cal parametric interactions, photorefractive mechanisms, thermal gratings, etc.). The specific choice of PCM is dependent upon myriad system parameters, including response time, power scaling, wavelength, frequency shift considerations, polarization, etc. Those well-skilled in the art are familiar with these and related issues; so, additional design details that pertain to the PCM and its implementation will be relegated to the systems design community.

Suffice it to say that the wavefront-reversed beam, upon its reverse passage through the optical system, essentially "undoes" the distortions encountered on its initial transit (fiber distortions and mode mixing, optical imperfections, depolarization, etc.). In addition, the HOM that emerges from the amplifier **1120**, will, as a result of the "time-reversed" nature of the PCM, precisely couple back into the HOM ribbon fiber in its reverse propagation trajectory. Moreover, this embodiment compensates for imperfections in the mode converter module that would otherwise limit the overall efficiency of the system.

The backward-going bean after reverse transit back through the HOM fiber and mode converter, can be outcoupled from the system using various well-known mechanisms, such as polarization decoupling, non-reciprocal methods (e.g., Faraday rotation techniques), and others, which are also well-known to the skilled artesian. In FIG. **11**, an example is shown that utilizes a Faraday rotator **1160**, in conjunction with a polarization sensitive beam splitter **1150**, such as a Glan prism, to direct the high-power, double-passed diffraction-limited beam out from the system. A quarter-wave plate, in conjunction with a Glan prism is another example to enable efficient out-coupling of the double-pass beam (in this case, polarization considerations may apply, as is well-known).

FIG. **12** depicts a phase-conjugate MOPA, with a similar configuration relative to that of FIG. **11**. This embodiment enables power scaling to higher powers, which, in the case of a single ribbon fiber, may otherwise be limited. The basic system builds upon the single-HOM power amplifier configuration of FIG. **11** by augmenting the system with a series/parallel cascaded network of ribbon fiber power amplifiers (three amplifiers, in this example). The seed laser **1210** in FIG. **12** is partitioned into three beams using a 1:3 beam splitter/combiner **1270**. Each beam is then directed into a dedicated mode-converter **1230**, followed by an associated HOM power amplifier **1220**. The set of three amplified output beams are then recombined using a three-way beam splitter/combiner **1280** aligned in a 3:1 configuration (in reverse, relative to the other splitter **1270**). The resultant beam is directed into a PCM **1240**. The wavefront-reversed replica retraces its trajectory, with all the beam paths precisely retraced. The action of the PCM effectively compensates for differential phase shifts amongst the three amplifier legs, with the result that the PC-MOPA functions as a phased-array, multiple amplifier system. As in FIG. **11**, the composite, diffraction-limited, high-power beam is out-coupled from the system using similar techniques, such as via a Faraday rotator **1260** and a Glan prism **1250**.

Note that, in the case wherein the 3:1 beam splitter/combiner **1280** functions optimally with low-order spatial modes (as opposed to HOMs), each ribbon-fiber output, on its forward-going transit, can be directed into a dedicated mode converter (analogous to module **1040** shown in FIG. **10**). In this manner, each ribbon fiber HOM output beam will be transformed to a TEM_{00} mode prior to impinging onto the 3:1 beam splitter/combiner **1280**.

The foregoing description of the invention has been presented for purposes of illustration and description and is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. The embodiments disclosed were meant only to explain, the principles of the invention and its practical application to thereby enable others skilled in the art to best use the invention in various embodiments and with various modifications suited to the particular use contemplated. The scope of the invention is to be defined by the following claims.

We claim:

1. An apparatus, comprising:

a HOM ribbon fiber amplifier configured to receive and amplify a higher order mode (HOM) input beam to produce an amplified HOM beam;

a first diffractive optical element (DOE) configured to impart a predetermined phase onto said amplified HOM beam to produce an amplified fundamental mode beam; and

a second DOE configured to transform the phase of said amplified fundamental mode beam into a single fundamental mode beam.

2. The apparatus of claim **1**, wherein said first DOE comprises a first phase plate and wherein said second DOE comprises a second phase plate.

3. The apparatus of claim **1**, wherein said first phase plate is configured to impart the requisite amount of phase shift across said amplified HOM beam to produce said amplified fundamental mode beam that is spread into multiple lobes matching the spatial pattern of said amplified HOM beam and wherein said second phase plate is configured to produce a single Gaussian beam from said amplified fundamental mode beam.

4. The apparatus of claim **1**, wherein said HOM ribbon fiber amplifier comprises a core having a first width configured to propagate a single mode and a second width orthogonal to said first width, wherein said second width is configured to propagate multiple modes or beams.

5. A method, comprising:

providing an apparatus comprising:

a HOM ribbon fiber amplifier configured to receive and amplify a higher order mode (HOM) input beam to produce an amplified HOM beam;

a first diffractive optical element (DOE) configured to impart a predetermined phase onto said amplified HOM beam to produce an amplified fundamental mode (TEM_{00}) amplitude profile; and

a second DOE configured to transform the phase of said amplified amplitude profile into a single fundamental mode (TEM_{00}) beam;

directing said higher order mode (HOM) input beam into said HOM ribbon fiber amplifier to produce said amplified HOM beam;

directing said amplified HOM beam onto said first DOE to produce said amplified fundamental mode (TEM_{00}) amplitude profile; and

directing said amplified fundamental mode beam onto said second DOE to produce said single fundamental mode (TEM_{00}) beam.

6. The method of claim **5**, wherein said first DOE comprises a first phase plate and wherein said second DOE comprises a second phase plate.

7. The method of claim **5**, wherein said first phase plate is configured to impart the requisite amount of phase shift across said amplified HOM beam to produce said TEM_{00} amplitude profile at the input plane of said second DOE, wherein said second DOE is configured to produce a TEM_{00} mode beam from said amplified TEM_{00} amplitude profile.