

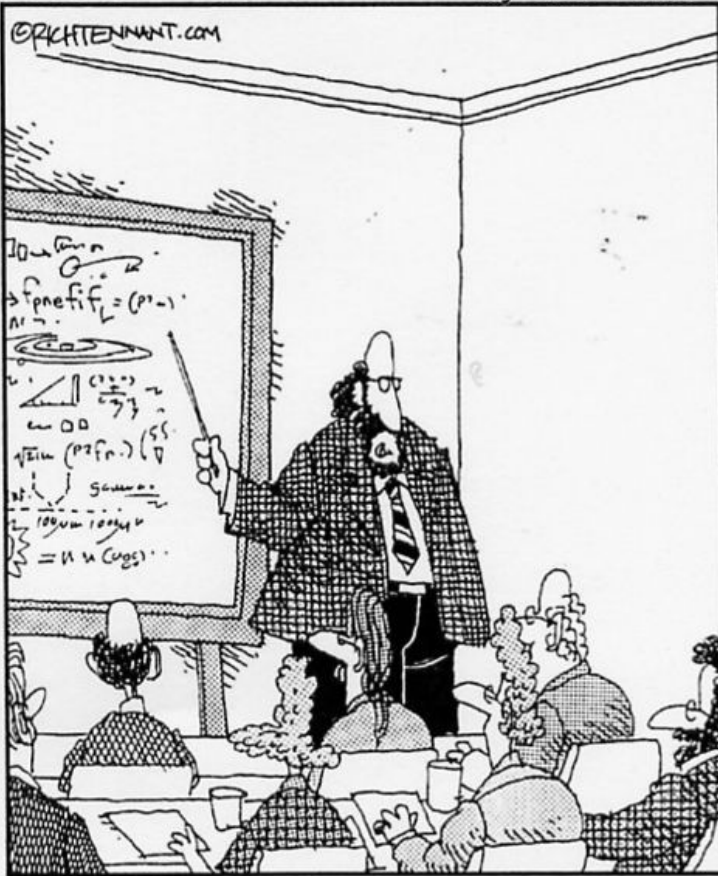
AEGIS

Fast Annihilation

Cryogenic Tracking

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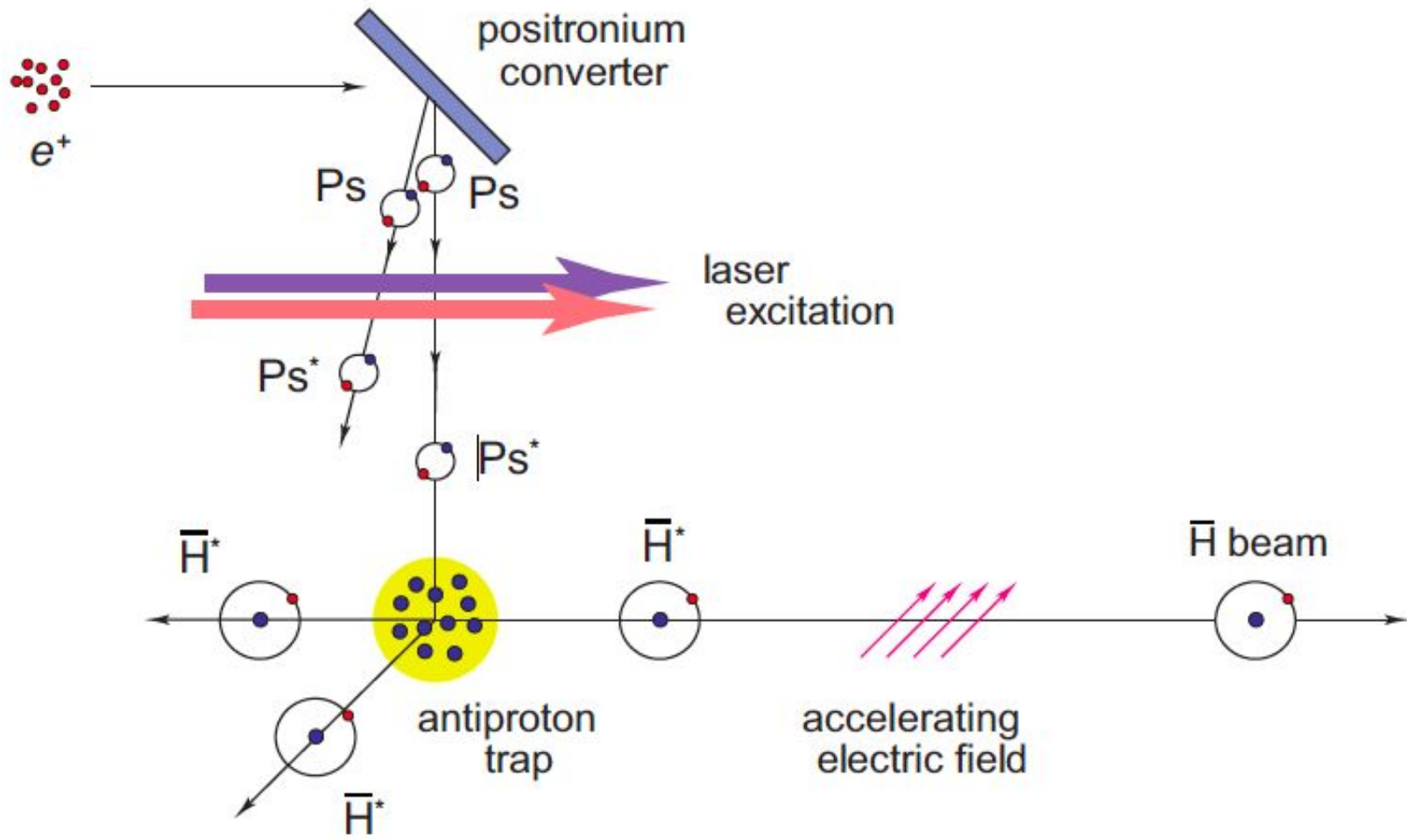
AEGIS

- Antihydrogen Experiment: Gravity, Interferometry, Spectroscopy
- Why does the observable universe appear to contain only ordinary baryonic matter and no sizable amounts of antimatter?

"After the discovery of 'antimatter' and 'dark matter', we have just confirmed the existence of 'doesn't matter', which does not have any influence on the Universe whatsoever."

AEGIS

- performing the first direct measurement of the Earth's gravitational acceleration on antimatter
- So the job divides into:
 - Cooling down antiproton
 - Trapping antiproton
 - Extending positronium's lifetime
 - Mix them to form antihydrogen
 - $\text{Ps}^* + \bar{\text{p}} \longrightarrow \bar{\text{H}}^* + \text{e}^-$



AEGIS

- a pulsed horizontal antihydrogen beam with a velocity of several 100 m/s will be produced.
- The productions of *cold* antiprotons, and in return, *cold* antihydrogen atoms are critical to AEGIS

FACT

- What FACT can do / What we expect from FACT
- The Setup of FACT
- What I have been doing / Where we are now
- What's next

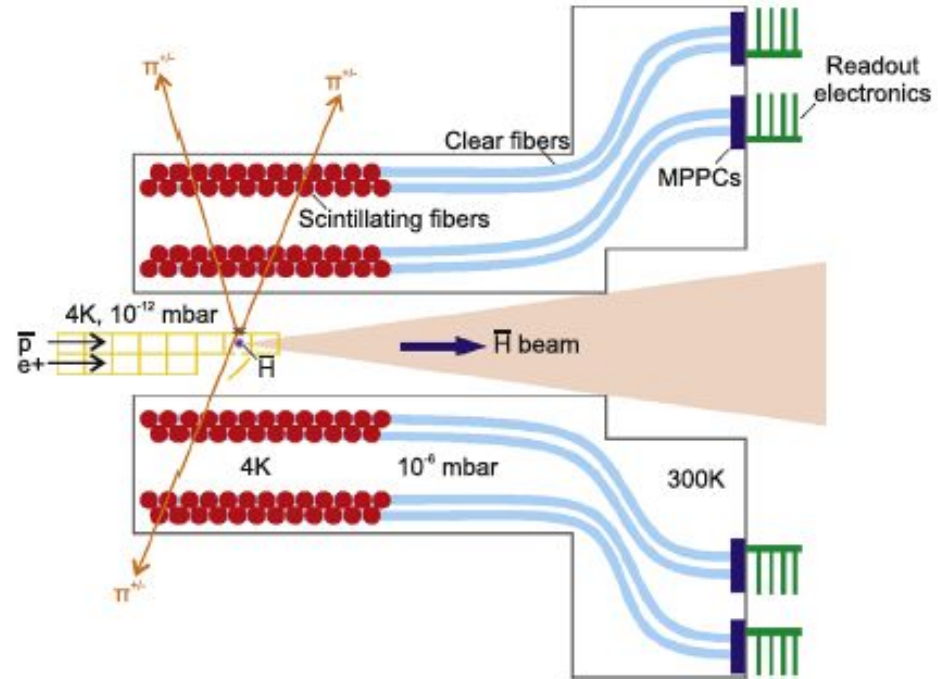
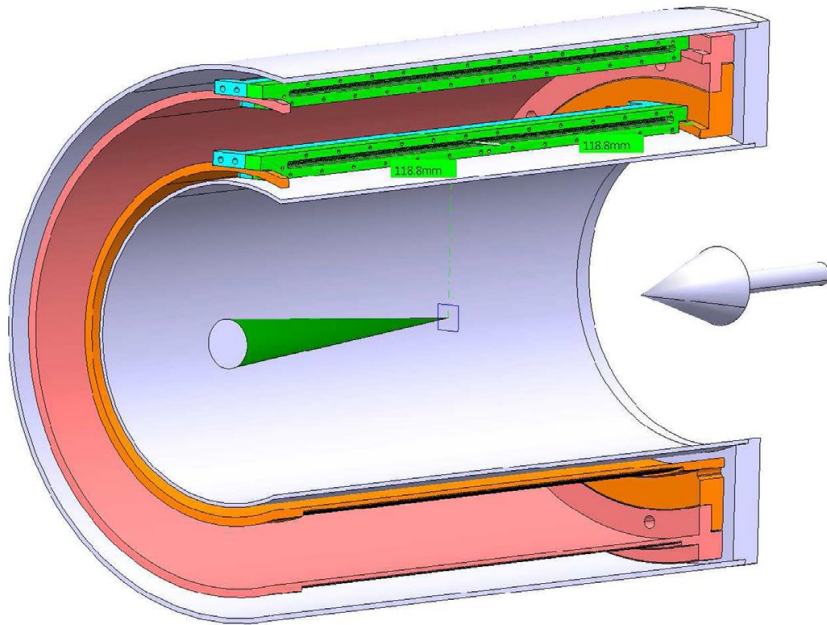
What Fact Can Do

What we expect from FACT

- measure the production and temperature of the antihydrogen atom and
 - identify each of the thousand or so annihilations in the 1ms period of pulsed antihydrogen production
 - operate at 4K inside a 1T solenoidal field
 - not produce more than 10W heat.
-

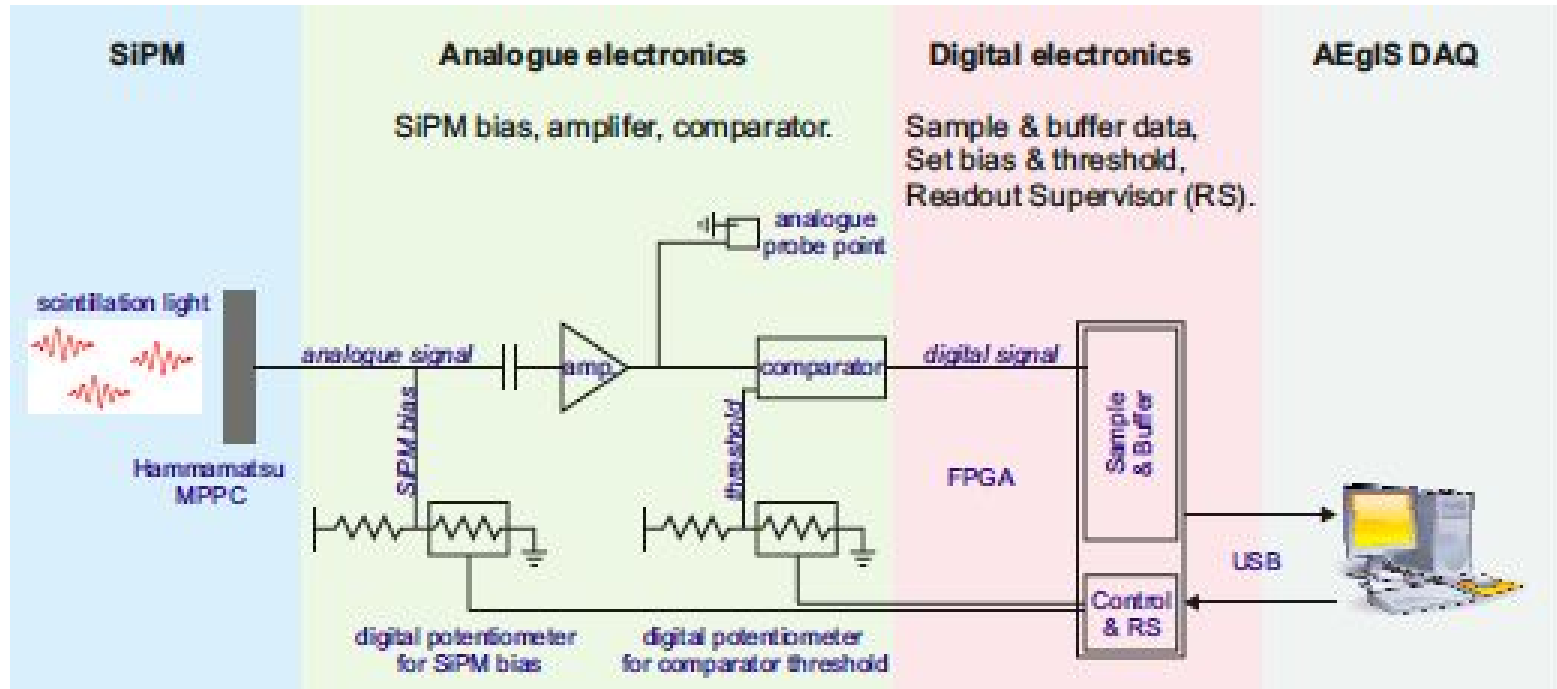
The Setup of FACT

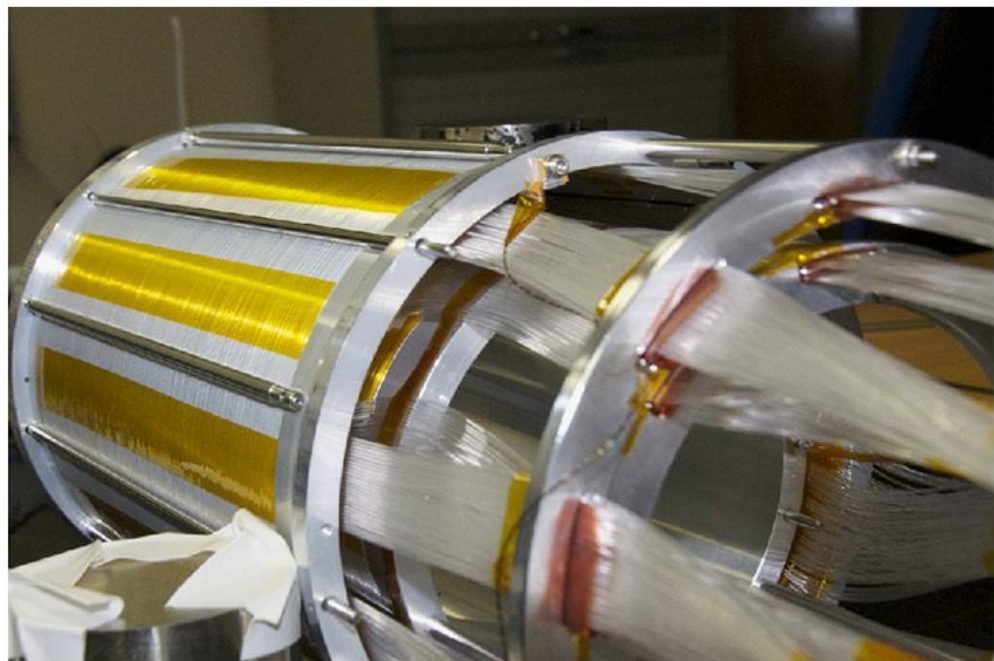
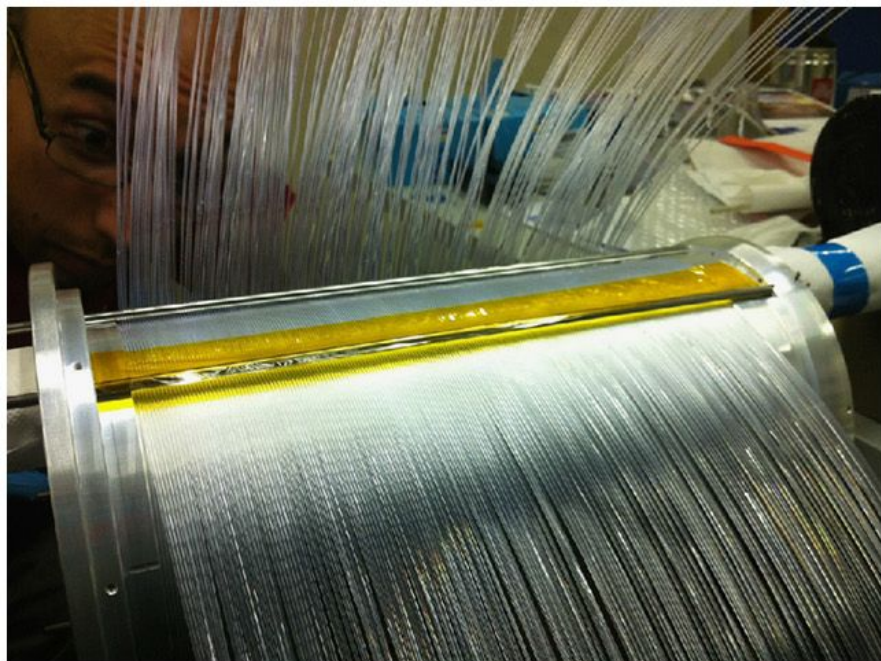
- 800 scintillating fibers (4x200)
- 70mm and 98mm from the beam line
- Each scintillating fiber is connected to a 200m long clear fiber sending signals to the electronics



The Setup of FACT

- 24 both Analog (Voltage) and Digital data readout + 768 only Digital + 8 dummy fibers

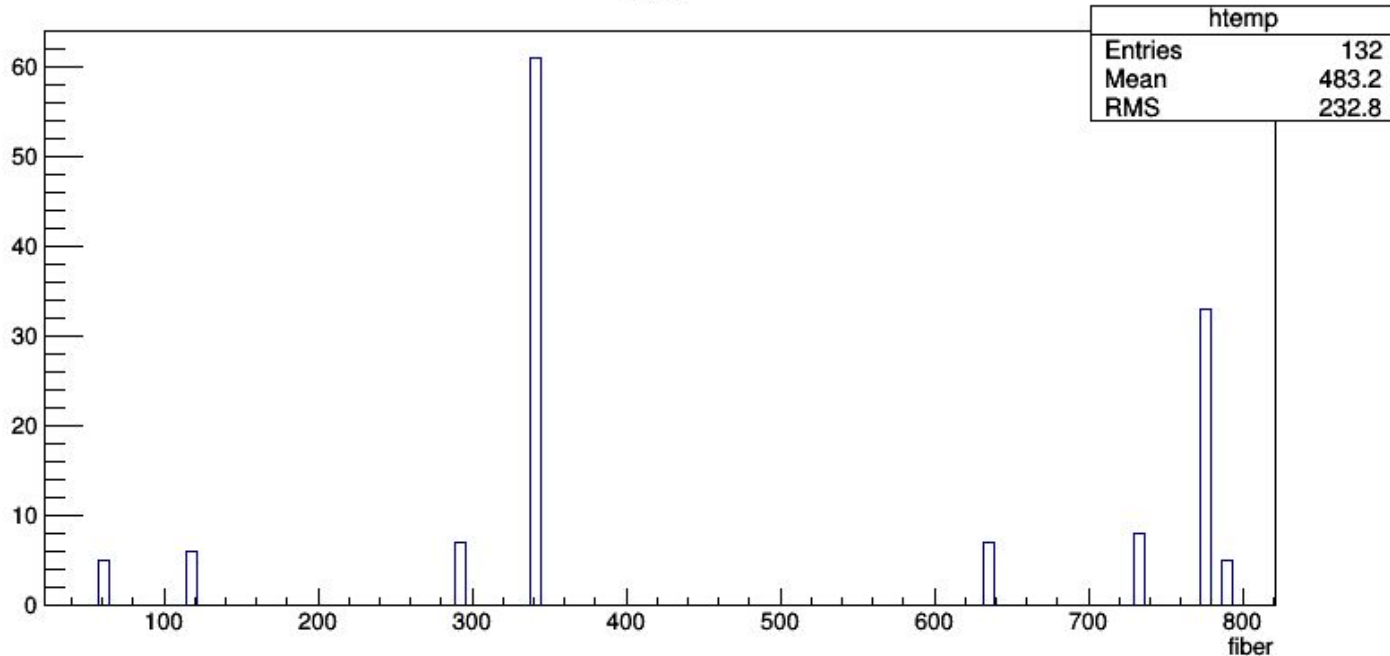




What I have been doing...

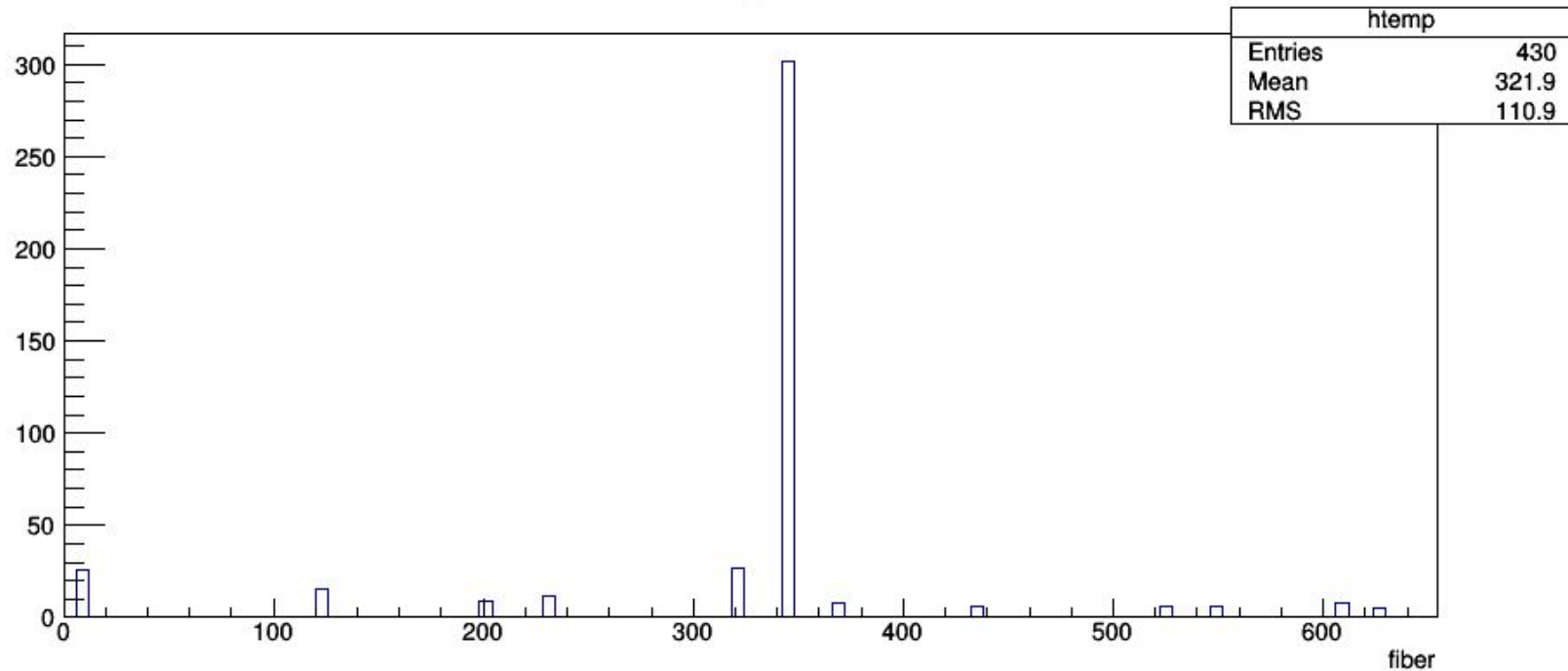
- Build an analysis system for the data coming out from the FACT
 - Transfer raw data into readable data
 - See if any of the fibers are not working (or working too well)

fiber



| | | | | | | |
|---|------|-------|------|------|-------|-----|
| * | 15 * | 342 * | 2 * | 16 * | 580 * | 0 * |
| * | 16 * | 342 * | 2 * | 16 * | 582 * | 0 * |
| * | 17 * | 342 * | 2 * | 16 * | 583 * | 0 * |
| * | 18 * | 342 * | 2 * | 16 * | 584 * | 0 * |
| * | 19 * | 342 * | 2 * | 16 * | 585 * | 0 * |
| * | 20 * | 342 * | 2 * | 16 * | 634 * | 0 * |
| * | 21 * | 342 * | 2 * | 16 * | 635 * | 0 * |
| * | 22 * | 342 * | 2 * | 16 * | 636 * | 0 * |
| * | 23 * | 342 * | 2 * | 16 * | 637 * | 0 * |
| * | 24 * | 634 * | 15 * | 16 * | 638 * | 0 * |
| * | | 634 * | 15 * | 8 * | 639 * | 0 * |
| | | | | 8 * | 718 * | 0 * |
| | | | | 8 * | 719 * | 0 * |

fiber



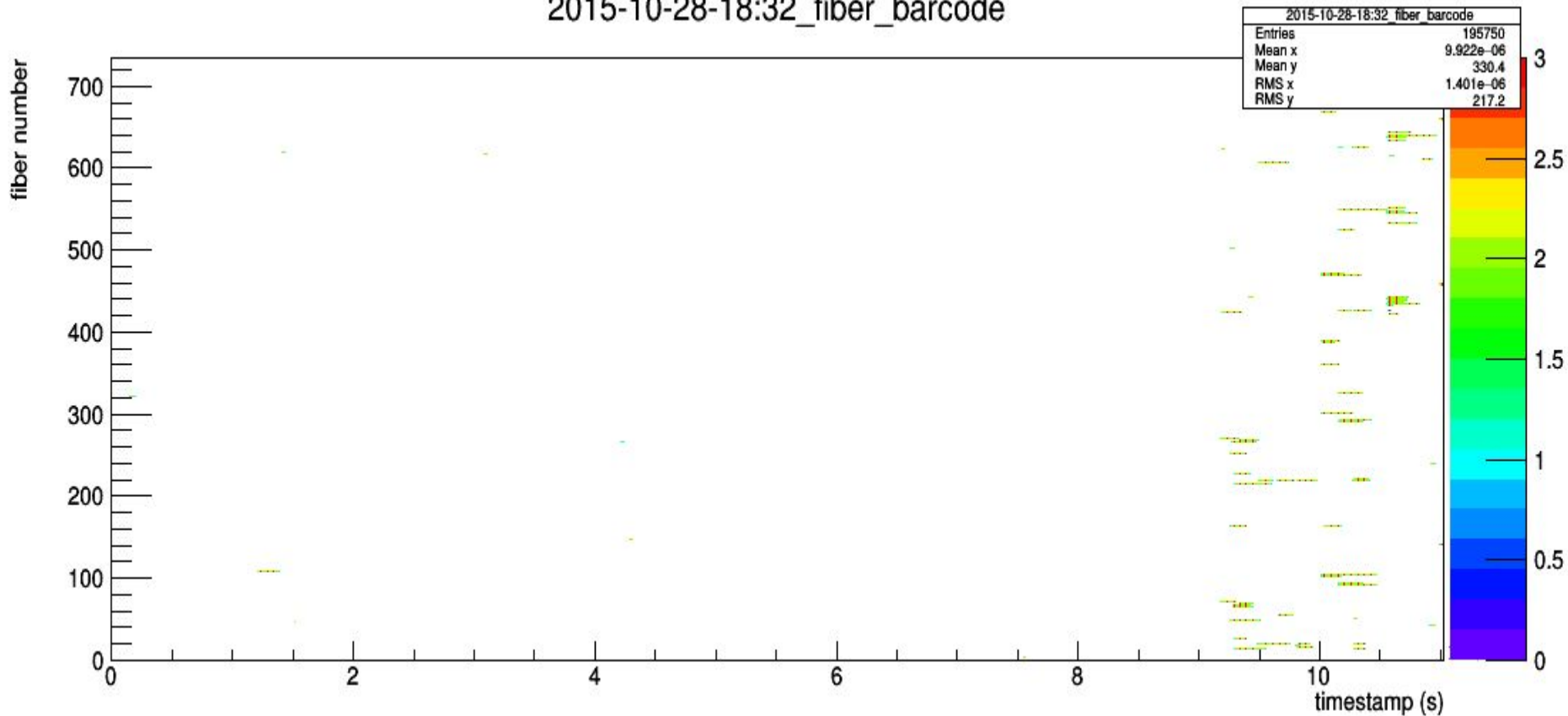
```
if(fiber_sorted != 342){  
  t_fiber_sorted->Fill();  
}  
}
```

What I have been doing...

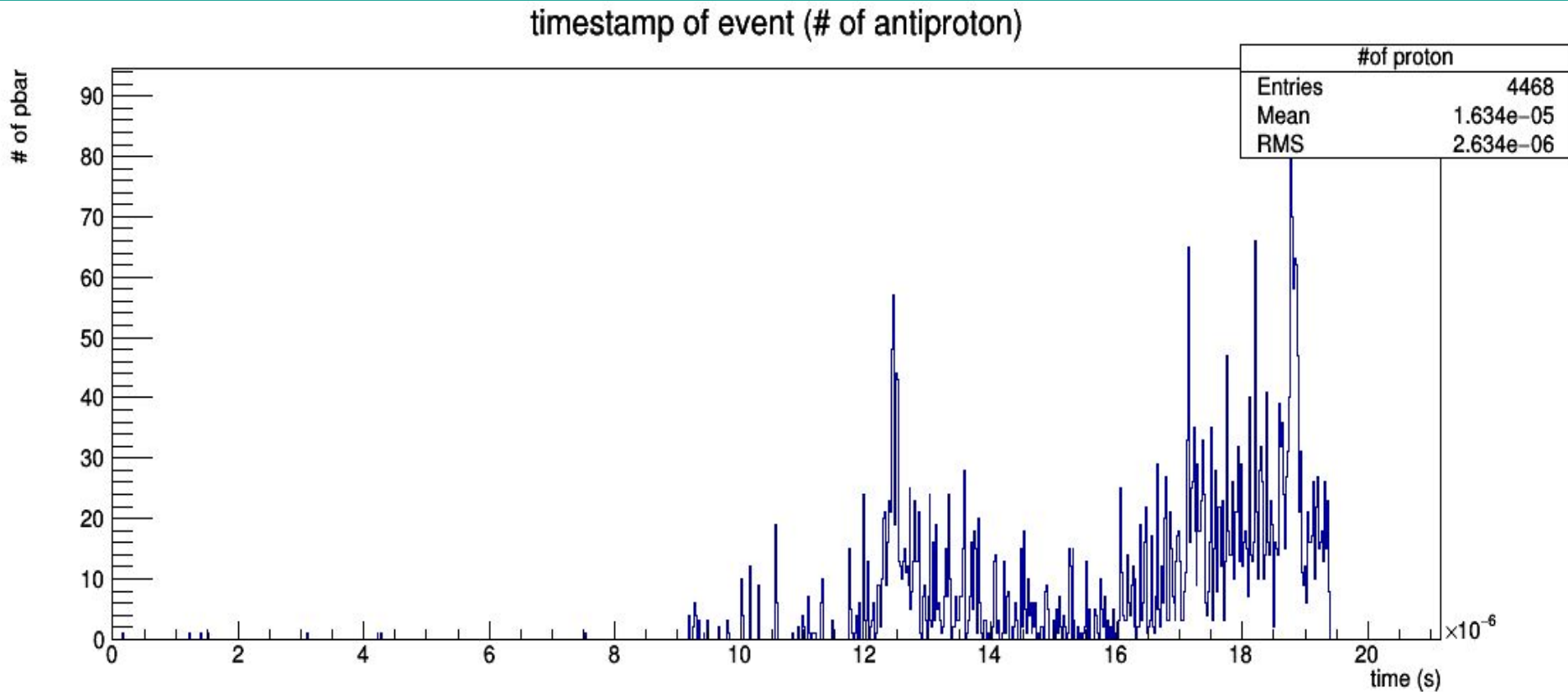
- Build an analysis system for the data coming out from the FACT
 - Check parameters for different antiparticles
 - Pbar: to look at pion tracks
 - Twophoton: to look at photon tracks

Pbar Parameter: 10s mixing e+ CD: $3.06e6 \pm 6e4$ pbar HD: 15000

2015-10-28-18:32_fiber_barcode

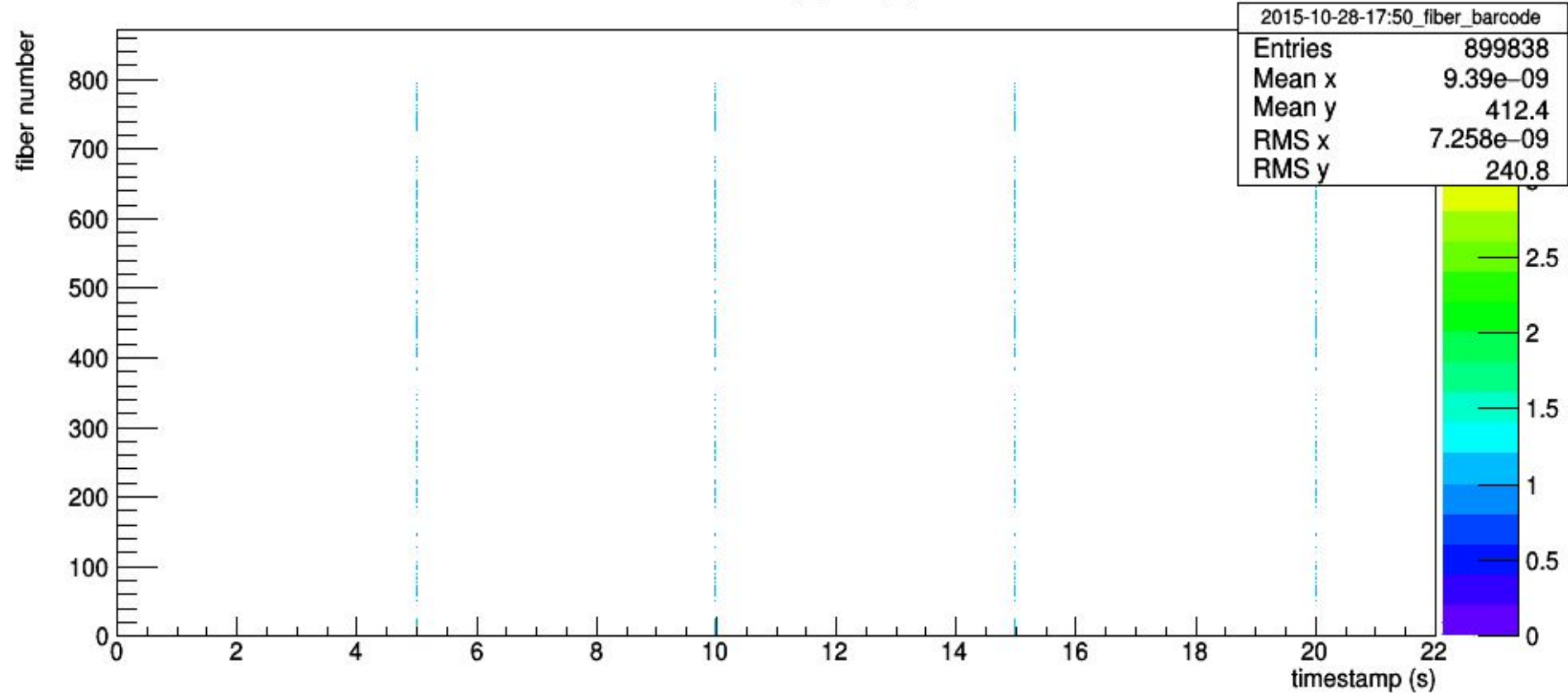


Pbar Parameter: 10s mixing e+ CD: $3.06e6 \pm 6e4$ pbar HD: 15000



Twophoton Parameter: $e+CD: 8e6 \pm 6e4$, pbar HD: 15000

2015-10-28-17:50_fiber_barcode



What's Next

- In a few weeks...open FACT and take dark count data
- In a few months...antiprotons are coming, AEGIS will use FACT to see if antiprotons are well-trapped; if positronium's lifetime is long enough
- Hopefully, in a few years, AEGIS will successfully continuously produce cold antihydrogen atom...

$\frac{5ns}{5ns}$
 timestamp start/min first-next
 new-coin-window & first-hit-timestamp-min = true
 (start_index)th entry
 new-window = true

time stamp - min = timestamp - start
 " " - max = min + 10ns
 (new-coin-window = false)
 nex - timestamp - min = timestamp - min + 5ns

② if timestamp start \geq timestamp min
 add fiber to the container
 event-fiber
 event-entires
 vector

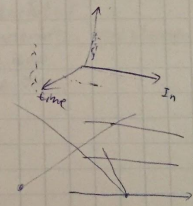
if timestamp start = timestamp min
 yes: start-index = i, first-next = false
 no: = i+1
 stay in for loop

① if timestamp outside the time window (timestamp - start > max)
 yes: record coincidence window
 => { inner hits, out hits }
 interesting-events stores this group of entires (a vector of vectors)
 Reset: event-fibers.clear()
 - entires
 new-coin-window = true
 first-next = true
 break the loop

what's stored in:
 < event-fiber > : all fibers fired in this window.
 This macro may be able to eliminate coincidence ~~footnote~~ a window with L 93-94 if inner hits > 0 = 3 ...

- histogram to see "interesting events" with inner and outlayers

5ns | 5ns



Reference

- Particle tracking at cryogenic temperatures: the Fast Annihilation Cryogenic Tracking (FACT) Detector for the AEGIS antimatter gravity experiment
- Particle tracking at 4K: The FACT detector for the AEGIS antimatter gravity experiment
- Probing antimatter gravity - The AEGIS experiment at CERN

-----“If I can understand a ‘for’ loop, I can work at CERN!!!”