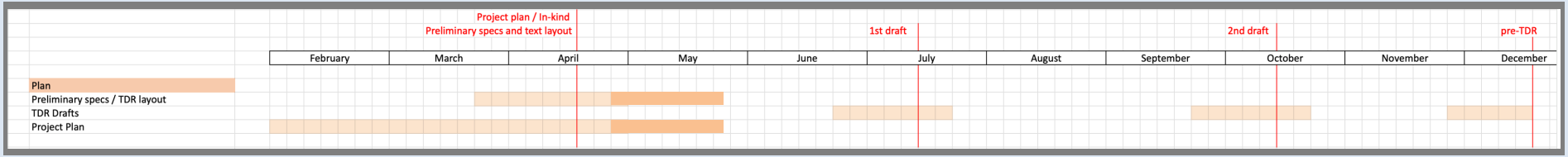
dRICH: pre-TDR Preparation Status

PID WG Meeting, 31th May 2024

TDR Effort in 2024



April: Preliminary specs & text layout
Project plan / in-kind preview

July: 1st draft

October: 2nd draft

December: Pre-TDR

Assumptions: Pre-TDR (CD2) required at the end of the year
Scheme driven by manpower/lead time: remains the same for a TDR (CD3)
Extra-time needed fo real-scale mechanics & RDO demonstrators

SiPM technical specs

SiPM LLP Review September 2023

baseline sensor device
64 (8x8) channel SiPM array
3x3 mm^2 / channel

Parameters	Value	Notes (all parameters at the recommended operating voltage and T = 25 C, unless specified)
Device type	SiPM array	
Number of channels	64	8 x 8 matrix
Active Area	3 x 3 mm^2	active area of one channel, total active area is 64 x 3 x 3 mm^2
Device Area	< 28 x 28 mm^2	device area should be small such as to have > 75% fraction of active area over device total area
Pixel Size	40 - 80 um	pitch of the microcell SPAD
Package Type	surface mount	
Operating voltage	< 64 V	
Peak Sensitivity	400 - 450 nm	
PDE	> 35%	at peak sensitivity wavelength
Gain	> 1.5 10^6	
DCR	< 1.5 MHz	
Temperature coefficient of Vop	< 60 mV / C	
Direct crosstalk probability	< 10%	
Terminal capacity	< 600 pF	
Packing granularity		
Vop variation within a tray	< 300 mV	Vop variation between channels in one device
Recharge Time	< 100 ns	ctau recharge time constant
Fill Factor	> 70%	
Protective Layer	silicone resin (n = 1.5 - 1.6)	radiation resistant, heat resistant (up to T = 180 C)
DCR at low temperature	< 10 kHz	at T = -30 C
DCR increase with radiation damage	< 1 MHz / 10^9 neq	at T = -30 C, after a radiation damage corresponding to 10^9 1-MeV neutron equivalent / cm^2 (neq)
Residual DCR after annealing	< 25 kHz / 10^9 neq	at T = -30 C, after a radiation damage of 10^9 neq and a 150 hours annealing cycle at T = 150 C
Single photon time resolution	< 200 ps FWHM	corresponding to < 85 ps RMS

very important parameters to ensure detector performance over the years

we will evaluate as part of QA, testing sensor samples in received batches

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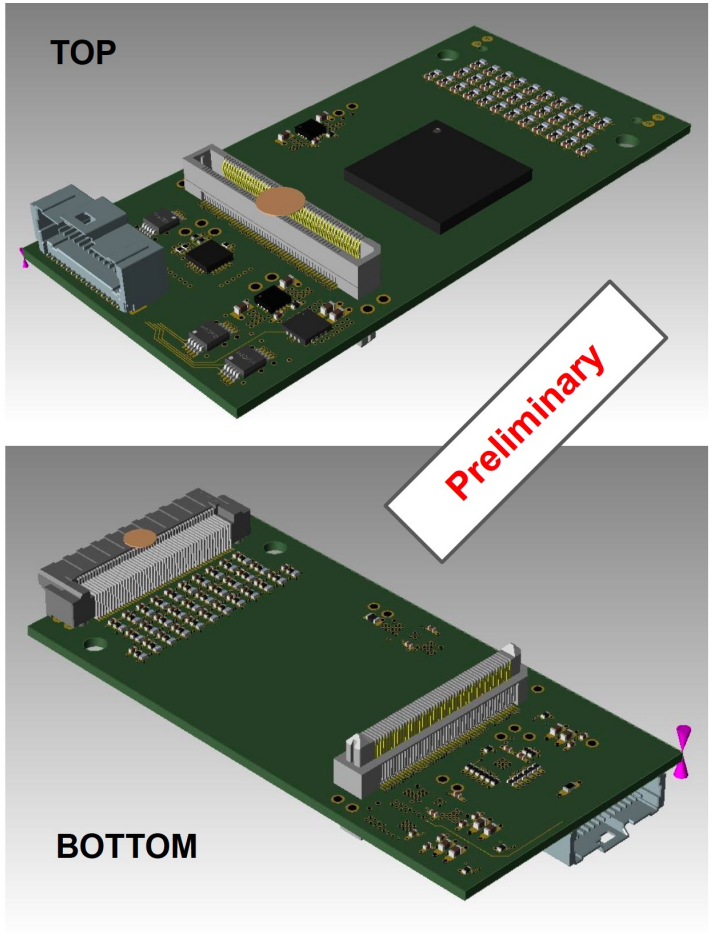
Preliminary selection of connectors and components:

- **Linear Regulators** (2.5 V DVDD_IO, 1.2 V DVDD, 1.2 V AVDD): *Analog Devices ADP1752ACPZ-2.5-R7, ADP1761ACPZ-R7*
- **Current monitors** (before regulators): *Microchip Technology MIC2040-1YMM-TR*
- **I2C to Parallel-Port Expander** (read/control regulators and current monitors): *Texas Instruments PCF8575RGER*
- **RC High Pass Filter** (AC-coupling between SiPMs and ALCOR)
- **Annealing circuit**: to be included



Preliminary specs: RDO

Component function	QTY	Baseline option	V	Comments
Main FPGA	1	Xilinx AU15P-SBVB484	0.85, 0.9, 1.2, 1.8 , 2.5	Artix Ultrascale+ Overview
Scrubber FPGA	1	Microchip MPF050T-FCSG325	1.0 1.2 1.8	Polarfire overview
QSPI Flash	1	MT25QU01	1.7 - 2.0 V	package W9 6x8 mm Datasheet
VTRX+	1	CERN	1.2V, 2.5V	https://edms.cern.ch/ui/file/2149674/1/VTRxPlusApplicationNote.pdf
SIPMbus connector	2	Samtec ERF5-020-05.0-L-DV-TR	N/A	
ALCORbus connector	2	Samtec ERF5-050-05.0-L-DV-K-TR	N/A	
ADC for NTC (4 = 1 per FEB)	2	Texas Instruments ADS1219-4	2,3-5.5 V	3x3 mm (WQFN package) Datasheet
IO expander (I2C)	2	Microchip MCP23017	1.8-5.5 V	likely needed: we save 32 I/O on FPGA 6x6 mm 16 I/O https://ww1.microchip.com/downloads/aemDocuments/documents/APID/ProductDocuments/DataSheets/MCP23017-Data-Sheet-DS20001952.pdf
LDO	2	LTM4709	VDH VDL	6x12 mm Datasheet link, Demo board link
Temperature sensors	2	TMP116NAIDRVT or TMP119	2.5	Close to LDO and VTRX https://docs.rs-online.com/2b49/A700000009837783.pdf https://www.ti.com/lit/ds/symlink/tmp119.pdf?ts=1711373203560&ref_url=https%253A%252F%252Fwww.ti.com%252Fproduct%252FTMP119
Step-Up Charge Pump	1	LTC3203	VDH	ededDH VBIAS a LDO Datasheet
uC to read current monitor	1	ATtiny416	VDH	Datasheet
Clock multiplier/ jitter cleaner	1	SkyWorks SI5326	1.8 or 2.5 V	6x6 mm, 2 input - 2 output Family Datasheet and Si5326 Datasheet
3OT Crystal for Si5236	1		N/A	3.2 x 2.5 mm SkyWorks guidance
Crystal oscillator	1			A 98.5 MHz crystal or "similar"

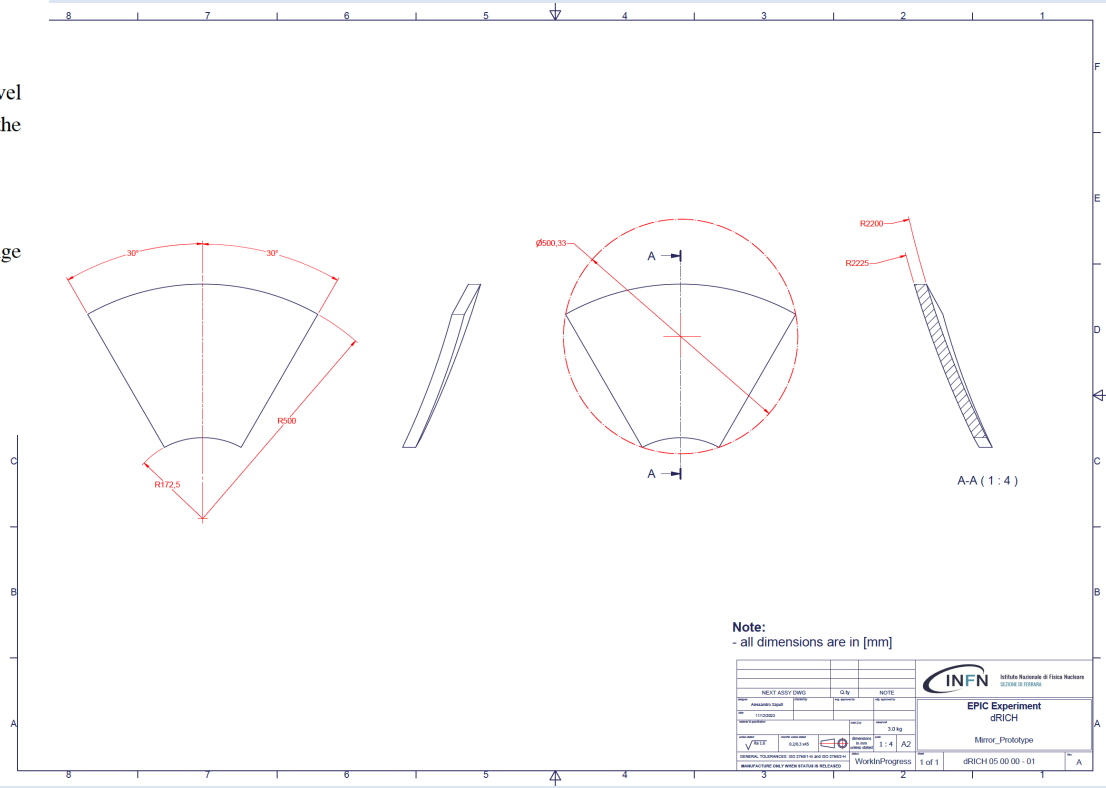
Annex C. Technical Requisite

Each spherical mirror is supplied with

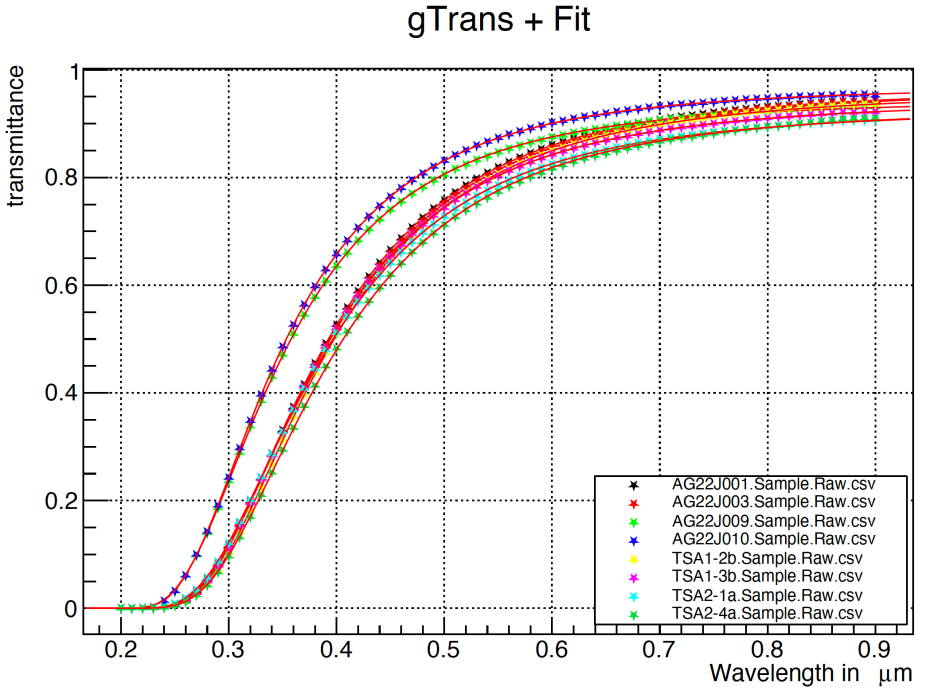
- a spot-size measurement,
- a report on dimensions,
- no reflective coating.

The spherical mirrors are replicated from the same mandrel. The latter is realized with the novel cost-effective technology that reduces the mandrel total mass and cost. Each mirror fulfills the following optical quality specification:

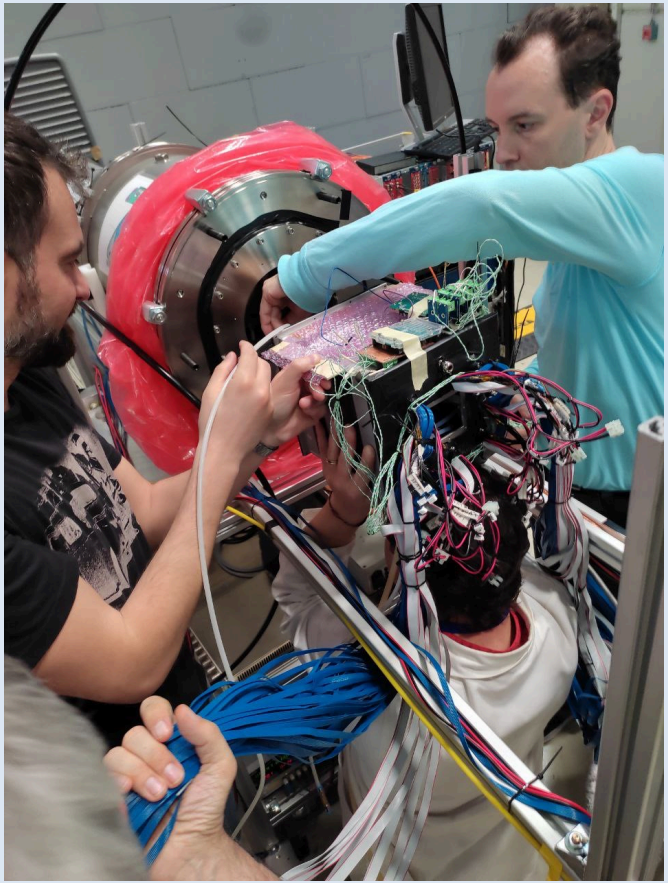
- Radius within 1% of nominal RoC value
  (the nominal RoC values is defined by the customer before production in the range 2000 mm +/- 10%),
- Roughness < 2 nm,
- Pointlike image spot size D0 < 2.5 mm,
- Compatibility with fluorocarbon gases (C_2F_6),
- Compatibility with SiO_2 reflecting coating.

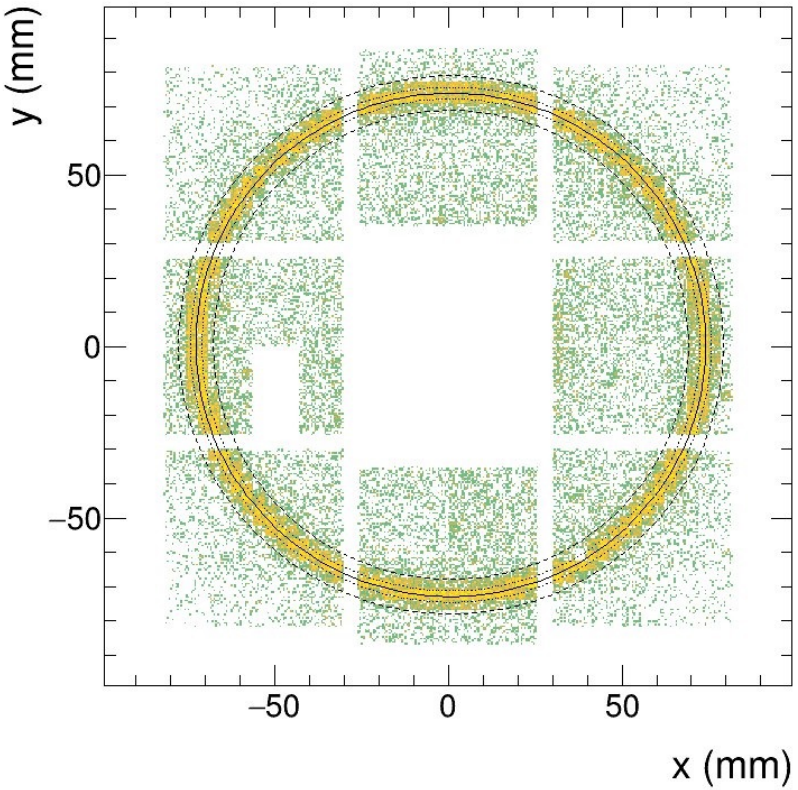


Optimization ongoing in the refractive index rage 1.02-1.03
New samples received from Aerogel Factory



Prototype Test-Beam





$X_0 = 0.72 \pm 0.01$ mm

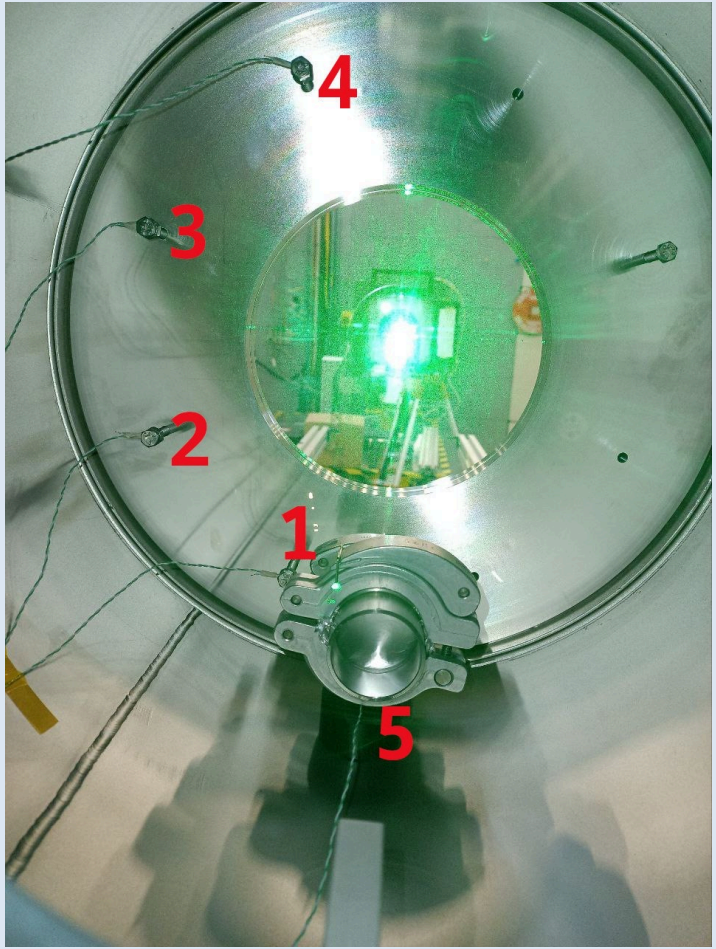
$Y_0 = 0.50 \pm 0.01$ mm

$R = 73.42 \pm 0.01$ mm

$\sigma_R = 1.68 \pm 0.01$ mm

$N_{sig} = 20.12 \pm 0.09$

$N_{bkg} = 12.55 \pm 0.10$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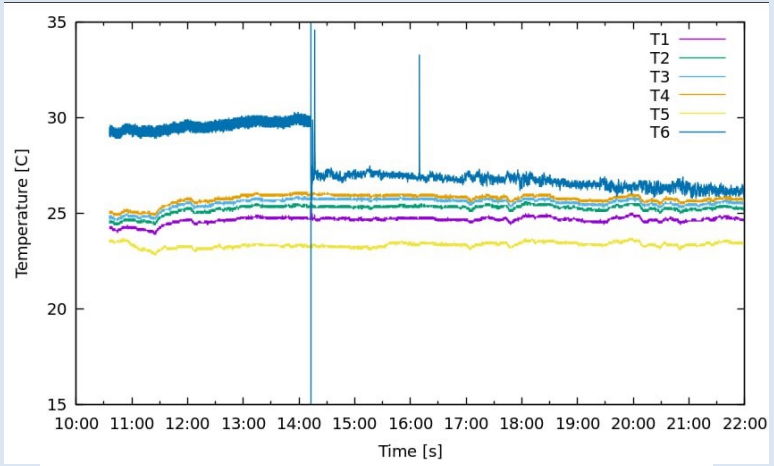
3
2
1
5


T1
T2
T3
T4
T5
T6
Temperature [C]
Time [s]
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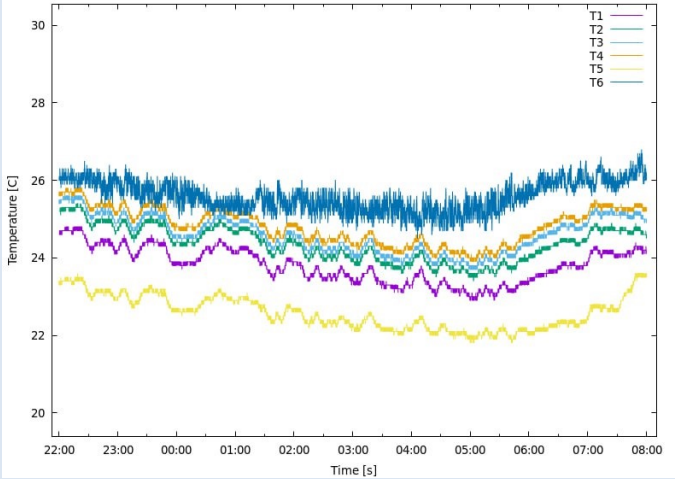
T1
T2
T3
T4
T5
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Temperature [C]
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dRICH simulation and reconstruction

to open to new collaborators

dRICH data filtering

to further discuss with project and other detectors