Cronin Science Symposium

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The Road to the Auger Observatory

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The Auger Observatory – the idea

The design of the Pierre Auger Observatory marries two well-established techniques

→ the ‘HYBRID’ technique

Fluorescence →

AND

Arrays of water-Cherenkov detectors
Dublin: International Cosmic Ray Conference
August 1991

Jim to spend from September to Christmas 1991 in Leeds

− but a lightning strike had wiped out CASA, in Utah

− was he still coming?

“You’re not nearly ambitious enough:

We should build 5000 km²”

This was the start of what has become the Pierre Auger Observatory

Early name – P5000
“The problem is lack of exposure: it has been clear for many years that 1000 km$^2$ of instrumented area is needed, but progress towards getting this has been slow.”

$10^{20}$ eV: flux is $\sim 1$ km$^{-2}$ per century

“The experimental problems are challenging and subtle but certainly soluble. All that is need is dedication, money and patience.”
Jim’s plan, while in Leeds, had been to work on some CASA data - where some showers due to protons?

In fact, most of the time was spent on early planning for what became the Auger Observatory.

Test measurements were made at Haverah Park and contacts were strengthened with our Electronic Engineers – particularly on GPS (GLONAS expert)

- led to GPS studies, largely by Clem Pryke

- and eventually to the work on the communications system by Paul Clark
For the first eighteen months or so, Jim and I were in favour of using only a ground array.

This was probably our worst piece of misjudgement throughout the whole enterprise.

"It's time we face reality my friends: we should keep to ground detectors."
A tank was opened at the ‘end of project’ party on 31 July 1987. The water shown had been in the tank for 25 years but was quite drinkable!

Jim: “An existence proof”
How to get the data back

It was not obvious how to do this

I suggested collecting signals at detectors only if they were very large or very slow and reading the data back once a day – procedure had been used with some success at the Sydney Shower Array (SUGAR) – and demonstrated at Haverah Park

Jim found the latter idea very hard to accept - many arguments – he could be very stubborn!

When Jim left Leeds in December 1991, he demanded an experimental demonstration before he would accept the idea
Figure 3.1 The integral risetime spectrum of pulses from the water Čerenkov detector.

Time Distribution in Haverah Park Tank

This is really the origin of ‘time-over-threshold’ at Auger

Time distribution in Auger tanks

COSMIC RAYS
ABOVE $10^{19}$ eV - 1992

Proceedings of the International Workshop on
Techniques to Study Cosmic Rays with Energies
Greater than $10^{19}$ eV

Paris, France
22–24 April 1992

Edited by
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Chicago, IL, USA

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Followed by workshops in Adelaide (January 1993)
and Tokyo (September, 1993)
Move to hybrid system under influence, in particular, of
Bruce Dawson
and Paul Sommers

Major Meeting in Paris in April 1992 organised by Murat Boratav
Adelaide was a real workshop where about 20 of us, including Jim, Antoine, Dave Nitz, Bruce Dawson, Roger Clay, Michael Hillas, Jeremy Lloyd-Evans, myself …….. brainstormed for about two weeks

Lead-burger (scintillator-lead-scintillator) idea to detect muons and electrons – later shown to work by Japanese

Jim hated the name!

Bruce Dawson pushed the hybrid idea – fell on deaf ears!

Australia Telecom came up with a plan for getting the data back – but for $12M!! – eventually solved by Paul Clark and his colleagues in Leeds
MAJOR PROBLEMS TO BE OVERCOME

• LACK OF MONEY TO DO ANYTHING

• Fight for recognition that the project was worthy of attention

• Site surveys –
  carried out by Ken Gibbs and Antoine Letessier-Selvon

• Develop a collaboration of critical mass and competence and with money to build a capital project of ~$100M

• How was the worth of the project to be assessed?

• A vulnerability, as with neutrino astronomy and, to a lesser extent, ground-based gamma-ray astronomy, at that time, was that there are no hard theoretical numbers demanding the construction of an instrument of a certain size
Coping with the lack of Money

Small amounts of money for travel and limited R&D from budgets of interested laboratories (e.g. Leeds: sale of lead previously used for muon shielding and aluminium lids)

UNESCO: Jim, with Murat Boratav, persuaded Director General to give significant support for three years (visits by scientists from developing countries to design study: $100k): USA was not a member!

Private donors whom Jim knew:

Robert Galvin, Motorola
David Grainger, benefactor of University of Chicago

Jim could get through doors that I could never even have knocked on!
August – September 1994

Visit to Far East with Jim (21 days)

Japan
South Korea
Hong Kong
China
Vietnam – Vice-President of the Communist Party
Australia – issues with Aboriginal land rites
- important visit to Mt Stromlo

Naming of the project:

A Unique Giant EAS Recorder \(\rightarrow\) A.U.G.E.R

\(\rightarrow\) Auger
The Auger Observatory Campus in Argentina

The Office Building in Malargüe
- funded by the University of Chicago ($1M) – strongly influenced by what we saw at Mt Stromlo
Design Study and Role of Fermilab director, John Peoples

“I do not remember a time when there was any doubt that we would participate in this project. John said at the time that he had recently read a book that was about or touched on the question of the source of cosmic rays. He was convinced that this was important work.

He agreed to support the workshop, provided space and people to help me organize it. There was a cost to John in all of this as there was a lot of hostility at Fermilab toward resources diverted from anything other than maintaining the machine and the big collider detectors. This hostility was running particularly high because of the perceived number of people in the Computing Division working the Sloan Sky Survey”.

Paul Mantsch, Auger Project Manager
Studies of various surface detector designs:

RPCs, water-Cherenkov, scintillators, radio…. “Let a thousand flowers bloom…."

Hybrid approach: ground array and fluorescence detectors - chose water as surface detector

Very extensive Monte Carlo calculations

Two sites to give all sky coverage

Each site ~3000 km² : site survey was contemporaneous

Approximate cost ~$100M

Design Study document completed in October 1995
The Auger Schematic Design

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AND

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Alan/Terence - it seems 1.2m is close to optimum depth for a water C detector!

Pryke

Post-Design Study

Tank depth studies (vertical muons)

96/02/19 12.40

Haverah Park tank depth
Assessment of the Project (November 1995)

No host institution (unlike new project at CERN, ESA, ESO, FNAL)

Formed own Review Committee

W I Axford (MPI: Director, Katlenburg-Lindau): Chair
R Cowsik (Indian Institute for Astrophysics, Bangalore, India)
M Demassieux, ENST (France)
R Eckers (Australain National Telescope, Australia)
M-T Koshiba (Japan)
J Steinberger (CERN, Switzerland)

‘Entirely favourable’ report used to help with agencies

“But of course it is a favourable report: you chose the committee”

- an agency that will remain anonymous
The Search for Funding in the USA

All countries watched what the US was doing

Significant promises of funding from Argentina, Brasil and Mexico

US assessment by SAGENAP committee:

DIFFICULT! Third time lucky (April 1998)

BUT:

BUILD ONLY ONE ARRAY and GO SOUTH
• Should we follow what SAGENAP said?

• Jim was totally depressed and felt a sense of failure

• The rest of us just enjoyed the caipirinhas!

  - and persuaded Jim that we should go ahead
After US funding announced in 1998, funding from European Countries came relatively quickly.

This allowed International Agreements to be signed

Ground-breaking Ceremony in March 1999
17 March 1999: Ground Breaking Ceremony
Ground Breaking Ceremony  17 March 1999
Did I always agree with Jim?

- No!
- Relationship with EUSO
- FD in North and South
- Some ‘infilling’ of 1500 m array at an early stage
Some thoughts after the wrap-up meeting following the Design Study at FNAL: August 1995

“I think we should consider operating an infilled-section of Auger for perhaps the first five years of the project. This need only be ~ 100 km\(^2\) and might have 500 m spacing.

My estimate is that this would be fully efficient at 5\(\times 10^{18}\) eV so that about **400 events per year would be recorded, a total of 2000 before the detectors were moved** to augment the array by ~ 1000 km\(^2\)

(or larger if operations with the sparse array **show that a spacing > 1.5 km was tolerable for the very largest events**).

**It will enhance the confidence with which we can reconstruct events in the decade above threshold with the 1.5 km spaced array**.”
Morelia Collaboration Meeting: 2000

- Discussions about lay-out of Engineering Array: infilling?

- Jim was stricken with Montezuma’s revenge

- I went to see him – strong feeling at the meeting for some infilling of Engineering Array

- He dragged himself from his sickbed – spoke passionately against the idea. The vote was 15 – 5 (with two abstentions) AGAINST infilling – but there was general agreement that we should do it later.

- Jim’s main arguments: political damage
distracti on
division of group into 2 (as at CASA)

“Triumph of irrationality” (Jim)
Layout of the Engineering Array: April 2001

Auger campus: Assembly hall, Office and Visitor building

City of Malargüe

Engineering Array
40 Surface Detectors

“Los Leones”
first 2 fluorescence telescopes
The Pierre Auger Observatory: talk in Chicago in November 2002
From Administration to Cosmic Rays

J W Cronin:


The first opportunity was an offer I received from Robert Wilson to be head of a new colliding-beams division at Fermilab. Flattered, I accepted, being quite uncritical about the conditions, the available staff, and the financial resources. In addition, there were intense and unpleasant interactions with Fermilab colleagues who felt they should have been given the responsibility. I accepted the appointment in January 1977 and resigned in frustration that fall. I will not use space here to go through the details that are described in the book Fermilab: Physics, the Frontier and Megascience by Lillian Hoddeson, Adrienne W. Kolb, and Catherine Westfall (71, pp. 286–88). Although I was unsuccessful, I did learn a great deal of accelerator physics. Also, I learned something very important about myself. Later in my career I gained a sufficient reputation to have offers to move to academic or scientific administration. My experience with the Fermilab colliding-beams position taught me that I would not be happy with such responsibilities, so over the remainder of my career I turned down every offer of that nature. The only (partial) exception
Attenuation curve by constant intensity technique
Measured from data not simulated

Normalized to 1.0 at sec theta = 1.27 or theta = 38 deg

Done using Fortran77 and TopDrawer – thanks to Valeri Galtsev and Mary Heintz
Conclusions

What an amazing man and what a fascinating road he led us along!