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# Report of the Scientific Assessment Group for Experiments in Non-Accelerator Physics (SAGENAP)

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University of California, Los Angeles

Presentation to HEPAP  
Washington, DC Sept 24, 2004

# Science

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Exciting research at physics/astronomy interface.

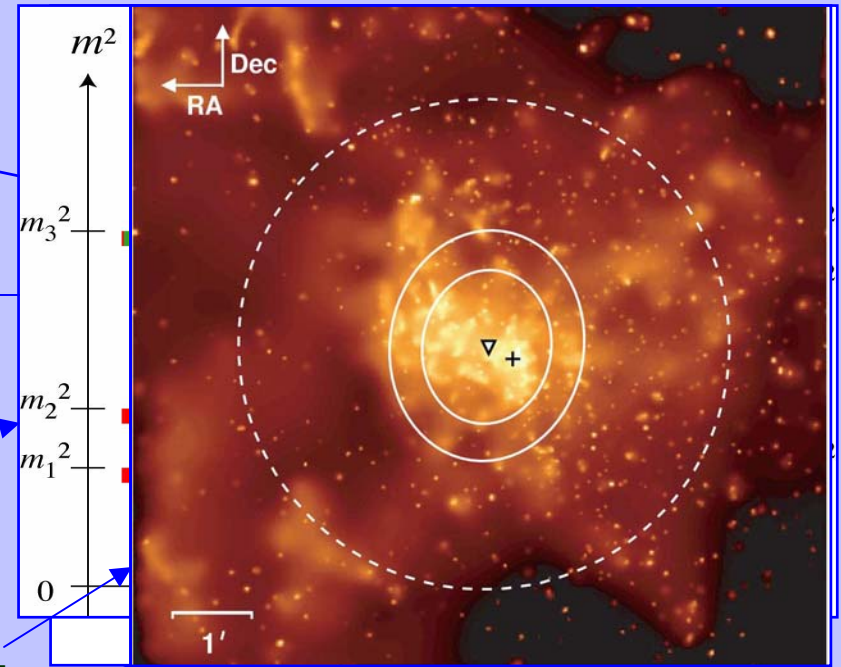
We grouped projects into four areas:

1. Dark Energy & Cosmic Microwave Bkgnd.
2. Dark Matter
3. Very High-Energy (VHE) particle astrophysics
4. Neutrinos

# Recent Highlights

- Discovery of acceleration in expansion of Universe (“Dark Energy”).
- Pinning down the key cosmological parameters.
- Discovery of two manifestations of neutrino oscillations.
- Cosmic  $\gamma$ -ray sources &  $10^{20}$  eV particles.
- Tighter constraints on particle dark matter.

TeV  $\gamma$ -rays from Center of Galaxy



Perlmutter, 2003  
Aha, Perlmutter, 2004  
Allen et al., 2004

# Charge

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Letter of [April 12, 2004](#) from R. Orbach and M. Turner to F. Gilman

“... request that the High Energy Physics Advisory Panel (HEPAP) establish a subpanel to assess projects in experimental non-accelerator physics ...”

“SAGENAP’s role is to provide one view of which projects are worthy of further, in depth, consideration for funding by the agencies. SAGENAP’s primary consideration is the scientific merit of the project.”

“SAGENAP will assess projects in three categories:

1. Projects in the conceptual phase;
2. Projects that are ready to request agency funding for concept studies, design and development, or construction;
3. Ongoing projects funded by the above named agencies.”

“For projects in category 3, SAGENAP will:

- Assess progress and any scientific issues on the ongoing project and identify any areas of concern for agency attention.”

# Charge (continued)

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“For projects in categories 1 and 2, SAGENAP will:

- Assess the scientific merits of the project.
- Assess the readiness of the project to request funding for concept studies, design studies, or construction.
- Assess the scientific and technical goals of the project in the context of related activities in the field.
- Assess the scientific, technical, organizational, and management capabilities of the project team.”

“SAGENAP will also identify activities that may lead to construction projects in the future, and assess their priorities, readiness, approximate timescales and cost.”

“The Chair ... will prepare a report following the meeting. The report should provide a balanced summary of the assessments of the SAGENAP members for each project on the agenda.”

# SAGENAP Members

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Mark Devlin (U. Penn)

James Musser (Indiana U.)

Steve Elliott (LANL)

Rene Ong (UCLA) - CHAIR

Garth Illingworth (UCSC)

Steven Ritz (GSFC)

Kim Griest (UCSD)

Hamish Robertson (U. Washington)

Richard Kron (U. Chicago/FNAL)

Robert Svoboda (LSU)

DOE: A. Byon-Wagner, G. Crawford, R. Imlay, R. Staffin, K. Turner, P.K. Williams

NSF: R. Boyd, J. Dehmer, C. Foltz, E. Loh, V. Pankonin, N. Sharp, M. Turner, W. Van Citters

Observers from NASA (P. Hertz) and other groups.

# Projects (26 !)

Area	Category 1 & 2	Category 3
Dark Energy & CMB	Dark Energy Survey Destiny LSST Polarbear Quiet	SNAP R&D
Dark Matter		CDMS II DRIFT R&D XENON R&D ZEPLIN II
VHE Particle Astrophysics	ASHRA Auger Project N HAWC Tel. Array/TALE	Auger Project S HiRes Milagrao STACEE VERITAS
Neutrinos	ICARUS LANND	EXO R&D KamLAND Super-Kamiokande

Also, general reports on:

Accelerator, reactor-based neutrino effort  
Double-beta decay  
Electron EDM projects

# Strategy

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- Scientific assessment is most important.
- Need scientific and programmatic context.
- Individual project assessment:
  - Category 1: “Heads-Ups”
    - Assessment of science.
    - Can they do what they propose?
    - Feedback on concerns for a future proposal.
  - Category 2: “Proposals” – LSST
    - Assessment of science.
    - Can they do what they propose?
    - Detailed review of the project.
  - Category 3: “Status Reports”
    - Summary of progress – i.e. sanity check.



# Strategy, Procedure

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- Decision made to not prioritize.
- Individual perspective vs consensus.
- Report: Dense, project-oriented  
Recommendations not detailed or highlighted.

## Procedure:

- 3-Day Meeting, April 14-16, 2004.
- Received materials from each project.
- Website: public and private sections.  
<http://astro.ucla.edu/~sagenap/>
- 4 teleconferences & copious e-mail.

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A very brief summary of the highlights of the report follows here:

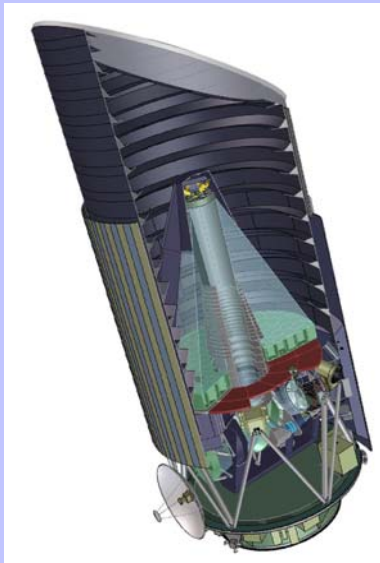
- slides are not inclusive and do not substitute for the report.
- for lack of time, there is relatively little on those projects that gave Status Reports.

# 1. Dark Energy

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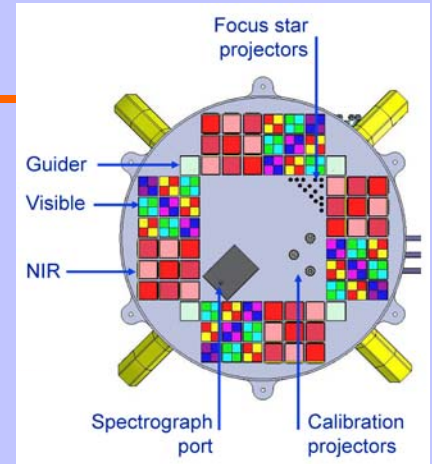
- Heard from:
    - 1 proposal: LSST
    - 2 heads-ups: Dark Energy Survey, Destiny
    - 1 status report: SNAP R&D
  - Dark Energy is a mystery of great scientific importance.
  - Variety of different techniques and approaches:
    - Supernova Ia, weak lensing, galaxy clusters, etc.
    - Space-borne and ground-based techniques.
    - Multiple wavebands, agencies and communities involved.
- SAGENAP recommends a Roadmap Study to provide context for this important area.

# SNAP



**SNAP Telescope concept**

- SuperNova Acceleration Probe:
  - Space-borne instrument to study DE.
  - Possible implementation for JDEM.
  - Extensive R&D for a number of years.
  - Relatively mature and well-developed concept.



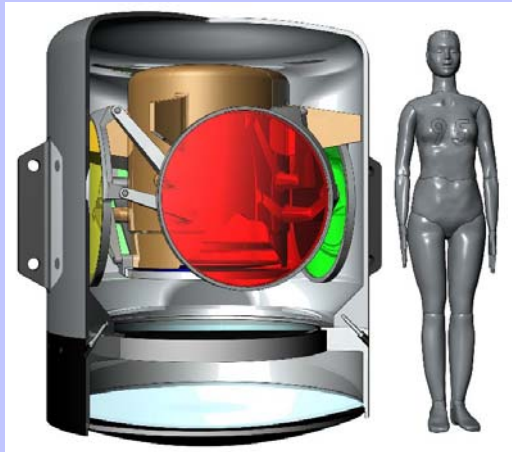
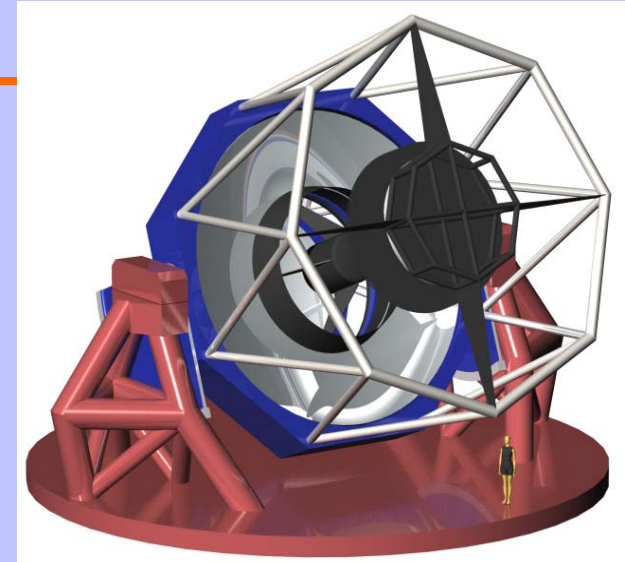
**Focal plane layout**

→ Very well-motivated experiment attacking superb science. Team is very strong and is attacking the critical issues. R&D is going well. No other concepts for DE are as mature or have better capability.

# LSST

- Large-aperture Synoptic Survey Telescope:
  - 8 m wide-field ground-based telescope.
  - Cosmology using weak lensing, SN et al.
  - Great capability to study transients.
  - Larger  $A\Omega$  than all other concepts.
  - Very high data rate, large data volume.

Telescope Concept



Camera concept

- Outstanding science, also highlighted in other reports.
- Excellent concept and very strong team.
- R&D funding is well-motivated.
- Some concerns in: science management, simulations, camera R&D, and data handling.
- Agencies should define a coherent process to move LSST forward through the R&D (possibly D&D) phase.

# Dark Energy Heads-Ups

## Cerro Tololo (Chile)

Blanco 4m on Cerro Tololo



Image credit: Roger Smith/NOAO/AURA/NSF

- Dark Energy Survey (DES):
  - DE measurements using lensing, SN, clusters.
  - New 3 deg<sup>2</sup> camera on existing telescope.
  - Partnership with SPT, universities, FNAL.
- Science goals are excellent; team is strong. Some concern on costs and software. Roadmap is needed to put this project into proper context.

- Destiny:
  - Space-borne instrument to study SN Ia.
  - Possible implementation for JDEM.
  - Simpler, currently less mature than SNAP.
- Relatively simple (grism), possibly lower cost, but may have larger systematic errors. Simulations and trade-off studies are required; team needs strengthening.

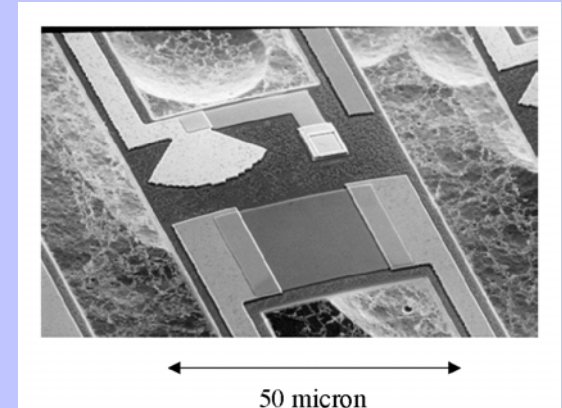
**Destiny  
Concept**



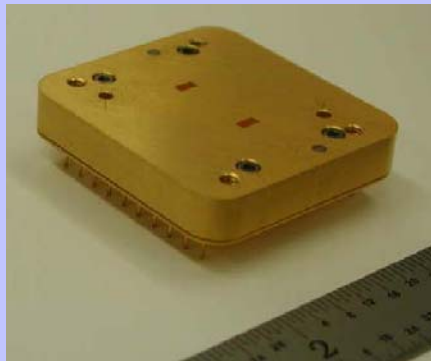
# CMB Heads-Ups

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- **Polarbear:**
  - Experiment for CMB polarization (B-modes).
  - 3 m telescope in eastern California.
  - Monolithic detector design (TES devices).
- Very important science (numerous groups).  
Technique is novel and promising. Merits funding in the broader picture provided by CMB roadmap.

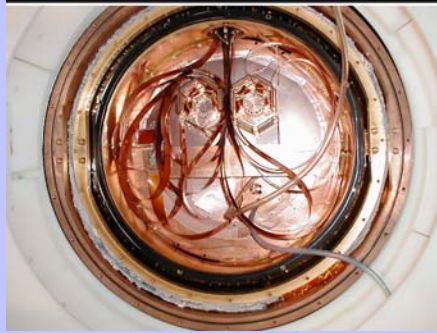


**Radiometer on a chip**



**MIMIC sensor**

- **QUIET:**
  - Experiment for CMB polarization.
  - Move existing 7 m telescope to Chile.
  - Compact MIMIC technology.
- Science goals are excellent; relatively few technical difficulties. Merits funding, also in the broader context.



## 2. Dark Matter



- Heard from:
    - 4 status reports: CDMS II, DRIFT R&D, XENON R&D, ZEPLIN II
  - Many projects worldwide searching for particle DM.
    - DAMA result has now been ruled out.
    - Pushing into interesting areas of SUSY parameter space.
    - CDMS is (and will remain) at the forefront. They should be supported.
  - Future:
    - Xe may be preferred technology for very large (ton) expts.
    - Good progress has been made by XENON, ZEPLIN groups.
- We encourage support for R&D towards a large Xe detector.



# 3. VHE Particle Astrophysics

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- Heard from:
  - 4 heads-ups: ASHRA, Auger N, HAWC, Tel Array/TALE
  - 5 status report: Auger S, HiRes, Milagro, STACEE, VERITAS
- Great deal of activity – new results from current experiments
  - $\gamma$ -ray sources at TeV scales (Milagro & STACEE)
  - probing mystery of UHE cosmic rays (HiRes) – discrepancy between expts. on flux of events  $> 10^{20}$  eV.
- Upcoming projects look very promising (Auger S, VERITAS).
- Three of the heads-ups involved study of particles at  $>10^{20}$  eV scale in the Northern Hemisphere. Possible need for a study to put these efforts into general context.

# VHE-PA Heads-Ups

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- HAWC:

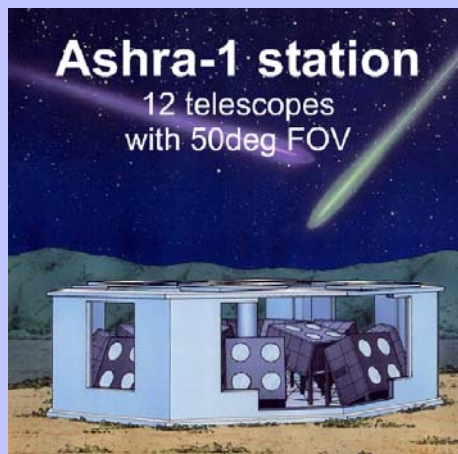
- Wide-field  $\gamma$ -ray telescope.
- Instrumented pond @ high altitude.
- Water Cherenkov technique (Milagro).



**HAWC  
Concept**

→ Science case not yet very strong. Need to justify what new physics HAWC would provide beyond existing and planned suite of  $\gamma$ -ray telescopes. Some technical and cost concerns.

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**ASHRA Concept**

- ASHRA:

- Concept for VHE  $\gamma$ -rays and UHE cosmic rays.
- $N_2$  fluorescence detectors; good optical performance.

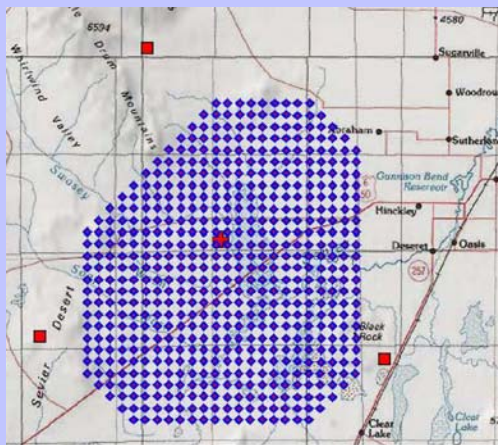
→ Concept has not yet demonstrated significant scientific advance. Detailed simulations needed. U.S. role in project needs to be understood. Broader context needed.

# VHE-PA Heads-Ups

- Auger Project North:
  - UHE cosmic ray detector.
  - 2<sup>nd</sup> observatory for complete sky coverage.
  - Ground array and N<sub>2</sub> fluorescence.
- Science case has not yet been established.  
Need to demonstrate why Auger S is not sufficient.  
Some concerns regarding design changes and site.



**AUGER**  
**Surface Detector**



**Proposed Tel. Array**  
**Layout in Utah**

- Telescope Array / TALE
  - N<sub>2</sub> fluorescence detector to study UHE cosmic rays.
  - Part of Telescope Array – low energy extension.
- Science and technical case for TALE is not yet strong.  
Overall context of Telescope Array not clear. Full scope and role of U.S. institutions must be understood.

# 4. Neutrinos

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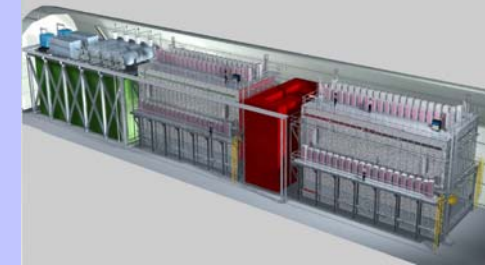
- Heard from:
  - 2 heads-ups: ICARUS, LANND
  - 3 status report: EXO R&D, KamLAND, Super-K
  - Presentations: Double- $\beta$ , reactor/accelerator  $\nu$  expts.
- Current experiments (Super-K, KamLAND) are outstanding:
  - Remarkable discovery and characterization of  $\nu$  oscillations.
  - Future scientific promise is great – efforts should be supported.
- Double- $\beta$  decay search is important.
  - Excellent progress on EXO R&D – should be aggressively pursued.
- Physics motivation for measuring  $\theta_{13}$  is compelling.
  - Reactor experiment appears to be a good bet – needs to be considered in overall context; the APS study is close at hand.

# Neutrino Heads-Ups

- ICARUS:

- Planned 3-kton Liquid-Ar TPC. 600T exists.
- N decay,  $\nu$  physics (incl.  $\nu$  beam from CERN)

→ We support the physics goals. U.S. contribution should be continued, in co-ordination with actual detector schedule.



**ICARUS Concept**

- LANND:

- Concept for Liquid-Ar detector in 100-kton range.
- N decay, long-baseline  $\nu$ , supernova  $\nu$ .



**5 m LAR test chamber**

→ Liquid-Ar detectors have important role to play in future  $\nu$  experiments. U.S. should regain technical strength. Support the idea of an increased R&D effort, subject to safety consideration & requiring a strong group.

# Central Findings I

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- Roadmapping & broader context needed
  - Key example: Dark Energy – multiple expts. & approaches.
  - We did not see everything; difficult to prioritize.
- 1. Dark Energy & CMB projects
  - Spectacular results → well-motivated new projects.
  - LSST very strong → reasonable to proceed with R&D.
  - CMB experiments excellent; wait until CMB Roadmap.
- 2. Dark Matter projects
  - Current projects going well & limits rapidly improving.
  - Development towards a large Xe detector worthwhile.

# Central Findings II

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- 3. VHE Particle Astrophysics projects
  - Lots of activity, exciting recent results.
  - $10^{20}$  eV mystery – general context needed.
- 4. Neutrino projects
  - Non-accelerator  $\nu$  expts: great results and great potential.
  - Reactor expt. very sensible – wait until APS  $\nu$  study.
  - Liquid Ar technology merits increased R&D effort.
- Electron EDM projects
  - Good science, best done in atomic physics community.

# Potential Improvements

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- Roadmapping needed
  - Science, measurements, exp. techniques, projects.
- Yearly meetings with broader context
- Larger panel or multiple panels
  - Sub-groups focused on specific areas.
  - Reasonable for panel chair to have input on meetings.
- Coordination/inclusion of other areas
  - Nuclear, astronomy.



# Summary

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- Very exciting time !
  - Scientific potential is outstanding.
  - Remarkable range of experimental opportunities.
  - Important to think about how to plan for the future.
- SAGENAP responded to charge to produce this report.
  - It's a draft and we welcome suggestions.
- Community is waiting for feedback from April meeting.