PHIL EXPERIMENT AT LAL
Motivations

1) In one experiment, measure the fluo yield line per line (0.1 nm) in all conditions of pressure (1000 to 10 mbar), temperature (-60 to +40°C) and humidity (all possible partial pressures allowed by the air pressure), with detectors absolutely calibrated to better than 3%.

2) Lifetimes of lines in all conditions.

Then, use the best geometry, that is the geometry most easy to simulate by Fernando.
➔ integrating sphere

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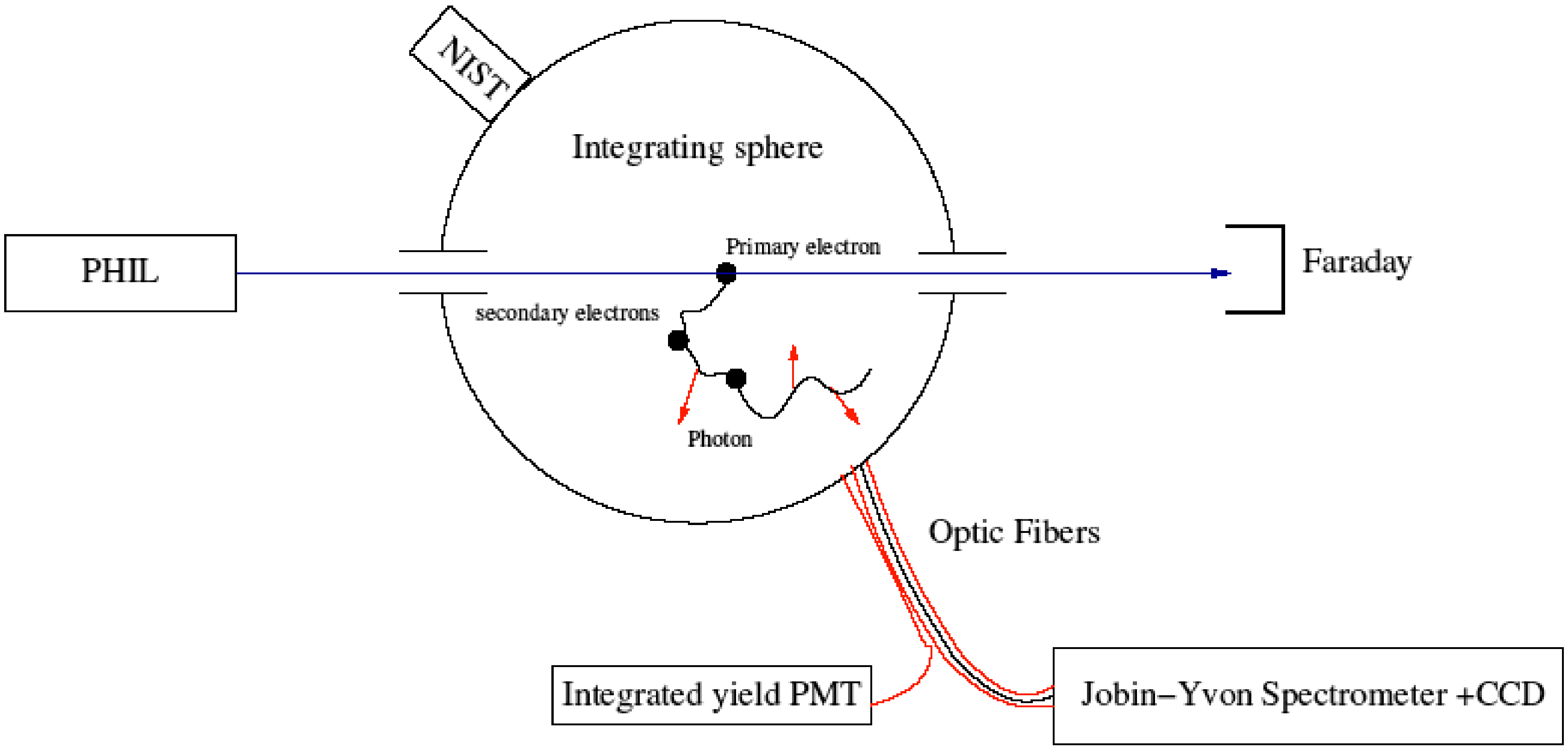
P. Gorodetzky, C. Blaksley (APC)

LAL set-up

This NIST is used only
during calibrations.



Beam mode

10 pulses of 0.1 nC (6 10^8 e^-)/sec. Each pulse is 4 ps (good for timing). E =4 MeV to start with

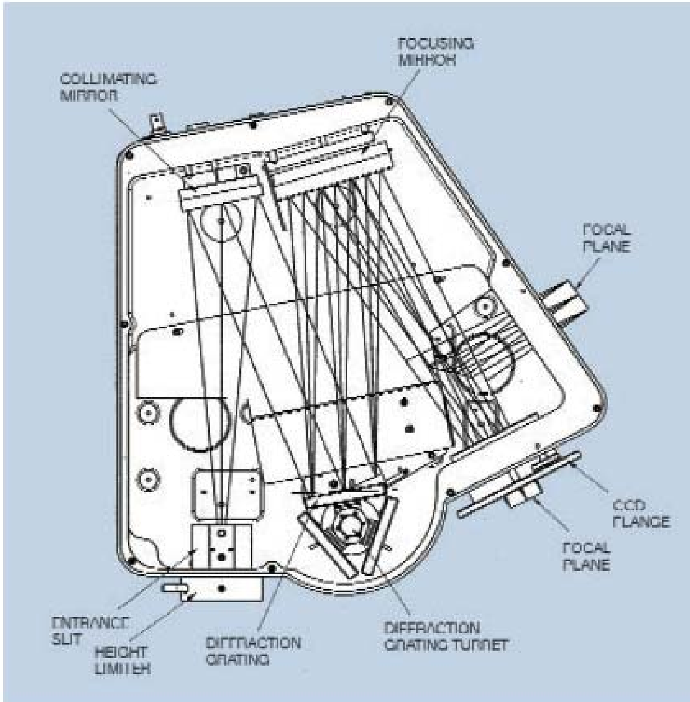
Not hidden beam path: 2 cm ➔ 5 10^7 ph/pulse (integrated spectrum)

S_{fiber}/S_{sphere} = 8 10^{-3} / 1.1 10^4 ➔ 10 pe/pulse
(In order to have 0.01 pe/pulse on the Integral PMT [Poisson stat to get clean single pe], a collimator with a 10^3 attenuation is required)

Rate on the Jobin-Yvon spectrometer (0.1 nm resolution):
The 337 is 25% of the integral ➔ 2 ph/pulse/fiber fall on CCD (1 pixel) ➔ 1 pe/pix/pulse/fiber
With 1 fiber: 1 pe/pix/pulse on 337 top. In one hour, we fill 90% of the charge that a pixel is able to accumulate (4 10^4 e)
With 80 fibers: we will have ≈ 3 10^6 e/hour in 80 pix vertically aligned which can be integrated.
Remember the CCD is LN_2 cooled with a noise of 1 e^-/pix/hour, so it is easy to see the dynamical range from 337 top to background: 3 10^6 /100 = > 10^4

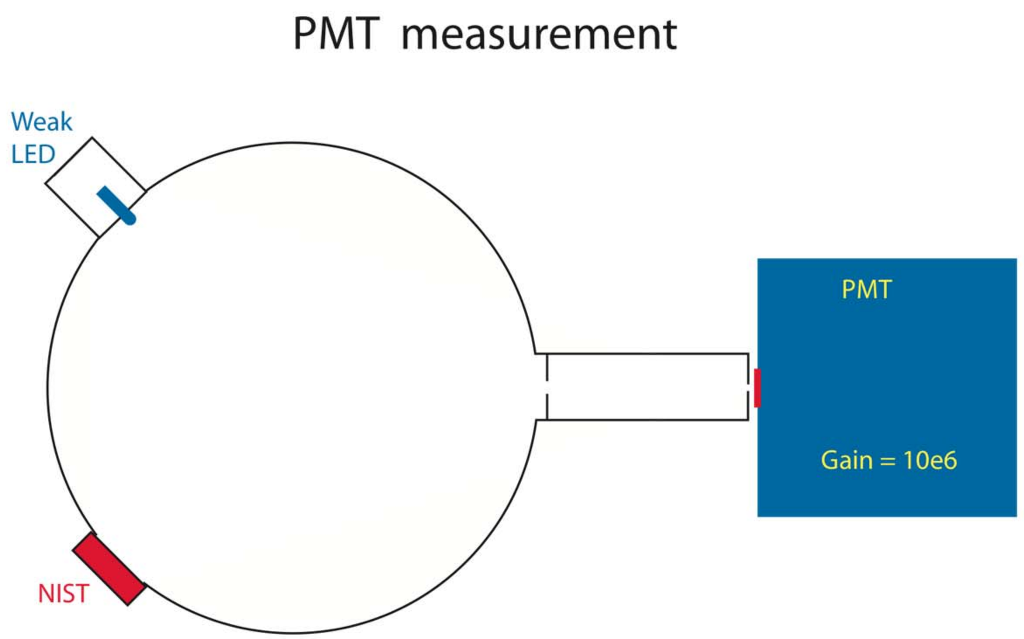
A minimum of 2 spheres of different diameters will be used to take into account the multiple scattering introduced by air

Jobin-Yvon picture



Calibration of the 2 PMTs

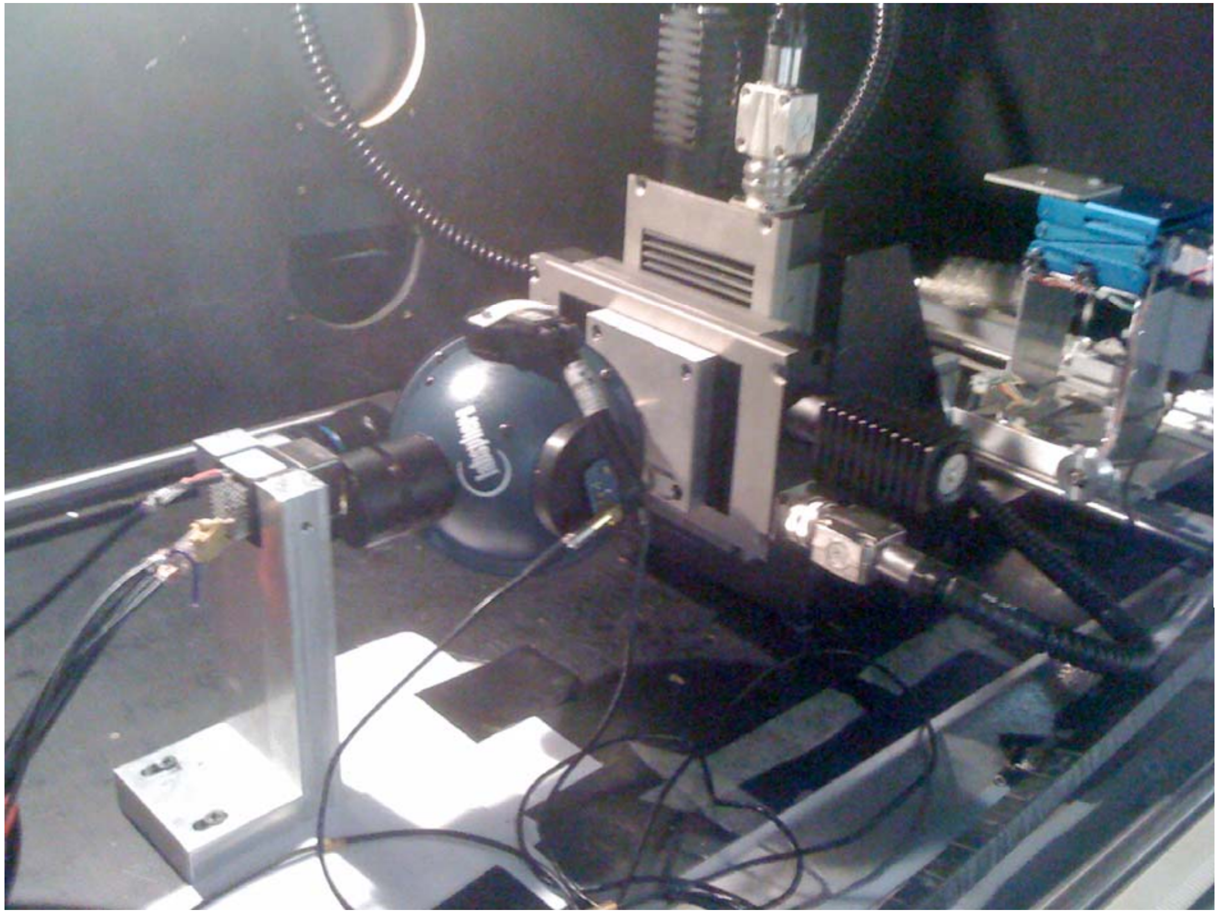
1)



Single pe mode: gain and efficiency are independent.

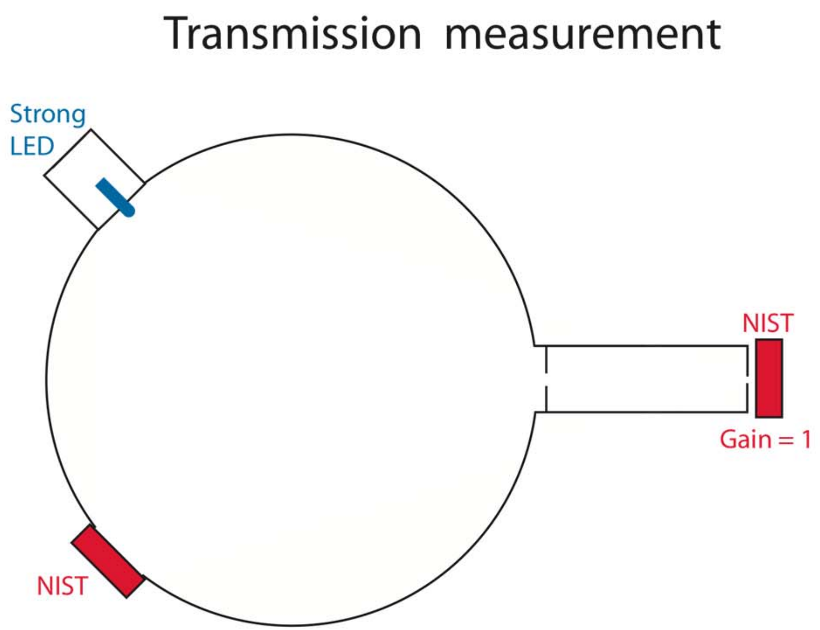
Calibration of the 2 PMTs

1)



Calibration of the 2 PMTs

2)



DC mode

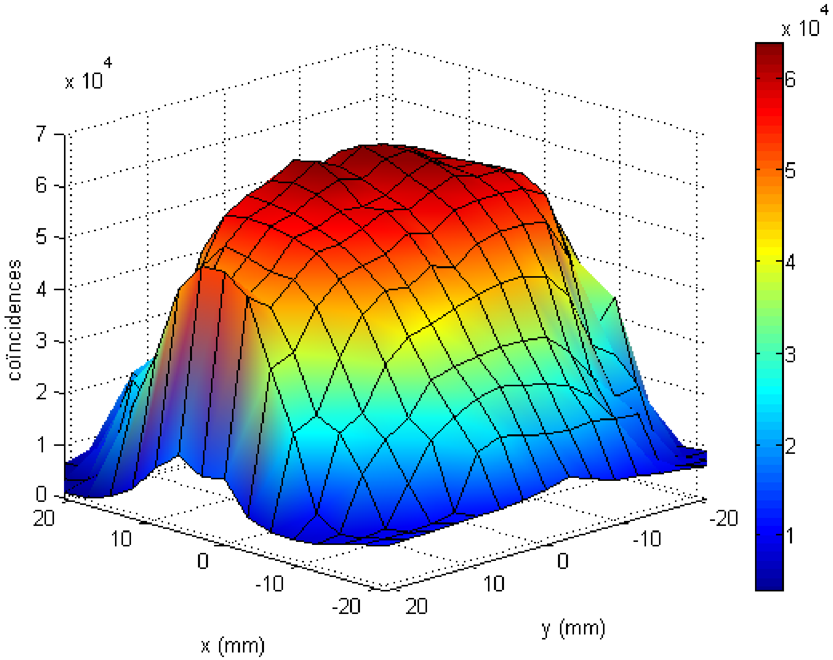
Flux reduction between NIST 1 and NIST 2 about 10^6

➔ Absolute efficiency (± 1.8%) of a small surface (< 4 mm^2) on PMT

Calibration of the 2 PMTs

Mapping of the photocathode

3)



Here, the photocathode is naked (Φ = 51 mm)

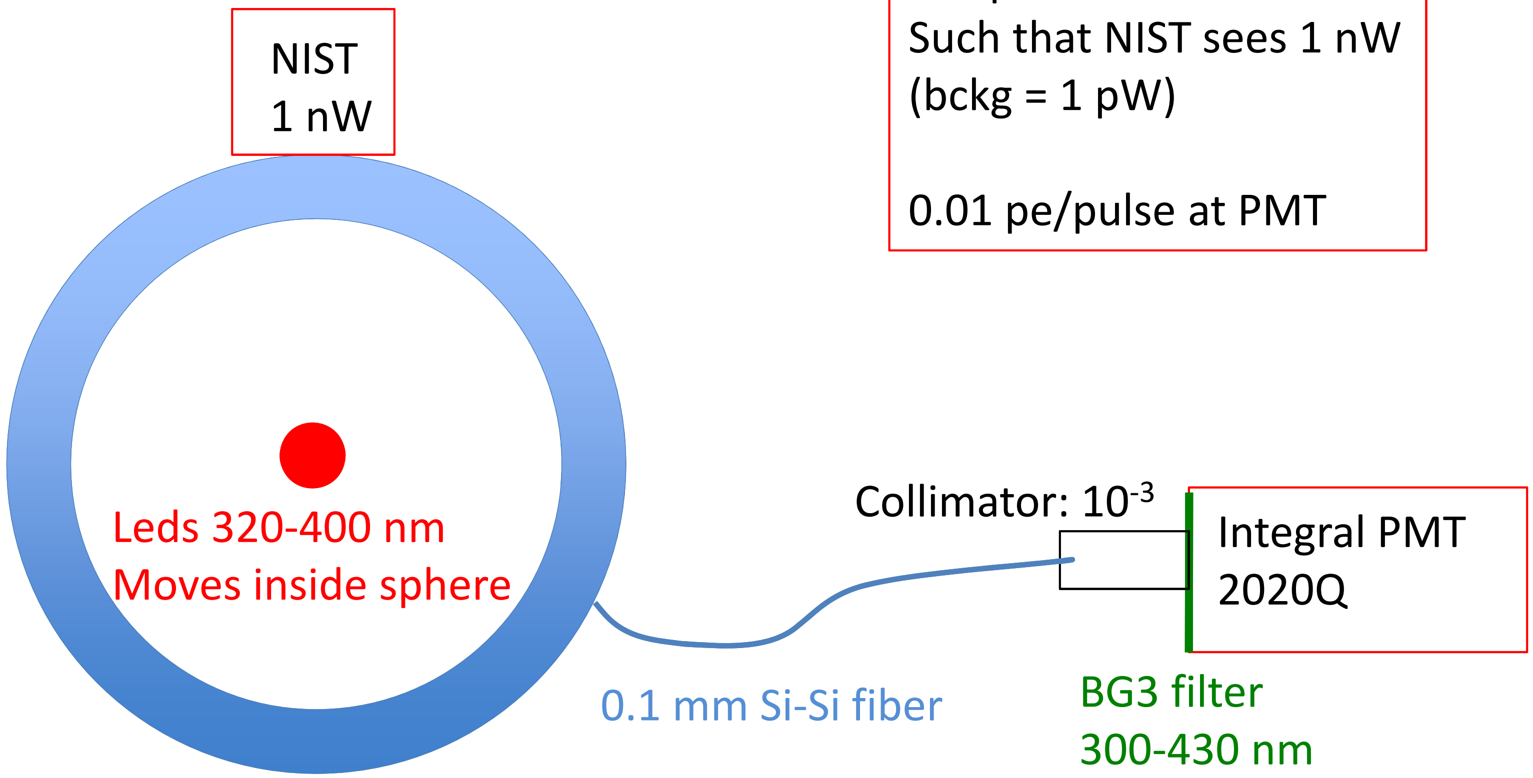
Fluctuations @ 1% level every 3 mm
==> need small light spot

We now have the absolute efficiency of the PMT ($d\varepsilon/\varepsilon < 2\%$) , on every point, or, if integrated, on its totality. Hence, we know what is the max of surface to use.

Calibration of the set-up with the integral PMT

Led pulsed at 20 kHz
Such that NIST sees 1 nW
(bckg = 1 pW)

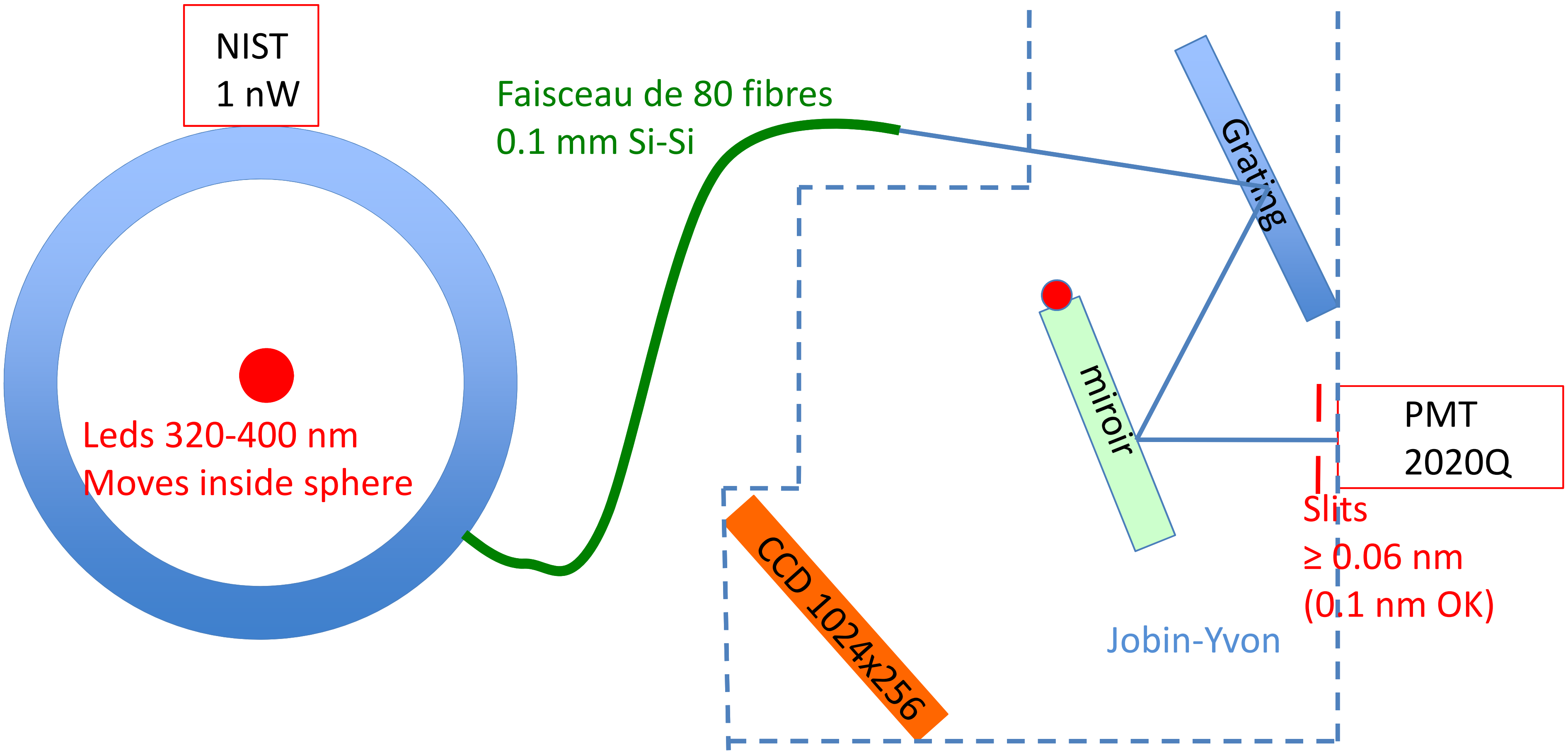
0.01 pe/pulse at PMT



Calibration of the set-up with the Jobin Yvon 1

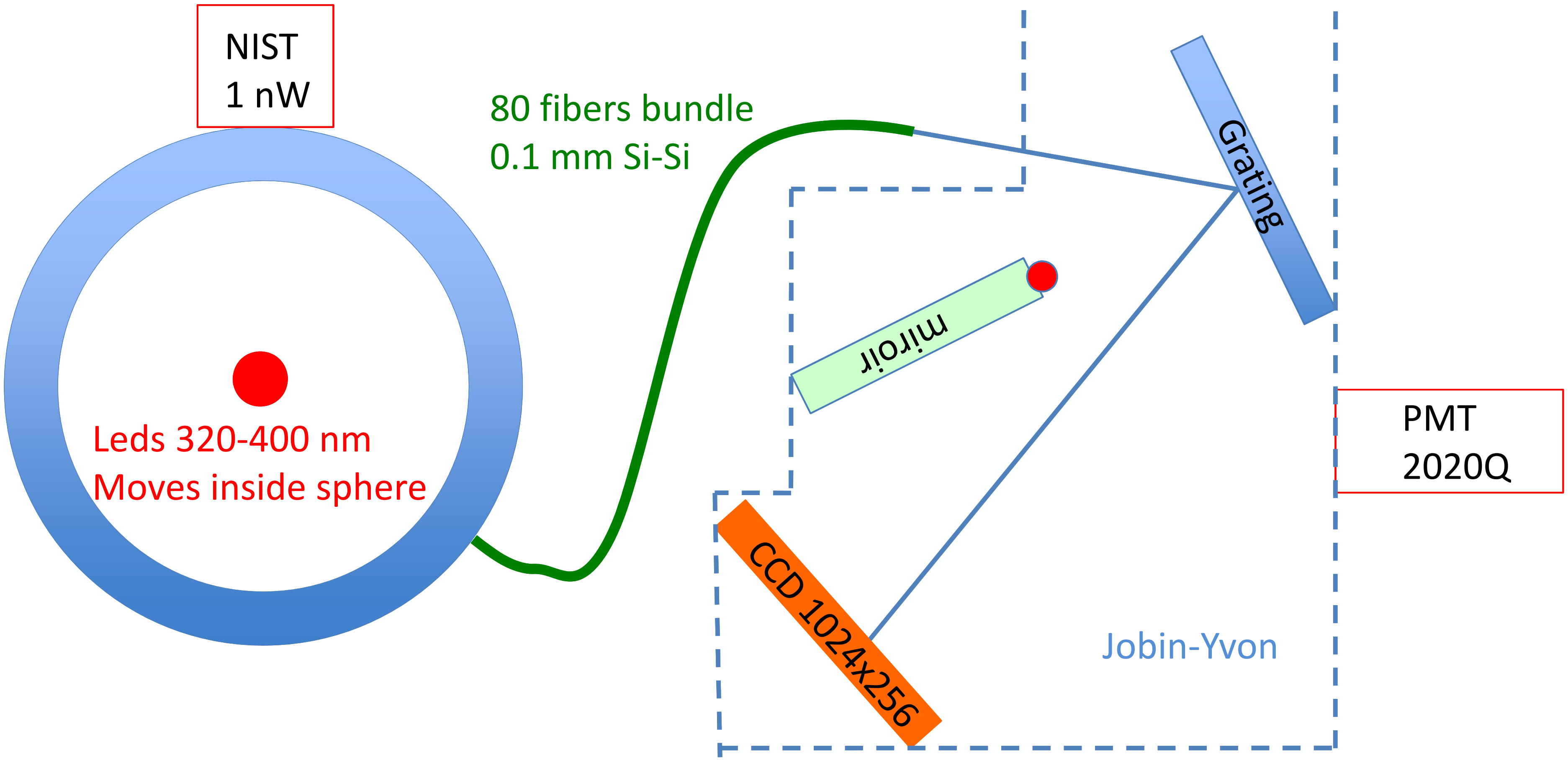
Led pulsed at 20 kHz
Such that NIST sees 1 nW
(bckg = 1 pW)

0.01 pe/pulse at PMT



Calibration of the set-up with the Jobin Yvon 2

Led pulsed at 20 kHz
such that NIST sees 1 nW
(bckg = 1 pW)
Bandwidth = 10 nm so that
we have 100 pixels X on CCD
and about 100 pixels Y
Each pix gets 4 10^{-3} pe/ pulse



How and when

Now to next spring:
Start with a crude teflon sphere (6 cm inside) to discover and solve all problems.
Comparison with MC.
Absolute calibration of PMTs
Absolute calibration of system with CCD
MC for final sphere
Beam tests with PMTs (intensity and lifetimes) and with spectrometer.

Spring to ….
Build new sphere
Build dewar
Build humidity provider
Take data

1 12. September 2011 B. Keilhauer Comments

Do we need to calibrate individual lines or bands ? Yes

 From measurement point of view, it might be difficult to measure individual lines absolutely. Thus using these as representatives for one band, could cause uncertainties.

Difficulties to convert measurements in pure N2 to air. We will use only air

 So calibration in air needed? Yes

Temperature-dependent collisional cross sections are important Yes

Humidity quenching is important Yes

What is going on with a temperature-dependent cross section for humidity quenching? We will see

For what accuracy are we aiming for? – We don‘t need to be perfect, but we need a satisfying level from CR-point of view.

Are the beams and / or the extensive air showers optically dense?

How to calculate / simulate the energy deposit inside the chambers of fluorescence experiments? Fernando et al

Accurate lifetimes of individual lines (cf A. Ulrich)