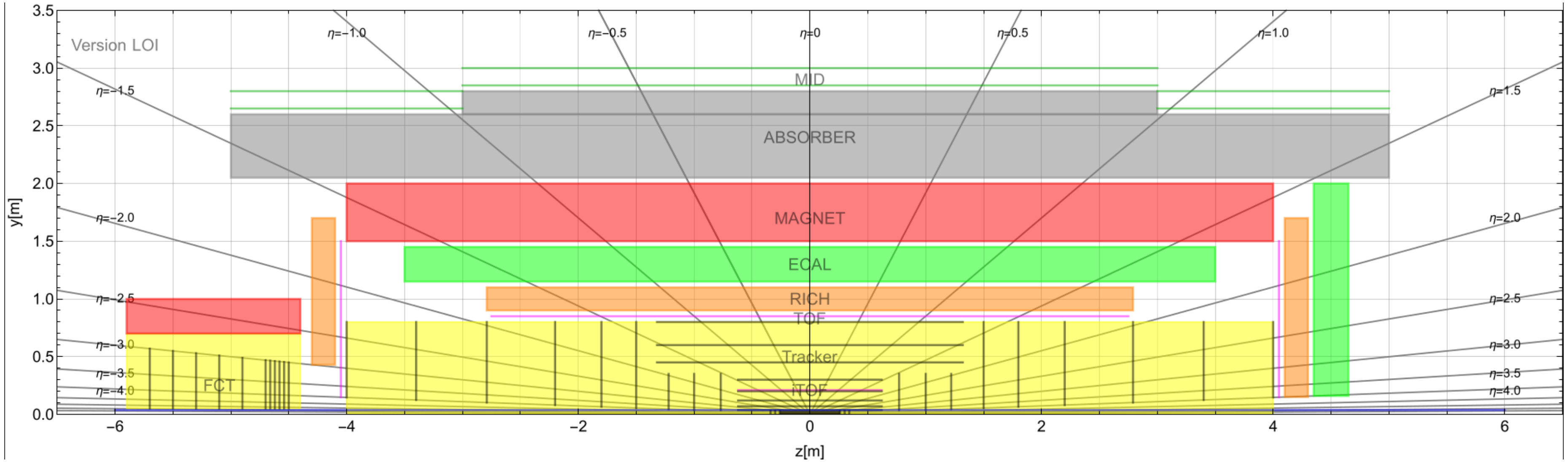
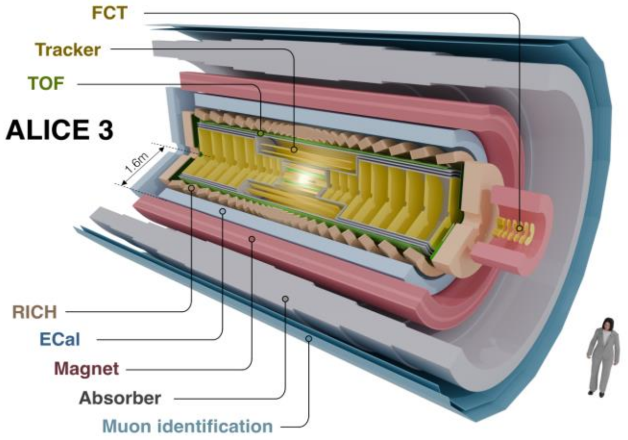
Technological Challenges and Electronics Development for the ALICE 3 RICH Detector

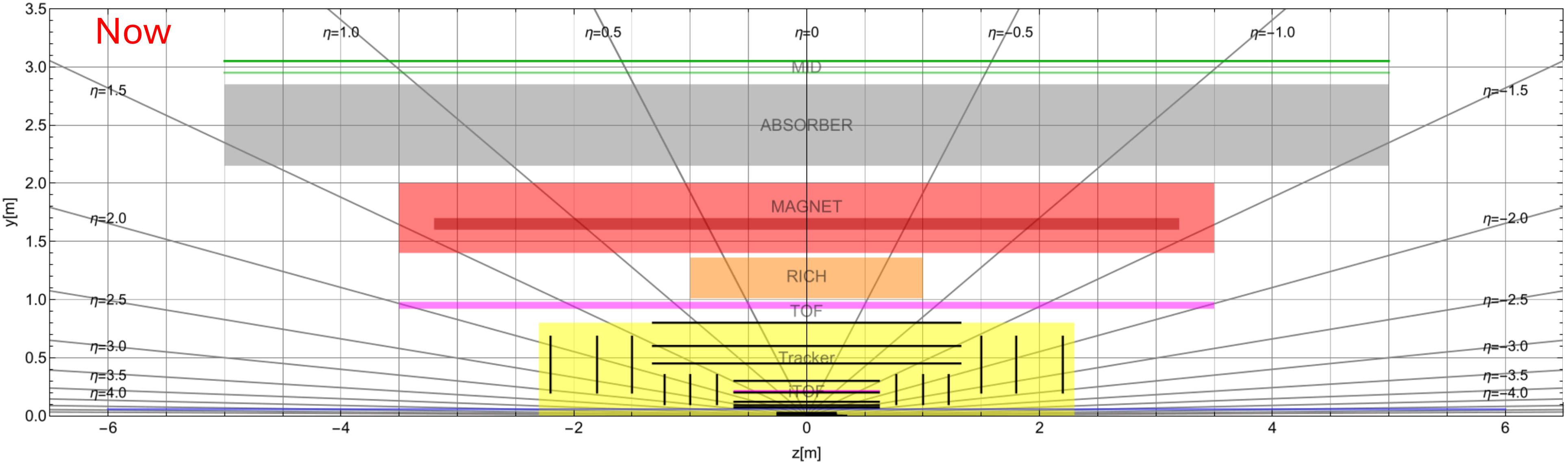
Jaime Octavio Guerra-Pulido

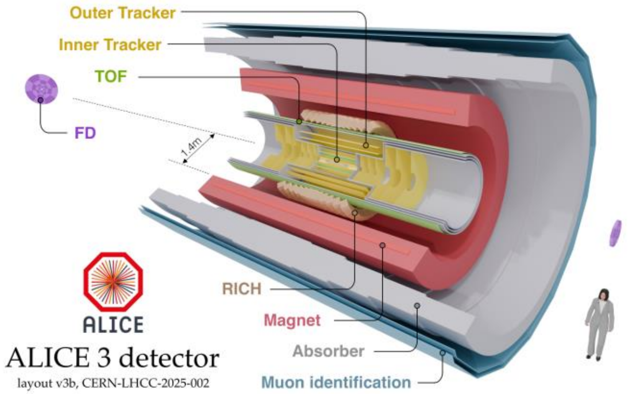
On behalf of the ALICE3 RICH working group

Detectors of the ALICE 3 upgrade









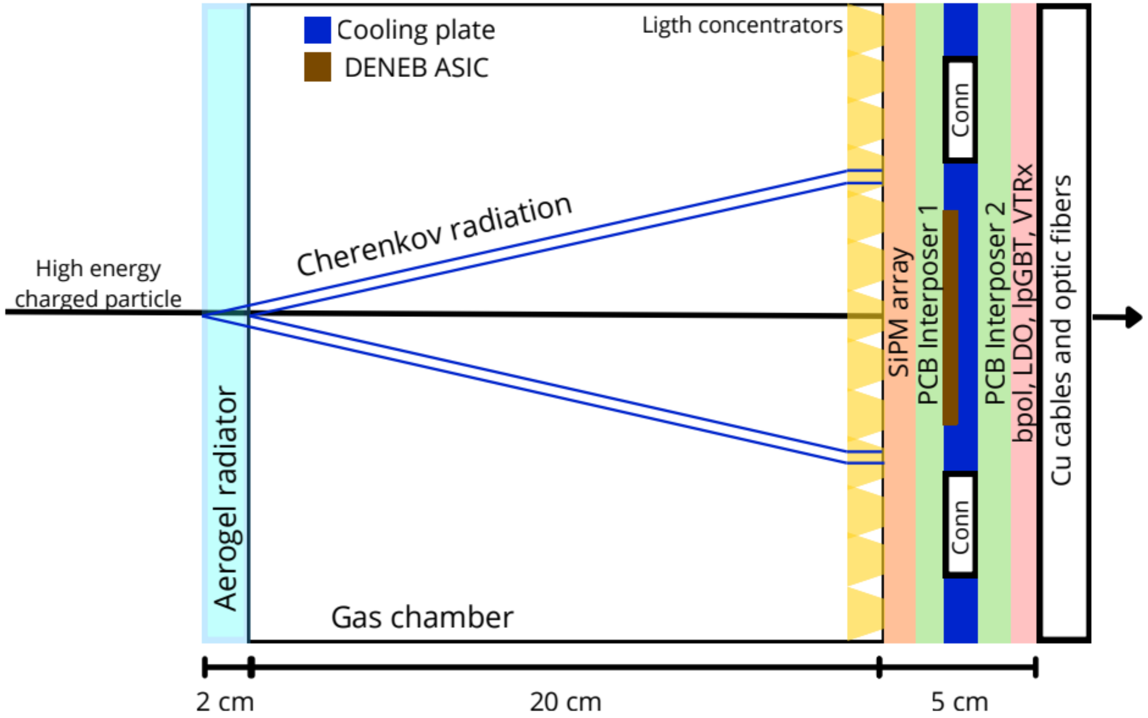
ALICE

ALICE 3 detector
layout v3b, CERN-LHCC-2025-002

ALICE 3 layout has evolved since its first version. Now, all detectors have reduced its size. However, many technological challenges remains.

ALICE 3 RICH detector: operation principle

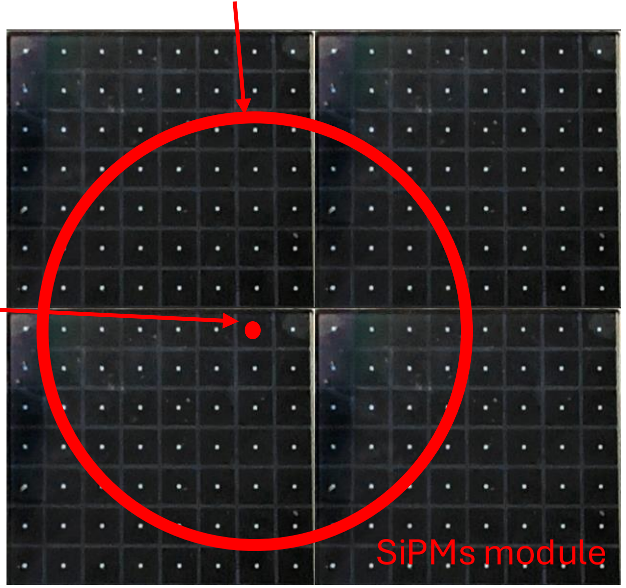
- A Ring-Imaging Cherenkov detector is used to identify charged particles. The ALICE 3 RICH aim is to extend the identification capabilities beyond the ToF .
- Cherenkov radiation is emitted when a charged particle travels through a medium at a speed greater than the speed of light in that medium.
- The opening angle of the Cherenkov light cone depends on the particle velocity and the refractive index of the radiator.



Schematic representation of the ALICE 3 RICH detector

Cherenkov Ring's

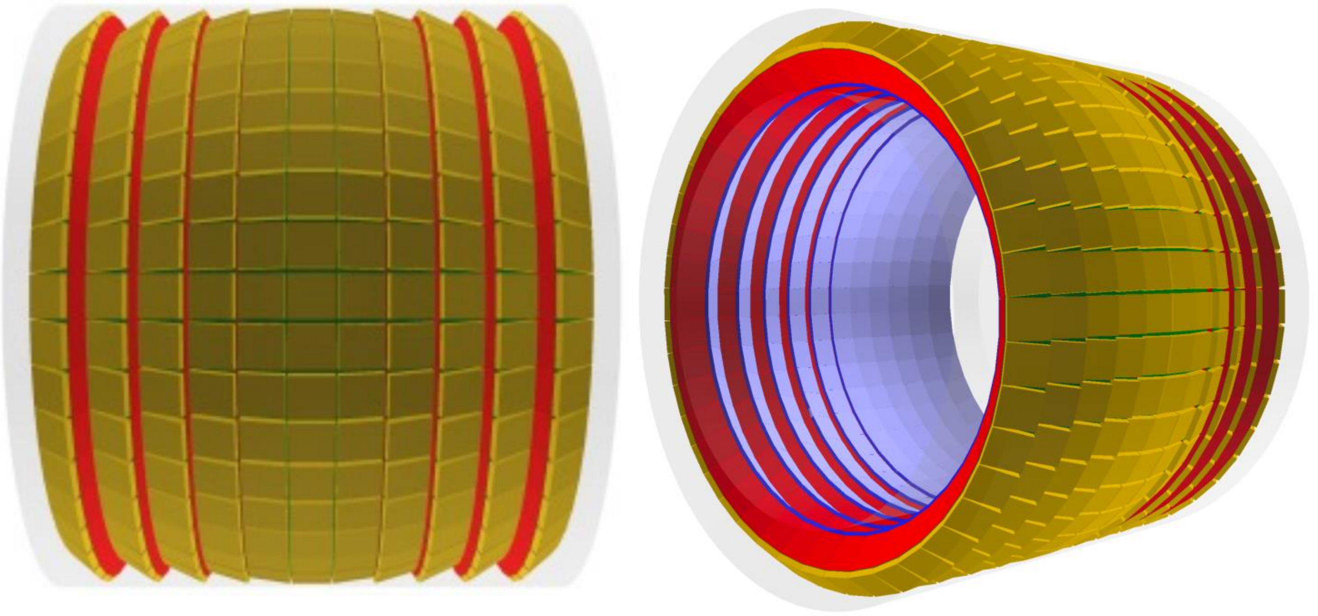
Hitting point of the particle when a window is used

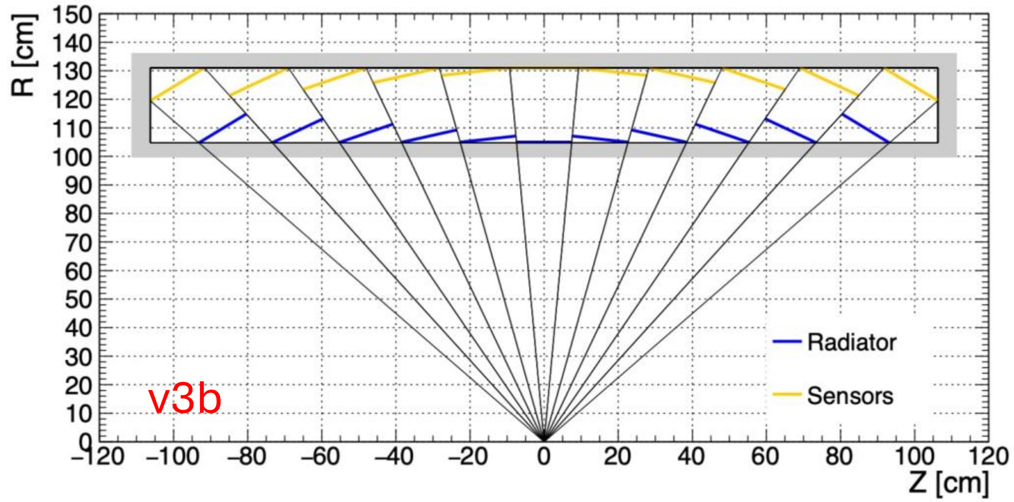


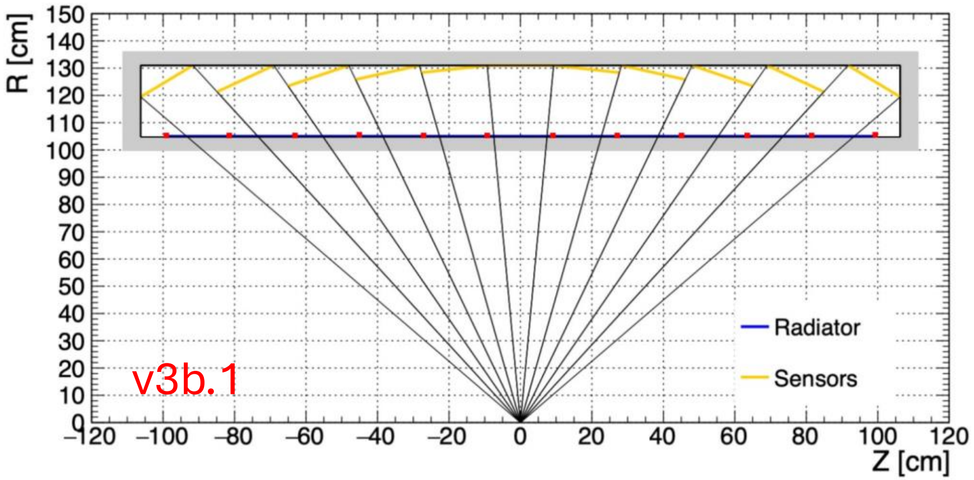
*for illustrative purposes only

Geometry of the ALICE 3 RICH detector

- 11 cylinders with 44 modules each.
- 1 module: 17x18 cm^2, 6237 SiPMs, 6-8 DENEB, 10 bpol, 18 LDOs, 6-8 lpGBT + VTRx.
- Total active area: Without and with light concentrators: 10.40 m^2 and 2.60 m^2.
- Light purple shows the aerogel tiles, yellow shows the back of electronics, and red the mechanical structure.
- Design is changing rapidly because of economical, mechanical, cooling, and pieces constraints.



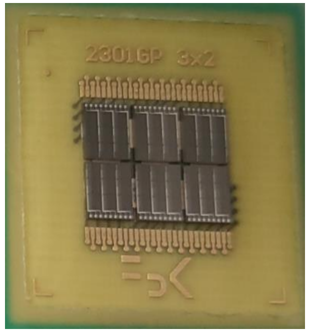




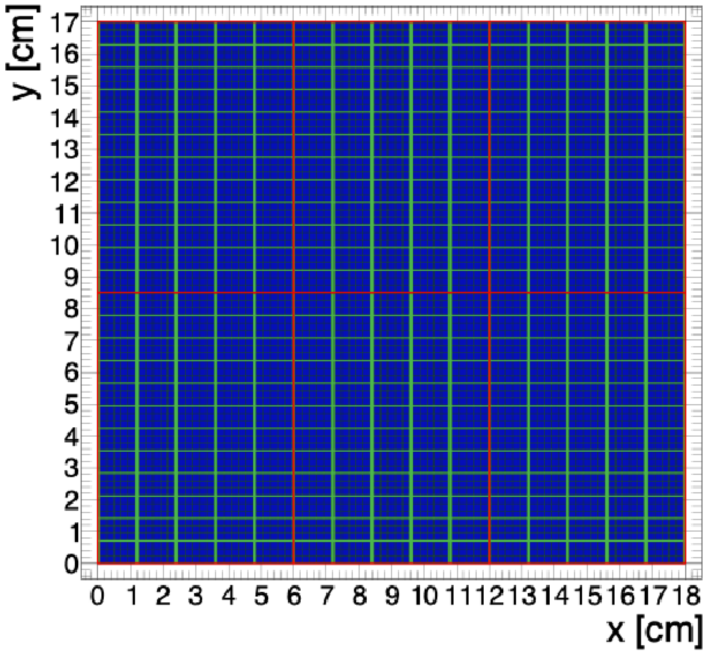
Credit: N. Nicassio

Technological challenges of the ALICE3 RICH: high granularity and low DRC

- **Granularity is so high** that it should have around **6,237 channels (SiPMs) per module** (17 cm x 18 cm = 306 cm^2) inside an area of six modules make the PCBs hard to route in order to preserve the signal integrity throughout all the system in both digital and analog domains.
- SiPMs with 2.2 mm and 1.3 mm have been considered. Blue color means SiPM area and green means free space between SiPMs. Many SiPMs arrays are being considered.
- Passive components have to be placed in the SiPM to make annealing reducing the free space on the PCB.

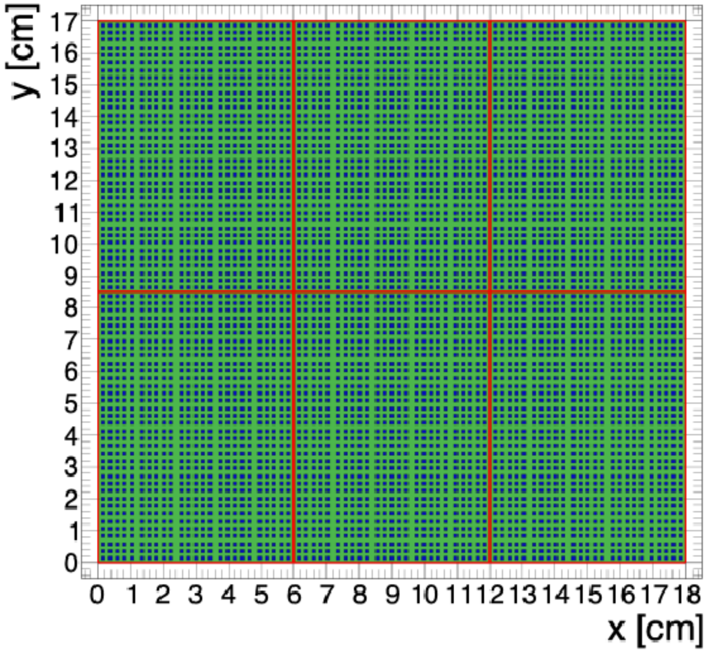


2.2 mm pitch
Without light concentrators

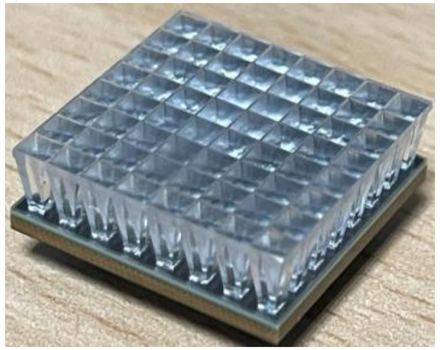


Pros: no light concentrators
Cons: less free space,
Larger active area means higher DRC.

1.3 mm pitch
With light concentrators



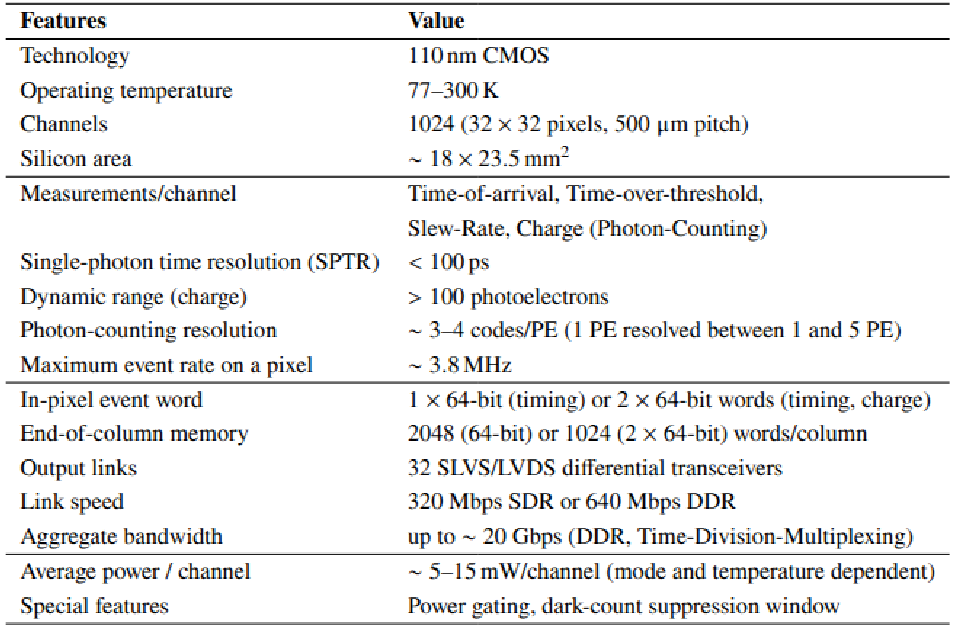
Pros: More free space, lower DRC
Cons: Light concentrators,
Harder to assembly



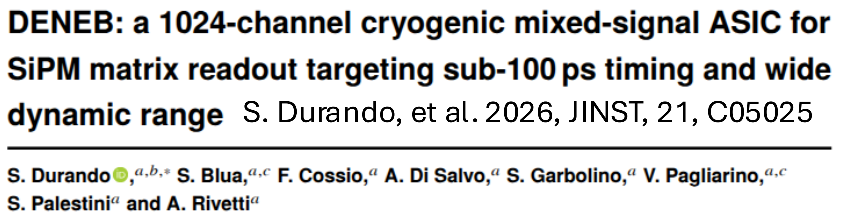
Credit: N. Nicassio, N. Mazziota

Technological challenges of the ALICE3 RICH: DENEB ASIC

- So many channels need a very high-density ASIC to read them all. DENEB chip is being designed by an international collaboration led by the INFN in Torino (Prof. Angelo Rivetti).
- This chip was originally developed to be used in DUNE experiment.
- Its predecessor is called ALCOR and it has been tested but it is designed only for 64 channels.
- Current commercial ASICs do not provide the required channel density. Although Weeroc chips are widely used and their performance has been proven, they support only up to 64 readout channels per chip which is not dense enough for the ALICE 3 RICH.

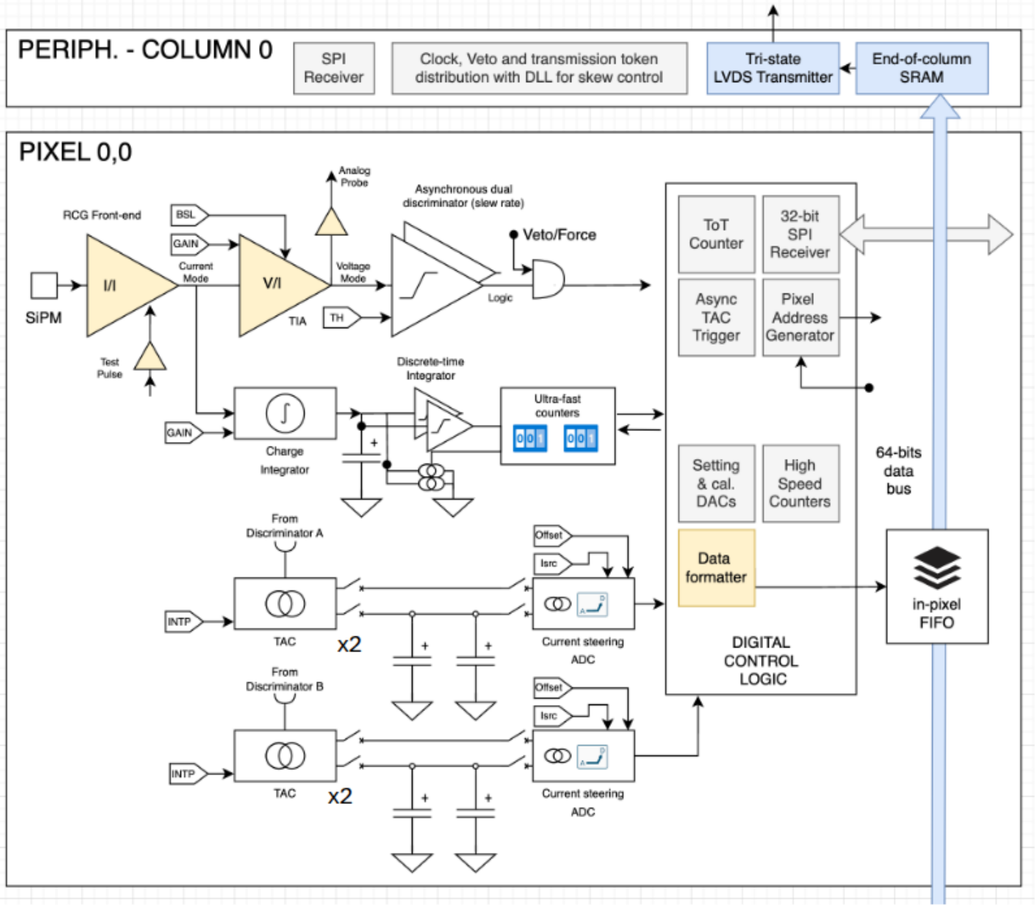


Features	Value
Technology	110 nm CMOS
Operating temperature	77–300 K
Channels	1024 (32 × 32 pixels, 500 μm pitch)
Silicon area	~ 18 × 23.5 mm^2
Measurements/channel	Time-of-arrival, Time-over-threshold, Slew-Rate, Charge (Photon-Counting)
Single-photon time resolution (SPTR)	< 100 ps
Dynamic range (charge)	> 100 photoelectrons
Photon-counting resolution	~ 3–4 codes/PE (1 PE resolved between 1 and 5 PE)
Maximum event rate on a pixel	~ 3.8 MHz
In-pixel event word	1 × 64-bit (timing) or 2 × 64-bit words (timing, charge)
End-of-column memory	2048 (64-bit) or 1024 (2 × 64-bit) words/column
Output links	32 SLVS/LVDS differential transceivers
Link speed	320 Mbps SDR or 640 Mbps DDR
Aggregate bandwidth	up to ~ 20 Gbps (DDR, Time-Division-Multiplexing)
Average power / channel	~ 5–15 mW/channel (mode and temperature dependent)
Special features	Power gating, dark-count suppression window



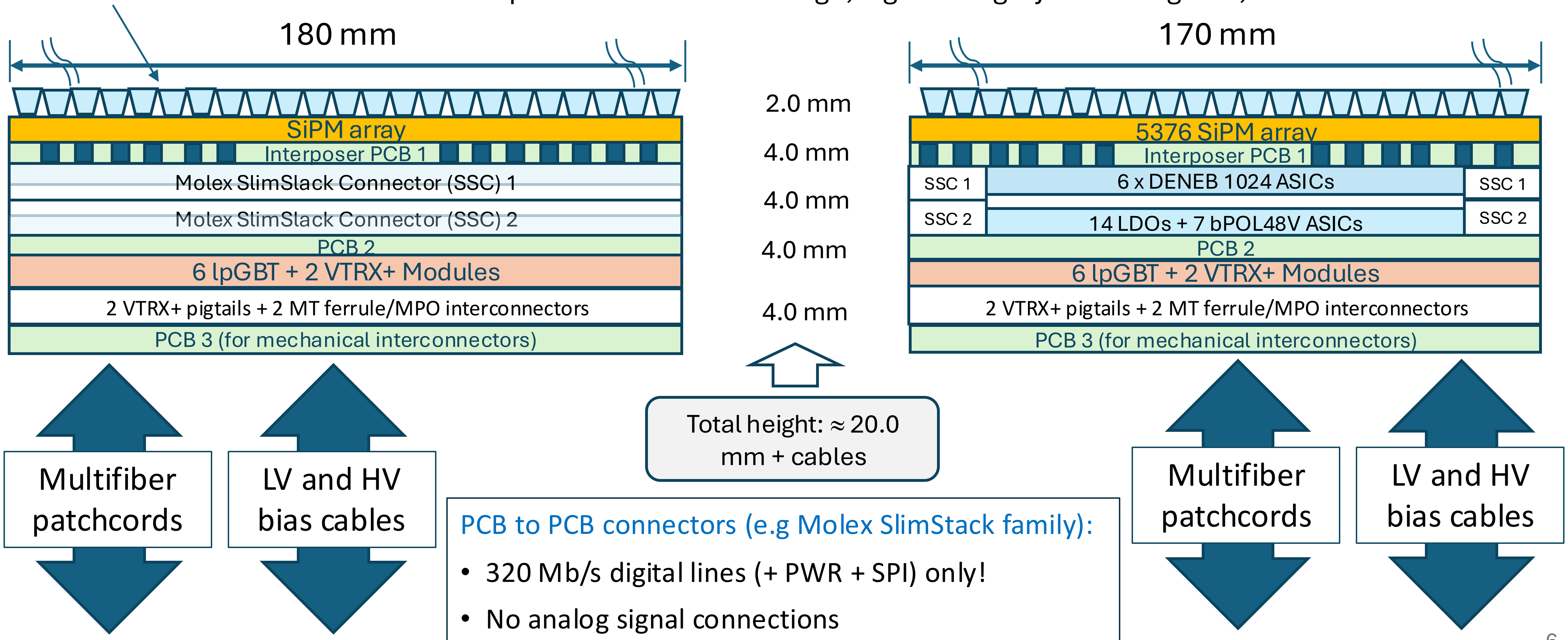
DENEB: a 1024-channel cryogenic mixed-signal ASIC for SiPM matrix readout targeting sub-100 ps timing and wide dynamic range S. Durando, et al. 2026, JINST, 21, C05025

S. Durando[a,b,*] **S. Blua,**[a,c] **F. Cossio,**[a] **A. Di Salvo,**[a] **S. Garbolino,**[a] **V. Pagliarino,**[a,c]
S. Palestini[a] **and A. Rivetti**[a]



Technological challenges of the ALICE3 RICH: PCB stacking

- The most conservative approach considers the use of 3 PCBs:
  - Interposer PCB1: The SiPM array (>=6237 SiPMs) is mounted on one side and the other has the DENEB ASIC.
  - PCB2: It contains the power supplies (bPol48V and the LDOs) and communication modules (lpGBTs and VTRx).
  - PCB3 is used to protect and give mechanical support to the pigtails and ferrules.
- There is an option to divide interposer PCB1 in two PCBs: the first one contains the SiPMs array, and the second has the DENEB ASIC. Pros: routing would be easier, PCBs can be replaced independently, DENEB's heat can be isolated better from the SiPMs. Cons: vertical space could not be enough, signal integrity could degrade, more connectors.



Total height: ≈ 20.0 mm + cables

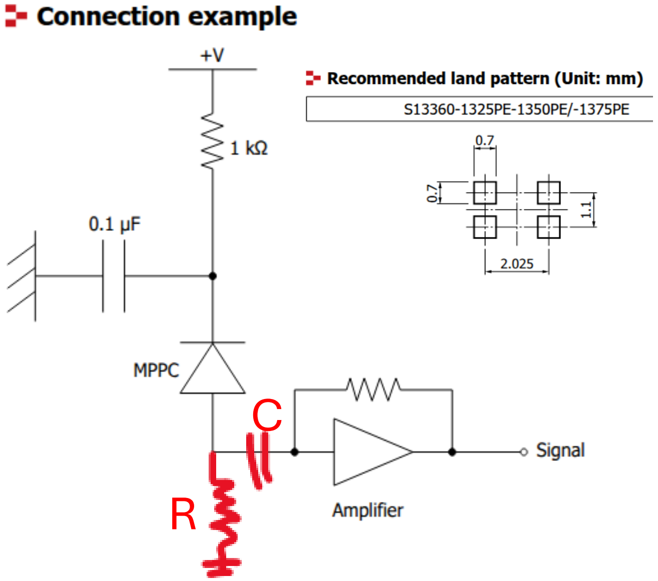
PCB to PCB connectors (e.g Molex SlimStack family):

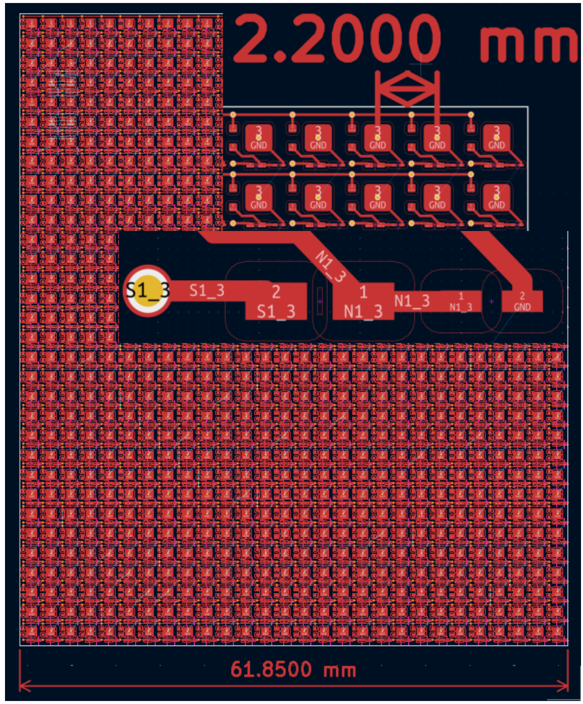
- 320 Mb/s digital lines (+ PWR + SPI) only!
- No analog signal connections

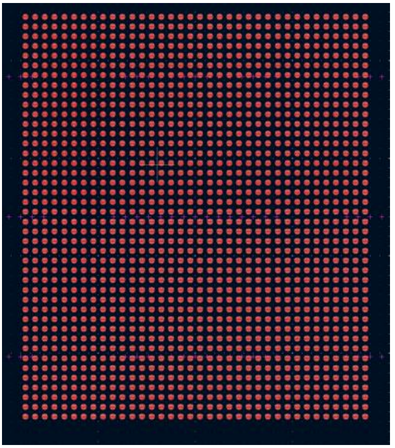
Figures: D. Durini

Technological challenges of the ALICE3 RICH: Routing of PCBs

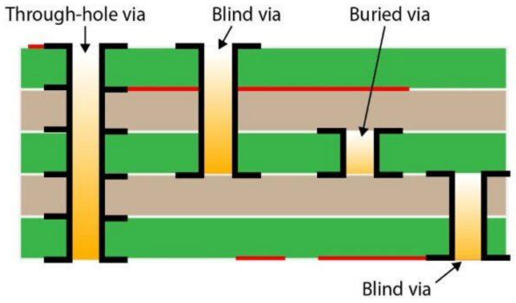
- SiPMs produce a current signal, and the DENEB ASIC includes a current-sensitive preamplifier at its input. Therefore, the SiPM anodes can be connected directly to the ASIC inputs. However, additional passive components have been included to allow for SiPM annealing.
- Passive components makes a hard routing even harder because the lack of space in the PCB due to a very high density.
- Density is so high that the recommended land pattern to place SiPMs was modified. Resistance is 0075 and capacitors 0203.







DENEB BGA
Footprint

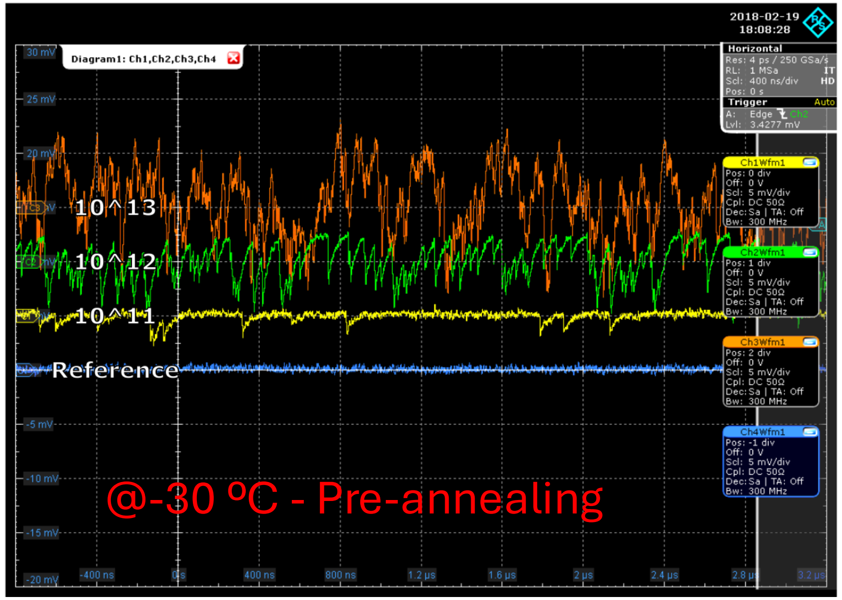


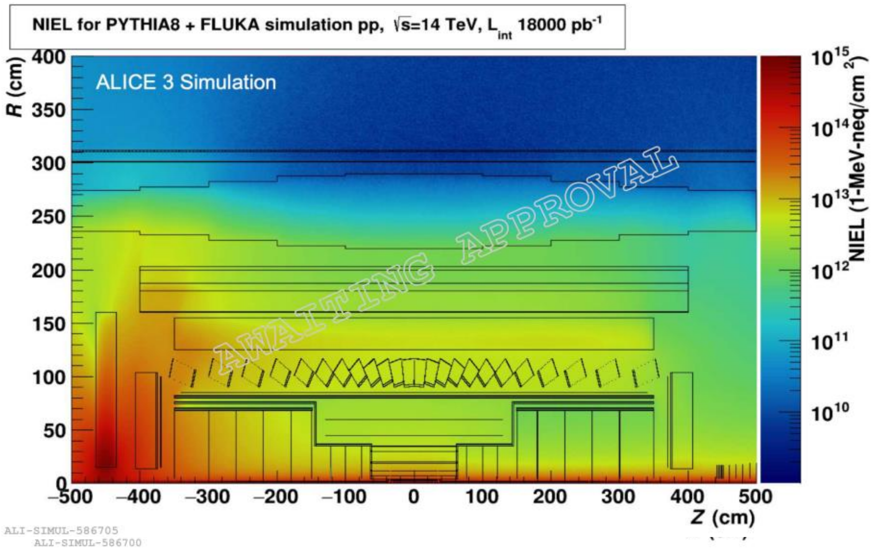
This task is fundamental.
Bad PCB ---> Bad data.
This task is being done in Mexico.

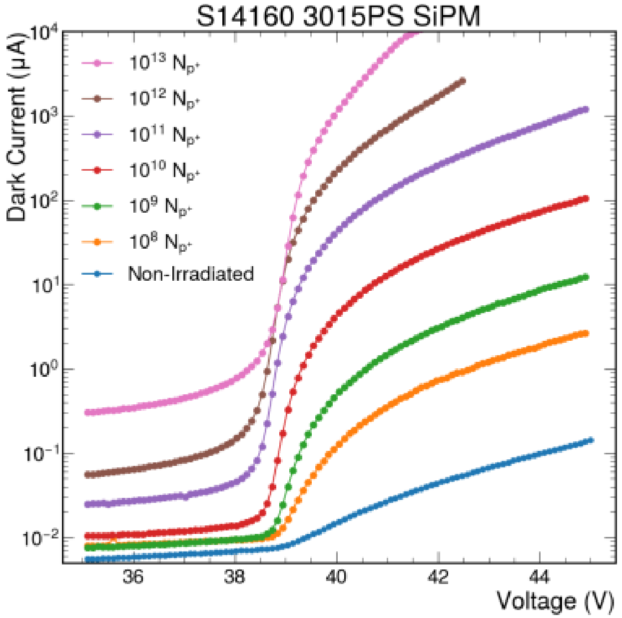
Credit: J.O. Guerra-Pulido

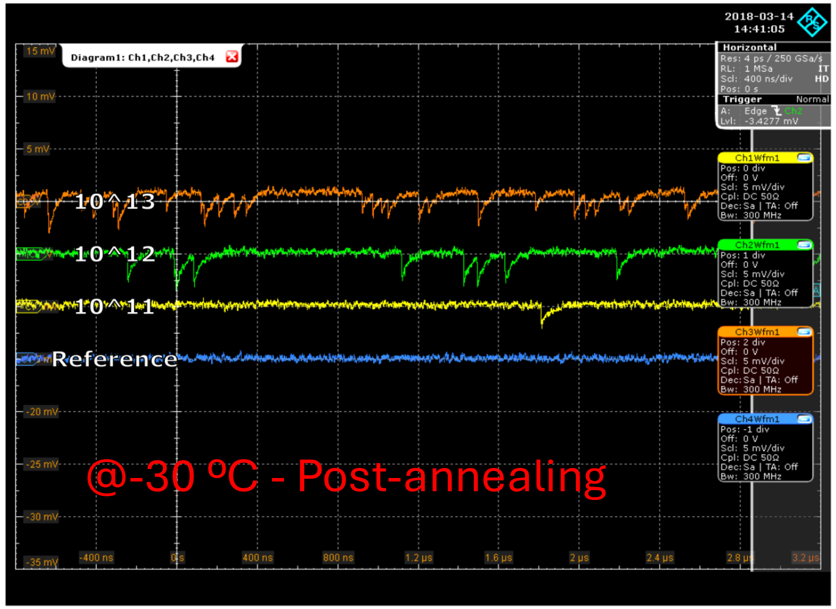
Technological challenges of the ALICE3 RICH: Radiation hardness

- The system is run in a **high radiation environment** making that the overall design must be radiation hard so not any element can be included in the design.
- Hadron radiation produces hard **damage in the crystal lattice of the SiPMs increasing the DRC**. Then, they have to be annealed to reduce DRC to acceptable levels again. Passive or active annealing has been considered.
- FPGAs or any other **sensitive element to radiation cannot be used** inside the RICH detector.







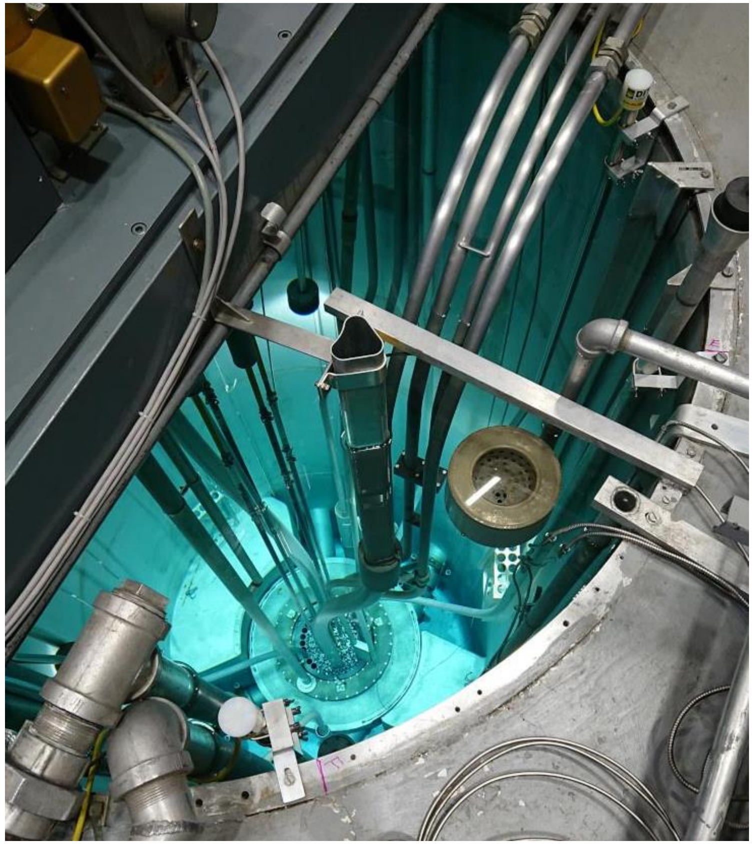


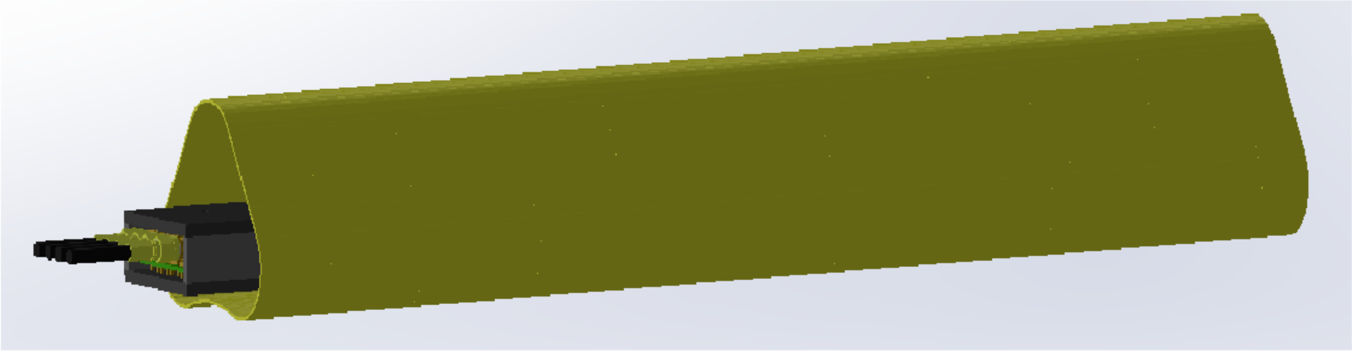
[1] Huang, J., Preins, S., Tsiao, R., Rodriguez, M., Schmookler, B., & Arratia, M. (2025). Measurement of SiPM Dark Currents and Annealing Recovery for Fluences Expected in ePIC Calorimeters at the Electron-Ion Collider. *arXiv preprint arXiv:2503.14622*.

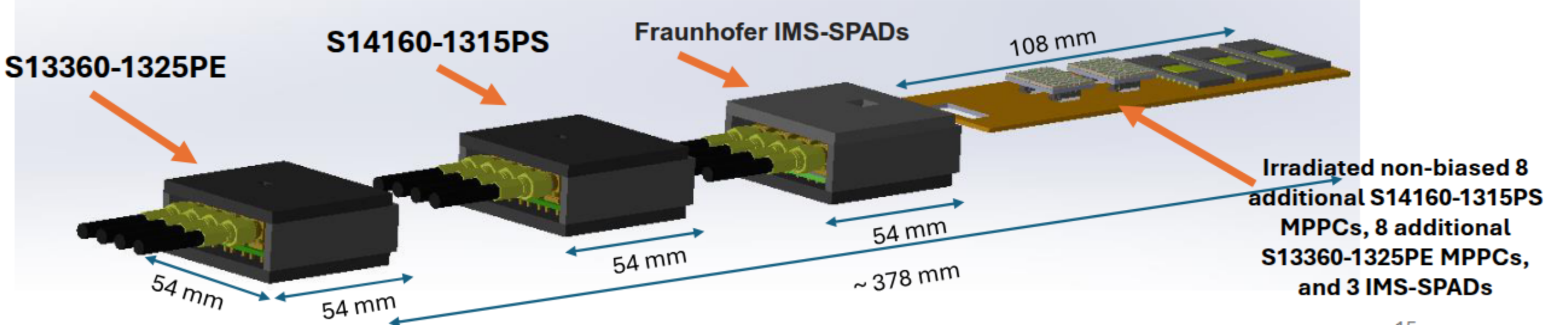
[2] Calvi, M., Carniti, P., Gotti, C., Matteuzzi, C., & Pessina, G. (2019). Single photon detection with SiPMs irradiated up to 1014 cm− 2 1-MeV-equivalent neutron fluence. *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, *922*, 243-249.

Irradiation test of cadidate SiPMs models

- To find SiPMs tolerance to hadron radiation, it is planned to make the irradiation of the possible SiPMs used in the RICH detector in the nuclear reactor of the Institute Josef Stefan in Ljubljana.
- Three types of SiPMs are going to be irradiated. Some SiPMs are going to be irradiated polarized and some others unpolarized. I vs. V curves of polarized SiPMs are going to be measured on site.
- It is expected that the dark current increases as a function of irradiation time. The main purpose of this study is to find the most resistant SiPM against neutron radiation.







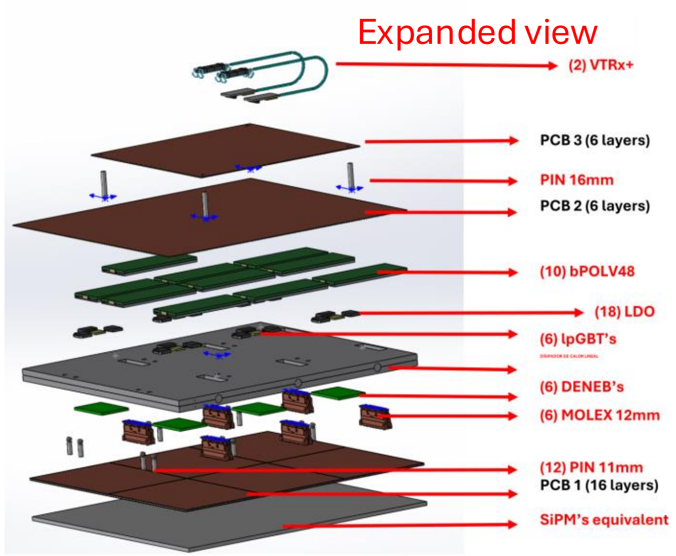
https://doi.org/10.1051/epjconf/202022504031

Credit: D. Durini, C. Osorio

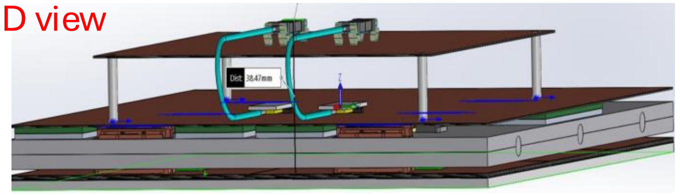
Technological challenges of the ALICE3 RICH: Cooling plate concept

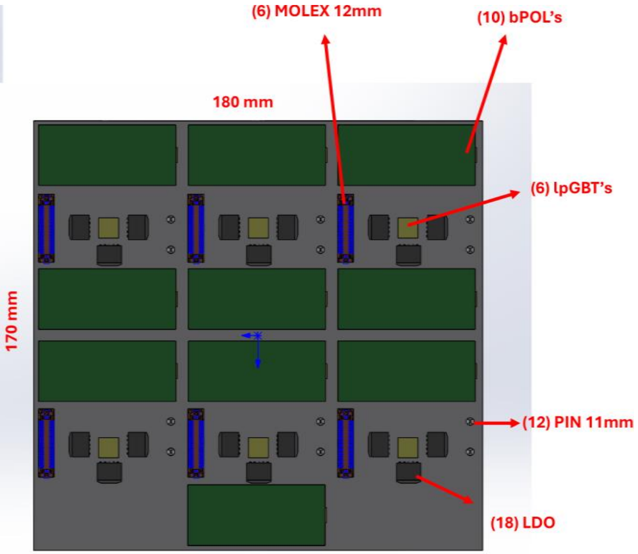
- DENEB disipates 5 to 15 mW/channel, however, the number of channels is too high (900 operational channels). It is expected that DENEB could disipate around 12 W of heat too close to the SIPM array.
- LDOs are inefficient (around 70 %) and they dissipate a considerable amount of heat. BPol48s, lpGBTs and VTRx produces heat that also should be extracted from the system.
- All the heat is produced in a small volume at the same time, and temperature gradient in the interposers could be high affecting mechanically the components. For example, BGA is known to be not very resistant to thermally produced mechanical stress.

Expanded view

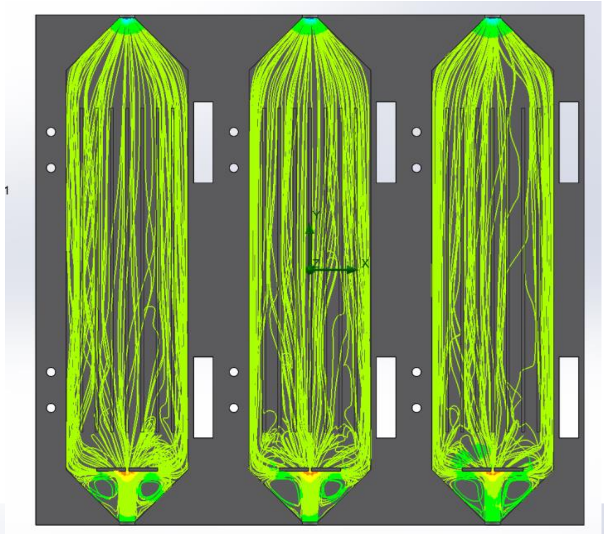


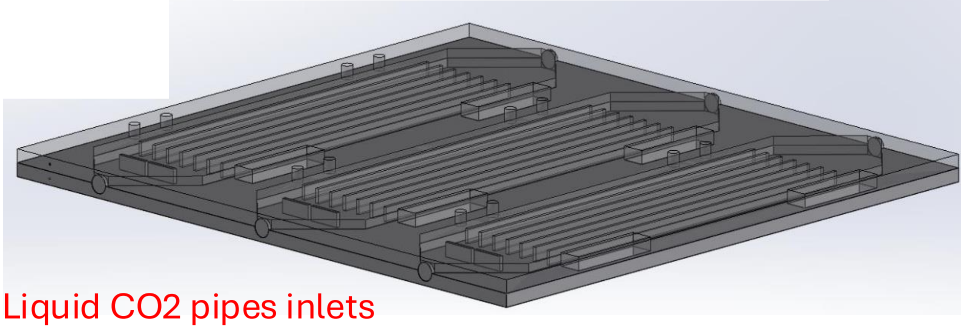
3D view





Tile 1 900 channels	Tile 2 900 channels	Tile 3 900 channels
Tile 4 900 channels	Tile 5 900 channels	Tile 6 900 channels





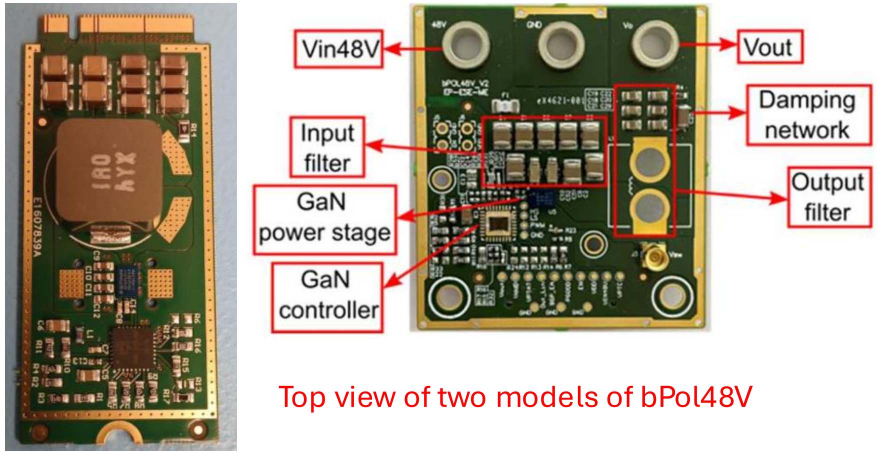
Liquid CO2 pipes inlets

*For illustrative purposes

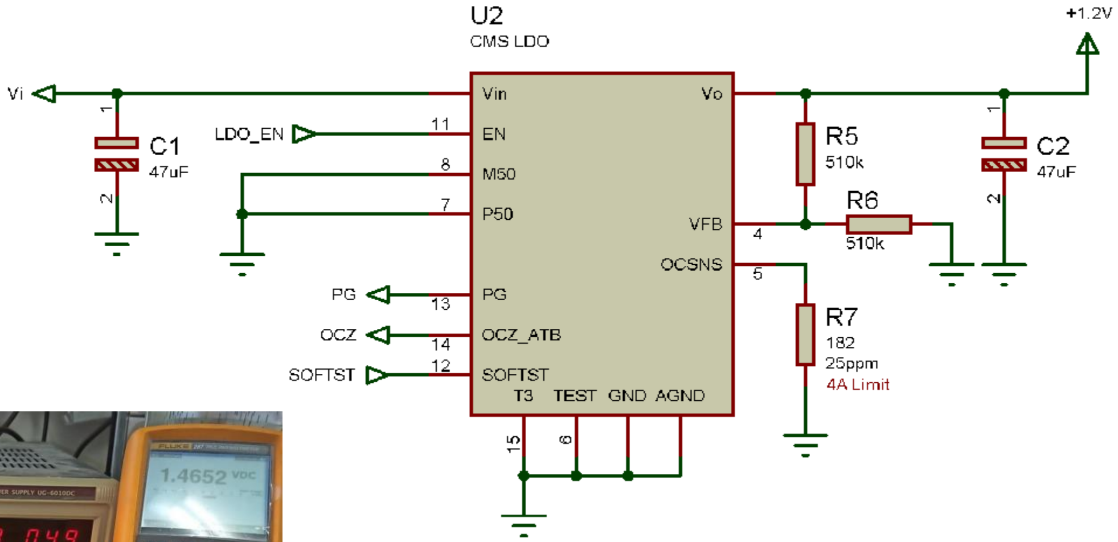
Credit: Miguel Velázquez de la Rosa, Paolo Petagna

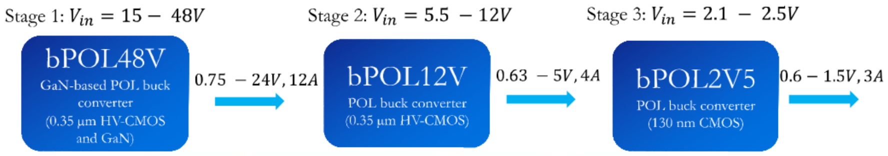
Technological challenges of the ALICE3 RICH: Power supplies

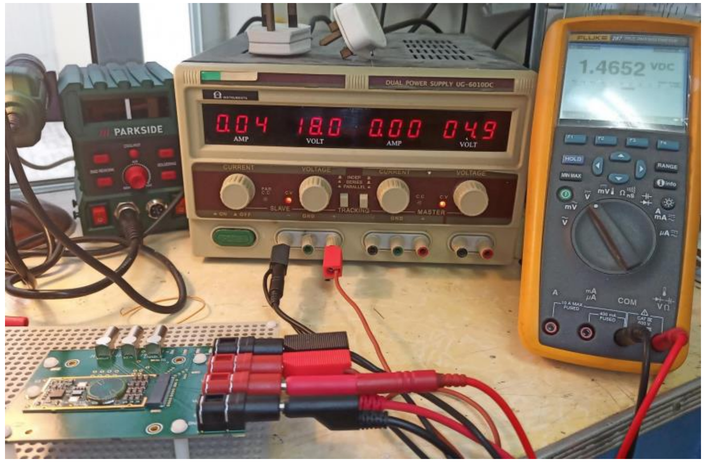
- Power supplies must be radiation hard because they will be placed inside the detector and they will be receiving a similar amount of radiation in comparison to SiPMs. bpol48V is a DC/DC converter in three stages designed for space applications and radiation environments. It can convert 15V-48V to 0.6V to 1.5V.
- Power supplies must be able to deliver high power and currents. DENEB works with 1.2 V, if it consumes 12W, then, 10 A must be delivered to the chip reaching the maximum current of the bpol48V. It can reach an efficiency of up to 97% switching at 1 MHz and using an inductor of 2.2 uH.
- CMS LDO is a low drop-out linear voltage regulator used in CMS experiment.

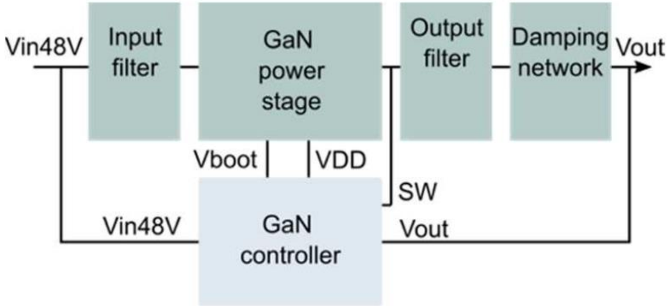


Top view of two models of bPol48V









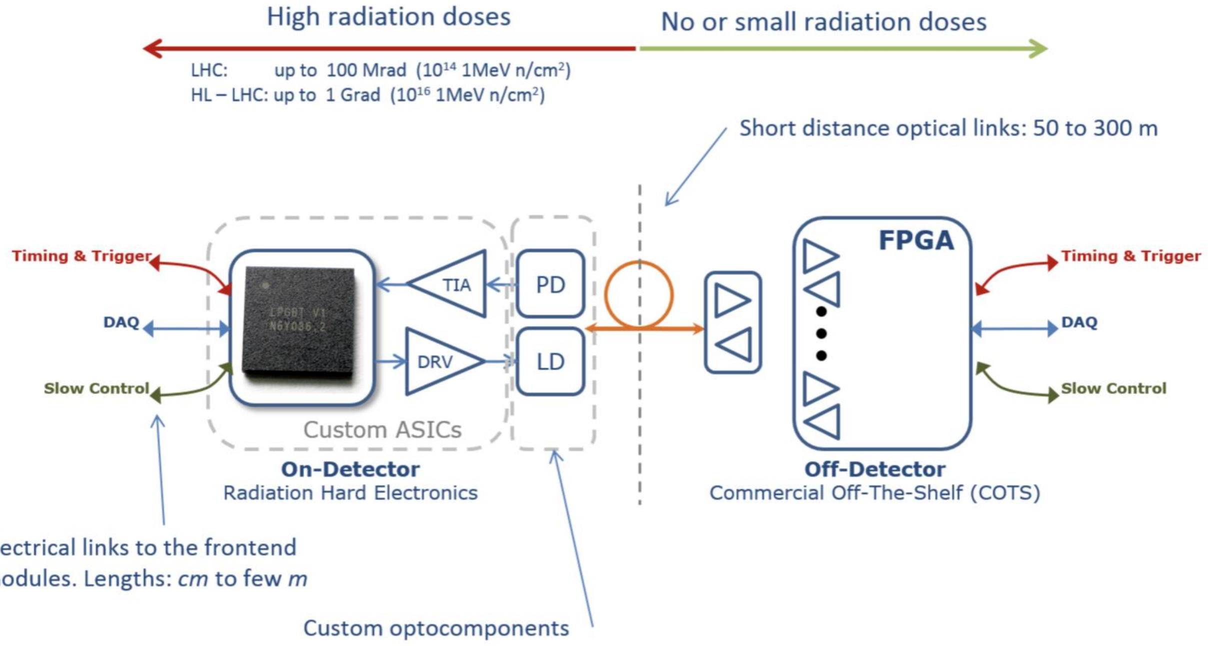
Power dissipation of 0.8W at 3 A with 1.2V output voltage

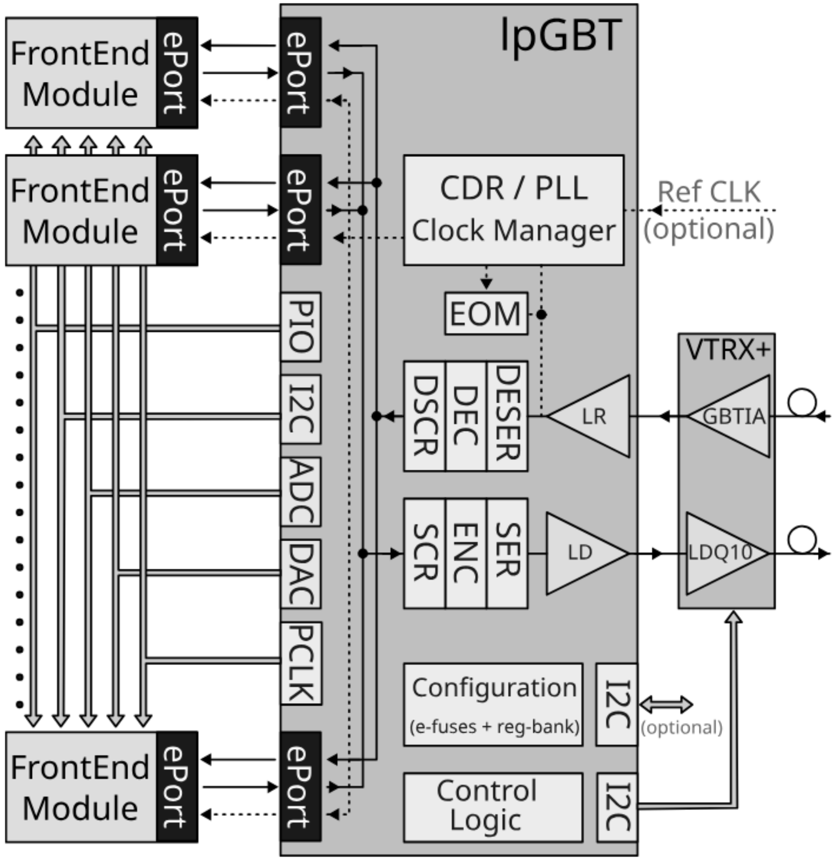
Credit: T. Kiss and J. Zammit

Michelis, S., Van Der Blij, N. H., Ripamonti, G., & Antoszczuk, P. D. (2023, October). bPOL48V, a rad-hard 48V DC/DC Converter for Space and HEP Applications. In *2023 13th European Space Power Conference (ESPC)* (pp. 1-4). IEEE.

Technological challenges of the ALICE3 RICH: Data transmission

- "The lpGBT is a multifunctional device, enabling data transmission between the off-detector and the on-detector systems".
- "Data can be transmitted from the detector at 5.12 and 10.24 Gb/s and to the detector at 2.56 Gb/s".
- "It implements data rate-configurable electrical links to communicate with the front-end ASICs and low-speed serial and parallel buses for experiment control".
- "A set of analog functions for monitoring and control of the physics detectors is also included".
- This technology is mature and it is produced now in industrial quantities.
- It has been tested in radiation environments proving to be reliable under this condition.
- DENEB send data through a 320 Mbits/s LVDS buses.

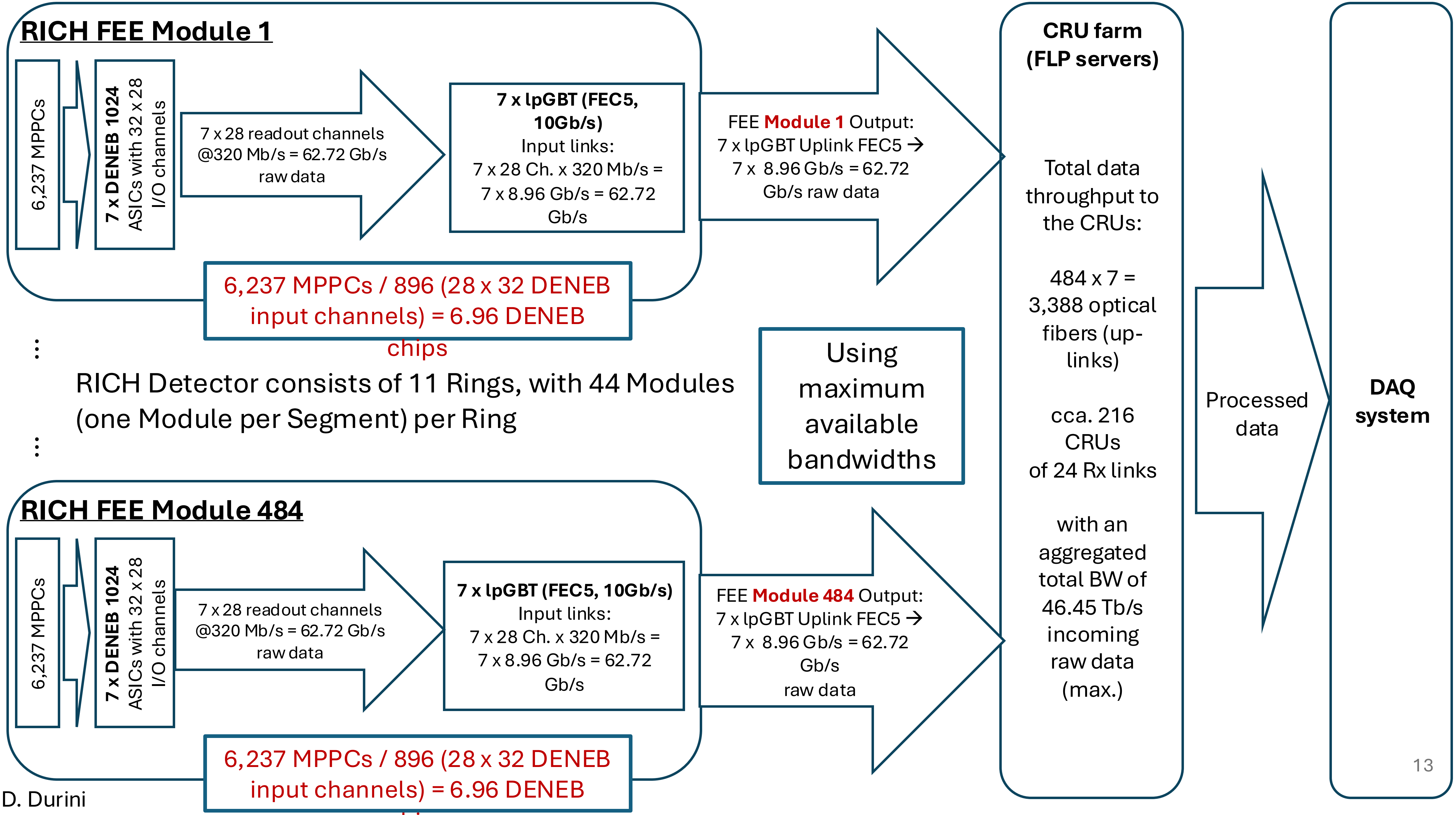




The total amount of data for the whole RICH detector is about 4.96 Tbits/s.

Moreira, P., Kulis, S., Baron, S., Biereigel, S., Mendes, E. B. D. S., Matos-Carvalho, J. P., ... & Zhou, W. (2024). lpGBT: Low-power radiation-hard multipurpose high-speed transceiver ASIC for high-energy physics experiments. *IEEE Transactions on Nuclear Science*, *72*(1), 24-37.

Technological challenges of the ALICE3 RICH: Bandwidth considerations



RICH FEE Module 1

6,237 MPPCs

7 x DENEB 1024 ASICs with 32 x 28 I/O channels

7 x 28 readout channels @320 Mb/s = 62.72 Gb/s raw data

7 x lpGBT (FEC5, 10Gb/s)
Input links:
7 x 28 Ch. x 320 Mb/s = 7 x 8.96 Gb/s = 62.72 Gb/s

FEE **Module 1** Output:
7 x lpGBT Uplink FEC5 →
7 x 8.96 Gb/s = 62.72 Gb/s raw data

6,237 MPPCs / 896 (28 x 32 DENEB input channels) = 6.96 DENEB chips

⋮

RICH Detector consists of 11 Rings, with 44 Modules (one Module per Segment) per Ring

⋮

Using maximum available bandwidths

RICH FEE Module 484

6,237 MPPCs

7 x DENEB 1024 ASICs with 32 x 28 I/O channels

7 x 28 readout channels @320 Mb/s = 62.72 Gb/s raw data

7 x lpGBT (FEC5, 10Gb/s)
Input links:
7 x 28 Ch. x 320 Mb/s = 7 x 8.96 Gb/s = 62.72 Gb/s

FEE **Module 484** Output:
7 x lpGBT Uplink FEC5 →
7 x 8.96 Gb/s = 62.72 Gb/s raw data

6,237 MPPCs / 896 (28 x 32 DENEB input channels) = 6.96 DENEB

CRU farm (FLP servers)

Total data throughput to the CRUs:

484 x 7 = 3,388 optical fibers (up-links)

cca. 216 CRUs of 24 Rx links

with an aggregated total BW of 46.45 Tb/s incoming raw data (max.)

Processed data

DAQ system

Credit: D. Durini

Conclusions

- A RICH detector is being developed for the ALICE 3 upgrade to extend charged hadrons and electrons identification capabilities beyond the momentum range covered by the Time-of-Flight (ToF) detector.
- The detector comprises approximately **3.0 million readout channels**. This large channel count requires the development of a **high-density ASIC capable of reading up to 1024 channels per chip**, at the expense of a relatively high-power consumption (~12 W per chip). The front-end electronics must provide **single-photon sensitivity to enable accurate Cherenkov ring reconstruction** and particle identification.
- **Radiation damage results in increased Dark Count Rate (DCR) and reduced Signal-to-Noise Ratio.** In order to decrease the DCR, **the goal is to operate the sensors at about −40 °C** by flushing cooler fluid in the microchannels embedded in the interposer. A further reduction of the DCR may be achieved by employing **light concentrators**, which would allow the SiPM size to be reduced from $2.2 \times 2.2\ \text{mm}^2$ to $1.3 \times 1.3\ \text{mm}^2$ with a **reduction in the DCR by a factor of 3 to 4.**
- Radiation damage degrades the silicon lattice of SiPMs over time. Consequently, **a SiPM annealing procedure with thermal cycles is under development to reduce radiation-induced damage** with the aim to extend sensors lifetime.
- The **PCB design must ensure signal integrity in both the analog and digital domains.** Additional passive components should be included when active annealing functionality is required.
- The **detector is expected to generate up to 30.6 Tbit/s** of data when operating at full bandwidth. Data transmission will employ FEC5 or FEC12 error-correction protocols to ensure reliable communication and data integrity.

Members of the group

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My apologies if somebody is missing

Participations and contributions of the Mexican teams

WP8 Integration, Coordinators: J. Guerra (UNAM), G. Paic (UNAM)

- Service integration: gas, cooling, power supply system, detector safety system

UNAM

Daniele
De
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Daniel
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WP3: SiPM module

Prof. Durini (INAOE) is co-responsible of WP3, which is in charge of SiPM module.

https://indico.cern.ch/event/1695875

Thank you for your attention!!

Questions?

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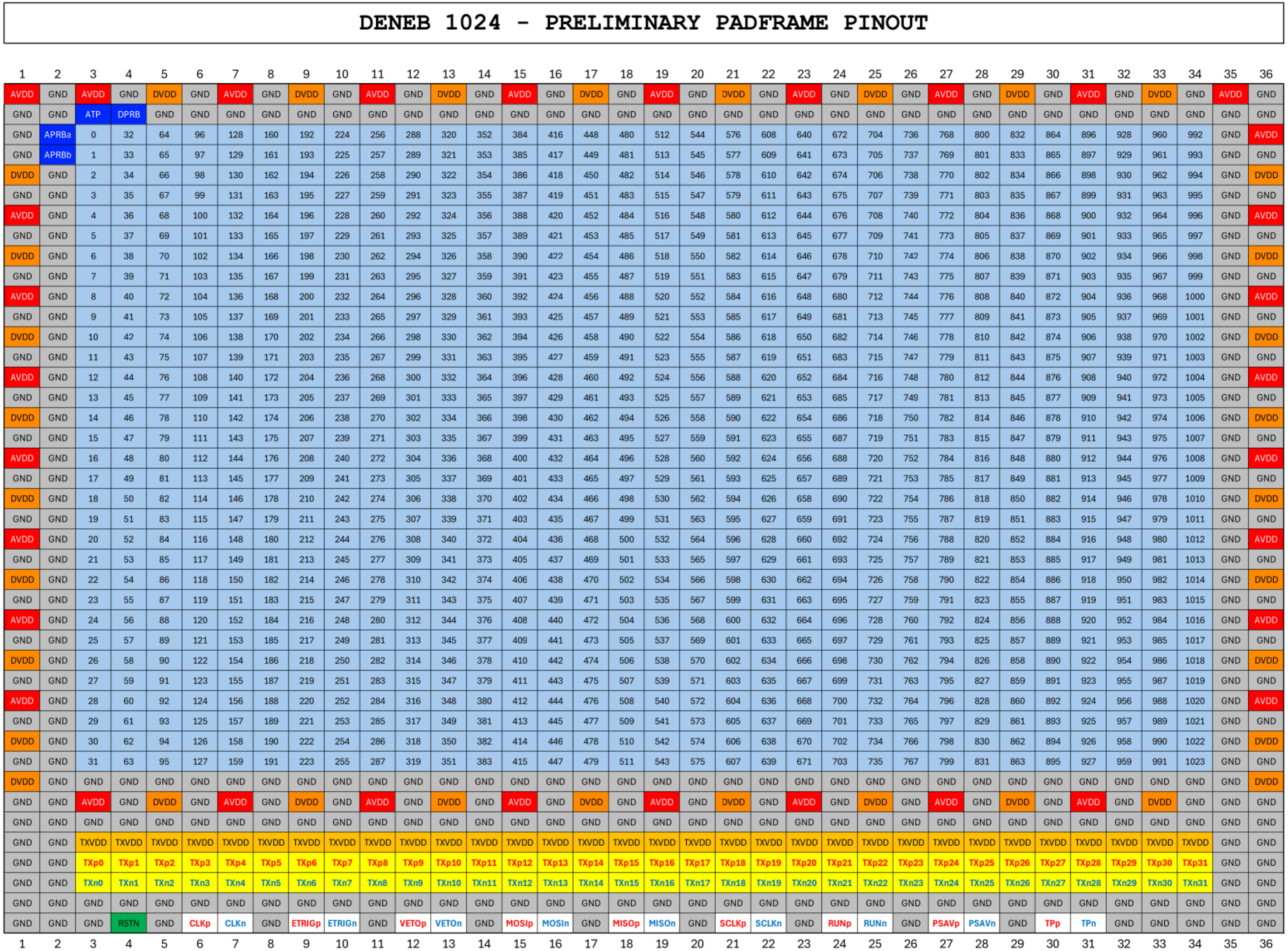
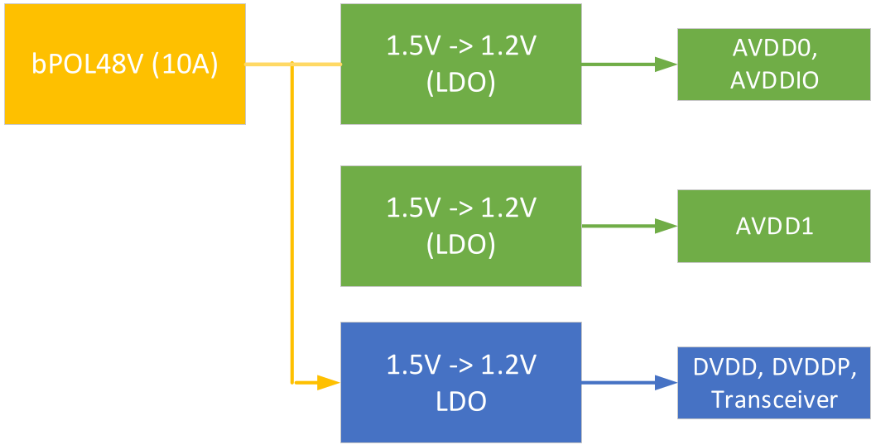


DENEB 1024 - PRELIMINARY PADFRAME PINOUT

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
1	AVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	1
2	GND	GND	ATP	DPRB	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	2
3	GND	APRBa	0	32	64	96	128	160	192	224	256	288	320	352	384	416	448	480	512	544	576	608	640	672	704	736	768	800	832	864	896	928	960	992	GND	AVDD	3
4	GND	APRBb	1	33	65	97	129	161	193	225	257	289	321	353	385	417	449	481	513	545	577	609	641	673	705	737	769	801	833	865	897	929	961	993	GND	GND	4
5	DVDD	GND	2	34	66	98	130	162	194	226	258	290	322	354	386	418	450	482	514	546	578	610	642	674	706	738	770	802	834	866	898	930	962	994	GND	DVDD	5
6	GND	GND	3	35	67	99	131	163	195	227	259	291	323	355	387	419	451	483	515	547	579	611	643	675	707	739	771	803	835	867	899	931	963	995	GND	GND	6
7	AVDD	GND	4	36	68	100	132	164	196	228	260	292	324	356	388	420	452	484	516	548	580	612	644	676	708	740	772	804	836	868	900	932	964	996	GND	AVDD	7
8	GND	GND	5	37	69	101	133	165	197	229	261	293	325	357	389	421	453	485	517	549	581	613	645	677	709	741	773	805	837	869	901	933	965	997	GND	GND	8
9	DVDD	GND	6	38	70	102	134	166	198	230	262	294	326	358	390	422	454	486	518	550	582	614	646	678	710	742	774	806	838	870	902	934	966	998	GND	DVDD	9
10	GND	GND	7	39	71	103	135	167	199	231	263	295	327	359	391	423	455	487	519	551	583	615	647	679	711	743	775	807	839	871	903	935	967	999	GND	GND	10
11	AVDD	GND	8	40	72	104	136	168	200	232	264	296	328	360	392	424	456	488	520	552	584	616	648	680	712	744	776	808	840	872	904	936	968	1000	GND	AVDD	11
12	GND	GND	9	41	73	105	137	169	201	233	265	297	329	361	393	425	457	489	521	553	585	617	649	681	713	745	777	809	841	873	905	937	969	1001	GND	GND	12
13	DVDD	GND	10	42	74	106	138	170	202	234	266	298	330	362	394	426	458	490	522	554	586	618	650	682	714	746	778	810	842	874	906	938	970	1002	GND	DVDD	13
14	GND	GND	11	43	75	107	139	171	203	235	267	299	331	363	395	427	459	491	523	555	587	619	651	683	715	747	779	811	843	875	907	939	971	1003	GND	GND	14
15	AVDD	GND	12	44	76	108	140	172	204	236	268	300	332	364	396	428	460	492	524	556	588	620	652	684	716	748	780	812	844	876	908	940	972	1004	GND	AVDD	15
16	GND	GND	13	45	77	109	141	173	205	237	269	301	333	365	397	429	461	493	525	557	589	621	653	685	717	749	781	813	845	877	909	941	973	1005	GND	GND	16
17	DVDD	GND	14	46	78	110	142	174	206	238	270	302	334	366	398	430	462	494	526	558	590	622	654	686	718	750	782	814	846	878	910	942	974	1006	GND	DVDD	17
18	GND	GND	15	47	79	111	143	175	207	239	271	303	335	367	399	431	463	495	527	559	591	623	655	687	719	751	783	815	847	879	911	943	975	1007	GND	GND	18
19	AVDD	GND	16	48	80	112	144	176	208	240	272	304	336	368	400	432	464	496	528	560	592	624	656	688	720	752	784	816	848	880	912	944	976	1008	GND	AVDD	19
20	GND	GND	17	49	81	113	145	177	209	241	273	305	337	369	401	433	465	497	529	561	593	625	657	689	721	753	785	817	849	881	913	945	977	1009	GND	GND	20
21	DVDD	GND	18	50	82	114	146	178	210	242	274	306	338	370	402	434	466	498	530	562	594	626	658	690	722	754	786	818	850	882	914	946	978	1010	GND	DVDD	21
22	GND	GND	19	51	83	115	147	179	211	243	275	307	339	371	403	435	467	499	531	563	595	627	659	691	723	755	787	819	851	883	915	947	979	1011	GND	GND	22
23	AVDD	GND	20	52	84	116	148	180	212	244	276	308	340	372	404	436	468	500	532	564	596	628	660	692	724	756	788	820	852	884	916	948	980	1012	GND	AVDD	23
24	GND	GND	21	53	85	117	149	181	213	245	277	309	341	373	405	437	469	501	533	565	597	629	661	693	725	757	789	821	853	885	917	949	981	1013	GND	GND	24
25	DVDD	GND	22	54	86	118	150	182	214	246	278	310	342	374	406	438	470	502	534	566	598	630	662	694	726	758	790	822	854	886	918	950	982	1014	GND	DVDD	25
26	GND	GND	23	55	87	119	151	183	215	247	279	311	343	375	407	439	471	503	535	567	599	631	663	695	727	759	791	823	855	887	919	951	983	1015	GND	GND	26
27	AVDD	GND	24	56	88	120	152	184	216	248	280	312	344	376	408	440	472	504	536	568	600	632	664	696	728	760	792	824	856	888	920	952	984	1016	GND	AVDD	27
28	GND	GND	25	57	89	121	153	185	217	249	281	313	345	377	409	441	473	505	537	569	601	633	665	697	729	761	793	825	857	889	921	953	985	1017	GND	GND	28
29	DVDD	GND	26	58	90	122	154	186	218	250	282	314	346	378	410	442	474	506	538	570	602	634	666	698	730	762	794	826	858	890	922	954	986	1018	GND	DVDD	29
30	GND	GND	27	59	91	123	155	187	219	251	283	315	347	379	411	443	475	507	539	571	603	635	667	699	731	763	795	827	859	891	923	955	987	1019	GND	GND	30
31	AVDD	GND	28	60	92	124	156	188	220	252	284	316	348	380	412	444	476	508	540	572	604	636	668	700	732	764	796	828	860	892	924	956	988	1020	GND	AVDD	31
32	GND	GND	29	61	93	125	157	189	221	253	285	317	349	381	413	445	477	509	541	573	605	637	669	701	733	765	797	829	861	893	925	957	989	1021	GND	GND	32
33	DVDD	GND	30	62	94	126	158	190	222	254	286	318	350	382	414	446	478	510	542	574	606	638	670	702	734	766	798	830	862	894	926	958	990	1022	GND	DVDD	33
34	GND	GND	31	63	95	127	159	191	223	255	287	319	351	383	415	447	479	511	543	575	607	639	671	703	735	767	799	831	863	895	927	959	991	1023	GND	GND	34
35	DVDD	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	DVDD	35
36	GND	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	AVDD	GND	DVDD	GND	GND	GND	36
37	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	37
38	GND	GND	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	TXVDD	GND	GND	38
39	GND	GND	TXp0	TXp1	TXp2	TXp3	TXp4	TXp5	TXp6	TXp7	TXp8	TXp9	TXp10	TXp11	TXp12	TXp13	TXp14	TXp15	TXp16	TXp17	TXp18	TXp19	TXp20	TXp21	TXp22	TXp23	TXp24	TXp25	TXp26	TXp27	TXp28	TXp29	TXp30	TXp31	GND	GND	39
40	GND	GND	TXn0	TXn1	TXn2	TXn3	TXn4	TXn5	TXn6	TXn7	TXn8	TXn9	TXn10	TXn11	TXn12	TXn13	TXn14	TXn15	TXn16	TXn17	TXn18	TXn19	TXn20	TXn21	TXn22	TXn23	TXn24	TXn25	TXn26	TXn27	TXn28	TXn29	TXn30	TXn31	GND	GND	40
41	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	41
42	GND	GND	GND	RSTN	GND	CLKp	CLKn	GND	ETRIGp	ETRIGn	GND	VETOp	VETOn	GND	MOSIp	MOSIn	GND	MISOp	MISOn	GND	SCLKp	SCLKn	GND	RUNp	RUNn	GND	PSAVp	PSAVn	GND	TPp	TPn	GND	GND	GND	GND	GND	42
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	

backup

- 

bPOL48V (10A)

1.5V -> 1.2V (LDO)

AVDD0, AVDDIO

1.5V -> 1.2V (LDO)

AVDD1

1.5V -> 1.2V LDO

DVDD, DVDDP, Transceiver

	Current/Pixel	Total Current	Total Power
Analog Domain			
AVDD0	0.005	4.48	5.376
AVDD1	0.005	4.48	5.376
Digital Domain			
DVDD	0.005	4.48	5.376
DVDDP	0.005	0.16	0.192
Transceiver	0.002	1.79	2.150
Total		13.6	16.32