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PSI


NMI3 - Integrated Infrastructure Initiative for
Neutron Scattering and Muon Spectroscopy

# NMI3/JRA8 MUON-S Working Group Meeting 17.02.2005

## *High Magnetic Field μSR Project at PSI – Status Report*

**R. Scheuermann**

# PSI - Design Specifications

Maximum magnetic field (TF): $H_{max} \geq 10$ T

Field homogeneity / stability: $\Delta H/H \leq 10^{-5}$

(over sample volume 10×10×2 mm$^3$ for typ. 1 hr.)

compact, max. length: $l_{max} \leq 30$ cm

⇒ split coil with integrated cryostat, $T = 0.025 - 300$ K

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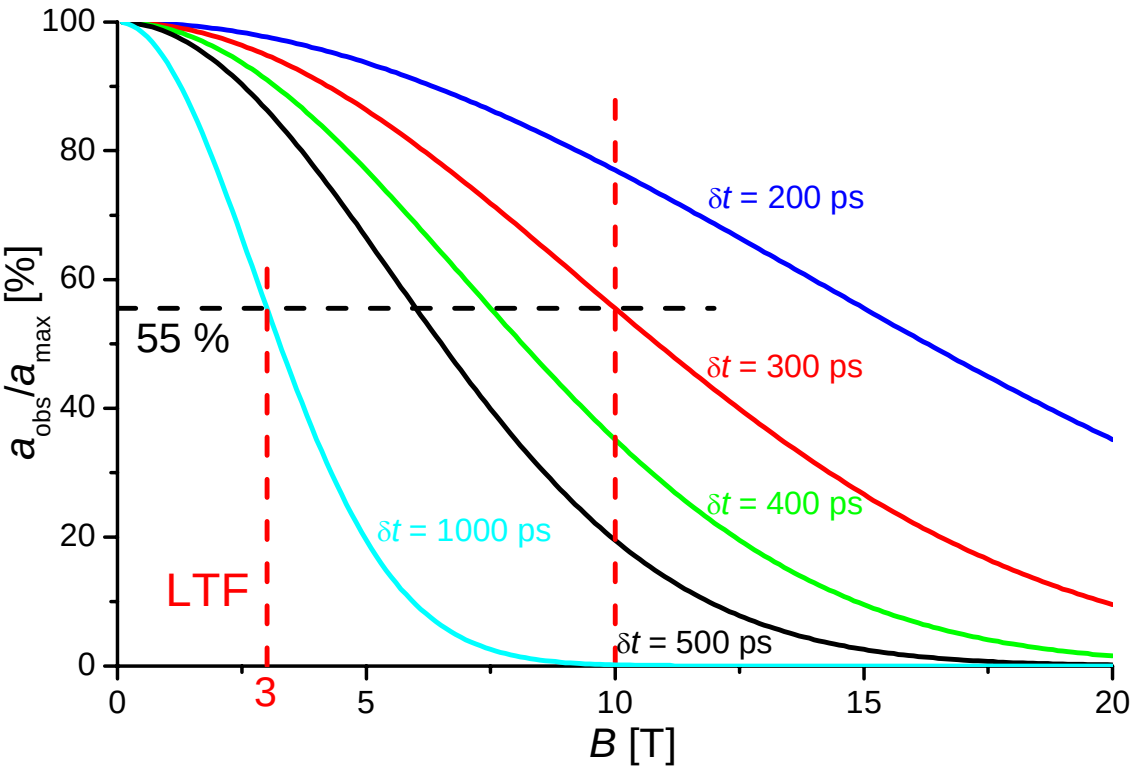
$\mu^+$, $E_{kin}$ = 4.2 MeV

TF: 90° spin rotation

time resolution:
$\delta t \leq 300$ ps

compact detector system: AMPDs ?
(Avalanche Microchannel Photodiodes)



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# Problems / Challenges

Magnet design: length, field homogeneity & long-term stability

Stray field minimization (spin phase coherence)

Muon phase space / momentum bite

Muon beam collimation

Detector system (fast & compact)

Sample environment (incl. scintillators)

## Belle

Magnet Type: Superconducting Helmholtz
Field Strength/Orientation: 7.5 T // z
Counter acceptance: 4π
Experiment types: HTF

http://musr.org/

## High-Time

Magnet Type: Superconducting Solenoid
Field Strength/Orientation: 7.0 T // z
Counter acceptance: 4π
Experiment types: HTF

Time resolution: 425 ps

# Fast-Timing Detector Development - 1

## Avalanche Microchannel Photodiodes (AMPDs)

collaboration with Z. Sadygov (JINR, Dubna):
new generation of AMPDs

sensitive to blue, active area 25×25 $mm^2$, rise time « 1ns, …

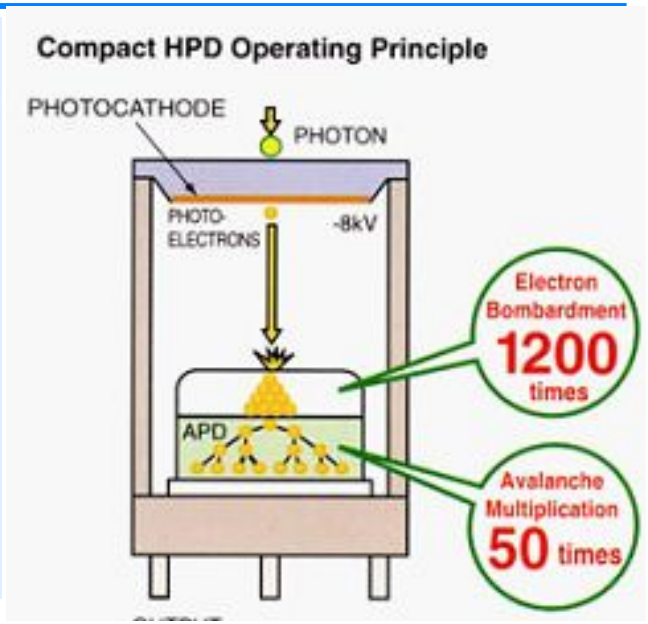
$\Rightarrow \delta t \leq 50$ ps

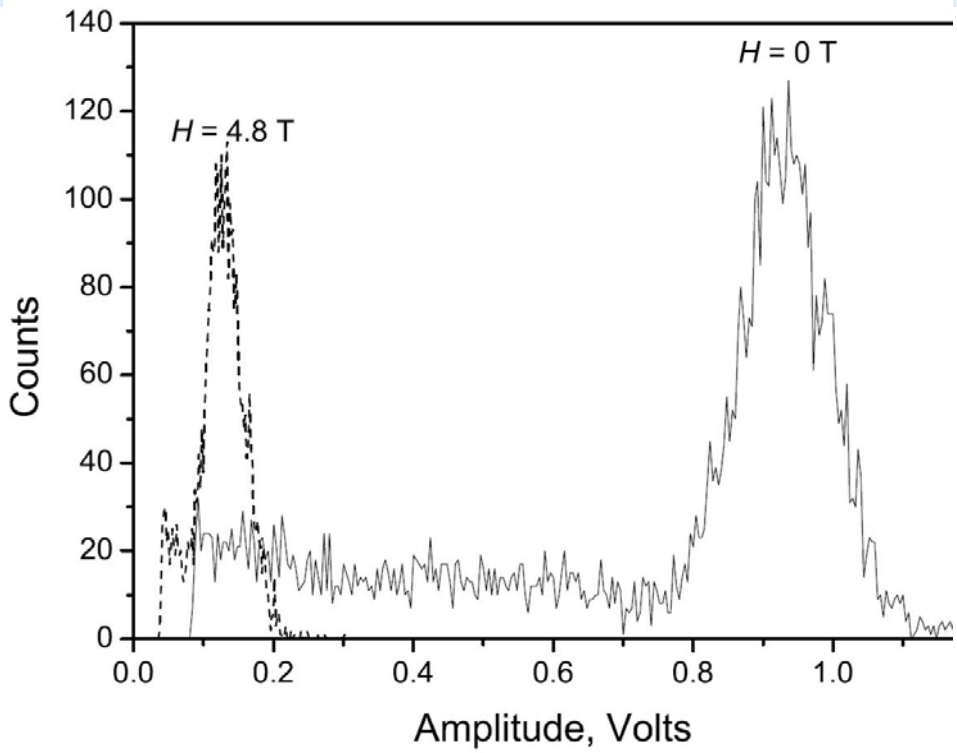
# Fast-Timing Detector Development - 2

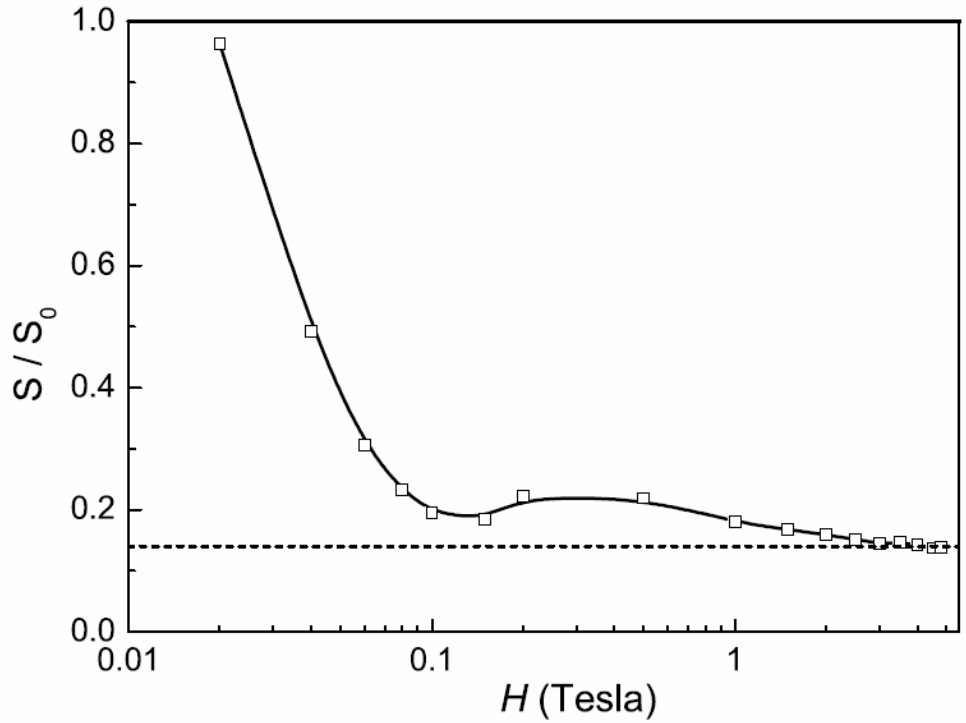
## Hybrid Avalanche Photodetector Hamamatsu R7110U-07:

electrostatic focussing lost above 1 kG // axis: decrease of signal amplitude

timing properties (rise time) do not change



# Fast-Timing Detector Development - 3

## Multianode-MCP PMTs

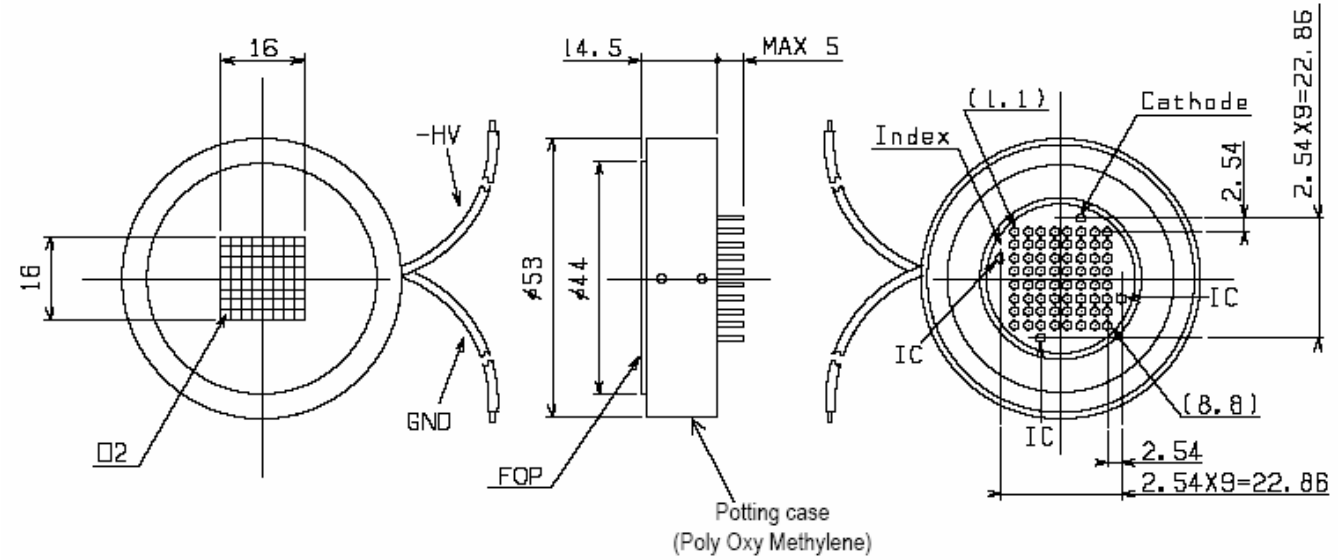
BURLE PLANACON™ 85001-501

4 channels – tbt

# Fast-Timing Detector Development - 4

## Multipixel HPD

Hamamatsu R9503U-04-M064 8x8 pixels, 16x16 mm$^2$ eff. area
– tbt ????? (25 kSFr…)



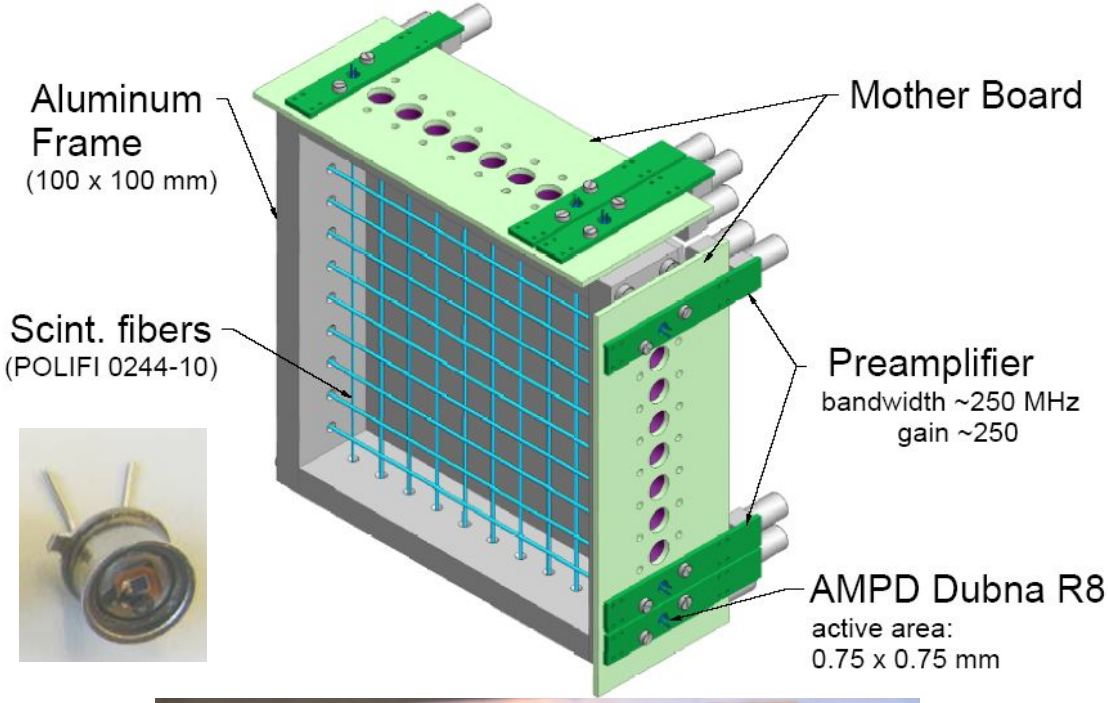
# Detector Development

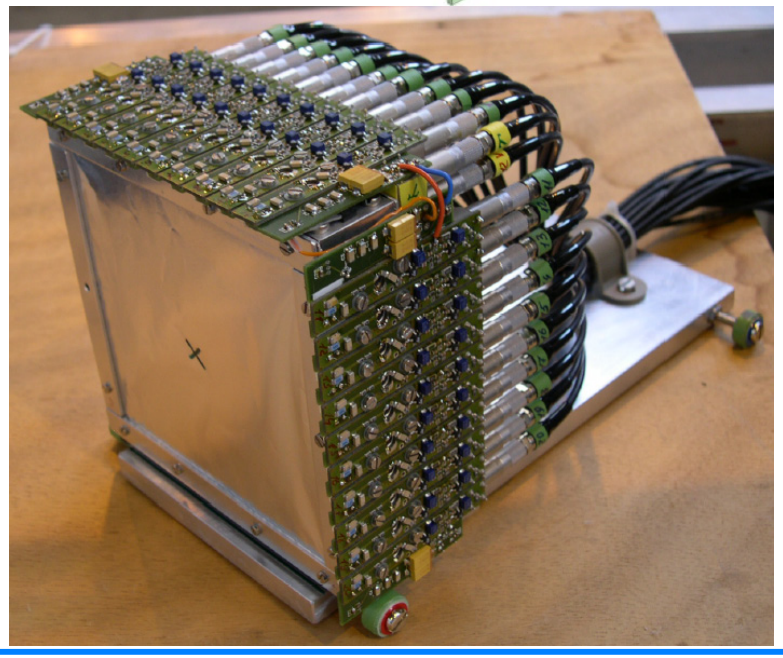
## Muon beam profile monitor:

**A. Stoykov** *et al.*

Muon beam profile measurement in center of ALC solenoid:

AMPDs and preamps work fine in 5 T!



# Beam Profile Measurements

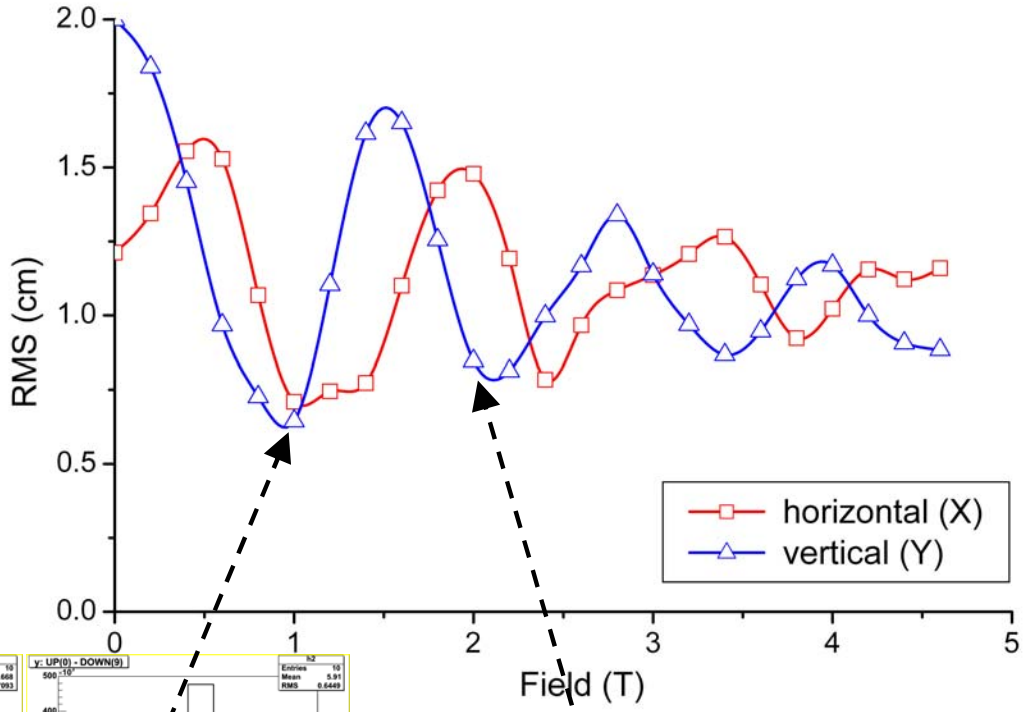
Variation of muon spot size on sample

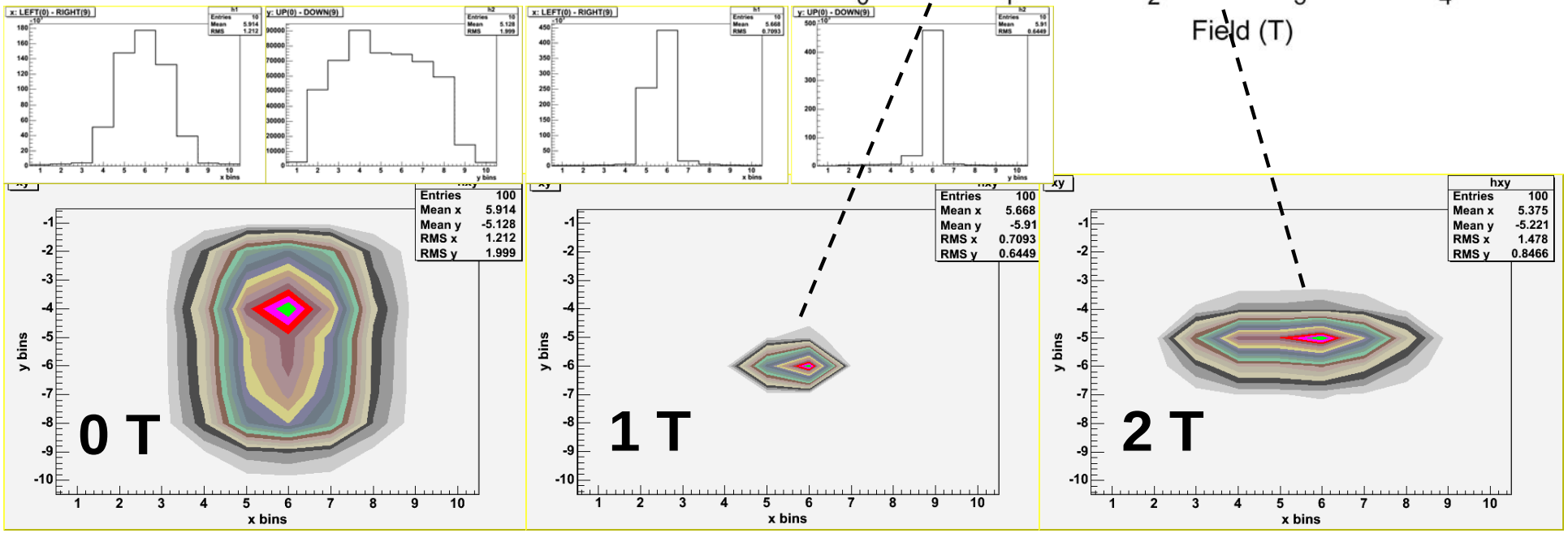
⇒ different trajectories of decay $e^+$

in high magnetic fields (spiraling),

this affects the F-B asymmetry!

⇒ Simulations (T. Lancaster)



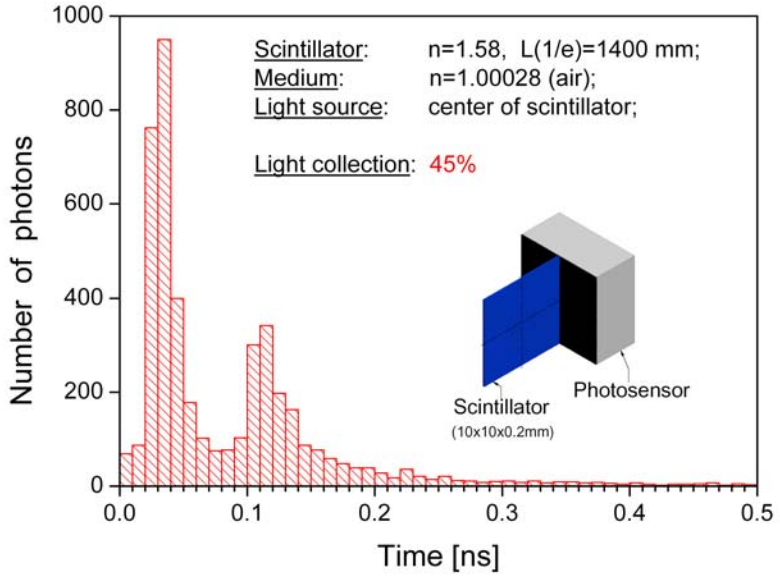
# Tests planned 2005

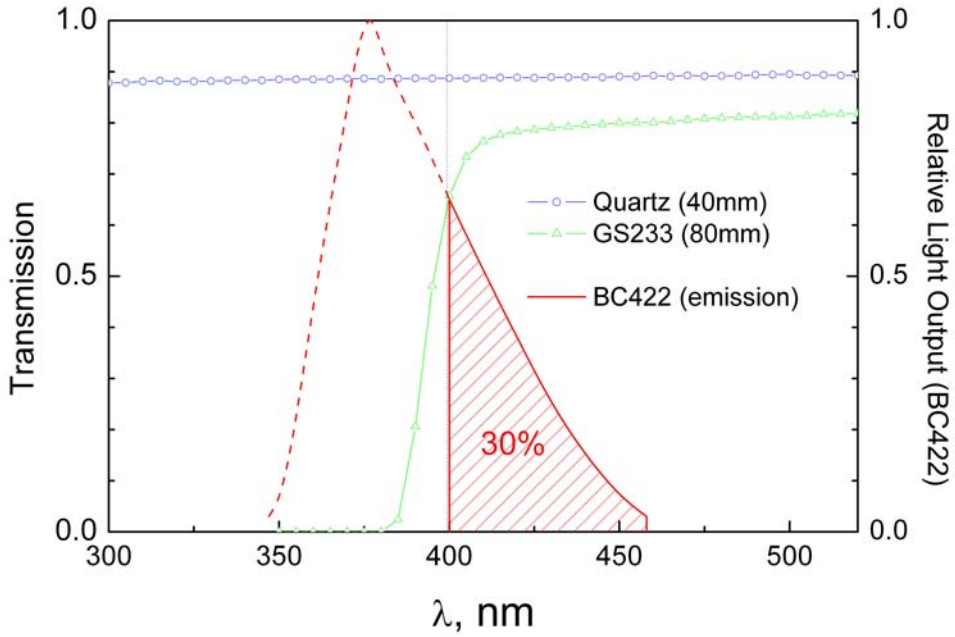
Light collection from scintillator:

MC simulation
(V.V. Zhuk 2005, code: NIM A 374 (1996) 335)
≈45% of light from 10×0.2 mm² face collected in less than 200 ps

fast plastic scintillator BC422:

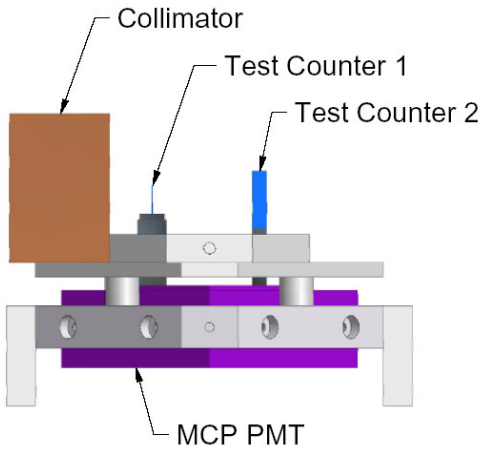
70% of light lost with standard plexiglass light guides!

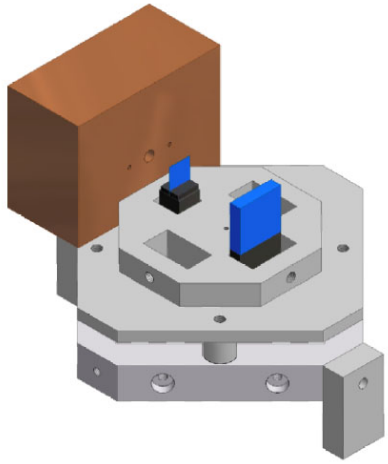


# Tests

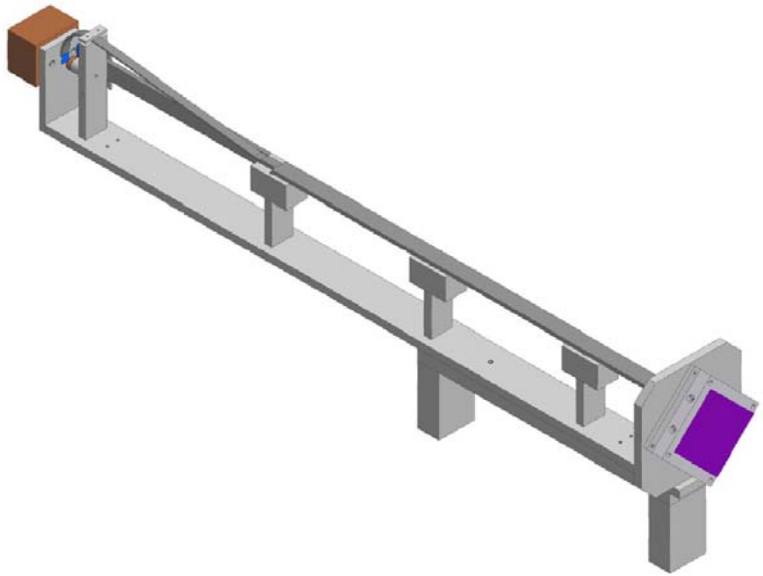
**Test setup based on BURLE PLANACON 85001-501 MCP PMT**



**Test setup to study the effect of long light guides on timing properties,**

**evtl. to be used in RA-05-25**



# Magnet

**field maps required for simulations:**

**particle tracking & spin phase evolution**

# Oxford Instruments – initial design

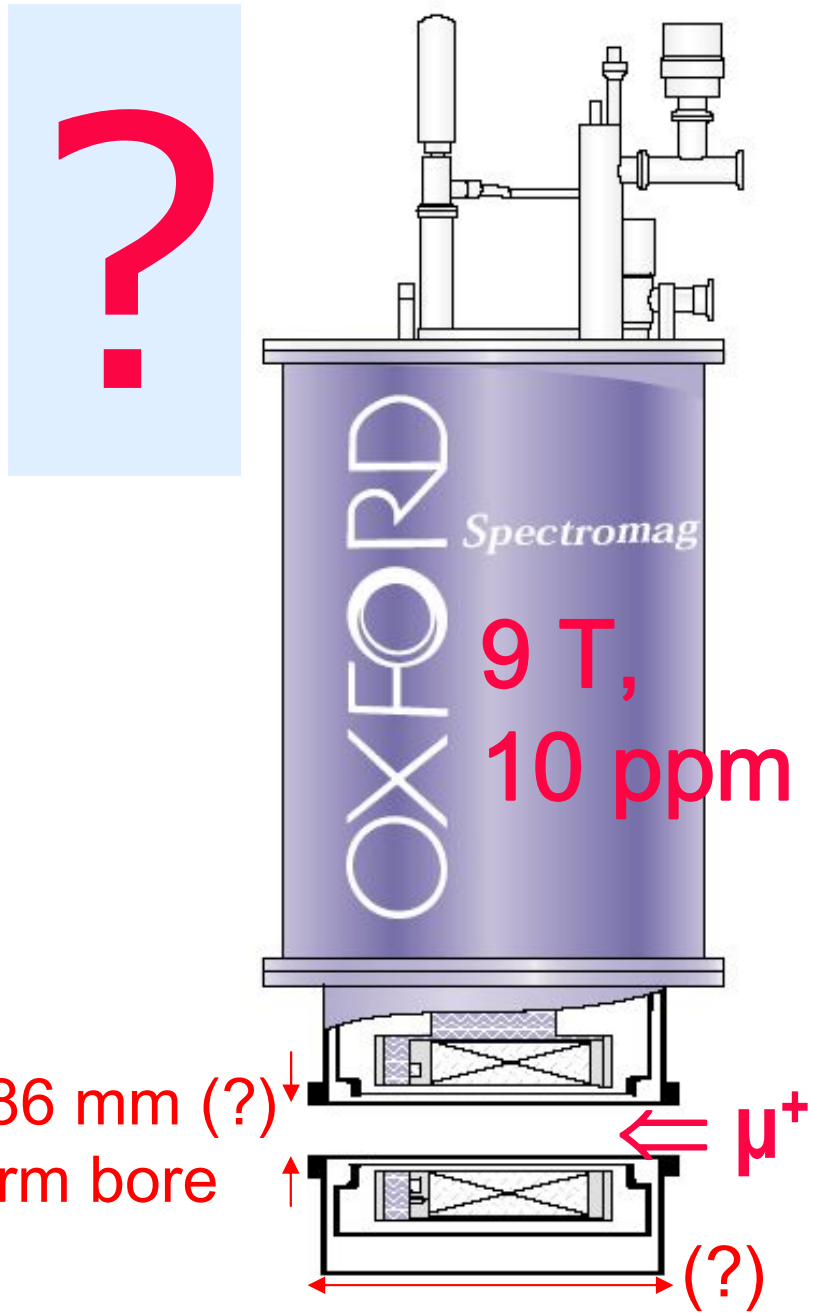
10 T cold magnet split (20 mm)

contact only to engineer only via sales manager…

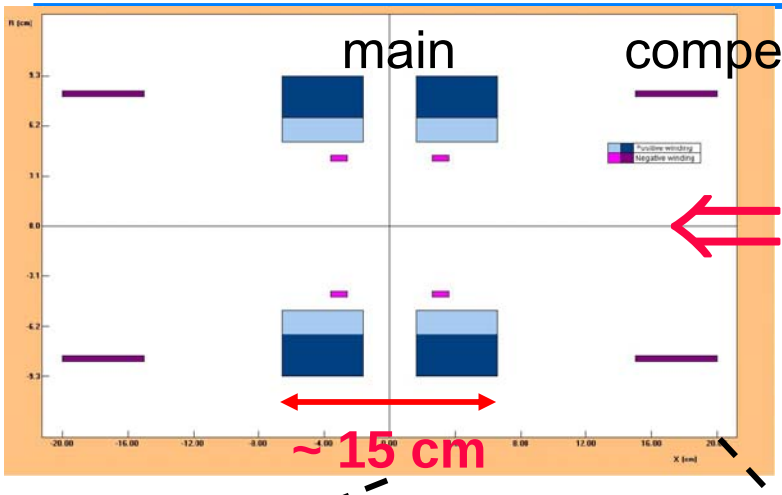
recently restructured:
delays and loss of information

initial design (no-cost, completed 13/07/2004, received 09/2004): useless…

# OI-2: ‘horizontal’ dl + solenoid



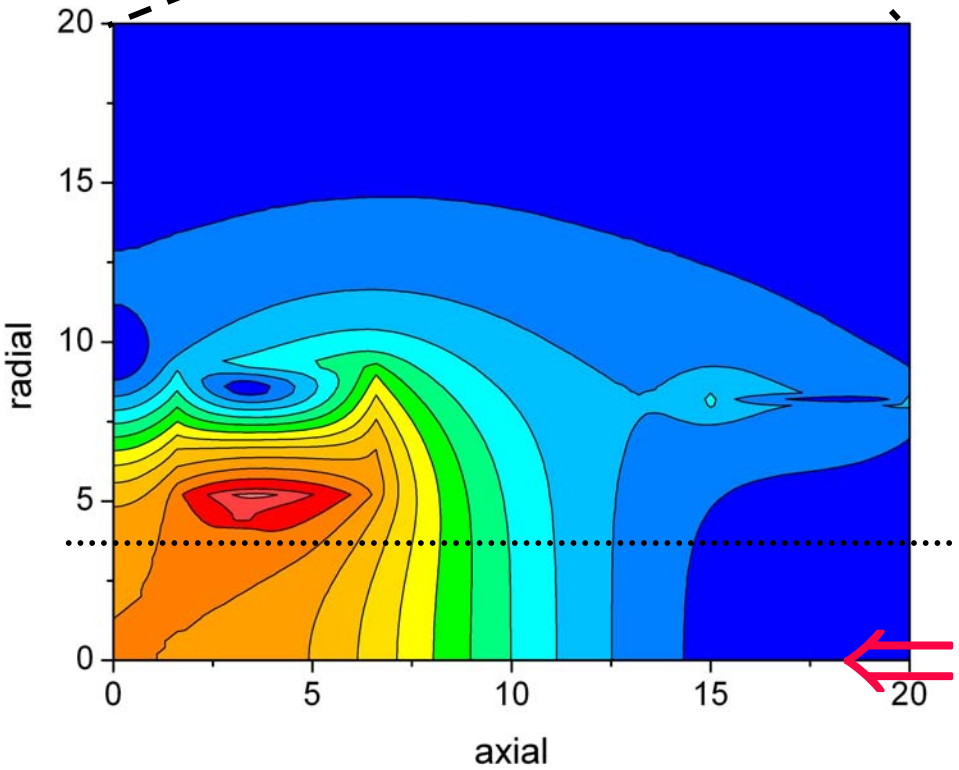
# Cryogenics LTD. – 10 T design study (€)

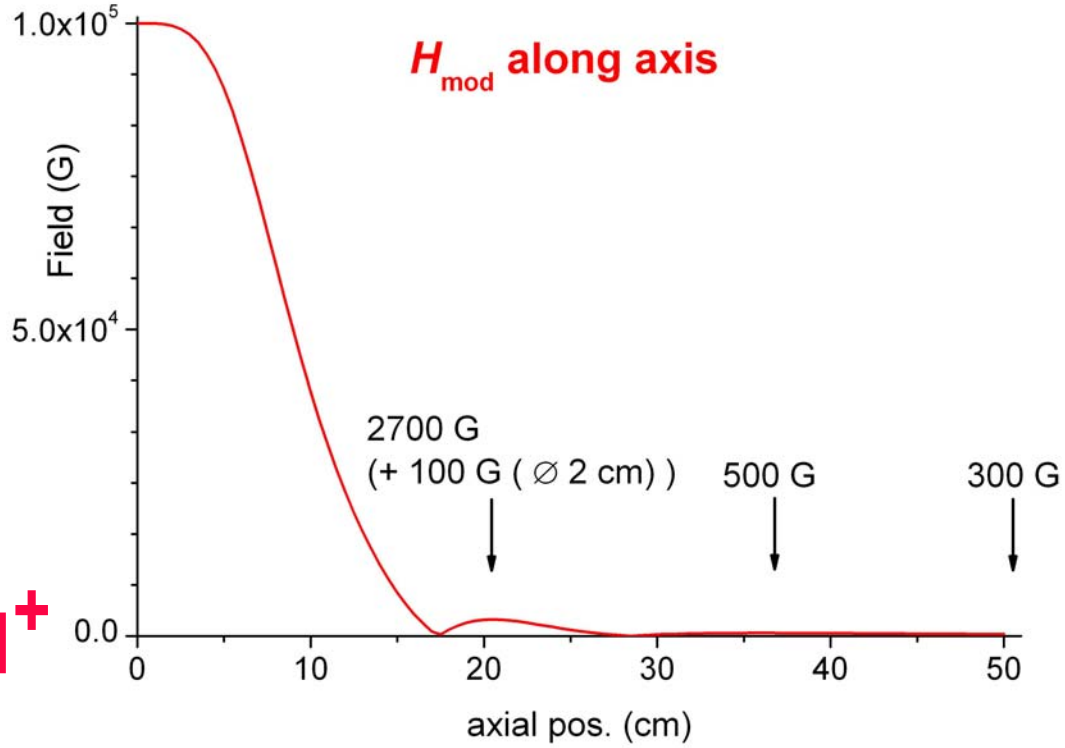



axial bore ∅: 68 mm

coil split ∅: 28 mm

homogeneity (disc ∅ 10 mm × 5 mm):
10.28 ppm



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# Next Steps

**Particle tracking / simulations with 'real' field maps (split coil + evtl. solenoid)**

**Short solenoid: minimize length at given homogeneity**

**Fast Timing: test Multianode MCP-PMT PLANACON™ 85001-501**
**new AMPDs**

**Performance of fast plastic scintillators at low *T***

**Detector design and simulations**

**Full instrument simulation (secondary beamline + spectrometer)**