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Lemelson-MIT Prize
U.S. Patent Portfolio of Feng Zhang - 2017 Winner
Report for: Lemelson-MIT Program

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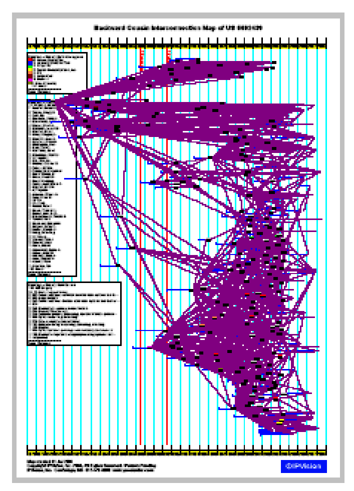

IPVision
Patent Interconnection Map

Report Date: August 15, 2017

U.S. Patent Portfolio of Feng Zhang - 2017 Winner
Report Prepared For: Lemelson-MIT Program

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Important Note About Data. The analyses presented in this Report were based on data as of August 15, 2017 – i.e., the patents listed for a given company represent patents owned of record as shown at the U.S. Patent and Trademark Office databases as of that date. Patents issued to, acquired by or disposed of by such a company after August 15, 2017 will not appear in the list of patents shown in this Report. However, patents that issue after August 15, 2017 that cite a patent shown in an analysis in this Report will appear in any citation analysis run after August 15, 2017 on the information stored on See-The-Forest.com ™. In such as case there will be an inconsistency between the results presented in this Report (which is a snapshot in time) and the results shown on See-The-Forest.com ™.

1. FENG ZHANG

Feng Zhang is Investigator, McGovern Institute for Brain Research at MIT; Associate Professor with Tenure, Department of Brain and Cognitive Sciences; and Core Member, Broad Institute of Harvard and MIT. Feng Zhang has transformed molecular biology in a breathtakingly short time by pioneering three technologies: optogenetics, TALE-based gene editing in mammals, and a suite of systems for CRISPR-based mammalian gene editing.

He received his A.B. in chemistry and physics from Harvard College (2004) and his Ph.D. in chemistry from Stanford University (2009).

As of the date of this report Dr. Zhang is listed as a named inventor on 36 issued U.S. patents and 68 published pending U.S. patent applications (the “Zhang Patent Properties”). The 10 most hightly cited issued Zhang Patent Properties are:

Top Ten Most Highly Cited U.S. Patent Properties of Feng Zhang				
Patent #	Inventors	Title	Citations By (BCs)	Citations To (FCs)
20090093403	Systems, methods and compositions for optical stimulation of target cells	Zhang Feng (Stanford, CA); Deisseroth Karl (Palo Alto, CA); Gradinaru Viviana (Palo Alto, CA)	0	50
20100190229	System for optical stimulation of target cells	Zhang Feng (Stanford, CA); Deisseroth Karl (Palo Alto, CA); Mishelevich David J. (Playa Del Rey, CA); Schneider M. Bret (Portola Valley, CA)	0	50
20110301529	Systems, methods and compositions for optical stimulation of target cells	Zhang Feng (Stanford, CA); Deisseroth Karl (Palo Alto, CA); Gradinaru Viviana (Palo Alto, CA)	0	43
8398692	System for optical stimulation of target cells	Deisseroth, Karl; Zhang, Feng; Boyden, Edward	143	38
8697359	CRISPR-Cas systems and methods for altering expression of gene products	Zhang, Feng	4	37
8815582	Mammalian cell expressing Volvox carteri light-activated ion channel protein (VChR1)	Deisseroth, Karl; Zhang, Feng; Gradinaru, Viviana	196	24

Top Ten Most Highly Cited U.S. Patent Properties of Feng Zhang				
Patent #	Inventors	Title	Citations By (BCs)	Citations To (FCs)
20140186843	Methods, systems, and apparatus for identifying target sequences for cas enzymes or CRISPR-Cas systems for target sequences and conveying results thereof	ZHANG, Feng; HABIB, Naomi	0	20
8603790	Systems, methods and compositions for optical stimulation of target cells	Deisseroth, Karl; Zhang, Feng; Gradinaru, Viviana	173	18
8993233	Engineering and optimization of systems, methods and compositions for sequence manipulation with functional domains	Zhang, Feng; Cong, Le; Platt, Randall Jeffrey; Sanjana, Neville Espi; Ran, Fei	7	16
20140179770	Delivery, engineering and optimization of systems, methods and compositions for sequence manipulation and therapeutic applications	ZHANG, Feng; RAN, Fei	0	15

View Top 10 Zhang Patents on IPVision *See-The-Forest.com*™ ► Link to List

View Full List of Patent Properties on IPVision *See-The-Forest.com*™ ► Link to List

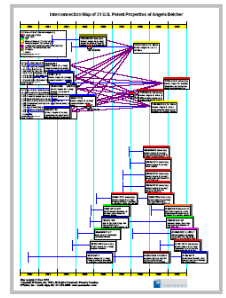
1.1 ZHANG PATENT PORTFOLIO INTERCONNECTION MAP

An IPVision Patent Portfolio Interconnection Map shows all of the U.S. patents and published U.S. patent applications that comprise the patent portfolio of the Inventor. These are displayed as "patent boxes" arrayed in time from left (earliest) to right (more recent). A line connecting a later patent box to an earlier patent box shows that the later patent cited the earlier patent as "prior patent art". See, Appendix A – Reading IPVision Maps.

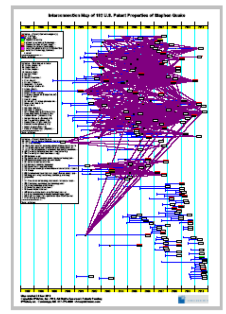
Note: A portfolio with a high degree of self citation is likely to have more commercial potential than a portfolio of individual inventions "scattered about".

Two examples of patent portfolios are shown to the right. The top portfolio is of Angela Belcher (44 patent properties), the 2013 Lemelson-MIT Prize Winner. The bottom portfolio is that of Stephen Quake (192 patent properties), the 2012 Lemelson-MIT Prize Winner. Not only does Dr. Quake have more patents, they are also more "clustered" than those of Dr. Belcher. Note: in both cases we have included published U.S. patents applications that have issued as U.S. patents.

Dr. Quake's portfolio is more clustered primarily because of the patents issued to Fluidigm, a leading microfluidics company founded by Dr. Quake.



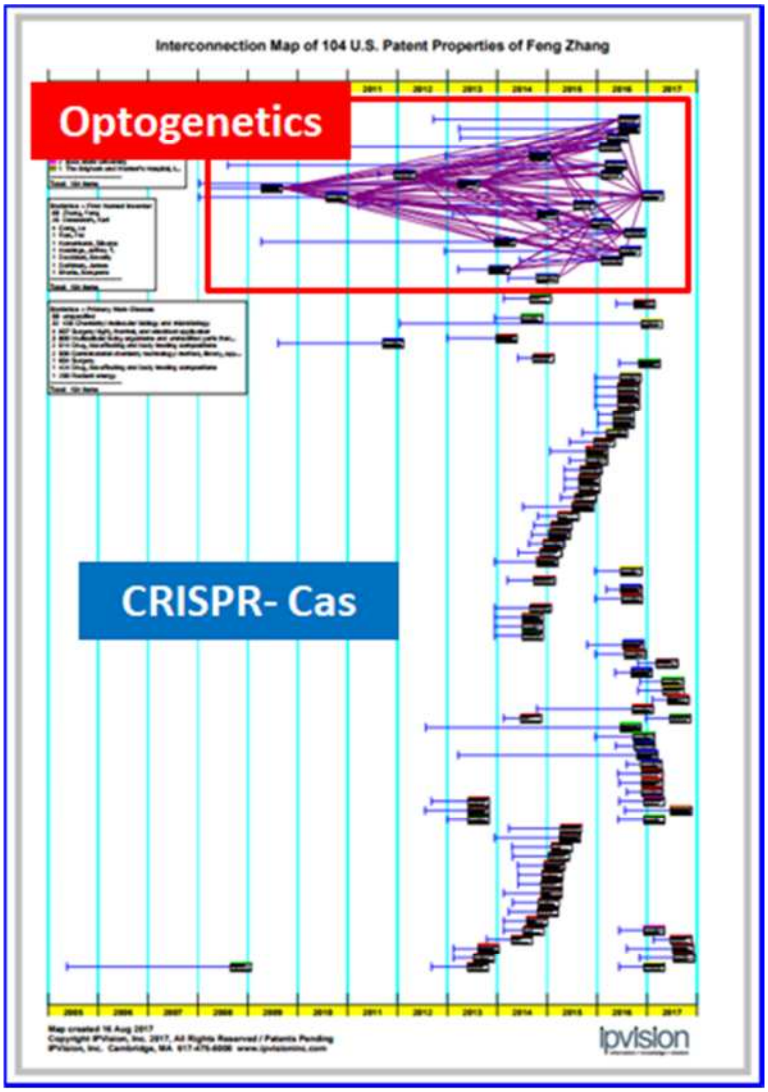
Angela Belcher – 2013 Winner



Stephen Quake – 2012 Winner

The following is an IPVision Patent Portfolio Interconnection Map™ showing the patent citation relationships among the Zhang Patent Properties:

Patent Portfolio Interconnection Map™ of Feng Zhang



Statistics -- Primary Current Assignee(s)
- 49 The Broad Institute Inc.
- 28 Stanford University
- 11 MIT
- 6 Harvard
- 4 The Rockefeller University
- 3 unspecified
- 2 Iowa State University
- 1 The Brigham and Women's Hospital, I...

Total: 104 Items

Patent Portfolio Interconnection Map™: This IPVision Patent Portfolio Interconnection Map™ shows the U.S. patent properties of Feng Zhang on a timeline from left to right. Each box is a patent or pending application with the left edge of the box aligned in time based on issue date (for patents) or publication date (for applications).

The lines connecting the boxes are citation references.

Click on the Map Image to view an interactive map online. When viewing the interactive map you can "right click" to view the underlying patent and related information.

The cluster of patents at the top of the map relate to Dr. Zhang's work at Stanford under the guidance of Karl Deisseroth where he developed the technologies behind optogenetics with Edward Boyden. The other patents relate to CRISPR-Cas and TALE.

Note: For information about Reading IPVision Maps, see Appendix A

View Live IPVision Map™ ► Link to Map

As shown on the Portfolio Interconnection Map above, Dr. Zhang's work breaks down into two main areas:

- Optogenetics
- CRISPR-Cas

The following sections investigate each area separately.

1.2 Optogenetics Portfolio

"*Optogenetics (from Greek optikós, meaning 'seen, visible') is a biological technique which involves the use of light to control cells in living tissue, typically neurons, that have been genetically modified to express light-sensitive ion channels. It is a neuromodulation method employed in neuroscience that uses a combination of techniques from optics and genetics to control and monitor the activities of individual neurons in living tissue—even within freely-moving animals—and to precisely measure these manipulation effects in real-time*." From Wikipedia.

Within the Zheng Patent Portfolio there are 16 issued U.S. patents and 13 published patent applications related to Optogenetics.

View "List of Optogenetics Patents" on IPVision *See-The-Forest.com*™ ► Link to List

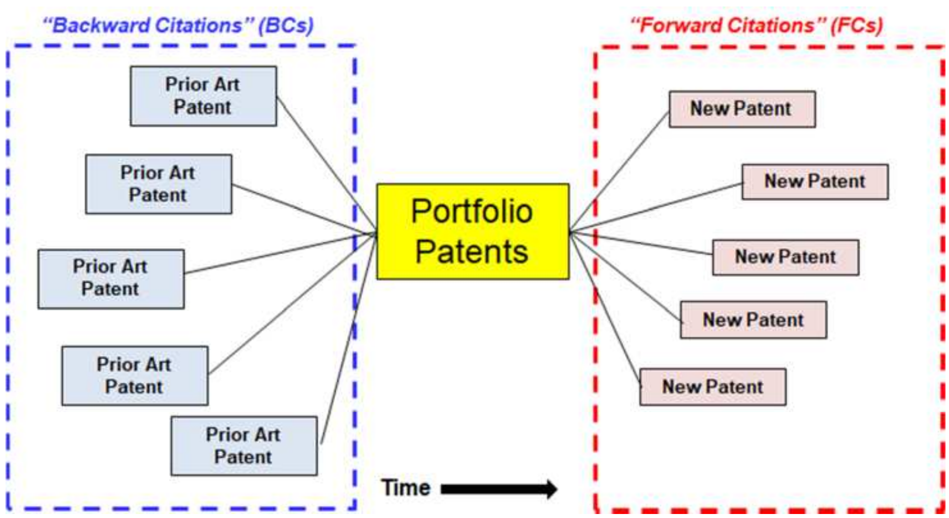
1.2.1 Optogenetics Direct Patent Citation Landscapes

In order to obtain a patent an inventor must show that his or her invention is "novel", i.e. new. During the patent prosecution process the inventor must disclose to the U.S. Patent and Trademark Office all "prior art" of which the inventor is aware that is relevant to the determination of whether the invention is novel. Prior art consists of papers, articles and patents. In addition the Patent Office Examiner conducts searches of literature and patents as part of the novelty determination.

The citations by patents of prior art are often more relevant than citations in academic papers because the prior art citations have legal significance, i.e., a patent can be invalidated if an inventor fails to cite prior art of which he or she is aware, so called Fraud on the Patent Office.

Patent citations also provide insights into how the invention(s) described in the patent lead to later inventions, i.e., how those inventions "spawned" later inventions.

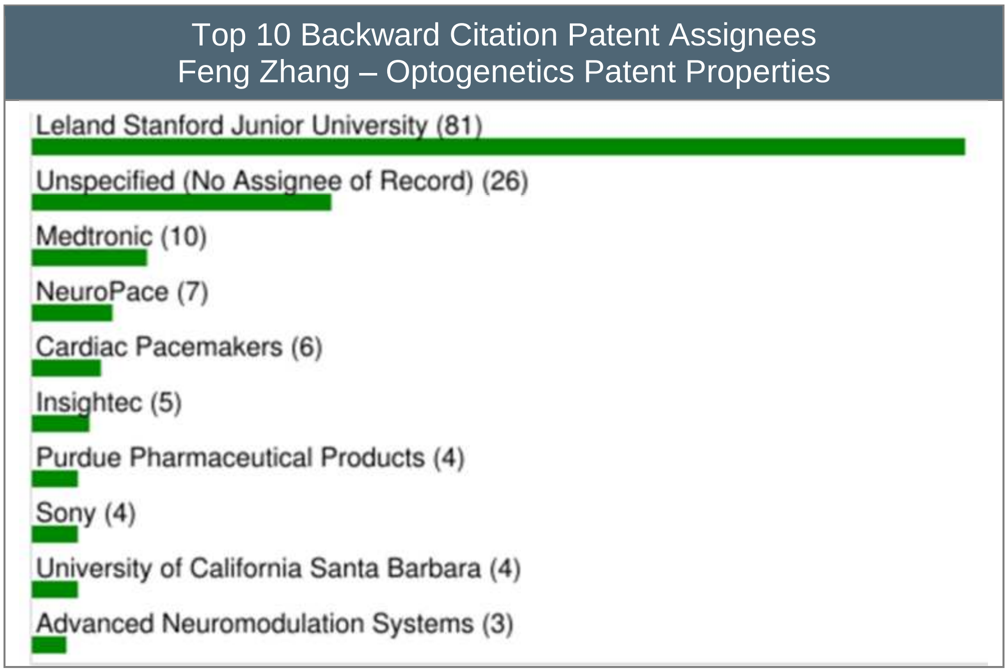
To get a sense of how "crowded" the technology area is around Dr. Zhang's optogenetics patent portfolio we looked at the direct patent citation landscape, i.e., the patents that the patents in the portfolio cite as prior art (Backward Citations) and the patents that cite patents in the portfolio (Forward Citations):



Backward Citations: **Patents Cited by Zheng Optogenetics Patents**. There are 300 other U.S. patent properties ("Backward Citation Patents" or "BCs") that are cited by the 16 patents[1] in the Zhang Optogenetics Portfolio. These patents are cited 3,495 times by patents in the Portfolio. These Backward Citation patents are owned of record by 140+ organizations or persons:

View "List of Optogenetics Backward Citation Patents" ► Link to List

According to the U.S. Patent and Trademark Office records, the Top 10 Current Assignee/Owners of the Optogenetics Backward Citation Patent Properties are:



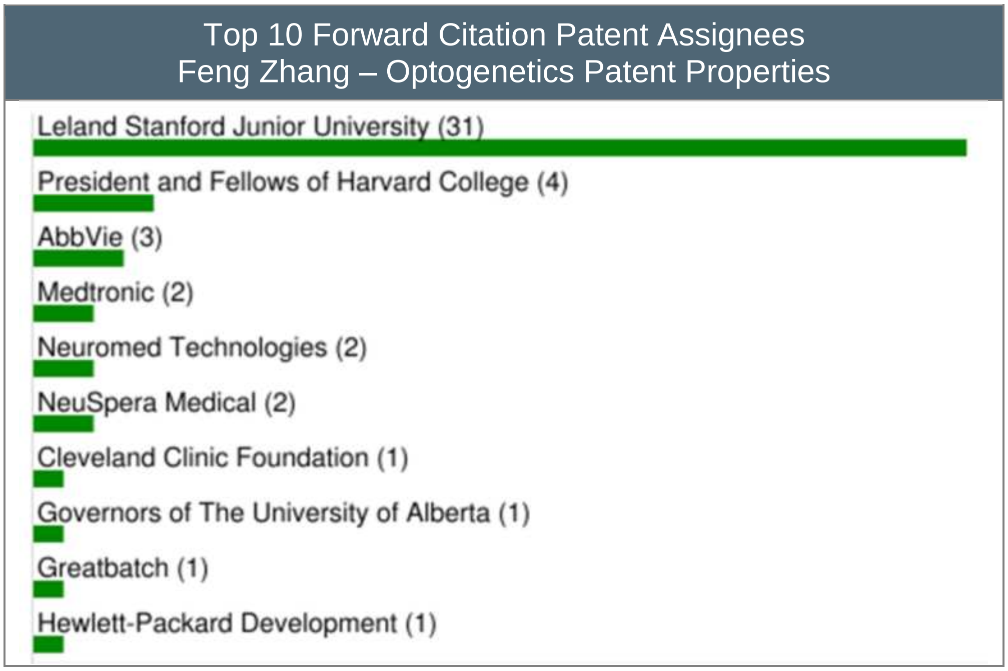
View "Optogenetics Backward Citation Assignee Analysis" ► Link to Analysis

Forward Citations: **Patents Citing Zheng Optogenetics Patents**. There are 51 other U.S. patent properties ("Forward Citation Patents" or "FCs") that cite the U.S. patent properties in the Zhang Optogenetics Portfolio. These FC patents cite the Zhang Optogenetics Portfolio 215 times. These Forward Citation patents are owned of record by 14 organizations:

View "List of Optogenetics Forward Citation Patents" ► Link to List

According to the U.S. Patent and Trademark Office records, the Top 10 Current Assignee/Owners of the Optogenetics Forward Citation Patent Properties are:

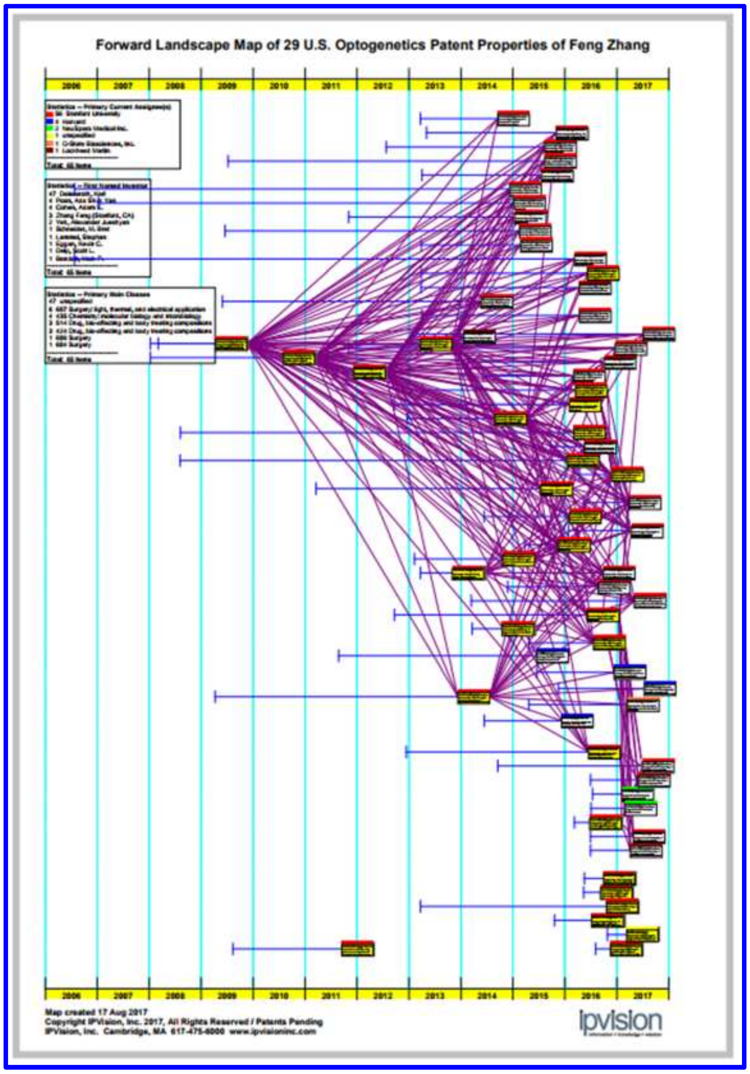
[1] Patents cite other patents and published patent applications. A published patent application does not contain prior art citations – those are added if and when the application becomes an issued patent.



View "Optogenetics Forward Citation Assignee Analysis" ► Link to Analysis

Landscape Map of Optogenetics Portfolio. Because of the large number of Backward Citation Patents for the Zhang Optogenetics Portfolio it is not practicable construct a full landscape map for this portfolio. Instead we have created a "Forward Landscape Patent Map" which shows the Zhang Optogenetics Portfolio and the 51 Forward Citation Patents:

Forward Patent Citation Landscape Map™
Zhang Optogenetics Portfolio



Statistics -- Primary Current Assignee(s)
56 Stanford University
4 Harvard
2 NeuSpera Medical Inc.
1 unspecified
1 Q-State Biosciences, Inc.
1 Lockheed Martin

Total: 65 Items

Patent Citation Landscape Map™: This IPVision Forward Patent Citation Landscape Map™ shows the Zhang Optogenetics Patents (yellow colored) on a timeline from left to right. To the right of each Zhang patent are the Forward Citation Patents, – i.e., patents that cite the Zhang Patents as prior patent art.

As can be seen from the list of Current Assignees, most of these patents are owned by Stanford University, indicating that this technology has not yet seen any significant commercialization.

Note: For information about Reading IPVision Maps, see Appendix A

View Live IPVision Map™ ► Link to Map

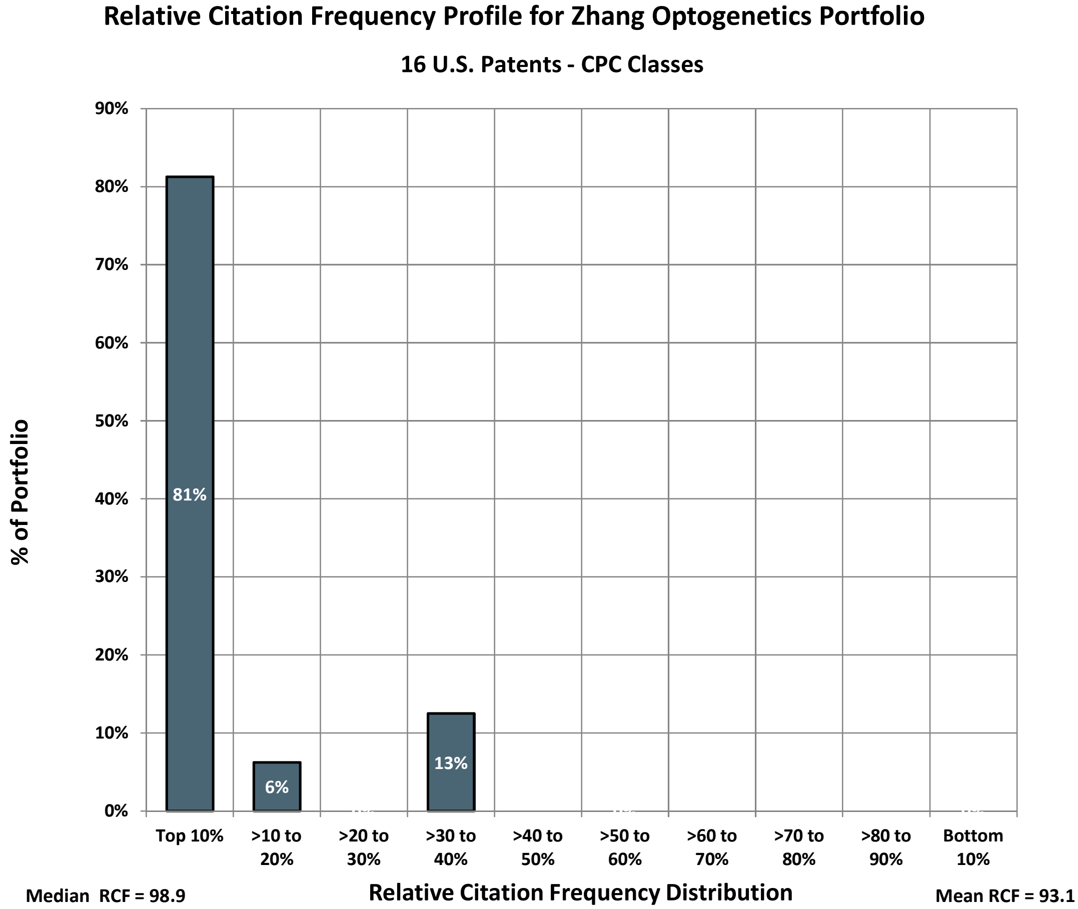
1.2.2 Optogenetics Relative Citation Frequency

The number of citations of an inventor’s patents by other inventors is a measure of the importance of an invention.[2] The Relative Citation Frequency for a patent is an IPVision developed normalized metric that measures how highly cited the patent is relative to Peer Patents (patents in the same technology area of the same age) where 100 equals the most cited.[3]

[2] See, Jaffe, Adam B. and Trajtenberg, Manuel, *Patents, Citations & Innovations: a Window on the Knowledge Economy* (Cambridge, The MIT Press, 2002)

[3] See “Appendix B - Relative Citation Frequency” for a fuller description of Relative Citation Frequency.

The Relative Citation Frequency scores distribution for the Zhang Optogenetics Portfolio are:



This profile shows that the Zhang Optogenetics patents are **Highly Cited** relative to their Peer Patents, with 87% of the patents in the portfolio being in the top 20% most highly cited range and 81% in the top 10%.. Mean RCF Score = 98.9; Median = 93.1. See Appendix B - Relative Citation Frequency.

1.3 CRISPR-CAS PORTFOLIO

CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats, which are the hallmark of a bacterial defense system that forms the basis for CRISPR-Cas9 genome editing technology…. that can be programmed to target specific stretches of genetic code and to edit DNA at precise locations, as well as for other purposes, such as for new diagnostic tools. With these systems, researchers can permanently modify genes in living cells and organisms and, in the future, may make it possible to correct mutations at precise locations in the human genome in order to treat genetic causes of disease. From Broad Institute "Questions and Answers About CRISPR".

The bulk of Dr. Zhang's non-optogenetics patents are filed around CRISPR although he is also a named inventor on U.S. patent properties relating to TAL (transcription activator-like) effectors.

Within the Zheng Patent Portfolio there are 18 issued U.S. patents and 55 published patent applications relating to CRISPR or TAL technologies (collectively "CRISPR").

View "List of CRISPR Patents" on IPVision *See-The-Forest.com*™ ► Link to List

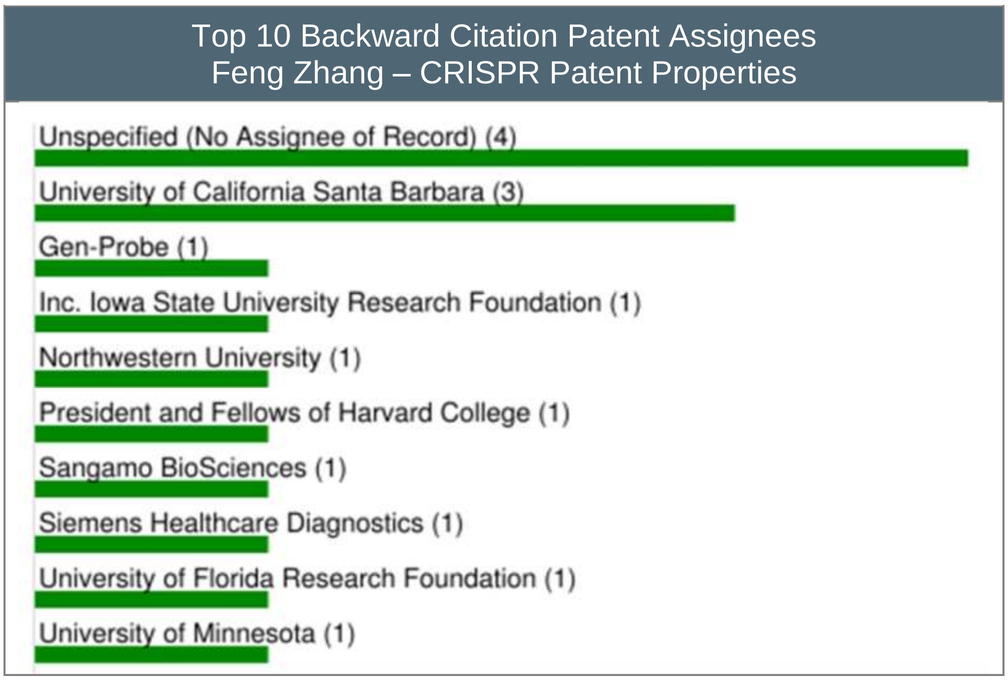
1.3.1 CRISPR DIRECT PATENT CITATION LANDSCAPES

As explained in Section 1.2.1 above, patent citations are often more relevant than citations in academic papers because the prior art citations have legal significance.

Backward Citations: Patents Cited by Zheng CRISPR Patents. There are 15 other U.S. patent properties ("Backward Citation Patents" or "BCs") that are cited by the 18 patents in the Zhang CRISPR Portfolio. These patents are cited 96 times by patents in the Portfolio. These Backward Citation patents are owned of record by 11 organizations.

View "List of CRISPR Backward Citation Patents" ► Link to List

According to the U.S. Patent and Trademark Office records, the Top 10 Current Assignee/Owners of the CRISPR Backward Citation Patent Properties are:

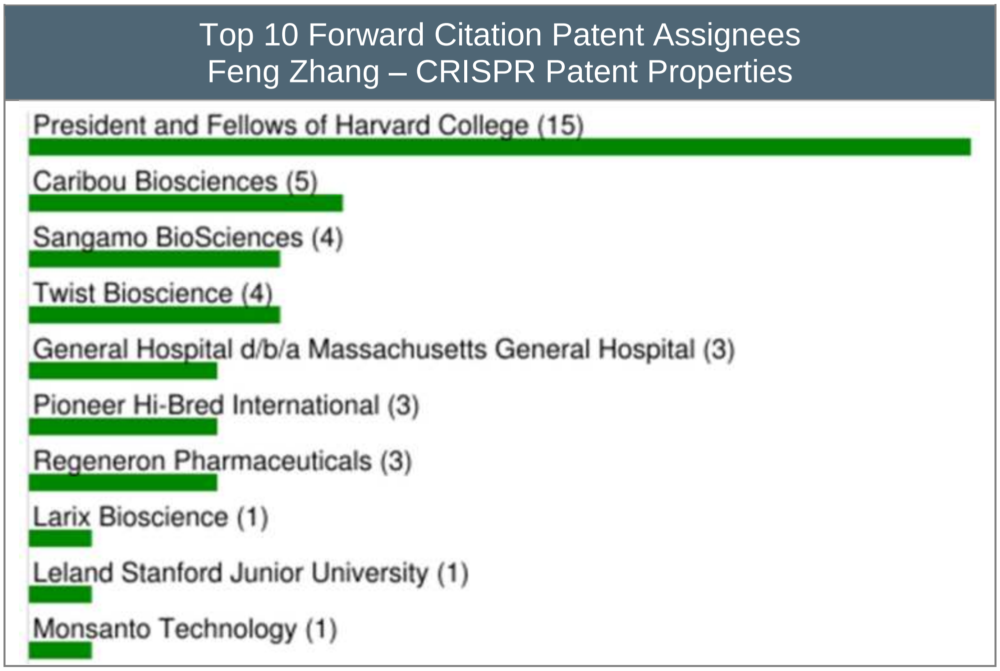


View "CRISPR Backward Citation Assignee Analysis" ► Link to Analysis

Forward Citations: Patents Citing Zheng CRISPR Patents. There are 46 other U.S. patent properties ("Forward Citation Patents" or "FCs") that cite the U.S. patent properties in the Zhang CRISPR Portfolio. These FC patents cite the Zhang CRISPR Portfolio 362 times. These Forward Citation patents are owned of record by 16 organizations.

View "List of CRISPR Forward Citation Patents" ► Link to List

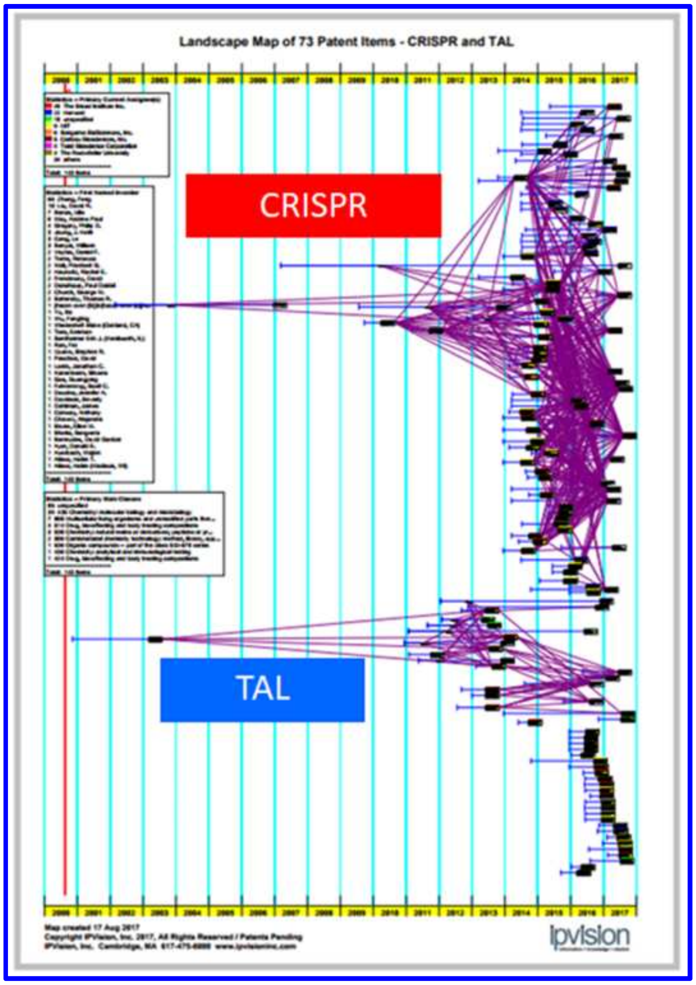
According to the U.S. Patent and Trademark Office records, the Top 10 Current Assignee/Owners of the CRISPR Forward Citation Patent Properties are:



View "CRISPR Forward Citation Assignee Analysis" ► Link to Analysis

Landscape Map of CRISPR Portfolio. The following Patent Landscape Map shows the 73 Zhang CRISPR patent properties, the 15 Backward Citation patents, the 46 Forward Citation Patents and the patent citation relationships among these patents:

Patent Citation Landscape Map™
Zhang CRISPR – TAL Portfolio



Statistics -- Primary Current Assignee(s)
49 The Broad Institute Inc.
22 Harvard
10 unspecified
9 MIT
6 Sangamo BioSciences, Inc.
5 Caribou Biosciences, Inc.
4 Twist Bioscience Corporation
4 The Rockefeller University
34 others

Total: 143 Items

Patent Citation Landscape Map™: This IPVision Patent Citation Landscape Map™ shows the Zhang CRISPR Patents Properties (body colored yellow) on a timeline from left to right. To the right of each Zhang patent are the Forward Citation Patents, – i.e., patents that cite the Zhang Patents as prior patent art. To the left of each Zhang patent are the Backward Citation Patents, – i.e., the patents that Zhang cites as prior art.

The cluster of patents at the top of the map relate to CRISPR. The cluster in the middle relate to TAL.

The “unconnected” patent boxes at the bottom right are published U.S. patent applications relating primarily to CRISPR. If and when these issue as U.S. patents they most likely will cite one or more of the CRISPR patents in the top cluster.

Note: For information about Reading IPVision Maps, see Appendix A

View Live IPVision Map™ ► Link to Map

1.3.2 CRISPR RELATIVE CITATION FREQUENCY

The number of citations of an inventor’s patents by other inventors is a measure of the importance of an invention.[4] The Relative Citation Frequency for a patent is an IPVision developed normalized metric that measures how highly cited the patent is relative to Peer Patents (patents in the same technology area of the same age) where 100 equals the most cited.[5]

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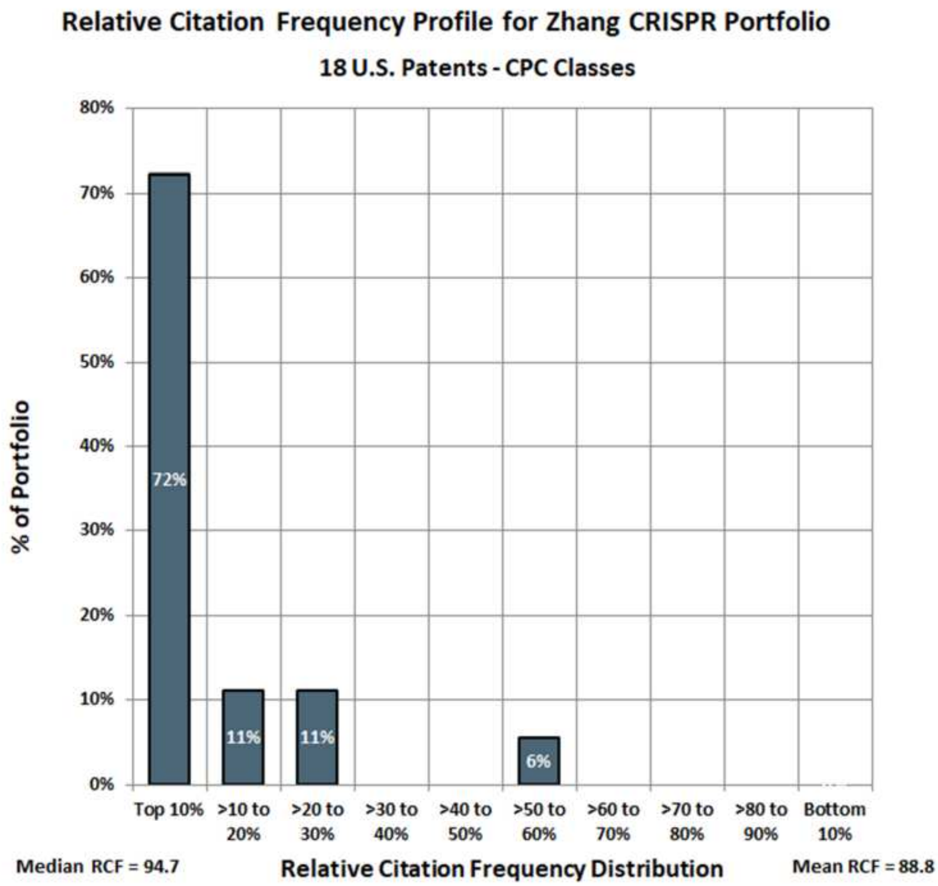
[4] See, Jaffe, Adam B. and Trajtenberg, Manuel, *Patents, Citations & Innovations: a Window on the Knowledge Economy* (Cambridge, The MIT Press, 2002)
[5] See “Appendix B - Relative Citation Frequency” for a fuller description of Relative Citation Frequency.

The Relative Citation Frequency scores distribution for the Zhang CRISPR Portfolio are:



This profile shows that the Zhang CRISPR patents are **Highly Cited** relative to their Peer Patents, with 83% of the patents in the portfolio being in the top 20% most highly cited range and 72% in the top 10%. Mean RCF Score = 94.7; Median = 88.8. See Appendix B - Relative Citation Frequency.

1.3.3 Zhang CRISPR Patent Ownership and Licensing

1.3.3.1 Ownership of Zhang CRISPR Patents

Ownership of Zhang CRISPR Patents. Dr. Zhang is part of a team at the Broad Institute in Cambridge, Massachusetts. The Broad Institute was founded in 2004

> *"… to seize the opportunity that arose from the Human Genome Project the international effort that successfully deciphered the entire human genetic code. Despite that accomplishment, scientists knew they still lacked a clear understanding of the genetic basis of disease, and how to translate that understanding into more effective prevention, diagnosis, and treatment.*
>
> *To reach these goals, it was clear that a new type of research institution had to be created. The traditional academic model of individual laboratories working within their specific disciplines was not designed to meet the emerging challenges of biomedicine. To gain a comprehensive view of the human genome and biological systems, they instead had to work in a highly integrated fashion.*
>
> *That meant working in nimble teams that combined biology, chemistry, mathematics,*

computation, and engineering with medical science and clinical research. It also meant working at a scale usually seen in industry, with access to world-class infrastructure. At the same time, this institution had to foster an atmosphere of creativity, risk-taking, and open sharing of data and research. Finally, this new model needed to seek collaborations beyond its borders.

Broad Institute is an "experiment" in this new way of doing science. It spans some of Boston's leading institutions (Harvard, MIT, and Harvard-affiliated hospitals) and scientific disciplines (biology, chemistry, medicine, computer science, and engineering). Today, the Broad community includes more than three thousand scientists, committed to advancing research in areas including infectious disease, cancer, psychiatric research, and cardiovascular disease." From Broad Institute website.

As part of this experiment the Broad Institute is the focal point for patenting and licensing for work that results from these collaborations and as such is the owner or co-owner of the Zhang CRISPR Patents.

1.3.3.2 BROAD INSTITUTE CRISPR LICENSING PROGRAM

The Broad Institute states on its Information About Licensing CRISPR Genome Editing Systems webpage:

"Broad Institute, MIT and Harvard share the goal of developing innovative technologies such as CRISPR genome editing tools and promoting its translation into genomic medicines to benefit patients.

* * *

- ***We make CRISPR tools, knowledge, methods and other IP for genome-editing freely available to the academic and non-profit community**. Since February 2013, Addgene has shared more than 40,000 plasmids and reagents with more than 2,000 institutions across 59 countries to help accelerate research into virtually every aspect of human health— including cancer, schizophrenia, diabetes, HIV and other infectious diseases.*
- ***We license CRISPR IP non-exclusively to companies to use in their own commercial research.***
- ***We also license CRISPR IP non-exclusively to companies wishing to sell tools and reagents for genome editing.***
- ***For human therapeutics, we concluded that exclusivity is necessary to driving the level of investment needed to develop the technology to the point that it is safe, effective, and capable of precise editing in specific cell types.***
- ***Broad Institute, Harvard, and MIT therefore developed an approach that we call an "inclusive innovation" model.** Under this model, Broad, Harvard, and MIT have licensed their CRISPR technology to a primary licensee, Editas Medicine, Inc. (Editas). Editas has a right to exclusively use the technology on targets of its choosing for the development of genomic medicines. However, after an initial period, other companies may apply to license certain CRISPR IP for use against genes of interest not being pursued by Editas. Specifically:*

  (i) a third party interested in an individual gene target would provide a bona fide development plan,

  (ii) Editas then has a pre-defined period to decide whether it intends to pursue the gene of interest and to commit funding and launch a program, and;

  (iii) if Editas is not already working on the gene of interest and chooses not to launch a new program of its own within this period, the IP may be available for licensing by Broad, Harvard, and MIT to the third party.

The goal of our inclusive innovation model is to enable Editas to devote sufficient investment to develop CRISPR-based genome editing technology to treat human diseases, while supporting broad development of medicines to reach many patients."

1.3.4 CRISPR PATENT DISPUTE

There have been disputes over CRISPR patents between the University of California at Berkeley and the Broad Institute.

University of California, Berkeley. A team led by molecular biologist Jennifer Doudna at the University of California, Berkeley, and microbiologist Emmanuelle Charpentier, now at Umeå University in Sweden and the Max Planck Institute for Infection Biology in Berlin published a 2012 paper demonstrating that the Cas9 enzyme can be directed to cut specific sites in isolated DNA (M. Jinek et al. Science 337, 816–821; 2012) published on August 17 2012, and filed a patent application in the United States Patent and Trademark (USPTO) on March 15, 2013.

Broad Institute. A team, led by Feng Zhang at the Broad Institute of MIT and Harvard in Cambridge, Massachusetts, published a 2013 paper demonstrating the application of CRISPR–Cas9 in mammalian cells (L. Cong et al. Science 339, 819–823; 2013) published on February 15, 2013. Zhang's team filed a patent application in the USPTO on December 12, 2012.

In February 2017, the Patent Patent Trial and Appeal Board (PTAB) of the United States Patent and Trademark Office (USPTO) issued a decision in a CRISPR patent interference between the two groups. The PTAB stated

> *"Broad has persuaded us that the parties claim patentably distinct subject matter, rebutting the presumption created by declaration of this interference. Broad provided sufficient evidence to show that its claims, which are all limited to CRISPR-Cas9 systems in a eukaryotic environment, are not drawn to the same invention as UC's claims, which are all directed to CRISPR-Cas9 systems not restricted to any environment. Specifically, the evidence shows that the invention of such systems in eukaryotic cells would not have been obvious over the invention of CRISPR-Cas9 systems in any environment, including in prokaryotic cells or in vitro, because one of ordinary skill in the art would not have reasonably expected a CRISPR-Cas9 system to be successful in a eukaryotic environment. This evidence shows that the parties' claims do not interfere. Accordingly, we terminate the interference."*

UC Berkeley has appealed the PTAB finding and the issues are not resolved as of the date of this report. For further information see the Broad Institute page Statement And Background On The CRISPR Patent Process.

1.3.5 CRISPR-CAS 9 LICENSING POOL

As the patent determination process winds it ways through the USPTO and the courts, there has been an effort to create a worldwide licensing pool in order to advance the use and commercialization of the technology. According to the Broad Institute website:

> *"Cambridge, Mass., July 10th, 2017*
> *Seeking new opportunities to make CRISPR genome editing technology widely available, the Broad Institute of MIT and Harvard has joined discussions to create a non-exclusive CRISPR-Cas9 joint licensing pool being coordinated by MPEG LA, an organization that operates patent pool licensing programs across institutions and countries. The Broad Institute has submitted key CRISPR-Cas9 patents for consideration with joint owners Harvard University, the Massachusetts Institute of Technology, and The Rockefeller University.*
>
> *A patent pool would create a one-stop shop for commercial users to license CRISPR patents without needing to navigate a complex patent and licensing landscape.*
>
> * * *
>
> *MPEG LA issued a call for a worldwide CRISPR licensing standard earlier this year. In its application letter, available here, the Broad Institute expressed interest in working with MPEG LA and other CRISPR patent holders to streamline non-exclusive access to the*

genome editing technology.

In many cases, commercial groups must apply for licenses from multiple institutions, which a patent pool would coordinate and streamline. The US Patent and Trademark Office has issued more than 60 patents with claims to CRISPR and/or Cas9 to approximately 100 inventors from 18 applicant organizations, including to some academic institutions that have only issued exclusive licenses. The European Patent Office (EPO) has issued more than 20 such patents to approximately 30 inventors from about ten applicant institutions.

* * *

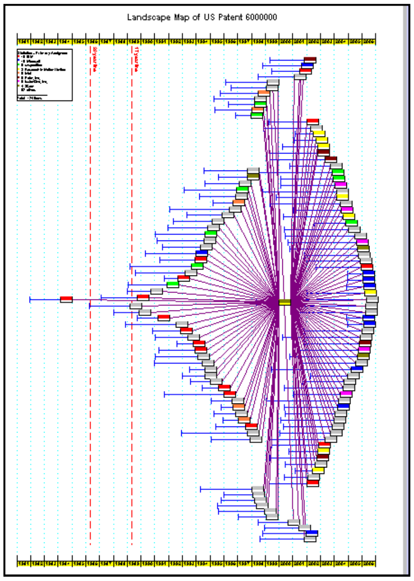
Although the Broad Institute, MIT, Harvard, and Rockefeller have chosen to make this application to join the MPEG LA patent pool public, such a disclosure is optional. It is not clear what other institutions may also have applied. "We hope many other patent holders will consider joining the patent pool to ensure access to CRISPR tools are open and available," Rozen said. "We believe we all share a goal of making sure that CRISPR can have the greatest possible impact to transform medicine and improve lives."

As of the date of this report it remains to be seen how the patent ownership and licensing issues will play out for this important new technology.

2. APPENDICES AND EXHIBITS

APPENDIX A – HOW TO READ AN IPVISION MAP

An IPVision Map is a visual representation of the relationships between objects. The following is an example of a Landscape Map for a single U.S. Patent:

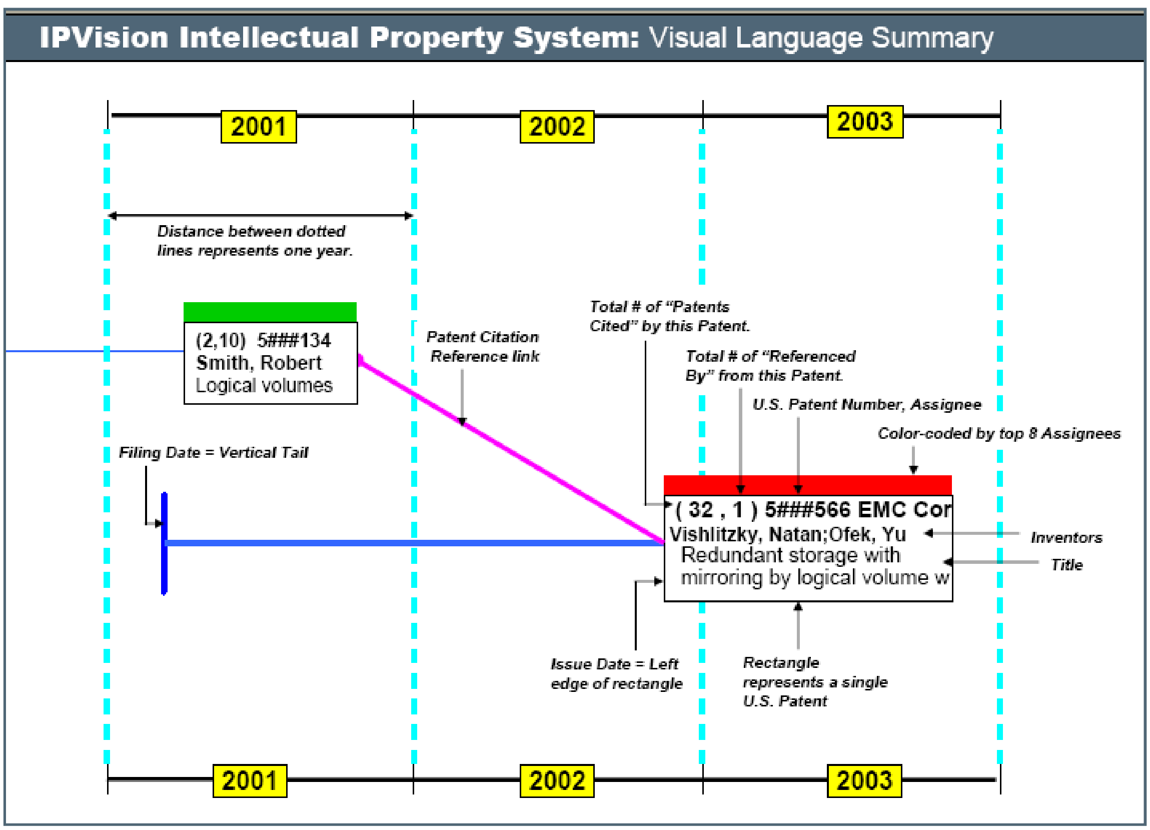


This Landscape Map is of U.S. Patent 6,000,000 entitled "Extendible method and apparatus for synchronizing multiple files on two different computer systems". It is the basic patent for the Palm Pilot software.

The horizontal X axis is "time"

Patent 6000000 is in the middle of the "fan". The lines going backward (to the left) are the patents cited by Patent 6000000 and the lines going forward (to the right) show the patents which cite Patent 6000000.

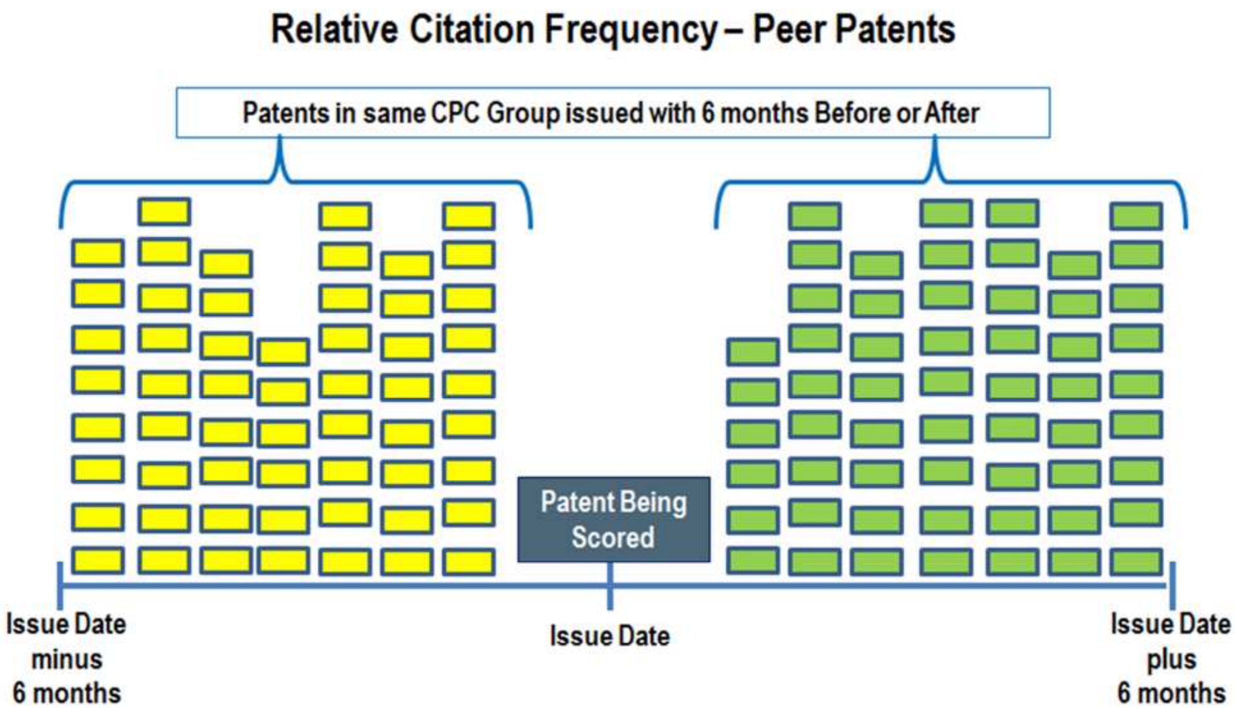
The details of an IPVision Map are explained in more detail below. See also a [Guide To Reading IPVision Patent Maps].



APPENDIX B - RELATIVE CITATION FREQUENCY

The number of citations of an inventor's patents by other inventors is a measure of the importance of an invention.[6] However, the number of patent citations to a patent is a function of the importance of the patent, the speed of patenting in the technology area and the age of the patent (the older the patent the more time it has to be cited). Accordingly, one can not tell whether a patent that is cited 50 times is "highly cited" or whether 50 citations is "average" unless you look at the number of citations relative to the patent's "peers".

IPVision has developed a Relative Citation Frequency (RCF) Score for a patent. For a given patent the RCF Score algorithm finds that patent's "Peer Patents", i.e., all patents in the same Cooperative Patent Classification System[7] "group" that were issued within 6 months before or after the patent being scored. RCF then determines the relative citation frequency of the patent versus its Peer Patents.



RCF Score for a Patent

Once the Peer Patents are assembled for the patent being scored we look at the minimum and maximum number of citations to the Peer Patents and we normalize these on a scale from 0 to 100 where 100 is the most highly cited of the Peer Patent group. We then place the patent being scored in context in the Peer Patent group. The resulting score represents the percentage of the Peer Patents that are cited LESS than the patent being scored, -e.g., a score of 92 means the patent is cited more often than 91.9% of the Peer Patents.

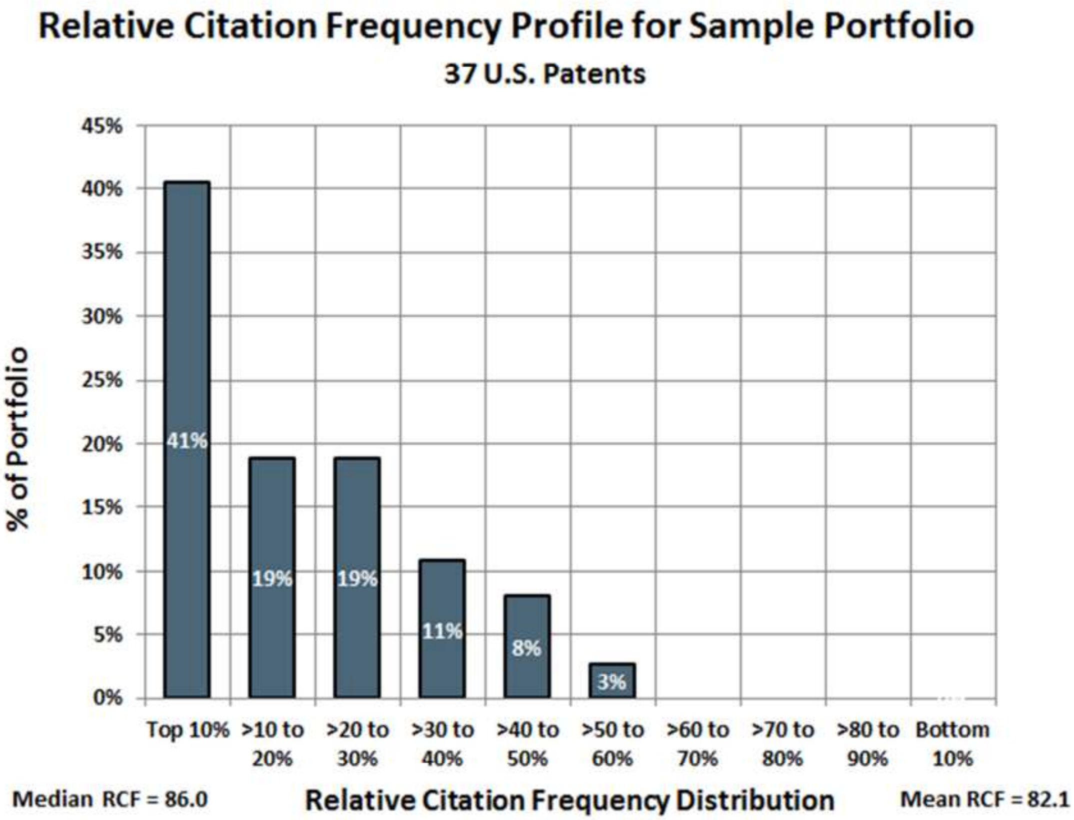
RCF Score for a Portfolio

To analyze a group or portfolio of patents we run RCF Scores on each patent and then calculate the Mean or Average RCF Score for the group. We then group the individual scores into deciles and present this

[6] See, Jaffe, Adam B. and Trajtenberg, Manuel, *Patents, Citations & Innovations: a Window on the Knowledge Economy* (Cambridge, The MIT Press, 2002)

[7] See the description of the Patent Classification System at the end of this Appendix.

information in a visual form such as:



This profile shows that the patents in this Sample Portfolio are highly cited relative to their Peer Patents, with 60% of the patents in the portfolio being in the top 20% most highly cited range and 41% in the top 10%. Mean RCF Score = 82.1; Median = 86.0 Explanation: a RCF Score of 92 on an individual patent means that it is more highly cited than 91.9% of its Peer Patents (all patents in its technology area that were issued in the same time period) – i.e. it is in the "Top 10%" category in the above chart. For this Sample Portfolio 41% of the patents are in the Top 10% most highly cited category and the Mean RCF Score of 86.0 means that overall the patents in the Sample Portfolio are more cited than 85.9% of Peer Patents.

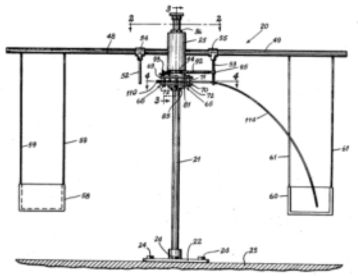
What is a Patent Classification? This is how the U.S. Patent and Trademark Office describes a Patent Classification:

> "*A Patent Classification is a code which provides a method for categorizing the invention. Classifications are typically expressed as "482/1". The first number, 482, represents the class of invention. The number following the slash is the subclass of invention within the class. There are about 450 Classes of invention and about 150,000 subclasses of invention in the USPC.*
>
> *Classes and subclasses have titles which provide a short description of the class or subclass. Classes and subclasses also have definitions which provide a more detailed explanation. Many Classes and subclasses have explicitly defined relationships to one another….*
>
> *A patent classification also represents a searchable collection of patents grouped together according to similarly claimed subject matter.*
>
> *A classification is used both as a tool for finding patents (patentability searches), and for assisting*

in the assignment of patent applications to examiners for examination purposes….. Classifications have hierarchical relationships to one another."

What is a Class Hierarchy? The USPTO Classification System sets up a hierarchy of classes to describe areas of technology and invention. The following Class Hierarchy for "playground equipment" illustrates how a hierarchy is set up:

Example: Class Hierarchy for "Playground Equipment"



This is the drawing of the invention described in a patent entitled "Occupant-Propelled Roundabout Swing Set". A rider sitting in one of the swings can pull on a cable which causes the swings to rotate around the poll.

The USPTO placed this invention in Class 472/122: Amusement Devices/Swing/Having a hand operator/Cable grasp. This Hierarchy is illustrated as follows:

US Patent Class 472 - Amusement Devices

106	SEESAW		
	107	Motor Operated	
	108	Foot, hand or seat operated	
	109	Having a safety feature	
	etc		
116	BODY SLIDE		
	117	Water Slide	
118	SWING		
	119	Motor operated	
	120	Having hand and foot operator	
	121	Having hand operator	
		122	Cable grasp
	124	Having foot operator with separate suspender	

What is the CPC? The Cooperative Patent Classification (CPC) is a joint partnership between the USPTO and the European Patent Office (EPO) where the Offices agreed to harmonize their existing classification systems (ECLA and USPC, respectively) and migrate towards a common classification scheme. As of June 1 , 2015 US utility patents and applications are no longer published with USPCs. Plant patents and design patents are the exception, and they will continue to carry a USPC designation.

The CPC has the following "top level" Sections:

A: Human Necessities
B: Operations and Transport
C: Chemistry and Metallurgy
D: Textiles
E: Fixed Constructions
F: Mechanical Engineering
G: Physics
H: Electricity
Y: Emerging Cross-Sectional Technologies

From the "top level" Section the classification hierarchy goes as follows:

Hierarchy

- Section (one letter A to H and also Y)
    - Class (two digits)
        - Subclass (one letter)
            - Group (one to three digits)
                - Main group and subgroups (at least two digits)

In the above example "A01B 35/16"
Section: A *(Human Necessities)*
Class: 01 *(A01: Agriculture; Forestry; Animal Husbandry; Hunting; Trapping; Fishing)*
Subclass B *(A01B: Soil Working In Agriculture Or Forestry; Parts, Details, Or Accessories Of Agricultural Machines Or Implements, In General)*
Group 35 (*A01B 35: Other machines for working soil)*
Main group 16 (A01B 35/16: with rotating or circulating non-propelled tools)

An example of a patent classified in A01B 35/16 is US 8393407 "Crop residue clearing device"

Abstract: Apparatus for clearing crop residue from a field is adapted for attachment to a tool bar of an agricultural implement or to a planter unit such that the apparatus is pulled through a field by the implement. The apparatus includes a support structure extending forward of the tool bar and at least one and preferably a pair of floating arms pivotally attached to a forward portion of the support structure and extending rearwardly, with a toothed wheel rotationally attached to an aft end of the arm(s). A coulter attached to the support structure is disposed between and extends forward of the soil-engaging toothed wheel(s) and in combination with the wheel(s) severs and removes residue in the seeding pathway. An adjustable biasing arrangement urges the toothed wheels, either in unison or independently, downwardly into engagement with the soil. Upper and lower stop limits are provided to limit vertical positioning of the toothed wheel(s).