“Discrete” calorimeter readout power distribution trees

except B0 Calorimeter, ZDC Crystal Calorimeter – have to leave to a future meeting, the requirements and relation to FEMC-style readout is not yet clear to me; if readout must differ then of course a fair amount of further work is needed… will be happy to try to address these soon.

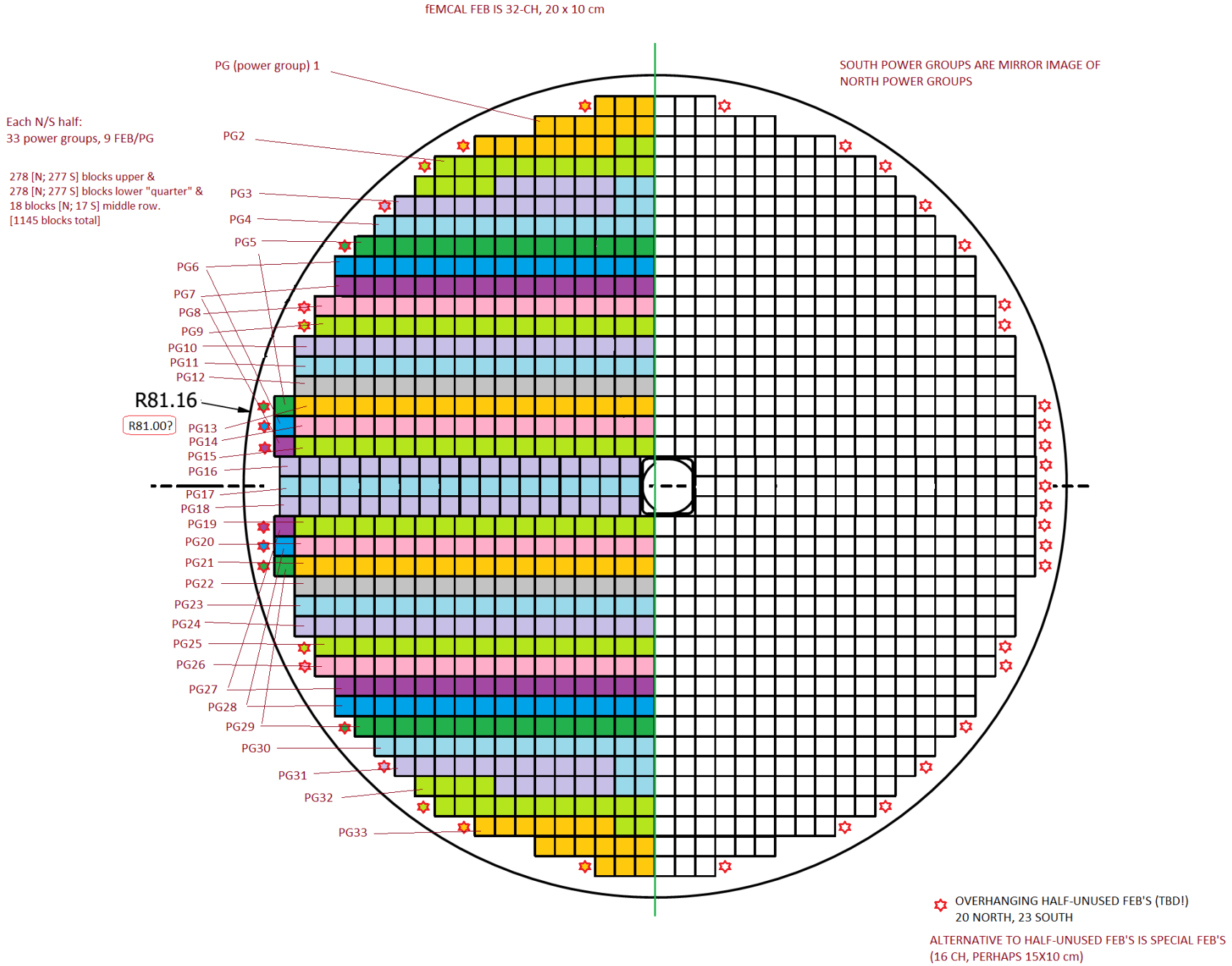
Gerard Visser, Indiana University
ePIC Elec/DAQ meeting 4/16/26

FEMC is divided into two halves that move independently and therefore all services must be independent between the two halves.

Each half has 297 32-ch FEB's. [Some FEB's are half-unused or are 16-ch FEB's, TBD.]

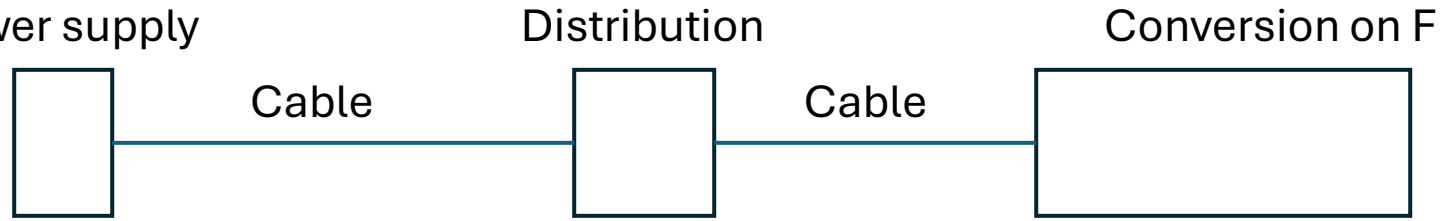
The FEB's are arranged in 39 rows of various length.

Power is distributed to the FEB's on multidrop cables largely arranged by row, but keeping the number of FEB per cable ≤9. In the upper and lower rows the cable covers portions of several rows; the 6 rows with 10 FEB's have their outermost ones served together with shorter rows. Specifically, the arrangement is shown in the figure at right here. There are 33 power groups (33 multidrop power cables + 6 extra cables separately fed together with 6 of them). It turns out that all the power groups have 9 FEB.



Power Distribution Tree

Sub-Detector: **FEMC** Type: **LV**



#Ch: 66
Ch V/I: 16 V / 3.84 A
Model: MPV 4016I
Qty: 18 (2 crates)

On-detector: Y
Qty: 66

On-detector: Y
Qty: 594

DC/DC: yes (70% eff. assumed) ~15V input
V/I: 1.8V/2.5A (**simplified** – actually several voltages, 4.5W load)
Qty: 594

LDO: (some, but included in that simplified load picture)
V/I:
Qty:

note:
- would prefer a ~20 V PS
- and MPOD is nice, but overkill
- baseline plan no remote sense
  - but maybe…

Wire Gauge: 1×16AWG per leg
Current/Wire: 3.6 A
Part#:
Length: 8 m (WAG)
Qty: 66

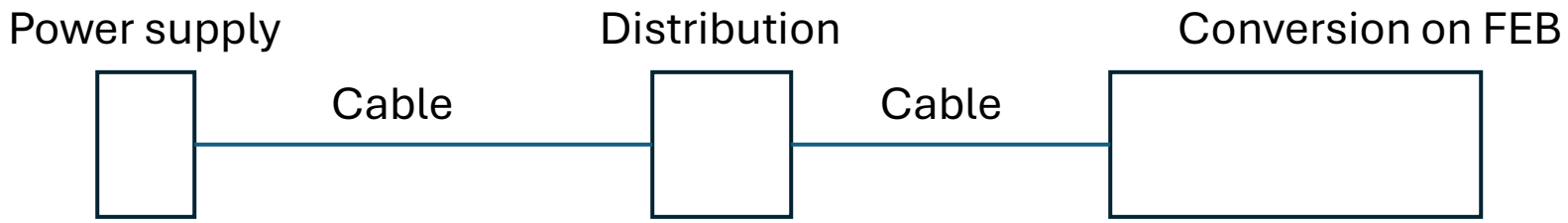
Wire Gauge: 2×22AWG per leg
Current/Wire: 1.8 A
Part#:
Length: var. ~2.2m **multidrop**
Qty: 66

see calculation spreadsheet (following)

Power Loss:	*187 W*	*~0 W*	*47 W*	*1146 W*	*2673 W (load power)*
	to air (outside)	*to air*	*to air*	*to water*	*to water*

Power Distribution Tree

Sub-Detector: **FEMC** Type: **BIAS**



#Ch: 34 (1 PS ch → 2 PG's)
Ch V/I: 52 V / 360 mA
Model: MPV 8060I (?)
Qty: 6
not clear what is best crate plan

On-detector: Y
Qty: 66

On-detector: Y
Qty: 594

DC/DC: no
V/I:
Qty:

LDO: yes
V/I: 25-47 V / 600 μA†, w/ current monitoring
Qty: 19008

† Only innermost channels will reach such currents

Wire Gauge: 1×22 AWG per leg
Current/Wire: 180 mA
Part#:
Length: 8 m (WAG)
Qty: 66

Wire Gauge: 1×22 AWG per leg
Current/Wire: 180 mA
Part#:
Length: var. ~2.2m **multidrop**
Qty: 66

Power Loss:	*0.8 W*	*~0 W*	*0.2 W*	*57 W (to water)*	*536 W (load power) (to air / detector blocks)*

these are very worst case estimates and will never really be achieved, only innermost SiPM's reach current limits

FEMC LV calculation spreadsheet (iterative/recursive calculations)

V drop & loss calculator										
V in	16	V								
P load per FEB	6.428571	W								
external cable length	8	m								
external cable resistance/length (2 legs)	0.0241	Ohm/m								
multidrop cable length outer length	0.5	m								
multidrop cable length per drop	0.21	m								
multidrop cable resistance/length (2 legs)	0.0469	Ohm/m								
CHAIN:	ext	MD outer	MD 1	MD 2	MD 3	MD 4	MD 5	MD 6	MD 7	MD 8
Vin	16	15.26002	15.17001	15.13639	15.10694	15.08169	15.06063	15.04378	15.03114	15.02271
Vdrop	0.739983	0.090003	0.033628	0.029445	0.025254	0.021055	0.016851	0.012643	0.00843	0.004216
Vout	15.26002	15.17001	15.13639	15.10694	15.08169	15.06063	15.04378	15.03114	15.02271	15.01849
Iload added	0	0.423768	0.42471	0.425538	0.42625	0.426846	0.427324	0.427684	0.427924	0.428044
Iload total	3.838087	3.838087	3.414319	2.989609	2.564071	2.137821	1.710975	1.283651	0.855967	0.428044
P(cable segment)	2.84012	0.34544	0.114815	0.088028	0.064752	0.045013	0.028832	0.016229	0.007216	0.001805
total cable power (66 groups)	187.4479	47.00055								

EEEMC is an undivided “disk” with beampipe hole and 12-sided outer perimeter. FEB’s will be mounted in 4, 6, or 12 water-cooled “FEB-boxes” just to the rear of the detector at the outer perimeter. Services will not be shared between “FEB-boxes”, except possibly cooling water shared.

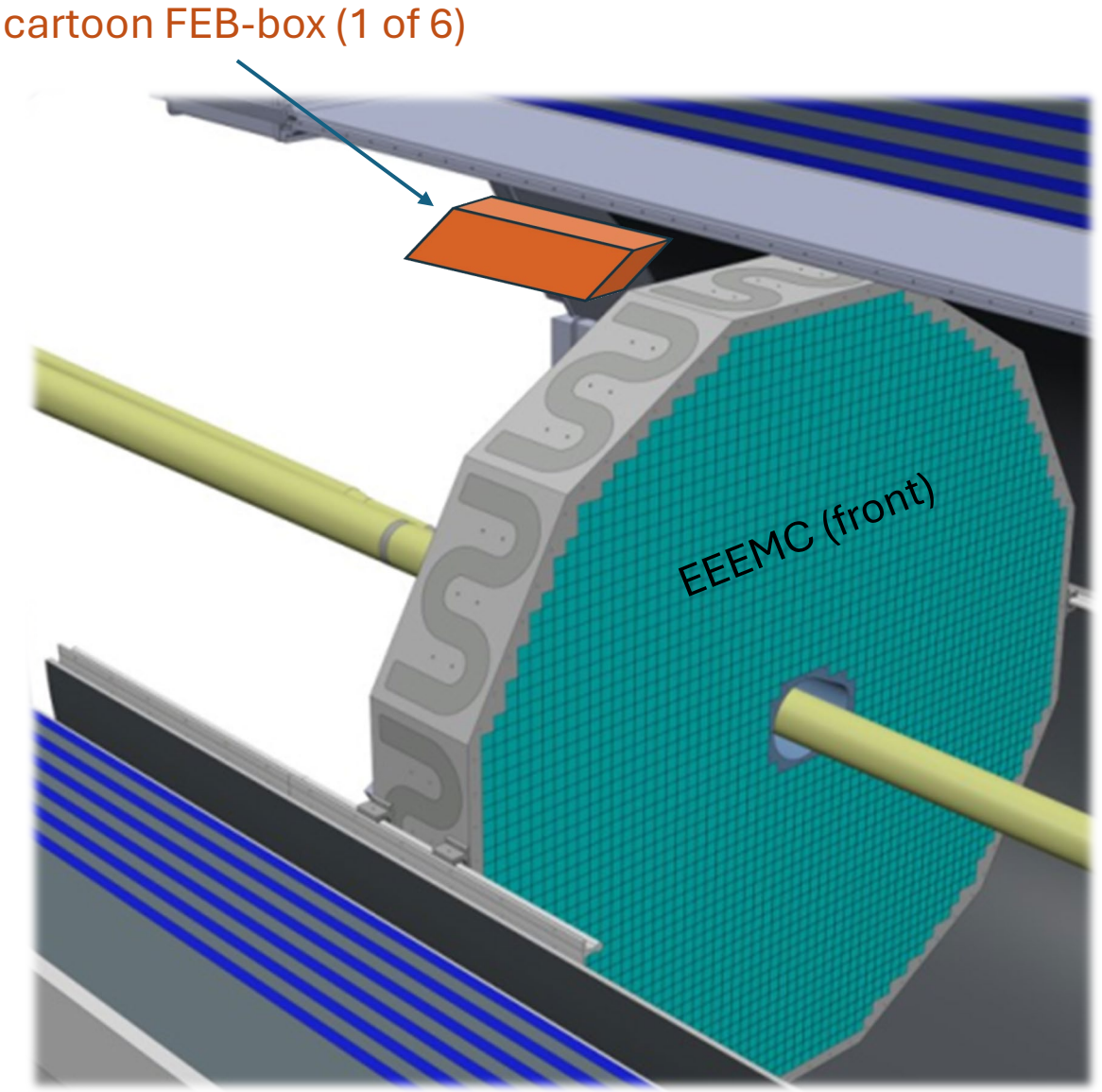
There are 2852 crystals in the detector, 2852 readout channels. FEB’s will be 32 channel as in FEMC, or possibly 24 channel if motivated by some mechanical details not yet considered.

For 6 FEB-boxes, 15 FEB are needed per box. This seems most likely arrangement. 2 power groups per FEB-box with 7 or 8 FEB per power group. [cf. FEMC 9 FEB per power group.]

Power is distributed to the FEB’s on multidrop cables with the FEB-box, transitioning to external cables at the box boundary. External cables are long (depending on platform rack allocation), assume 18 m. Tray-rated cable.

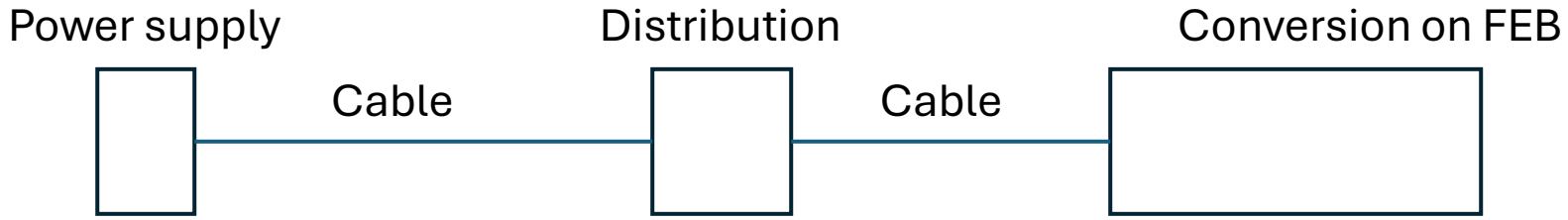
There are 12 power groups in the whole detector, in this arrangement.

There are 28 channels of FEB/readout not connected to real detector signals. (Handy spares in case of isolated simple channel failures.)



Power Distribution Tree

Sub-Detector: **EEEMC** Type: **LV**



#Ch: 12
Ch V/I: 17.4 V / 3.2 A
Model: MPV 4016I
Qty: 3

On-detector: Y
Qty: 12
remote sense connection point

On-detector: Y
Qty: 90

DC/DC: yes (70% eff. assumed) 16V input
V/I: 1.8V/2.5A (**simplified** – actually several voltages, 4.5W load)
Qty: 90

LDO: (some, but included in that simplified load picture)
V/I:
Qty:

Note: Some small portion of the load is on preamp boards mounted behind SiPM boards at detector. This slide needs a little revision for that point… But the off-FEB preamp board might not be necessary.

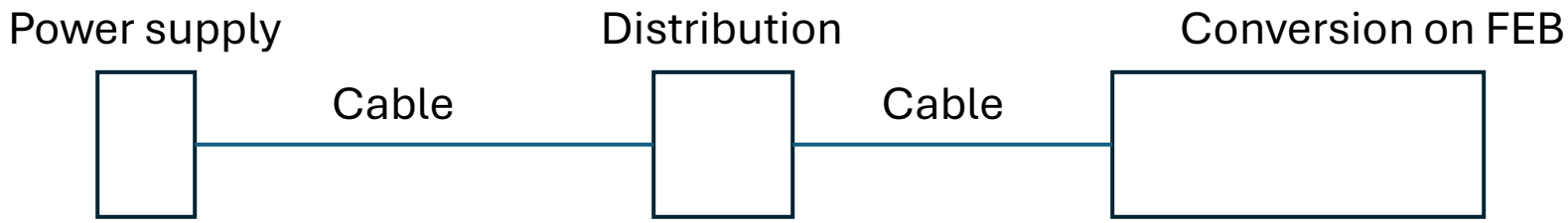
Wire Gauge: 1×16AWG per leg
Current/Wire: 3.2 A
Part#:
Length: 18 m (WAG)
Qty: 12

Wire Gauge: 2×22AWG per leg
Current/Wire: 1.6 A
Part#:
Length: 0.2 m **multidrop**
Qty: 12

Power Loss:	*53 W to air (outside)*	*~0 W to air*	*~0 W to air*	*174 W to water*	*405 W (load power) to water*

Power Distribution Tree

Sub-Detector: **EEEMC** Type: **BIAS**



#Ch: 6 (1 PS ch → 2 PG's)
Ch V/I: 52 V / 320 mA
Model: MPV 8060I (?)
Qty: 1

Wire Gauge: 1×22 AWG per leg
Current/Wire: 160 mA
Part#:
Length: 18 m (WAG)
Qty: 12

On-detector: Y
Qty: 12

Wire Gauge: 1×22 AWG per leg
Current/Wire: 160 mA
Part#:
Length: 0.2m **multidrop**
Qty: 12

On-detector: Y
Qty: 90

DC/DC: no
V/I:
Qty:

LDO: yes
V/I: 25-47 V / 600 μA[†], w/ current monitoring
Qty: 2880

[†] Only innermost channels will reach such currents

Power Loss: *2 W* *~0 W* *~0 W* *9 W (to water)* *81 W (load power) (to air / detector blocks)*

*these are very worst case estimates and will **never** really be achieved, only innermost SiPM's reach current limits*