## CLAIMS

1. An air ionization display device, comprising:

a pulse-light-source module configured to generate a plurality of synchronous pulse light beams, and

a light field control module, the plurality of pulse light beams being projected to the light field control module and the light field control module being configured to adjust and converge the plurality of pulse light beams and ionize air in a display area to form a holographic real image,

wherein the pulse-light-source module comprises:

a plurality of pulse light sources configured to generate the plurality of pulse light beams, respectively; and

a first beam combiner, the plurality of pulse light beams generated by the plurality of pulse light sources being projected on the first beam combiner to combined into one light beam and the combined light beam being projected to the light field control module,

wherein the device further comprises a first pulse-repetition-frequency adjustment component, arranged between the plurality of pulse light sources and the first beam combiner and configured to adjust pulse repetition frequencies of the plurality of pulse light sources so as to lock the pulse repetition frequencies of the plurality of pulse light sources at a same value.

2. The device as claimed in claim 1, wherein the first pulse-repetition-frequency adjustment component comprises:

a plurality of first photodetectors, arranged one by one between the plurality of pulse light sources and the first beam combiner and configured to detect the pulse repetition frequencies of the plurality of pulse light sources;

a first frequency reference source configured to provide a frequency reference standard; and

a first servo controller, signally coupled to the plurality of first photodetectors, the first frequency reference source and the plurality of pulse light sources and configured to control the pulse repetition frequencies of the plurality of pulse light sources based on pulse-repetition-frequency signals received by the plurality of first photodetectors and a reference frequency of the first frequency reference source.

3. The device as claimed in claim 2, wherein a plurality of first beam splitters are provided between the plurality of pulse light sources and the first beam combiner and configured to reflect partial light beams of the plurality of pulse light sources to the plurality of first photodetectors one by one.

4. The device as claimed in claim 1, further comprising:

a first pulse delay monitor, arranged between the first beam combiner and the light field control module and configured to monitor a pulse delay signal of the beam emitted by the first beam combiner; and

at least one first delay line, arranged between the plurality of pulse light sources and the first beam combiner, signally coupled to the first pulse delay monitor and configured to compensate pulse delays of beams output from the plurality of pulse light sources based on feedback information of the first pulse delay monitor.

5. The device as claimed in claim 4, wherein a number of the at least one first delay line is one less than a number of the plurality of pulse light sources and the at least one first delay line is corresponding to the same number of pulse light sources one by one.

6. The device as claimed in claim 5, wherein a second beam splitter is provided between the first beam combiner and the light field control module and configured to reflect partial light beam emitted by the first beam combiner to the first pulse delay monitor.

7. The device as claimed in any one of claims 1 to 6, wherein there are a plurality of first beam combiners, a number of the plurality of first beam combiners is one less than a number of the plurality of pulse light sources, the plurality of first beam combiners are arranged at intervals along a light beam emitted by one of the plurality of pulse light sources, light beams emitted by remaining pulse light sources are projected on the plurality of first beam combiners one by one, and light beams emitted by the plurality of pulse light sources are combined into one light beam.

8. The device as claimed in any one of claims 1 to 6, further comprising:

a plurality of first reflecting mirrors, arranged between the plurality of pulse light sources and the first beam combiner and configured to reflect light beams transmitted by the plurality of pulse light sources to the first beam combiner.

9. The device as claimed in claim 1, wherein the pulse-light-source module comprises:

a pulse seed source configured to generate a pulse light beam;

a light splitting coupler, arranged along an optical path of the pulse light beam and configured to split the pulse light beam into a plurality of sub-beams to generate a plurality of pulse light beams; and

a second beam combiner, the plurality of sub-beams being projected on the second beam combiner to combine into one light beam and the combined light beam being projected to the light field control module.

10. The device as claimed in claim 9, further comprising:

a plurality of pulse amplification modules, arranged along optical paths of the plurality of sub-beams one by one, configured to amplify pulses of the plurality of sub-beams and arranged between the light splitting coupler and the second beam combiner.

11. The device as claimed in claim 9, further comprising:

a plurality of second delay lines, arranged along optical paths of the plurality of sub-beams one by one, between the plurality of pulse amplification modules and the second beam combiner, and configured to adjust pulse time positions of the plurality of sub-beams so that a plurality of pulse time in the beam coincide after the plurality of sub-beams pass through the second beam combiner.

12. The device as claimed in claim 11, further comprising:

a plurality of pulse compression devices, arranged along the optical paths of the plurality of sub-beams one by one, between the plurality of pulse amplification modules and the plurality of second delay lines, and configured to compress pulse widths of the plurality of sub-beams to increase pulse light peak powers of the plurality of sub-beams.

13. The device as claimed in claim 12, further comprising:

a plurality of beam collimating devices, arranged along the optical paths of the plurality of sub-beams one by one, between the plurality of pulse compression devices and the plurality of second delay lines, and configured to adjust the plurality of sub-beams into a plurality of collimated beams that satisfy an ionization threshold after being converged.

14. The device as claimed in any one of claims 9 to 13, wherein there are a plurality of second beam combiners, a number of the plurality of second beam combiners is one less than a number of the plurality of sub-beams, the plurality of second beam combiners are arranged at intervals along one of the plurality of sub-beams, remaining sub-beams are projected on the

plurality of second beam combiners one by one, and the plurality of sub-beams are combined into one light beam.

15. The device as claimed in any one of claims 9 to 13, further comprising:

a plurality of second reflecting mirrors, wherein a number of the plurality of second reflecting mirrors is the same as a number of the plurality of second beam combiners, and the plurality of second reflecting mirrors are arranged between the plurality of second delay lines and the plurality of second beam combiners one by one and configured to reflect the plurality of sub-beams to the plurality of second beam combiners.

16. The device as claimed in claim 1, wherein the pulse-light-source module comprises:

a plurality of pulse light sources configured to generate the plurality of pulse light beams, respectively;

wherein a pulse energy of each of the plurality of pulse light sources is less than an air ionization threshold and a sum of the pulse energy of each of the plurality of pulse light sources is greater than the air ionization threshold.

17. The device as claimed in claim 16, further comprising:

a second pulse-repetition-frequency adjustment component, arranged between the plurality of pulse light sources and the display area and configured to adjust pulse repetition frequencies of the plurality of pulse light sources.

18. The device as claimed in claim 17, wherein the second pulse-repetition-frequency adjustment component comprises:

a plurality of second photodetectors, arranged one by one between the plurality of pulse light sources and the display area and configured to detect the pulse repetition frequencies of the plurality of pulse light sources;

a second frequency reference source configured to provide a frequency reference standard; and

a second servo controller, signally coupled to the plurality of second photodetectors, the second frequency reference source and the plurality of pulse light sources and configured to control the pulse repetition frequencies of the plurality of pulse light sources based on feedback information of the plurality of second photodetectors and feedback information of the second frequency reference source.