OPT 300
Computational Laboratory #2:
Design a Telescope to Spy on a Chinese Lunar Base
Assigned 2007/4/10
Due 2007/5/1
Dr. Anders M. Jorgensen

"Dr. Oddliking. I appreciate your coming in as quickly as possible" said General Ripper. It is not as if I had come willingly. I was in Stockholm ahead of the Nobel prize ceremony when I was called back to Washington, or actually more likely kidnapped back to Washington, in a black CIA jet even. "I understand you were given a preliminary briefing on your flight" continued the General's aggressive tone.

"The bottom line as you know is that the construction of the Chinese base on the moon is now much further along than we had expected." "Further, it seems that they are doing... well we don't know what they are doing, but it is important to find out." I had almost recovered from my jet lag and now it was back in full force.

"We need that telescope you've been kicking around, and we need it faster than ever." blared the General's voice. Mmhmmm.. the one they rejected my conceptual proposals for about five times already.

"I want to know what their base looks like. I want to see them when they go outside their domes to light up a smoke." And the general knows a lot about lunar atmospherics too.

"Have you considered what kind of telescope you would like, or any of its parameters??" I finally interjected. "Dr. do I look like an engineer to you?" quipped the general as he pointed with his baton at his thick gray hair. "Definitely not!" I retorted with total honesty.

"The CIA tells me we need to be stealthy. China has already proven themselves capable of shooting down satellites, and we think they may have guided weapons on the moon as well, possibly disguised as ice cream trucks." "So you need to be as far away as possible, but I want fine fine detail."

"How fine details would you like my General?"

"As fine as you can give me Dr. Oddliking. As fine as you can give me, but certainly better than a foot, and if you can do inches, that would be even better. But for gods sake, don't get too close to the moon. The launch vehicle will be a Delta IV rocket."

"Another thing, I encourage you to team up with your classmates..err. I mean with some fellow engineers, because this is a project that could seriously benefit from putting heads together." "If you have any technical questions," the general said nonchalantly while rustling his thick hair, " get in touch with my lackey Dr. Jorgensen." I now noticed the man sitting quietly in the far corner of the meeting hall slowly typing away at a laptop.

Later that afternoon I met up with my buddy Ralph at Cosi, a strange DC coffee chain. Their big attraction is the tabletop campfire for cooking marshmallows.

"So what do you think Val?"

"I think he is an asshole and I am going to miss meeting the King of Sweden!"

"No I mean about the telescope."

"Oh right. Well, this is a tricky problem. For the launch we are limited by the fairing and

the capacity of the Delta IV. I suspect a the cargo capacity to escape velocity is probably a good enough approximation for now.“

“The fairing will tell us how large a mirror we can use. That will give us an idea of how far away we can be and still get acceptable resolution. But we still need to figure out a reasonable field of view. How much do we want to see? How large is a lunar base anyway? And how fine detail do we want across it? Are we going to have enough light to produce an image when it is night?”

“Yeah, that is a good point,” chimed in Ralph, “ the base is on the far side of the moon, so it will be illuminated by the sun about 15 days and then only by starlight for the other 15 days.” “I am sure the general does not want to wait 15 days in the dark. But the length of our exposures is limited by the orbital velocity of the telescope. I suppose the higher up we are the slower we will travel, and the longer exposures we can make if necessary.”

“I am not at all convinced that we can do night images, but let’s figure it out. By the way, how long can we make the scope to fit on the Delta IV?”

“I don’t know that one. Remind me to check. So we have telescope design, aberrations, sensitivity, light collection ability. We need to worry about the camera pixel size and match that to the telescope resolution.”

“I think it is more likely the other way around” I said “with the kind of time line we are operating under we need to use an off-the-shelf camera and just match the telescope design to the pixel size.”

“I suppose vignetting is not a big problem? We are going to be imaging a tiny field of view if we are thinking kilometers across at a range of what.. 1000 km or so?”

“Could be, but the analysis has to be done anyway.”

“So when does the general want this by?”

“He said we had three weeks to put it together and do our best. He wants the report on the 1st of May, no if’s no but’s. This lab is going to count against half of our lab grade.. I mean half of my bonus for the year, so we better make it good. Teamwork is really important. We need to find a couple more people to work with.”

Instructions

1. Please form the following two teams and work together. Each of you may have specialized knowledge to solve a unique aspect of the problem.

Team 1		Team 2	
Julie Walter	jeilers@nmt.edu	Tanner Oakes	tako@nmt.edu
Rhett Lawrence	rlawrenc@nmt.edu	Jeff Darrow	pdarrow@nmt.edu
Alisa Shtromberg	ashtromberg@mro.nmt.edu	Jamey Christy	jchristy@nmt.edu
Eleazar Martinez	emartine@nmt.edu	Stephen Trumbull	st51@nmt.edu

2. I do not intend for team meeting coordination to be a big burden. I think that you can get by with only meeting a few times and then communicating via e-mail the rest of the time. It is up to you.

3. The format is free. During this course you have developed the tool set to ask some fundamental question related to the design of an optical system and to answer those

questions. I want you to ask the right questions and provide meaningful answers. Demonstraing good analysis is more important than producing a particular answer.

4. Please write a single report per group, and include a description of what work was carried out by each team member.

5. This will be the final lab of this course, and will thus count for half of your lab grade.

6. Please talk to me MUCH sooner than April 30^{th} about any questions you might have.