A few words on the CCOB @ LPSC
The LPSC in few words:

The scientific environment : Grenoble

- 4 Universities or Engineer Schools : 60,000 students
- About 10,000 positions in research, 200 laboratories
- Major laboratories and facilities
  - ILL (neutrons), ESRF (light source), EMBL (Biology), LCMI (High Field), CEA (INAC, LETI), MINATEC (nanotechnology) …
- Ambitious plans are under discussion to extend this scientific potential
  - GIANT & 10 Campus

The laboratory

- One of the IN2P3 laboratories
- CNRS (IN2P3&ST2I) and Universities of Grenoble (UJF, INPG)
- About 210 staff people
  - 67 Physicists, 100 Technical staff, 32 PhD students, 10 Postdoc, ...
- Budget 3 M€/year (not including salaries)
  - 2 M€ for the scientific projects
    - ≈ 75 % from IN2P3
    - ≈ 25 % from University, Europe, ANR, Industry
- More than 30 projects underway (experiments, theory, and technology)
  - Covers most of the physics case of IN2P3 + interdisciplinary/valorization

This bench is to be attached in front of the fully assembled LSST Camera while it is in either the final ssembly room at SLAC or in the ready room at Cerro Pachon.

The purpose of the CCOB is

- to provide a controlled and well calibrated source of light that can be used for verification and calibration of the fully assembled LSST camera system.

The goals for the CCOB and the procedures that use it include:

- verification of system operations, data acquisition, and image processing; - measurement of the throughput of the optics, filters, sensors, and electronics;

- evaluation of the amount of light scattered within the optical system of the camera;

- and to lesser extent, confirmation of the spatial properties of images on the focal plane.

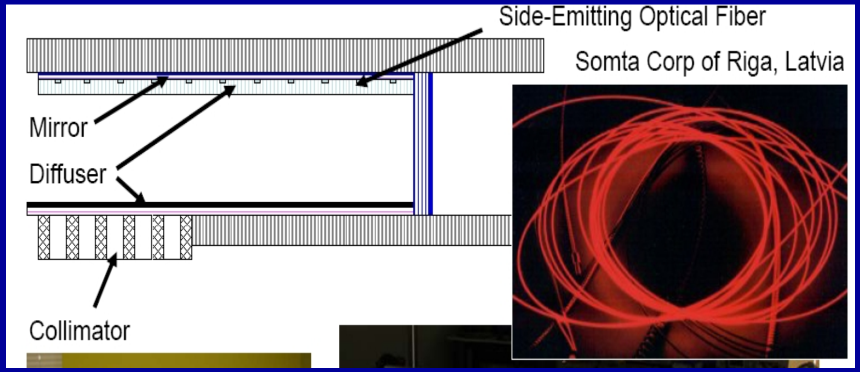
We suggest a three-step procedure:

1) **Flat fielding → relative response of the sensors**
2) **Thin calibrated beam with L3 only → sensors + electronics**
3) **Wider calibrated beam with all lenses → ghost light**

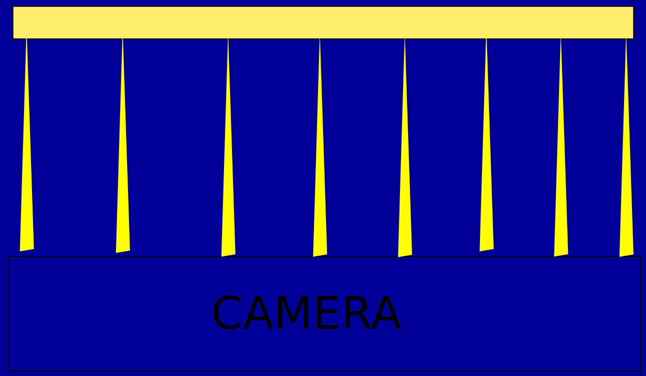
Flat field

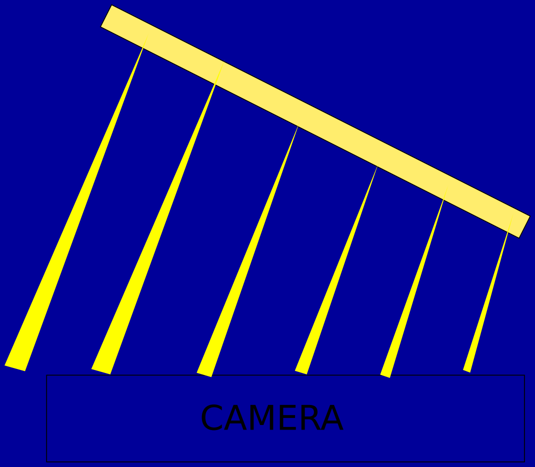
Preferably used without the lenses in front of the camera to make the modelling easier. Integration over

1) A « cell » of the screen developped for the telescope could be used – possibly with a different baffle screen – and a tilt capability



Cf. Discussion with Christoph Stubbs
2m screen for PanSTARRS

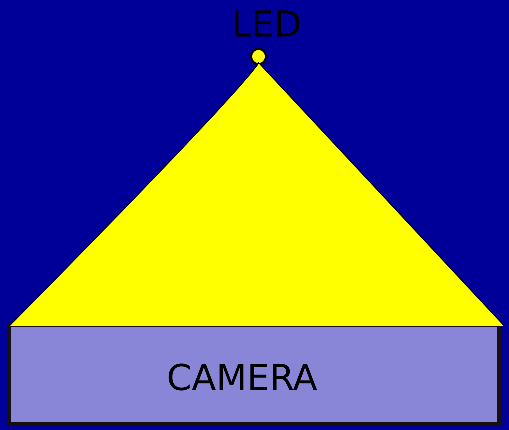




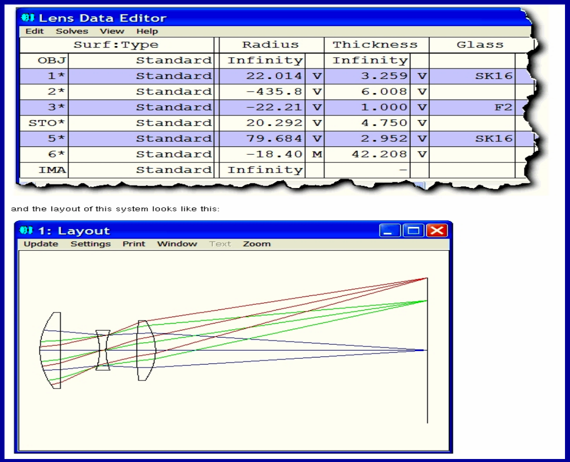
Aurélien Barrau LPSC-Grenoble (CNRS / UJF)

Flat field

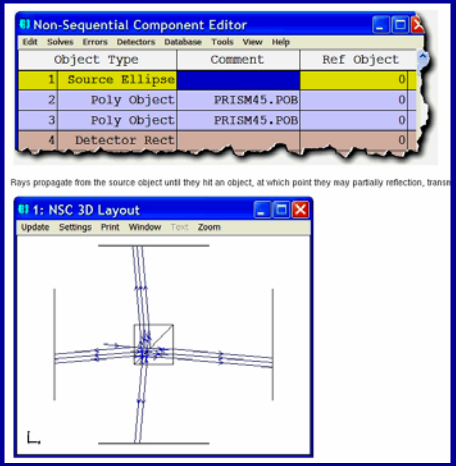
2) A LED could be used, possibly at different angles. Each pixel « sees » a single angle but this angle varies from on epixel to the other



Probably without the lenses.
In any case, a model will be required to compute the expected pattern → Zemax soft



	Surf:Type	Radius		Thickness		Glass
OBJ	Standard	Infinity		Infinity		
1*	Standard	22.014	V	3.259	V	SK16
2*	Standard	-435.8	V	6.008	V	
3*	Standard	-22.21	V	1.000	V	F2
STO*	Standard	20.292	V	4.750	V	
5*	Standard	79.684	V	2.952	V	SK16
6*	Standard	-18.40	M	42.208	V	
IMA	Standard	Infinity		-		



	Object Type	Comment	Ref Object
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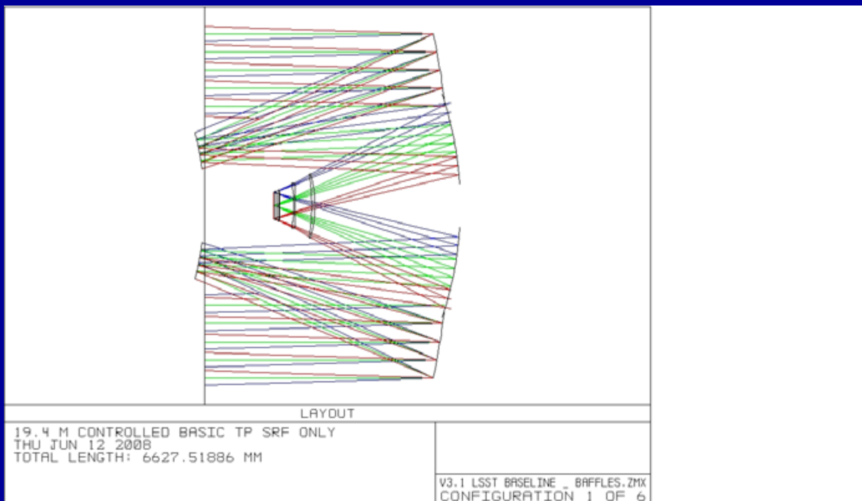
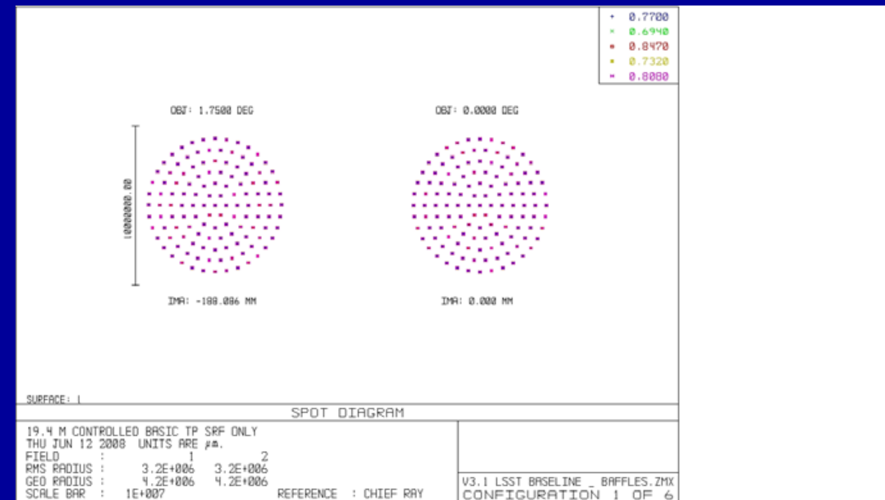
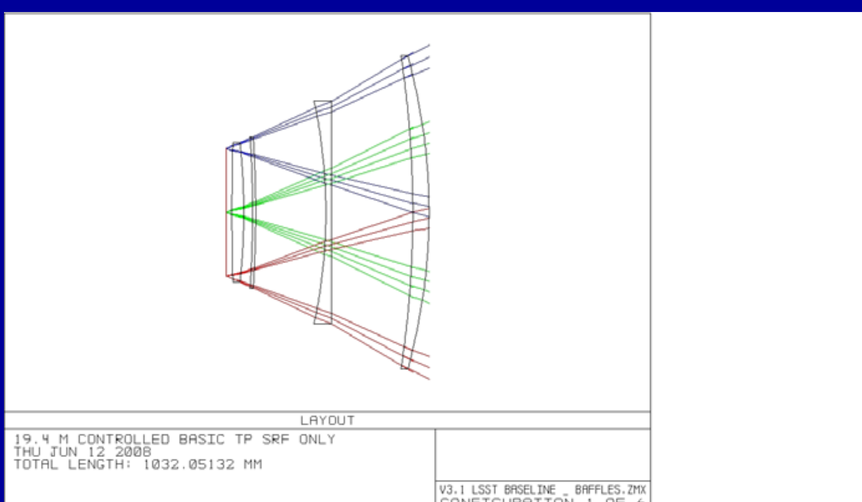
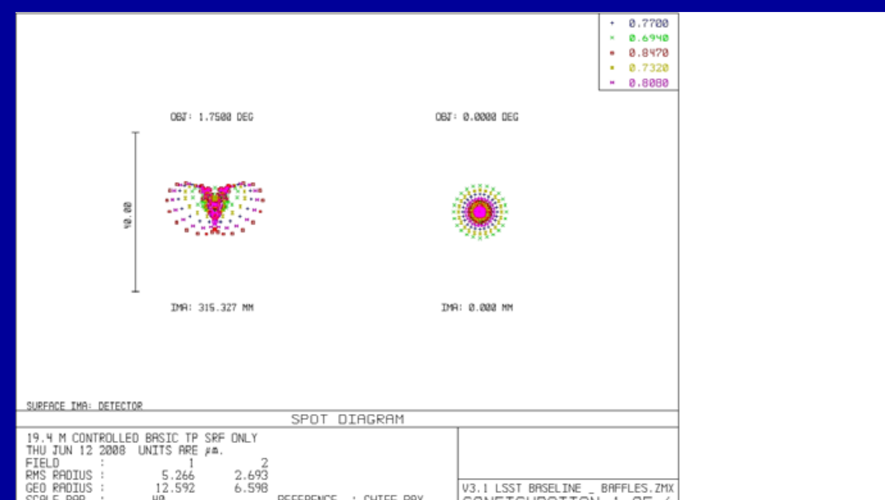
2	Poly Object	PRISM45.POB	0
3	Poly Object	PRISM45.POB	0
4	Detector Rect		0

Global simulation









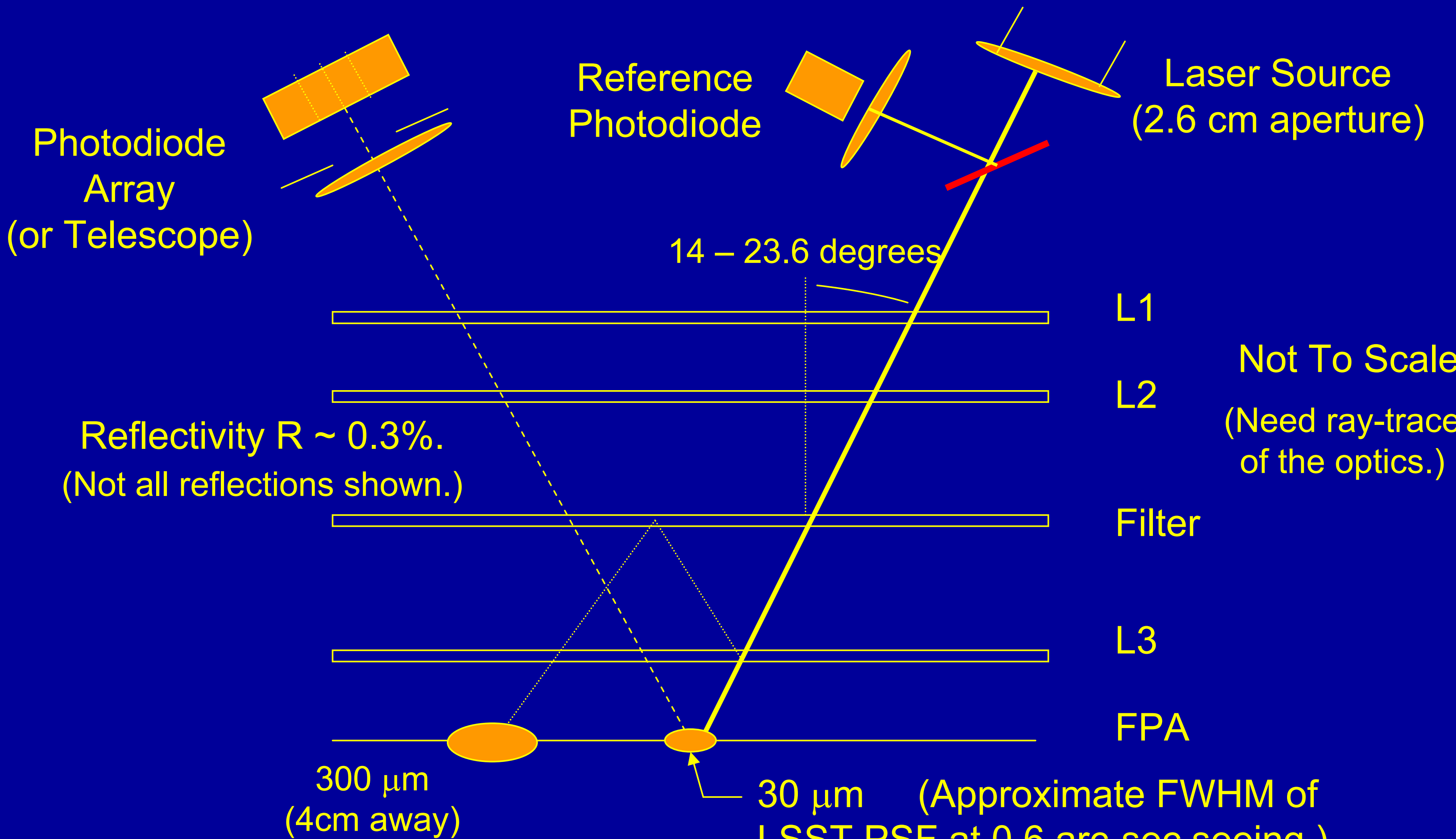
Flat field

Aims :

- Determine the relative response of the sensors, as a function of the angle and wavelength if necessary (intensity ?)

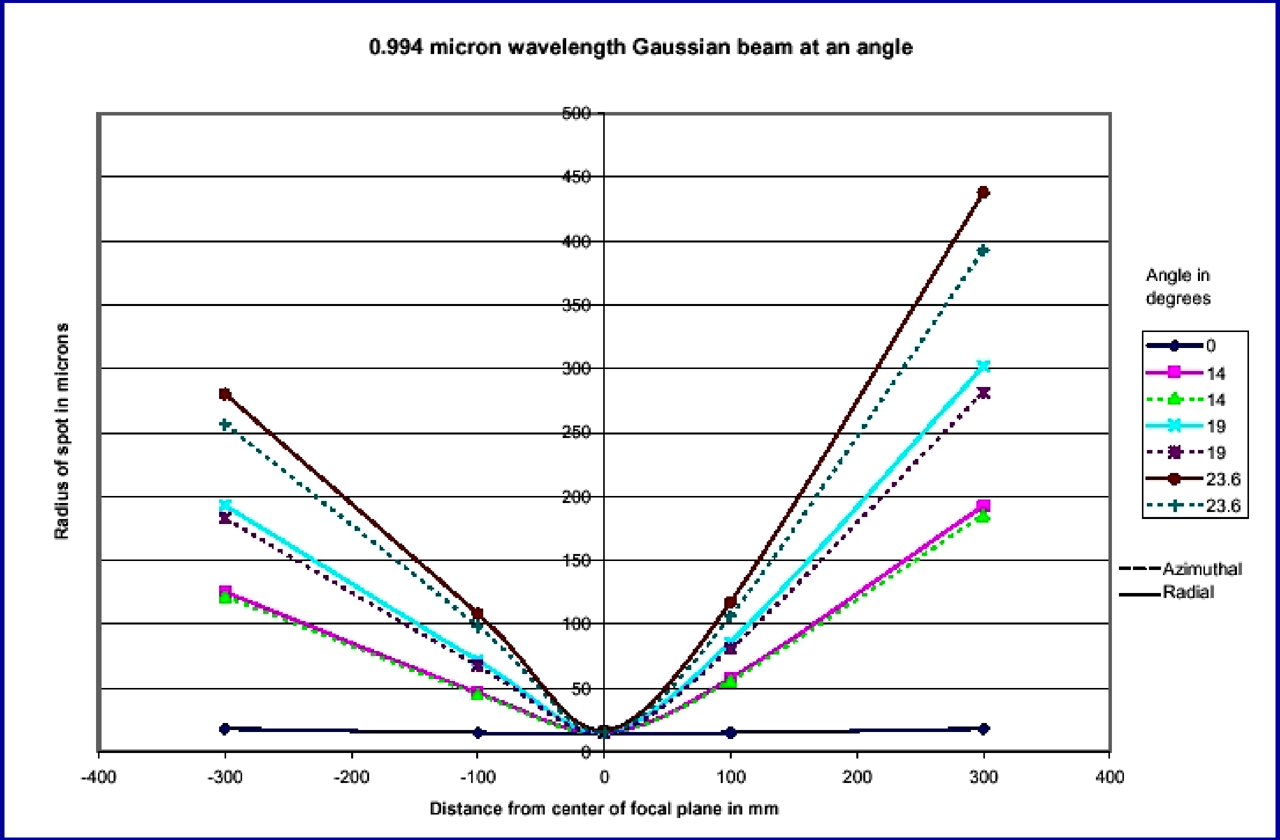
- Verification of the electronics, system operation, data acquisition

Parallel beam

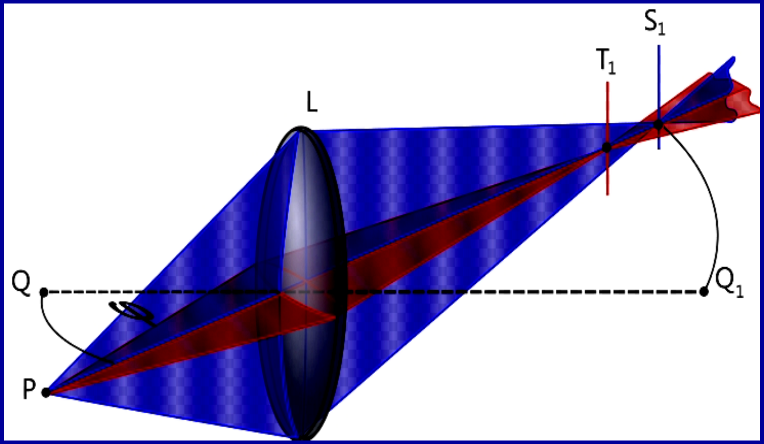


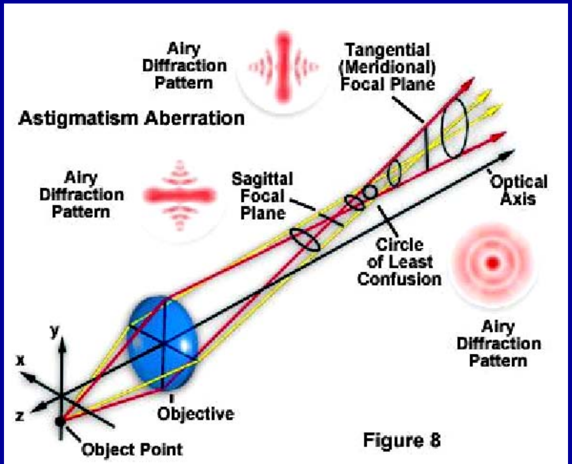
Initial drawing from D. Burke

Study from Andy Scacco



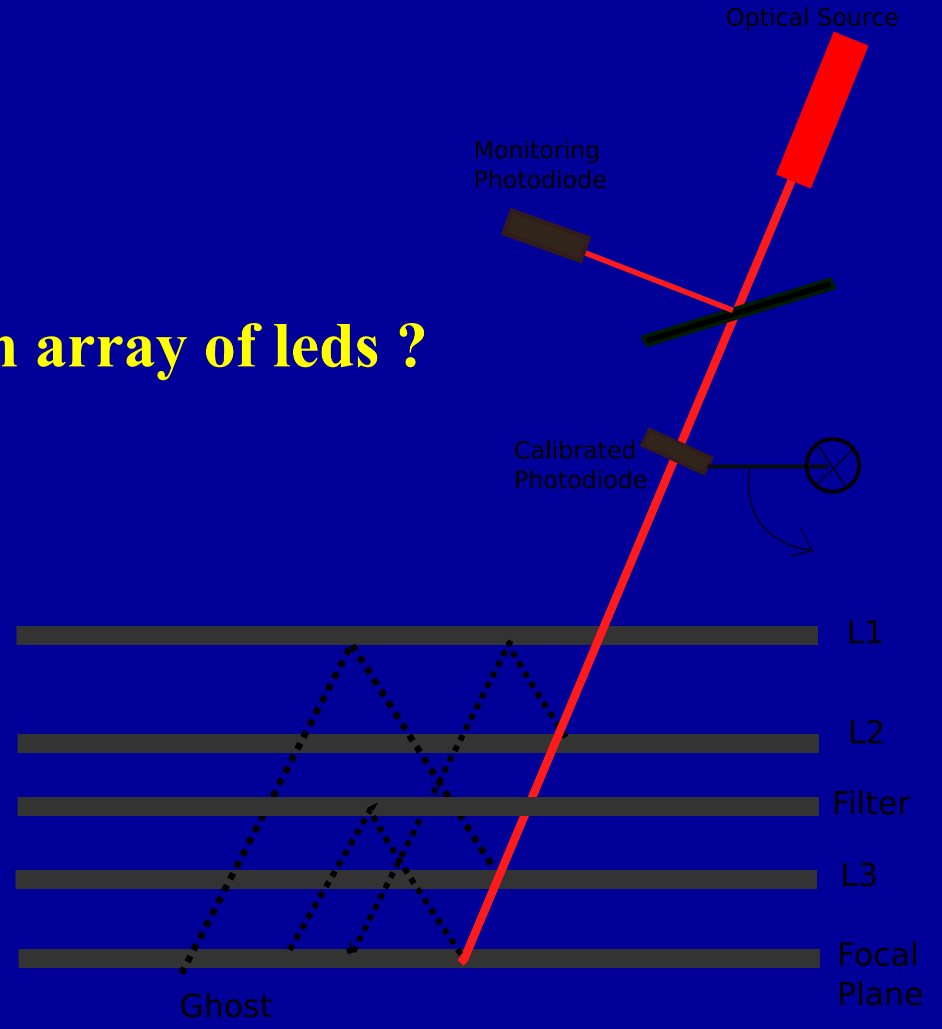
Why a 30µm beam ?





Parallel beam

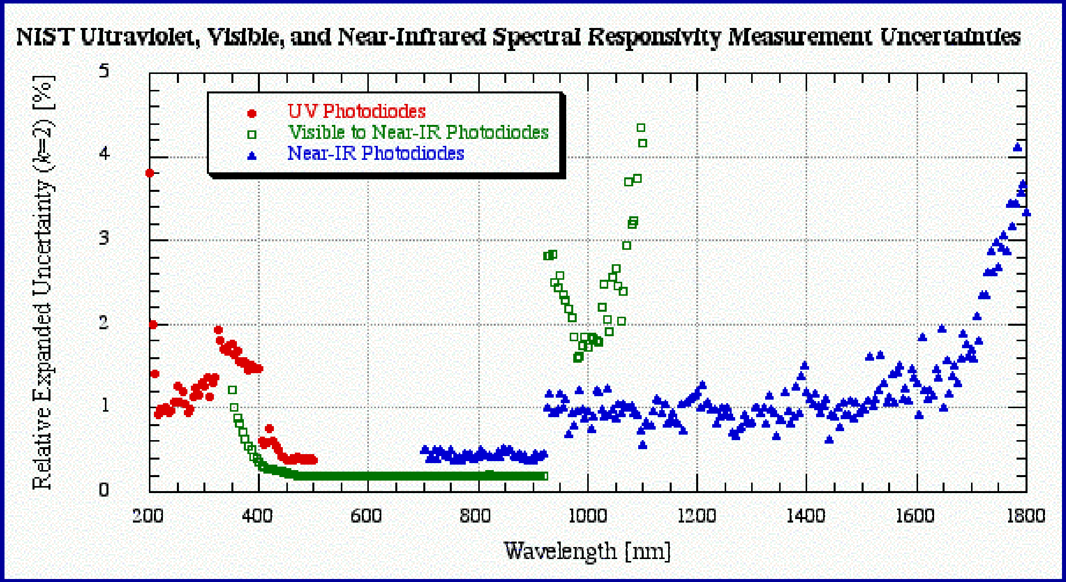
Basically, the aim is to know where goes every photon which enters the system



Why using an array of leds ?

Parallel beam

Beam monitored by a NIST calibrated photodiode



39077C - UV to Near-Infrared Silicon Photodiodes

NIST will supply customers with a Hamamatsu model windowed silicon photodiode characterized in the UV to near-IR spectral region. The spectral responsivity of the photodiode is measured from 200 nm to 1100 nm in 5 nm steps. The 1 cm2 photosensitive area of the photodiode is underfilled for the measurements. The spectral responsivity is measured with a beam of diameter 1.5 mm from 200 nm to 400 nm at radiant power levels of less than 20 µW. The bandpass of the measurement is 3 nm. From 405 nm to 1100 nm the spectral responsivity is measured with a beam of diameter 1.1 mm at radiant power levels of less than 1 µW. The bandpass of the measurement is 4 nm. The spatial uniformity of responsivity over the photosensitive area is also measured at 500 nm. The measurement uncertainty is found in the Photodetector Measurement Services and Uncertainties table.

Image positions

```
theta 10
k = 1 g =  0 final position = -152.885 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
i =  2 g =  0 final position = -355.908 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
i =  2 h =  1 final position = -327.005 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
k =  3 g =  0 final position = -366.482 P-Wave Intensity= 0.000868129 S-Wave Intensity = 0.000868129
k =  3 h =  1 final position = -337.58 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
k =  3 g =  2 final position = -171.213 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
i =  4 g =  0 final position = -493.372 P-Wave Intensity= 0.000862928 S-Wave Intensity = 0.000862928
i =  4 h =  1 final position = -464.469 P-Wave Intensity= 0.000868129 S-Wave Intensity = 0.000868129
i =  4 g =  2 final position = -319.251 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
i =  4 h =  3 final position = -308.677 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
k =  5 g =  0 final position = -499.012 P-Wave Intensity= 0.000857759 S-Wave Intensity = 0.000857759
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k =  5 g =  2 final position = -324.891 P-Wave Intensity= 0.000868129 S-Wave Intensity = 0.000868129
k =  5 h =  3 final position = -314.316 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
k =  5 g =  4 final position = -176.148 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
i =  6 g =  0 final position = -515.225 P-Wave Intensity= 0.00085262 S-Wave Intensity = 0.00085262
i =  6 h =  1 final position = -486.323 P-Wave Intensity= 0.000857759 S-Wave Intensity = 0.000857759
i =  6 g =  2 final position = -341.104 P-Wave Intensity= 0.000862928 S-Wave Intensity = 0.000862928
i =  6 h =  3 final position = -330.53 P-Wave Intensity= 0.000868129 S-Wave Intensity = 0.000868129
i =  6 g =  4 final position = -203.64 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
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k =  7 g =  0 final position = -535.316 P-Wave Intensity= 0.000847512 S-Wave Intensity = 0.000847512
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k =  7 g =  2 final position = -361.195 P-Wave Intensity= 0.000857759 S-Wave Intensity = 0.000857759
k =  7 h =  3 final position = -350.621 P-Wave Intensity= 0.000862928 S-Wave Intensity = 0.000862928
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k =  7 h =  5 final position = -218.092 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
k =  7 g =  6 final position = -161.696 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
i =  8 g =  0 final position = -545.362 P-Wave Intensity= 0.0561623 S-Wave Intensity = 0.0561623
i =  8 h =  1 final position = -516.459 P-Wave Intensity= 0.0565008 S-Wave Intensity = 0.0565008
i =  8 g =  2 final position = -371.241 P-Wave Intensity= 0.0568413 S-Wave Intensity = 0.0568413
i =  8 h =  3 final position = -360.666 P-Wave Intensity= 0.0571839 S-Wave Intensity = 0.0571839
i =  8 g =  4 final position = -233.777 P-Wave Intensity= 0.0575286 S-Wave Intensity = 0.0575286
i =  8 h =  5 final position = -228.137 P-Wave Intensity= 0.0578753 S-Wave Intensity = 0.0578753
i =  8 g =  6 final position = -211.923 P-Wave Intensity= 0.0582241 S-Wave Intensity = 0.0582241
i =  8 h =  7 final position = -191.833 P-Wave Intensity= 0.058575 S-Wave Intensity = 0.058575
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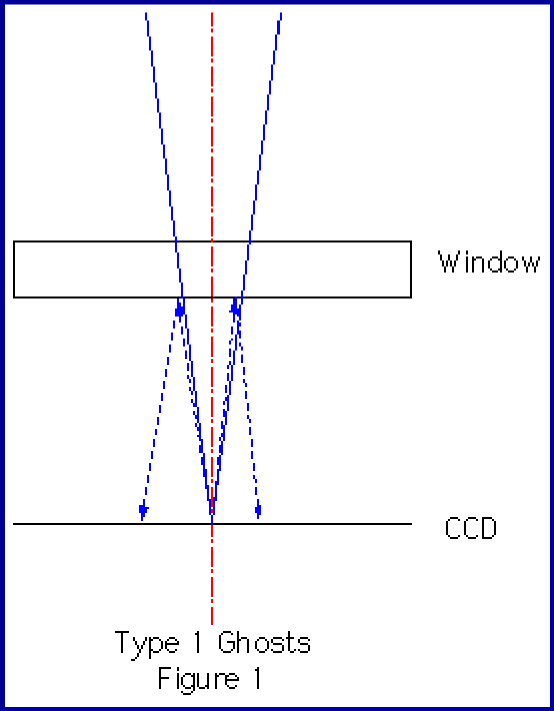
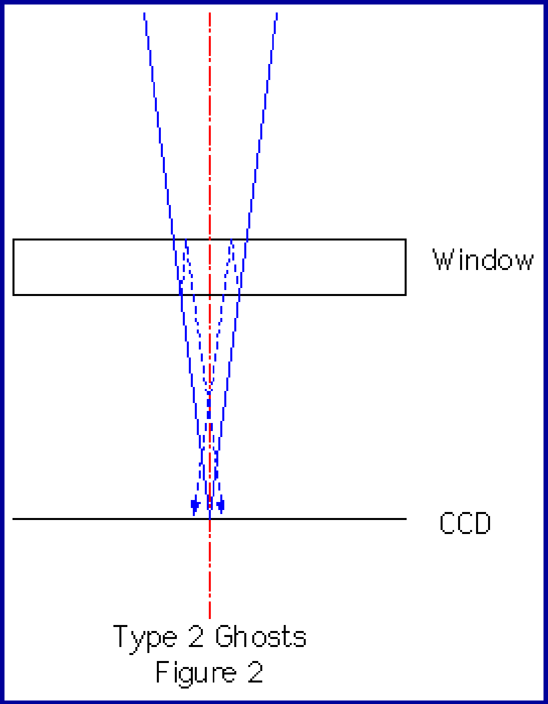
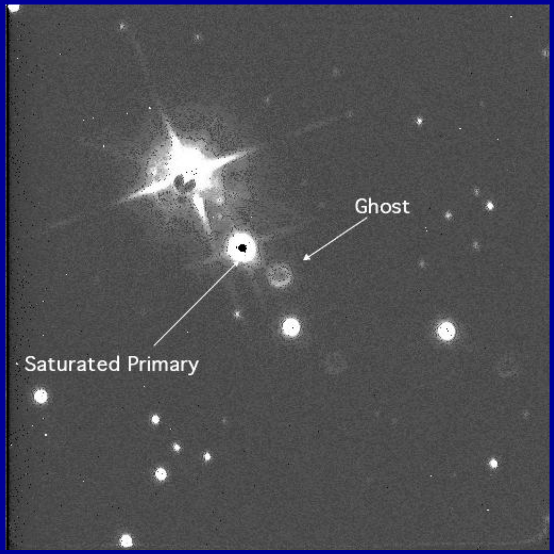
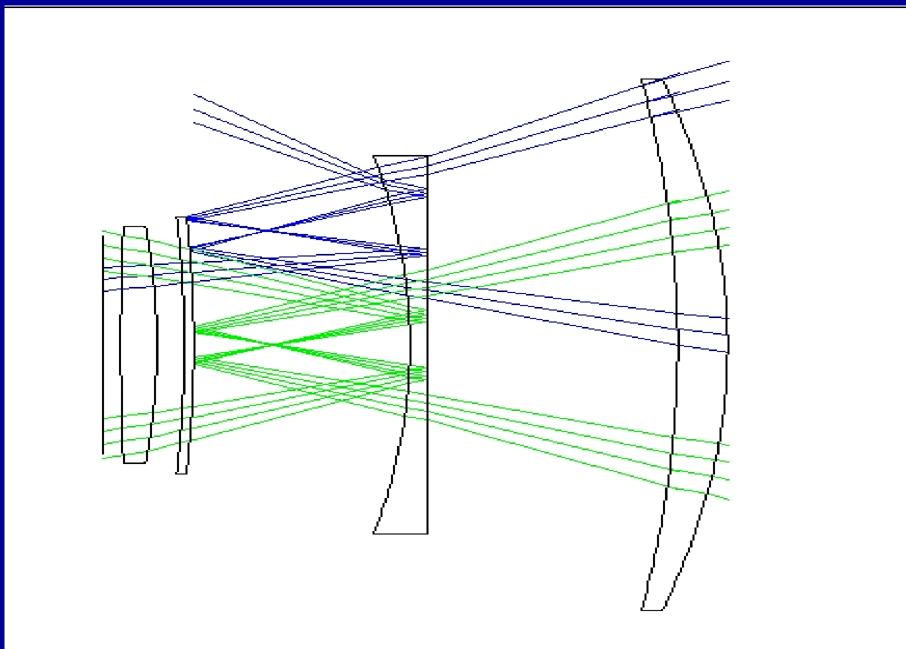
Ghosts

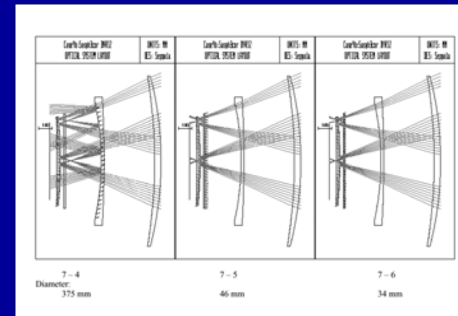

Window
CCD
Type 1 Ghosts
Figure 1

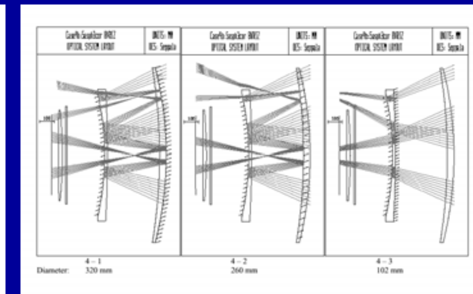

Window
CCD
Type 2 Ghosts
Figure 2

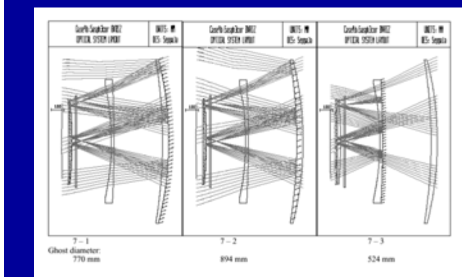

Ghost
Saturated Primary

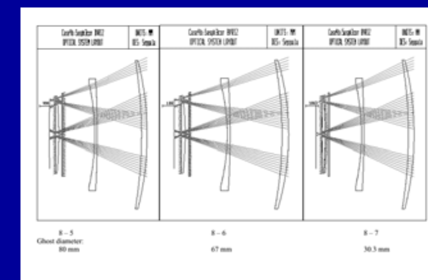
Simulation des étoiles dans LSST

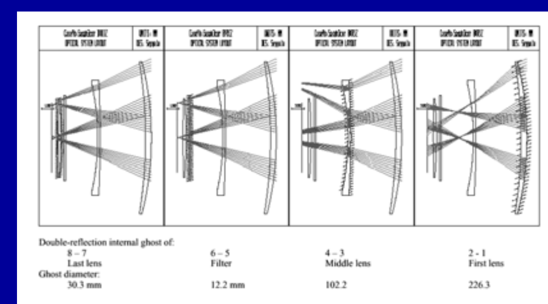


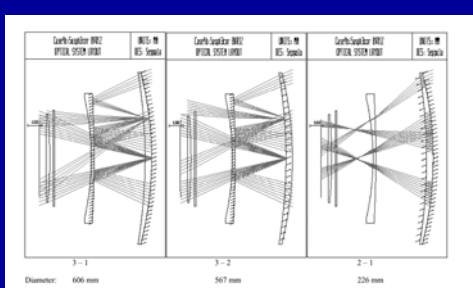


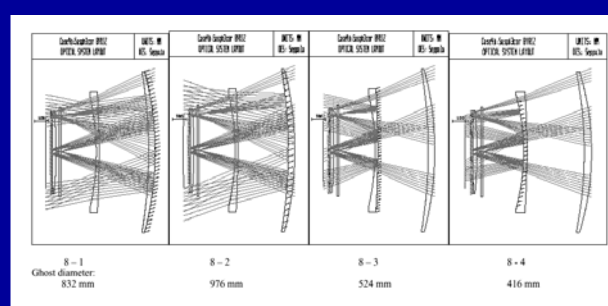


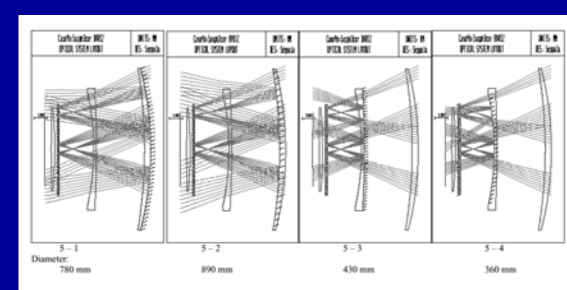












Aurélien Barrau LPSC-Grenoble (CNRS / UJF)

Position of the ghosts

87	57	-22
86	144	-52
85	241	-86
84	265	-94
83	1593	-297
82	1087	-417.3
81	2640	-649.0
80	7000	-501.2
76	83	-32
75	177	-66
74	200	-74
73	1372	-287
72	1029	-397
71	2503	-637
70	5642	-500
65	87	-32
64	108	-40
63	1111	-251
62	940	-337
61	2307	-571
60	4320	-457
54	20	-7.8
53	897	-231
52	842	-299
51	211	-342
50	3416	-444
43	852	-225
42	817	-287
41	2065	-532
40	3244	-440
32	93	-490
31	551	-123
30	725	-186
21	962	-378
20	1093	-419
10	372	-198

Parallel beam :

-Absolute response
-Scattered light

→Large beam for the optical properties (with lenses)
→Thin beam for the electronics/sensors properties (without lenses)

Summary:

- **flat-field**
- **thin beam (sensors)**
- **larger beam (scattered light)**

Aurélien Barrau LPSC-Grenoble (CNRS / UJF)

CCOB prototype to be developped

Clean room in preparation
NIST calibrated photodiodes ordered

Schedule

R3.1 Design study (2009)

AIMS:

1) Detailed study of the required specifications for the Camera Calibration Optical Bench (CCOB) through an optical simulation of the LSST camera and telescope.

2) Tests and first implementation of the different technical solutions considered for the optical bench.

DELIVERABLE:

Full Zemax simulation model of the LSST camera and mirrors.

Working optical bench including CCD and readout with a controlled beam fulfilling the requirements.

R3.2 Functional prototype (2010)

AIMS:

1) Optical and mechanical design of the CCOB

2) Tests of the optical functionalities of the bench with a dedicated "functional prototype"

DELIVERABLE:

1) Zemax simulation and first mechanical design of the CCOB. Final design of the "CCOB prototype".

2) "Functional prototype" of the CCOB.

R3.3 CCOB prototype (2011)

AIMS:

1) Stand-alone prototype of the CCOB

2) Full design of the CCOB

DELIVERABLE:

The CCOB prototype

Open questions

-Mechanical links between the CCOB and the camera ?
-Thermal/mechanical tests ?

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i =  6 g =  4 final position = -203.64 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
i =  6 h =  5 final position = -198.001 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
k =  7 g =  0 final position = -535.316 P-Wave Intensity= 0.000847512 S-Wave Intensity = 0.000847512
k =  7 h =  1 final position = -506.413 P-Wave Intensity= 0.00085262 S-Wave Intensity = 0.00085262
k =  7 g =  2 final position = -361.195 P-Wave Intensity= 0.000857759 S-Wave Intensity = 0.000857759
k =  7 h =  3 final position = -350.621 P-Wave Intensity= 0.000862928 S-Wave Intensity = 0.000862928
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i =  8 g =  6 final position = -211.923 P-Wave Intensity= 0.0582241 S-Wave Intensity = 0.0582241
i =  8 h =  7 final position = -191.833 P-Wave Intensity= 0.058575 S-Wave Intensity = 0.058575
```

```
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i =  2 g =  0 final position = -734.633 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
i =  2 h =  1 final position = -674.975 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
k =  3 g =  0 final position = -756.459 P-Wave Intensity= 0.000868129 S-Wave Intensity = 0.000868129
k =  3 h =  1 final position = -696.801 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
k =  3 g =  2 final position = -353.402 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
i =  4 g =  0 final position = -1018.37 P-Wave Intensity= 0.000862928 S-Wave Intensity = 0.000862928
i =  4 h =  1 final position = -958.715 P-Wave Intensity= 0.000868129 S-Wave Intensity = 0.000868129
i =  4 g =  2 final position = -658.969 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
i =  4 h =  3 final position = -637.143 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
k =  5 g =  0 final position = -1030.01 P-Wave Intensity= 0.000857759 S-Wave Intensity = 0.000857759
k =  5 h =  1 final position = -970.356 P-Wave Intensity= 0.000862928 S-Wave Intensity = 0.000862928
k =  5 g =  2 final position = -670.61 P-Wave Intensity= 0.000868129 S-Wave Intensity = 0.000868129
k =  5 h =  3 final position = -648.784 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
k =  5 g =  4 final position = -363.588 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
i =  6 g =  0 final position = -1063.48 P-Wave Intensity= 0.00085262 S-Wave Intensity = 0.00085262
i =  6 h =  1 final position = -1003.82 P-Wave Intensity= 0.000857759 S-Wave Intensity = 0.000857759
i =  6 g =  2 final position = -704.077 P-Wave Intensity= 0.000862928 S-Wave Intensity = 0.000862928
i =  6 h =  3 final position = -682.25 P-Wave Intensity= 0.000868129 S-Wave Intensity = 0.000868129
i =  6 g =  4 final position = -420.336 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
i =  6 h =  5 final position = -408.695 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
k =  7 g =  0 final position = -1104.95 P-Wave Intensity= 0.000847512 S-Wave Intensity = 0.000847512
k =  7 h =  1 final position = -1045.29 P-Wave Intensity= 0.00085262 S-Wave Intensity = 0.00085262
k =  7 g =  2 final position = -745.546 P-Wave Intensity= 0.000857759 S-Wave Intensity = 0.000857759
k =  7 h =  3 final position = -723.72 P-Wave Intensity= 0.000862928 S-Wave Intensity = 0.000862928
k =  7 g =  4 final position = -461.806 P-Wave Intensity= 0.000868129 S-Wave Intensity = 0.000868129
k =  7 h =  5 final position = -450.165 P-Wave Intensity= 0.000873362 S-Wave Intensity = 0.000873362
k =  7 g =  6 final position = -333.759 P-Wave Intensity= 0.000878625 S-Wave Intensity = 0.000878625
i =  8 g =  0 final position = -1125.69 P-Wave Intensity= 0.0561623 S-Wave Intensity = 0.0561623
i =  8 h =  1 final position = -1066.03 P-Wave Intensity= 0.0565008 S-Wave Intensity = 0.0565008
i =  8 g =  2 final position = -766.281 P-Wave Intensity= 0.0568413 S-Wave Intensity = 0.0568413
i =  8 h =  3 final position = -744.455 P-Wave Intensity= 0.0571839 S-Wave Intensity = 0.0571839
i =  8 g =  4 final position = -482.541 P-Wave Intensity= 0.0575286 S-Wave Intensity = 0.0575286
i =  8 h =  5 final position = -470.9 P-Wave Intensity= 0.0578753 S-Wave Intensity = 0.0578753
i =  8 g =  6 final position = -437.433 P-Wave Intensity= 0.0582241 S-Wave Intensity = 0.0582241
i =  8 h =  7 final position = -395.963 P-Wave Intensity= 0.058575 S-Wave Intensity = 0.058575
```