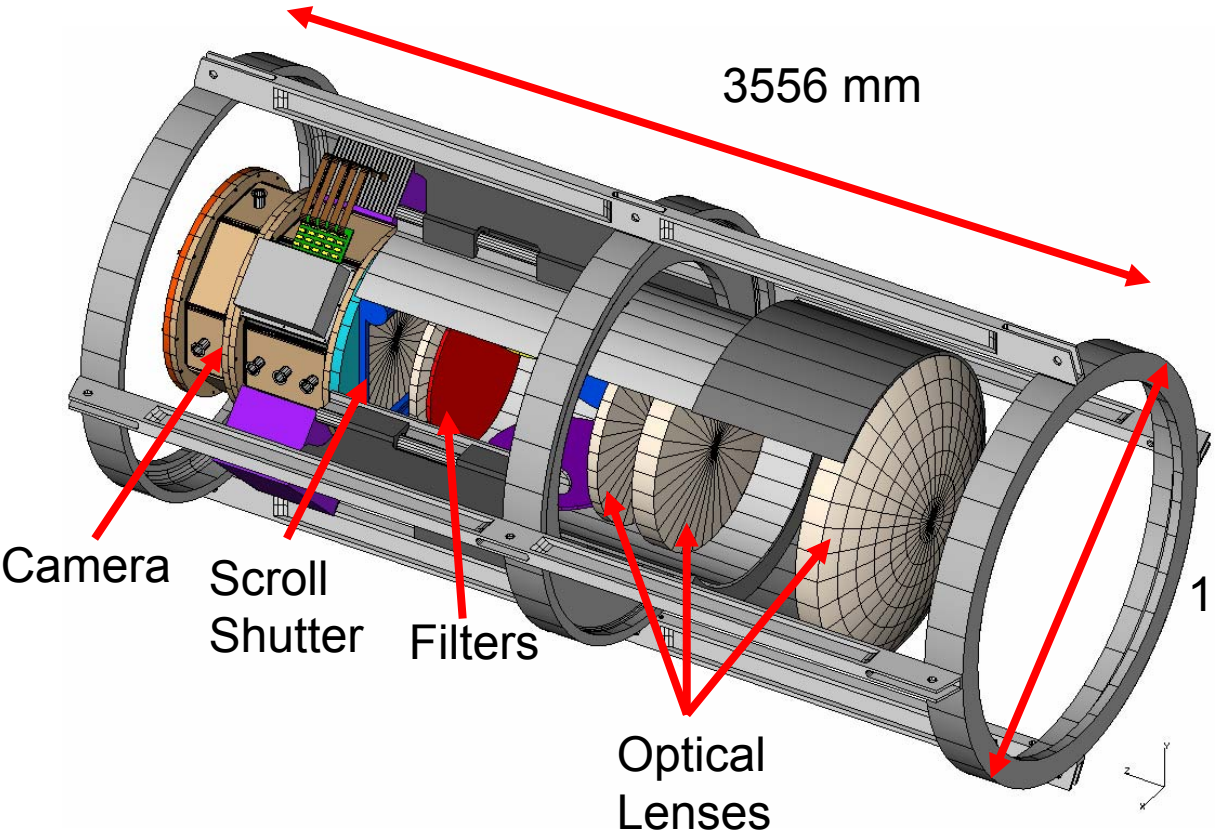
DES Technical Progress, Cost and Schedule

DARK ENERGY SURVEY



Outline

- **Update since last PAC**
- **CCD's**
- **FEElec & DAQ**
- **Camera Vessel/Cooling**
- **Optics**
- **Cost and Schedule update**
- **Conclusion**

DARK ENERGY SURVEY

Updates

- July 2004 DES received Stage 1 approval from the Directorate, and submitted the “DES Proposal” (200 pages) to NOAO
- Juan Estrada – new Wilson Fellow joined the DES project in Sept. and is taking a leading role in the CCD testing
- Trip to CTIO Oct. 2-8: engineers figured out how to integrate DES with existing facilities, established contacts and working relationships
- Very recent Updates
  - Fermilab and LBNL have signed an MOU to initiate the CCD preproduction run
  - UC and UIUC are in the process of signing MOUs which contribute funds for DES M&S costs – these will be used mostly this year to jump start the CCD packaging development, the optics, and setting up a CCD testing center.

DARK ENERGY SURVEY

CCDs

- CCD Specification Review Oct. 15th
  - Goal: generate list of specifications for the preproduction CCD masks
  - had talks on Science req., packaging, control of QE, and technical aspects of the LBNL CCDs
  - generated a spread sheet of specifications
  - final details being discussed now
- CCD Preproduction Procurement Details
  - Once we iron out the details, LBNL will design the masks (~6 wks)
  - Before submission to Dalsa we will have a final review of the masks
  - LBNL will order the wafers from Dalsa (7-9 months ARO)
  - Before processing these wafers at LBNL we come back to PPD to secure the funding (24k$/wafer)

CCD Mask Layout

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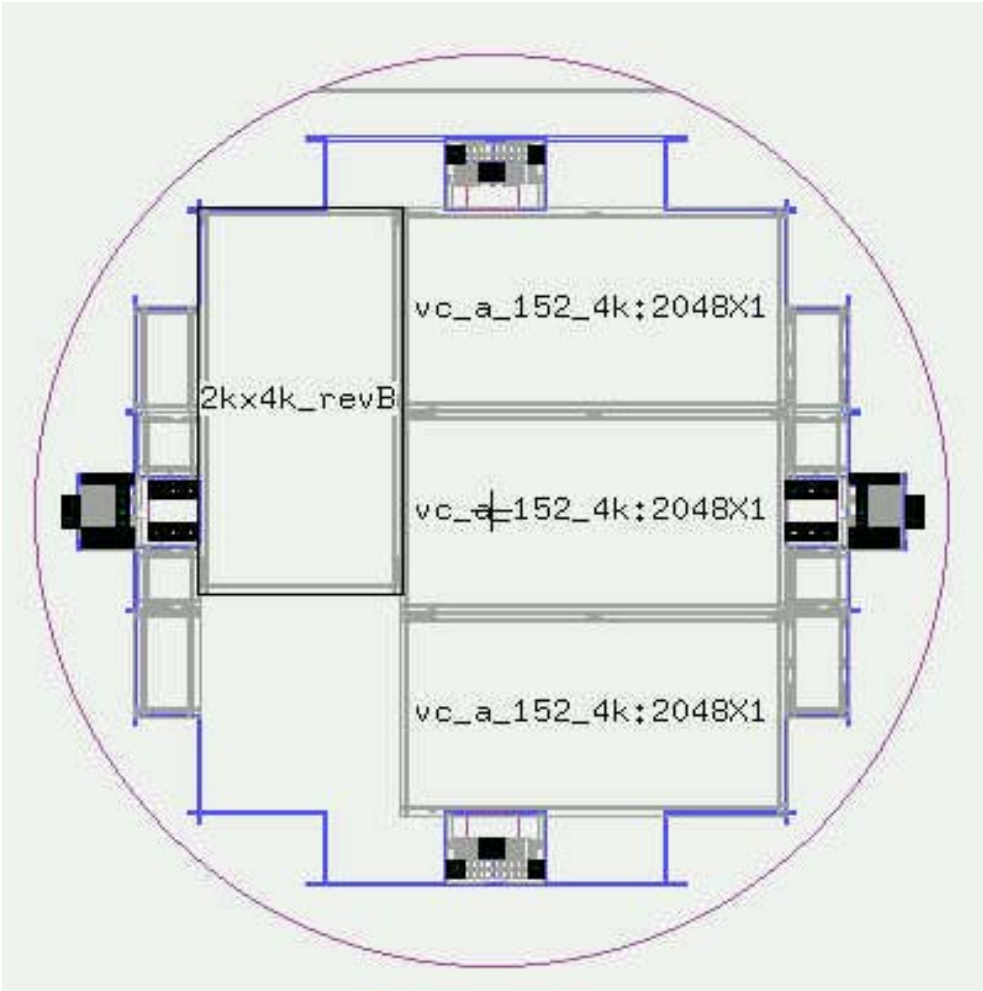
- Each mask will contain
  - 4 2kx4k devices. These are the Image CCDs
  - 1 ~2kx2k device
  - 2 ~1kx1k devices

- For Guide and Focus chips we have options
  - 2k devices are easier to handle and package than 1k so we will fill the space with a 2k x 2k device
  - guiders need fast readout (~ 1sec) we can use sub arrays

- Small chips ~ 1k x 1k will be used as test structures in picture-frame packages for tuning up the test stands.



CCD Procurement Plans

DARK ENERGY SURVEY

- Nov 2004 to Nov 2005: Phase A - Startup
  - Learn to operate CCDs,
  - begin packaging and work with R. Stover (LICK)
- Nov. 2004 to Dec. 2005: Phase B - Preproduction
  - new mask with four 2kx4k devices/wafer
  - 24 wafer run at Dalsa
  - process 2-5 wafers at LBNL
  - package and test and FNAL
  - Dec. 2005 Review Phase B CCD production and packaging results
- Dec. 2005 – July 2006: Phase C
  - process remaining Phase B wafers at LBNL
  - package and test at FNAL

CCD Procurement Plans

DARK ENERGY SURVEY

- Dec. 2005 – Dec. 06: Phase D1 – Part of CCD R&D program
  - Order 3 lots of 24 wafers each, assume 20 wafers/lot survive
  - processing at Dalsa ~ 6 months
  - process and package enough wafers to determine yield (~5 wafer/lot)
  - Dec. 06 Review Phase D1 CCD production and packaging yield results and determine if contingency run is needed

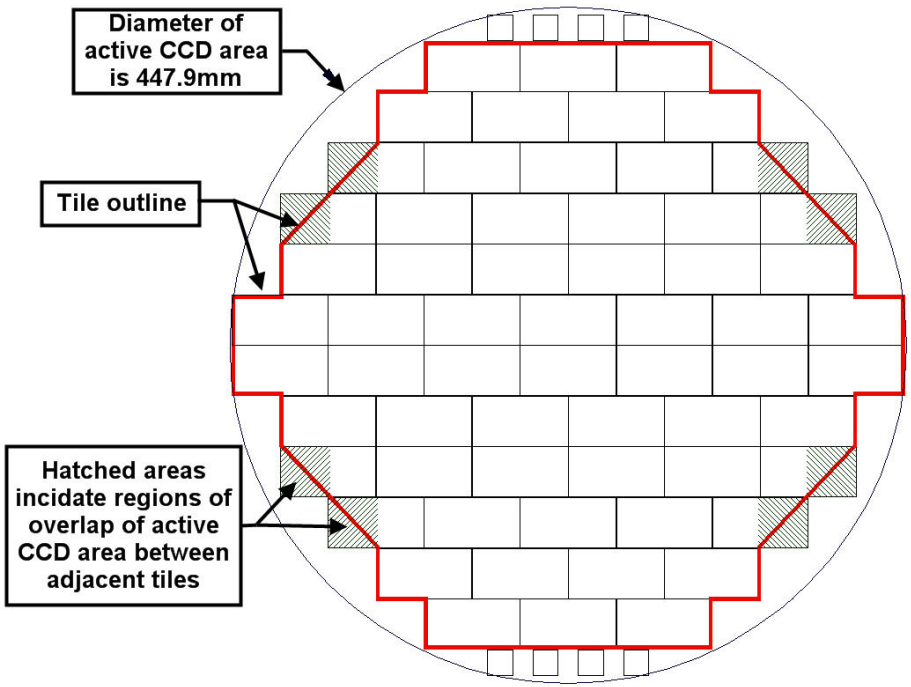
- Dec. 06 – Sept. 07 Phase D2 = CCD production
  - Process Phase D wafers at LBNL as needed depending on yield
  - LBNL produces 20 tested CCDs/month for 9 months (starting 3m aro)
  - FNAL packaging and testing designed to keep up with LBNL delivery

- Dec. 06 Phase E – Contingency Run
  - if Phase D1 indicates lower than 25% yield, place order for additional wafers

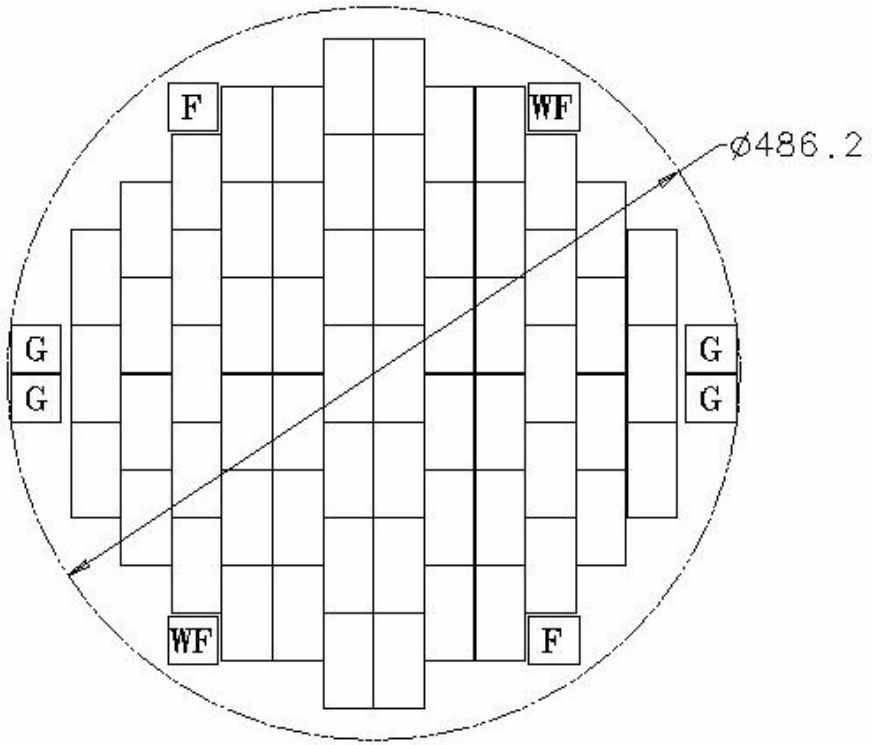
Focal plane layouts

DARK ENERGY SURVEY

August 04



Nov. 04

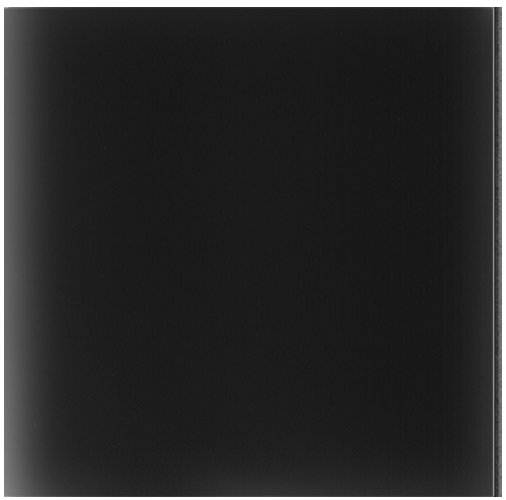


Rotated so tiles have constant declination, WF and focus sensors included, guiders slightly offset to allow for baffles

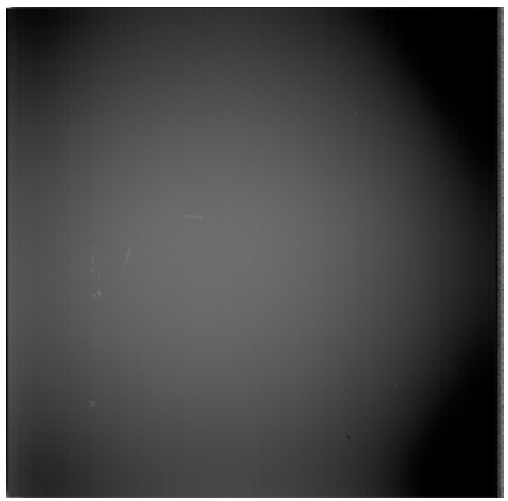
CCD testing

DARK ENERGY SURVEY

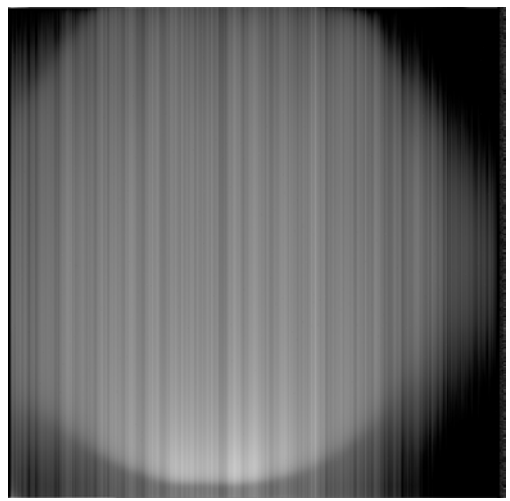
- In Sept. we borrowed a CCD and a CCD readout system from Tom Droege.
- Set up on 14th floor and then in Lab 6. It works!!
- LAB6 has most of the equipment need to test CCDs. We can borrow the equipment and dark room for a few months.



dark 10 sec



Light 10 sec



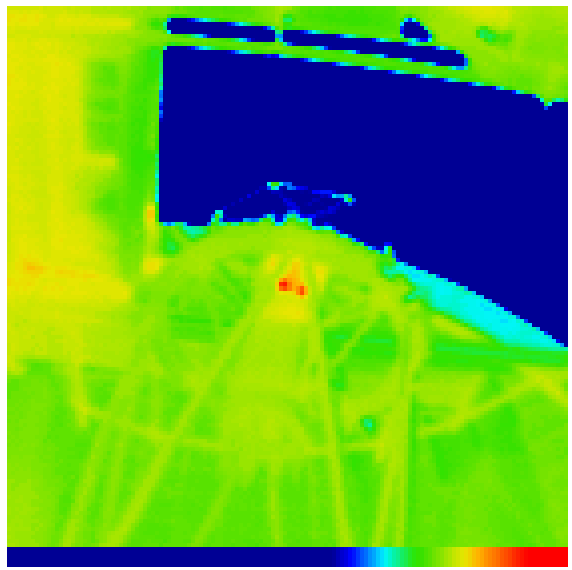
Light 100 sec, Saturated

Front End Electronics and DAQ

DARK ENERGY SURVEY

- NOAO is developing a Front End and DAQ system called MONSOON.
  - Front End Electronics sit in crates in PF cage
  - fibers run down the telescope trusses to the Pixel Analysis Node PC (PAN) - assembles the images
- We have two options under consideration:
  - Reference Design (in NOAO proposal): Modified/repackaged Monsoon Front End plus Monsoon software
  - Backup Solution: Monsoon Front End Electronics (DHE) + Monsoon software
    - this is what we will use for testing CCDs in the near future and probably for at least the next year (or two)
- Issues for Prime focus cage are heat and space. Cost and schedule are also considerations

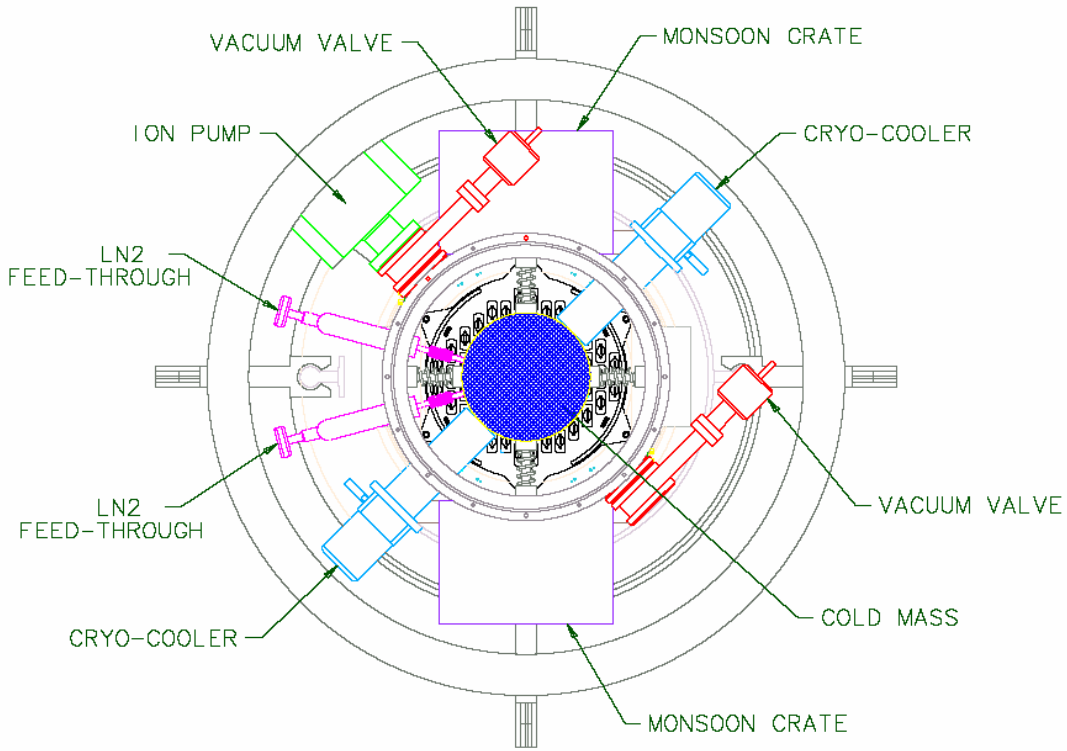
Thermal image



Cooling System

DARK ENERGY SURVEY

- Cooling with Cryo-Coolers
  - Design includes two
  - Both operate during cool-down
  - Require one in normal operations
  - Vibration analysis is ongoing
  - Use of Vibration Dampener is planned
- Cooling Reserve Options
  - LN2 Reservoir
    - 3-4 hour reserve is possible
    - Implementation is more complex than a cold mass
  - Copper Cold Mass
    - 30 minute reserve (dT=20 K)
    - Easier to maintain a consistent temperature distribution

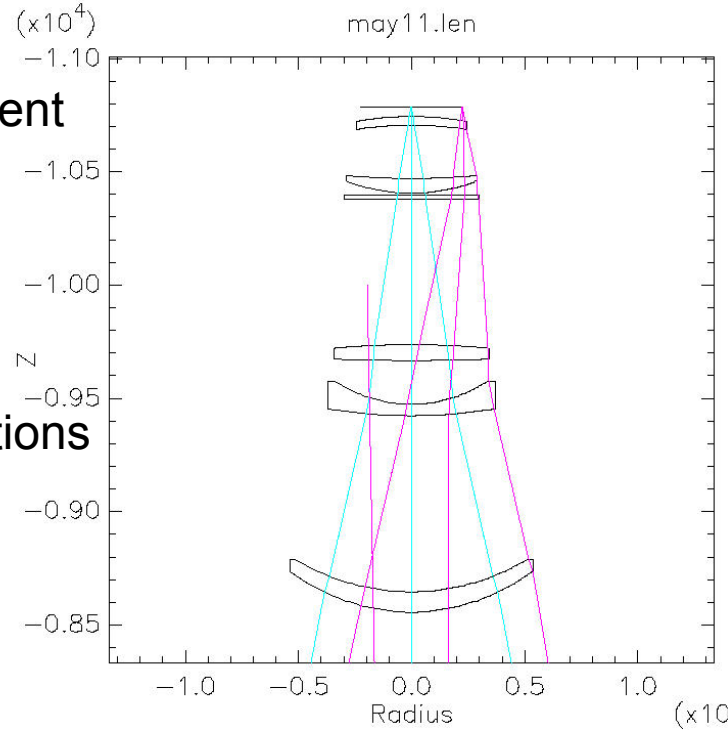


Corrector Optics

DARK ENERGY SURVEY

Chicago and hopefully UCL will take the lead on the Optical design

- Steve Kent and Mike Gladders developed our current optical design (May 04)
- UCL has an Optical Science Center & experience procuring corrector optics.
- UCL reviewed our design and presented some options for future optimization
  - reverse the aspheric surface (manufacturing)
  - remove one element, have a flat window
- UCL also obtained independent cost estimates.
  - Glass 600k$, 5 months – agrees with our est.
  - Figuring 600k$, 1 year delivery (400k$ and 6m less than in our schedule)

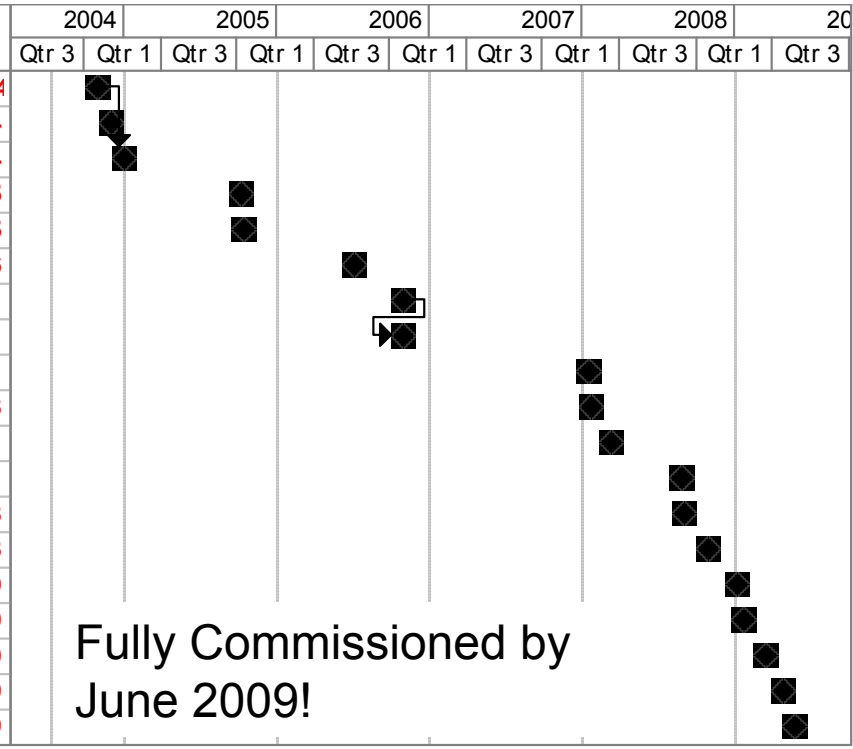


Schedule Milestones

DARK ENERGY SURVEY

- Optics and CCDs are the most Challenging tasks
- Optics are critical path: Order glass in FY06, Figuring/polishing in FY07

ID	Task Name	Start
10	Funds available (Fermilab R&D, external)	Fri 10/29/04
38	Ready to submit masks to Dalsa	Thu 12/2/04
40	Order 24 wafers of devices	Thu 12/30/04
43	1st fully processed CCDs (8) in hand	Thu 10/6/05
46	Submit order for final processing of remaing 1st batch wafers	Thu 10/13/05
58	First production CCDs in hand	Thu 7/6/06
17	FY07 funding available	Tue 10/31/06
363	Order Corrector elements	Tue 10/31/06
146	CCDs Ready for mounting on focal plane	Tue 1/15/08
368	Lenses and filters complete	Mon 1/21/08
335	Dewar closed, ready for testing	Tue 3/11/08
265	Camera testing complete - ready for corrector	Tue 8/26/08
423	corrector, filters and cage ready for camera	Mon 9/1/08
453	Prime focus cage complete	Mon 10/27/08
455	Testing complete	Mon 1/5/09
457	Ready to Ship to Chile	Mon 1/19/09
489	Ready to Mount on Blanco	Mon 3/16/09
491	1st light	Mon 4/27/09
493	1st useful data	Mon 5/25/09



DARK ENERGY SURVEY

Total Cost profile in Then Yr $

(excluding institutional overhead)

This corresponds to the profile discussed in the responses to the PAC questions for the June 04 meeting.
The optics procurements are funding limited and set the critical path.

	FY04	FY05	FY06	FY07	FY08	FY09	Total
M&S	0	1,097	3,321	3,362	520	68	8,368
M&S Contingency	0	0	379	338	1,580	782	3,079
Total M&S	0	1,097	3,700	3,700	2,100	850	11,447
Labor	609	1062	955	1150	560	299	4,635
Labor Contingency	304	531	478	575	280	150	2,318
Total Labor	913	1593	1433	1724	839	449	6,953
Total (M&S + Labor)	913	2,690	5,133	5,424	2,939	1,299	18,400

Estimated overhead if all funds spent at FNAL is 4.1M$ in then year $

This profile has us ready for observations by June 2009.

DARK ENERGY SURVEY

Plans for FY05

- Initiate the Preproduction CCD order – Done
- Learn to test CCDs – in progress
  - Testing started (all borrowed equipment)!
  - Fabricate our own test Dewar – drawings out for bids
  - Fabricate “personality board” for testing LBNL CCDs with TD readout system – in layout
- Learn to package CCDs – waiting for MOUs to be signed
  - order a small number of devices ~ off the shelf at LBNL (3m ARO)
  - begin procuring the CCD packaging hardware
- Hope to have a 2k x 4k CCD (phase A) packaged and tested at FNAL by early summer 2005
- Initiate Prototype efforts for FE electronics, filter and shutter
- Optical design trade studies and firmer quotations

- We will rely on UIUC, UC and Fermilab for the R&D funds

DARK ENERGY SURVEY

Conclusions

- Money starting to be available, project is getting underway!

DARK ENERGY SURVEY

Dark Energy Survey (E939) Funding status and reviews

- DES Status as of July 2004
- NOAO response to the DES proposal
- Status of financial commitments to the DES
- Securing the remaining funds
- Dark Energy Task Force and fund raising

DARK ENERGY SURVEY

DES Status as of July 2004

- DES had prepared a proposal that included a design and preliminary cost estimate of DECam (the survey instrument).
- It was reviewed by the Laboratory and considered by the PAC.

- June PAC meeting outcome:
  - Recognized importance of the DES science and its relevance to the Fermilab scientific program
  - The Director authorized the DES to submit the proposal to NOAO
  - The Director granted Stage I approval

DARK ENERGY SURVEY

DECam cost and funding plan as of July 2004

- DECam estimated cost $18.4 M*
  - M&S (cash) $11.4 M
  - Staff costs (exclusive of scientists) $7.0 M

  *without indirect costs of ~$4.1 M

- DECam Funding plan
  - Fermilab M&S request $7.4 M
  - Fermilab staff request $ 6.4 M
  - UIUC-HEP staff request $ 0.6 M
  - Cash from “Other Sources” $ 4.0 M

- “Other sources”: NSF and private sources

DARK ENERGY SURVEY

NOAO Review and outcome

- The NOAO Director appointed the BIRP (Blanco Instrumentation Review Panel) to review our proposal:
  - The BIRP Recognized the importance of our science and
  - recommended that the DES collaboration form the instrumentation partnership described in the AO with NOAO.

- The Director accepted the recommendations and asked the CTIO Director and DES Project Director to draft a Memorandum of Agreement for signature by the NOAO and Fermilab Directors. It will provide:
  - DECam, the software and archive to NOAO
  - the observing time to the DES Collaboration
  - the telescope improvements and infrastructure for DECam

DARK ENERGY SURVEY

Financial Commitments to the DES

- The UIUC and Chicago MOU's are ready for signature. They provide DES with:
  - $ 400K (all available in FY05) from UIUC
  - $ 500 K ($300 K available in FY05) from Chicago
  - The indirect cost as an FNAL contribution
- Fermilab has given DECam an FY05 budget that :
  - provides funding for the masks and the wafers and enables the Fermilab-LBNL MOU for the CCDs.
  - the DECam development program can proceed with the university funds
- DES now needs to raise $3.1 M from "other sources"

DARK ENERGY SURVEY

DES presentation to the NSF and outcome

- We presented the DES plan to the NSF in September. It was well received, but later we learned that:
  - NSF will not provide funds for the instrument.
  - The NSF will consider a DES Data Management proposal if the Dark Energy Task Force recommends an intermediate term Dark Energy program that contains a survey like the DES.

- The DES elected to delay submitting their Data Management proposal to the NSF until after the DETF issues its preliminary report (early summer?).

DARK ENERGY SURVEY

DES presentation to DOE and outcome

- We presented the DES plan to DOE/HEP in September and it was well received. We learned that:
  - DOE/HEP will allow Fermilab to spend R&D funds in FY05 and FY06 for DES development.
  - DOE/HEP will use the DETF report to request CD-0 from DOE for the intermediate term Dark Energy Program .
  - FY07 is the earliest budget year for the Dark Energy Program
  - The DES project could be base-lined (CD-1) in late summer 05

DARK ENERGY SURVEY

"Other Sources": new partners

- University College London, Cambridge and Edinburgh have proposed to join the DES. Lahav, Sutherland, Peacock and Doel submitted a Statement of Interest to PPARC. It requests 1.2 M pounds.
  - They propose to provide the optical elements as an in kind contribution. This will reduce our cash needs by > $ 1 M.
  - They are interested in weak and strong lensing, photo-z's, and galaxy evolution. They strengthen our science effort.
  - UCL is already working on the DECam optics design and photo-z's on a provisional basis.
  - They expect to hear on whether they will be invited to submit a proposal to PPARC on November 18.

DARK ENERGY SURVEY

Other possibilities for new partners

- We are searching for new partners that can afford the ~$500 K admission price. Each new partner must reduce our need for cash by ~ $500 K.
- We have contacted several interested US Universities that understand the admission fee.
- We have had more indefinite contacts as well
- We will also search for private donors.
- If the UK consortium proposal is approved we will only need $2 M in cash, less any reduction in contingency that our cost studies justify.

DARK ENERGY SURVEY

Summary of the DES financial status

- DES looks forward to the Dark Energy Task Force report and expects that it will get a place in the intermediate term Dark Energy program.

- If the DES gets a place then a joint DOE/NSF task force will review the DES. This step will be competitive with other intermediate term projects that propose the same goals. We are confident that we can succeed.

- We are confident that we can raise all of the “Other Funds”. We will still have to pass DOE reviews for CD-1, CD-2, and CD-3 and the appropriate NSF reviews.

- We should know our fate by late summer.

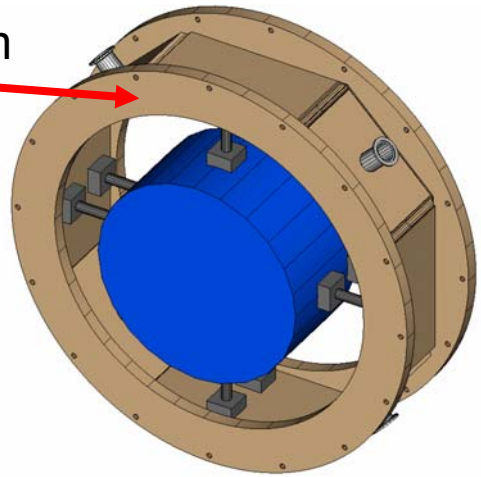
DARK ENERGY
SURVEY

Extra slides

Camera Vessel

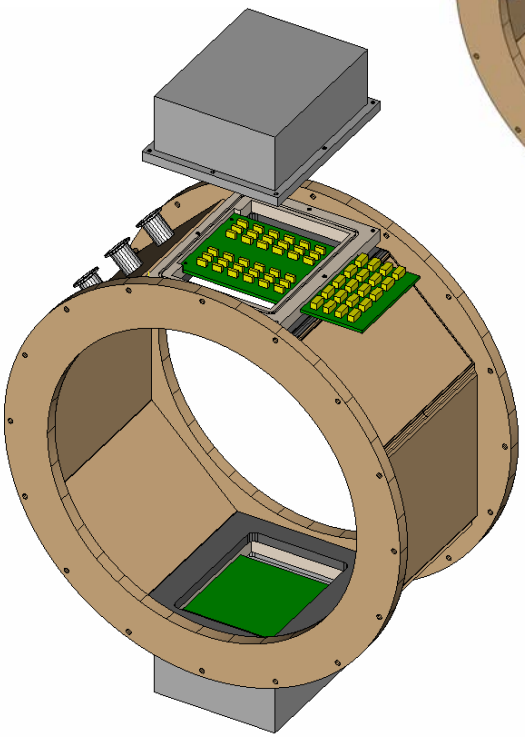
DARK ENERGY SURVEY

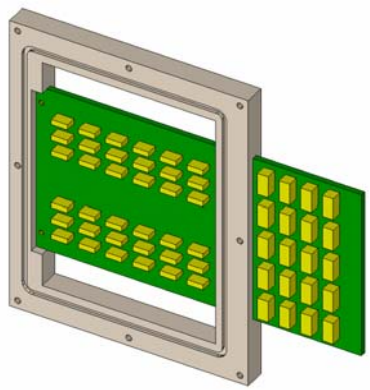
Cooling/ Vacuum spool piece



Camera is separated into two spool pieces: one for signal feed throughs one for cooling and vacuum services

Removal of cooling spool piece allows access to back of focal plane and cables





- Vacuum feed through board brings signals out of cryostat

Cost Estimate breakdown

DARK ENERGY SURVEY

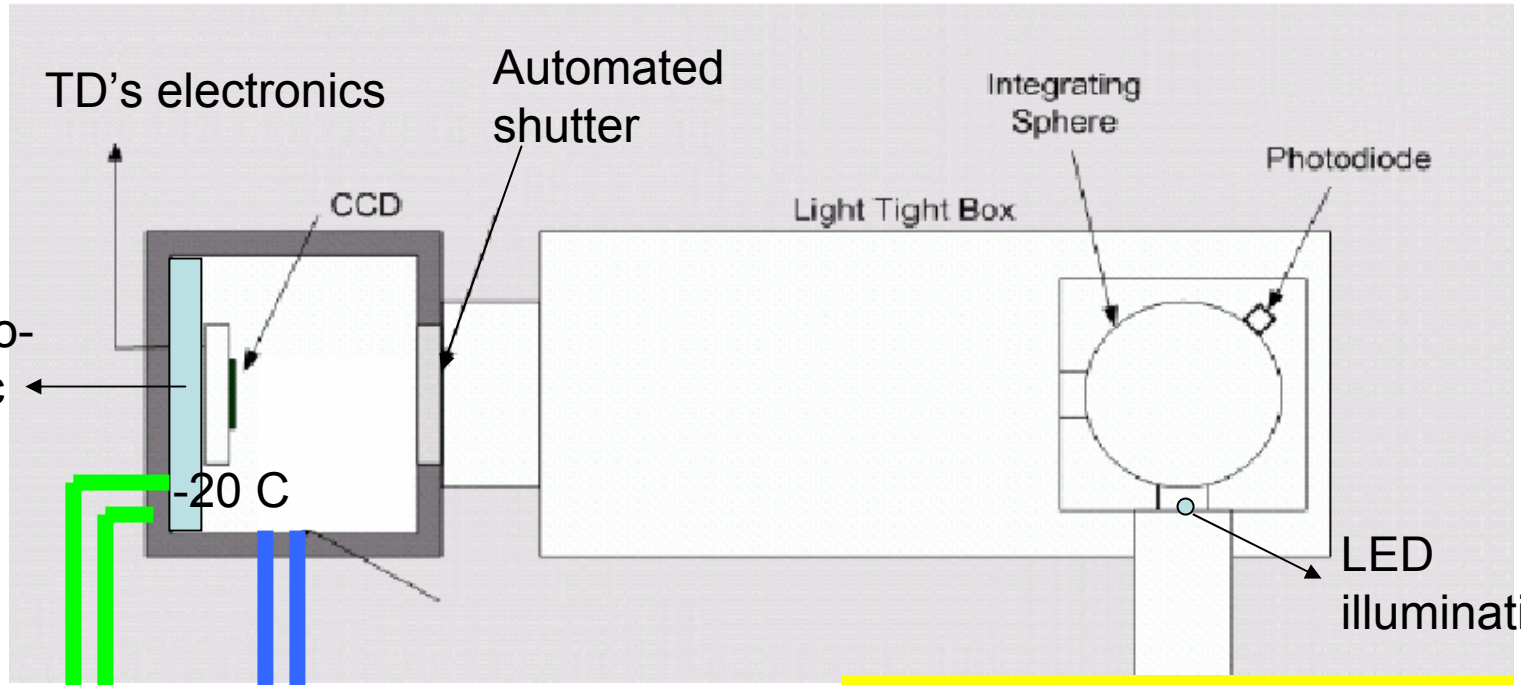
		M&S ($K)	Labor $K)	Total ($K)
1	**Dark Energy Survey Instrument**	**8,368**	**4,635**	**13,003**
1.1	**Management**	**235**	**189**	**423**
1.2	**Dark Energy Instrument Construction**	**7,734**	**3,692**	**11,426**
1.2.1	CCDs	**2,155**	**25**	**2,180**
1.2.2	CCD Packaging	**287**	**607**	**895**
1.2.3	Front End Electronics	**595**	**640**	**1,235**
1.2.4	CCD Testing	**579**	**364**	**942**
1.2.5	Data Acquisition	**167**	**299**	**466**
1.2.6	Focal Plane,Camera Vessel	**163**	**366**	**529**
1.2.7	Cooling	**427**	**160**	**587**
1.2.8	Corrector	**2,463**	**121**	**2,584**
1.2.9	Primary Cage mechanics, corrector housing	**618**	**779**	**1,397**
1.2.10	Auxiliary Components	**146**	**164**	**309**
1.2.11	Final Assembly and Testing	**135**	**167**	**302**
1.3	**Survey Strategy**	**399**	**539**	**938**
1.4	**Telescope Improvements**	**0**	**0**	**0**
1.5	**Commissioning (at CTIO)**	**0**	**134**	**134**
1.6	**System Integration**	**0**	**82**	**82**
1.7	**Dark Energy Science**	**0**	**0**	**0**
	Contingency	**3,080**	**2,318**	**5,397**
	Total cost (w/o overhead)	**11,447**	**6,953**	**18,400**

Costs in Then Year $ w/o overhead

$22.5M inc. overhead

CCD Testing Setup at LAB 6

DARK ENERGY SURVEY



Different sources of illumination are available at LAB6. Including several options for the monochromator (next step).