A METHOD FOR MEASURING THE STATISTICAL SPREAD-
SPECTRUM DISTRIBUTION OF LASER BEAM PROPAGATING
IN THE RANDOM MEDIAM **

Guan-Long Tan , Ai Yong
Qi-Pei Tan* and Huang Xing*

Physics Department, Wuhan University, Wuhan, China
**Project Supported by the Science Fund of the
Chinese Academy of Sciences

SUMMARY: A method was proposed for measuring the statistical
spread distribution curves of laser beam. The techniques were
found on the beam Width-Time-Amplitude conversion. With this
technique the relative precision of the beam width measurement
is of 1.3%(19 μm) in the turbulent air, and of 1%(14 μm) in the
static air. When the laser beam passes through the rigion of
flame of the alcohol lamp, the precision of the width measurem-
ent is of 2.7%(52 μm).

ABSTRACT: When a laser beam passes through the turbulent atmos-
phere, several effects induced by the turbulence would be
formed. The main effects are intensity fluctuation, intensity
distribution, the spot dancing and the beam spread. Under the
condition of strong turbulence for the one of effects has
attachment to the other, it is difficult to measure them separ-
ately. But in view of the physical measurement, the measuremen-
ts of the intensity fluctuation and the distribution depend on
the detection of light intensity and the position. And the
spot dancing or the beam spread will be to determine the dis-
placement or beam cross-section respectively. By using the
displacement-Time conversion technique(Guan-Long Tan,J. Optics
(Paris), Vol.12,4,241, 1981) the intensity of laser beam is
converted into a train of photoelectric pulses, and the motions
of laser beam passing through the atmosphere will be changed
into the motions of the photoelectric pulses on the time axis.
Thus the pulse amplitude, pulse shape(leading edge, fall edge
and width) and appearing moment on the time axis are directly
related to the effects mentioned above. If the variations of
pulse amplitude and shape caused by the intensity change are
eliminated or reduced to the least(G.L. Tan, ICL Digest, Guang-
zhou, China, 1983), then the pulse width is just the width of
the beam cross- section expressed by the values of time , And
the fluctuation of the appearing moment of pulses actually
represents the motion of the spot dancing. Based on the measur-
ing techniques of the spot dancing(G.L. Tan, IEEE/AP-S Digest,
P843-850, 1985, Canada), it has been found the techniques of
measuring the statistical spread sprectrum distribution curve.
The method is as follows:
    Firstly, using the high sensitive photoelectric detector,
3DU912, and the rotating slit system, the intensity of the
----
*Qi-Pei Tan, Huang Xing are with Wuyu University, Jiangmen.

laser beam is converted into a train of pulses. And the
original photoelectric pulses coming from the detector are
processed by successive limiter at a low photoelectric current.
And so the output amplitude of the pulse from the limiter will
be not varied with the change of intensity of the laser beam if
the intensity is higher than that the value of threshold.

Secondly, we adopt the eliminating techniques to reduce the
pulse shape variation to the least caused by the change of
intensity of the beam.

Finally, the pulses their shape variations being eliminated
to the least are fed into the pulse Width-Amplitude converter.
From which the pulse are delivered to the multi-channel analy-
zer. And the statistical distribution curves of the beam spread
and the statistical parameters are finally obtained.

The experiments shown in block diagram Fig(1), were carried
out. A colimated laser beam with cross-section of 3mm ⋋ 8mm
passed through the experinental box of the length 74cm, and
then arrived at the photoelectric detector. At the receiving
point there was a rotating system with speed adjustable and
stabilized, and rotating frequency was of 29 Hz. It had been
tested the statistical distribution curves of beam spread under
the conditions of static air, turbulent air and of hot turbul-
ent air. Especially, we finished the experiment, the laser beam
passed through the region of flame of alcohol lamp. The experi-
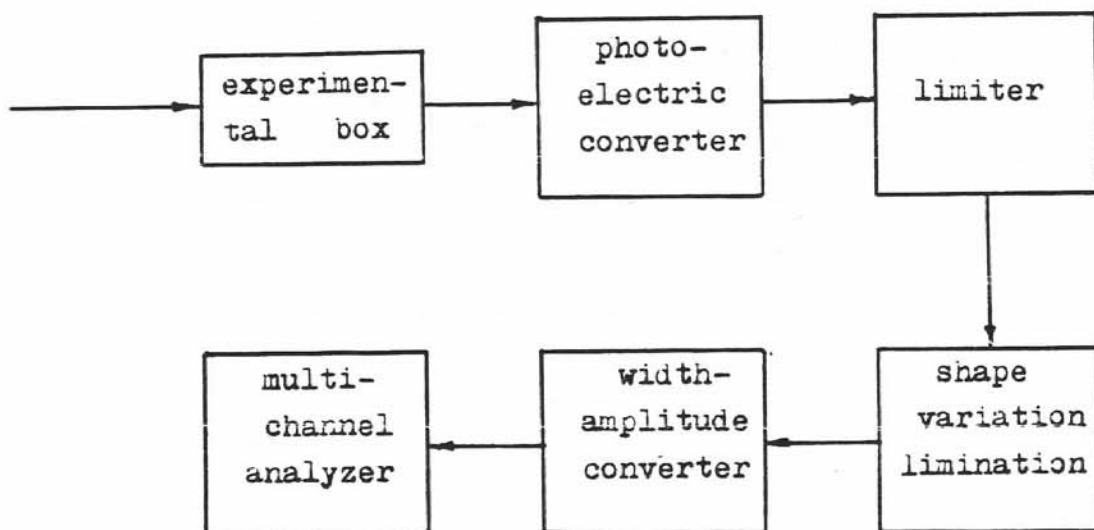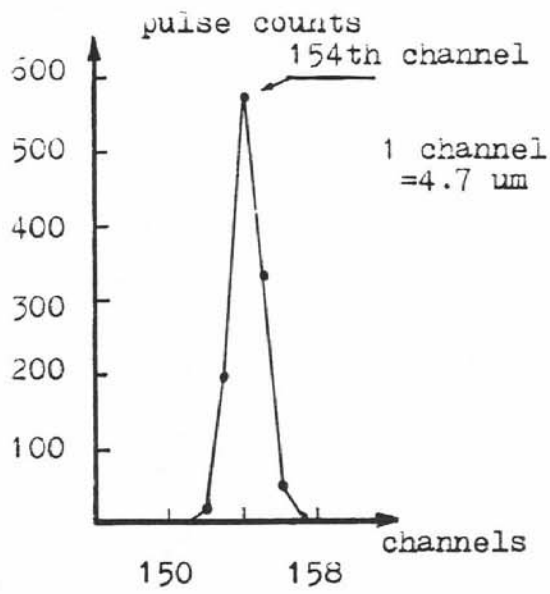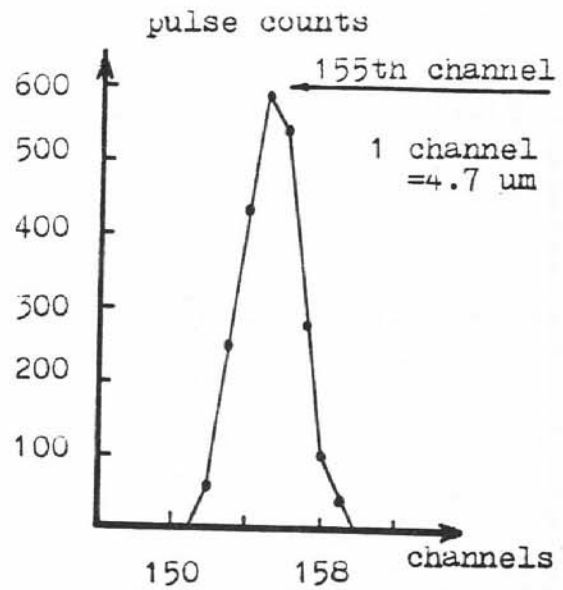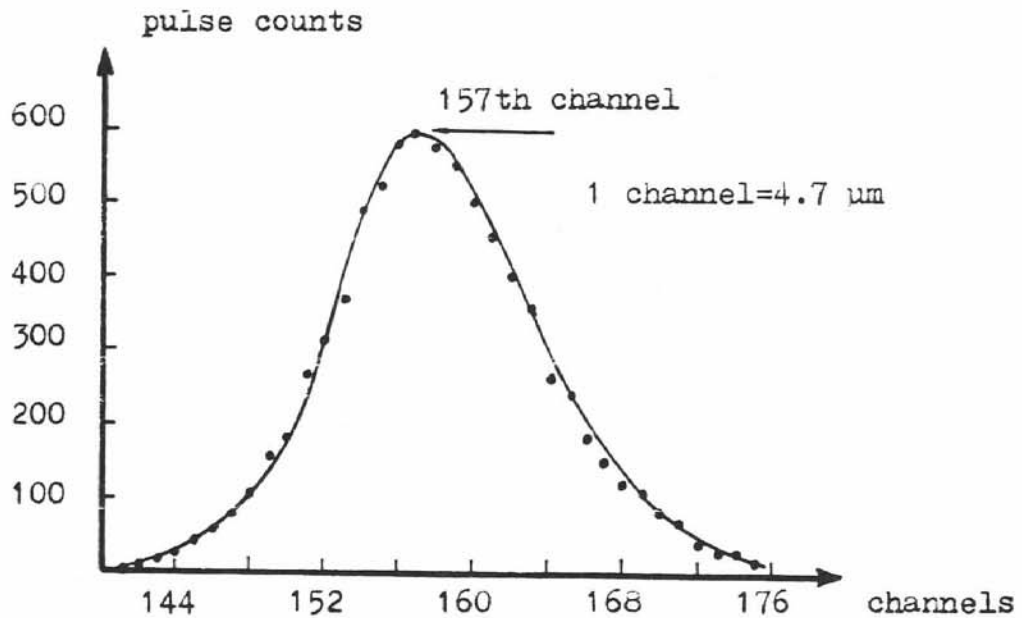mental results were shown in Fig(2) and Fig(3).

Fig.(1) Block Diagram Measuring Beam Spread

Fig.(2) Beam spread Distribution

pulse counts   146th channel   Temperature

T=353 c°
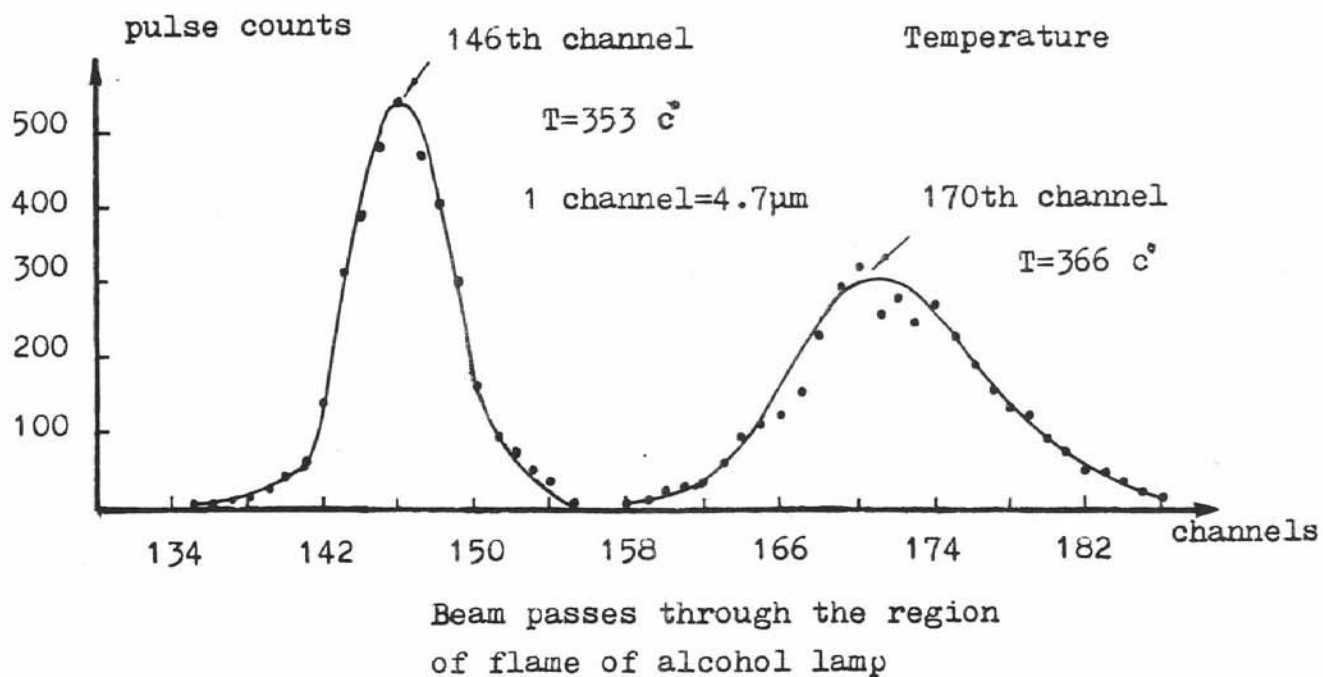
1 channel=4.7μm   170th channel

T=366 c°

Beam passes through the region
of flame of alcohol lamp

Fig.(3) Beam spread Distribution