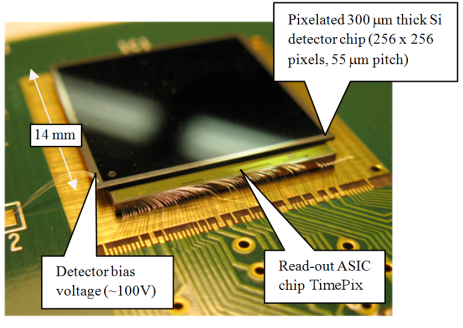
WP2 – Timepix

- A reminder about Timepix

  Timepix is an ASIC – needs a sensor, usually Silicon.

  From the CERN-Medipix collaboration initially medical Imaging

  Current projects with Timepix3
  - Polarimeter for lin pol photons
  - RFPMT for picosecond timing



Timepix3

Next generation: Timepix4
bigger, better, buttable

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Timepix3 vs Timepix4

Timepix4: A 4-side tillable large single threshold particle detector chip with improved energy and time resolution and with high-rate imaging

			Timepix3 (2013)	Timepix4 (2019)	
Technology			130nm – 8 metal	65nm – 10 metal	
Pixel Size			55 x 55 µm	55 x 55 µm	
Pixel arrangement			3-side buttable 256 x 256	4-side buttable 512 x 448	3.5x
Sensitive area			1.98 cm²	6.94 cm²	
Readout Modes	Data driven (Tracking)	Mode	TOT and TOA		
		Event Packet	48-bit	64-bit	33%
		Max rate	0.43x10⁶ hits/mm²/s	**3.58x10⁶ hits/mm²/s**	
		Max Pix rate	1.3 KHz/pixel	**10.8 KHz/pixel**	8x
	Frame based (Imaging)	Mode	PC (10-bit) and iTOT (14-bit)	CRW: PC (8 or 16-bit)	10x
		Frame	Zero-suppressed (with pixel addr)	Full Frame (without pixel addr)	5x
		Max count rate	~0.82 x 10⁹ hits/mm²/s	~5 x 10⁹ hits/mm²/s	8x
TOT energy resolution			< 2KeV	< **1Kev**	
Time resolution			1.56ns	**~200ps**	
Readout bandwidth			≤5.12Gb (8x SLVS@640 Mbps)	**≤163.84 Gbps (16x @10.24 Gbps)**	

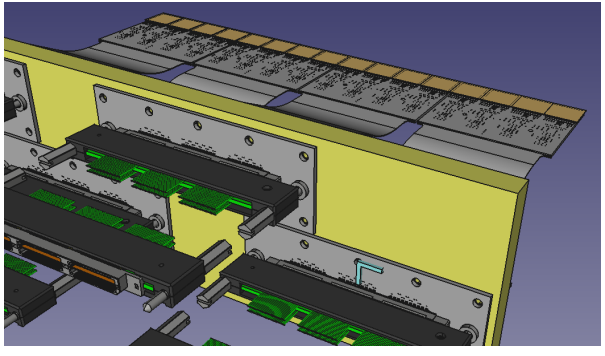
WP2 – Timepix

- Developing Timepix4 as pixel detector for the low-Q^2 electron tagger and other possible uses at EIC.

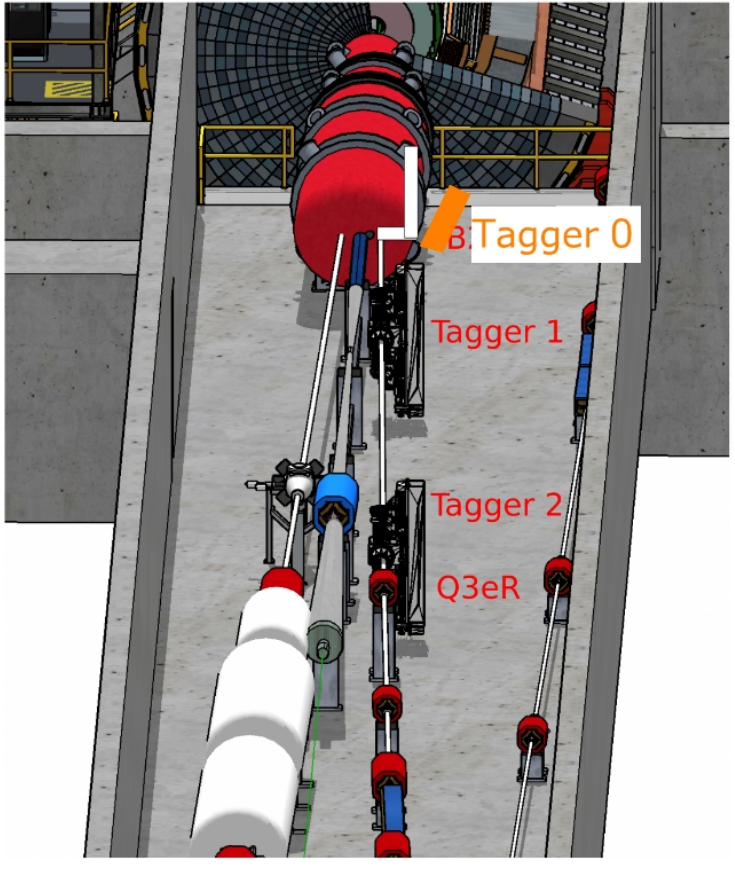
  Tagging of electrons at very low angles; quasi-real photons

  Exploits Glasgow's membership of the CERN-Medipix collab.

  Grows out of PRD for polarimeter devel based on Timepix3

  - Glasgow: Ken Livingston, Dima Maneuski, Simon Gardner
  - Daresbury: Mos Kogimtzis, James Lawson, Carl Unsworth
  - 

CAD design for Timepix3 modular in-vacuum readout (Mos Kogimtzis)

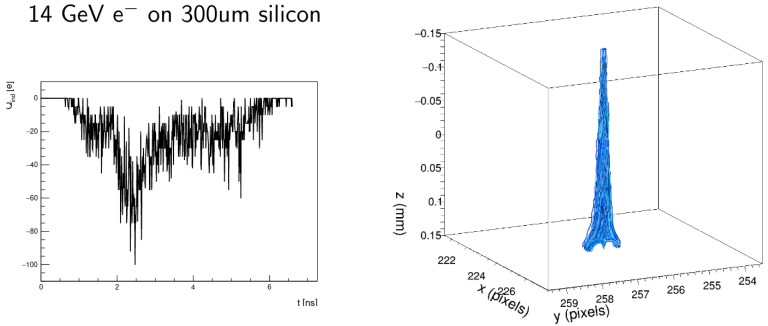


Beam line with far backward detectors (Simon Gardner)

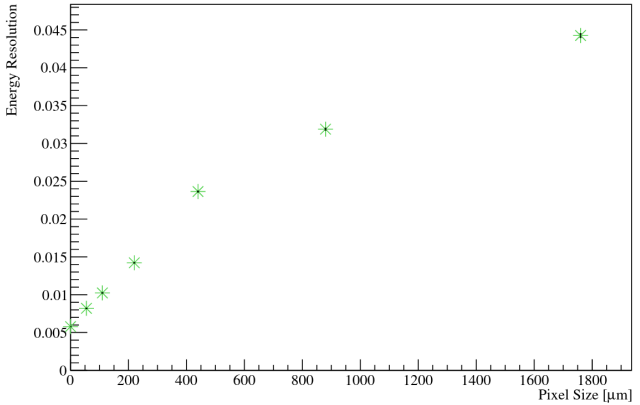
Timepix4 sensors are larger, faster and 4-side buttable: High rate capability (3.5 x 10^6 hits/mm^2/s), good position resolution (< 55 μm) and good timing resolution (~ 0.1 ns)

WP2.1 – Timepix: Low Q2 Tagging simulations

- Far backward detector simulations (Gardner, Glazier)
  - Generic pixel detectors in DD4HEP.
  - Allpix² being added
  - Taggers with 2 tracking layers
  - Machine learning approach using simple ROOT TMVA (DNN) neural network.
- Look at resolutions, rate, BG as function of:
  - No of taggers
  - Separation of layers
  - Position of taggers
  - Pixel size
- Show so far:
  - Calorimeter possibly not needed
  - Advantage to smaller pixel size
  - In vacuum, close to int. point is potentially best



Charge collection in timepix with Allpix² (Simon Gardner)

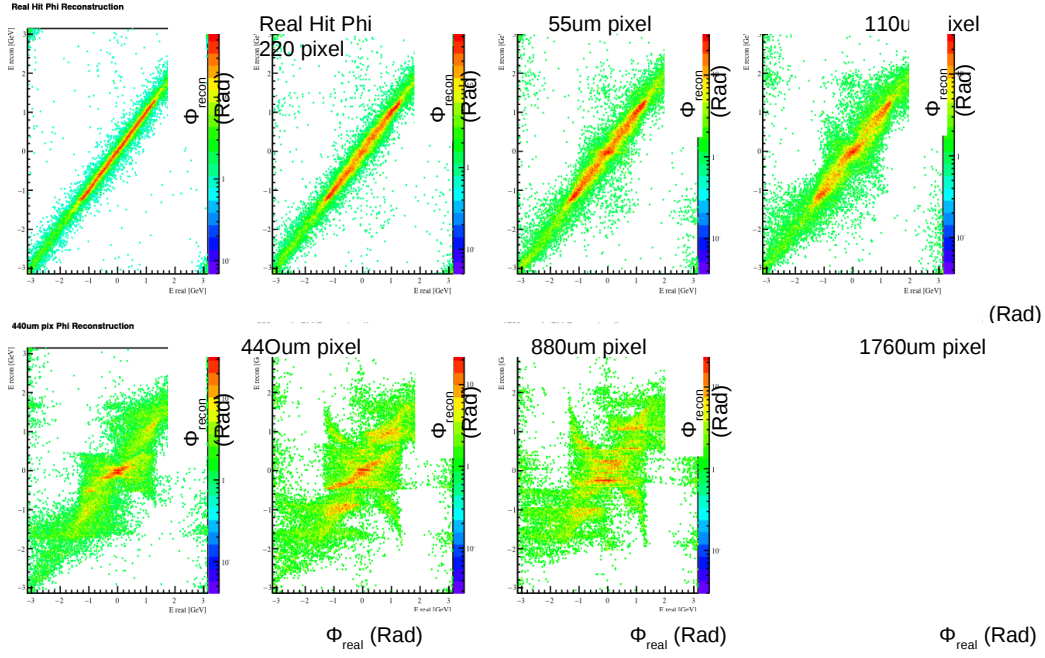


Energy resolution as a function of pixel size (Simon Gardner)

WP2.1 – Timepix: Low Q2 Tagging simulations

Phi Resolution - Tagger 2 - 18GeV

Cut Q^2 >-4



- Realistic simulations in progress
  - In-vacuum, out of vacuum and hybrid.
  - Resolutions. Calorimiter. Practicality.

Advert

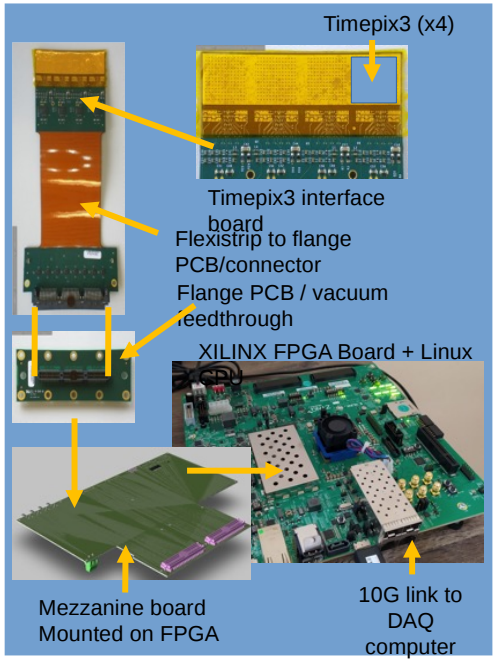
https://indico.bnl.gov/event/14792/

Workshop: CFNS Stony Brook. 15-19 August 2022
Contact: Derek Glazier
Exotic heavy meson spectroscopy and structure with EIC
…. a main user of the low Q2 tagger.
*The workshop will be conducted as an **in-person** meeting at CFNS Stony Brook and intends to make maximal use of this opportunity. Particular emphasis will be placed on enabling **group discussions and informal personal interactions.** Accommodations will be made for remote presentations and participation in organized discussions.*

WP2.2 – Timepix: Readout and DAQ

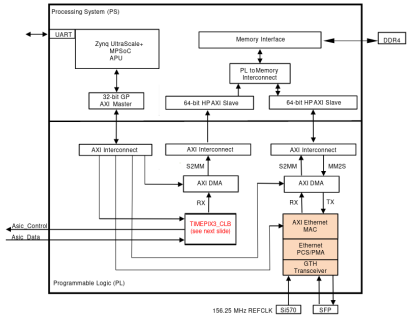
Hardware (Ken Livingston, Mos Kogimtzis, James Lawson)

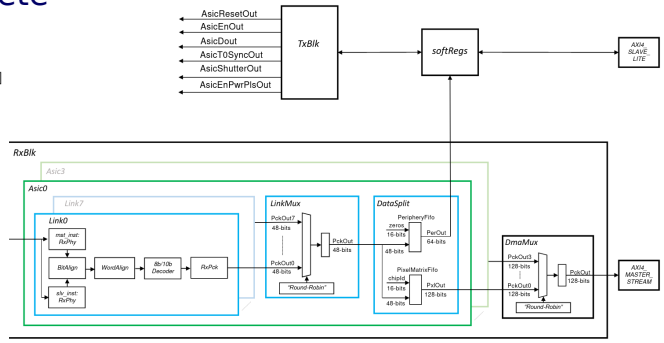
- Main components designed and test versions made
- ASCI bonded on interface board (no silicon sensor)
- Issues with component availability – mezzanine redesign underway



FPGA (Mos Kogimtzis)

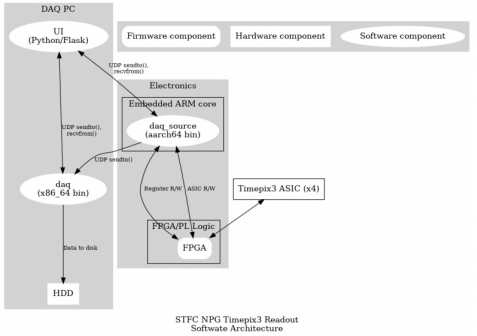
- Designed, 50% complete





- Software (Carl Unsworth)

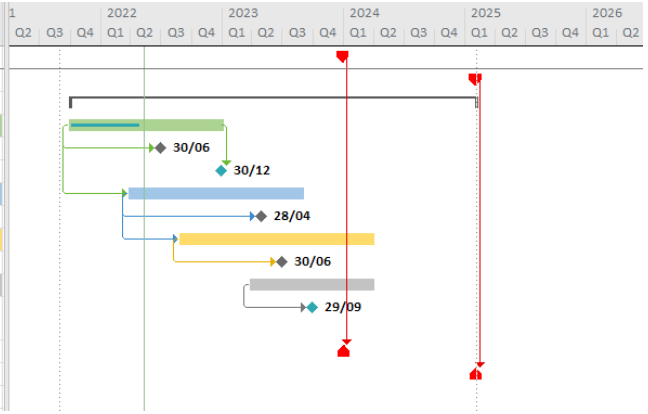
- Modular design complete (python / flask based interface)
- Testing with simulated data beginning in July 2022



Project Schedule & Milestones

- WP2 Schedule & Milestones

Mile	Deliv	Task Name	Duration	Start	Finish
		EIC- Critical Decision 2 (CD2)	1 day	Fri 29/12/23	Fri 29/12/23
		EIC - Critical Decision 3 (CD3)	1 day	Fri 31/01/25	Fri 31/01/25
		WP2	**872 days**	**Fri 01/10/21**	**Mon 03/02/25**
		2.1 Simulation	326 days	Fri 01/10/21	Fri 30/12/22
M2.1		low-Q2 tagging demonstration	0 days	Thu 30/06/22	Thu 30/06/22
	D2.1	NIM paper submission	0 days	Fri 30/12/22	Fri 30/12/22
		2.2 Timepix3 board, Readout, DAQ	369 days	Fri 01/04/22	Wed 30/08/23
M2.2		Readout of Timepix3 with new e-DAQ	0 days	Fri 28/04/23	Fri 28/04/23
		2.3 Prototype construction and Test	412 days	Thu 01/09/22	Fri 29/03/24
M2.3		Completion and testing of prototype	0 days	Fri 30/06/23	Fri 30/06/23
		2.4 Timepix4 design and cost	261 days	Sat 01/04/23	Fri 29/03/24
	D2.2	Design and costing for Timepix4 detector modules	0 days	Fri 29/09/23	Fri 29/09/23
		EIC- Critical Decision 2 (CD2)	1 day	Mon 01/01/24	Mon 01/01/24
		EIC - Critical Decision 3 (CD3)	1 day	Mon 03/02/25	Mon 03/02/25



Milestones (including Deliverables) Table										
No.	Work Package	Description	Baseline Date	Target		Completion Date	Status	Delay due to		Affects Critical Path?	See Note
				Date	Change			UK	Other		
M2.1	WP2	Demonstrate benefit of pixel detectors for low-Q2 tagger	Jun-22	Jun-22	↔		On track				
D2.1	WP2	Submission of NIM paper on tagging of low-Q2 events	Dec-22	Dec-22	↔		On track				
M2.2	WP2	Readout of Timepix3 with new electronics / DAQ	Apr-23	Apr-23	↔		On track				
M2.3	WP2	Detector prototype ready for testing	Jun-23	Jun-23	↔		On track				
D2.2	WP2	Preliminary design, performance and costing of Timepix4 detector modules	Sep-23	Sep-23	↔		On track				