24/06/2020

Proposal to build and test a large μRWELL chamber with a Tiger ASIC

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INFN BO, FE, LNF, TO

IDEA Muon detector dimensions

Barrel

Layer	R [mm]	Length [mm]	Thickness [mm]	int. length	pixel size [mm]	area [cm²]	# of channels
µRwell	4520	±4500	20		1.5×500	2.6M	341K
iron	4560	±4500	300	1.5			
µRwell	4880	±4500	20		1.5×500	2.8M	368K
iron	4920	±4500	300	1.5			
µRwell	5240	±5260	20		1.5×500	3.5M	462K

50x50 cm² strips 50 cm pitch 1.5 mm

Endcap

Disk	R_{in} [mm]	R_{out} [mm]	z [mm]	Thickness [mm]	int. length	pixel size [mm]	area [cm²]	# of channels
µRwell	454	5220	±4520	20		1.5×500	1.7M	227K
iron	454	5220	±4560	300	1.5			
µRwell	454	5220	±4880	20		1.5×500	1.7M	227K
iron	454	5220	±4920	300	1.5			
µRwell	454	5220	±5240	20		1.5×500	1.7M	227K

IDEA's Muon detector would have in total:

Barrel 900x2 m² (1800 m² total)

Barrel 1200000x2 channels

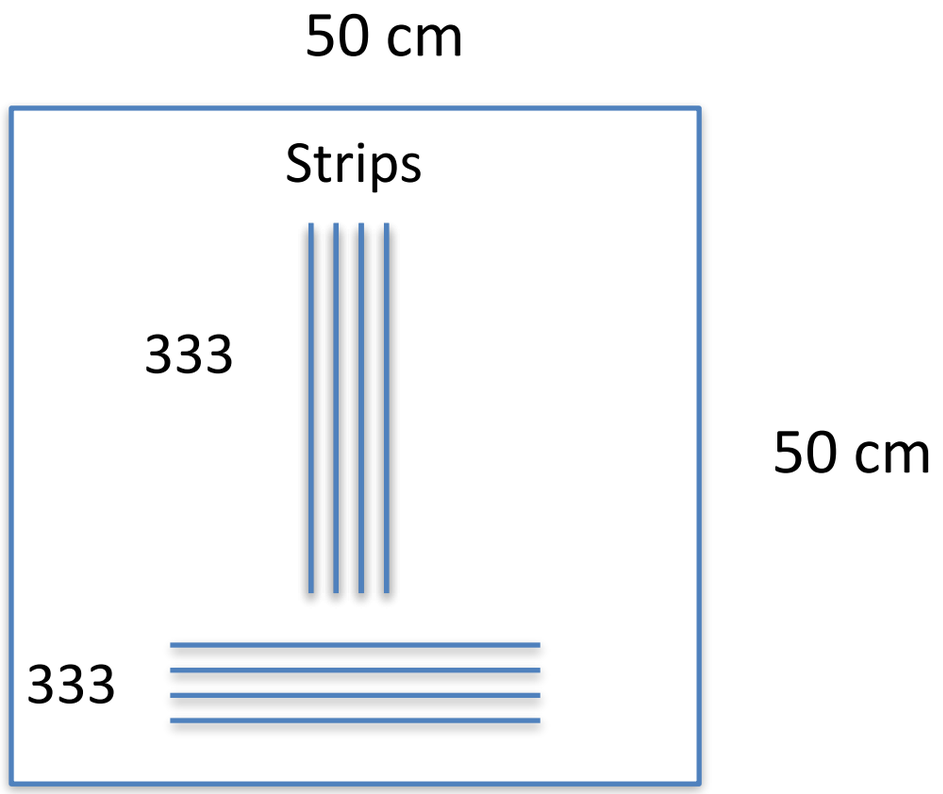
Endcaps 500x2x2 m² (2000 m² total)

Endcaps 1350000x2 channels

~5M channels in total

μRWELL module for IDEA muon det.

Assume a modular construction with μRWELL detectors of active area 50x50 cm²
Each detector has x and y readout with 50 cm long strips and a strip pitch of 1.5 mm

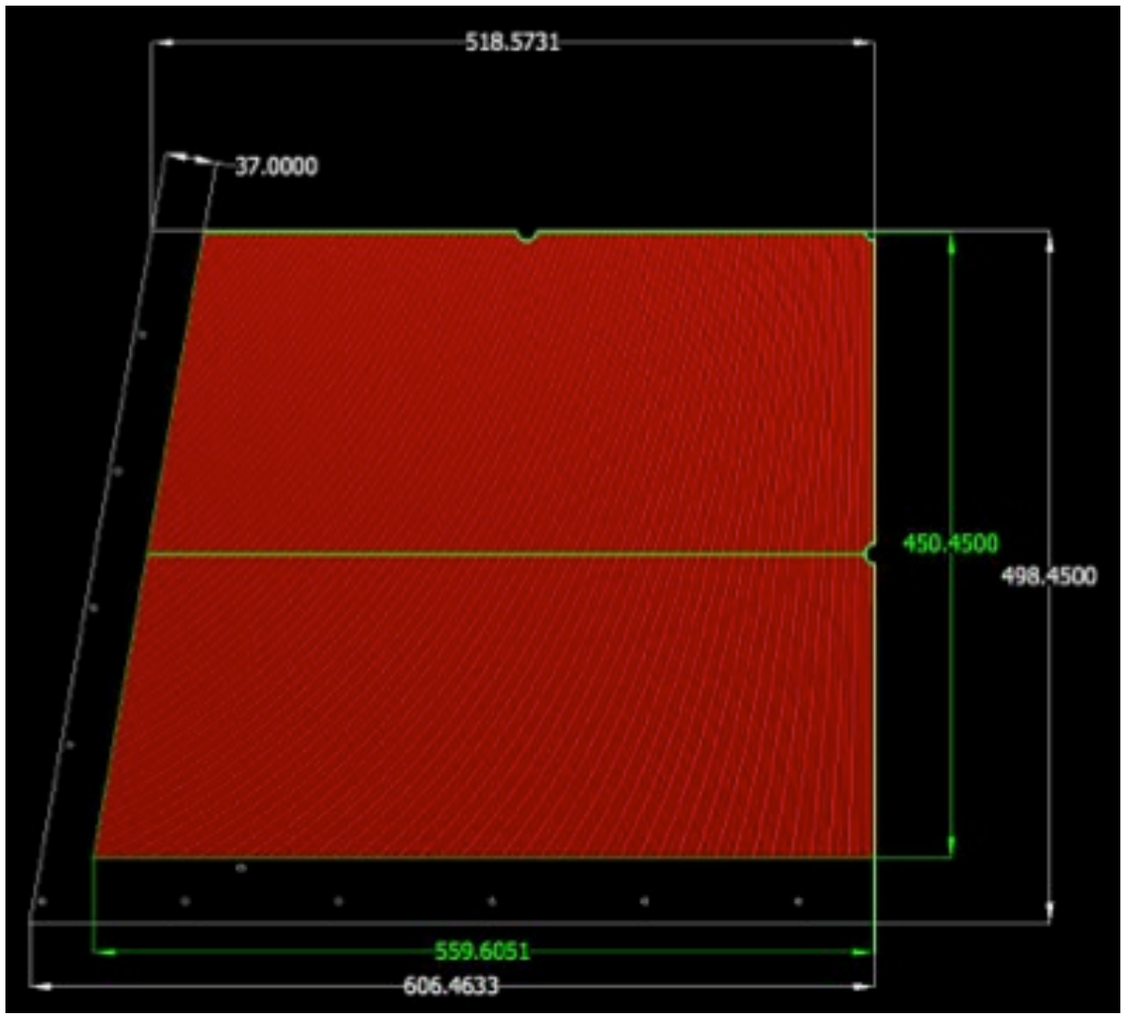


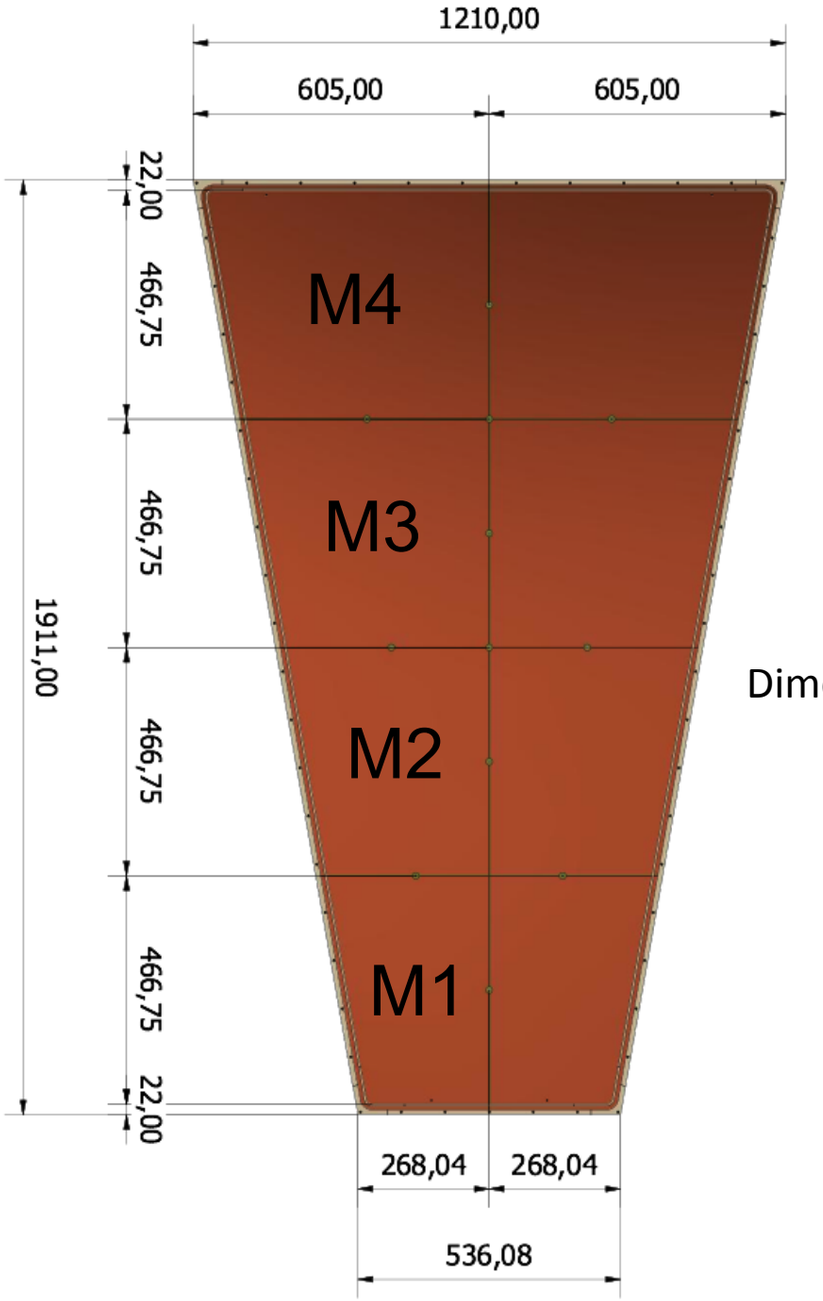
The CMS M4 μRWELL chamber has a similar strip pitch with about half the strip length
So testing a M4 chamber can give a good idea of how an IDEA μRWELL module could work.

New M4 large μRWELL chamber

- Rui de Oliveira confirmed me that he can build another large M4 μRWELL chamber in his lab at CERN. He will use the drawings used for the CMS M4.

Size: 606.5 x 498.5 x 1 mm
Active area: 559.6 - 480 (w) x 450 (h) mm
373 radial strips
strip pitch 1.29 - 1.5 mm
strip length ~ 22 cm





Dimensions in mm

CMS GE2/1 sector μRWELL prototype (2017)

GE2/1 20^0 sector with M4 μRWELLs
(2m height, 1.2 m base)

H4 test beam with 150 GeV muons:

- **Voltage scan (amplification scan)**
- **Uniformity scan across the surface of the detector at 530 V (~12000 gain, still to be conditioned)**
- **Small high rate prototype reached a gain of ~10^5 and a rate of ~700 kHz/cm^2**

The excellent results obtained demonstrate the great collaboration between INFN-Eltos and Rui de Oliveira's lab

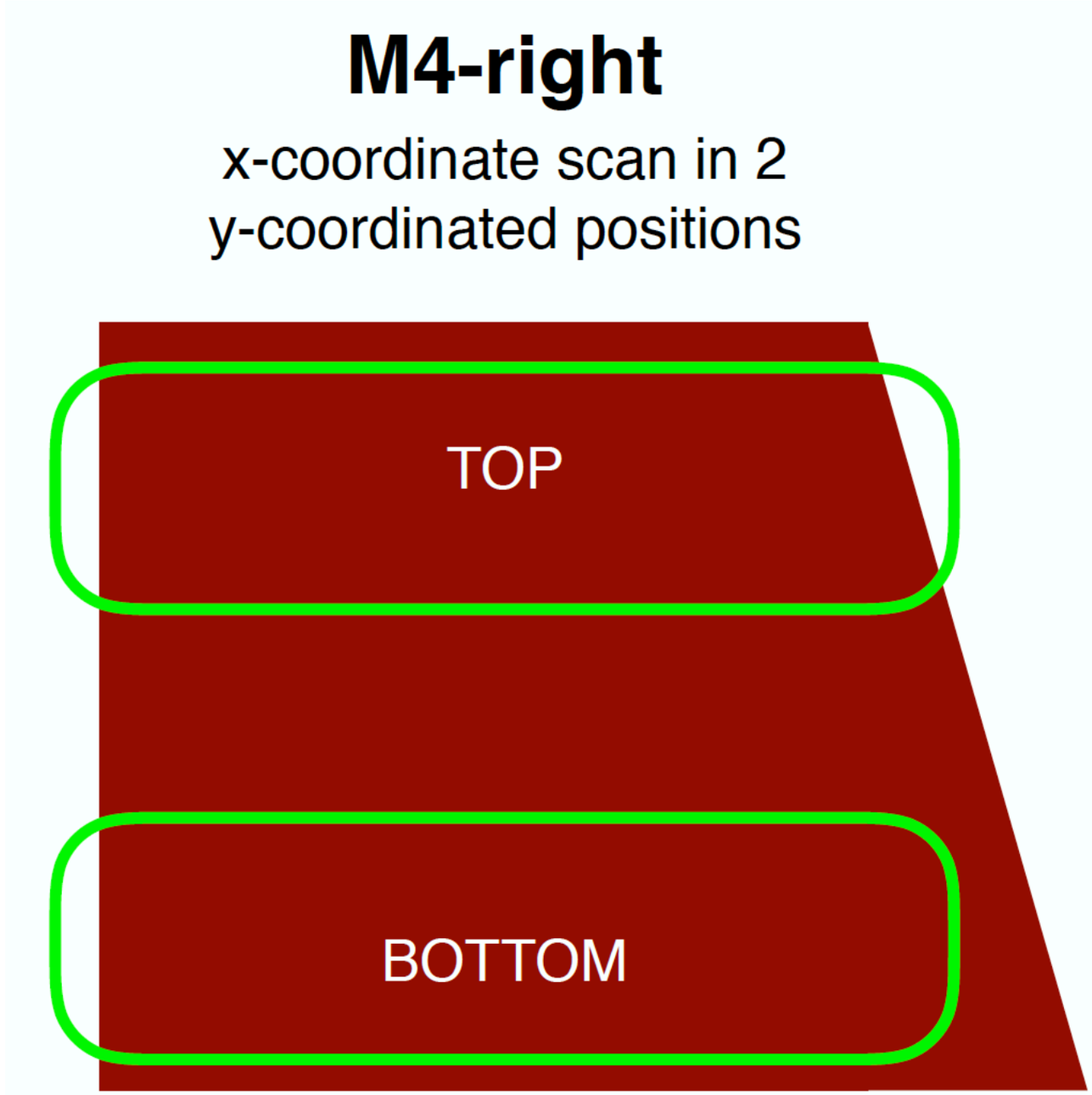
M4 μRWELL

Unfortunately this M4 μRWELL chamber got destroyed after the beam test!

M4 μRWELL prototype

Strips

Strip length
~22.5 cm



Muon detector cost

	Cost [Meuro]	Engineers [years]	Technicians [years]	Operators [years]
Detectors	4,9	0,4	1,0	0,0
Installation	0,7	0,6	2,8	2,9
Electronics	15,4	0,3	1,5	0,0
HV/LV Systems	0,7	0,2	1,4	0,0
Gas System	0,3	0,2	1,3	0,0
TOTAL	**22,0**	**1,7**	**7,9**	**2,9**

Assumed 3 euro/channel

Assuming the following manpower costs:

Engineer	80 euro/hour
Technician	40 euro/hour
Operator	30 euro/hour

36 hours/week * 48 week/year = 1728 hours/year

Electronics is by far the dominant cost

	Cost [Meuro]
Detectors	4,9
Installation	0,7
Electronics	15,4
HV/LV Systems	0,7
Gas System	0,3
TOTAL	**22,0**

Assuming 300 MEuro as the cost of a FCC-ee or CEPC detector, the Muon detector would be ~7.3% of the total

Proposal

- Build a large μRWELL detector and equip it with a Tiger-based readout
  - Would be a very valid test of an IDEA-dimension μRWELL detector equipped with a custom-made ASIC
  - The TIGER chip was developed by TO and FE for GEM detectors in the frame of BESIII
  - Manuel is convinced that with a custom-made ASIC, the cost of the complete front-end electronics to readout a μRWELL would not exceed 1 euro/channel
    - This solution would be extremely appealing to reduce the total cost of the IDEA muon detector.
- We could then test the M4 with the Tiger with the large cosmic rays telescope (Bologna), with sources (Ferrara) and with a X-ray gun (LNF) before bringing the whole setup onto a test beam sometime in 2021
- In parallel perform simulation studies, with special emphasis on Long Lived Particles, to justify the interest of having a performing tracker in the muon detection system rather than a simple tagger and optimise the detector consequently.
  - This task is foreseen by the IDEA group and will receive special consideration.

Proposal

	A	B	C	D	E	F	G	H	I
1									
2	**rivelatore**	**costo unitario**	**quantita'**	**totale (kE)**	**note**				
3	*camera uRWell*	7.5	1	7.5					
4	*connettori hirose*	0.006	25	0.15					
5	*adattatori Panasonic-hirose*	0.02	25	0.5					
6									
7									
8	**HV**	**costo unitario**	**quantita'**	**totale (kE)**	**note**				
9	*mainframe*	0	0	0	presente nelle varie sezioni - costo 6 kE				
10	*modulo caen A1561HD*	0	0	0	in house - costo 5.5 kE				
11	*PC*	0	0	0	in house				
12	*cavi*	0	0	0	in house				
13									
14									
15	**LV, FEE, DAQ**	**costo unitario**	**quantita'**	**totale (kE)**	**note**				
16	*mainframe*	0	0	0	stesso dell'HV				
17	*caen A2519*	2.5	1	2.5					
18	*TIGER FEB*	0.5	6	3	costo per piccole produzioni - 6 FEB per la camera grande				
19	*dissipatori cooling*	0	6	0	fatti in casa				
20	*Readout Cards*	3.05	2	6.1	una legge 4 FEB, noi ne dobbiamo leggere 6 per la camera grande				
21	*cavi LV e segnale*			1					
22	*DAQ, trigger e PC*	0	0	0	in house				
23									
24									
25	***Grand Total***			**20.75**	**kE**				
26									

M4 μRWELL Offer

Mail address: CERN,
PH Department
DT Group
CH-1211 GENEVE 23

Telephone : 0041 22 767 37 45

E-Mail: Rui.de.oliveira@cern.ch
E-Mail: bertrand.mehl@cern.ch

Paolo Giacomelli
Giovanni Bencivenni

Our reference: 1754-B

Geneva, 13/09/2017

Subject: Price Offer for one GE2/1 M4 u-Rwell detector

1 Read-out :	1800 CHF
1 Drift :	1400 CHF
1 Special O-ring acting as a frame:	100 CHF
1 Set of screws , brass fitting, gas plugs etc.. :	500 CHF
Total:	2800 CHF
Design uRwell foil :	800 CHF
Tooling uRwell foil :	1200 CHF
Production of 1 uRwell foil :	2100 CHF
Total :	4300 CHF
Connector assembly:	600 CHF

Grand total 7500 CHF

CERN is the producer of these parts.
Price don't include VAT.

Rui De Oliveira

CAEN A2519 Offer

Istituto Nazionale di Fisica Nucleare
http://www.fe.infn.it
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C.F. 84001850589

Sezione di Ferrara
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44100 FERRARA (FE)
Telefono : +39 0532 974269-316-280
Fax : +39 0532 790003 +39 0532 974300

lara.magri@fe.infn.it, paola.fabbri@fe.infn.it

Ordine di acquisto n. 2495 del 03-NOV-16
(Da citare in fattura, nelle comunicazioni e sugli imballaggi)
Vs. riferimento Offerta 16OFC.01063 del 28/10/2016
Codice Fornitore INFN: 14206
Ns. Riferimento **CIG Z561B701E1**
CUP I72I14000130006
Codice Univoco Ufficio di Fatturazione Elettronica: UITGDC

Spett.le
CAEN S.P.A.
VIA VETRAIA 11
55049 VIAREGGIO LU ITALIA
Cod. Fisc.00864500467
P.IVA 00864500467

Con la presente ci pregiamo ordinarvi quanto segue, alle condizioni sottoindicate:
Descrizione sintetica:

QUANTITA'	DESCRIZIONE	SCONTO	%	PREZZO UNITARIO	IMPORTO
2,0	Offerta 16OFC.01063 - mainframe SY5527 BASIC 600W			4.870,00	9.740,00
4,0	moduli A2519 con connettori di uscita di tipo D-Sub 8W8			2.030,00	8.120,00
4,0	kit connettori per A2519. Si ricorda che è obbligatoria la fattura elettronica e che l'INFN è escluso dal regime IVA "Split payment" legge n. 190.2014. L'IVA sarà applicata regolarmente in fattura.			140,00	560,00

TOTALE EUR : 18.420,00
IVA AL 22% EUR 4.052,40 **TOTALE** EUR **(Ivato):** 22.472,40

LUOGO DI CONSEGNA	**Via Saragat, 1 Polo Scientifico Tecnologico Edificio C - 44122 FERRARA - attenzione Ing. Angelo Cotta Ramusino Stanza C 102**
TERMINE DI CONSEGNA	**60 giorni da invio ordine**
METODO DI SPEDIZIONE	**Vs. Carico**
PAGAMENTO	**30 GG. D.R.F.**
SUBAPPALTO	**Il subappalto parziale o totale del presente contratto non è permesso senza autorizzazione formale dell'INFN.**
GIURISDIZIONE	**Per qualsiasi controversia relativa al presente contratto è competente, in via esclusiva, il Foro di Roma.**
NORME DI SICUREZZA	**La commessa deve essere conforme alla legislazione vigente in materia di sicurezza sul lavoro.**
GARANZIA	**La garanzia avrà la durata almeno di 12 mesi dalla consegna.**
Resp. Unico del Procedimento	**COTTA RAMUSINO ANGELO** **Indirizzo Mail cotta@fe.infn.it**
Alla consegna Contattare	**Cotta Ramusino, Angelo**

Readout card

Offerta n° 1189 Rev. A del 10/10/19

Mod. Qualità 07.02.04
rev. 1 del 23/01/2018

Dati offerta n° 1189 rev. a del 10/10/19

Oggetto: GEMROC_IFC_CARD

Consegna: 8 weeks lav D.R.O. (salvo reperibilità di materiali)

Validita offerta 60 gg - Valuta: Euro

Resa: DAP Ferrara - Pagamento: BB30GGDFFM

Intestatario Documento

Infn Sezione di Ferrara

Via Saragat, 1 Polo Scientifico Tecnologico Edificio C - 44100 FERRARA FE - Italy

Alla c.a. : Responsabile Unico del Procedimento Sig. Chiozzi Stefano

Pos.	Codice	Descrizione	Q.tà	Imp. Unitario	Imp. Totale
1	GEMROC_IFC_CARD	Assemblaggio schede con A.O.I. 3D, X-Ray 3D.	10	210,01 € +	2.100,12 €
2	GEMROC_IFC_CARD	Kit componenti come da distinta *	10	615,00 € +	6.150,00 €
3	GEMROC_IFC_CARD	Circuiti stampati da file Gerber	10	129,00 € +	1.290,00 €
4	GEMROC_IFC_CARD	Avvio lavorazione e carico macchina	1	279,75 € +	279,75 €
1	GEMROC_IFC_CARD	Spese di trasporto e assicurazione	1	150,00 € =	150,00 €

COSTI RICORRENTI

Importo Unitario: € 996,987
Importo Totale: € 9.969,87

1 GEMROC_IFC_Card ~**1400** euro

1 FPGA starting kit ~**850** euro https://www.digikey.com/product-detail/en/intel/DK-START-5AGXB3N/544-2742-ND/3476229

1 DS3470.18 box | TEKO **50** euro https://www.soselectronic.com/products/teko/ds3470-18-299182

Lemo connectors, etc. **200** euro

Total for 1 Readout card ~ **3050** euro (with VAT)

Backup

M4 cluster size