***Supplementary Material***

1. **Derivation of Eq. 3.**

The partially coherent beam is produced via a Schell-model source (at source plane), the cross spectral density (CSD) can be expressed in the following well-known form [23]:

|  |  |  |
| --- | --- | --- |
|  | $$W\left(r\_{1},θ\_{1},r\_{2},θ\_{2}\right)=\left〈E^{∗}\left(r\_{1},θ\_{1}\right)E\left(r\_{2},θ\_{2}\right)\right〉=A\left(r\_{1},θ\_{1}\right)A\left(r\_{2},θ\_{2}\right)g\left(r\_{1},θ\_{1},r\_{2},θ\_{2}\right)exp\left(i\left(ψ\_{1}−ψ\_{2}\right)\right)$$ | (13) |

Where *A*(*rα*, *θα*) (*α* = 1, 2) is a Gaussian amplitude and is expressed as:

$$A\left(r\_{α}, θ\_{α}\right)=exp\left(−\frac{r\_{α}^{2}}{w\_{0}^{2}}\right) (14)$$

Moreover, *g*(*r*1, *θ*1, *r*2, *θ*2) is the degree of the coherence function which satisfies the Schell-model correlation distribution and can be expressed as [32]:

$$g\left(r\_{1},θ\_{1},r\_{2},θ\_{2}\right)=exp\left[−\frac{r\_{1}^{2}−2r\_{1}r\_{2}cos\left(θ\_{1}−θ\_{2}\right)+r\_{2}^{2}}{2σ^{2}}\right] (15)$$

Finally, *Ψα* is the phase term of the PC-PEPV beam and is written as:

$$ψ\_{α}=2π\left[\frac{rem\left(mθ\_{α},2π\right)}{2π}\right]^{n} (16)$$

Substituting Eqs. (14) - (16) into Eq. (13), the CSD function of the PC-PEPV beam can be expressed as follows:

|  |  |
| --- | --- |
| $$W\left(r\_{1},θ\_{1},r\_{2},θ\_{2}\right)=exp\left(−\frac{r\_{1}^{2}+r\_{2}^{2}}{w\_{0}^{2}}\right)×exp\left[−\frac{r\_{1}^{2}−2r\_{1}r\_{2}cos\left(θ\_{1}−θ\_{2}\right)+r\_{2}^{2}}{2σ^{2}}\right]×exp\left(i2π\left\{\left[\frac{rem(mθ\_{1},2π)}{2π}\right]^{n}−\left[\frac{rem(mθ\_{2},2π)}{2π}\right]^{n}\right\}\right)$$ | (17) |