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Derivation of Preliminary Specifications for Transmitted Wavefront and Surfaces Roughness for Large Optics used in Inertial Confinement Fusion

(Viewgraphs only)

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I.C.F. OPTICS SPECIFICATIONS

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for
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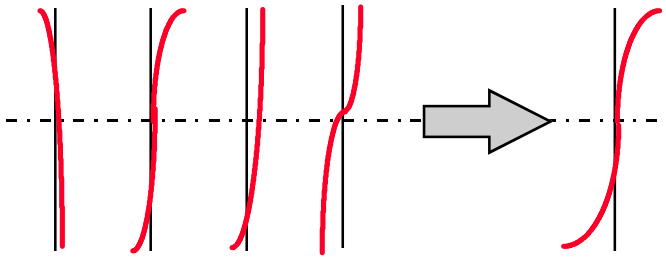
I.C.F. OPTICS SPECIFICATIONS

- SPECIFICATIONS IN GENERAL
- QUICK LESSON IN NON-LINEARITY
- LOW SPATIAL FREQUENCIES
  - GEOMETRICAL ERRORS
- MID and HIGH SPATIAL FREQUENCIES
  - RIPPLE, ROUGHNESS
- COMPARISON WITH CURRENT FABRICATION
- CONCLUSION

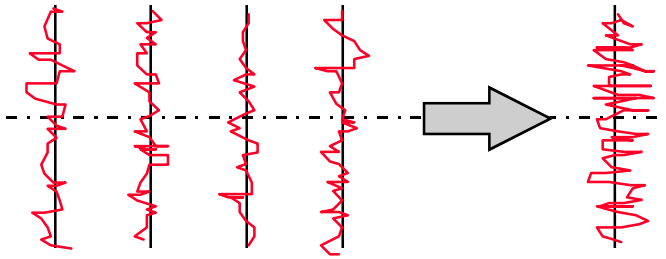
OPTICS SPECIFICATIONS SHOULD BE . . .

- **SIMPLE :**
  - **They must be easy to understand and to apply in the workshop.**
- **ACCURATE :**
  - **They must reflect the desired quality exactly.**

THE CASE OF "CLASSICAL" OPTICS . . .



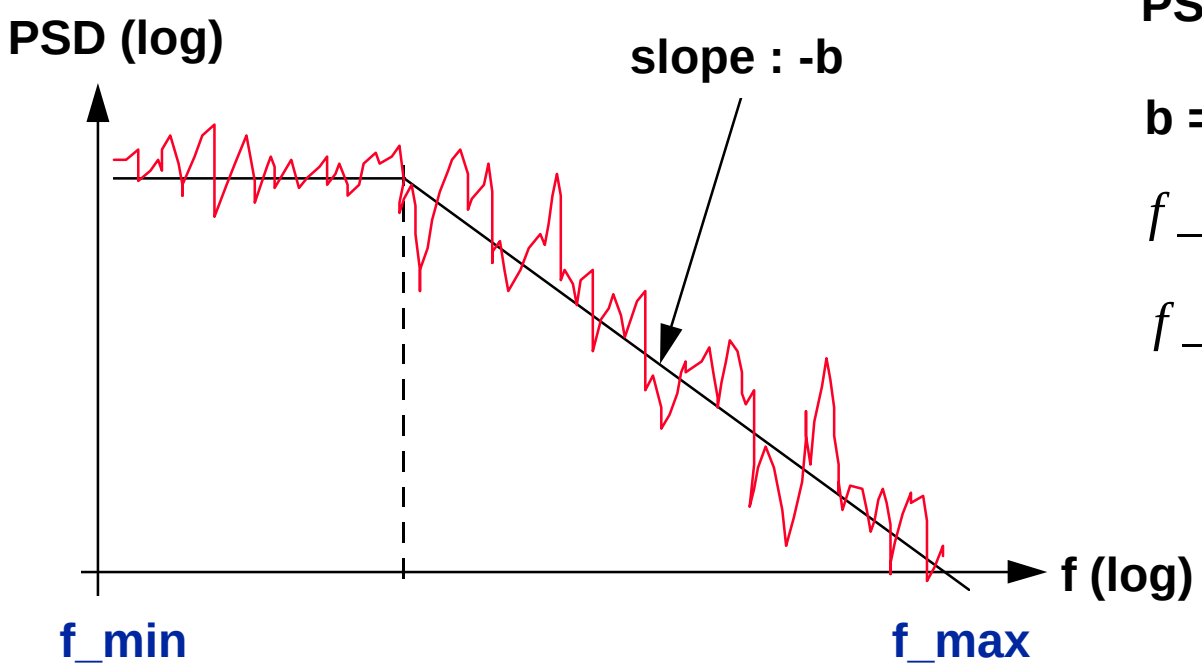
Large scale errors add
in AMPLITUDE
(curvature, astigmatism,...)



Small scale errors add
in POWER
(roughness)

POWER SPECTRAL DENSITY (P.S.D.)

•POWER SPECTRAL DENSITY - ILLUSTRATION:



PSD(f) = a / f ^{b}

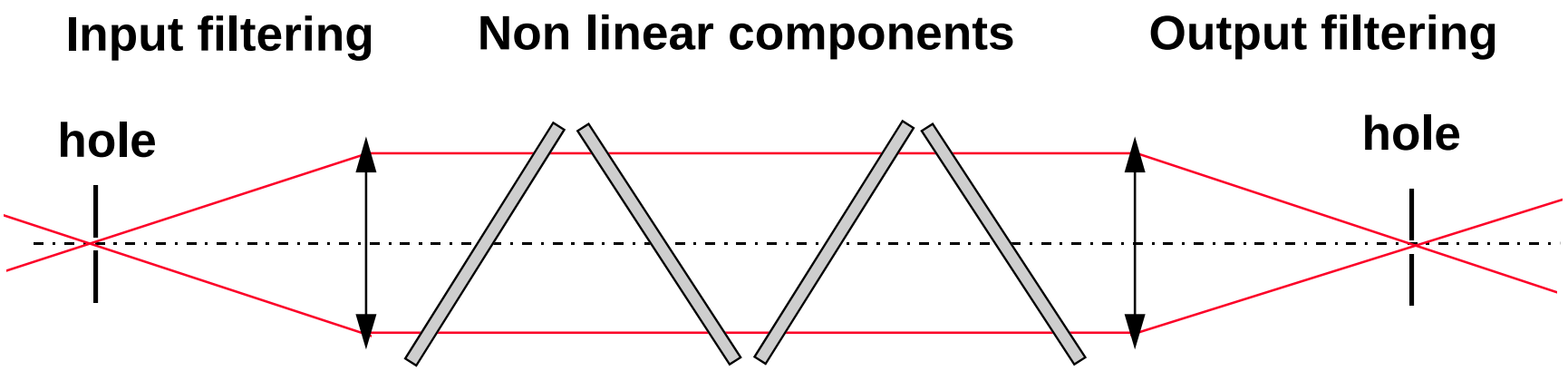
b = 1 to 3

$$\int_{f\_min}^{f\_max} PSD(f).df = RMS^2$$

THE CASE OF I.C.F. LASERS . . .

- **Large components :**
  - Large dynamic range for defect scale.
- **Long system :**
  - Large dynamic range for Fresnel lengths.
- **Non linear effects :**
  - Very large amplification of certain spatial frequencies.
- **Wide variety of components :**
  - Specifications must adapt to each type of part.

AMPLIFIER SECTION - illustration



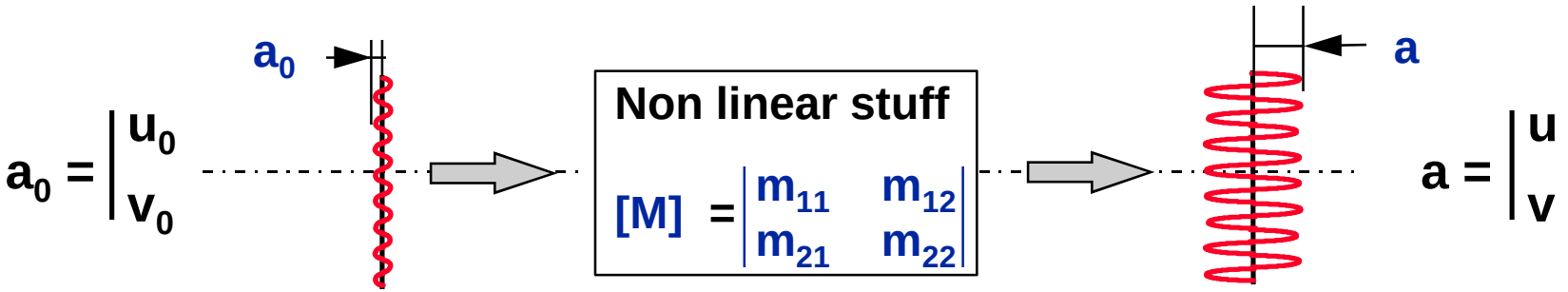
- Typical hole size : ± 100 µrd : equivalent to feature size of 10 mm.
- Features smaller than 10 mm don't "get through" the output hole.
- Measure of non-linearity : $B = \Sigma \{ k . length . \delta n \}$ (in radians).

SMALL RIPPLE AMPLIFICATION

$E(x,y,z) = E_0 \{ 1 + a(z) . e(x,y) \}$ $\quad a(z) = u(z) + i . v(z)$

u : real part : mode **amplitude**
v : imaginary part : mode **phase**

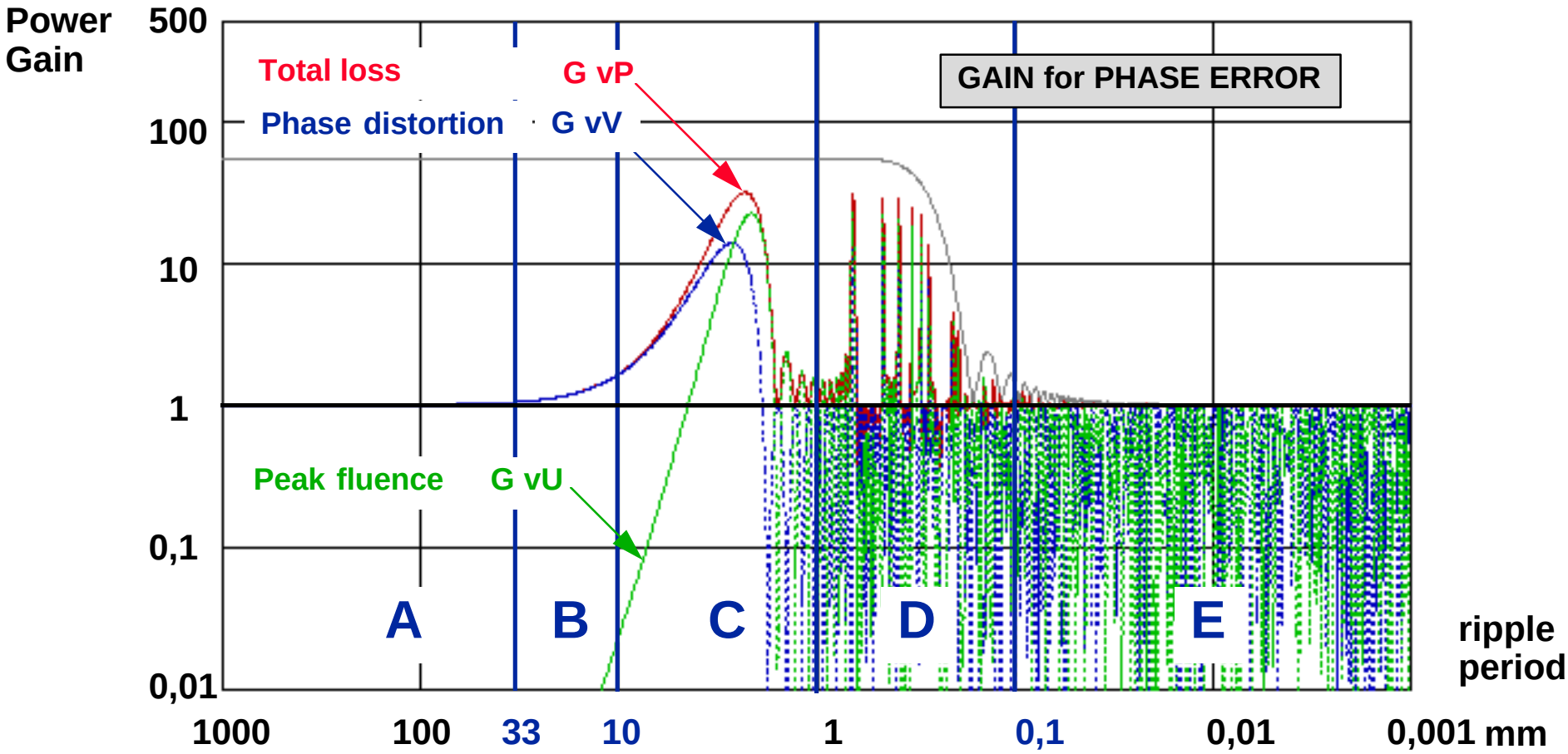
} Mode **Power** : $u^2 + v^2$



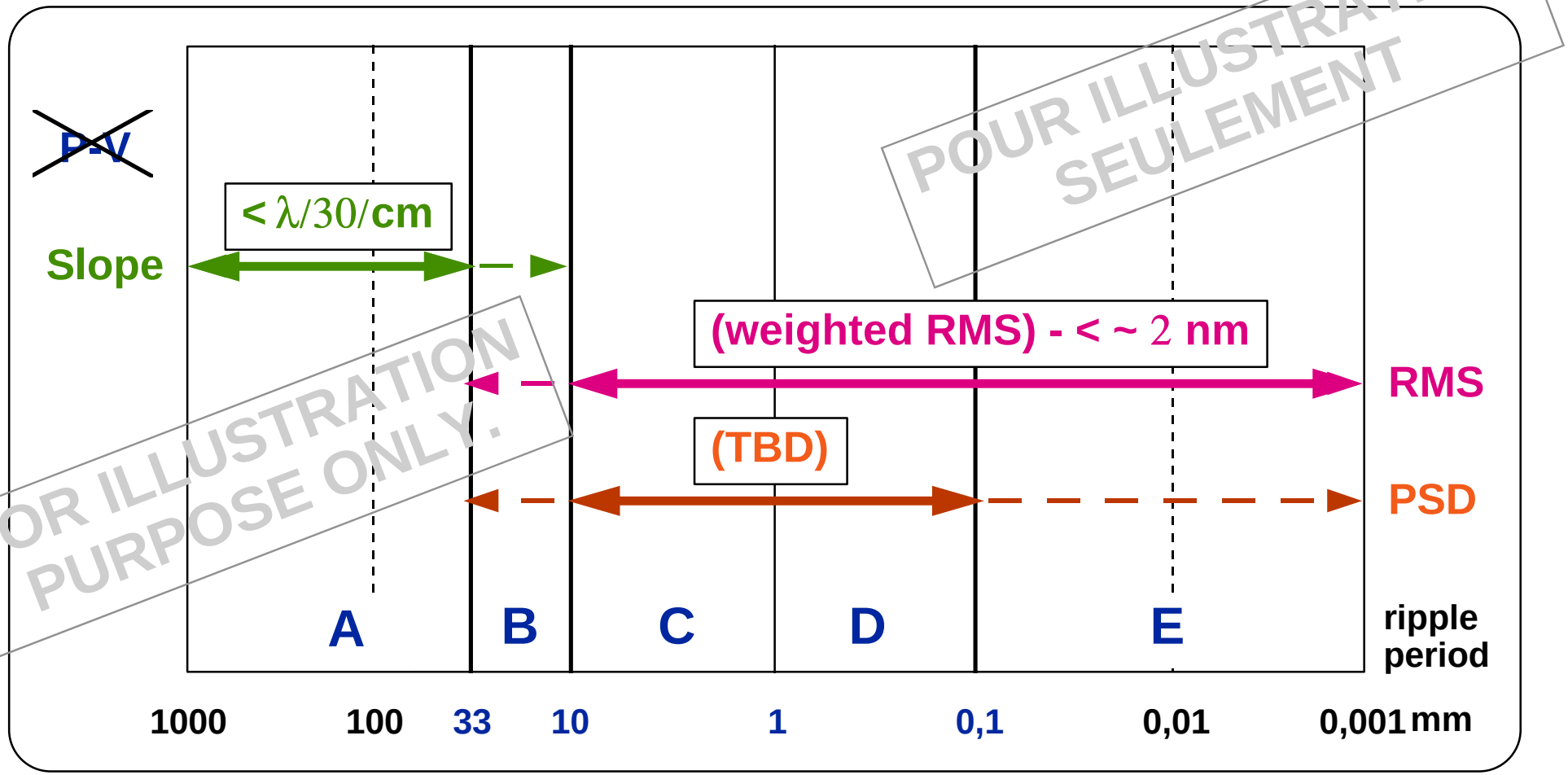
- MODE **AVERAGE POWER** over spatial frequencies relates to **ENERGY LOSS**.

- MODE **PEAK AMPLITUDE** relates to **OPTICS DAMAGE**.

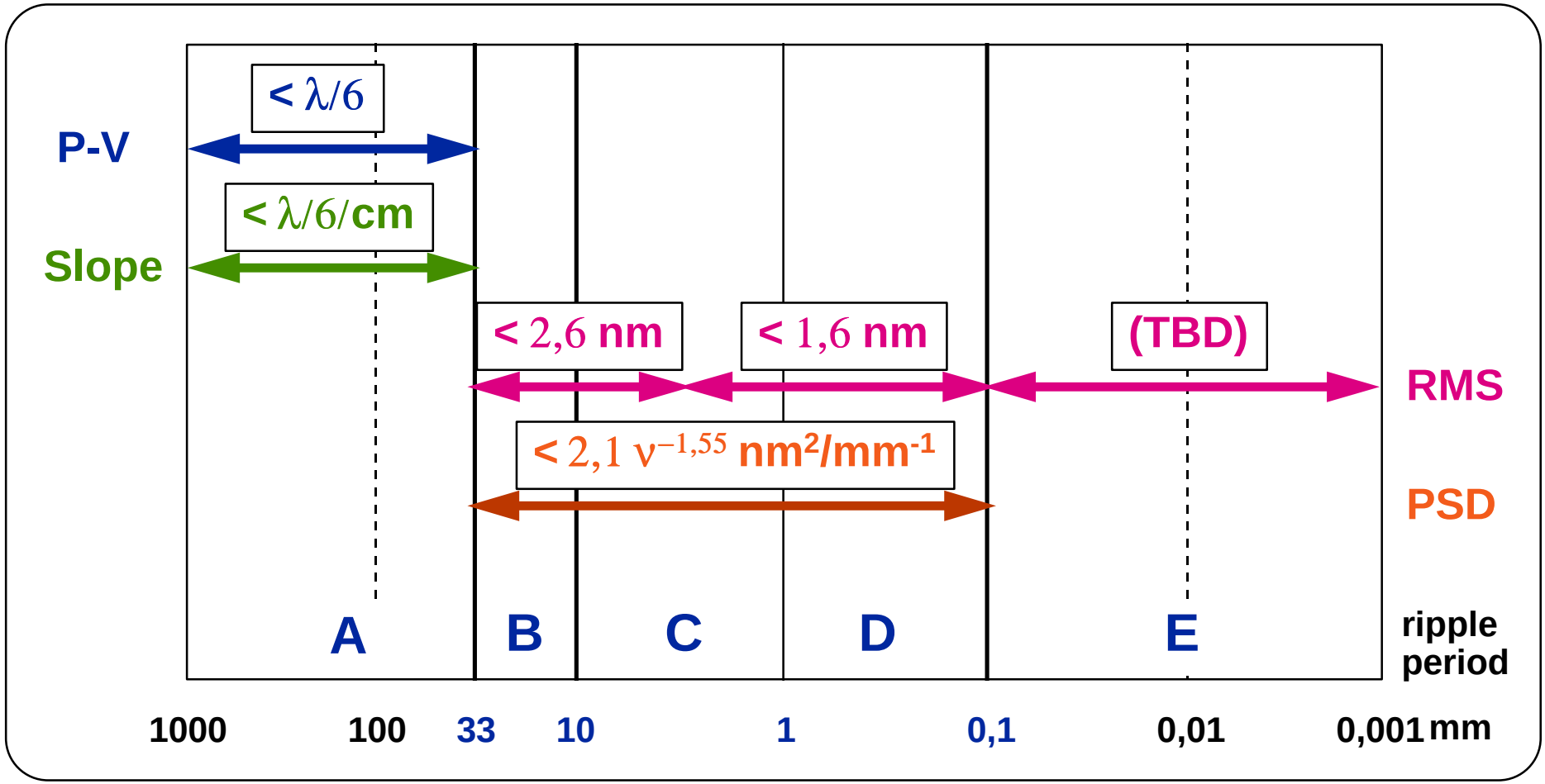
AMPLIFIER GAIN SPECTRUM - illustration



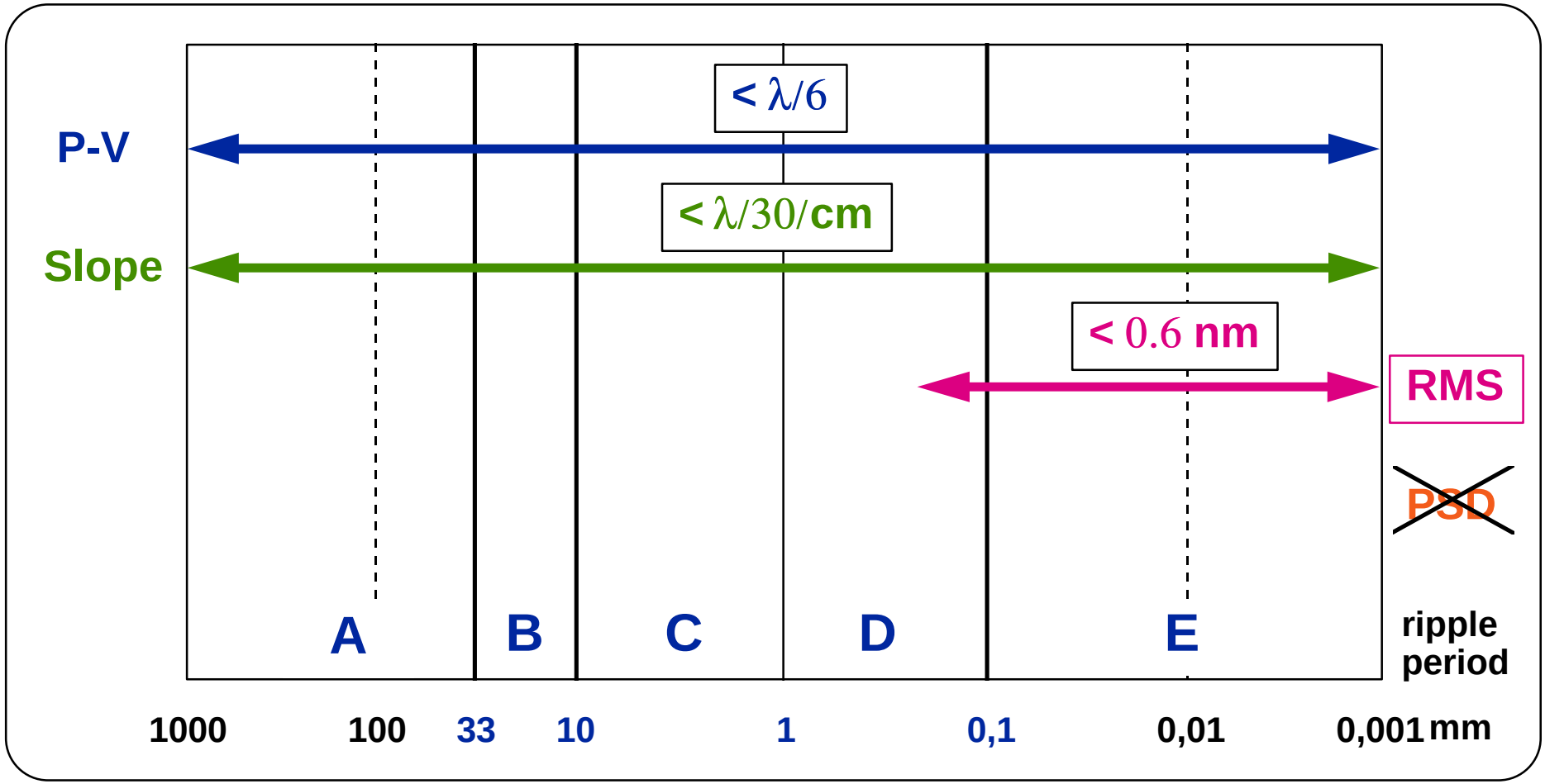
SPECS (I) - based on FIRST PRINCIPLES



SPECS (II) - based on METROLOGY (to date)



SPECS (III) - BEAMLET (1991)



CONCLUSION

We have shown how optical specifications for MégaJoule and NIF have been derived, using first principles :

- **They are highly correlated to the final performance of the laser system, making them efficient.**
- **They define spatial frequency bands, which was not explicitely done previously, making measured values independant of measurement devices.**
- **They are simple enough that they can be used in industry with little training, using existing metrology devices.**