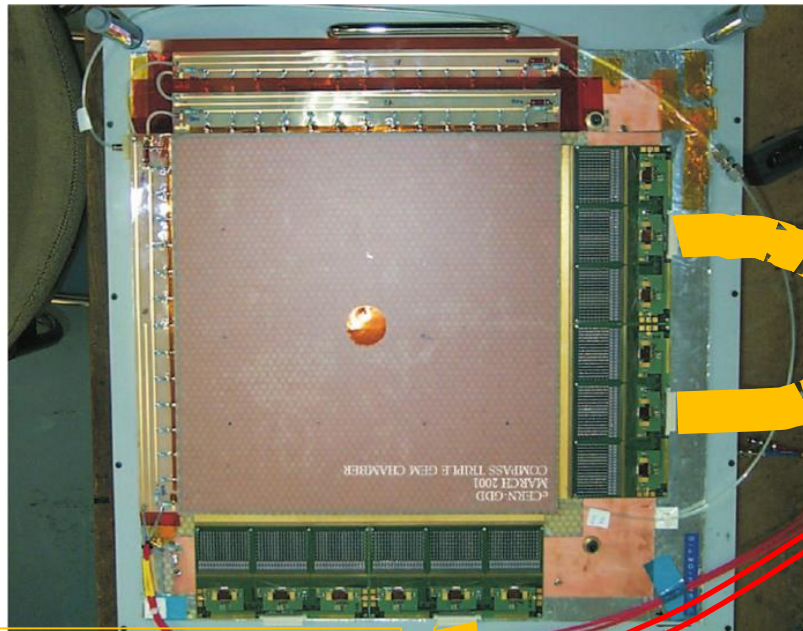


# First Generation GEMs (CG1G)

- 1 station = 2 detectors = 4 planes
- 6 APV25 (S0/S1) per plane

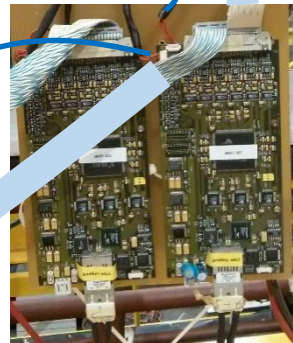


APV LV: 2ch per plane ( $\pm 3.5V$ , GND,  $-0.9A$ ,  $+0.7A$ )  
 FLEX.COPPER CABLE 12x 2,5 mm<sup>2</sup>

TP Flat cable, 2x20 cond., max. 3 m  
 FLAT CABLE TWIST  
 40C 1.27MM  
 AWG28  
 3M type 2100/40

S-HV cable HV COAX.CABLE HTC-50-1-1, 5kV,RED  
 type HTC-50-1-1

ADC Cards  
 (2 Detectors)



ADC LV: 2ch per station ( $\pm 5.5V$ , GND,  $+3.2A$ ,  $-0.6A$ )

TP flat cable 2x25 cond., max. 60 cm  
 E - TWISTED PAIRS FLAT CABLES FOR  
 IDC - PITCH 0.635 mm  
 3M type 79992-25P-270A



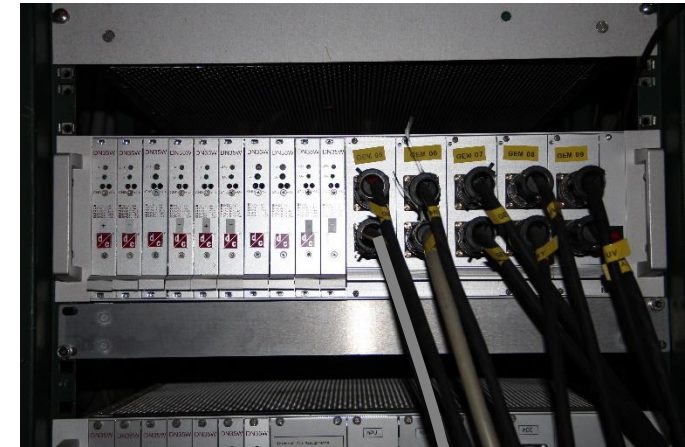
Repeater  
 Card

TRG/CLK  
 SCREENED VIDEO  
 CABLE, 4,7 mm, 2  
 PAIRS  
 type VB 04 P

HV Switch

$\pm 12V$

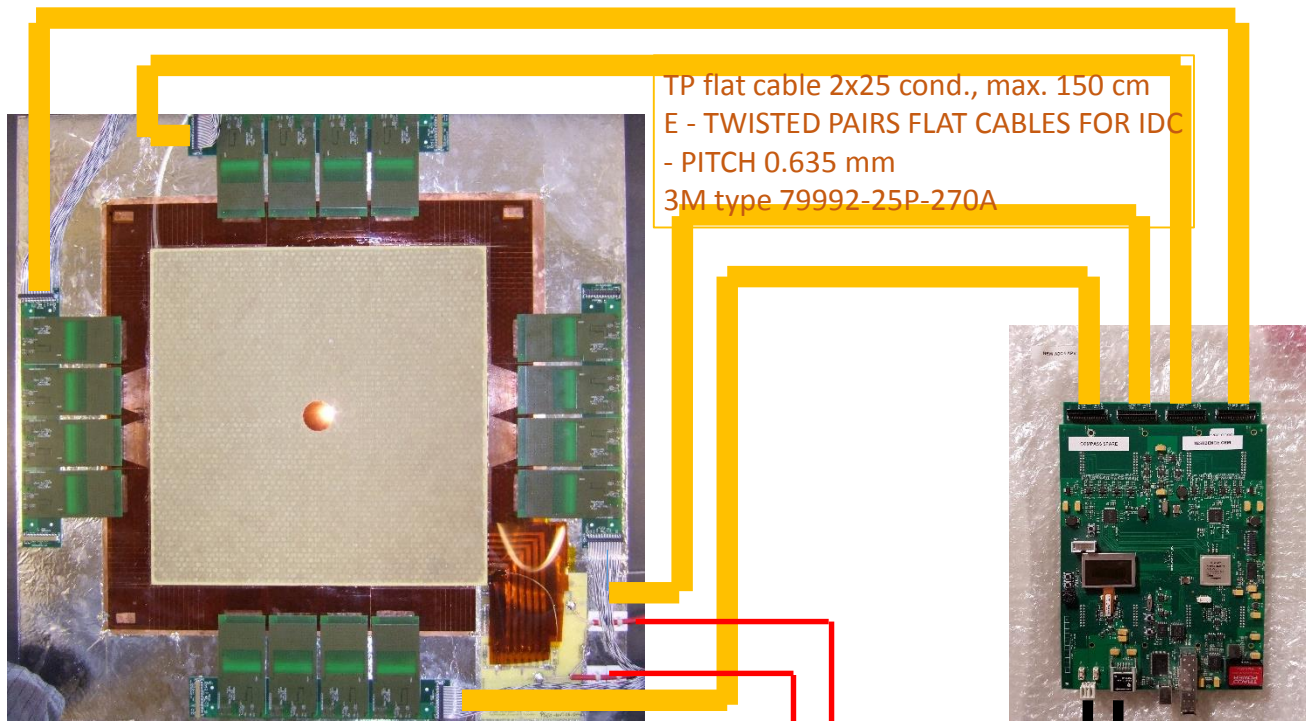
Deutronics DN35W-5 (5.5V, 6A)



A732N (6kV, 1mA)

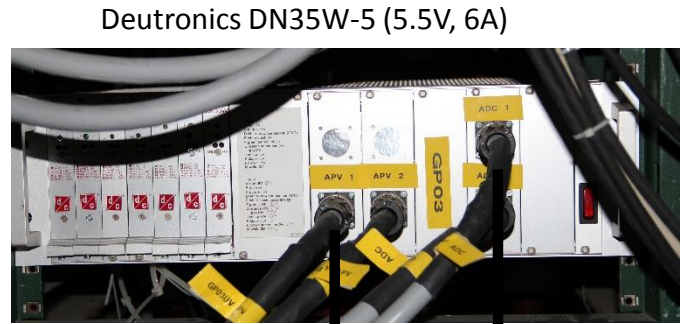
A516 (12V, 1.5A)

# PixelGEMs (CG2G)



- 1 station = 2 detectors = 4 planes
- 8 APV25 (S1) per plane

S-HV cable HV COAX.CABLE HTC-50-1-1, 5kV, RED  
 type HTC-50-1-1



LV APV: 2 ch. per det. ( $\pm 5V$ , GND)

LV ADC: 3 ch. per station (2x +5V, 1x -5V, GND)



A732N (6kV, 1mA)



# Upgraded Triple GEMs (CG3G)

- 1 station = 2 detectors = 4 planes
  - 12 APV25 (S1) per plane
- Required Power Supply Rails for 1 Detector:**
- 4 kV, 1 mA for GEMs & Drift
  - 3.3 V, 3 A (4x) for APV Supply (floating, remote sense wires)
  - 5 V, 3 A for each ADC (floating)

New ADC chain (iFTDC) (for 24 APVs in total)

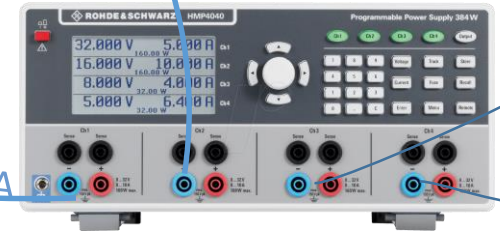
Flat cable EQDP-014-40.00-STR-SBL-5-B

Per ADC +5V & <3A

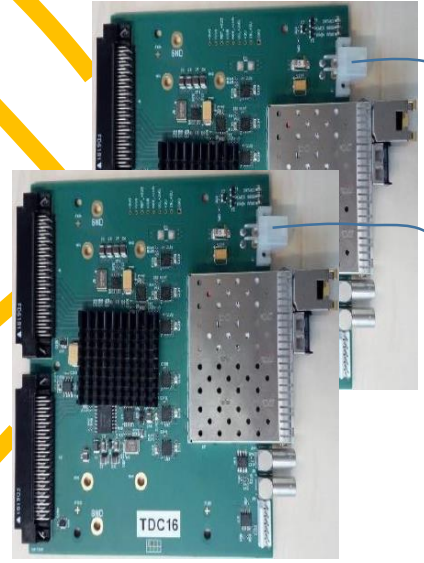
3.3V & 2x3A

S-HV cable HV COAX.CABLE HTC-50-1.1 5kV RED type HTC-50-1-1

3.3V & 2x3A



Rohde&Schwarz HMP4040 | 4 chan. (each 10 A), 384 W



A732N (6kV, 1mA)

CAEN SY527 Mainframe

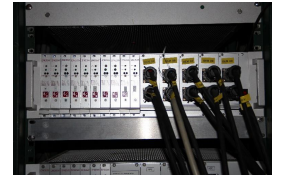
# Triple GEMs with VMM (CG4G)

Auxiliary front-end electronics: (2.9 – 3.5) V, 2.4 A

→ 6.9 – 8.4 W



Deutronics DN35W-5 (5.5V, 6A)



Or

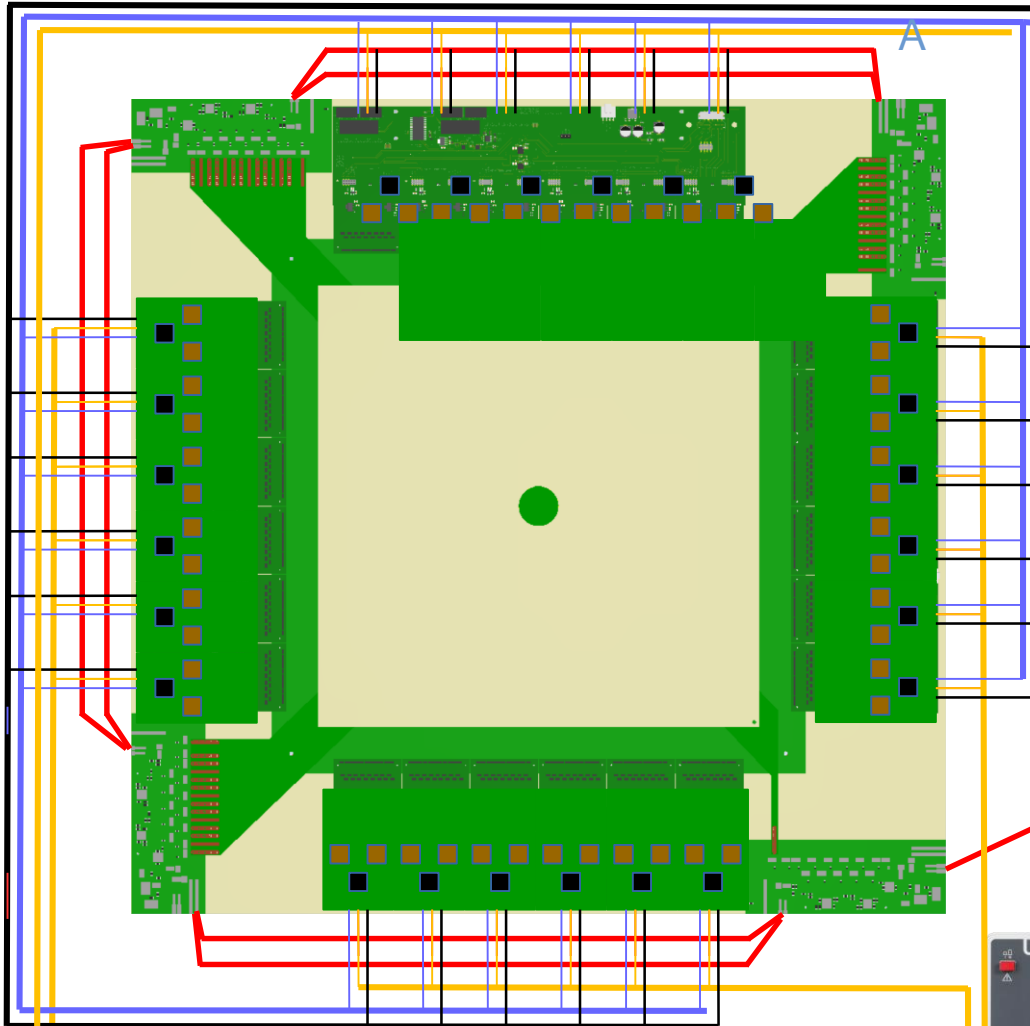
*Example SRS VMM hybrid:*

- 2 VMM ASICs, Aux. (FPGA, ...)
- VMMs: (1.9-3.5) V @ 1.67 A
- Aux.: (2.9-3.5) V @ 0.1 A

→ 24 hybrids/detector

**Bare VMM ASIC: ~0.8 A @ 1.2 V**  
48 VMM ASICs need/detector

- 1 station = 2 detectors = 4 planes
  - 24 VMM3a ASICs per plane
- Required Power Supply Rails for 1 Detector:**
- 4 kV, 1 mA for GEMs & Drift
  - VMM ASICs:
  - (1.9 – 3.5) V, 24 x 1.67 A grouped to 4 x 10 A
  - Auxiliary front-end electronics:
  - (2.9 – 3.5) V, 2.4 A (all front-end boards)

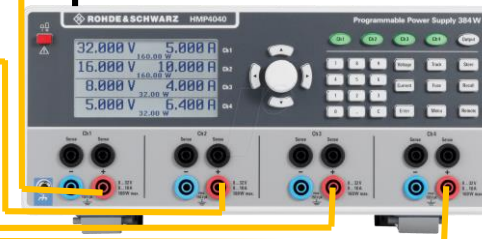


VMM ASIC Power: (1.9 – 3.5) V, 4 x 10 A

A

→ 76 – 140 W

S-HV cable HV COAX.CABLE HTC-50-1-1, 5kV, RED type HTC-50-1-1



Rohde&Schwarz HMP4040 | 4 chan. (each 10 A), 384 W



A732N (6kV, 1mA)

# GEM LV Setup

## Proposed Low Voltage configuration

(R&S HMC8043 Output: 3x 0-32 V@0-3 A)

- Does not work!
- Old ADCs (CG1G) need 2ch with  $> 3A$  (?) per station
  - New ADCs (CG3G): 4 ADCs per station needed

Power Supply 1			Power Supply 2		
Output 1	Output 2	Output 3	Output 1	Output 2	Output 3
X/Y APV (Sym.)		ADC	U/V APV (Sym.)		Center SW

(Negative ADC voltage generated via DC/DC converter on pos. ADC channel)

→ 2x R&S HMC8043 power supplies needed per GEM Station.

green: existing  
 dark orange: plan for 2021  
 light orange: possible future

# LV Configurations

Generation	p.s. type	GMnnU1	GMnnV1	GMnnX1	GMnnY1
<b>CG1G</b>	APV: CAEN A516	2ch, $\pm 3.5V$ , -0.9A, +0.7A	2ch, $\pm 3.5V$ , -0.9A, +0.7A	2ch, $\pm 3.5V$ , -0.9A, +0.7A	2ch, $\pm 3.5V$ , -0.9A, +0.7A
	APV: HMP4040	2ch, $\pm 3.5V$ , -1.8A, +1.4A		2ch, $\pm 3.5V$ , -1.8A, +1.4A	
	ADC: DN35-5	2ch, $\pm 5V$ , +3.2A, -0.6A			
<b>CG2G (PGEM)</b>	APV: DN35-5	2ch, $\pm 3.5V$ , -1.8A, +1.4A		2ch, $\pm 3.5V$ , -1.8A, +1.4A	
	ADC: DN35-5	3ch, $\pm 5V$ , +6A, -3A			
<b>CG3G</b>	APV: HMP4040	1ch, +3.3V, 4-6A	1ch, +3.3V, 4-6A	1ch, +3.3V, 4-6A	1ch, +3.3V, 4-6A
	ADC: HMP4040	1ch, +5V, <3A	1ch, +5V, <3A	1ch, +5V, <3A	1ch, +5V, <3A
<b>CG4G</b>	VMM (SRS): HMP4040	1ch, 1.9-3.5V, 9.6A	1ch, 1.9-3.5V, 9.6A	1ch, 1.9-3.5V, 9.6A	1ch, 1.9-3.5V, 9.6A
	Auxiliary	1ch, 2.9-3.5V, 2.4A		1ch, 2.9-3.5V, 2.4A	

For Center HV switch: 1 ch 12V, no current  $\Rightarrow$  find simpler solution

# Price Tags

Type	Web price	Needed per station
HMC8043 (3ch)	1450	2 (Moritz' conf.)
HMP4040 (4ch)	2310	1 (CG1G), 2 if also ADC
		2 (CG2G, CG3G)

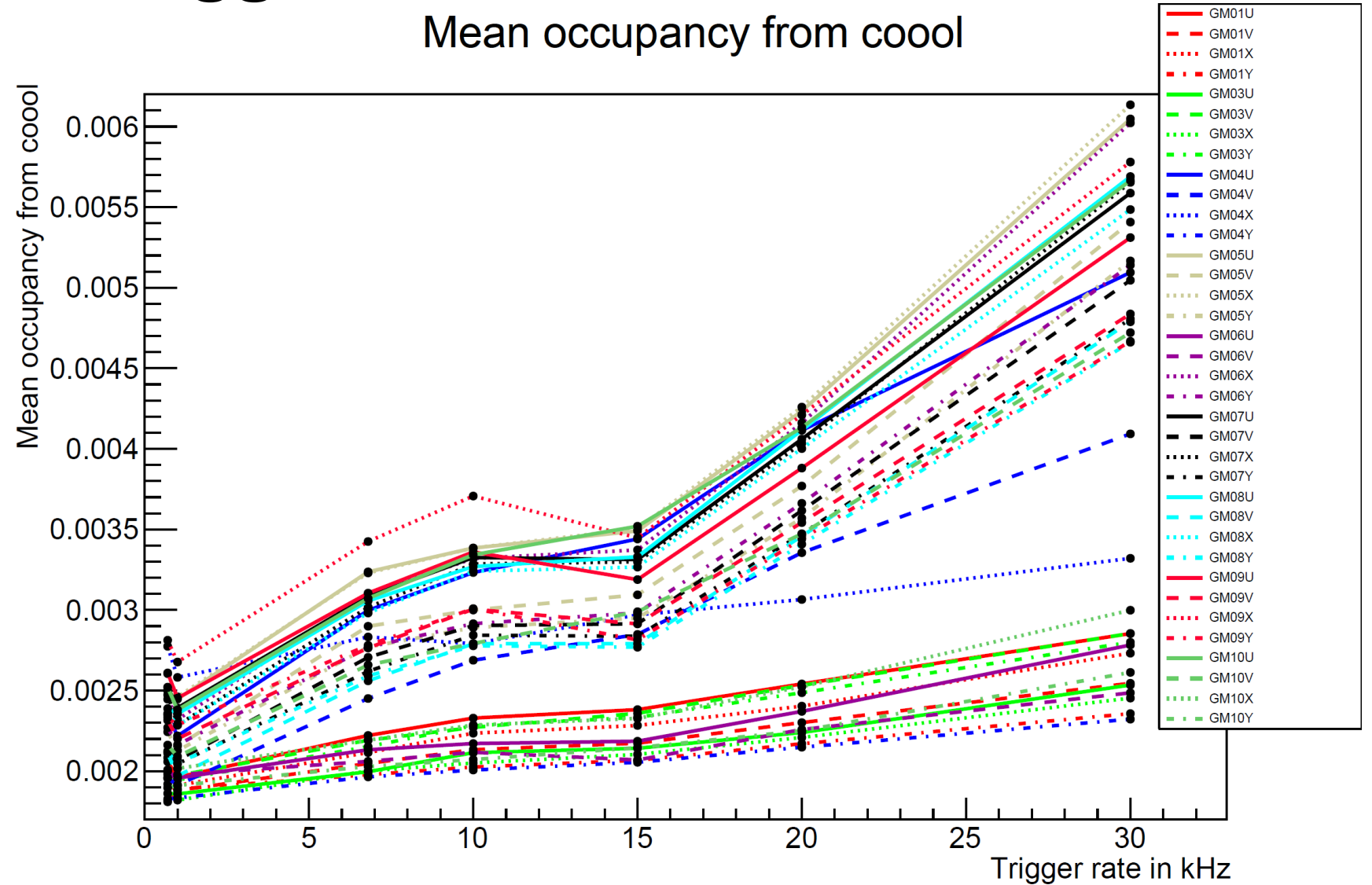
but not sufficient for ADCs!

## Note:

- HMP4040 already in use for APVs at NA64 and in the lab
- will perform rate test in the lab
- compatibility with DCS?
- connection on backside?

# Occupancy vs Trigger Rate

Mean occupancy from cool





## Costs for replacing LV for 6 GEM Stations (gallery)

Item	Model Description / Estimated Delivery (Weeks)	Part Number	Qty. pc.	Unit Price CHF	Total Price CHF
1	<a href="#">R&amp;S@HMC Power Supply</a>		13		
1.1	<b>HMC8043</b> 3 channel power supply, 0V to 32V/3A, max. 100W, resolution 1mV/0.1mA, tracking, EasyArb, electronic fuse, FuseLink, USB stick connector, Ethernet/USB  Country of Origin: Czech Republic	3593.1041.02	13	1,425.00 -12.00%	18,525.00 <b>16,302.00</b>
2	<b>HZC95</b> 19" rackmount kit, 2HU, for HAMEG@HMC series (accessory)  Country of Origin: Czech Republic	5800.2054.02	6	296.00 -12.00%	1,776.00 <b>1,562.88</b>
<b>Total Net Price</b>				<b>CHF</b>	<b>17,864.88</b>