An interaction tagger for the dRICH

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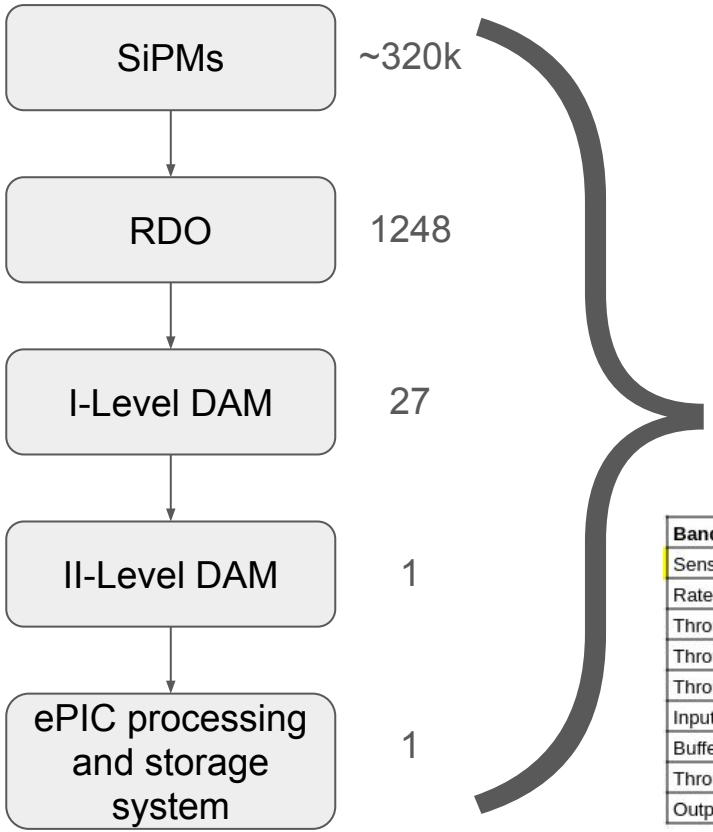
The dRICH DAQ chain in ePIC → the throughput issue



dRICH DAQ parameters	
RDO boards	1248
ALCOR64 x RDO	4
dRICH channels (total)	319488
Number of DAM L1	27
Input link in DAM L1	47
Output links in DAM L1	1
Number of DAM L2	1
Input link to DAM L2	27
Link bandwidth [Gb/s] (assumes VTRX+)	10
Interaction tagger reduction factor	1
Interaction tagger latency [s]	2,00E-03
EIC parameters	
EIC Clock [MHz]	98,522
Orbit efficiency (takes into account gap)	0,92

Bandwidth analysis		Limit
Sensor rate per channel [kHz]	300,00	4.000,00
Rate post-shutter [kHz]	55,20	800,00
Throughput to serializer [Mb/s]	34,50	788,16
Throughput from ALCOR64 [Mb/s]	276,00	
Throughput from RDO [Gb/s]	1,08	10,00
Input at each DAM I [Gbps]	50,67	470,00
Buffering capacity at DAM I [MB]	12,97	
Throughput from DAM I to DAM II [Gbps]	50,67	10,00
Output to each DAM II [Gbps]	1.368,14	270,00

Sensors DCR: 3 - 300 kHZ (increasing with radiation damage → with experiment lifetime).

Detector throughput: 14 - 1400 Gbps.

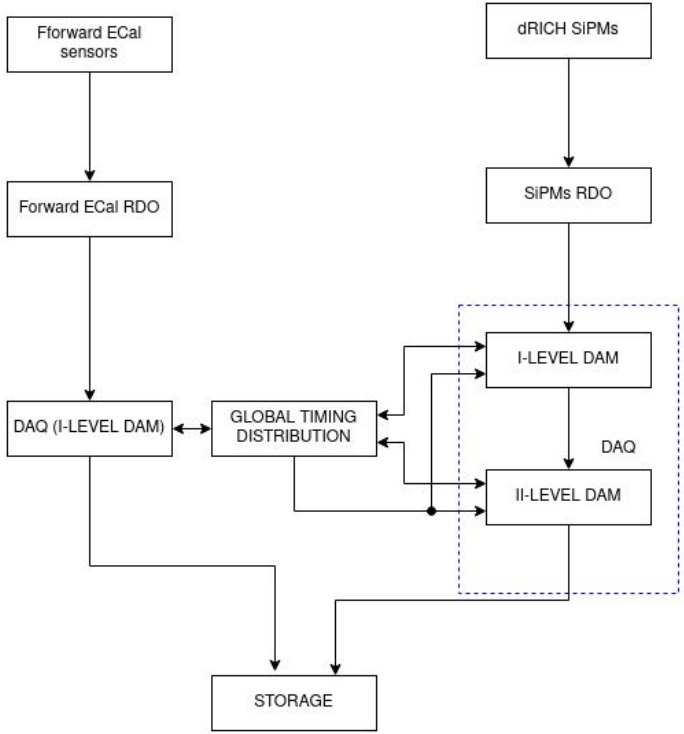
EIC beams bunch spacing:10 ns → bunch crossing rate of 100 MHz.

For the low interaction cross-section → one interaction every ~ 200 bunches → interaction rate of 500 kHz

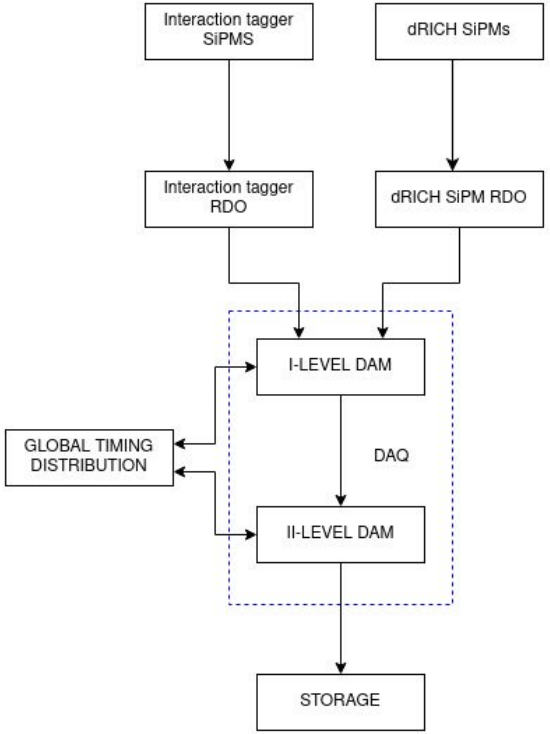
A system tagging the interacting bunches can solve the throughput issue.

The dRICH interaction tagger possibilities

Based on information provided by other sub-detectors through the Global Timing Unit board.



Integrate it directly on the dRICH, adding few RDO and scintillating fibers layers.



The internal interaction tagger option

It could be directly integrated into the dRICH mechanical structure;

Only few cm of the detector width will be occupied

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It could use the same front-end boards, providing a stand-alone working system;

It naturally fits into a steaming readout chain, avoiding complex online information transmission between the same level of different detectors;

Being a triggerless experiment is one of the ePIC cornerstone

See the A. Lonardo talk

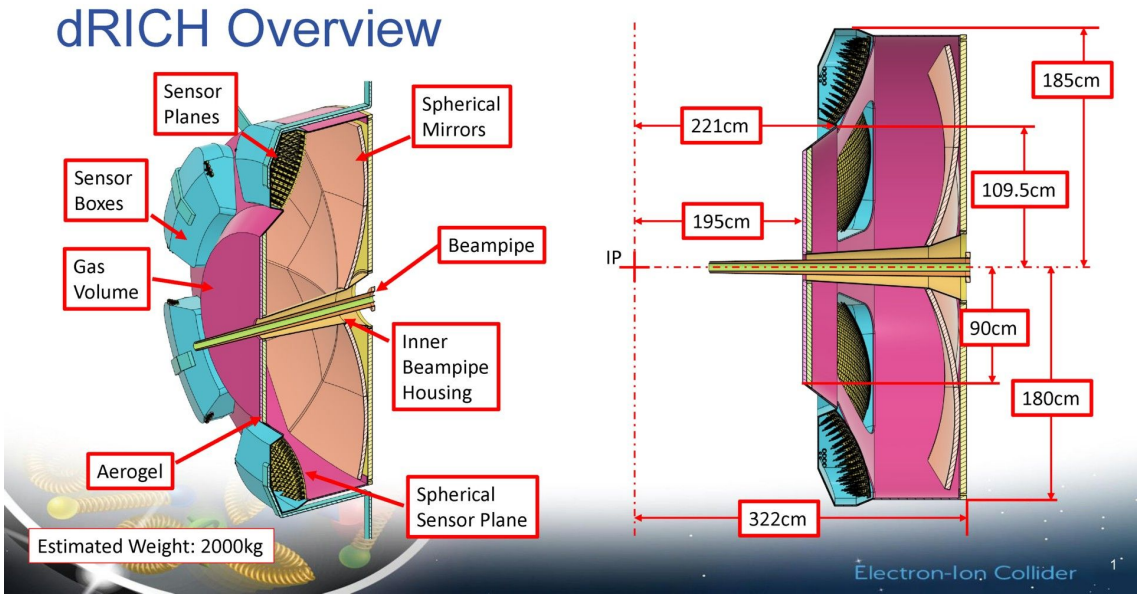
It could provide quick, minimal information on particle track, helping the signal/noise discrimination that will occur in the FPGAs;

How could it be designed?

The interaction tagger could be made by adding some Scintillating Fibers (SciFi) layers, forming a grid in front of the detector entrance cap. The area it needs to cover is the same as that covered by the aerogel → Disk with 100 cm ⌀

A very preliminary idea of design could include:

- 2 layers consisting of 1000 SciFi with 1.5 m length and 0.5 cm ⌀;
- SciFi: attenuation length ~ 4 m, rising edge ~ 100 ps, and hit duration ~ 10-20 ns;
- SciFi optical coupled with optical fibers to bring light to SiPMs;
- Two-sides read → 4000 SiPMs & 4000 channels;
- 256 channels for RDO →need to add 16 RDO.



Summary

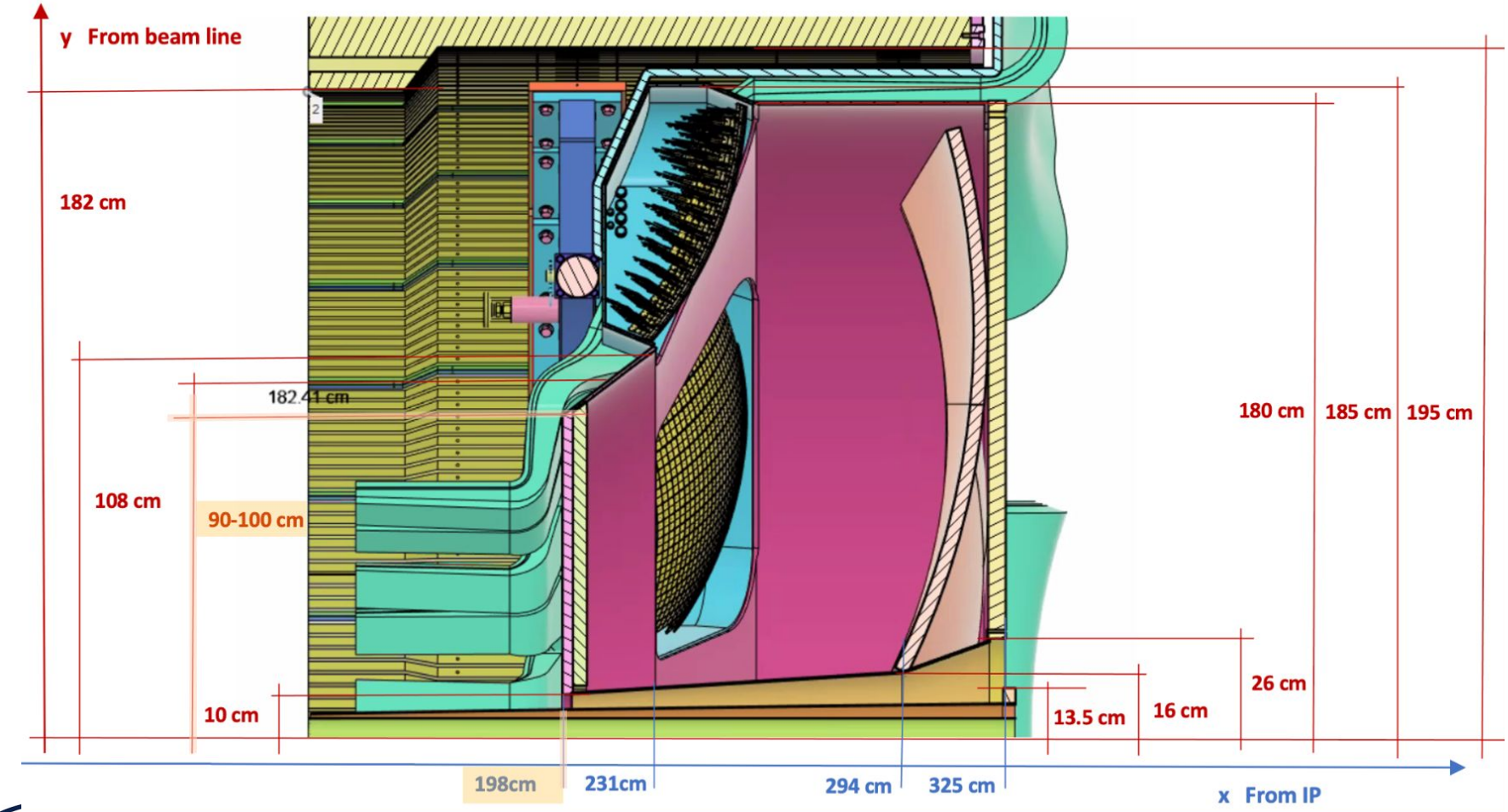
- One interaction tagger system is needed to make the ePIC dRICH sustainable;
- The internal interaction tagger option has the clear advantage of providing a complete detector that is not dependent on the rest of the experiment; moreover it can provide quick additional information like a sort of particle tracking;
- The same Front-End electronic and DAQ chain of the dRICH could be used for the tagger;
- Introducing the internal tagger will affect the dRICH design minimally because it will only require a few centimeters of width in the entrance cap.

Well, this sounds interesting, but:

- A deeper understanding of the background rate spatial distribution and energy spectrum is needed to provide the precise design and the expected performance of the interaction tagger;
- The impact of introducing some SciFi layers needs to be evaluated through the simulation;
- This option must be submitted and approved by the ePIC collaboration before more resources are invested in developing it.

Thank you

Backup slides


y From beam line
182 cm
182.41 cm
108 cm
90-100 cm
10 cm
180 cm
185 cm
195 cm
26 cm
13.5 cm
16 cm
198cm
231cm
294 cm
325 cm
x From IP