

Roger Forty (CERN)
Rui Gao (Oxford)

TORCH: a possible application in LHCb

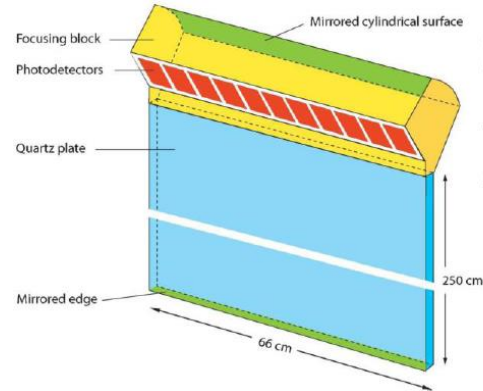
- TORCH (Timing Of internally Reflected CHerenkov light) is a detector concept for high-precision TOF over large areas
Under development as a possible addition to the LHCb upgrade
- R&D project funded by the ERC (2013–16) between CERN, Bristol and Oxford Universities, with industrial partner Photek (UK)
Mainly focused on developing a suitable photon detector
- Assuming the R&D is successful, a proposal will be made to LHCb for the full detector, which would be a client for the new TDC

New CERN ps TDC meeting, 12 February 2015

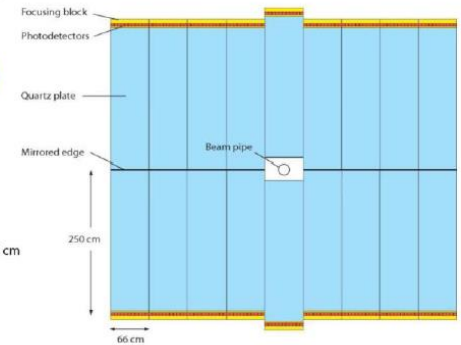
TORCH detector

- Aiming for 10–15 ps resolution per track, to separate $\pi/K < 10$ GeV
- Use Cherenkov light trapped in quartz plate, a la DIRC
- Focused onto photon detectors around edge, ~ 50 ps / photon
- Photon detector MCP-PMT: require
 1. long lifetime (done, ALD coating)
 2. fine pixellisation (in progress)
 3. large active area (next year)
- Assuming 1024 channels/MCP
Application in LHCb ~ 200 MCPs
 $\rightarrow \sim 3000 \times 64$ ch. readout chips

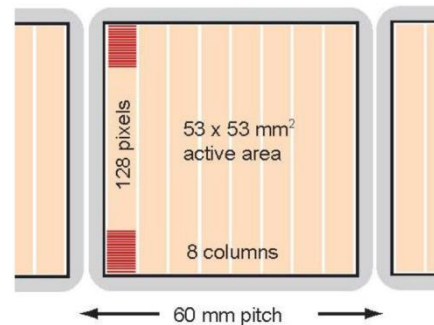
TORCH module



Layout for LHCb



MCP pixellisation



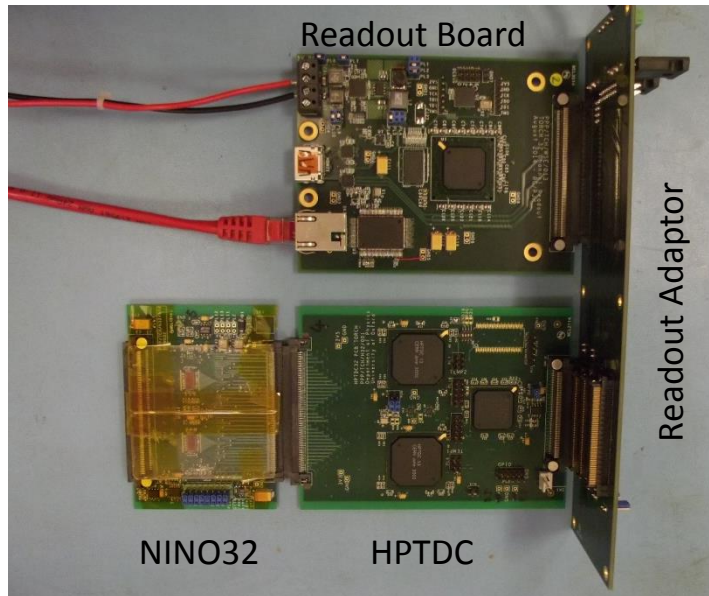
MCP prototype



Prototyping

- Prototype prepared for beam test this year
- Read-out electronics: NINO + HPTDC
Aim to use TOT from NINO for charge measurement → charge division

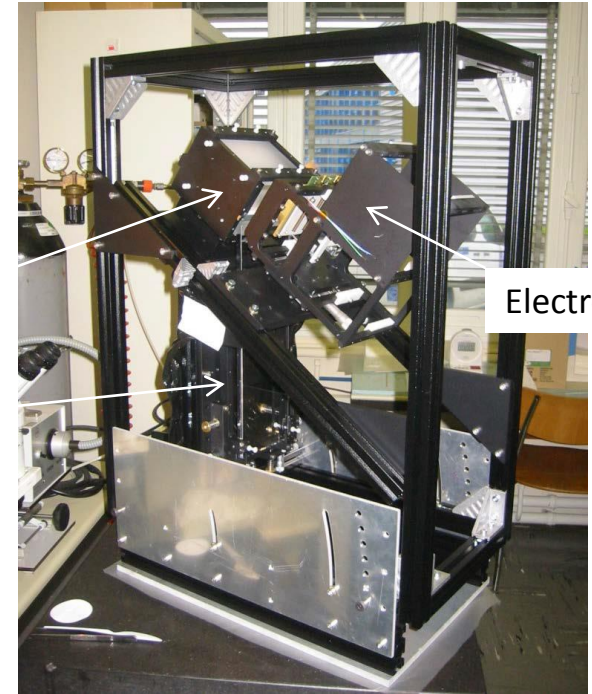
Electronics to read out MCP



Test-beam setup

Focusing +
MCP mount

35 x 12 x 1cm
quartz plate



- LHCb upgrade environment:
40 MHz collisions
- High track multiplicity →
high rate ~ 500 kHz/ch.

TORCH TDC Requirements -1

- Background and constrains: TDC to be integrated with NINO32 (IRPICS-2) front-end and LHCb trigger-less readout.
- Time reference: 40Mhz
- Hit interface: LVDS is preferred so NINO32 can be connected directly
- Hit rates: 1Mhz per channel average, local hit rate may be 5 time higher.
- Hit pulse width: should be able to register NINO pulse (2.5-6ns)
- Acceptable deadtime:5ns
- Time resolution: 12ps binning is fine
- Power supply: no particular requirements
- Readout: GBT preferred, configurable via GBT-SCA

TORCH TDC Requirements-2

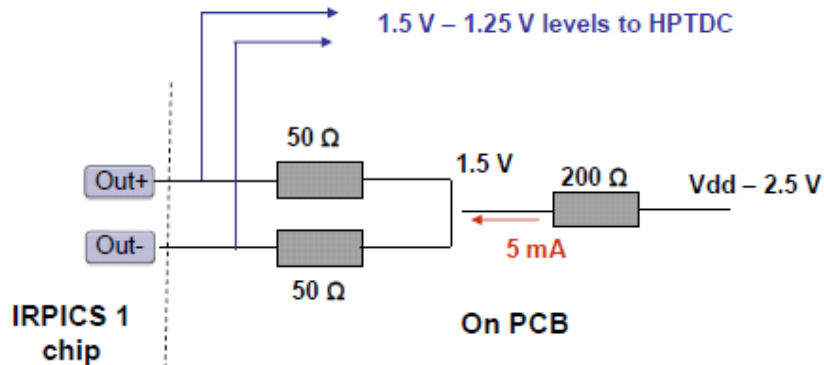
- Trigger requirements:
 - Non triggered 40Mhz LHCb trigger-less readout
Data are aligned using BXID
Readout only fine counter in TDC to save bandwidth
 - Triggered mode are useful for test beams
 - Latency: Programmable ranged hundreds nanoseconds,
 - Rate: Less than 1Mhz, for test beams only
 - Trigger window: Programmable up to 4095 x 25ns
- How many TDCs do you need, when:
 - Assuming 64-ch TDC, 3K in 5 years time if TORCH detector is approved,
 - Individual samples for development
- Radiation dosage: Less then 100krad/ year, (100krad/year is the estimated dosage for RICH 2 in upgrade)

The End

Back up slides

NINO32 interfacing to SLVS

Current circuit, IRPICS-1 to drive HPTDC - LVDS



IRPICS-2 has built-in LVDS drivers

AC couple to SLVS – overdrive the SLVS

IRPICS-1, Possible SLVS driver

5mA transistor drivers

