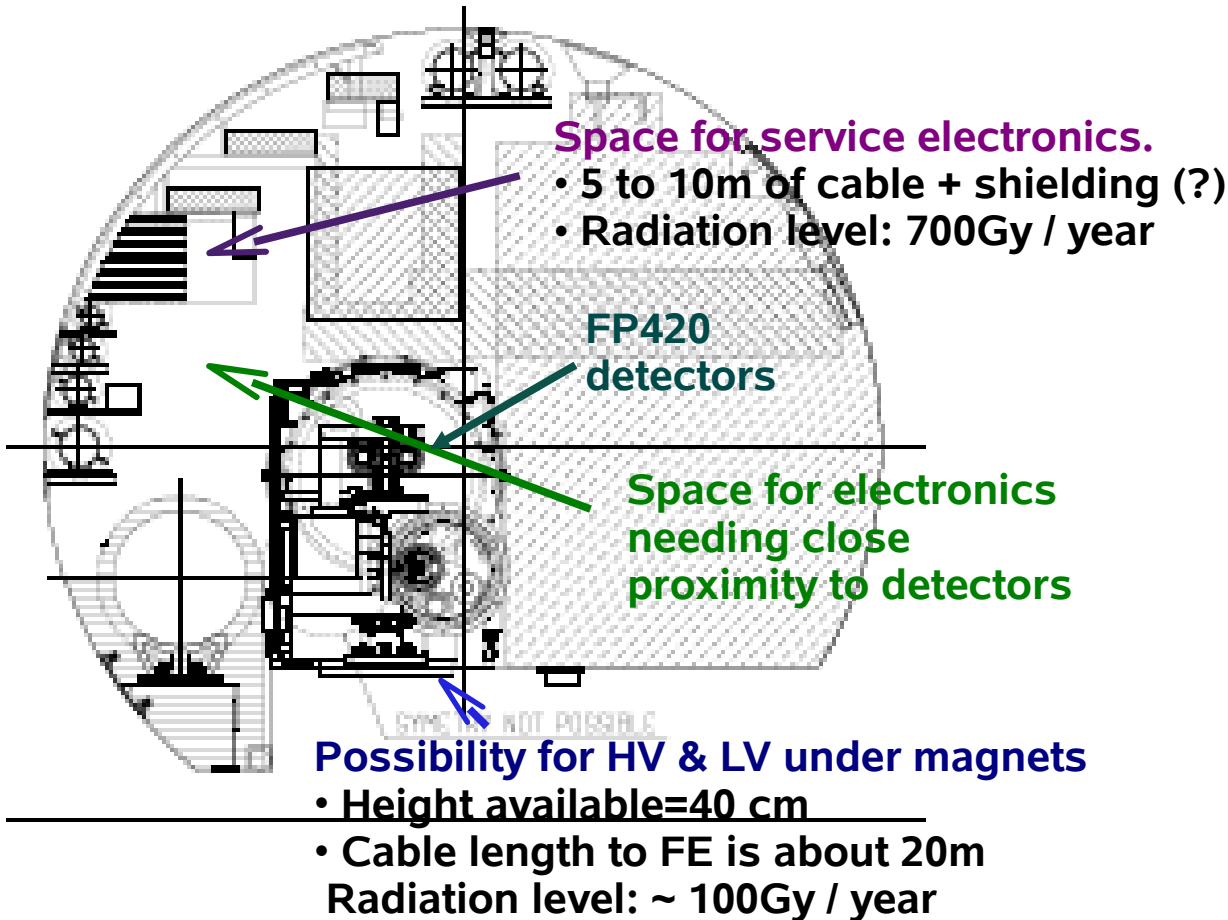
Tracking: Silicon

Timing: GASTOF + QUARTIC

FP420 Desing Report: [arXiv: 0806.0302 \[hep-ex\]](https://arxiv.org/abs/0806.0302)

Location for service electronics and power supplies

1) near to detectors



2) in RR alcove areas

*Expected level of radiation:
0.05 – 0.36 Gy / year*

3) in the counting room

radiation-hard linear regulators

