QuantTera

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Nano-Engineered Materials and Devices
for Microelectronic Applications

My Journey with Entrepreneurship in Science

University of Illinois
Oct 1, 2015

Outline

Entrepreneurship for Scientists

- Building My Team
- My background and experience:
  - What did I do at QuantTera (SBIR) /MicroLink (Venture)
- The why and how of small business
- How science/technology and business interconnect in QuantTera

What is an Entrepreneur

Full Definition of ENTREPRENEUR (Merriam Webster)

- one who organizes, manages, and assumes the risks of a business or enterprise

For Me:

- "I took the one less traveled by" (R. Frost)
- "Not all those who wander are lost" (J.R.R Tolkien)

PHYSICS ENTREPRENEURSHIP AND INNOVATION (Orville R. Butler, M. Juris, PhD and R. Joseph Anderson, AIP)

- Our findings support the idea put forth by Nanda and Sorensen, who argue that a person is "more likely" to become an entrepreneur if his or her coworkers have had entrepreneurial experience. "Peer influences," they argue, appeared to substitute for other sources of entrepreneurial influence.
- History of Physics and Entrepreneurship (HoPE Report) https://www.aip.org/sites/default/files/history/files/HoPE-Report-2013-web.pdf

Building My Team

My Team
Efficency for getting my commitments, obligations or future projects done!!!!!!!!!!!!
They are a sound board for your ideas, problems, daily occurencies.

First need to **who am I**!
What do you consider your expertise, How well do you know your abilities,
What are your strengths and weaknesses
"Value" proposition: What makes you or your company special, where do you fit in.

Teaming or Networking Relationships:
Recognition of Opportunities, Snychronicity, Timing, Value of money, Personal Contact,
Need to develop relationships early.

Real Question --- Who to team with:
Need network of small companies (non-competing),
Vendor's (credit, pay your bill's on time),
Large Companies validate your existence,
Business colleagues's (who do you trust----look at their modus operandi)

Team's Core Values:
Philosophical, personal belief's,
Can you hang out together,
"Honor all your promises, and even the one's people think you made",

Strength of our Team, our value: Time, Credibility, Commitment.

My background and experience
What did I do at:
QuantTera (SBIR)
MicroLink (Venture)

Background

Bandgap Technology: Small Company R&D
Research Engineer & Supervisor: Characterization (1989-1994)
- High speed electronics & Telecom (Epitaxy)
- GaAs Heterojunction Bipolar Transistor (HBT)
- Vertical Surface Emitting Lasers

Motorola: Large Telecom Corporate Research
Principal Staff Scientist (1994-2000)
- RF Power Amplifiers for Cell Phones & Lasers (Epitaxy)
- GaAs Pseudomorphic High Electron Mobility

Core Expertise
Transistor's
Laser's
Technology

MicroLink Devices: Manufacturing, Ventured Funded
Co-Founder, VP (2000-2004)
- RF Power Amplifiers for Cell Phones (Epitaxy)
- GaAs and InP HBT

QuantTera: Small R&D Microelectronics
SBIR Funded
Founder, President (2005-present)
- Novel IP valued technology: Telecom, RF
  - HBT technology
  - Laser Technology

Arizona Nanotechnology Cluster: Non-Profit
Chairman (2004 – Present)
- General Public Education of Nanotechnology
- Small Businesses,
- K-20

American Physical Society
- Forum on Industrial and Applid Physics
- 4 Corners Local Chapter

Vertically Broad Expertise

- **R&D, Manufacturing, Facility Design and Building Experience**
- **Design, Crystal Growth of nanostructured Materials:**
- **Materials Characterization: Quality Control**
- **Device Fabrication and Testing: Manufacturing**
- **Commercialization;**
  - **Present Products & Next Generation strategy**
  - **Intellectual Property**
  - **Synergistic Collaboration**
- **Research: Next products**

Manufacturing Expertise

Microlink Devices Production Facility (Founder and VP of Operations)

Epitaxy Fabrication Facility

- Designed and setup MOCVD production facility
- Implemented procedures and safeguards compliant to governmental regulations
- Implemented QA/QC procedures for manufacturing of III/V wafers
- Recruited and trained technical staff.

Materials Characterization

- Setup electrical, structural, optical characterization equipment and facilities.
- Trained and supervised engineers.

Device Fabrication and Testing of III/V Devices

- Trained and supervised engineers in the design, testing and fabrication of electronic devices for quick lot testing of heterojunction bipolar transistors.
- Setup device processing area: photolithography, etching, metallization, inspection, and fabrication process flow formulation, device testing equipment.

Commercialization

- Product qualification, sale and commercialization of GaAs HBT and InP/GaAsSb HBT to companies such as **Agilent Technologies and Mitsubishi Electronics.**

Why and how of small businesses:
QuantTera
MicroLink

MicroLink Devices

- Company was started May 2000, located to Niles, IL November 2000
- Venture Backed: Taiwanese investors $8M (start-up), upto $18M (bridge loans)
- Founders: Noren Pan CEO, Matt Kim VP Operations

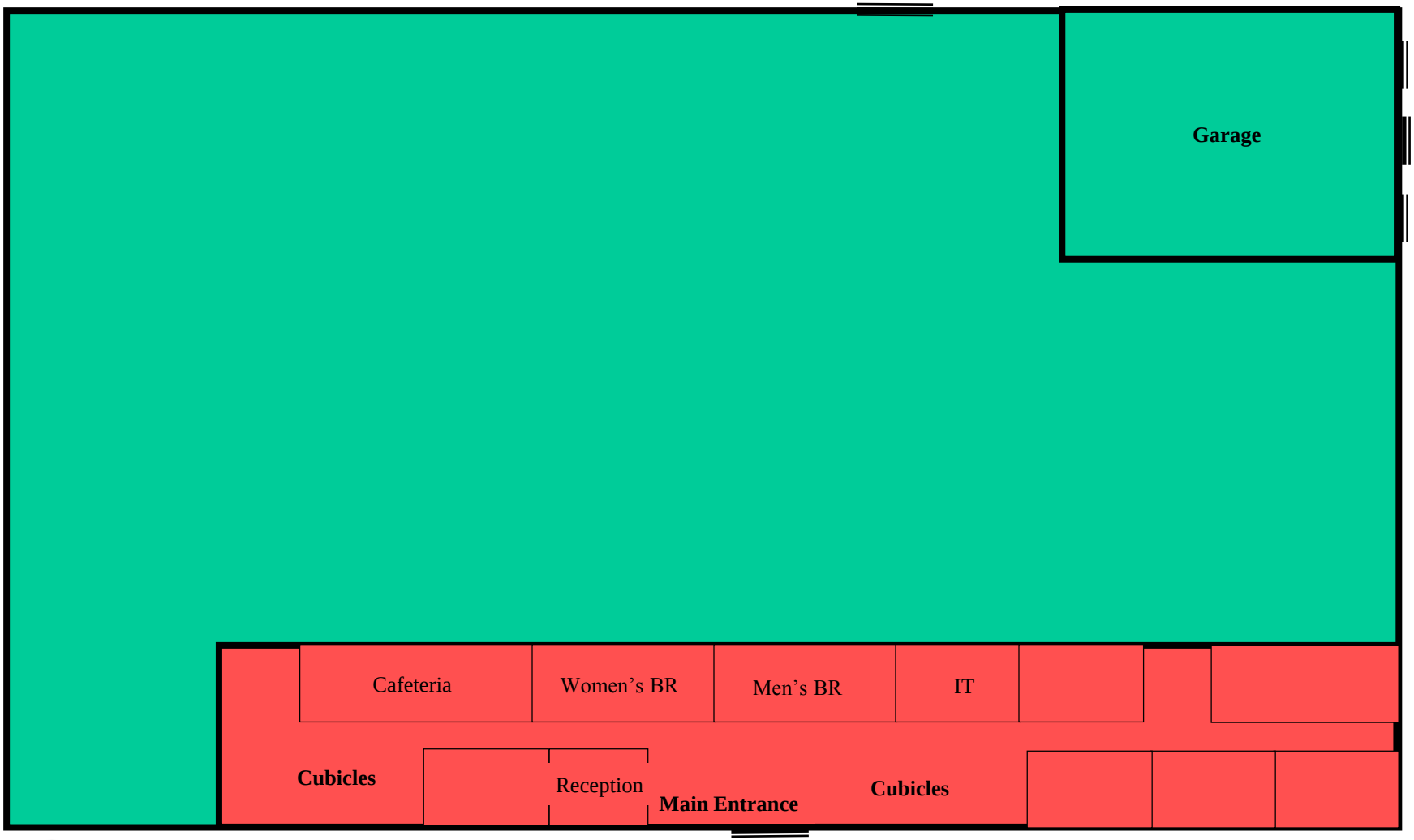
- Facility finished August 2001
- MicroLink has a 30,000 sq-ft facility located in Niles, IL
- Located near Chicago's O'Hare Airport for world wide customer access
- Aixtron's main service facility is located in Chicago
- Near major Universities expertise (Univ. Ill, Northwestern, Univ. Wisconsin)

- MicroLink has a 30,000 sq-ft facility on 1.77 acres
- 5470 sq-ft of fabrication space
  - 2600 sq-ft of class 1000 cleanroom space
  - Growth (2 Aixtron 2600 reactors), Materials Characterization, Devices
  - Final Inspection and packaging
- 10000 sq-ft of manufacturing support area
  - Hydride gas storage, Maintenance, Loading dock
  - Chemical storage, Mechanicals, Electricals, Cryogenics
- 7440 sq-ft of office space, 7100 sq-ft for additional expansion

- Customer's: Agilent, Mitsubishi, etc.

MicroLink Before Construction

Building diagram before construction

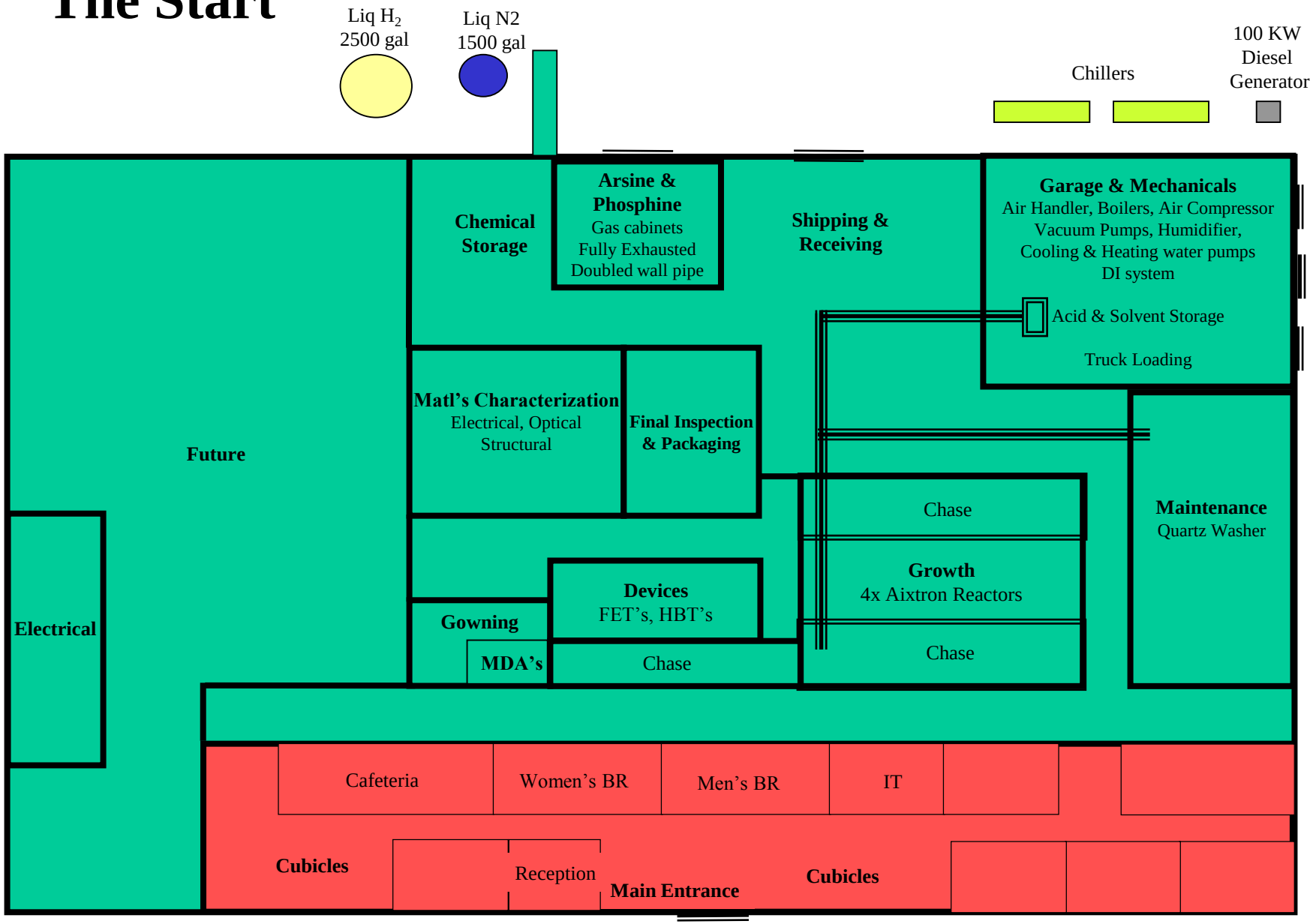


MicroLink Devices Facilities

The Reactors and Abatement

QuantTera Matt Kim, cell: 602-214-3524, email: mk@quanttera.com

The Start


Liq H_2
2500 gal
Liq N2
1500 gal
Chillers
100 KW
Diesel
Generator
Chemical
Storage
Arsine &
Phosphine
Gas cabinets
Fully Exhausted
Doubled wall pipe
Shipping &
Receiving
Garage & Mechanicals
Air Handler, Boilers, Air Compressor
Vacuum Pumps, Humidifier,
Cooling & Heating water pumps
DI system
Acid & Solvent Storage
Truck Loading
Matl's Characterization
Electrical, Optical
Structural
Final Inspection
& Packaging
Future
Chase
Maintenance
Quartz Washer
Growth
4x Aixtron Reactors
Devices
FET's, HBT's
Gowning
MDA's
Chase
Chase
Electrical
Cafeteria
Women's BR
Men's BR
IT
Cubicles
Reception
Main Entrance
Cubicles

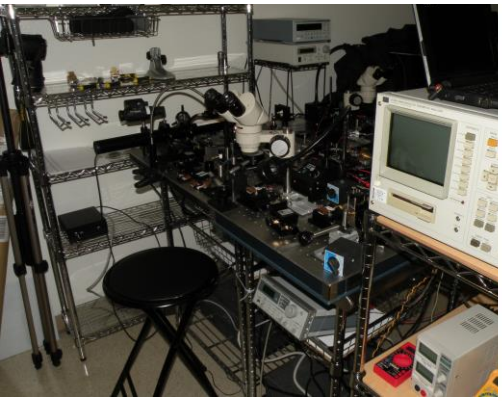
QuantTera's Business Strategy

1. Seed Funding: Small Business Innovative Research (SBIR)
2. Intellectual Property (Patented Laser Technology & Patent Pending Transistor technology)
3. Relationships in place with:
   - Crystal Growth source companies
   - Transistor Companies (Sumika)
   - Military Companies (Raytheon)
4. Manufacturing and commercialization expertise for both photonics and cellular application.

Leveraged R&D for quick turn
Prototype Develoment

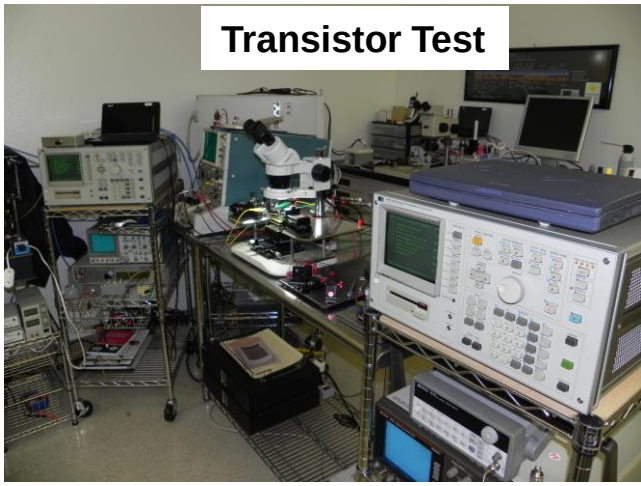
Optical/Electrical Testing

VCSEL and Polarization Test

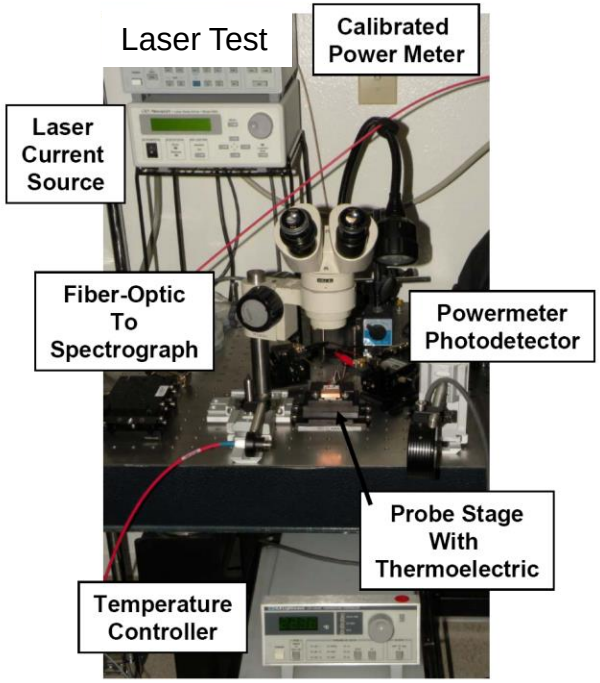


PL, tranmission, reflectance, Laser Test

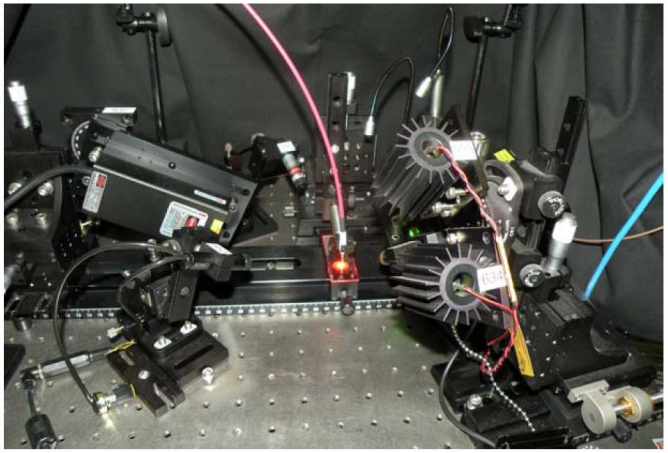
Transistor Test



Laser Test



QuantTera Laser Excitation Spectroscopy Setup



Hall Effect

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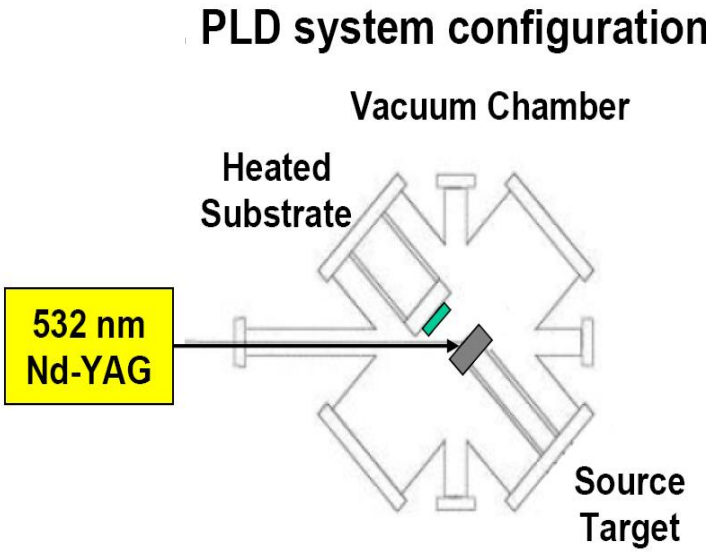
Pulsed Laser Deposition

QuantTera in-house PLD system

Table. Brilliant High Powered Pulsed Laser		
Wavelength (nm)	Energy (mJ)	Pulse Duration (ns)
1064	360	5
532	180	4
355	65	4
266	40	4



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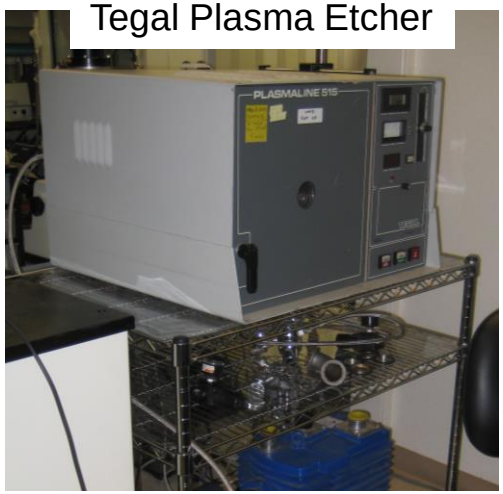
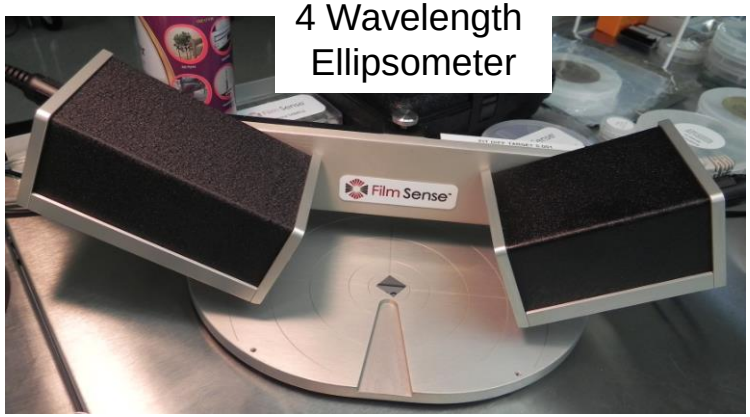
Wafer Bonding Process

Tegal Plasma Etcher



Fume Hood,
Oxide Etch, PR spinner,
Lapping Station, Gold Plating

4 Wavelength
Ellipsometer



Wafer Bonders

Mini-Cleanroom

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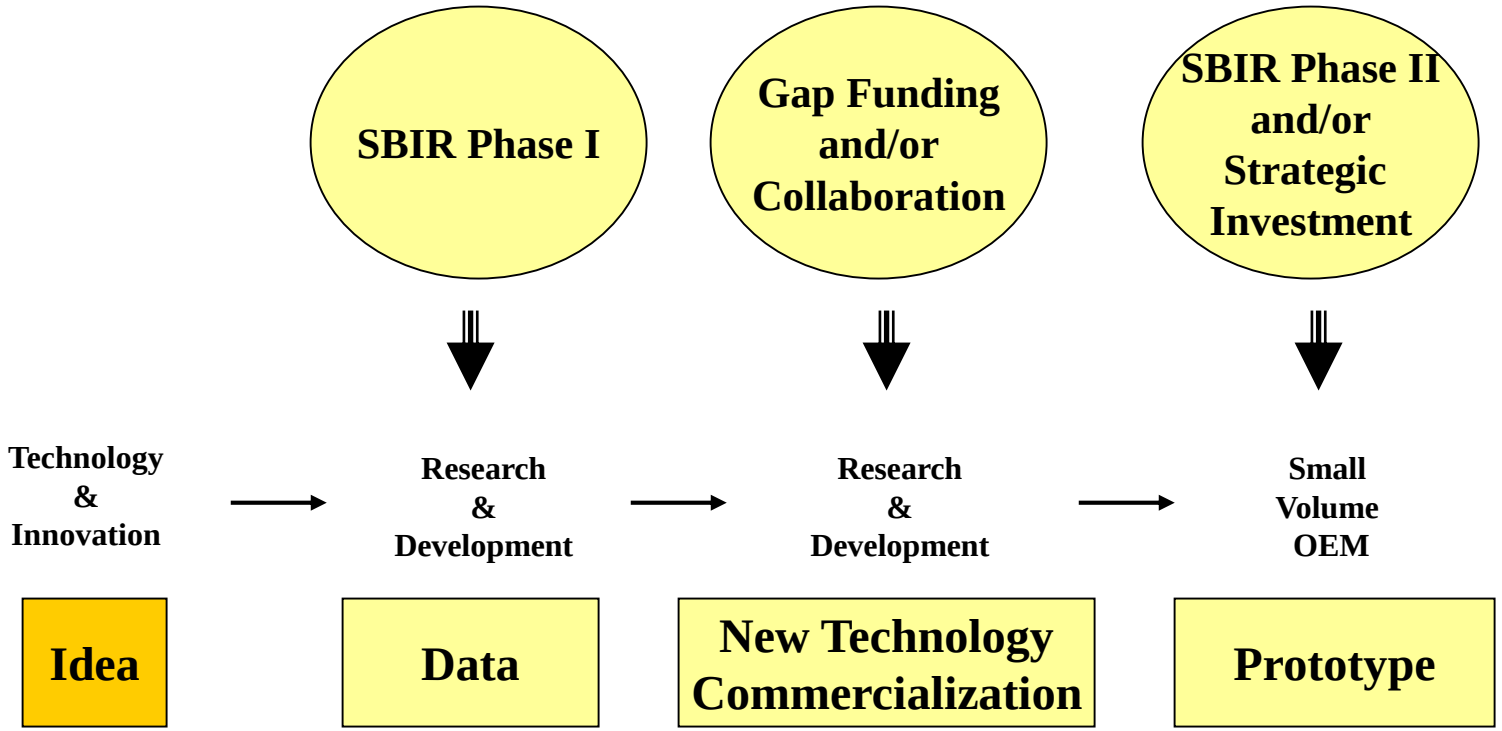
3: How science/technology and business interconnect in QuantTera

QuantTera's View of SBIR Funding

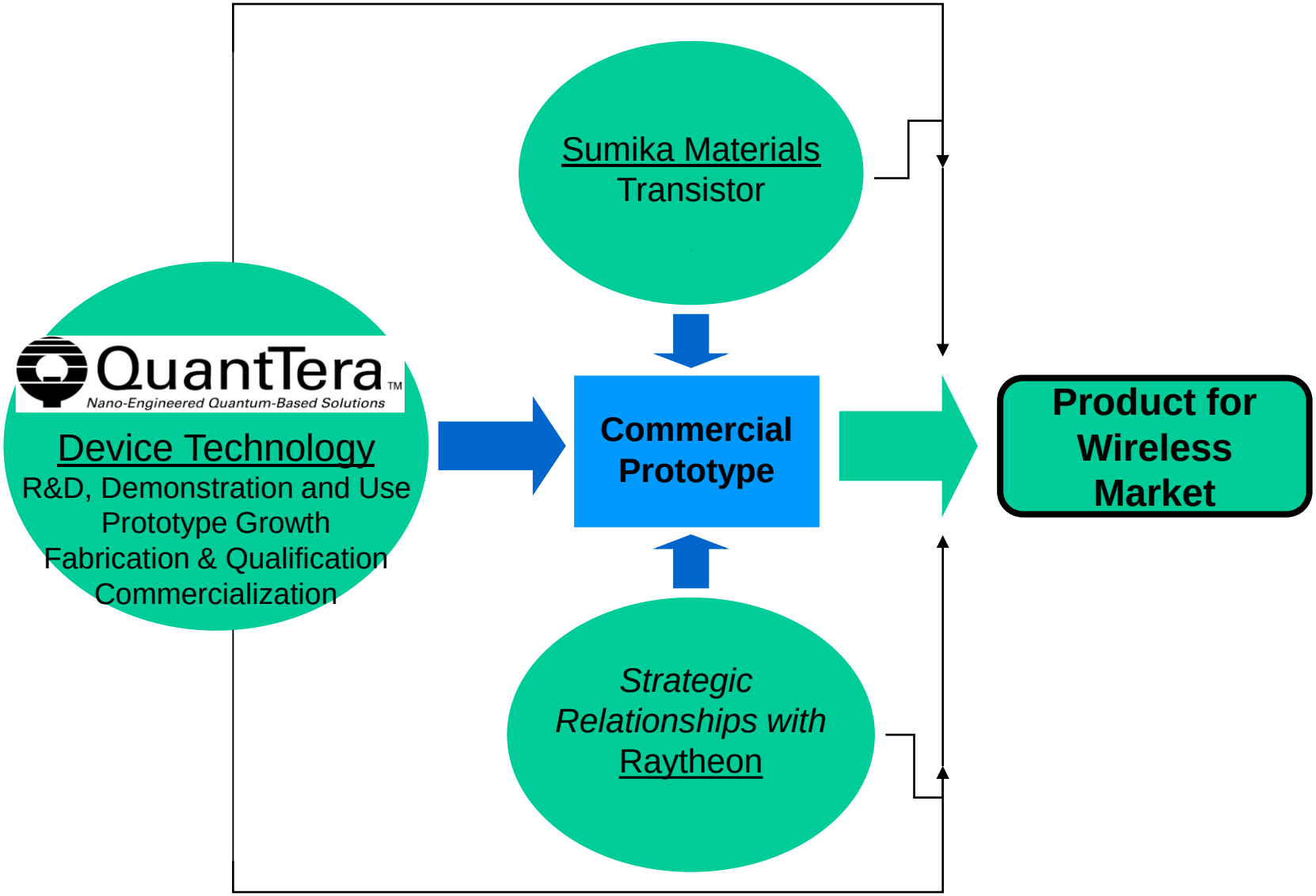
1. **SBIR is seed funding to develop military and commercial technology (dual use)**
2. **Technical expertise in pursuing niche markets (i.e. military, high end product, stringent specifications) for eventual commercial deployment.**
3. **The military application is the proving ground**
4. **SBIR allows funding of prototype development**
5. **Allows building of strategic partners and collaborators (business community)**
6. **Early stage companies like QuantTera are suited for the SBIR program.**
7. **Better than FFF (Friends, Family and Fools)**
8. **Better than VC**
    1. **Founded a company in 2000 for transistor amplifiers for cellular market with Venture/Angel funding**
    2. **Company is break-even but mostly owned by Investors due to dilution through Bridge loans**

- **<u>SBIR Programs</u>**
- SBIR is attractive to start-ups since all IP developed resides with the company.
- Cycle times of SBIRs are very short. Attractive since innovations occur rapidly.
- SBIR Phase I programs are 6-12 months for about $150,000.
- SBIR Phase II programs are 24 months for $750,000.

QuantTera's Strategy



QuantTera's Laser Commercialization from R&D



Management and Organization

	Venture	'True Start-up
Role of managers	Meet "milestones"	Hands-on
Management needs within entrepreneurial ventures	Name recognition	Generalist: Expert in one area, Will learn critical areas, good understanding in other's, can pinch hit in any position!
Boards of directors	Pre-determined by Investors	Advisor's determined by company needs. (Legal, Accounting, Commercialization, CEO's,
Org charts	CEO, CFO, COO, Managers, Engineers, Technician	CEO (chief everything officer
Hiring people	Base on completeness of organization (management, technical, IT, clerical, maintenance) Salaried	Critically needed and then may not hire! Contract labor!
Management compensation and incentives	Standard 4 year vesting schedule, bonuses, stock options	Ownership will be given with skin in the game, Bonuses paid only if company profitable
Relationship between management and investors	Beginning (honey moon), Middle (Power Struggle), End (Investor's in charge), Adversarial, Founder's and Investor have different visions	Love – Hate: Management is Investor

Entrepreneurs for Scientists

- Experience (Hand's On): What do you consider your expertise, How well do you know your abilities, Can you multi-task, or single focussed

- Desire to succeed: Passion! When working on something "does anybody know what time it is?", What will you do? (are you humble, can you do menial things)!

- Recognition of Opportunities: Snychronicity, Timing, Value of money, Personal Contact

- Strategic Relationships: Need network of small companies (non-competing), Vendor's (credit, pay your bill's on time), Large Companies validate your esxisistence, business colleagues's (who do you trust) (look at their modus operandi)your support

- "Value" proposition: What makes your company special, where do you fit in. Better be a unique small fish than big fish with many competitors

- Core Values: Philosophical, personal belief's. Glen Vaughn said's "Honor all your promises, and even the one's people think you made, Only say thing 's you would say to the person directly, There are only lags in information".

- Things we sell: Time, Credibility, Commitment.

Summary of Entrepreneurs for Scientists

- Experience (Hand's On)
- Desire to succeed
- Recognition of Opportunities
- Strategic Relationships
- "Value" proposition
- Core Values
- Cutting edge interfaces between various disciplines, Technologist's get "bang for the buck".
- Business Commercialization Opportunities: Main problem is communication!
  - Electronics and photonics
  - Medicine
  - Energy
  - Environment
  - Military