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

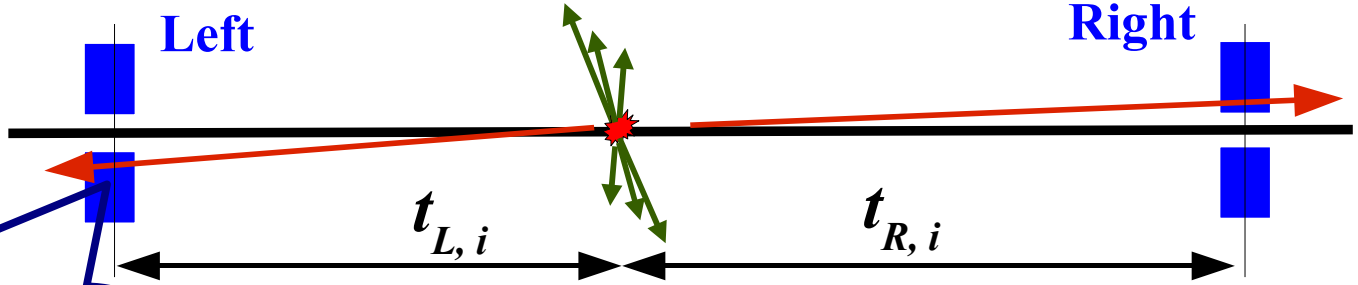
Gießen, 11-13 May 2009

Anatoli Astvatsatourov

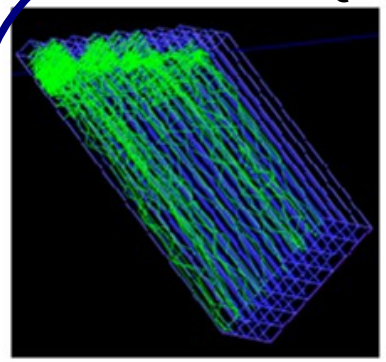
JUSTUS-LIEBIG-
UNIVERSITÄT
GIESSEN

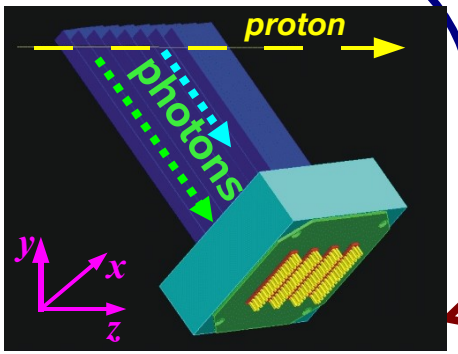
ATLAS FP Cherenkov Detectors

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

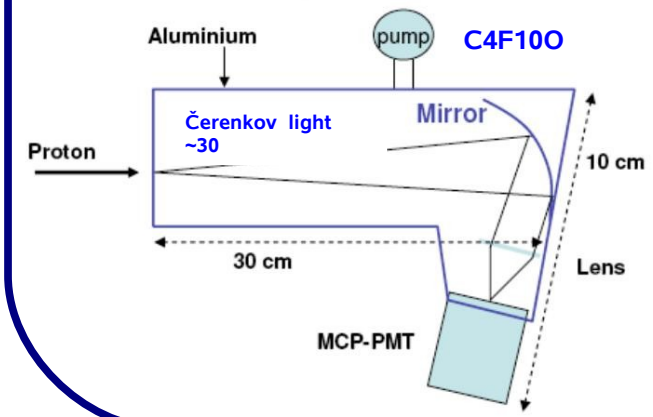


QUARTIC

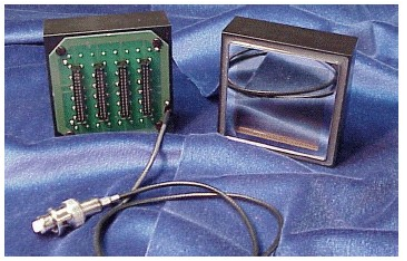


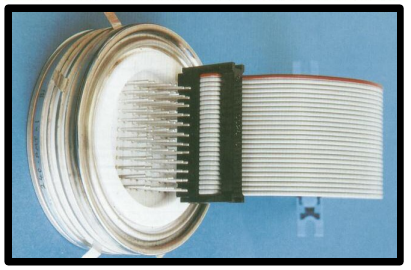


gastof™



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





MCP-PMT

Burle 10

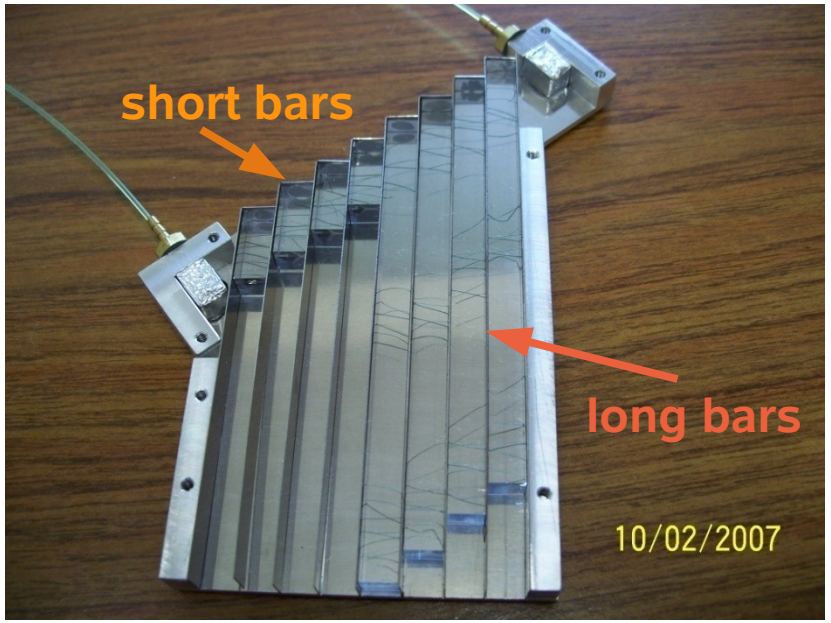
Photek 3-10 µm

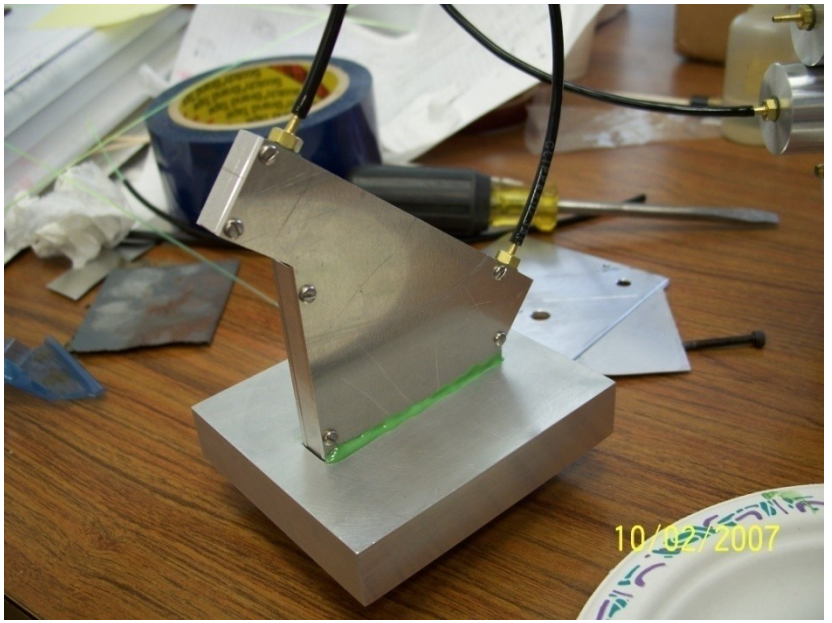
Hamamatsu 6µm

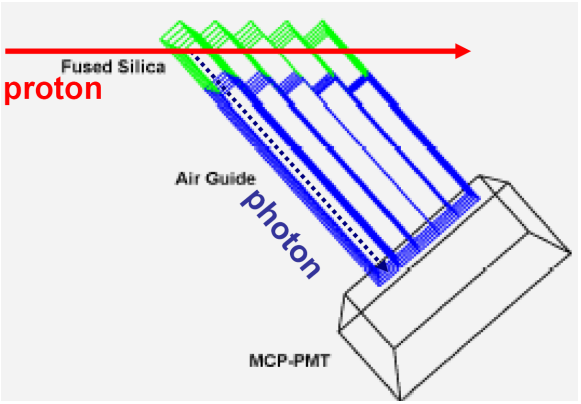
Expected Rates:
5 – 10 MHz

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

QUARTIC Prototype





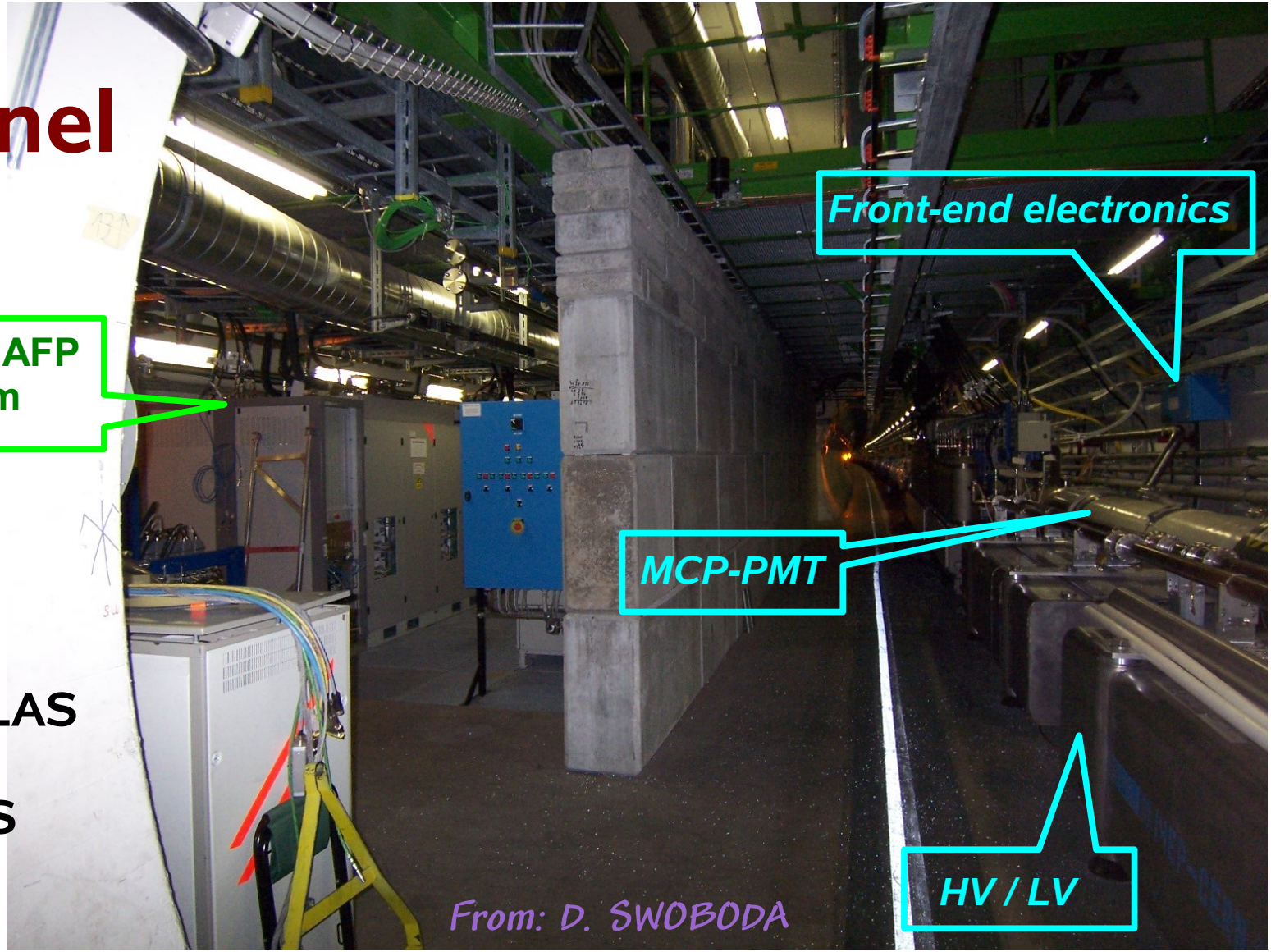


Testing **long bars 90 mm** and **mini bars 15 mm**

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



Tunnel Sectors:

RR17/13 for ATLAS
&
RR57/53 for CMS

Electronics Development

FP-420 readout electronics responsibility: Alberta and Louvain groups

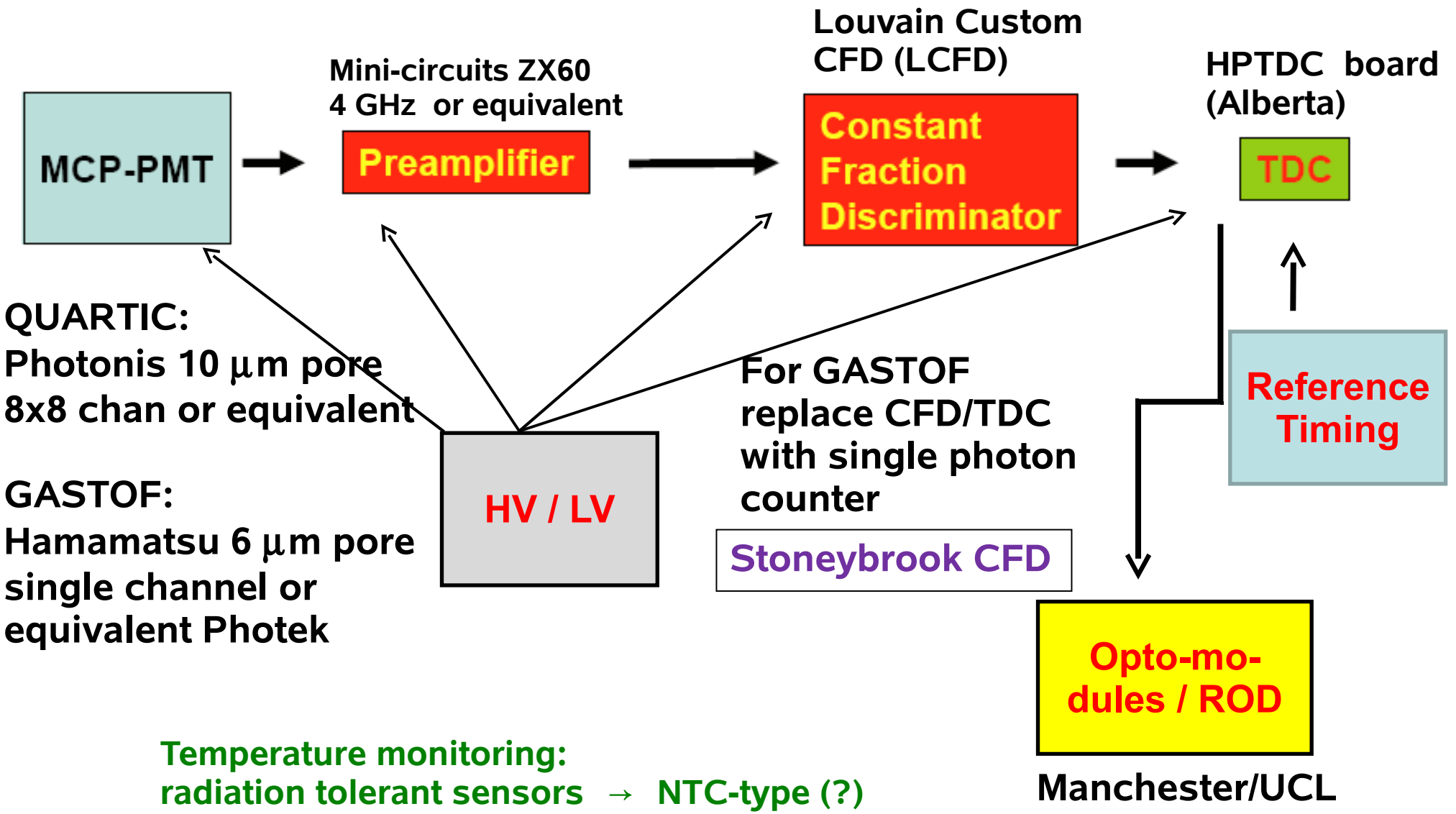
Developed: fast amplifier & CFD boards

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

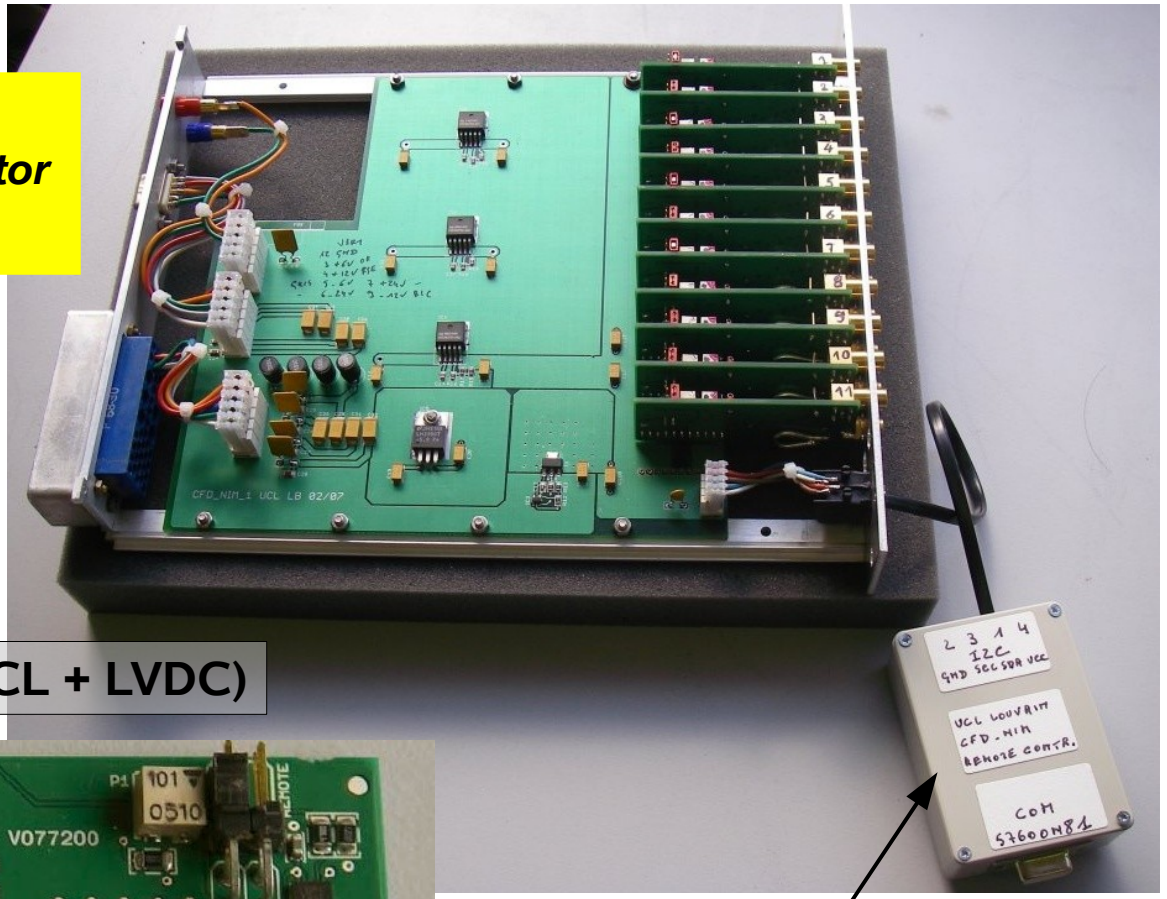


Temperature monitoring:
radiation tolerant sensors → NTC-type (?)

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

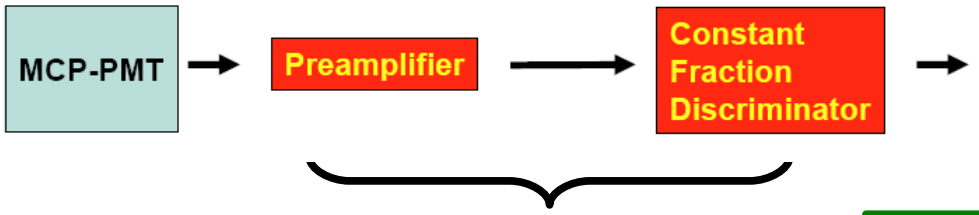


Lemo (to replace later with LVPECL + LVDC)

SMA

Remote control for threshold

Alberta High Precision TDC board (HPTDC)

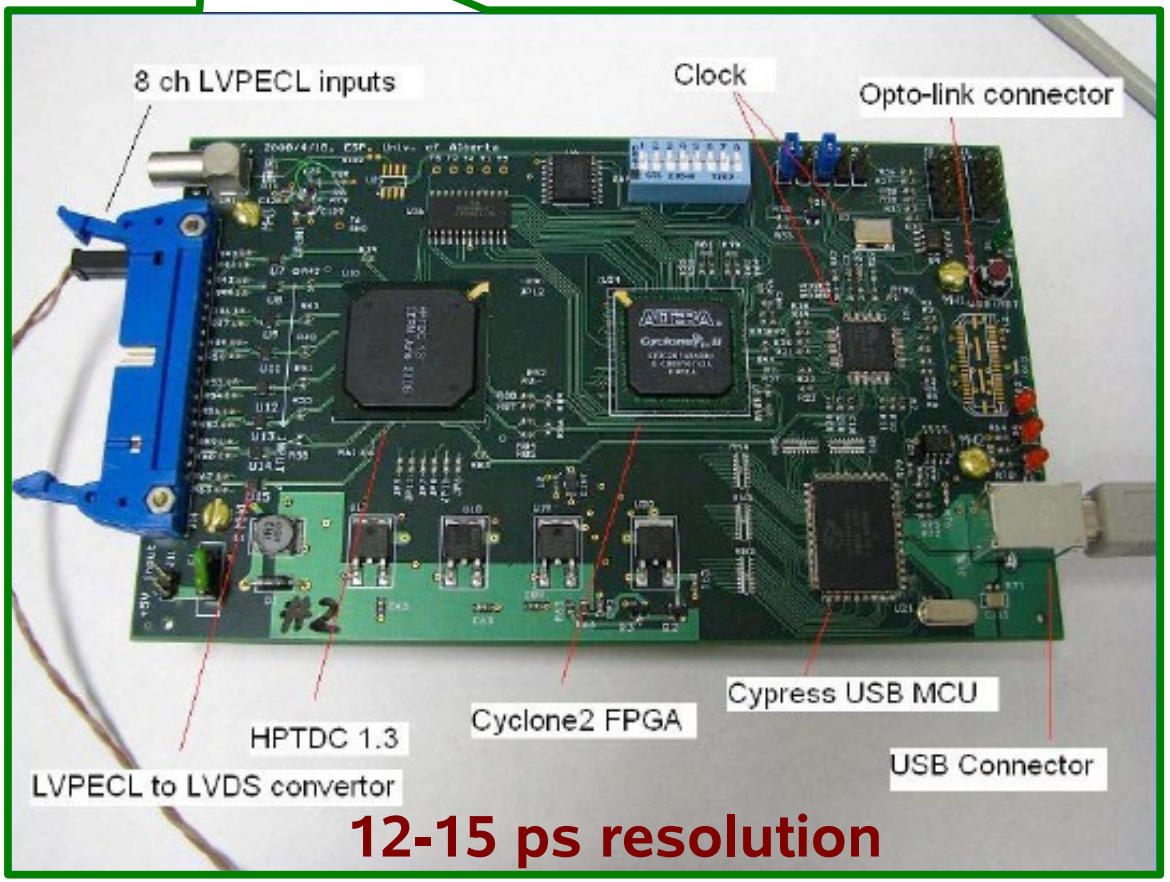


HPTDC has been tested with:
CAEN 1290 VME boards
Burle 10 µm tube, ZX60 amplifier, LCFD, 6 GHz scope

ACFD / LCFD:

previous tests show that castom 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 splited and sent to both left and right detectors for each banch crossing. Control the signal differences by spliting signal at the detectors and sendig back to comparator.

Goal: ≤ 5 ps rms jitter

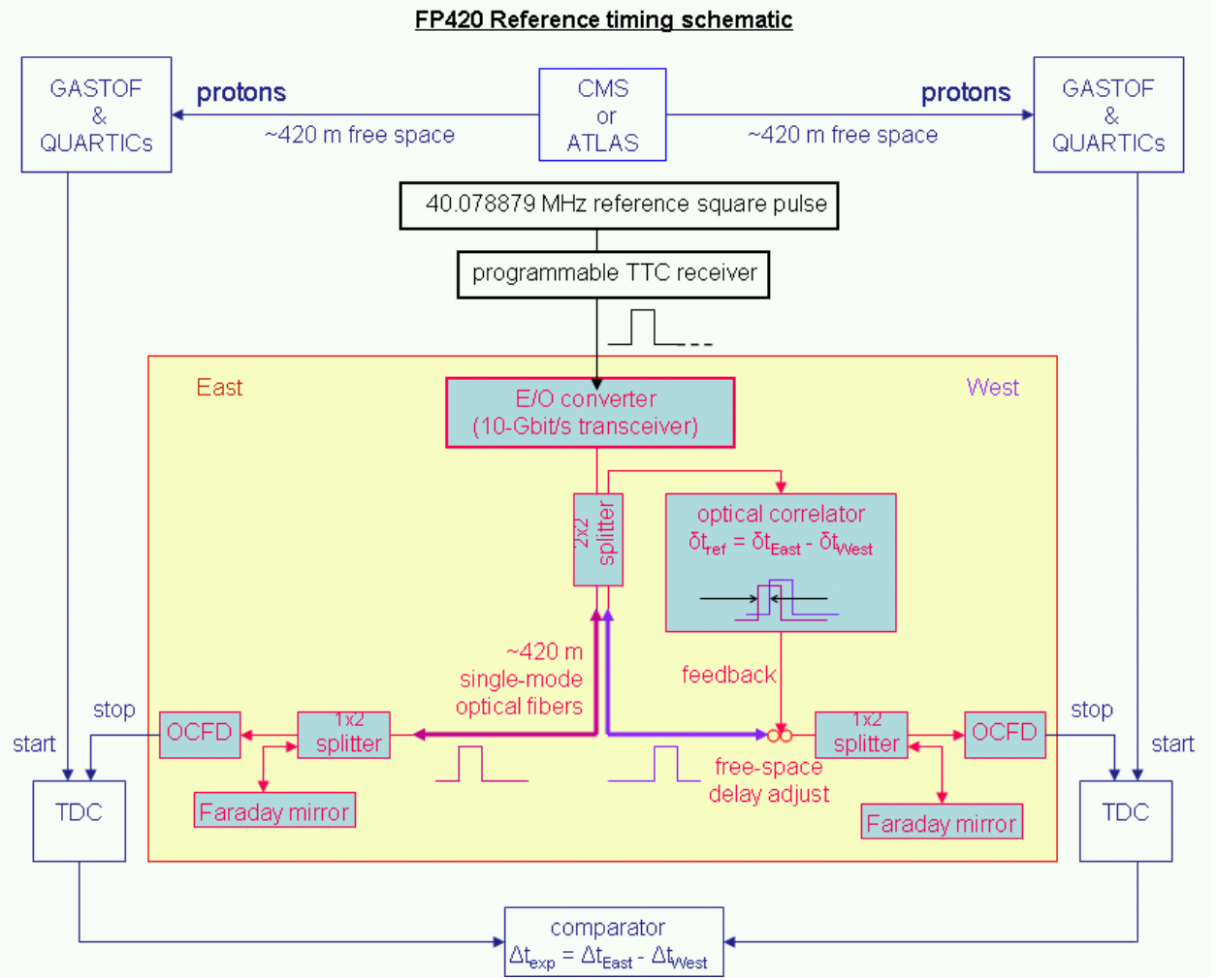
* use LHC clock (40 MHz)
  LHC Timing Trigger and Control (TTC)

- 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 $p\,p \rightarrow p\,X\,p$ 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

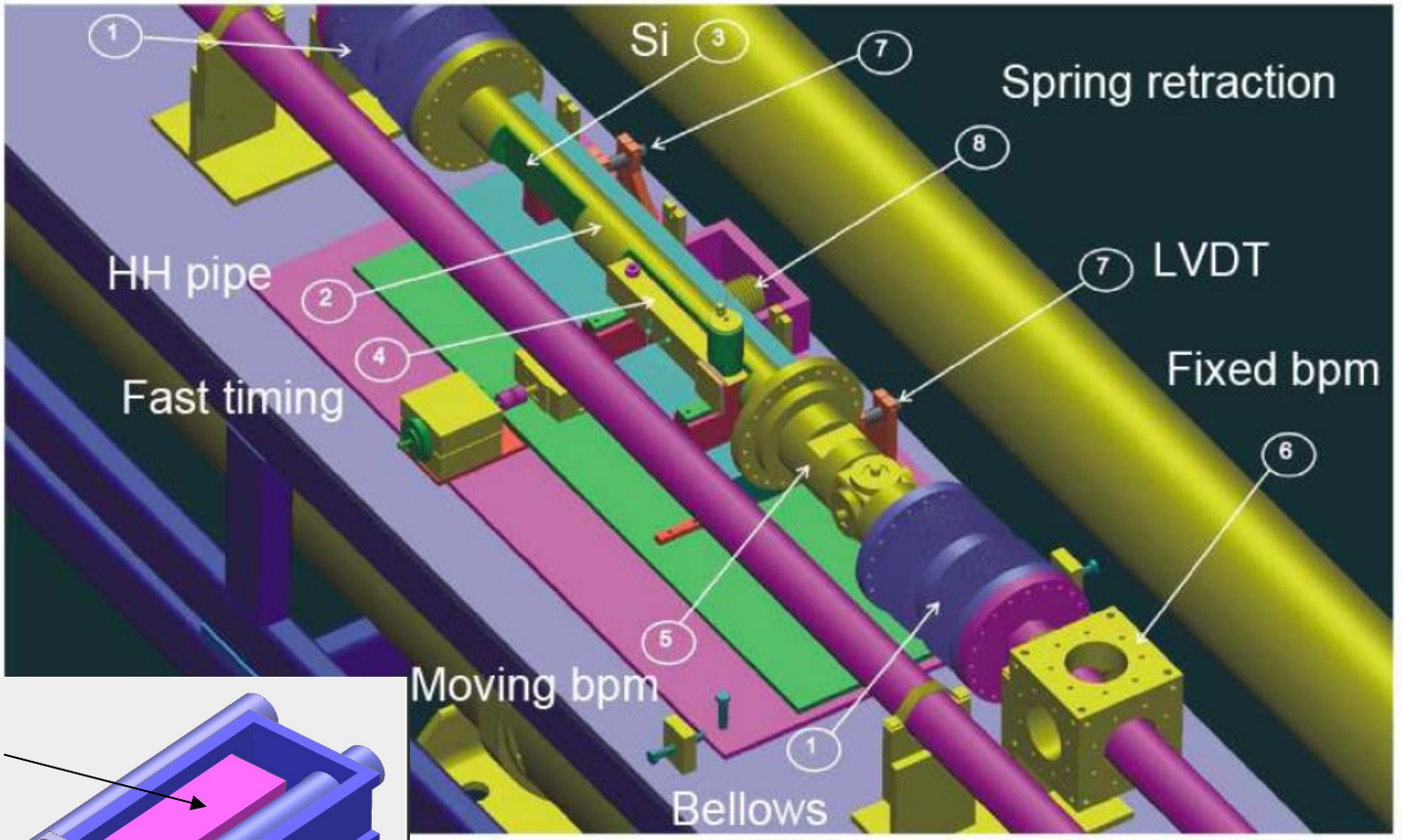
Moving "Hamburg pipe"

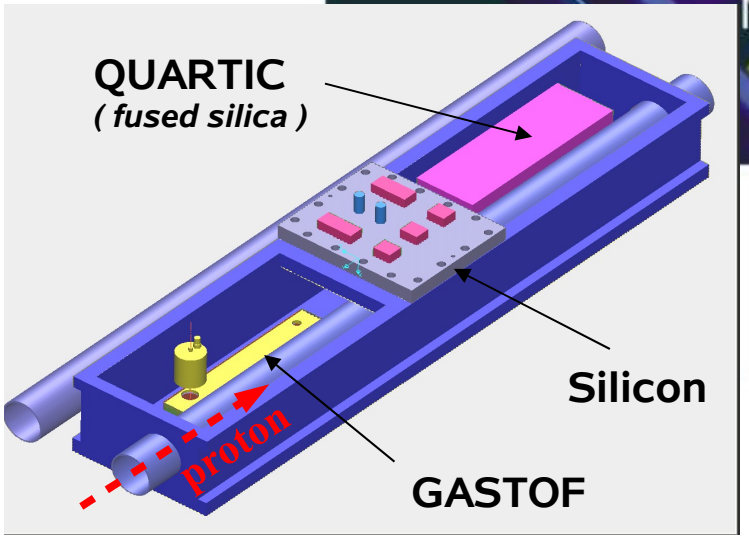
Moveable detector:

- parking position
- measuring position

Distance to the beam:

- beam conditions
- acceptance





Spectrometer/ToF inbetween beam magnets

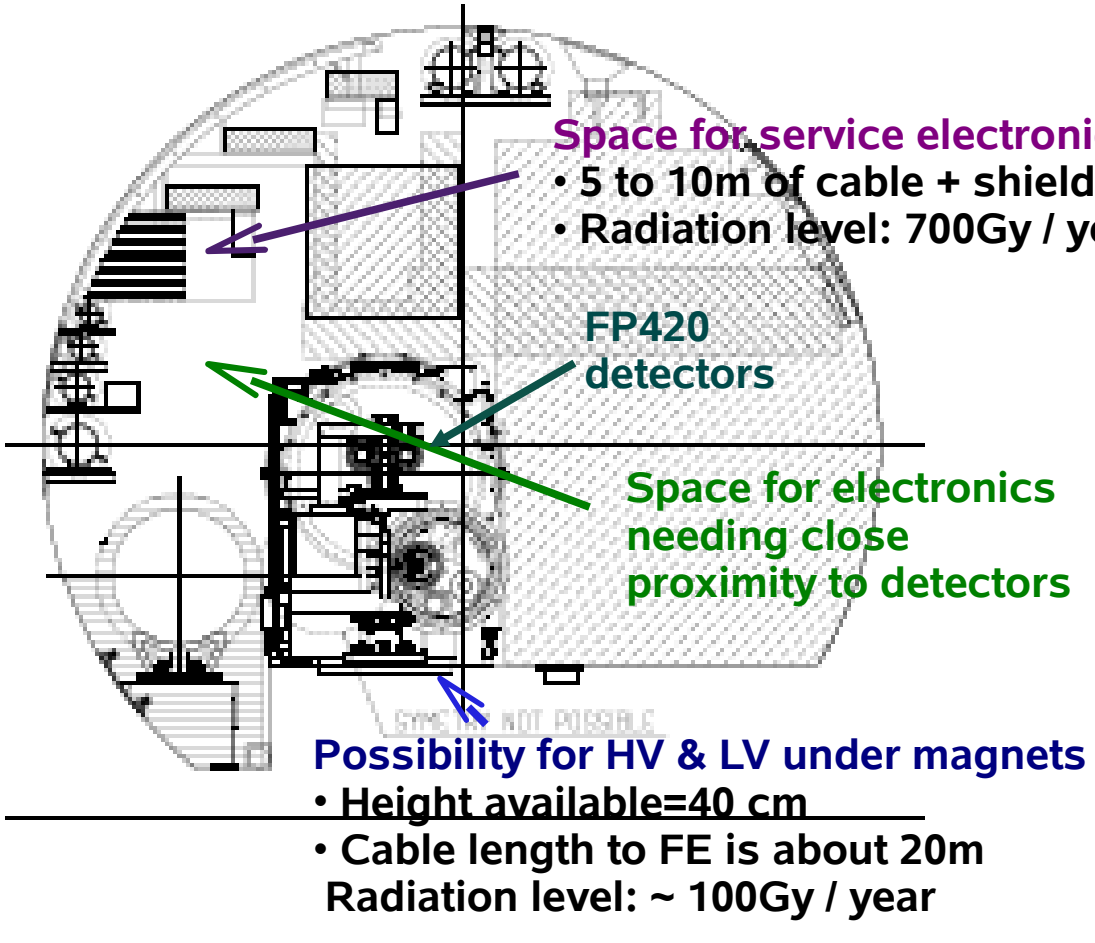
Tracking: Silicon

Timing: GASTOF + QUARTIC

FP420 Desing Report: arXiv: 0806.0302 [hep-ex]

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