Live ... High Energy Physics

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18th ...

23rd to 25...

WELCOME

Brief Introduction to Liverpool Particle Physics Activities

In the most recent UK Particle Physics Grants Panel award to Liverpool we are 3rd in size out of 17 University groups in HEP (behind Oxford and IC).

The recent deliverables include significant instrumentation provision to ATLAS (EndCap-C), LHCb (VeLo) and T2K (ND280) based on the facilities of workshop and Liverpool Semiconductor Detector Centre, LSDC, (for which the UK Science and Technology Facilities Council, STFC, provides nearly all the external support).

We currently have VeLo replacement (nearing completion) and Maintenance and Operation commitments plus design and prototyping of next generation detectors.

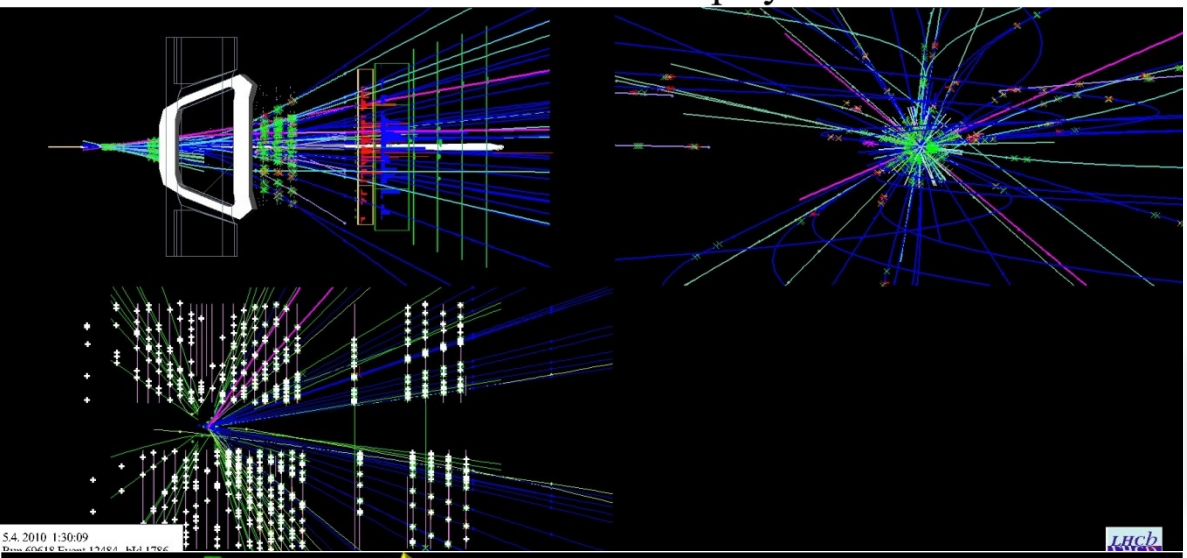
The LHC experiments are delivering high quality data and the group has developed analysis emphasis on electro-weak, Higgs and SUSY (ATLAS), electro-weak and b-physics (LHCb) and θ_{13} (T2K) with respectable showing on physics presentations at international conferences (eg ICHEP 2010) and within the collaborations.

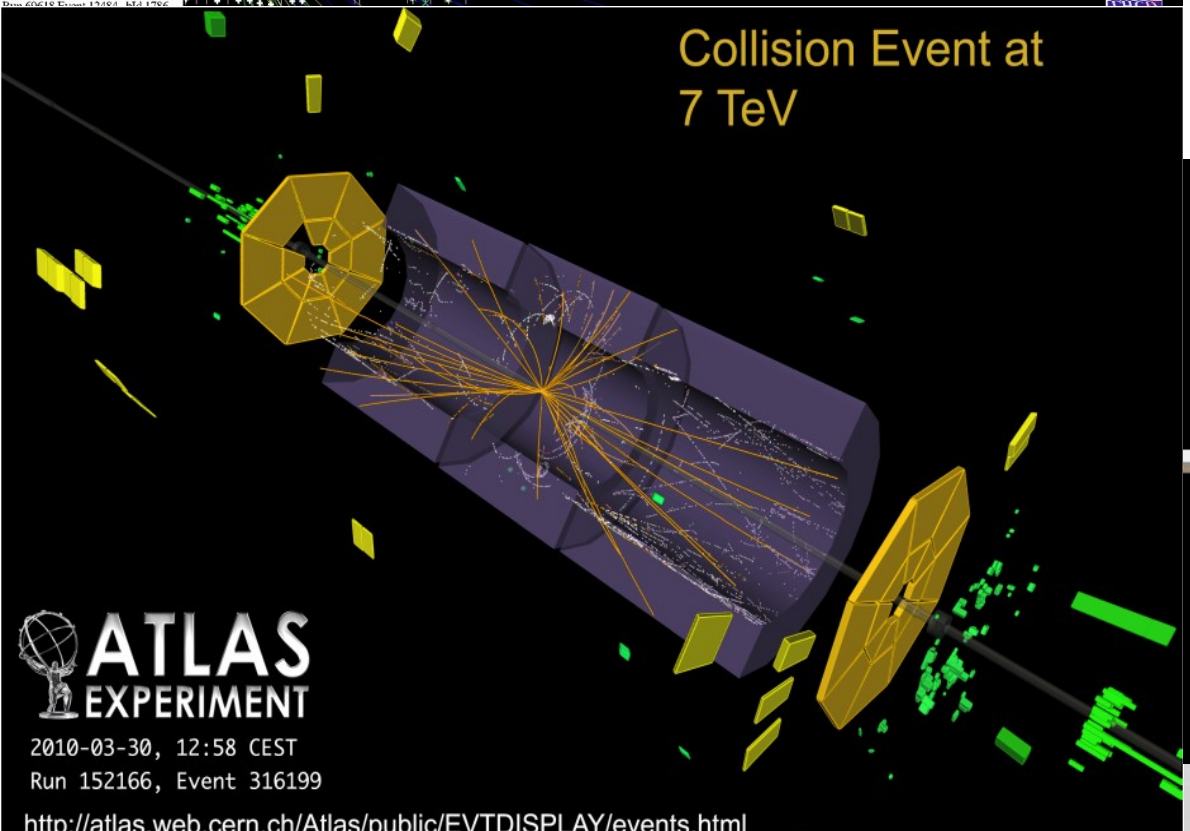
Towards the future, our work on radiation-hard silicon detectors underpins our roles in ATLAS tracker (including new activites on pixels) and LHCb VeLo upgrade R&D and we have developed a new liquid Argon detector based capability. We have joined the NA62 collaboration. We are prominent in the LHeC proposal for electron-proton collisions at the LHC.

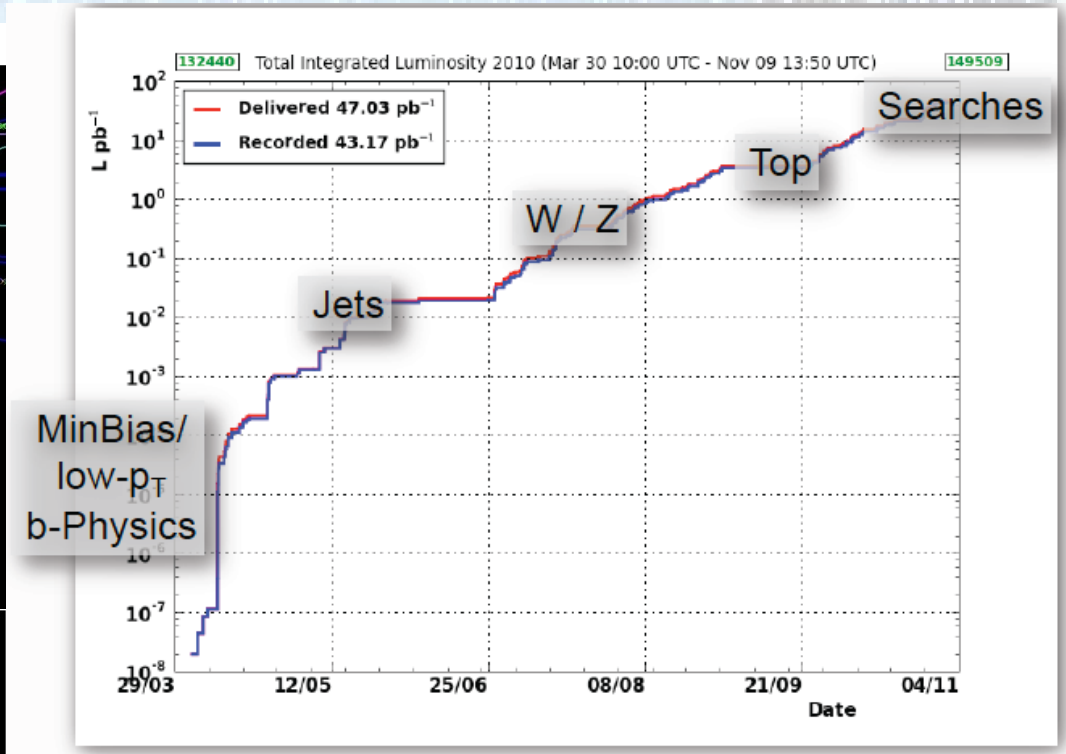
Other activities include CTA (high-energy astrophysics), terrestrial dark matter searches, medical, nuclear industry, security applications and outreach.

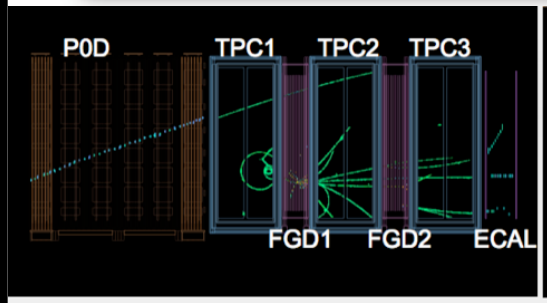
LHCb VeLo, ATLAS EndCap-C and T2K ND280

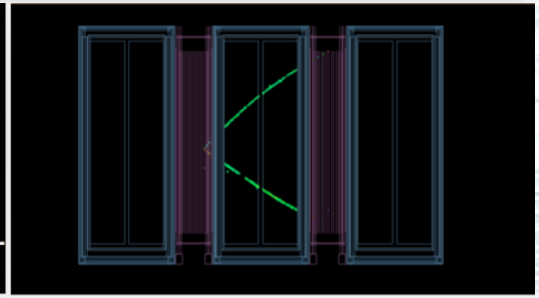
LHCb Event Display

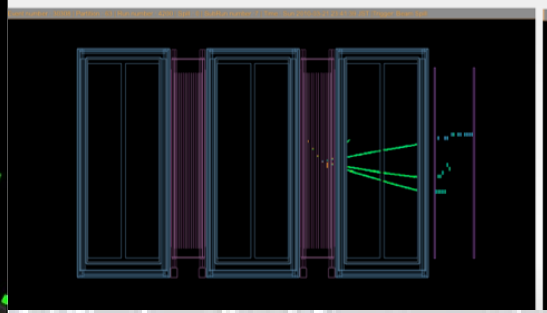


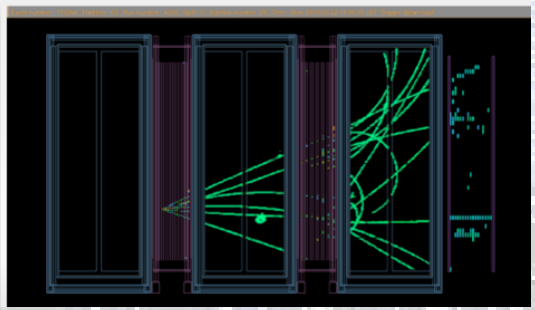












T2K ND280 ECAL Installation at JPARC (Tokai)

>2020 LHC Upgrade: Luminosity

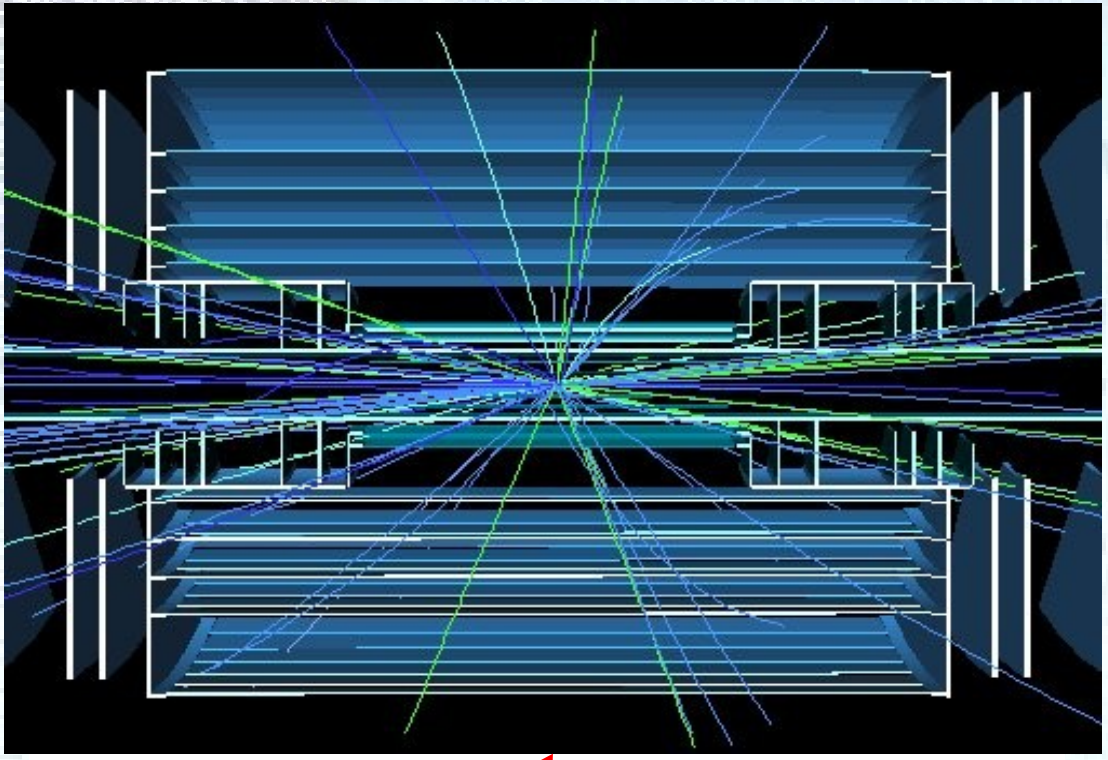
New Studies on schedule were launched more than one year ago

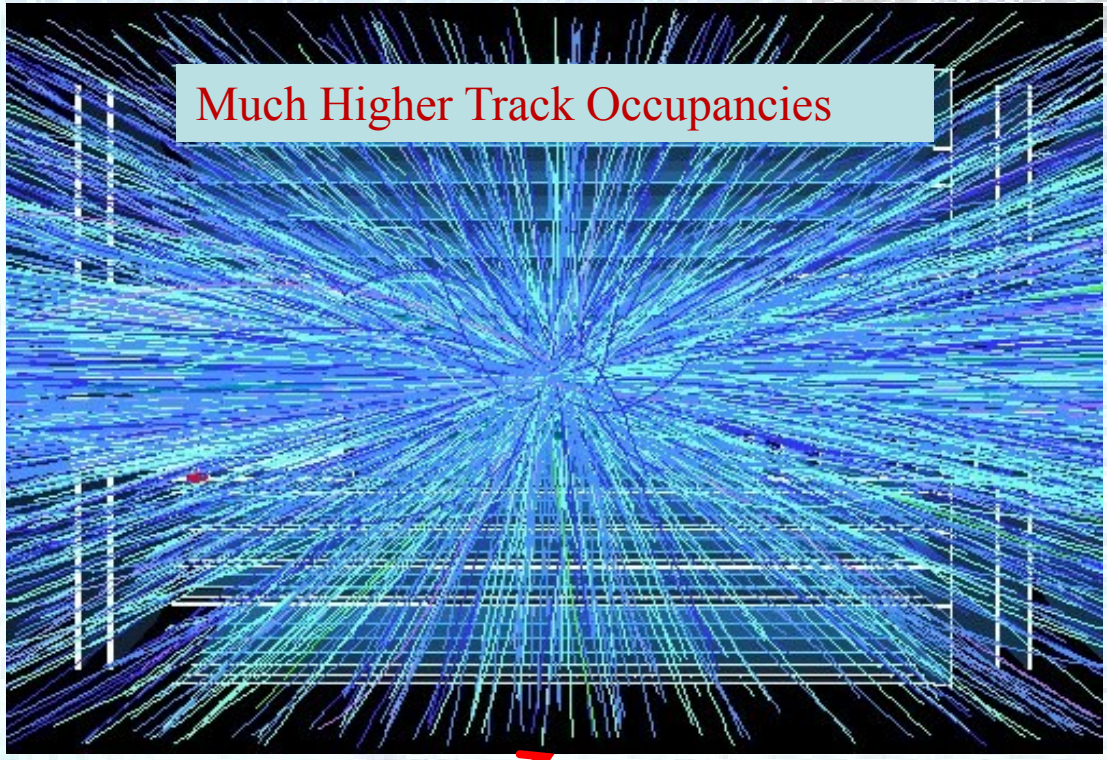
- Performance Aim
  - To maximize the useful integrated luminosity over the lifetime of the LHC
- Targets set by the detectors are:
  3000fb^{-1} (on tape) by the end of the life of the LHC
  → 250-300fb^{-1} per year in the second decade of running the LHC
  (requires new ATLAS tracker with~160m^2 of rad-hard silicon)

Beyond 2030 LHC Upgrade: Energy

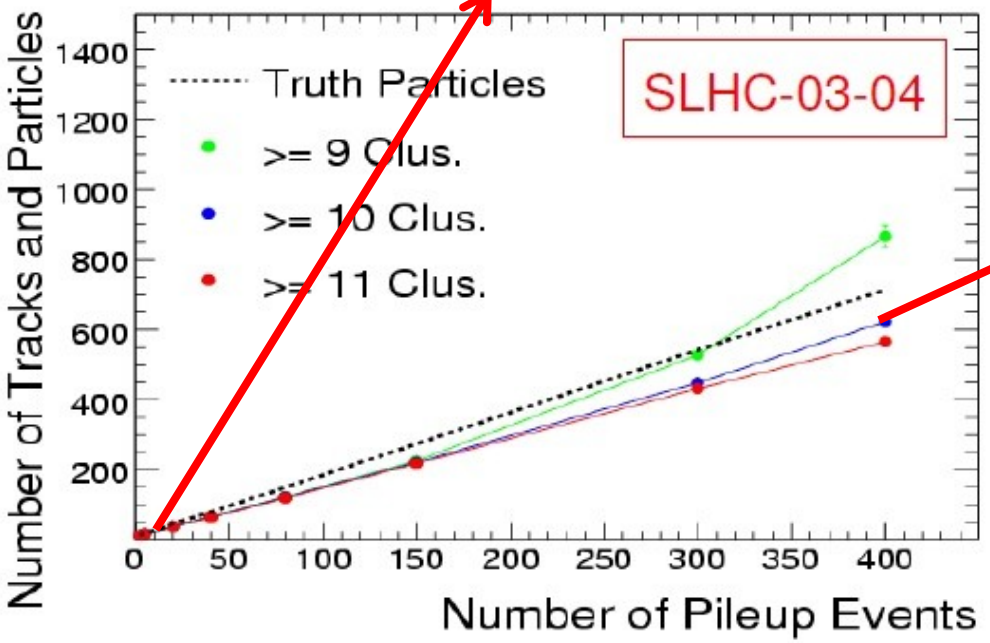
	nominal LHC	HE-LHC
beam energy [TeV]	7	16.5
dipole field [T]	8.33	20
dipole coil aperture [mm]	56	40-45
#bunches / beam	2808	1404
bunch population [10^{11}]	1.15	1.29
initial transverse normalized emittance [μm]	3.75	3.75 (x), 1.84 (y)
number of IPs contributing to tune shift	3	2

All-Silicon Tracker for LHC Luminosity Upgrade





Much Higher Track Occupancies



Much Higher Radiation Doses

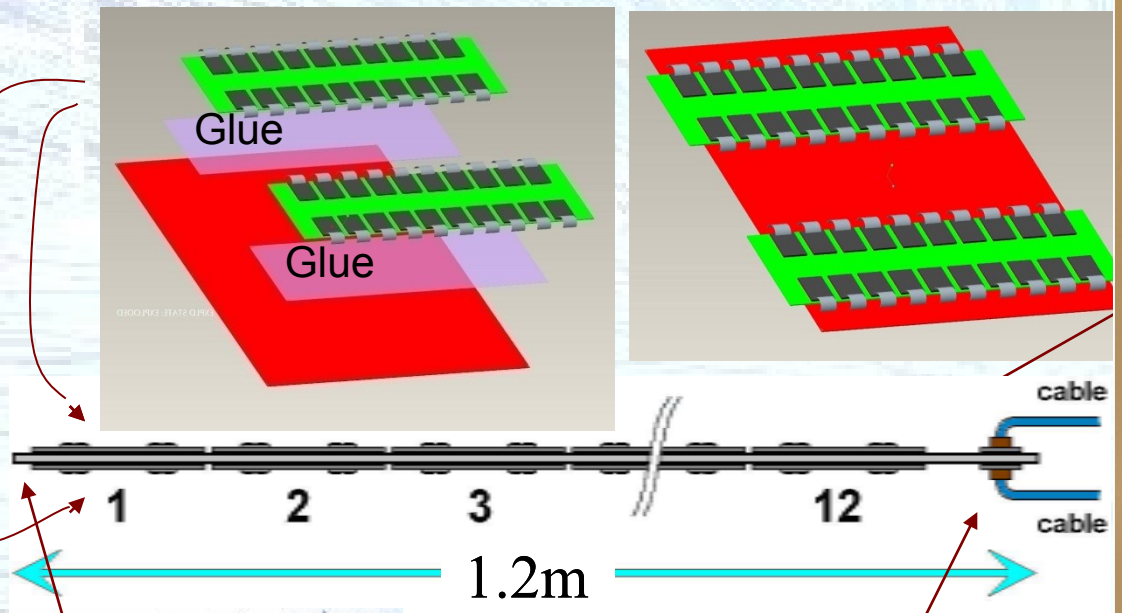
At inner pixel radii - target survival to 1-2×10^{16} n_{eq}/cm^2

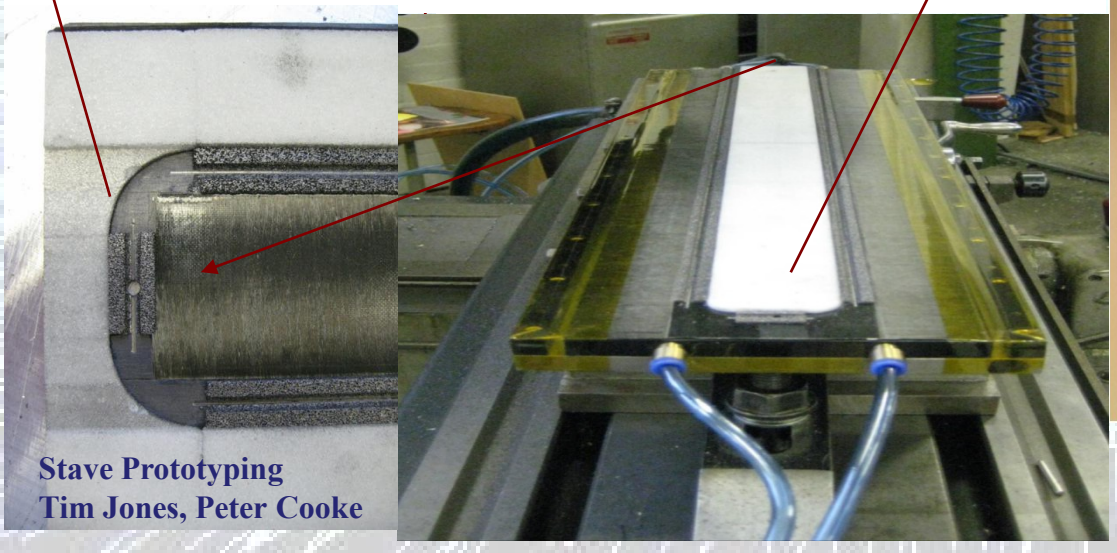
Numbers obtained 9/10/09 (corresponding to new layout) assuming 3000fb-1 and 84.5mb

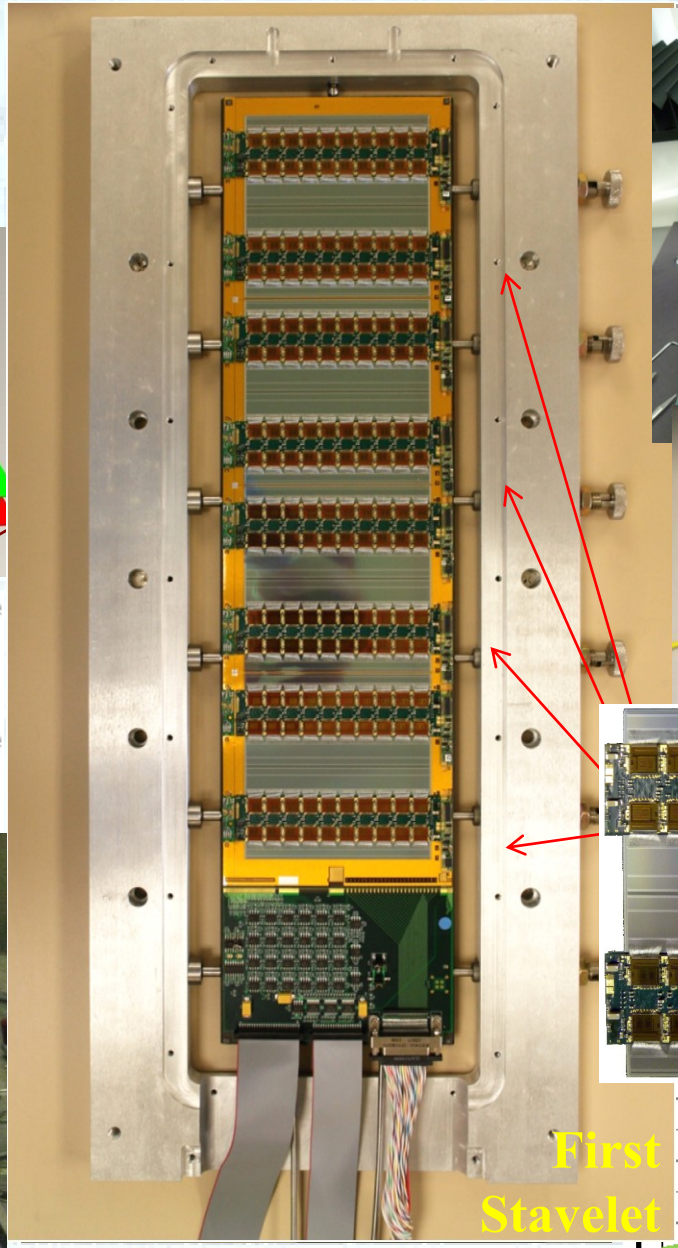
Strip barrel 1 (SS)	(r=38cm; z=0cm)	4.4x10^14
	(r=38cm; z=117cm)	4.9x10^14
Strip barrel 4 (LS)	(r=74.3cm; z=0.0cm)	1.6x10^14
	(r=74.3cm; z=117cm)	1.8x10^14
Strip Disc 1 (z=137.1, Rinner=33.6)		6.0x10^14
Strip Disc 2 (z=147.6, Rinner=33.6)		6.2x10^14
Strip Disc 3 (z=174.4, Rinner=33.6)		5.8x10^14
Strip Disc 4 (z=214.1, Rinner=33.6)		6.1x10^14
Strip Disc 5 (z=279.1, Rinner=44.4)		5.8x10^14
Strip Disc 5 (z=279.1, Rinner=54.1)		4.4x10^14
Strip Disc 5 (z=279.1, Rinner=61.7) new		3.9x10^14
Strip Disc 5 (z=279.1, Rinner=73.6)		3.0x10^14
Strip Disc 5 (z=279.1, Rinner=84.9)		2.7x10^14

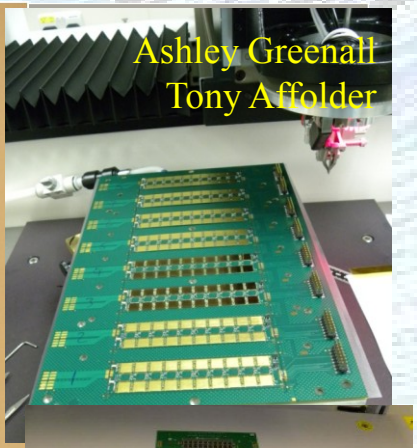
For strips 3000fb^{-1} ×2 implies survival required up to ~1.3×10^{15} n_{eq}/cm^2

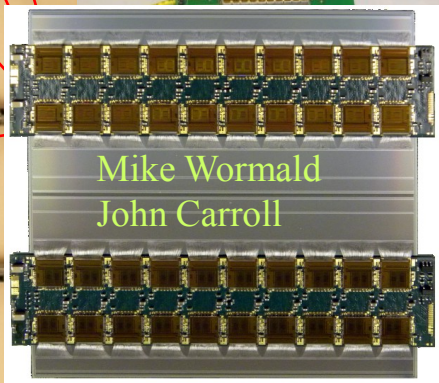
ATLAS Tracker Upgrade: Hybrids glued to Sensors glued to Bus Tape glued to Cooling Substrate

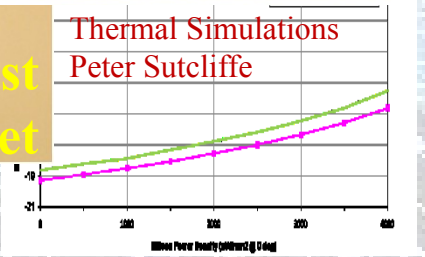




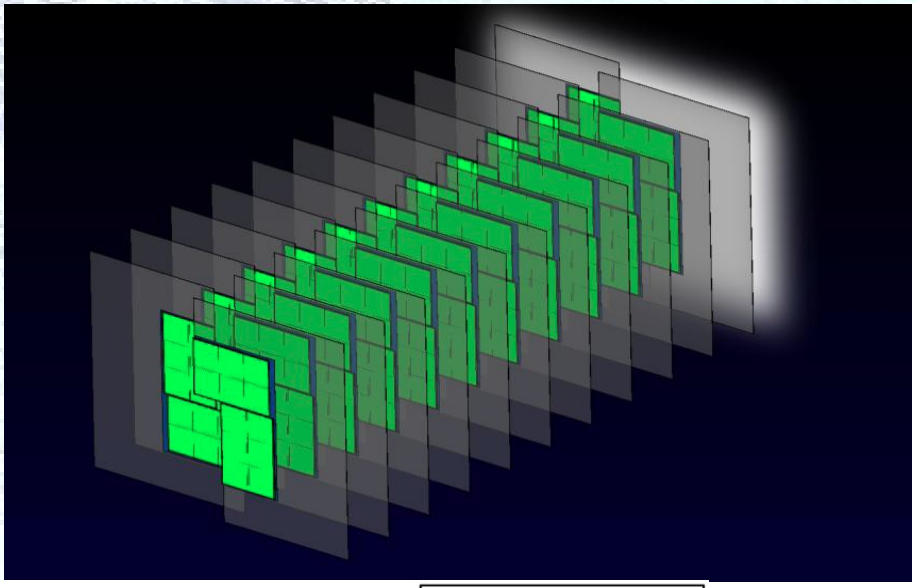




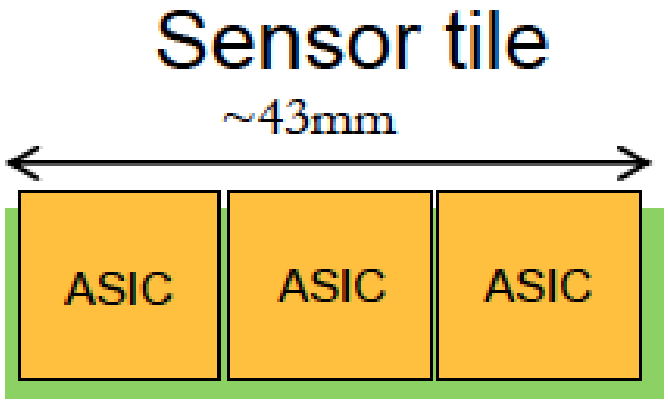


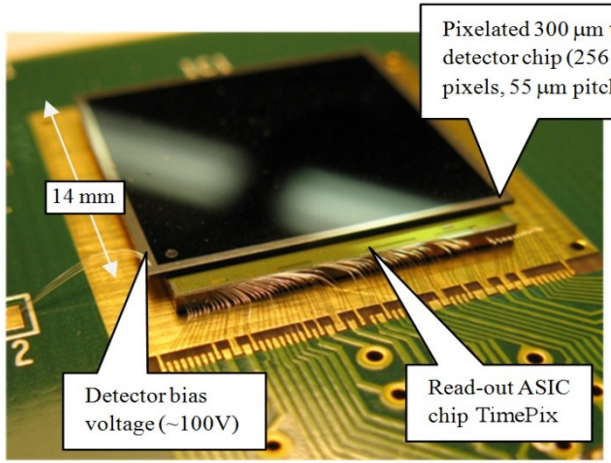


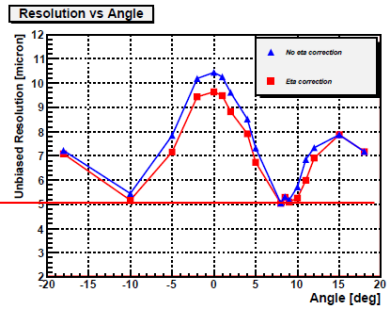
LHCb VELO PIXEL Upgrade



ASIC IS AN ARRAY OF 256X256 SQUARE PIXELS (55 μm X 55 μm)







Target ≥ 5μm resolution

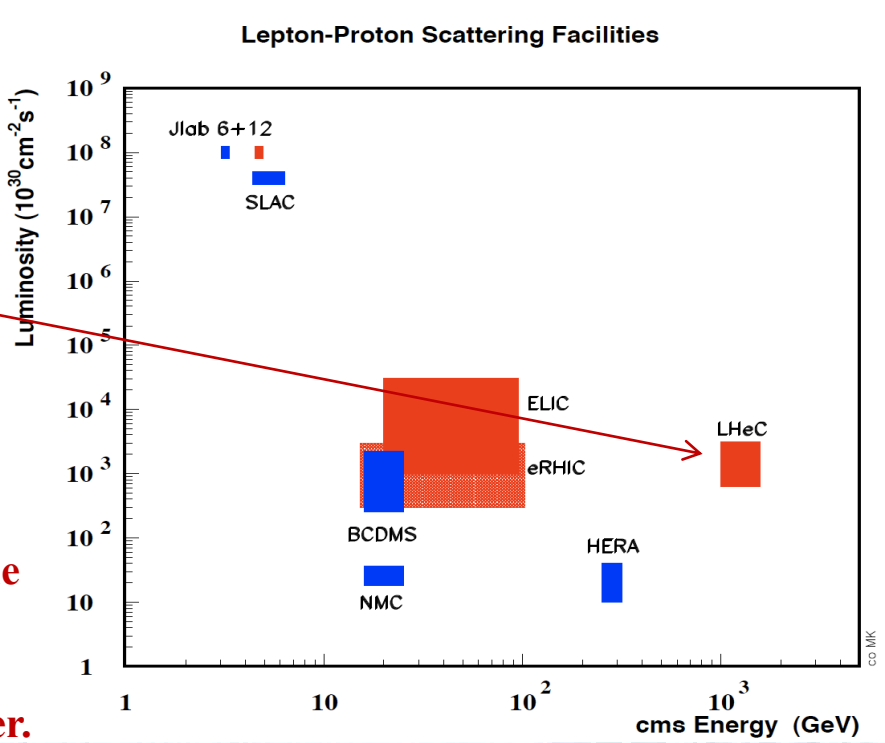
VELOPIX development of TIMEPIX2 from MEDIPIX collaboration with clustering of sparsified information, data formatting, buffering, and multi-Gbit output links for 40 MHz operation

Also involving Liverpool HEP at CERN

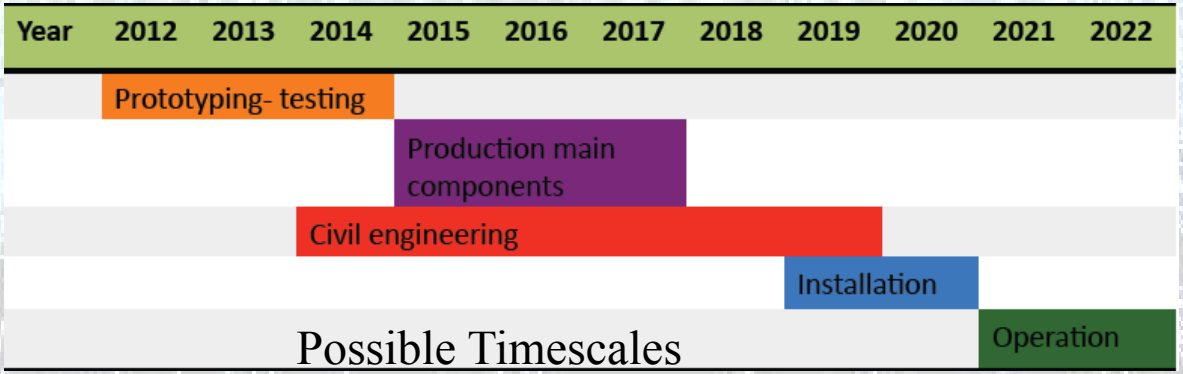
NA62 CEDAR project and ultra-rare kaon decay measurements

Utilising LHC protons for massively extending the HERA electron-proton kinematic reach (LHeC)

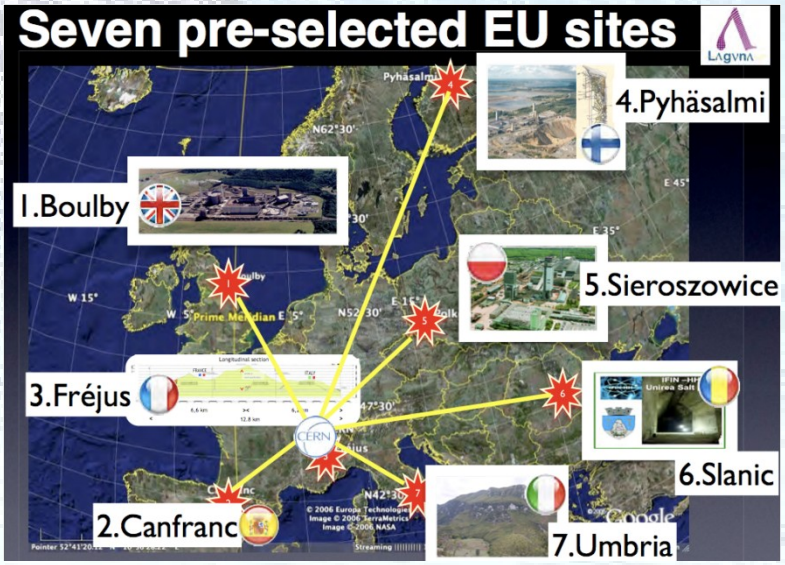
Opens new precision measurement possibilities with additional 60GeV electron beam (ring/linac)

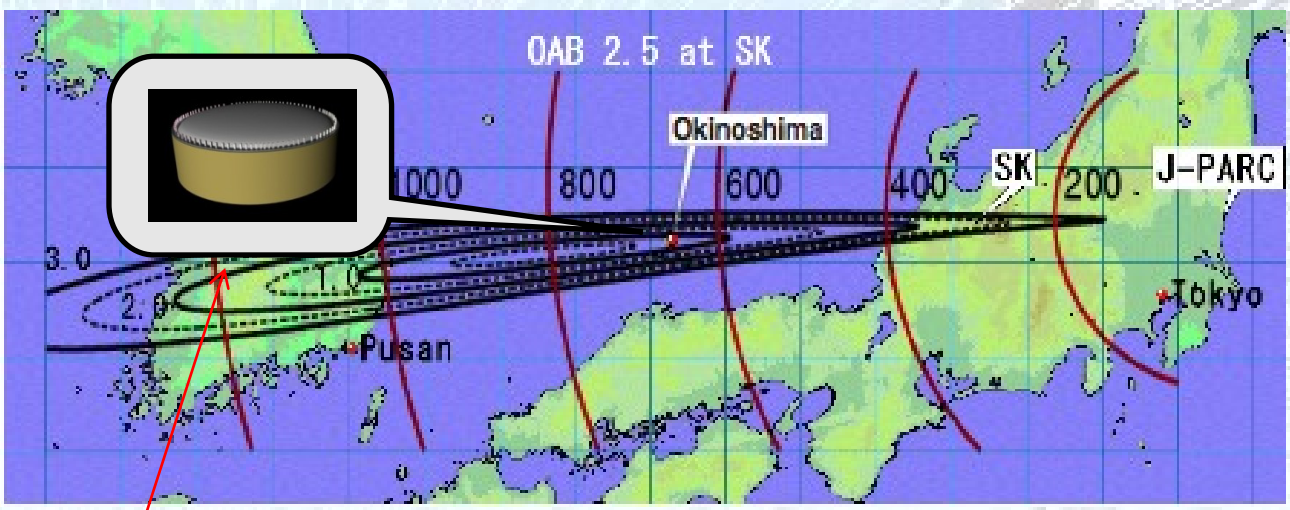


Max Klein is Chair of the International Steering Group on the Large Hadron Electron Collider.

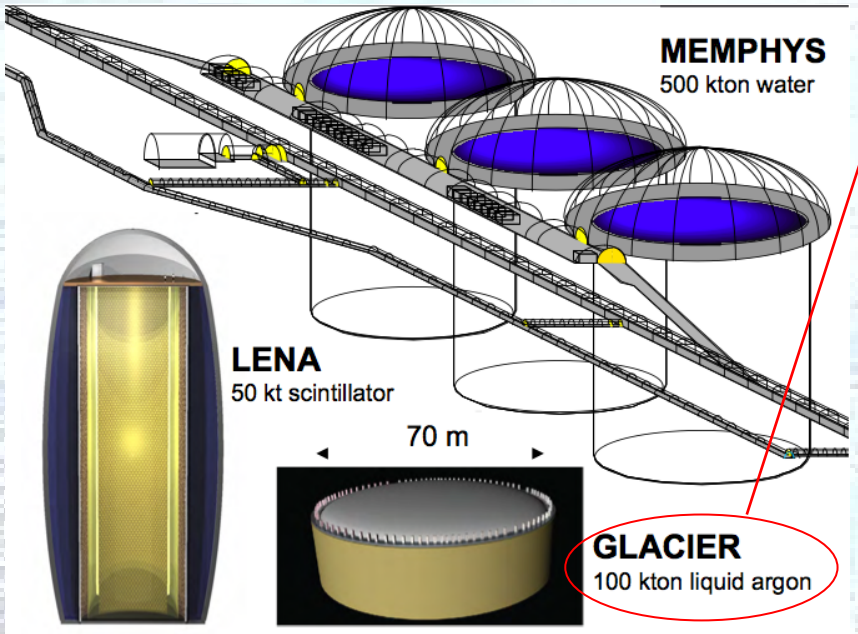


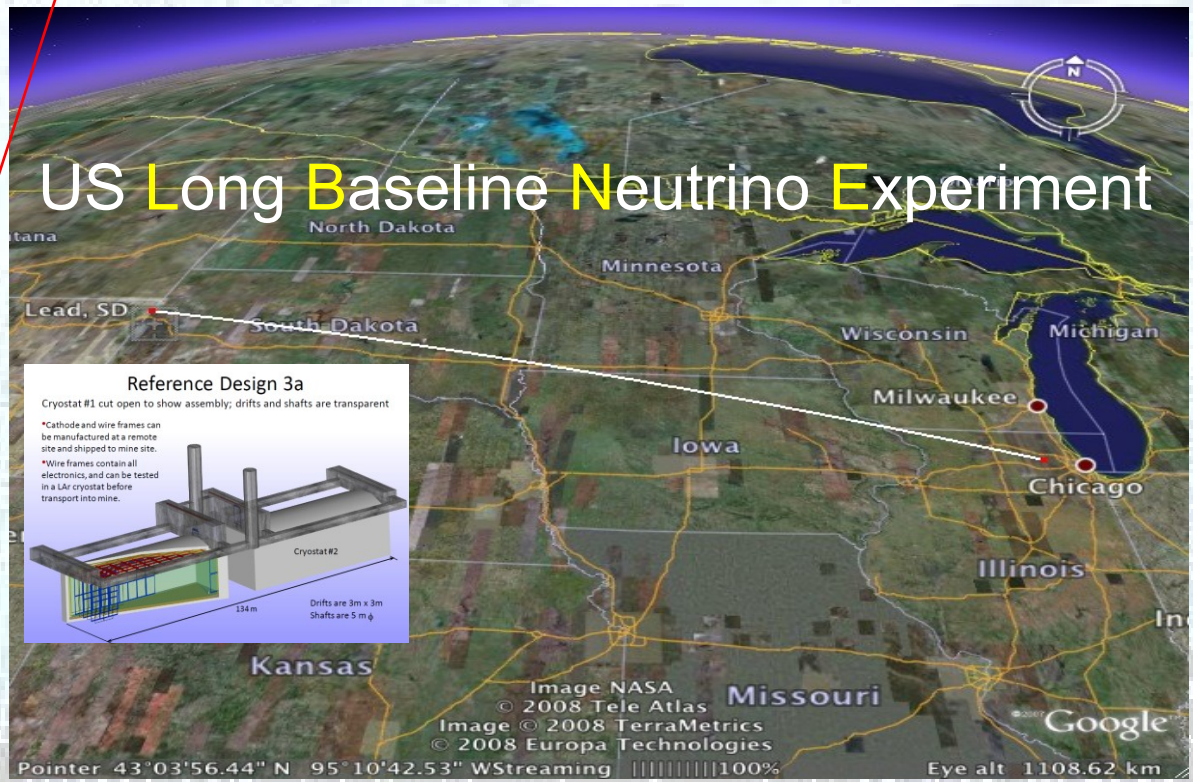
Next Generation Neutrino Physics





LAGUNA

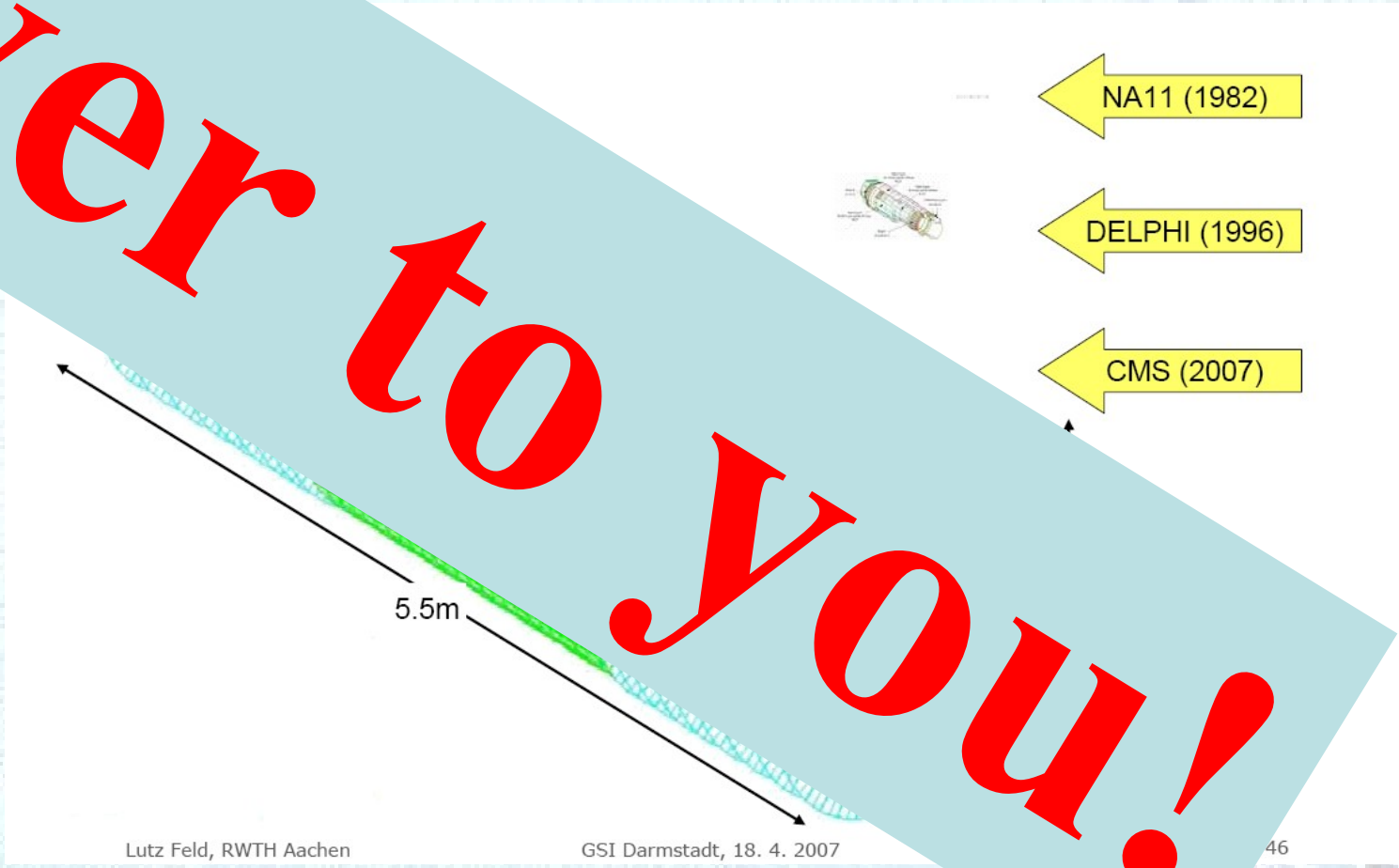




Liverpool prototyping LAr based detectors both at CERN and in the LSDC

Conclusions

- At the tir n LHC Workshop (http://cerncourier.com/cws/article/cern/35866) in 1990 t w the radiation levels of the LHC could be tolerated given the meas and with reverse annealing just having been observed
- Th mechanics and the sheer scale of the detectors were all
- The cha HL-LHC vert detectors and trac are still fairly daunting with the requirements of achieving another order of magnitude in radiation tolerance and channel density
- In addition, these have to be integrated into existing and potentially radioactive detectors



Over to you!

- The community has shown its ability before to meet such challenges and , and some time to come, the LHC and its upgrades will represent the focus of energy fr er physics