

Advanced Mathematical and
Computation Tools in Metrology and
Testing

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MODEL ADEQUACY IN MEASUREMENTS: ESTIMATION AND IMPROVEMENT

V. A. GRANOVSKY, T. N. SIRAYA

CENTRAL SCIENTIFIC RESEARCH INSTITUTE

“ELEKTROPRIBOR”

St. PETERSBURG, RUSSIA





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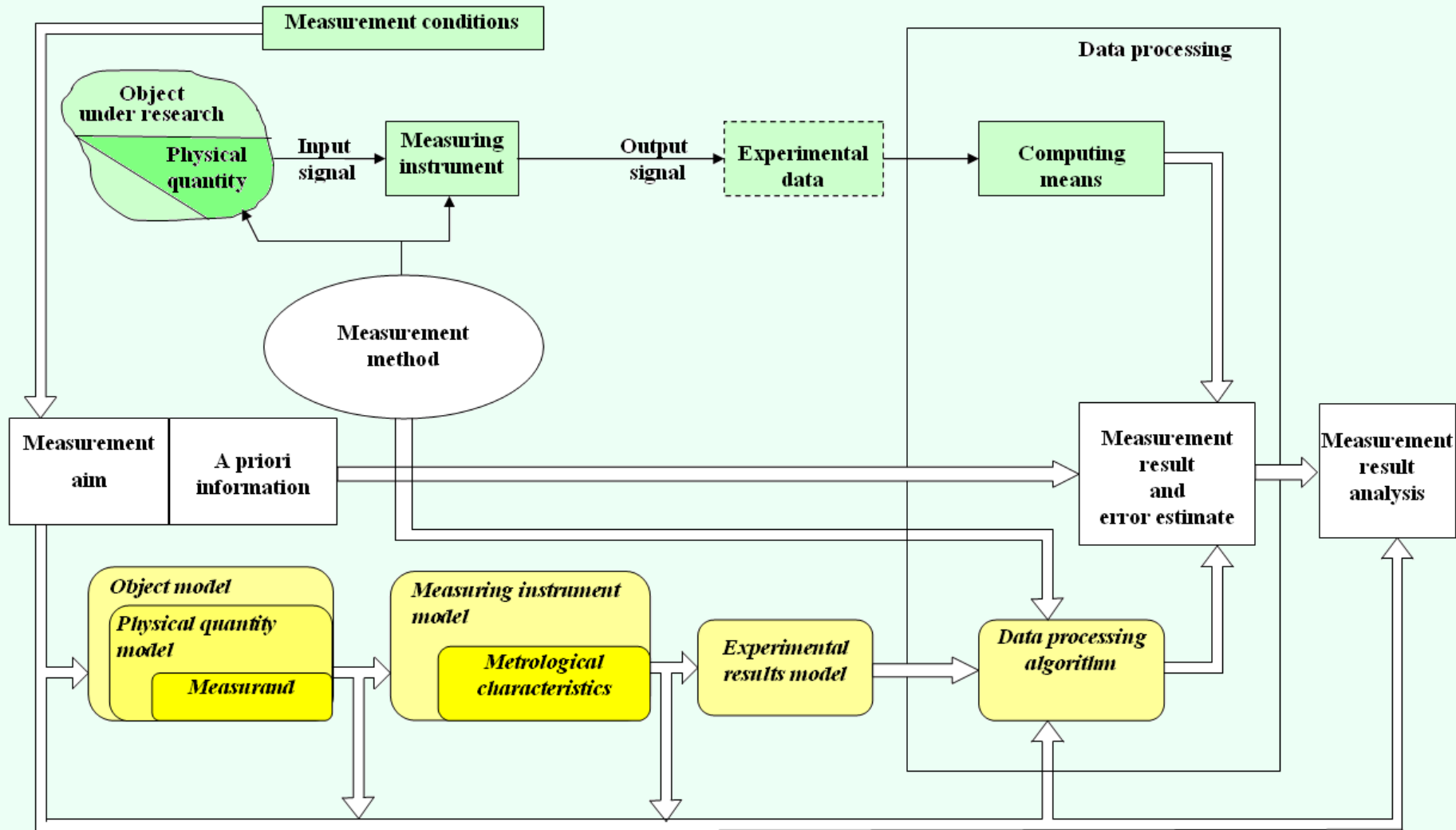


INTRODUCTION



Measurement procedure may be presented with two associated and interactive rows of elements:

- (i) the row with real objects**
- (ii) the row with mathematical models**





**While measurement realization,
the operator does not
pay due attention
to all the elements
of measurement model**



**So the general model
of measurement circumstances (MMC),
including all the model elements,
is never stated strictly and completely**



**But, the measurement result
may be correctly interpreted
(and properly understood)
only within the limits of MMC**



**Below an attempt is made
to outline the ways
for measurement model improvement
in order to overcome the difficulties
in measurement result
interpretation and presentation**

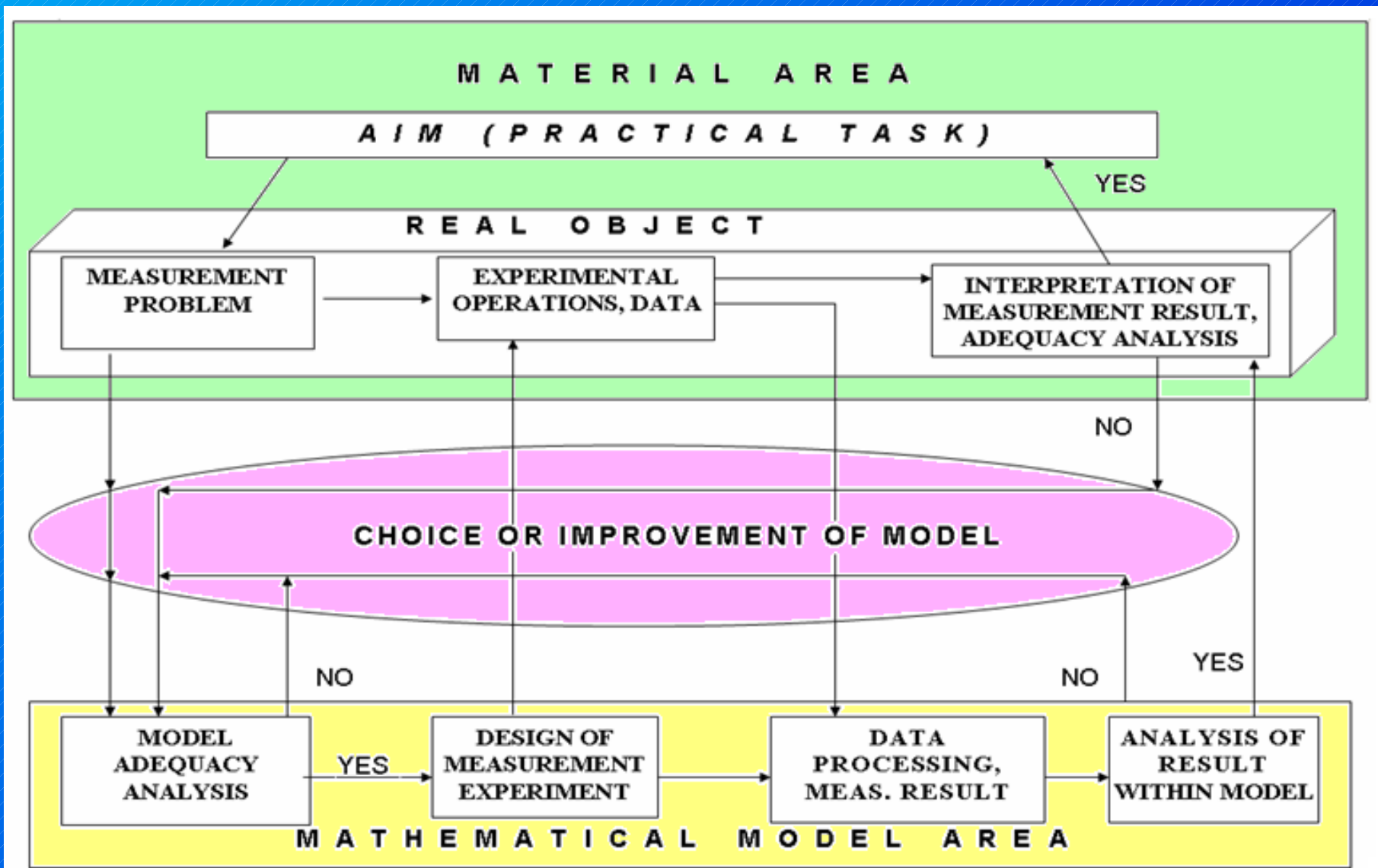


GENERAL METHODOLOGY



Earlier author's papers contain:

- principles of the model adequacy analysis for measurement;**
- formal (internal) and physical (external), qualitative and quantitative aspects of adequacy;**
- scales for inadequacy characteristics estimation;**
- step-by-step procedure for model improvement.**





MAIN SITUATIONS OF MODEL IMPROVEMENT



(i) Measurement is planned as a multistage process / it is necessary to find an initial approximation for the precision method



The total error consists of two components:

$$\delta f(\mathbf{X}) = \delta_c f(\mathbf{X}) + \delta_a f(\mathbf{X}),$$

where $\delta_c \mathbf{f}$ — approximation error

$\delta_a \mathbf{f}$ — inadequacy error



**(ii) Measurement
of the highest precision
is the target**



**The general model
is unknown or indefinite**

In:

Measurement on primary standard

Super-precise measurement

Measurement for fundamental

physical limits investigation



**(iii) The model
is under improvement
only a posteriory**



Variant 1

**The properties of data are different
from what are expected
according to the model assumed**



Variant 2

**The results of two measurements
based on different models
are different from one other**



CONCLUSIONS

The MMC is an inalienable element of the measurement description and result presentation.

The definition of measurement result may be extended as follows:

The measurement result may be presented as a set of three estimates for:
measurand, error (uncertainty), and model inadequacy



The problems under investigation:

(a) *classification of MMC*

**(b) *definition of general set
of model inadequacy measures***

**(c) *development of methods
for model inadequacy characteristic
estimation***

**(d) *formulation of criteria
for testing inadequacy characteristics
to be negligible***

30, Malaya Posadskaya str.,
Saint Petersburg, 197046, Russia.

Tel. 7 (812) 232 5915. Fax 7 (812) 232 3376.

e-mail: elprib@online.ru

<http://www.elektropribor.spb.ru>

·ELEKTROPRIBOR· CENTRAL SCIENTIFIC RESEARCH INSTITUTE

St.PETERSBURG, RUSSIA





**It was suggested that, generally,
the measurement result has to
include the third component –
model inadequacy characteristic**