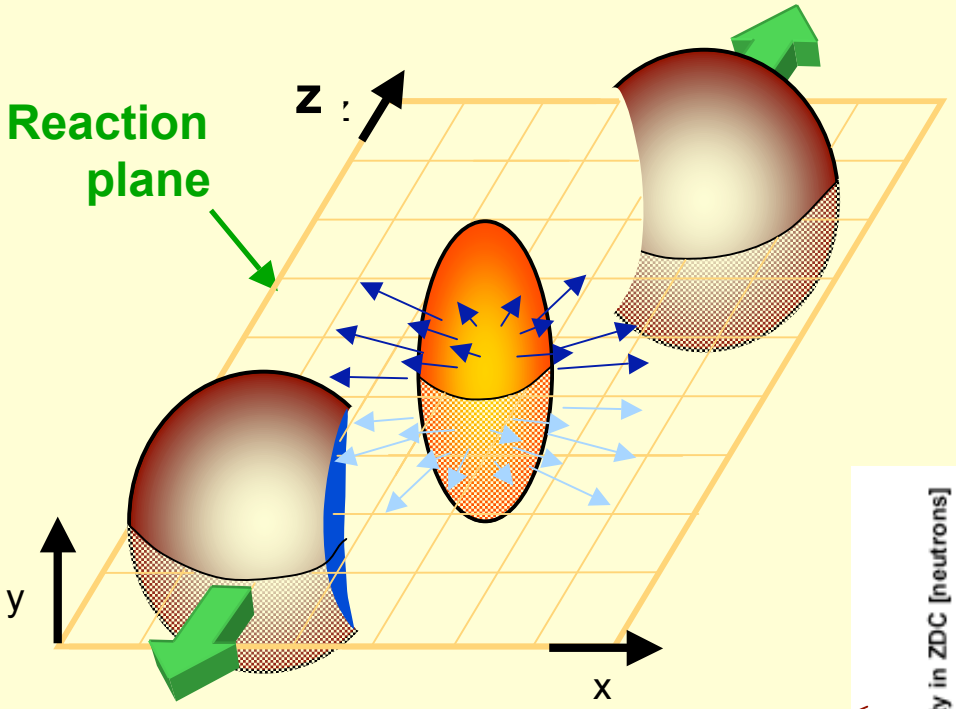
ATLAS ZDC Project

- Why we need it
- ATLAS ZDC solution
- Performance
- Integration Issues
- Run scenario

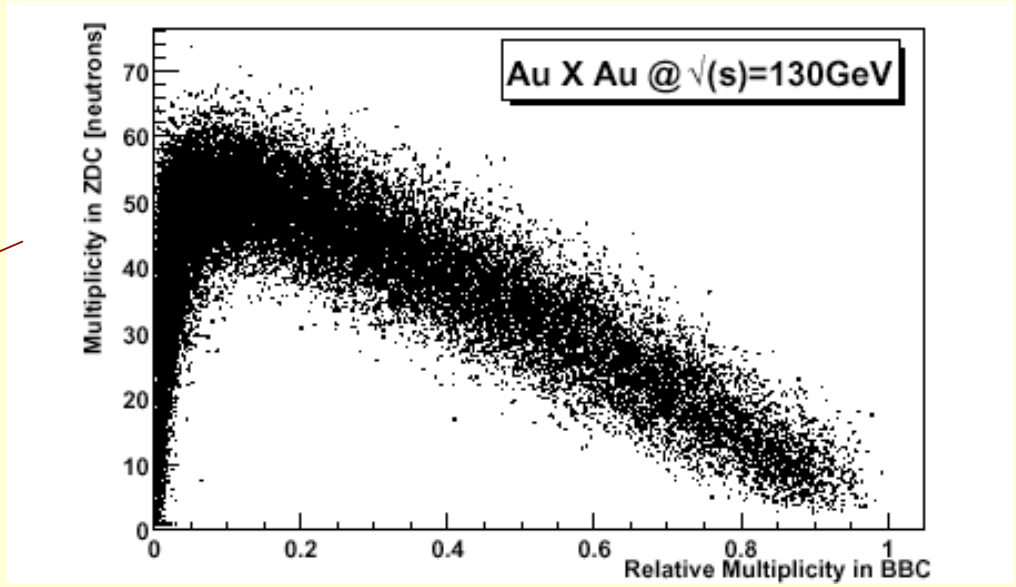
Event characterization using forward detectors

>>Direction and magnitude of impact parameter, b



Magnitude from complementary parameters

$N_{participant}=2*A-N_{spectator}$



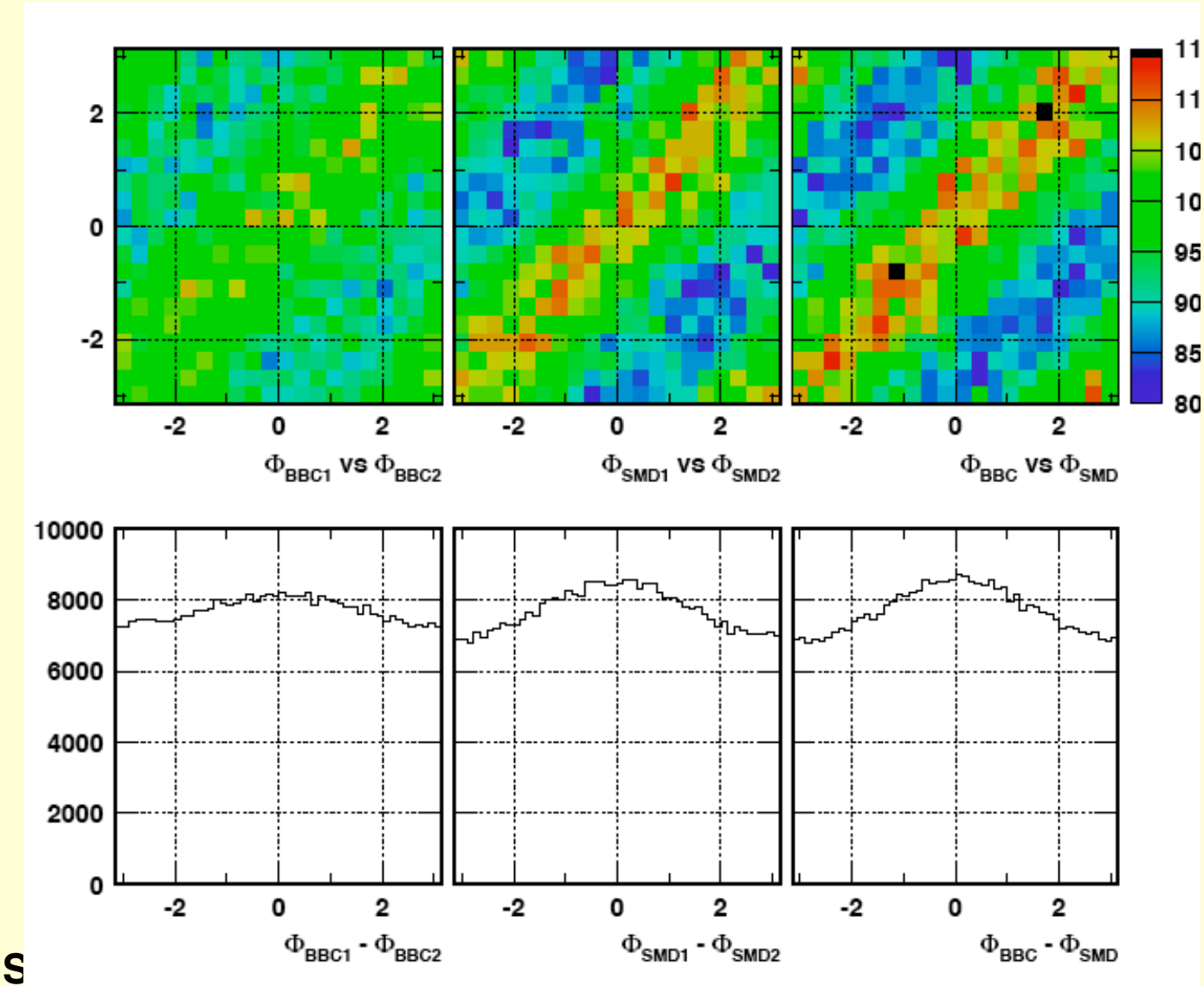
Beam-Beam Counter Mult/1000

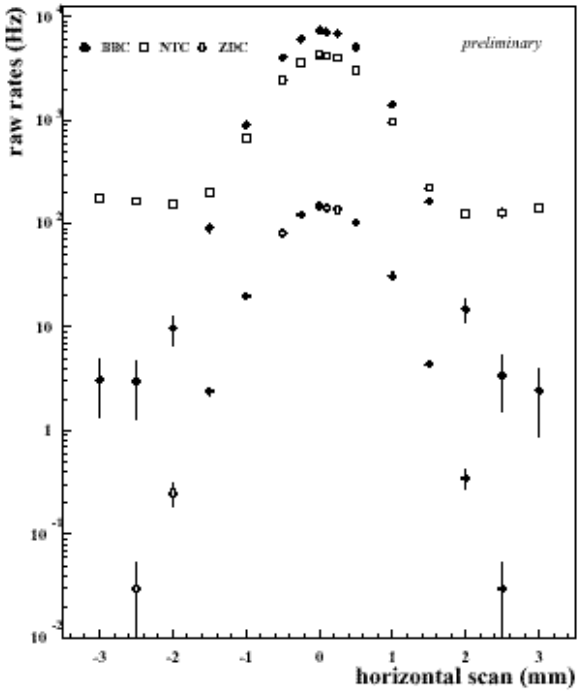
Spectator neutrons
- **measure centrality,**
- **Min_min_bias trigger**

(Calorimeter@θ<2mr.)

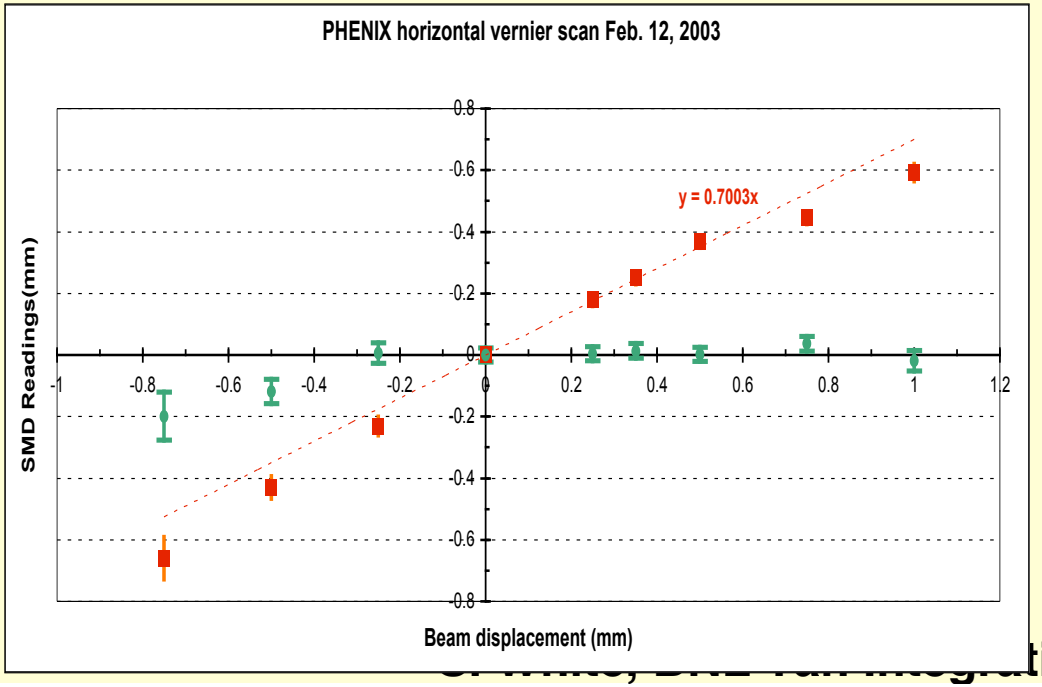
Directed flow, v_1, is largest at ZDC location

(Reaction Plane resol. from correlation in hemispheres:
BBC ZDC/SMD both)

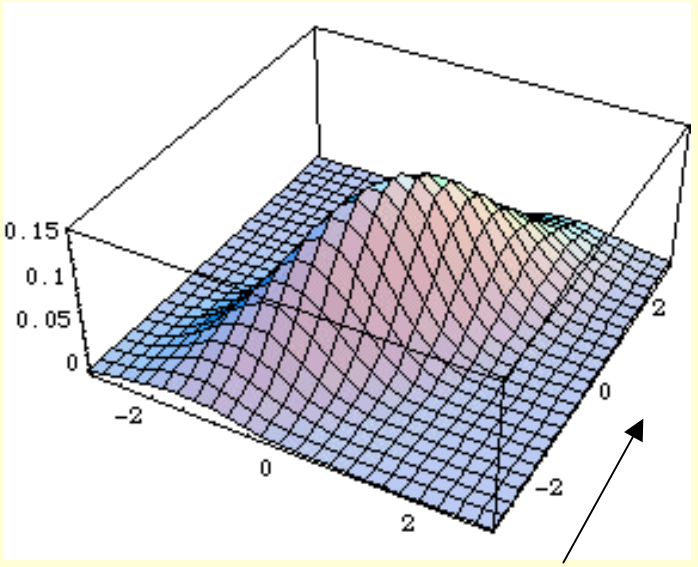




RHIC ZDC as an accelerator tool (in pp)



rate



Measured Beam x(mm)

Vernier bump

On the Potential Use of Zero Degree Calorimeters for LHC Luminosity Monitoring

CERN AB-note

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e–mail:white1@bnl.gov

Led to proposal to LARP to integrate ZDC in Accelerator Instrumenta

Calculated cross sections for PbPb@LHC

A.J.Baltz, C.Chasman and SNW NIM A417(1998)p.1

(errors can be inferred from RHIC discussion <5%)

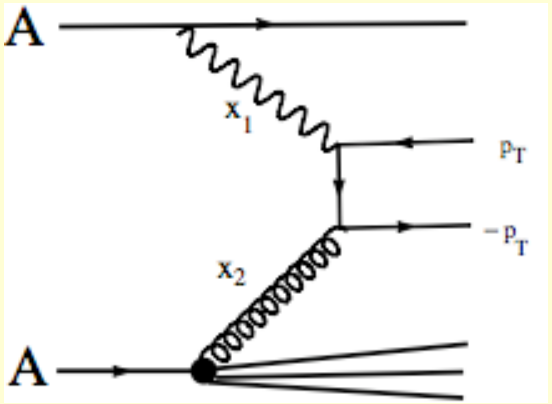
$\sigma_{1n,1n}$	0.537 barns
$\sigma_{1n,xn}$	1.897
$\sigma_{xn,xn}$	14.75
σ_{xn}	227.3

Impact of ATLAS ZDC on Luminometry

- In Heavy Ion runs, the 14.75 b. ZDC coincidence cross section will determine absolute Luminosity to better than 5%
- Important cross check of luminosity from machine parameters
- In pp mode ZDC coincidence (9%*σ_{inel})is a background free luminosity monitor-> very robust for commissioning luminosity. Useful reference for LBNL ion chamber
- 1st ZDC module provides uniform absorber (pre-radiator) for LBNL ion chamber

ZDC role in HI Physics (UPC event tag)

Probing small x structure in the Nucleus with γN->jets, heavy flavor.



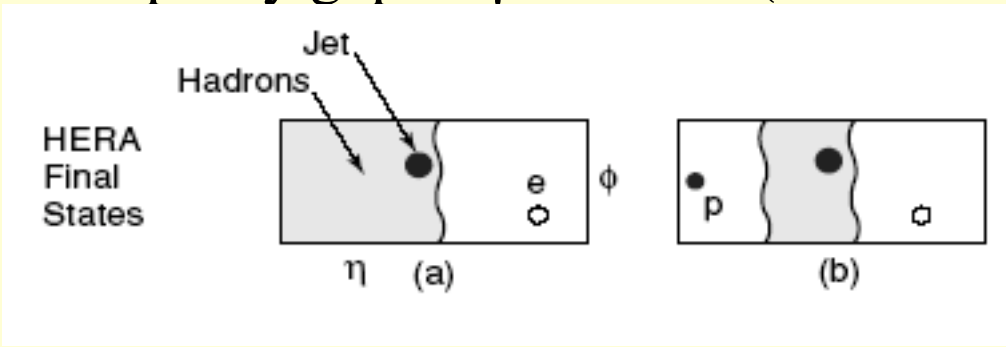
di-jet photoproduction-> parton distributions,x2 by γ with momentum fraction, x1

$4p_t^2/s=x1*x2$

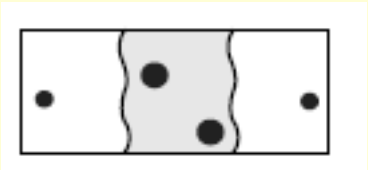
<y>~ -1/2*ln(x1/x2)

Signature: rapidity gap in γ direction(FCAL veto)

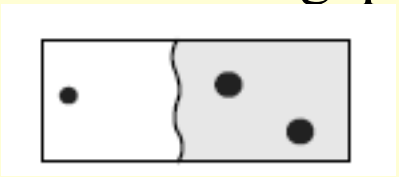
ATLAS coverage to |η|<5 units. P_t ~2 Gev "rapidity gap" threshold



Analogous upc interactions and gap structure

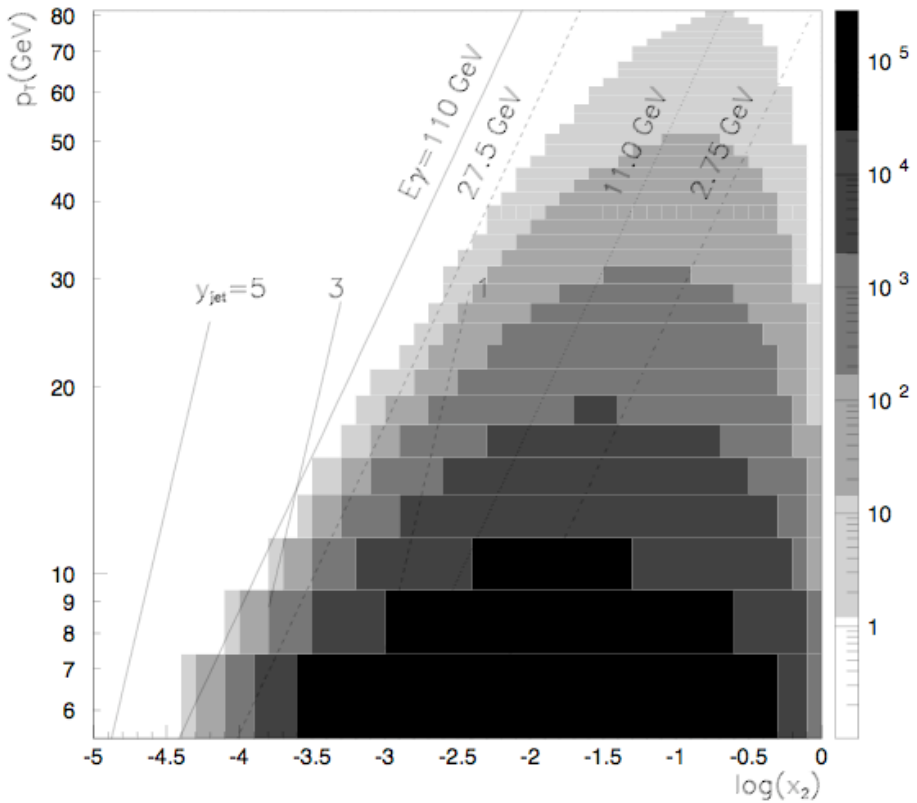


diffractive



Non-diffractive

UPC physics with ATLAS



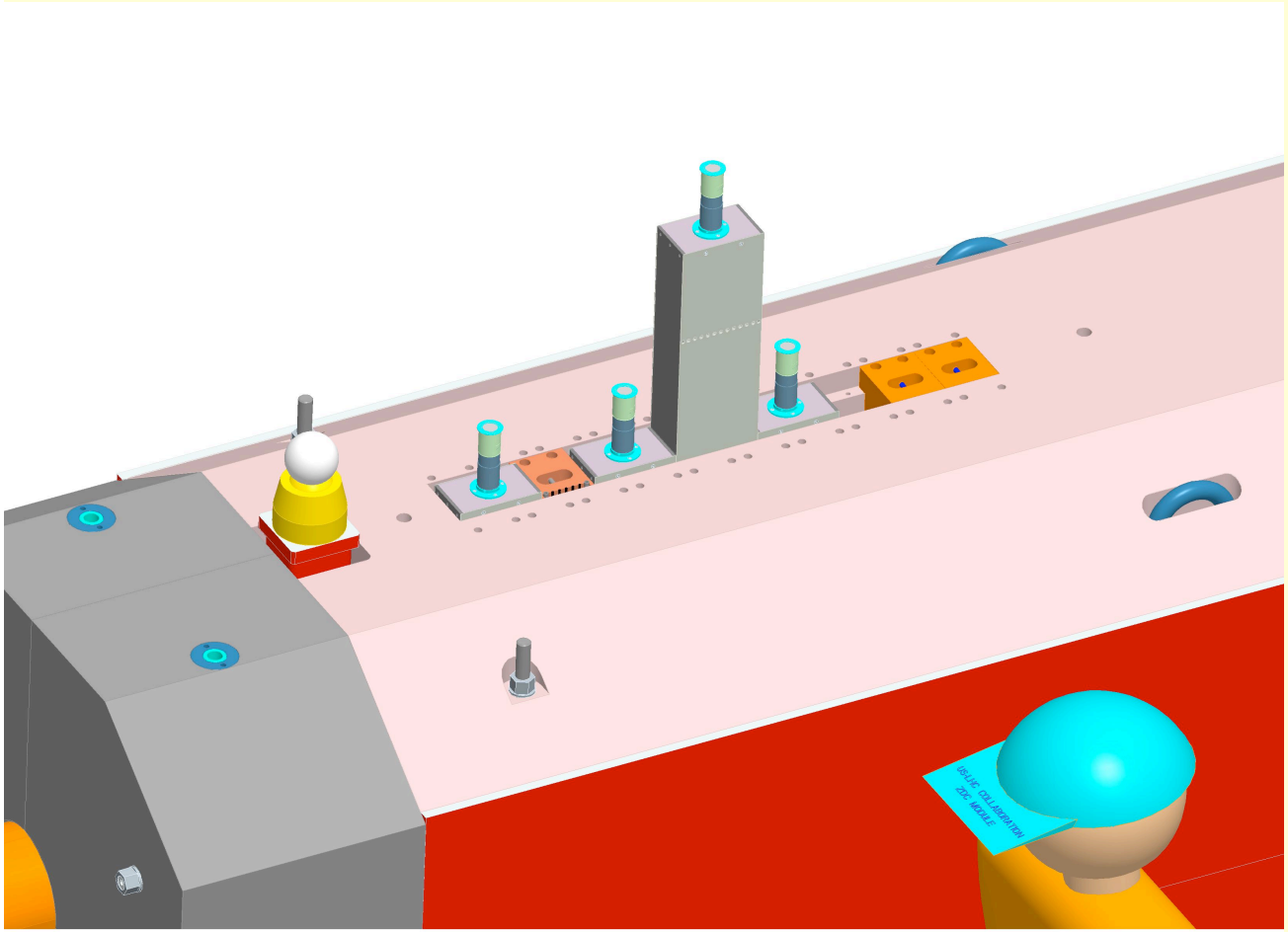
- Rates and energy beyond HERA

"an order of magnitude

Lower x for equiv virtuality"

- Both nuclear targets and p (pA)
- PHENIX UPC showed effectiveness of rap-gap+ZDC tag
- This is well matched to ATLAS coverage
- Current PRL : Vogt,Strikman and SNW

ATLAS ZDC Solution

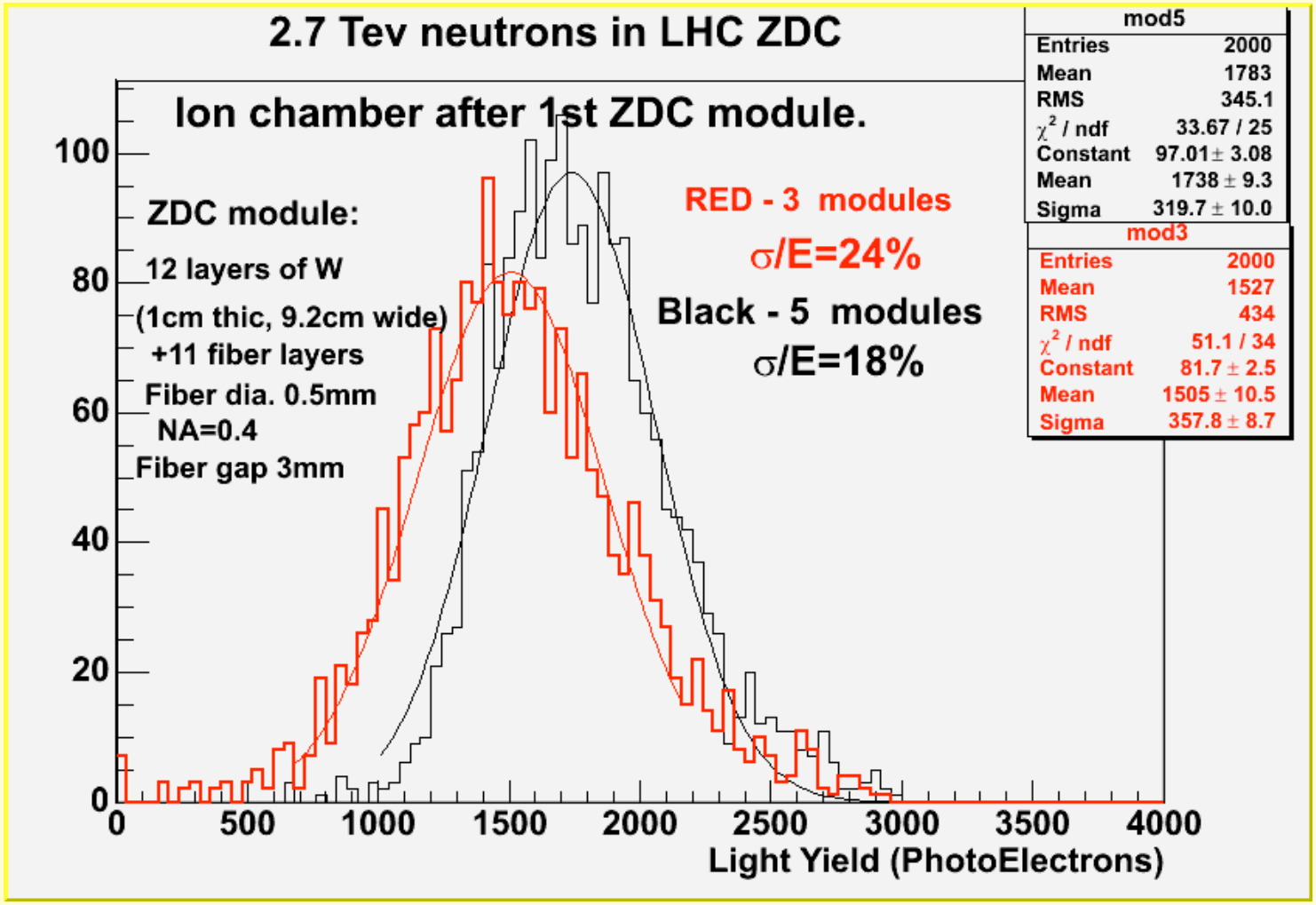


Identical modules Installed in the "TAN" enclosure @140m

Share space with Additional(passive) Absorber and Luminosity monitor

⇒ZDC designed to withstand few Grad dose

Neutron energy resolution adequate with 3 modules (each side)



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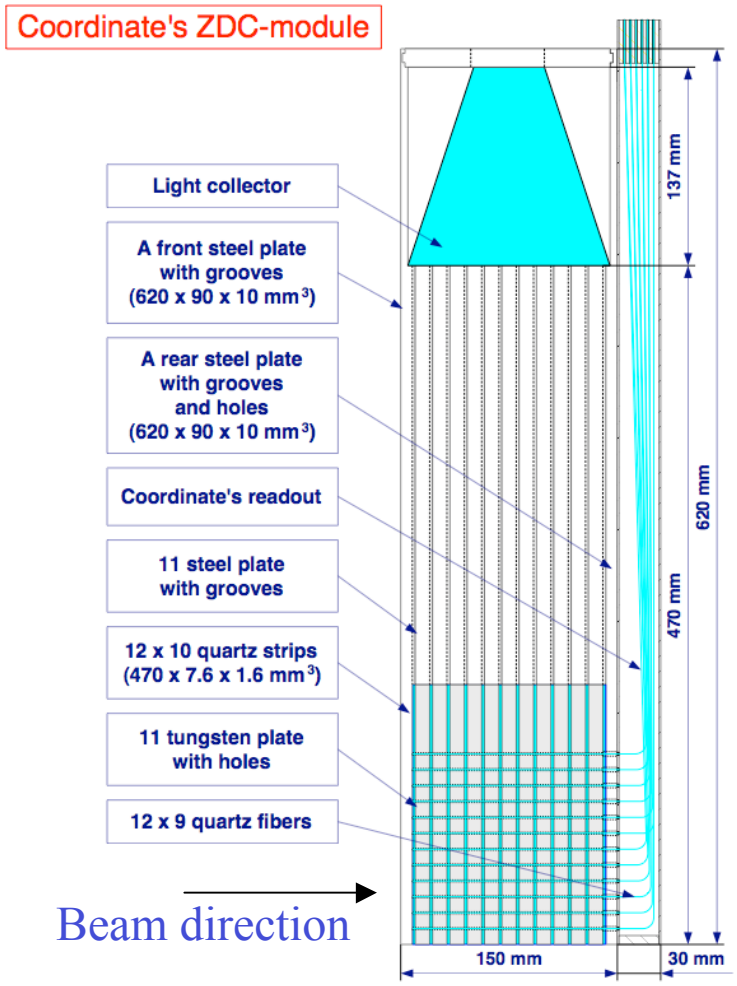
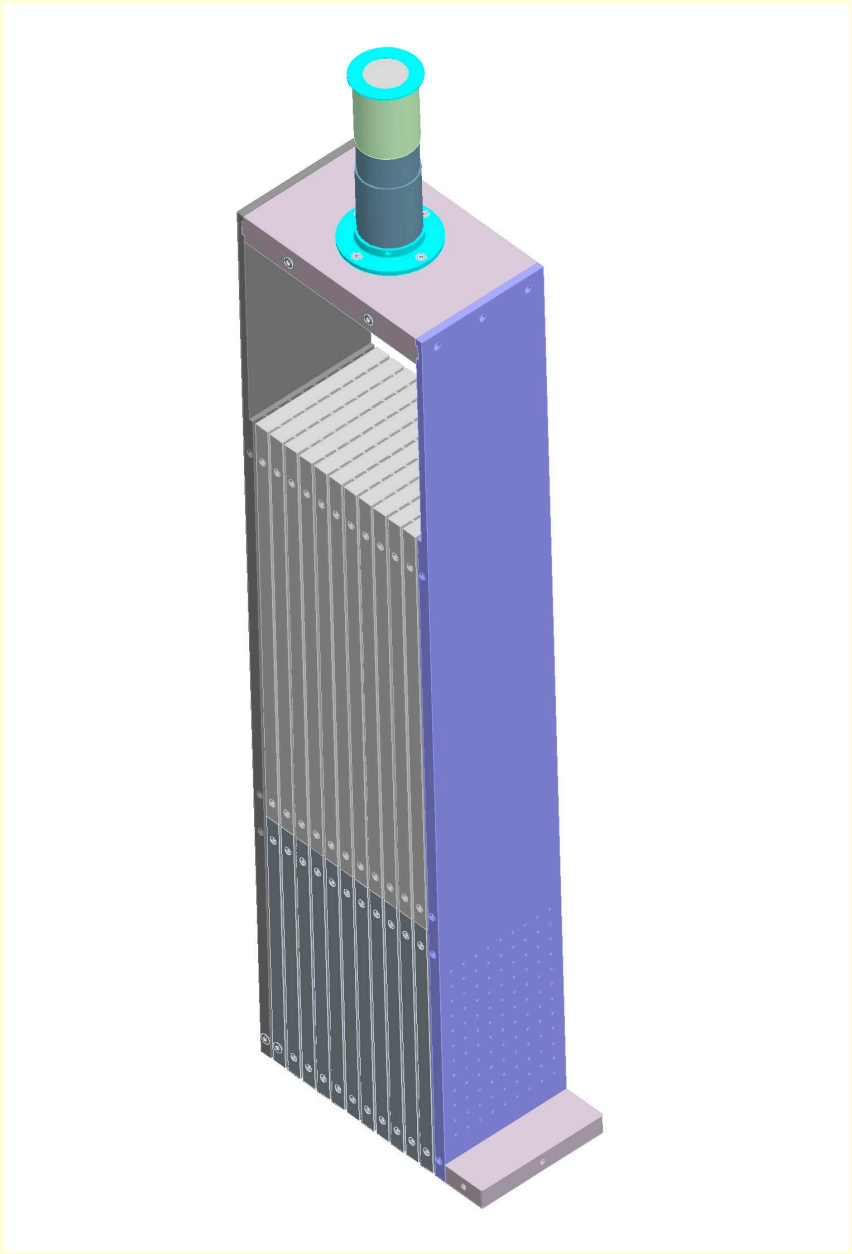
ZDC design, milestones



- ZDC LOI circulated within ATLAS
- Funding from BNL physics dept.
- ATLAS will submit LOI to LHCC after TMB review
- Radiation damage test at BNL isotope facility (May '06)
- test beam run in fall '06
- Note:ATLAS ZDC features coordinate measurement of energy deposit

Individual module (1 of 6 total)



Sandwich of 1 cm SS (Outer plates) with pattern of 1cm Tungsten Alloy, 1.6mm thick Quartz strips

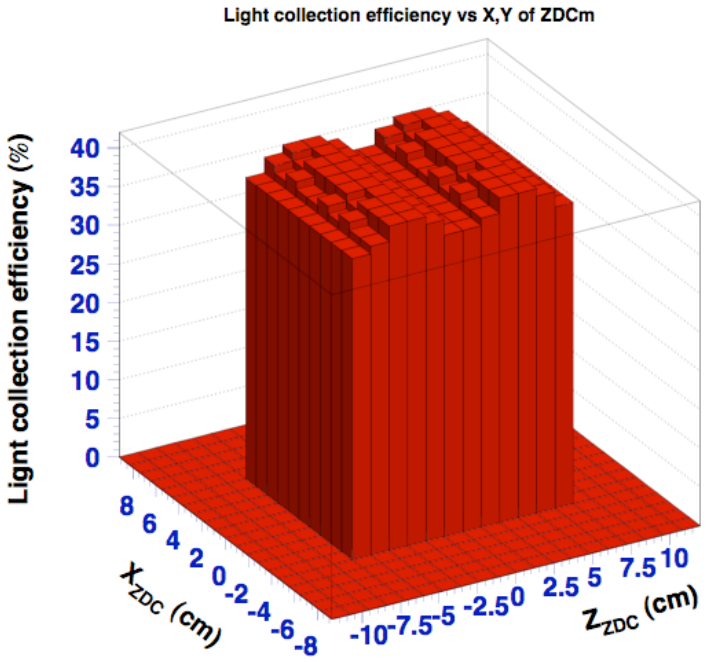
Vendor same as RHIC ZDC fab ~$12k/module

6 identical modules In total

Optical simulation (uniform light collection)

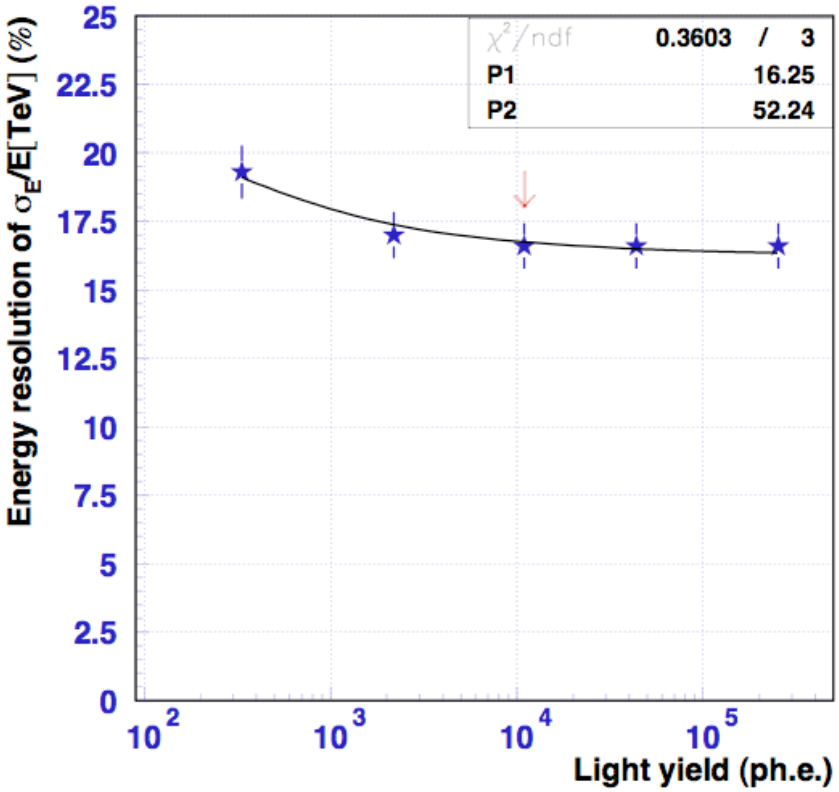
Light collection efficiency
Vs. impact point of showers.

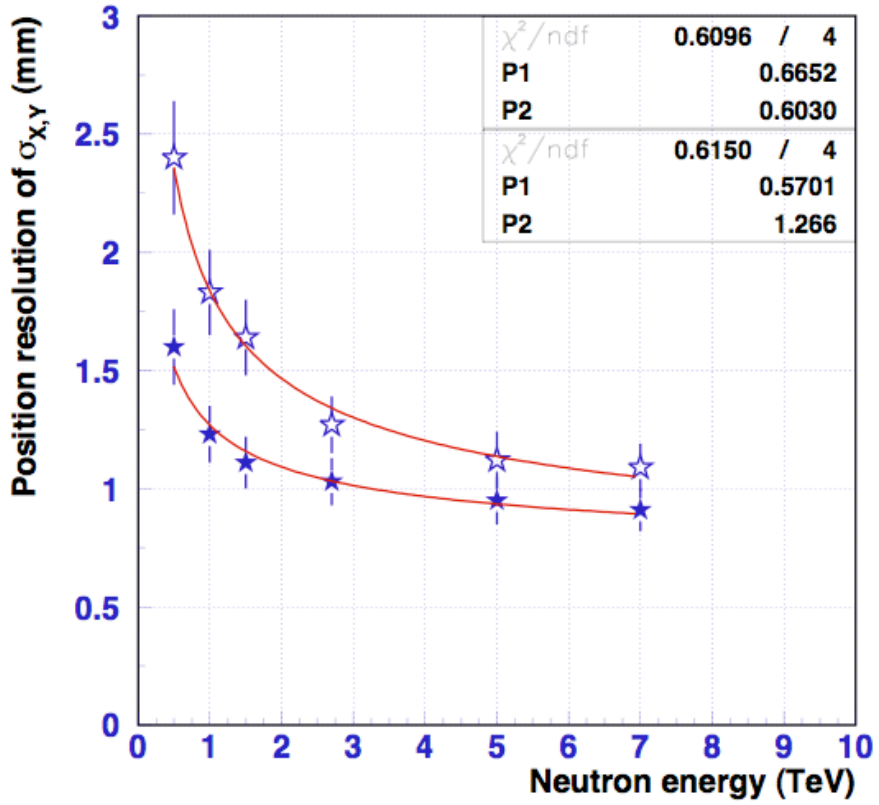
Solution with 2 or 4 PMT/module



Energy and Position resolution

Neutron energy resolution



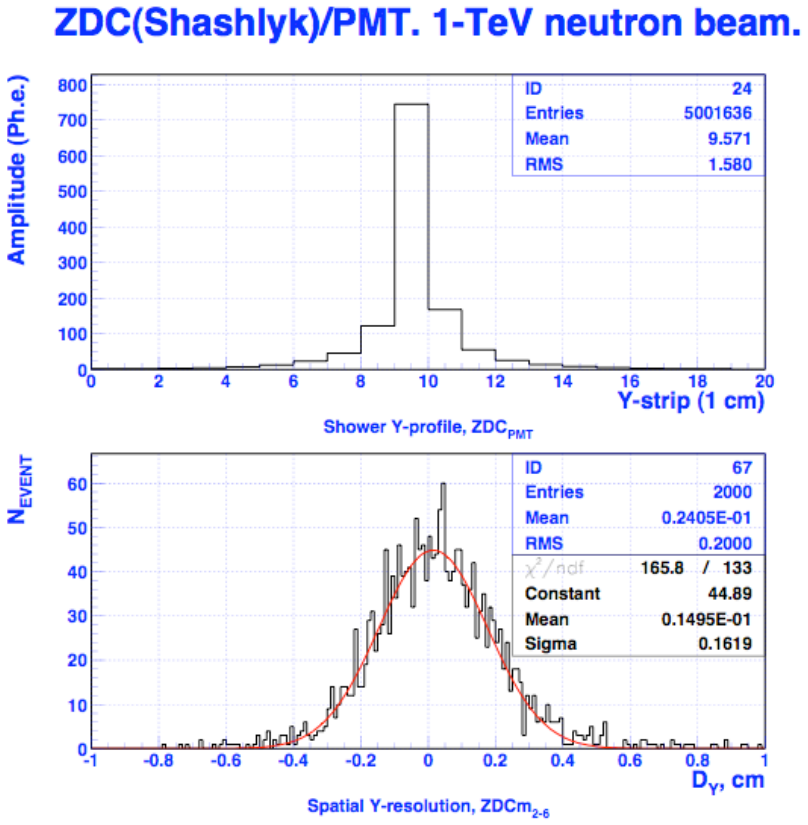


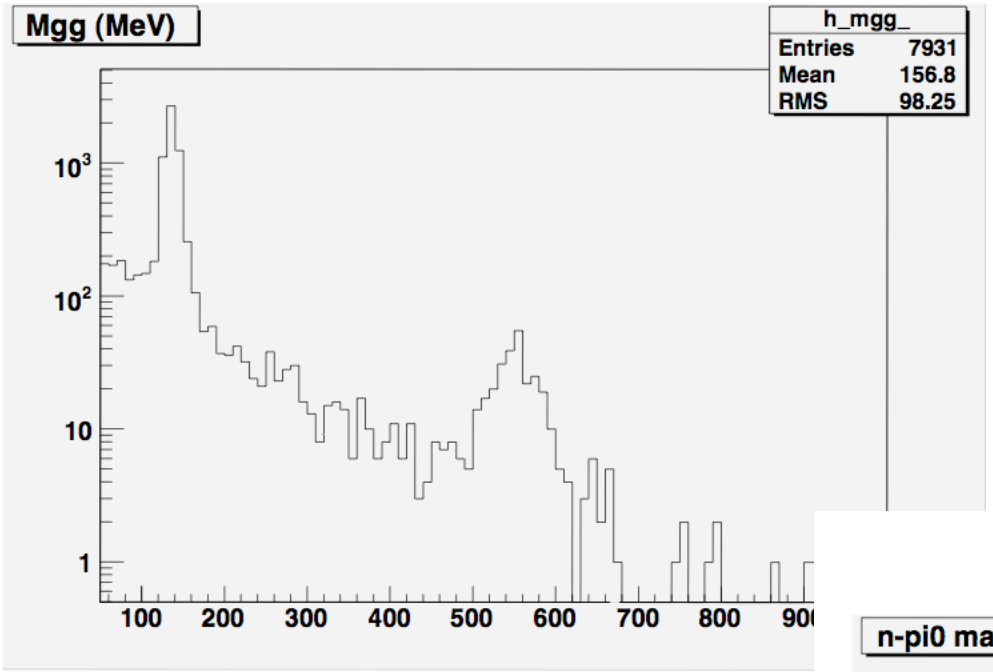
Position resolution from 1st and 2nd modules.

Spatial resolution for 1 TeV Neutron

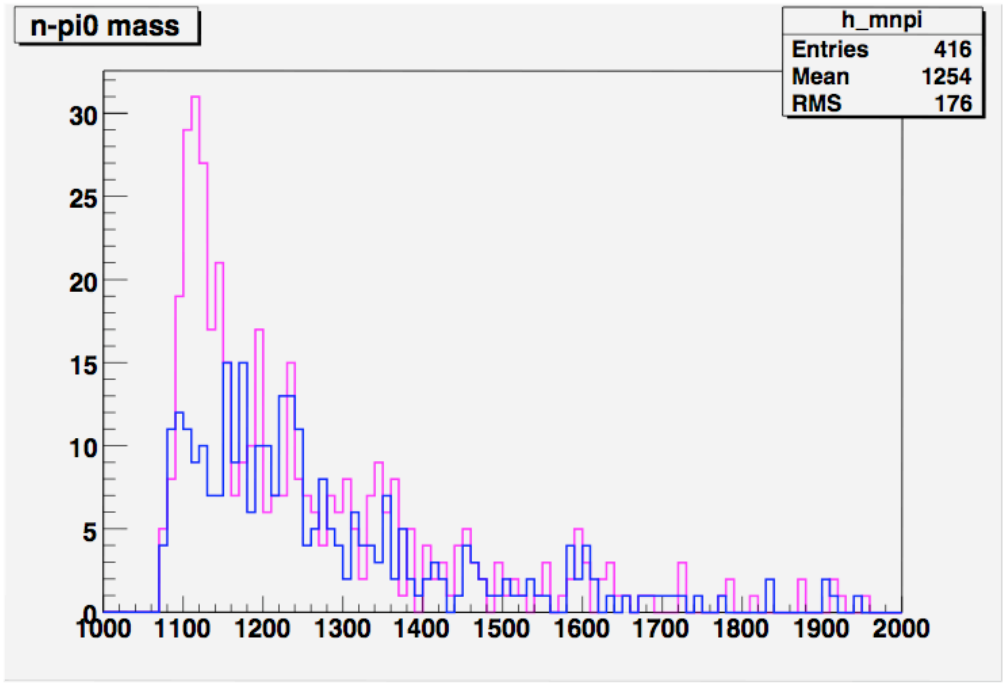
Light yield per strip

Coord resolution~ 1.5 mm





π0,η, reconstructed in ATLAS ZDC



Λ (and pure bkg)

Checks hadronic section

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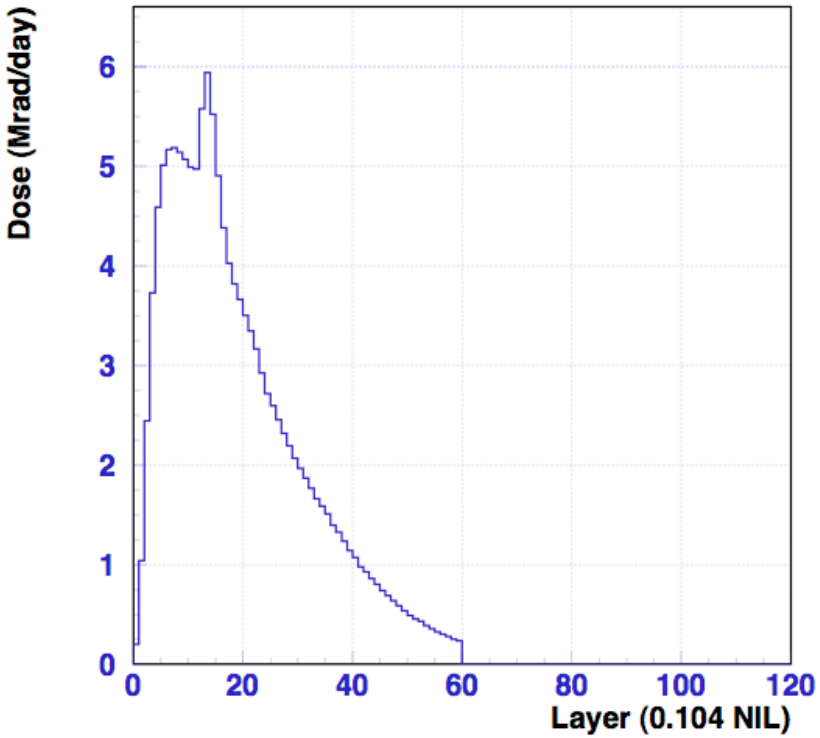
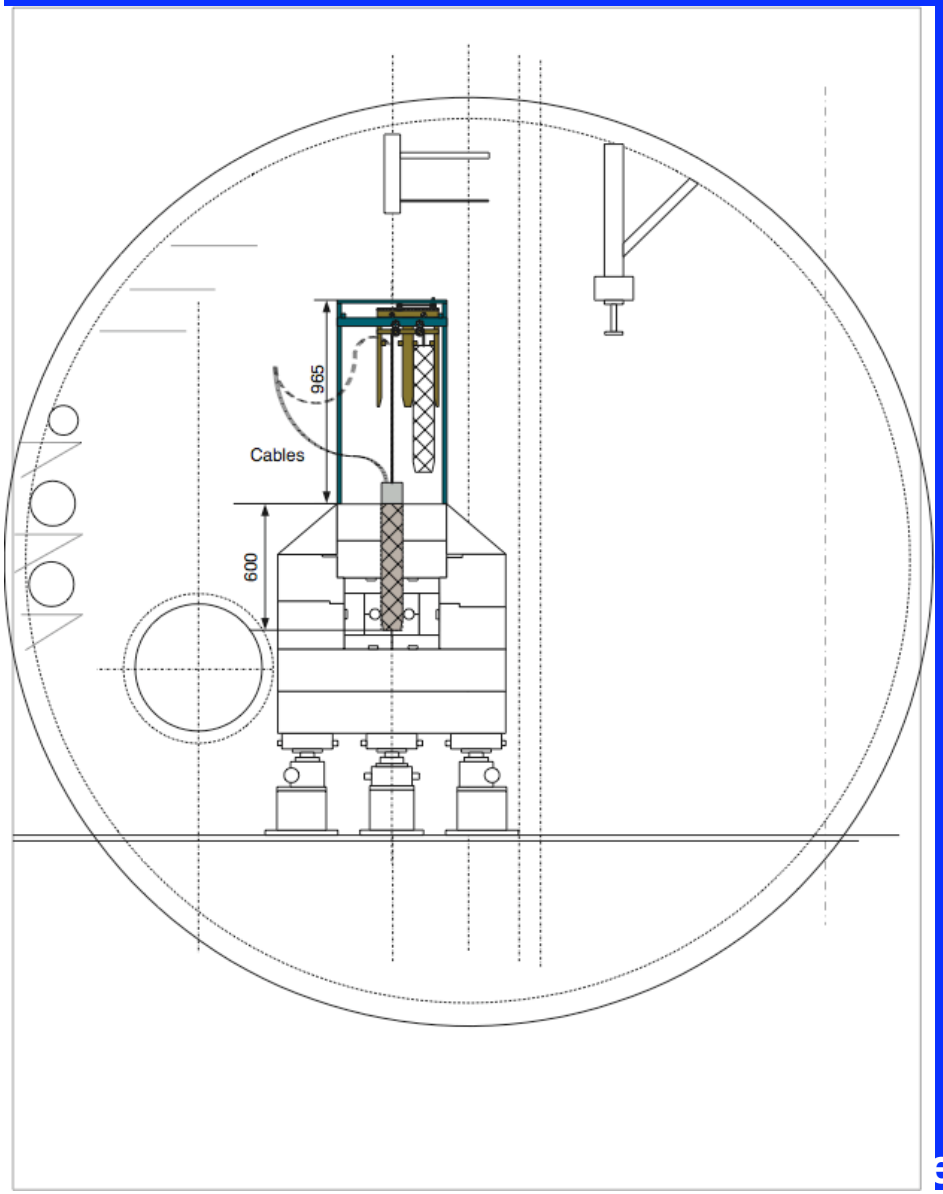
Radiation Dose @ 10^{34}

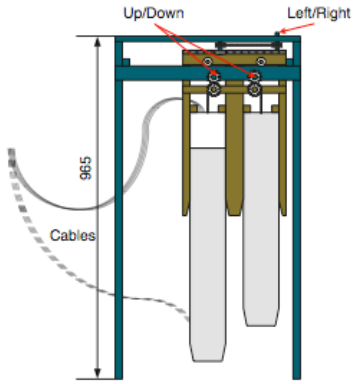


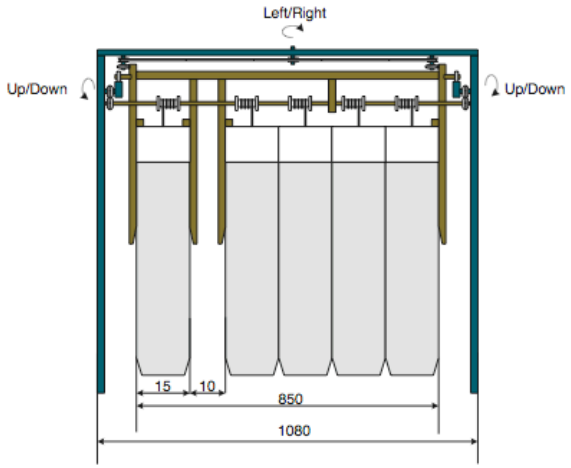
ZDC rad hard to ~4 Grad

@ 10^{34} annual dose significant
Consider rigging fixture to
Remove modules for highest
Luminosity pp.

Rigging fixture to replace modules



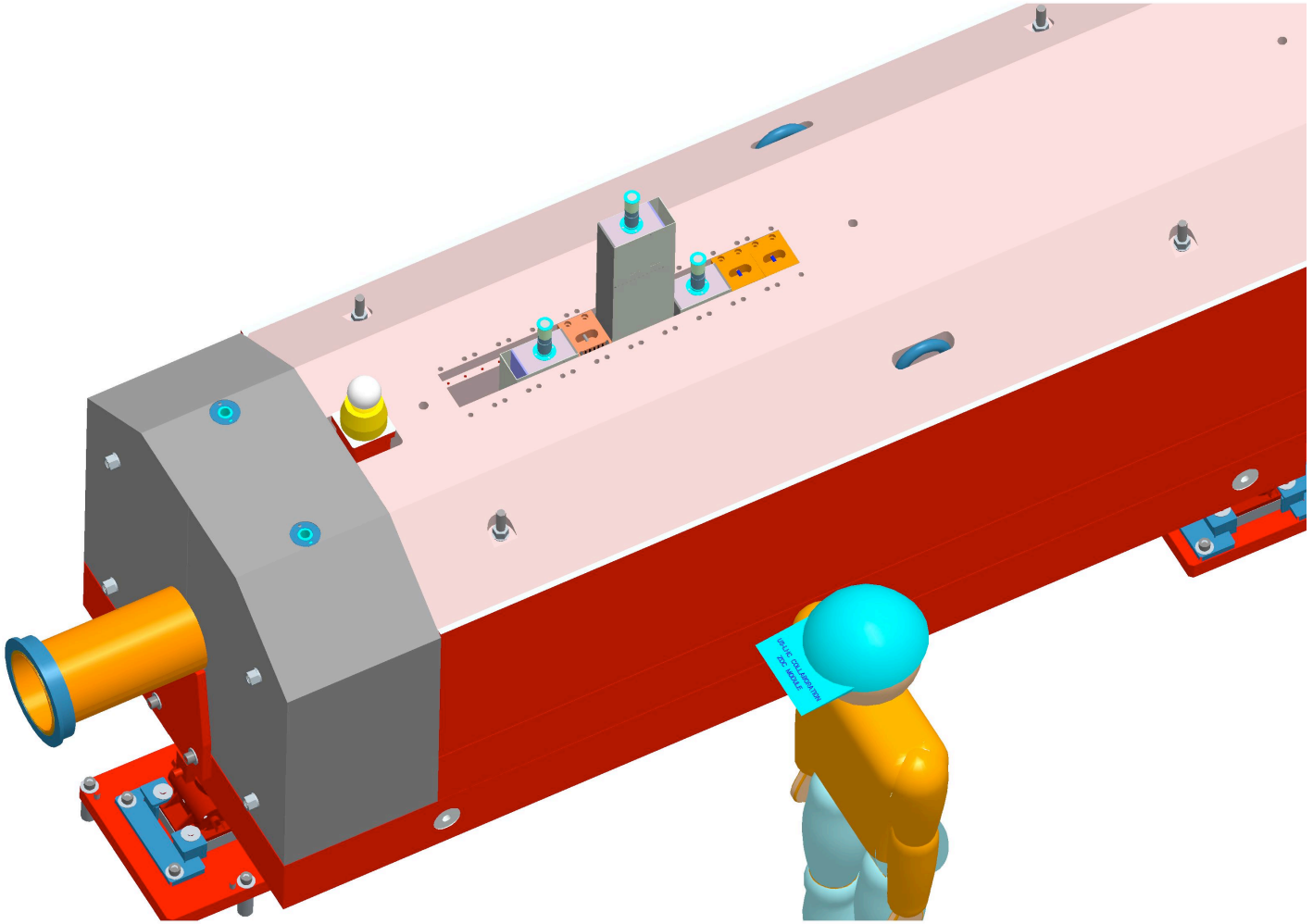




Proposed running scenario

- LBNL ion chamber to occupy slot 4 in TAN
- 1st 3 slots occupied by LHCf then by 1st ATLAS ZDC module
- Remaining ZDC modules after slot 4.
- These could also be useful as Hadron calorimeter section for LHCf

Configuration for LHCf compatibility



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Run Scenario(2)

- ZDC can be in place for initial Luminosity commissioning- provide both coordinate readout and clean calorimetry complementing ion chamber
- ZDC remains in for early LHC running in pp mode (except 1st module during LHCf)
- After machine achieves 10^{34} ,ZDC to be replaced by Cu absorbers during pp runs

Beam Crossing Angle @ IP1

=>forward neutrons displaced upwards

(This is favorable for ZDC performance)

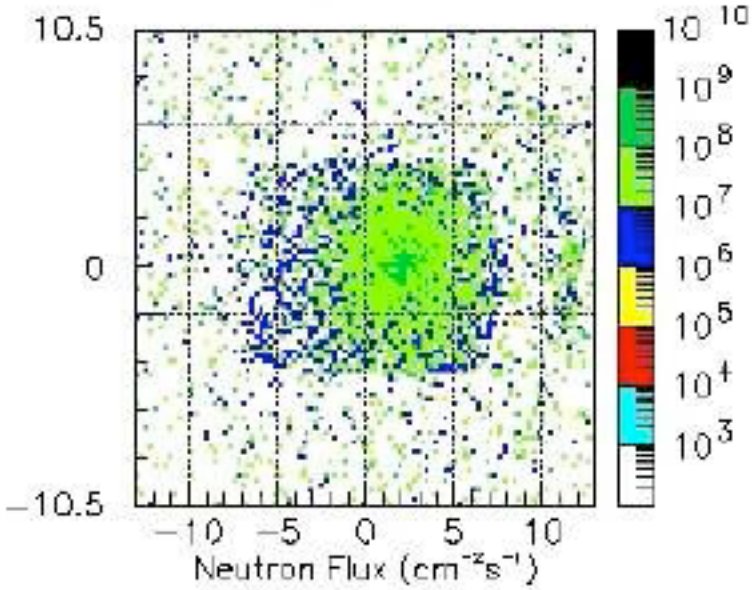

Figure 2: *Neutron flux at the TAN surface.*

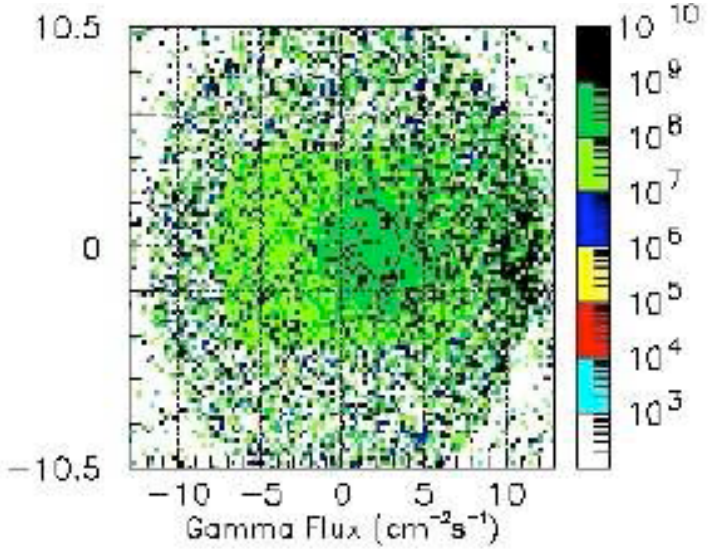

Figure 3: *Photon flux at the TAN surface.*

Primary Institutions BNL, IHEP, Yale

Physics

ATLAS Notes | Detectors and Experimental Techniques | CERN-ATL-COM-PHYS-2006-014 | ATL-COM-PHYS-2006-014

A Zero Degree Calorimeter for ATLAS

Atoian, G; Denisov, A; Isaakov, V; Poblaguev, A; White, S; Zeller, M;
(CERN)

Geneva : CERN, 14 Feb 2006 . - 12 p

Abstract: We present physics opportunities with a Zero Degree Calorimeter to be installed in the TAN. The design and simulation results from the proposed calorimeters are also discussed.

Keywords: Forward Physics HEAVYIONS
Note: This paper is a draft LOI for the Zero Degree Calorimeter.;

Accelerator: CERN LHC
Experiment: ATLAS

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CERN
CH-1211 Geneva 23
Switzerland

the **Large Hadron Collider** project

LHC Project Document No.
[doc no.]
CERN Div./Group or Supplier/Contractor Document No.
EDMS Document No.

Date:

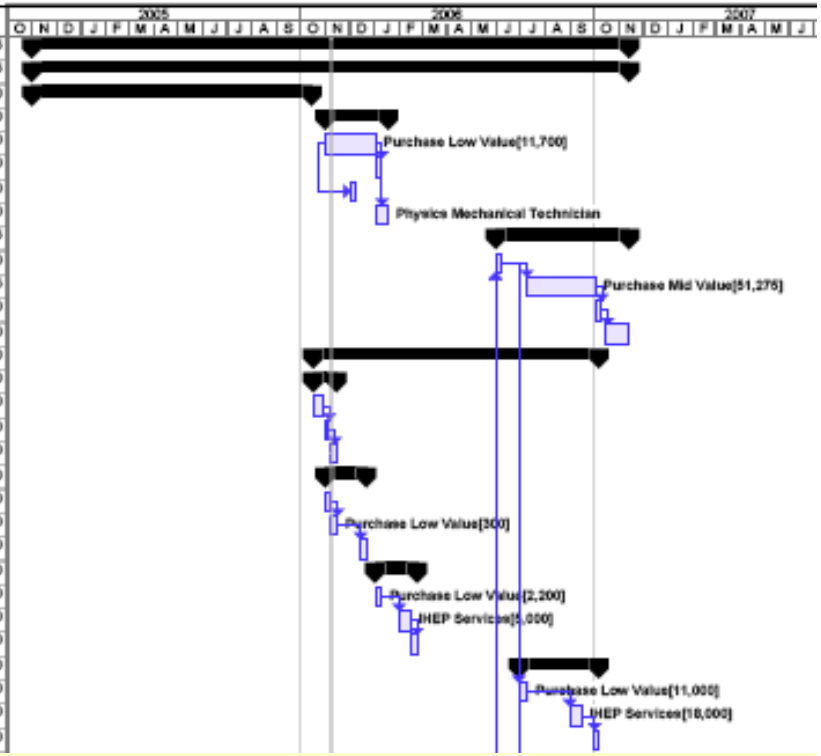
Engineering Spec

ZERO DEGREE CALORIMETERS LOCATED AT TAN ABSORBER ON EITHER SIDE OF IP1 (ATLAS IR)

Abstract

6 identical Tungsten/Steel modules with silica optical fiber readout will be installed- 3 in each TAN enclosure. One module is located in front of the LBNL Lumi monitor and 2 are located behind it. Each module is 92 mm wide by 153 mm long so the total linear space taken by the modules is only 459 mm out of 1000 mm total space in the TAN. Each Tan module has 3 external connections- a High Voltage cable (nominal 1800 v) a coaxial signal readout cable and an optical fiber for flasher testing. The modules will also have lift fixtures to be specified. Each module weighs 79 kg.
The purpose of this document is to provide a summary of the Zero Degree Calorimeter (ZDC) modules and their operation with respect to LHC absorber material and instrumentation that also occupies the TAN.

ID	WBS	Task Name	% Complete	Duration	Start	Finish	Cost
1		Project Summary	12%	510 days?	Mon 11/1/04	Mon 11/13/06	$214,168.15
2	1.1	ZDC Mech Structure	20%	510 days	Mon 11/1/04	Mon 11/13/06	$78,318.15
3	1.1.1	Module Design	80%	241.5 days	Mon 11/1/04	Fri 10/14/05	$0.00
10	1.1.2	Produce, Assem.(proto)	0%	50 days	Tue 11/1/05	Wed 1/18/06	$20,377.40
11	1.1.2.1	Order Prototype	0%	5 wks	Tue 11/1/05	Mon 1/2/06	$14,391.00
12	1.1.2.2	Prototype Delivery	0%	1 wk	Mon 1/2/06	Tue 1/10/06	$0.00
13	1.1.2.3	Fabricate Top-plate Details	0%	1 wk	Fri 12/2/05	Thu 12/8/05	$0.00
14	1.1.2.4	Assemble with Fibers	0%	2 wks	Mon 1/2/06	Wed 1/18/06	$5,986.40
15	1.1.3	Complete Assembly & Test	0%	114 days	Thu 6/1/06	Mon 11/13/06	$57,940.75
16	1.1.3.1	Final Design Review	0%	1 wk	Thu 6/1/06	Wed 6/7/06	$0.00
17	1.1.3.2	Place Order with Starck	0%	12 wks	Mon 7/10/06	Mon 10/2/06	$57,940.75
18	1.1.3.3	Deliver Five Production Modules to BNL	0%	1 wk	Tue 10/3/06	Mon 10/9/06	$0.00
19	1.1.3.4	Assemble with Fibers	0%	4 wks	Mon 10/16/06	Mon 11/13/06	$0.00
20	1.2	Optical Fibre System	0%	243.5 days	Mon 10/17/05	Fri 10/6/06	$39,605.00
21	1.2.1	Fiber Selection	0%	20 days	Mon 10/17/05	Mon 11/14/05	$0.00
22	1.2.1.1	Samples from SEDI, Ceramoptec, Polymicro	0%	2 wks	Mon 10/17/05	Fri 10/28/05	$0.00
23	1.2.1.2	Test Unjacketed Fiber	0%	1 wk	Mon 10/31/05	Fri 11/4/05	$0.00
24	1.2.1.3	Quote from Vendors for Prototype	0%	1 wk	Mon 11/7/05	Mon 11/14/05	$0.00
25	1.2.2	Ribbon Fabrication R&D	0%	34 days	Tue 11/1/05	Wed 12/21/05	$369.00
26	1.2.2.1	Test Fabrication Adhesives	0%	1 wk	Tue 11/1/05	Mon 11/7/05	$0.00
27	1.2.2.2	Purchase 200 Meter Test Fiber	0%	1 wk	Tue 11/8/05	Tue 11/15/05	$369.00
28	1.2.2.3	Fabricate Test Ribbons	0%	1 wk	Thu 12/15/05	Wed 12/21/05	$0.00
29	1.2.3	Prototype Module Fiber	0%	35 days	Mon 1/2/06	Wed 2/22/06	$7,708.00
30	1.2.3.1	Purchase 1,500 Meters of Fiber	0%	1 wk	Mon 1/2/06	Mon 1/9/06	$2,708.00
31	1.2.3.2	Fabricate 12 Ribbon Layers	0%	2 wks	Wed 2/1/06	Tue 2/14/06	$5,000.00
32	1.2.3.3	Assemble & Polish	0%	1 wk	Wed 2/15/06	Wed 2/22/06	$0.00
33	1.2.4	Production Fibers	0%	66 days	Fri 6/30/06	Fri 10/6/06	$31,530.00
34	1.2.4.1	Purchase 7,500 Meters of Fiber	0%	1 wk	Fri 6/30/06	Mon 7/10/06	$13,530.00
35	1.2.4.2	Fabricate Ribbon Layers	0%	2 wks	Fri 9/1/06	Fri 9/15/06	$18,000.00
36	1.2.4.3	Assemble 5 Production Modules	0%	1 wk	Mon 10/2/06	Fri 10/6/06	$0.00



Total project cost (w. burdens)= $270k

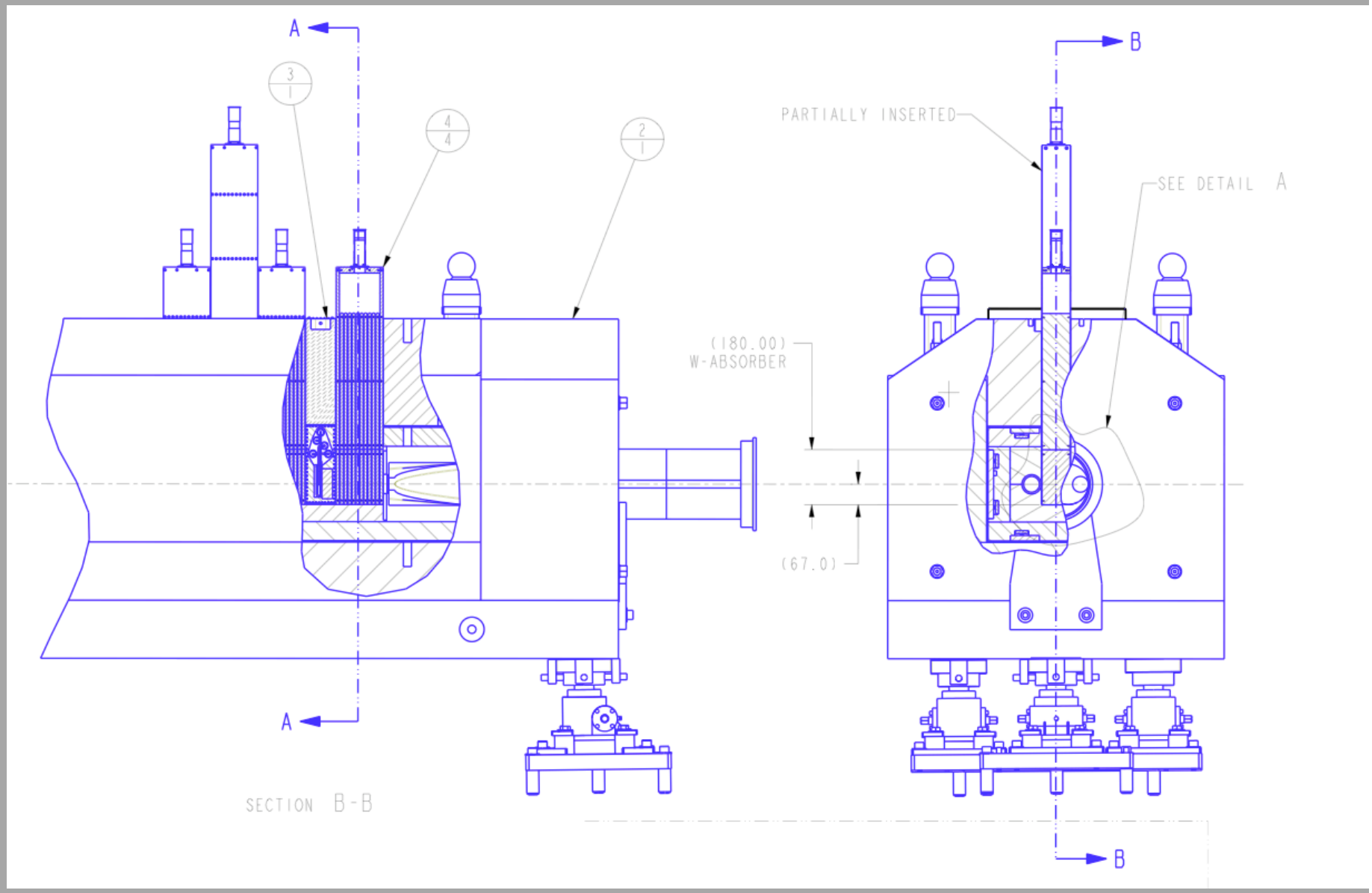
BNL funds now committed and building 1st module($50k)

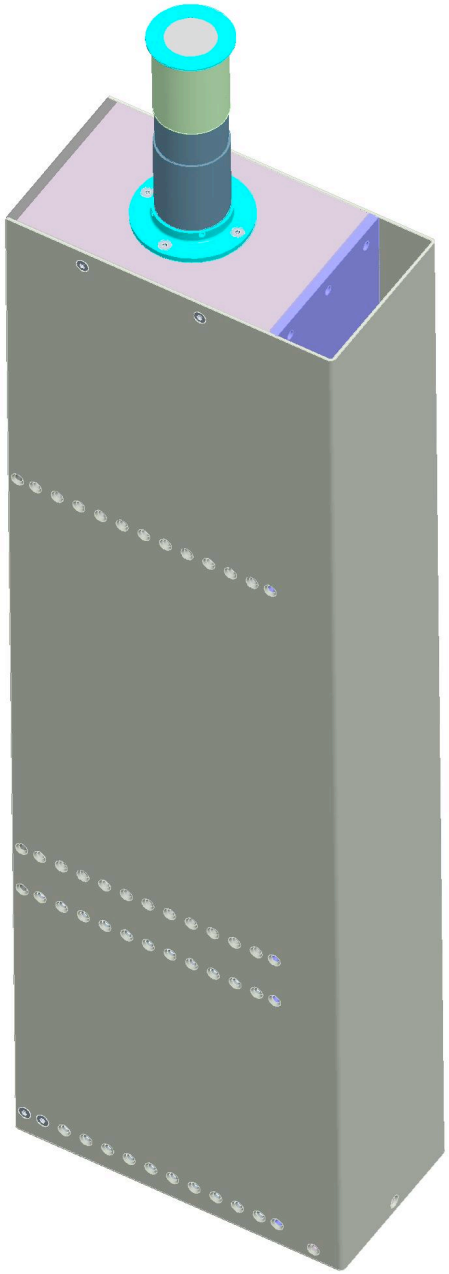
Completion this Spring

Full construction schedule driven by funding rate.

Summary

- ATLAS ZDC will make unique contribution to HI and pp programs, LHC commissioning
- Particularly to day-1 physics, event characterization and emerging UPC program
- ATLAS ZDC will provide data for all collider species
- Unique in coordinate measurement (v_1, particle spectra and for machine ops.)


A
3
4
4
2
PARTIALLY INSERTED
B
SEE DETAIL A
(180.00)
W-ABSORBER
(67.0)
A
SECTION B-B
B



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We would like to install three shower counters with a dimension
2x2,
3x3, 4x4 cm^2 and

43 radiation length respectively.