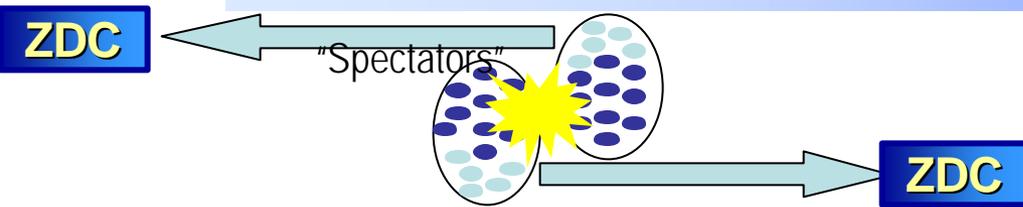
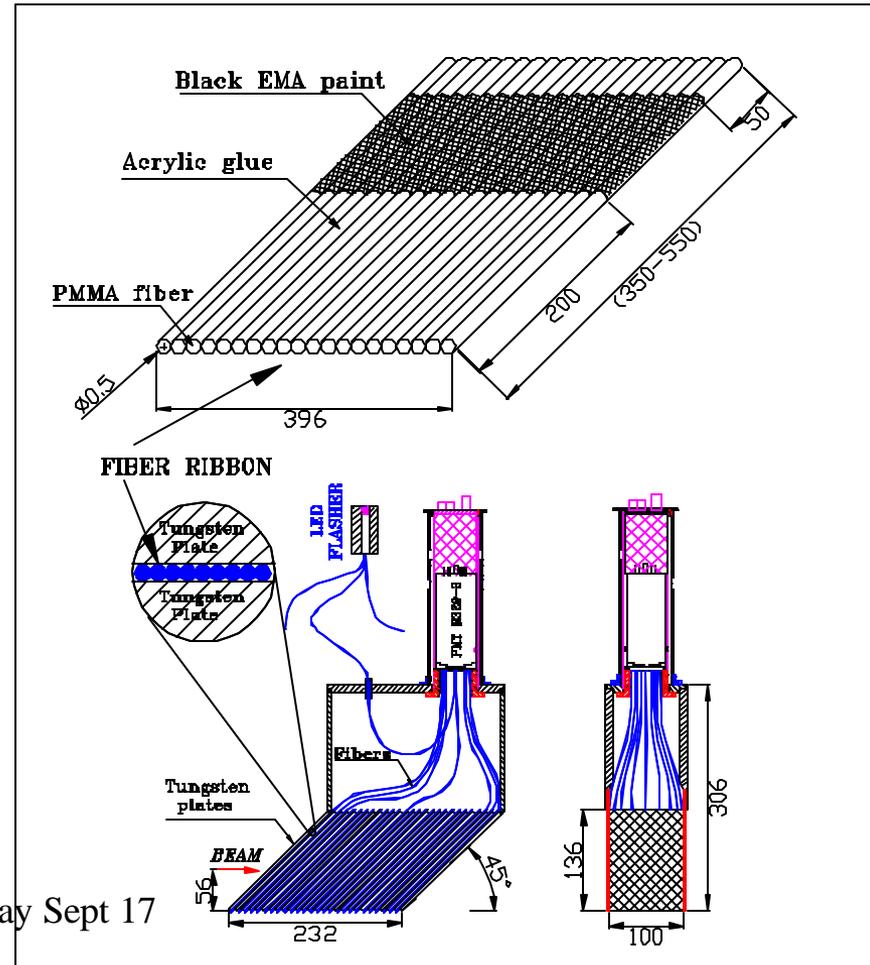
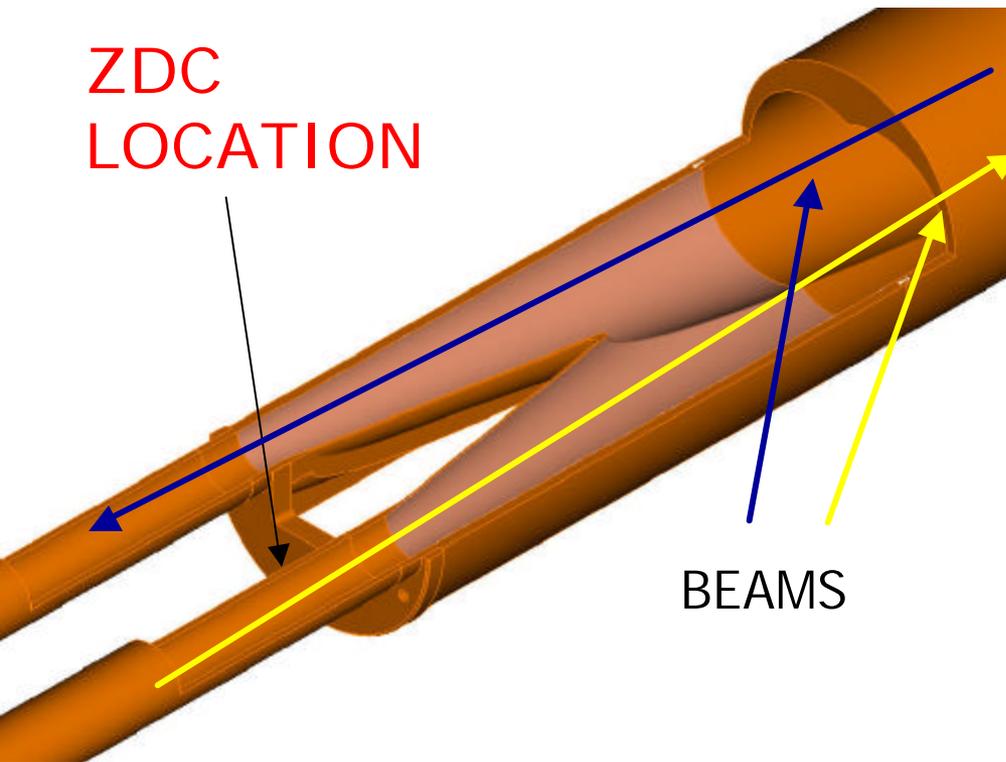


Zero Degree Calorimetry for LHC



Beam pipe splits 140m from IR

**ZDC
LOCATION**



Michael Murray Sept 17



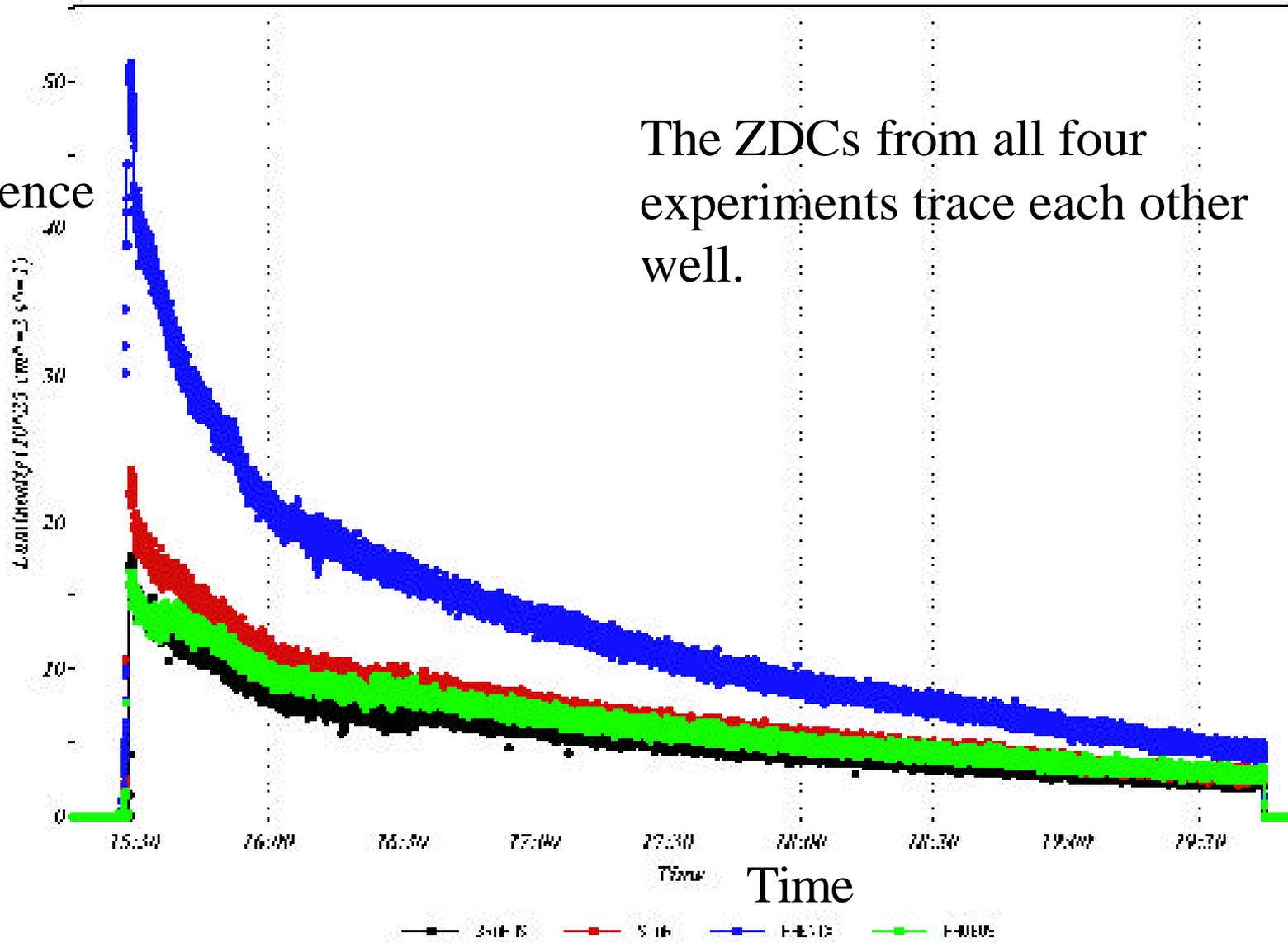
RHIC Experience

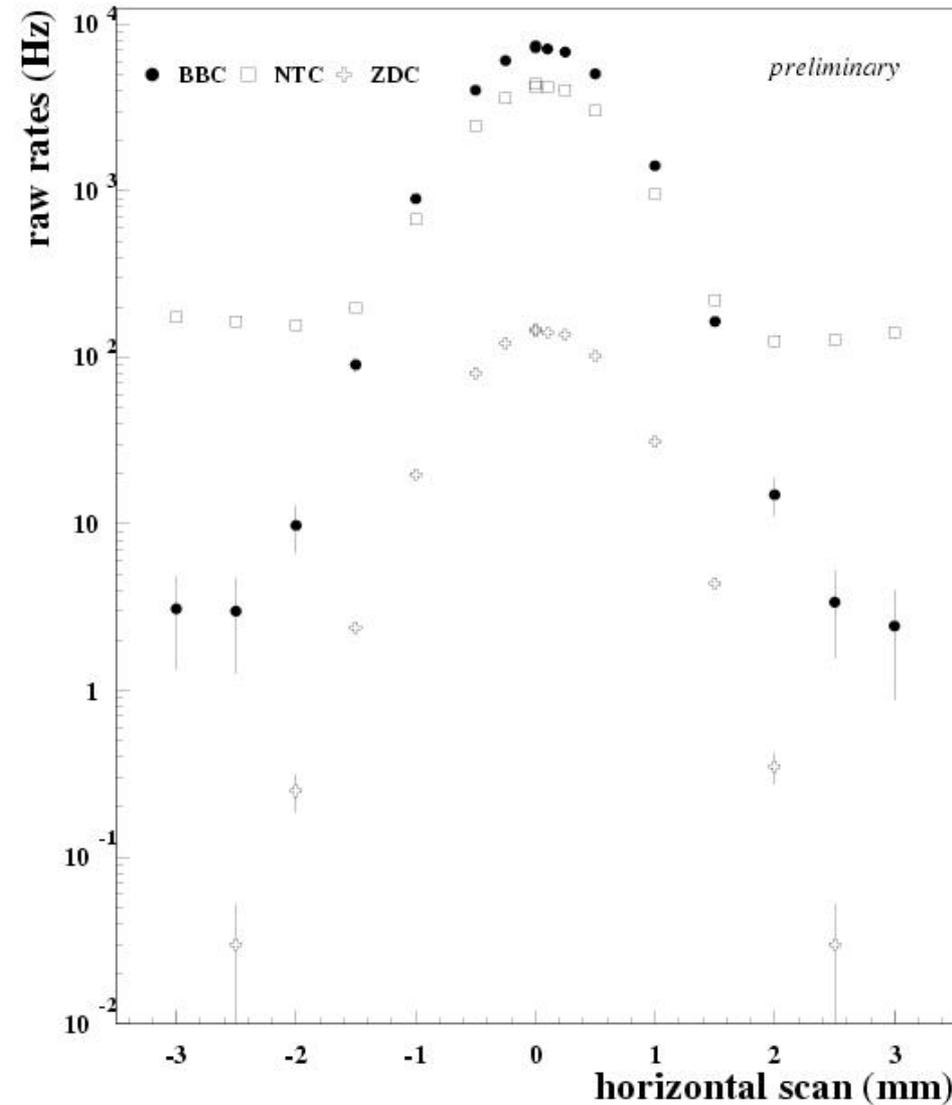
- ZDCs were a combined effort of BNL, Frankfurt, IHEP and Texas A&M
- Tungsten/Quartz fiber. The signal was Cherenkov light.
- Energy resolution 20%
- Time resolution 110ps

Luminosity Monitoring & Beam Tuning at RHIC

ZDC events RHIC #1807 (200 GeV Au-Au)

Coincidence
Rate





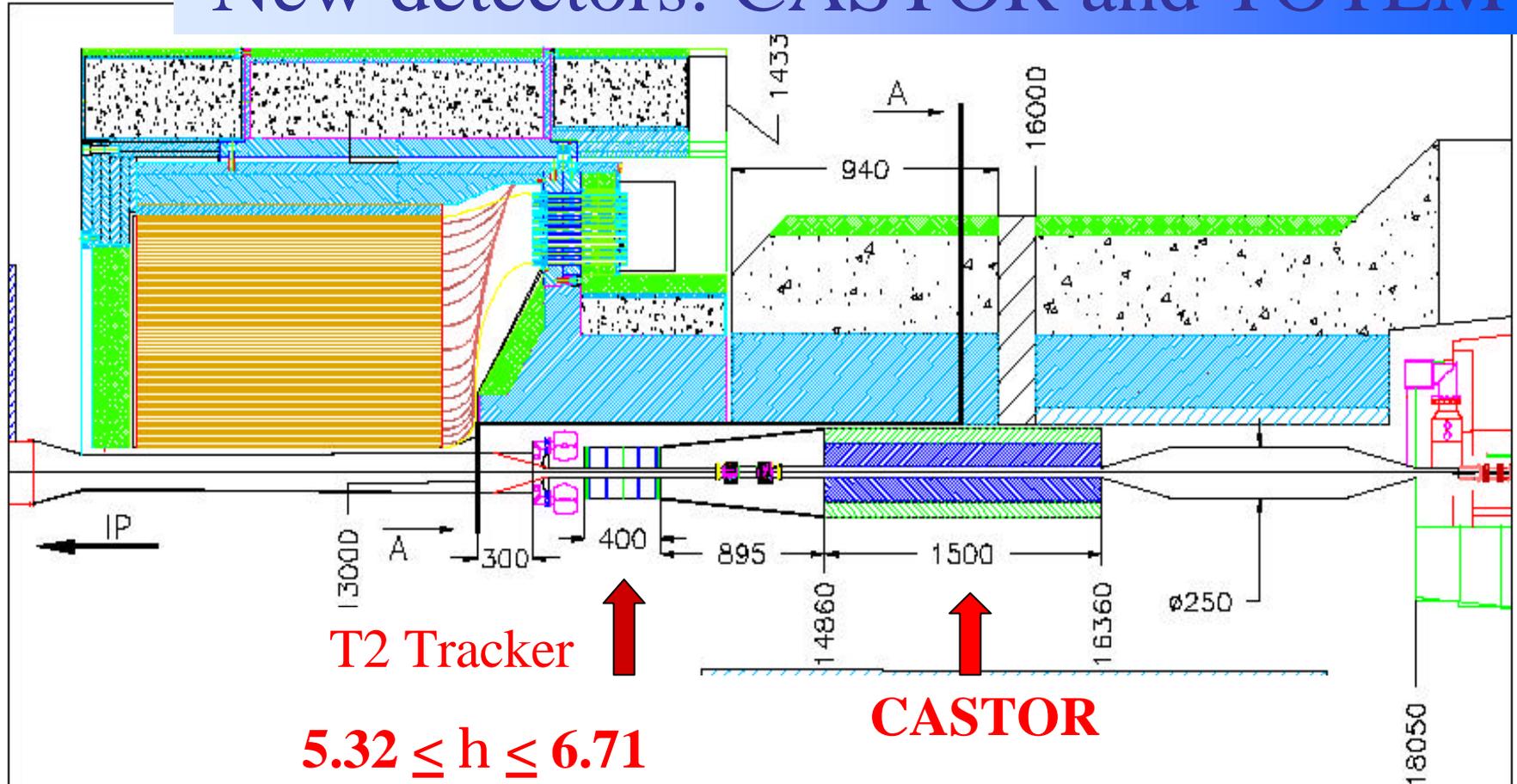
PP Beam Tuning

- During Van der Meer scans the ZDCs had lower backgrounds than other detectors.
- Angelika Drees has been working on estimates of the cross section for this process.

What can you do with ZDCs?

- Improve centrality by measuring spectators
- Trigger on electromagnetic events and study coherent events, (2 PRLs)
- Luminosity monitor for PbPb (and low luminosity pp via charge exchange process)
- Forward energy flow for UHE cosmic rays
- Vertex trigger and event cleanup with TOF.
- Search for exotica via unusual pattern of dE/dz .

New detectors: CASTOR and TOTEM



T2 Tracker

$$5.32 \leq h \leq 6.71$$

CASTOR

$$5.32 \leq h \leq 6.86$$

New Opportunity: Forward Silicon Counters and Calorimetry
Full Multiplicity Coverage up to η of 6.7

Opening of new physics chapter for both HI and pp: TOTEM+CASTOR+ZDC

ZDC is simple but CMS is not...

1. Visit LBL, talked to Turner, got drawings
2. CMS week: Adopted by HCAL, learn about HF electronics, trigger. HCAL wants ZDC for pp running.
3. Talked to CMS managers.
Make simple design, concentrate on CMS but allow possibility for feedback to LHC control group.
4. Kansas got 1/2 post-doc for ZDC effort.
5. Converted Monte Carlo to Geant4/C++ this summer working on integration of EM section and luminosity monitor

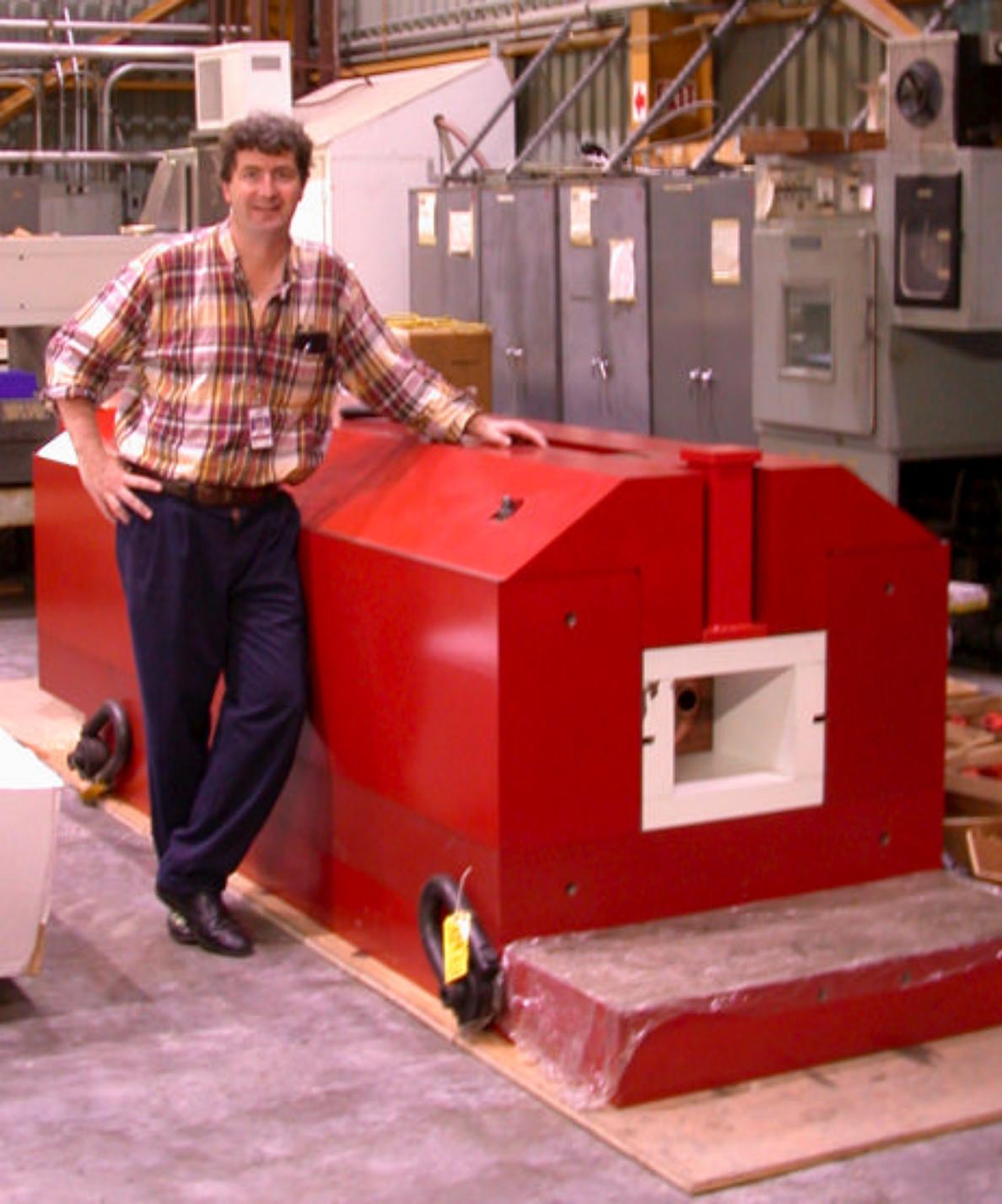
Approval steps:

1. "Concept" proposal to CMS management. Encouraged to prepare technical proposal and then TDR.
2. Submit Technical Proposal in December.
3. Prepare TDR for CMS management then it goes to the
4. Collaboration board.
5. If OK it goes to LHCC and
6. Finally the CERN research board.

Ready for installation at the start of LHC

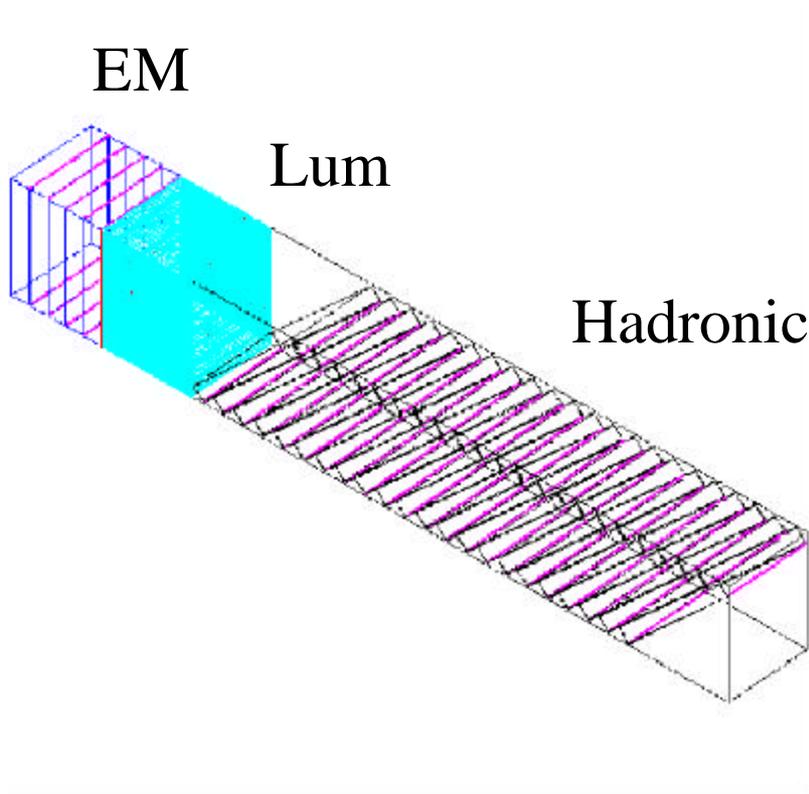
What needs to be done now?

- Design of a remote handling device. (LBL?)
- How do we get the heat out? (Mokov, Iowa)
- Fix the space used by pp and the amount of tungsten they allow in front.
- Readout electronics, use CASTOR test beam experience.
- Specify any requirements that the LHC instrumentation group would have of ZDC.



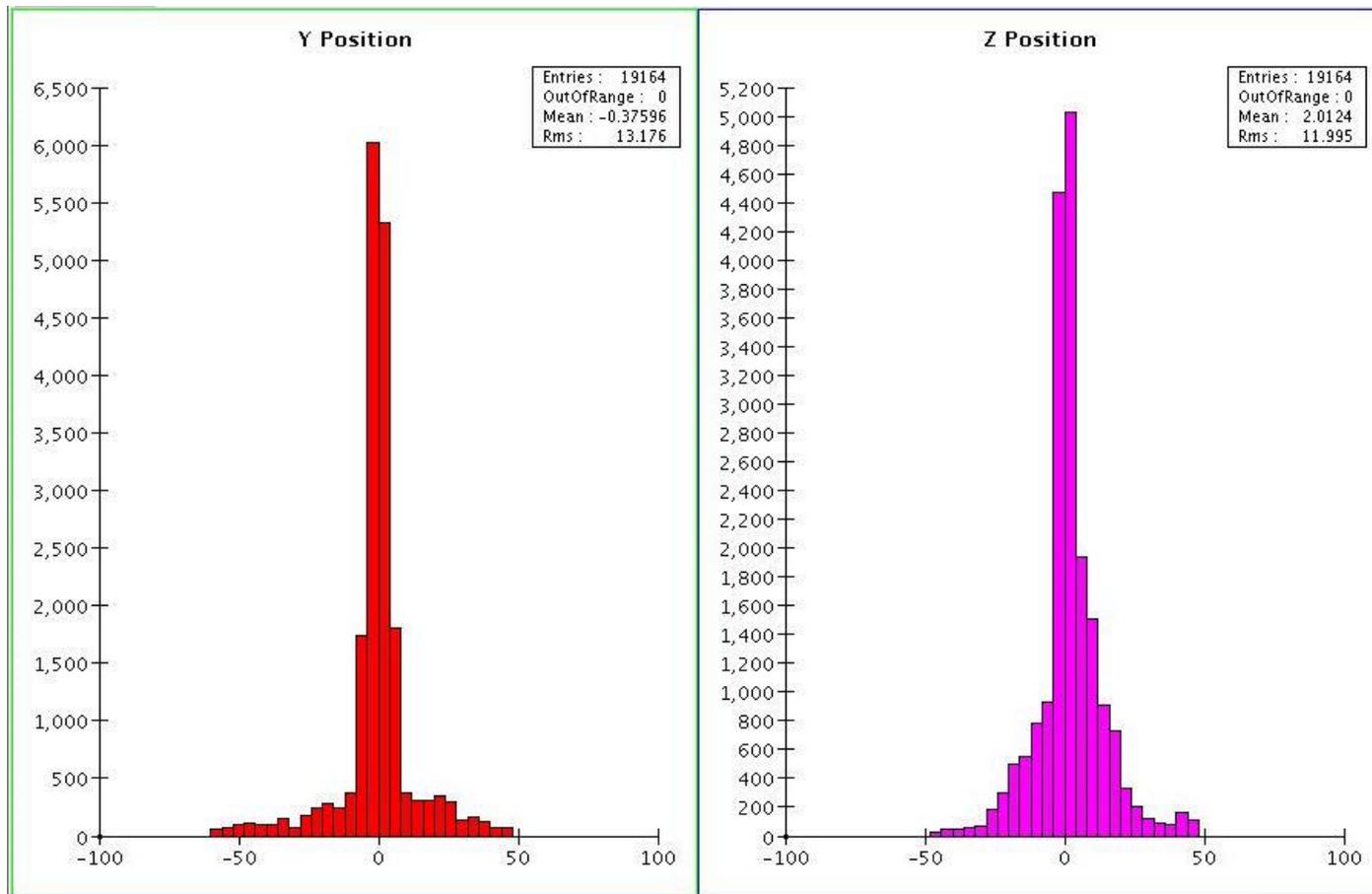
Bill Turner, Masimo Plaicodo and Bill Elliot of LBL have been very helpful so far. Makov's work on radiation loads is also essential. Integration at CERN is obviously very important. It surely makes sense for the ZDC group to work with these experts. It also would be very helpful if one TAN could stay in the US as long as possible so that problems of heat flow and the lift fixture could be dealt with easily.

One Possible Design



- CMS & ATLAS have same geometry Alice has more space
- 10cm of TAN slit will be used by pp luminosity monitor. This will need absorber in front.
- Make this the EM section and put the hadronic section after pp detector. Note the pp detector can function as our “shower max” detector. We are putting this in our MC.

Cerenkov showers are narrow



Radiation Tests

- Iowa group has tested quartz fibers at Argon using spallation neutrons from a uranium target.
- After ~ 50GRad fibers seem clear
- Optical tests are preceeding
- They also have a testing facility at Lep Injector Linac at CERN.

Keeping it simple

- 1 neutron and centrality triggers can be made with discriminators and input to global trigger.
- If possible send signals directly to counting room without electronics near TAN.
- If LHC wants the signal we will send them from CR
- CMS would like vertex information as an early beam diagnostic, therefore we will have TDCs.
- Use scalers to track coincidence/singles rates.

Activation and safe handling

- ZDC will almost certainly exceed $5\mu\text{Si}$ limit at which objects become “traceable” in France.
- We, (and probably CASTOR) will have to provide a materials list and also label each part
- The ZDC will need some kind of robotic lift fixture. Ideally this would be designed at the same time as the pp lift fixture.
- We need to check that removing the copper rods does not cause significant irradiation above the ZDC.

This is a real Calorimeter

- The pp running will produce significant heat which will have to be dissipated.
- Makhov of FNAL can give us estimates of the heat load for $L=2*10^{33}$ (roughly twice Cu rate)
- We may cool by contact with copper but we will have to handle different coefficients of expansion.
- Ideally we would test this with a real TAN at LBL.

Electronics

- Ideally ZDC & CASTOR will use HF electronics but we need to see which light detectors can survive radiation dose and produce enough signal to drive cables.
- CASTOR group is tested LPDs at SPS this year.
- $Z_{\text{vertex}} = c \cdot (T_{\text{left}} - T_{\text{right}})$. We will use HPTDC chip designed for ALICE to make this. Alessandro Marchioro will give us chips.
- Alessandro may also be help with scalers

ATLAS and CMS

- CMS wants ZDCs for PbPb, pp, forward physics.
- The cost of the ZDCs themselves are a small fraction of total cost and total effort.
- Obviously it would be good if ATLAS & CMS had identical calorimeters.
- These could be built at different places. Perhaps Howard Gordon of BNL/ATLAS and Dan Green of FNAL/CMS could review final design.

Moving Forward

- SPS will not run in 2005. Can we test at RHIC?
- DOE may call for Heavy Ion proposals this year. It would be helpful to have a positive relationship with LARP and LHC instrumentation group.
- ZDC philosophy is “First do no harm” to instrumentation group. Hopefully we can do some good.