25 Years of SCINT Conferences

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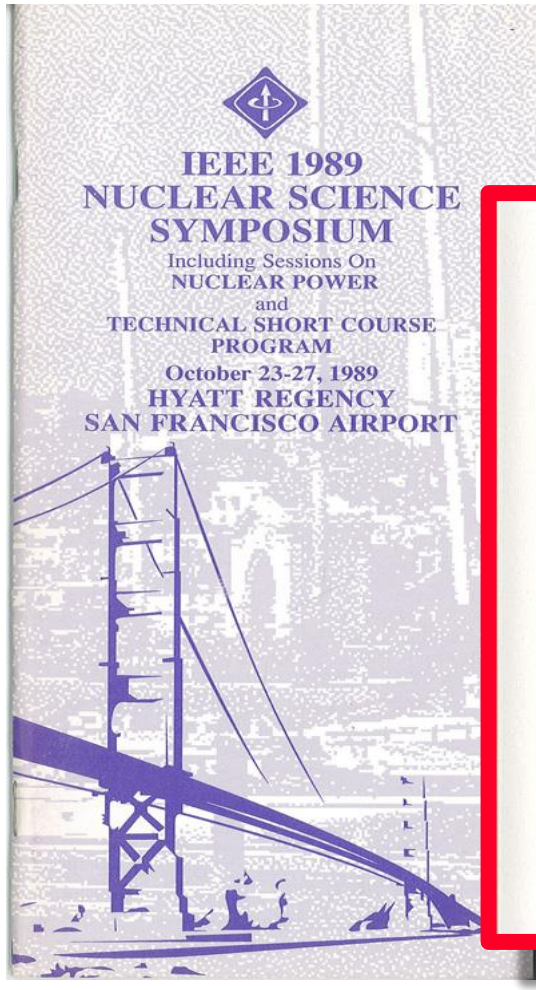
Lawrence Berkeley National Laboratory

September 18, 2017

The Scintillator World in 1989

- Used for L3 Crystal Calorimeter
- Used for ~All PET Cameras

1989 IEEE Nuclear Science Symposium



Thursday, October 26, 1989
9 AM to 12 Noon — Session 3A - Harbour

Radiation Detectors

Chairman: Richard Pehl
Lawrence Berkeley Laboratory

3A4 -(15) *New Scintillation Materials for High Energy Physics Applications* - C. Kennedy, B. Baumbaugh, A. Bose, T. Ditmire, D. Puseljic, R. Ruchti, J. Ryan, Z. Wu; University of Notre Dame: J. Kauffman; Philadelphia Coll. of Pharmacy/Medicine: A. Baumbaugh, K. Knickerbocker; Fermilab

INTERMISSION (25 min)

3A5 -(25) (Invited) *Prospects for New Inorganic Scintillators* - S. Derenzo; LBL

3A6 -(15) *Inorganic Scintillating Optical Fibers Using CVD Luminescent Films* - D. R. Winn; Fairfield University: P. S. Kirlin, C. P. Beetz; ATM

Plus 5 minute discussion period for each paper

3 Oral Presentations, 8 Poster Presentations

User Communities Needed Better Materials

	HEP	PET
Attenuation Length (mm)	OK	OK
Luminosity (photon/MeV)	OK	Too Low (5x)
Energy Resolution	Too Low (5x)	Too Low (2x)
Decay Time (ns)	Too Slow (10x)	Too Slow (10x)
Radiation Hardness	Too Low (1000x)	OK
Cost	Too High (5x)	OK

- HEP and PET Started Scintillator Searches
- Independent Efforts

Cerium Fluoride Recently Discovered

	BGO	CeF_3
Attenuation Length (mm)	11	18
Luminosity (photon/MeV)	8,200	4,000
Decay Time (ns)	300	27
Radiation Hardness	Moderate	Moderate

Problem for PET

Problem for HEP

- Promising for Both HEP and PET
- Some Improvement Needed for Each Application

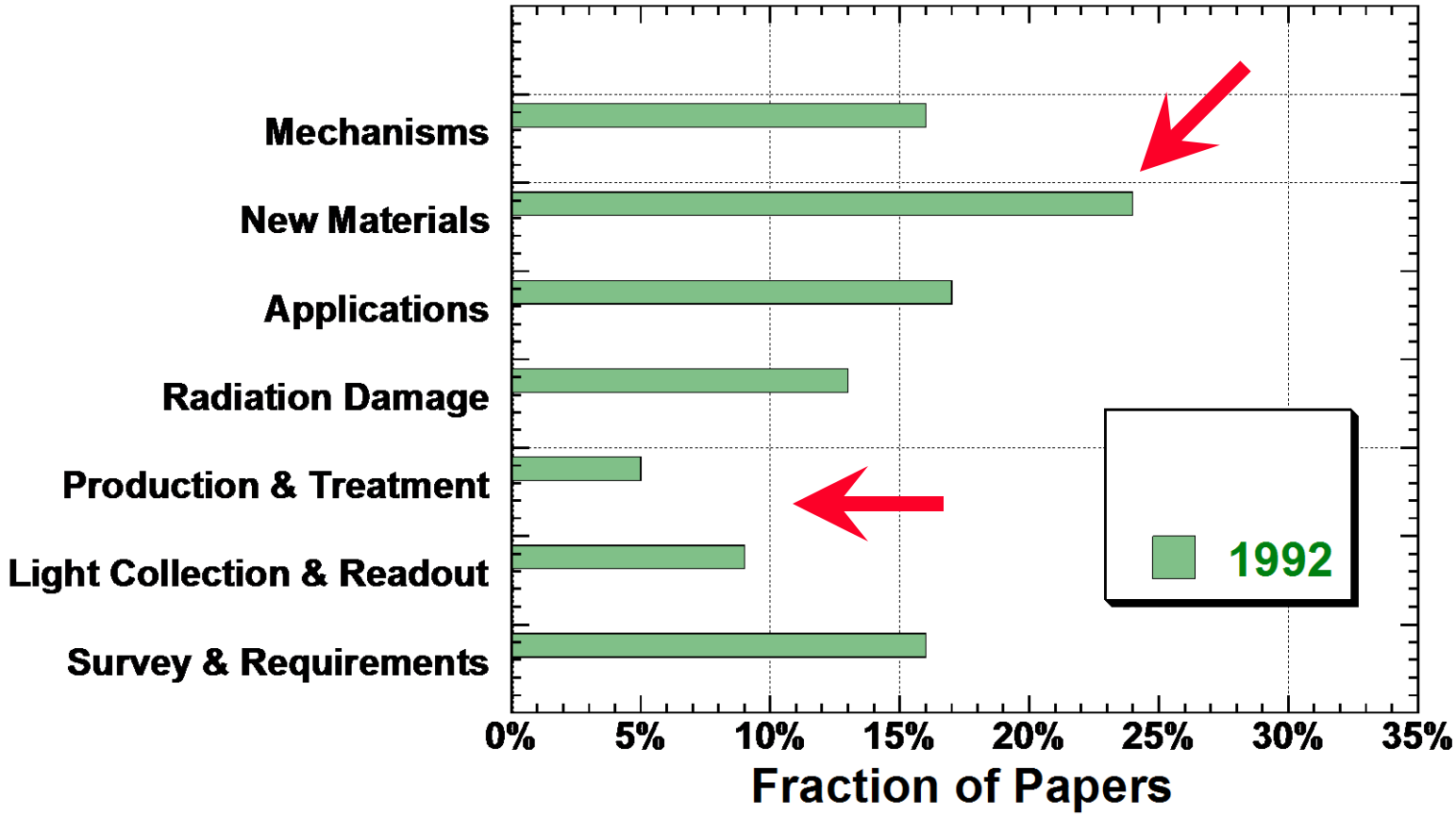

CRYSTAL 2000
22 - 26 Sept., 1992
CNRS - CERN
CHAMONIX, France
INTERNATIONAL WORKSHOP ON HEAVY SCINTILLATORS
FOR SCIENTIFIC AND INDUSTRIAL APPLICATIONS
CRYSTAL 2000
CHAMONIX, France, September 22-26, 1992

The Scintillator World in 1992

- Significant Search Efforts in HEP and Medical Imaging Communities
  - HEP Strongly Favoring CeF_3
  - No Strong Candidates for PET
- LSO and $PbWO_4$ Very Recently Discovered

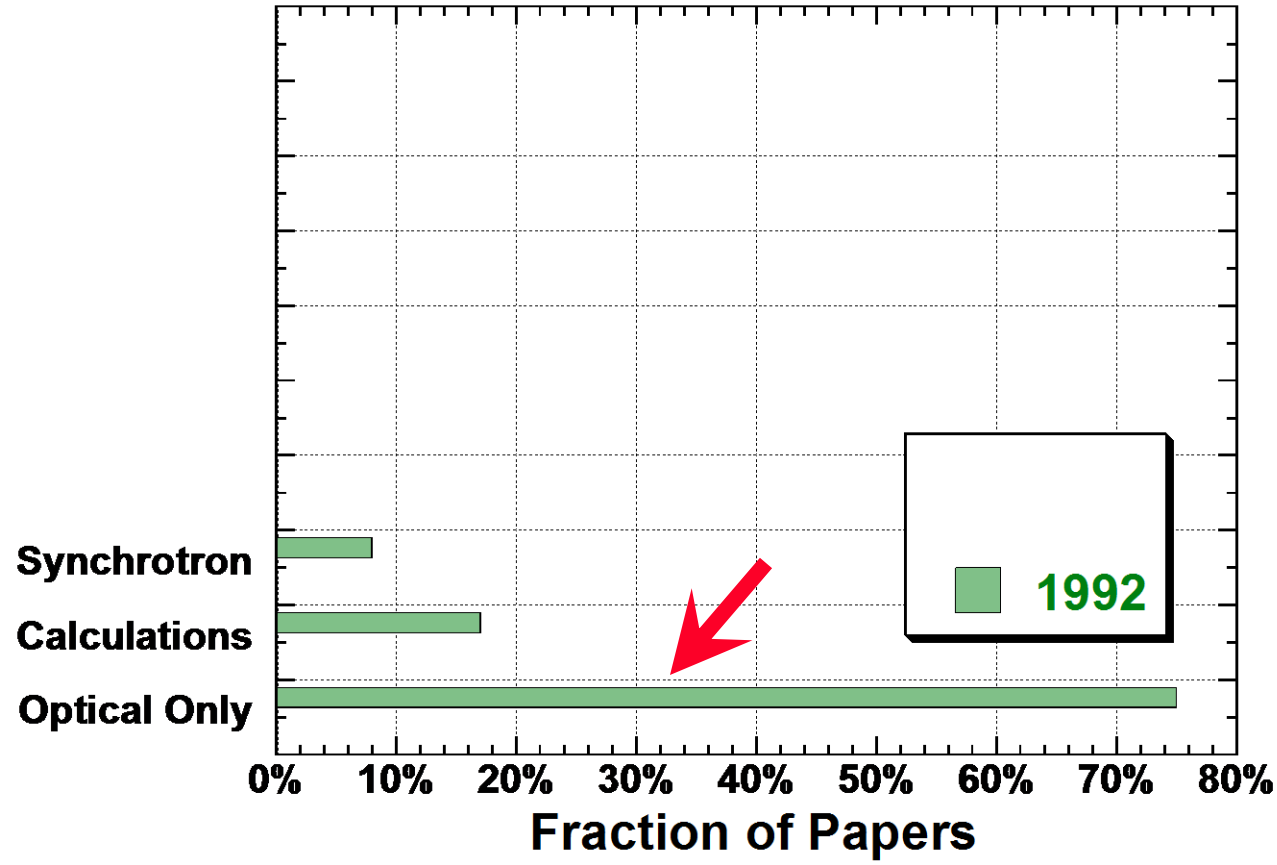
- Little Communication Between Materials Science, Luminescence, & Scintillator User Communities

Crystal 2000 Presentation Category



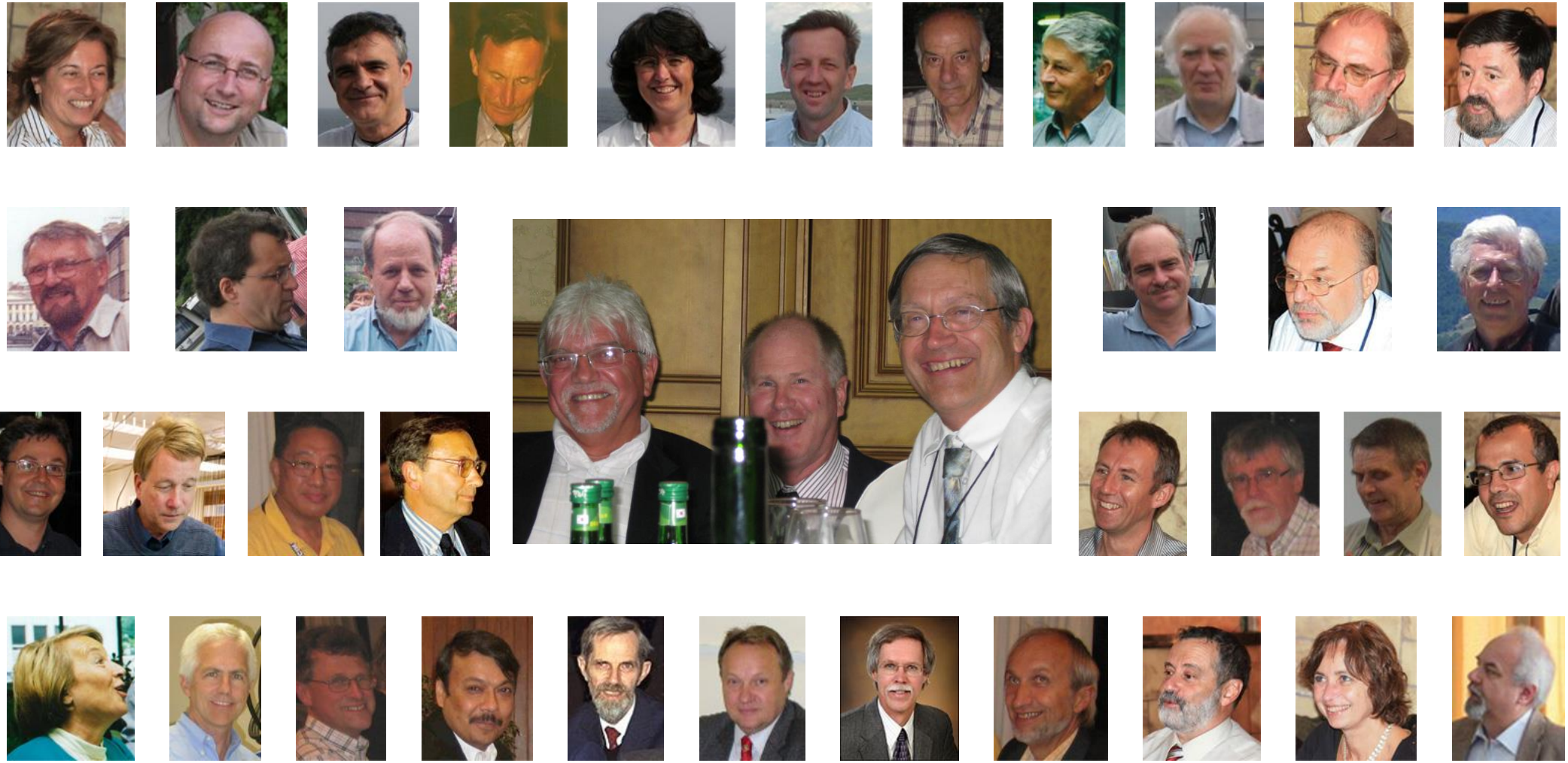
- Roughly Equal Number in All Categories
- Emphasis on "New Materials"
- Smaller Number in "Production" and "Readout"

Crystal 2000 “Mechanisms” Techniques



- Dominated by “Optical Only” Techniques
- Emission, Absorption, Excitation, & Decay Time Spectra
- Visible & Near UV Wavelengths

A Community Is Born



6th International Conference on Inorganic Scintillators and their use in Scientific and Industrial Applications

Main topics:

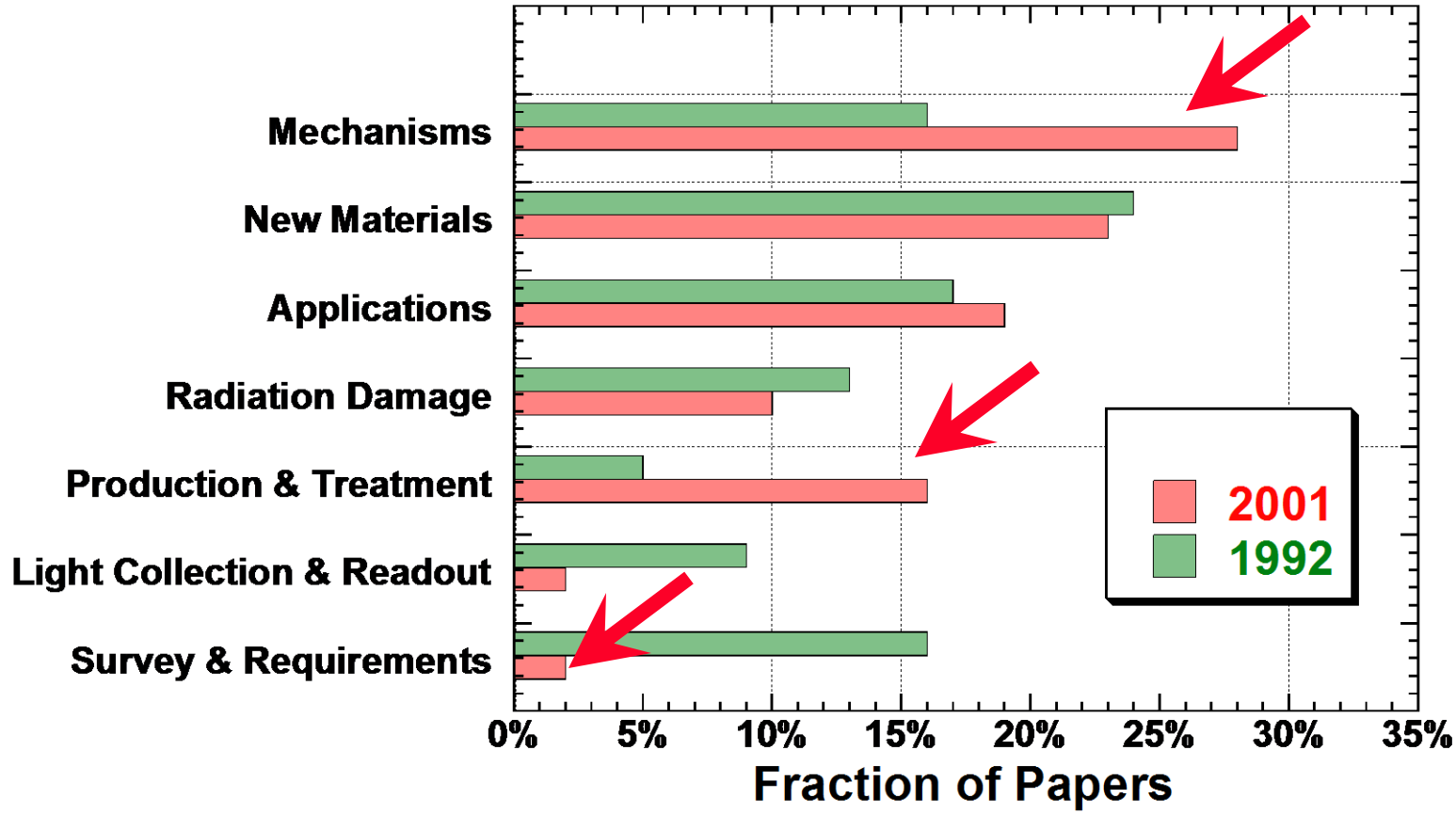
- Scintillation mechanisms
- Radiation damage mechanisms
- Perspective for new scintillators
- Applications in high energy physics and nuclear physics: prospects and limitations
- Applications in astrophysics: prospects and limitations
- Applications in medical imaging: prospects and limitations
- Applications for industrial processes, security equipments, radiation monitoring
- Crystal growth technologies and challenges
- Photodetectors and readout electronics

The Scintillator World in 2001

- LSO Adopted by PET & Developed
- CeF_3 Adopted by HEP & Developed
- CeF_3 Discarded by HEP
- $PbWO_4$ Adopted by HEP & Developed
- Both $PbWO_4$ and LSO in Full Production, Just Starting Common Use

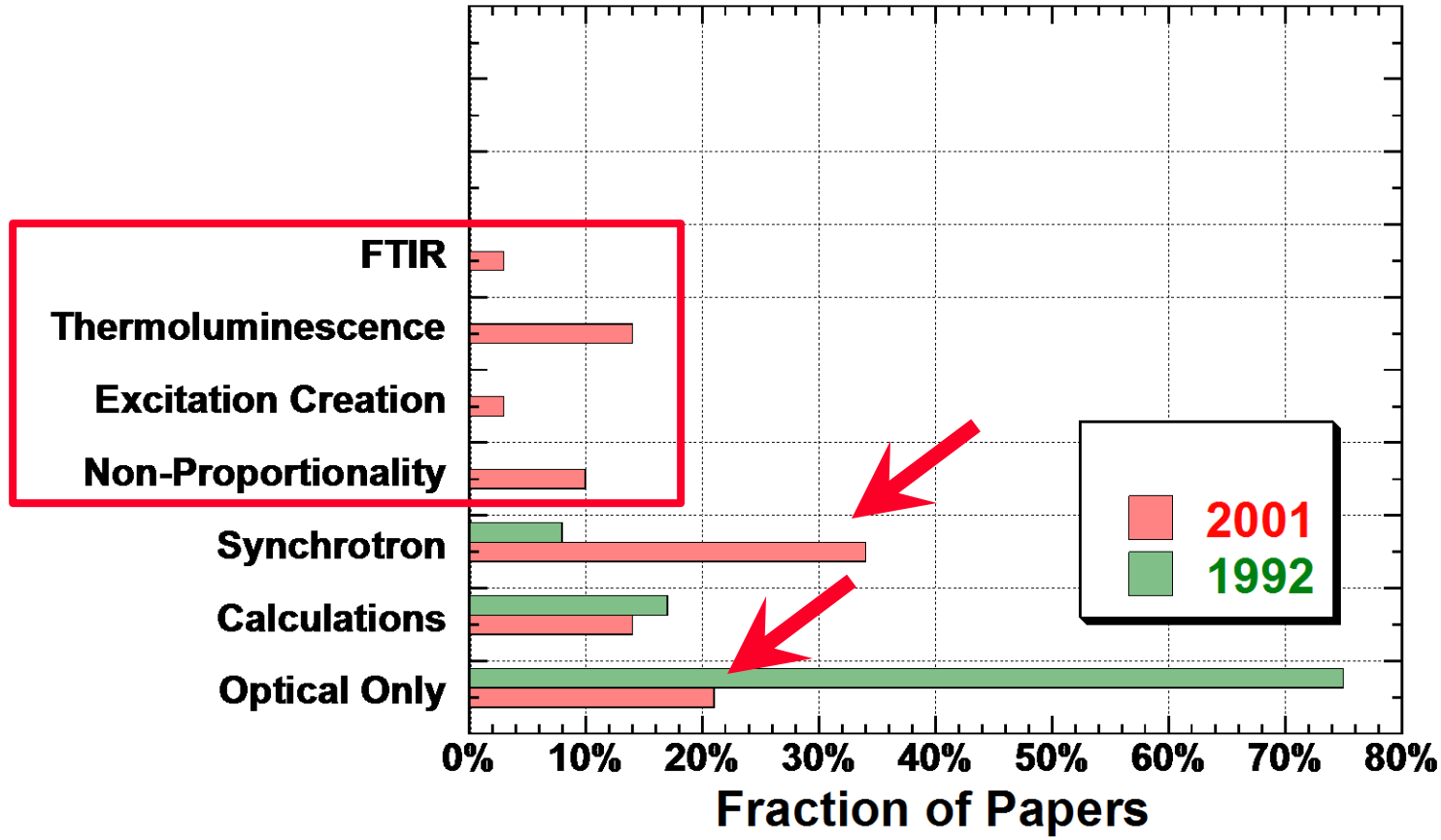
- 9/11 Attacks Occur ~One Week Before SCINT

SCINT 2001 Presentation Category



- "Mechanisms" is Largest Area
- Large Increase in "Production"
- Large Drop in "Survey" & Requirements"

SCINT 2001 “Mechanisms” Techniques

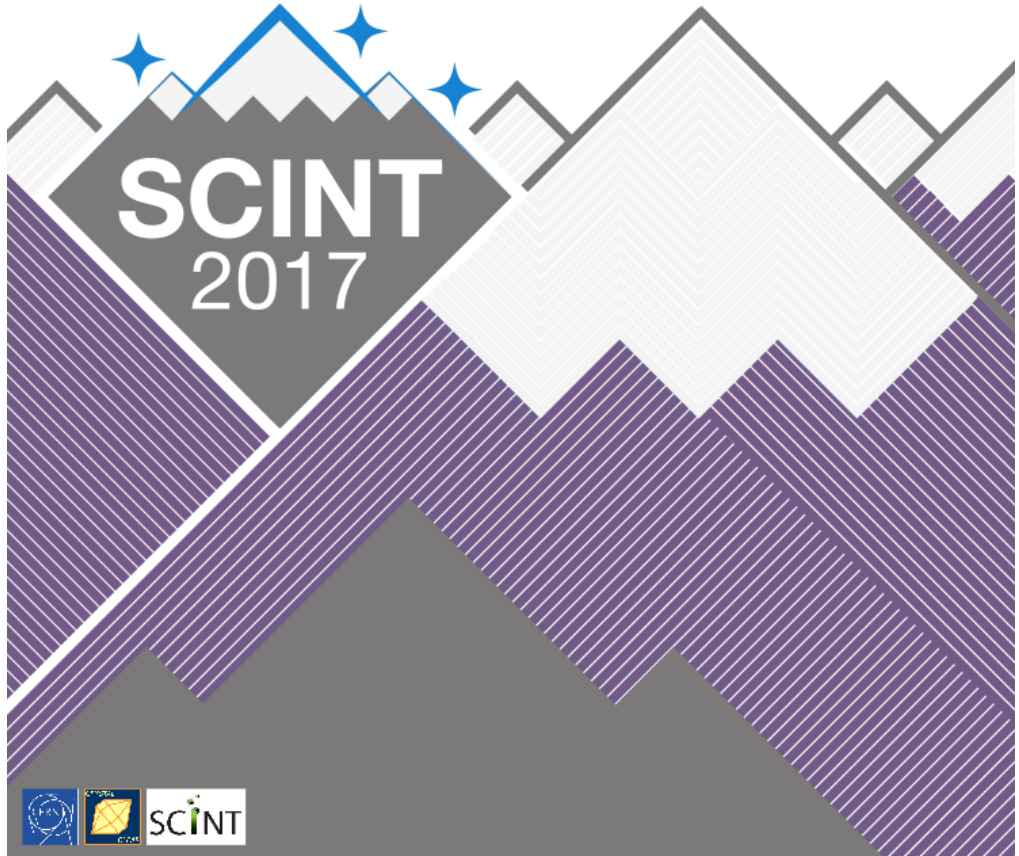


- Sharp Drop in “Optical Only”
- Many More ‘New’ Measurement Techniques
- Most Common Technique is “Synchrotron”

14th International Conference on Scintillating materials and their applications

September 18-22, 2017
Le Majestic, Chamonix, France

https://scint2017.web.cern.ch
Scint2017@cern.ch



Marvin J. Weber (1933–2017)

Luminescence of $Bi_4Ge_3O_{12}$: Spectral and decay properties

M. J. Weber *

Raytheon Research Division, Waltham, Massachusetts 02154

R. R. Monchamp †

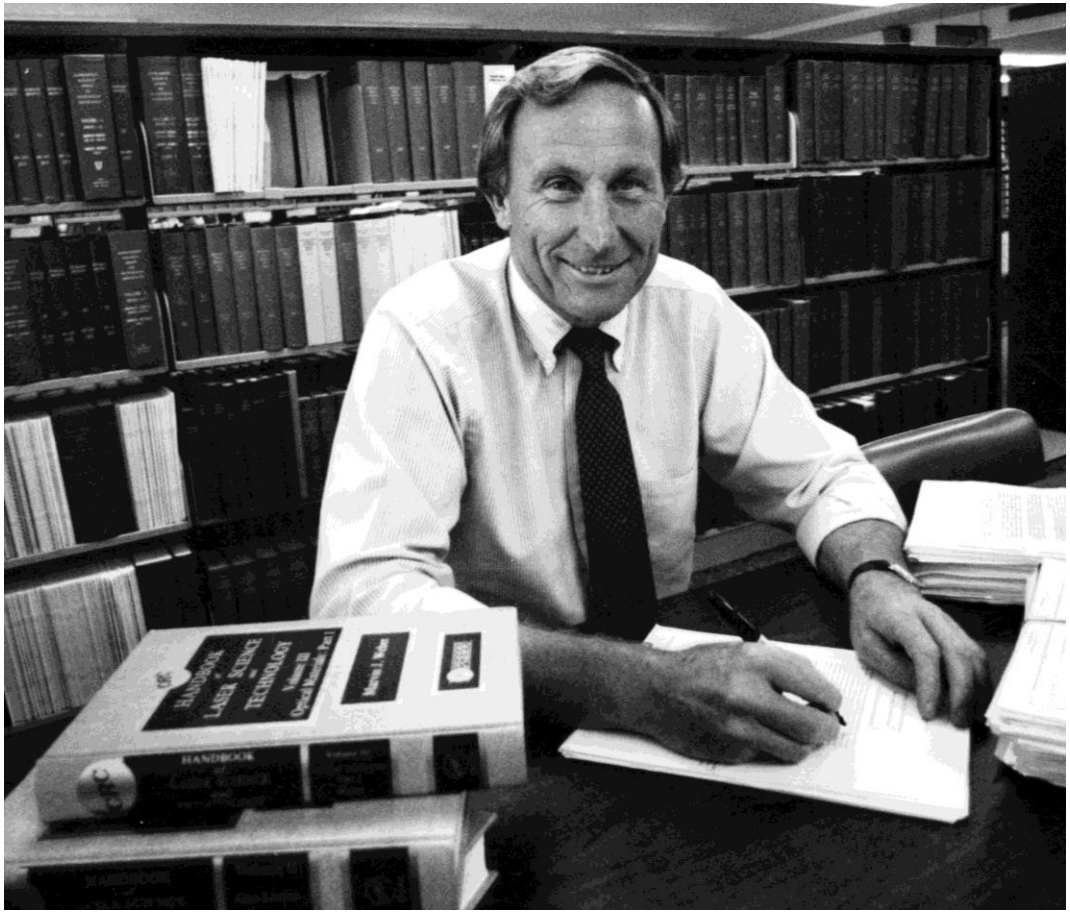
Raytheon Laser Advanced Development Center, Waltham, Massachusetts 02154

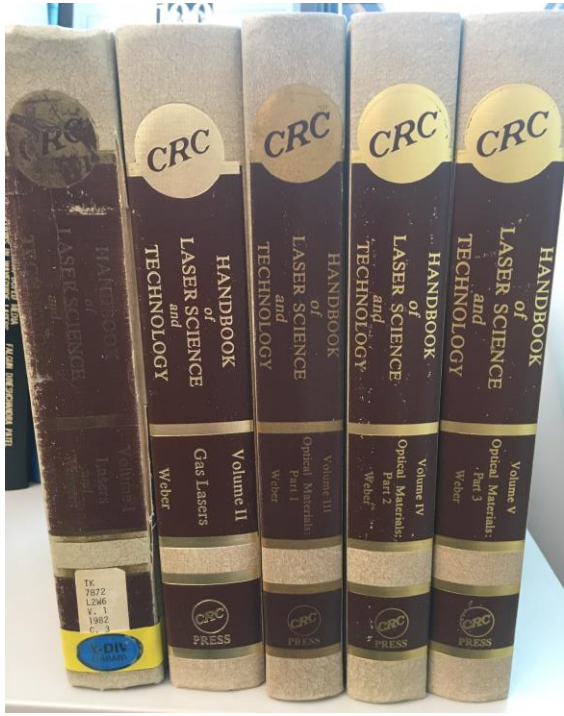
(Received 26 July 1973)

Intense broadband emission in the visible is observed from crystals of $Bi_4Ge_3O_{12}$ under optical and x-ray excitation. From measurements of absorption, reflection, fluorescence, and excitation spectra, the emission is assigned to $^3P_1 \rightarrow {}^1S_0$ transitions of Bi^{3+}. The Stokes shift is large, $\approx 14\,000\ cm^{-1}$. The temperature dependences of the fluorescence intensity and lifetime in the range 77–400 °K establish that nonradiative decay becomes significant at temperatures $\gtrsim 250$ °K. Comparison of the properties of $Bi_4Ge_3O_{12}$ with those of $Bi_{12}GeO_{20}$ and other bismuth-activated materials demonstrates the importance of the Stokes shift and the ^1S-^3P energy difference in determining the luminescence behavior. The use of $Bi_4Ge_3O_{12}$ as a laser host crystal for rare-earth and iron group activator ions, and as a scintillator material is discussed briefly.

- AB, MA, and PhD (1959) from UC Berkeley
- 1959–1973 Solid State Lasers at Raytheon
- Discovered BGO in 1973

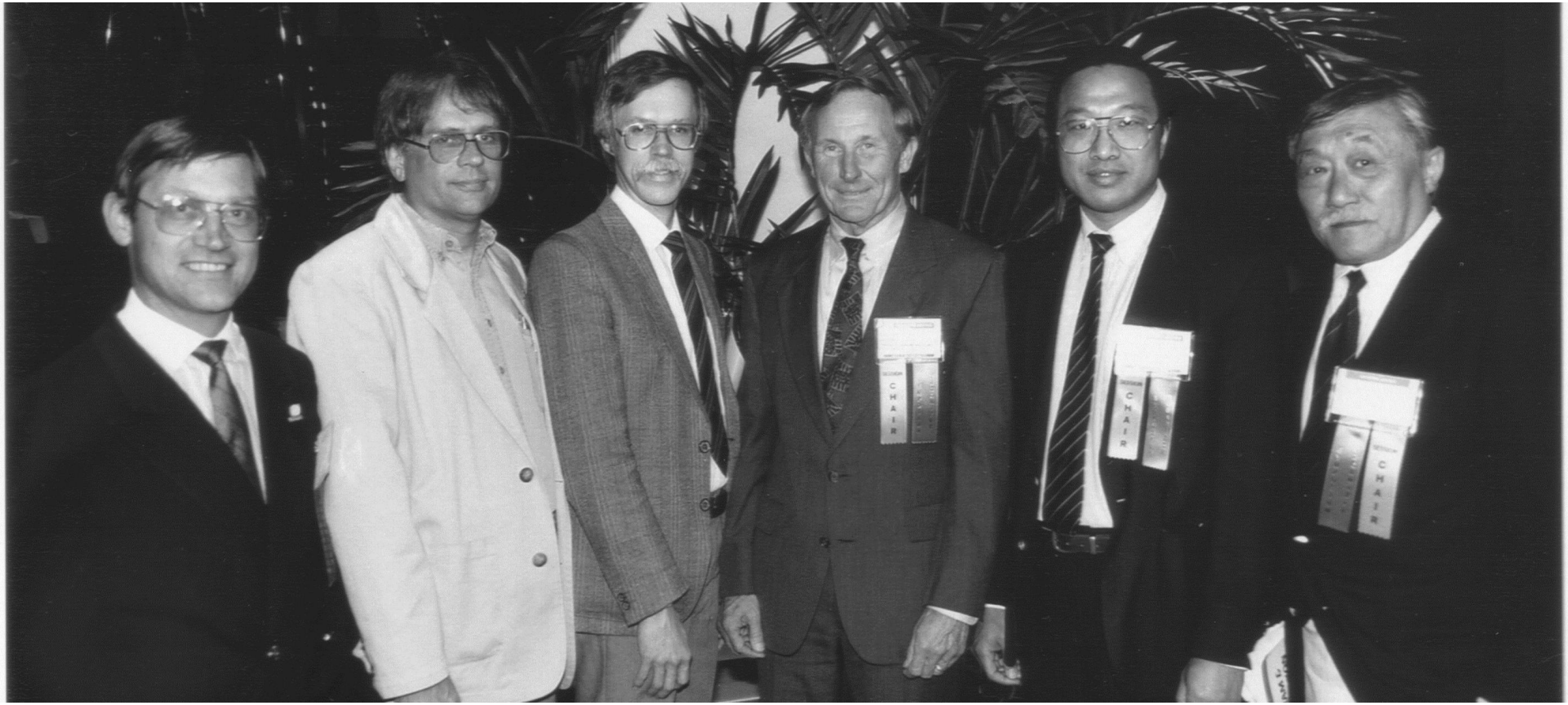
Marvin J. Weber (1933–2017)





- 1973–1994 Laser Program at LLNL
- Head of Basic Materials Research for Nova Laser
- Edited CRC Series on Laser Science & Technology

Marvin J. Weber (1933–2017)



- 1994–2017 Scintillator Development at LBNL
- Chaired the 1994 MRS “Physics and Chemistry of Scintillator / Phosphor Materials” (the Second SCINT)

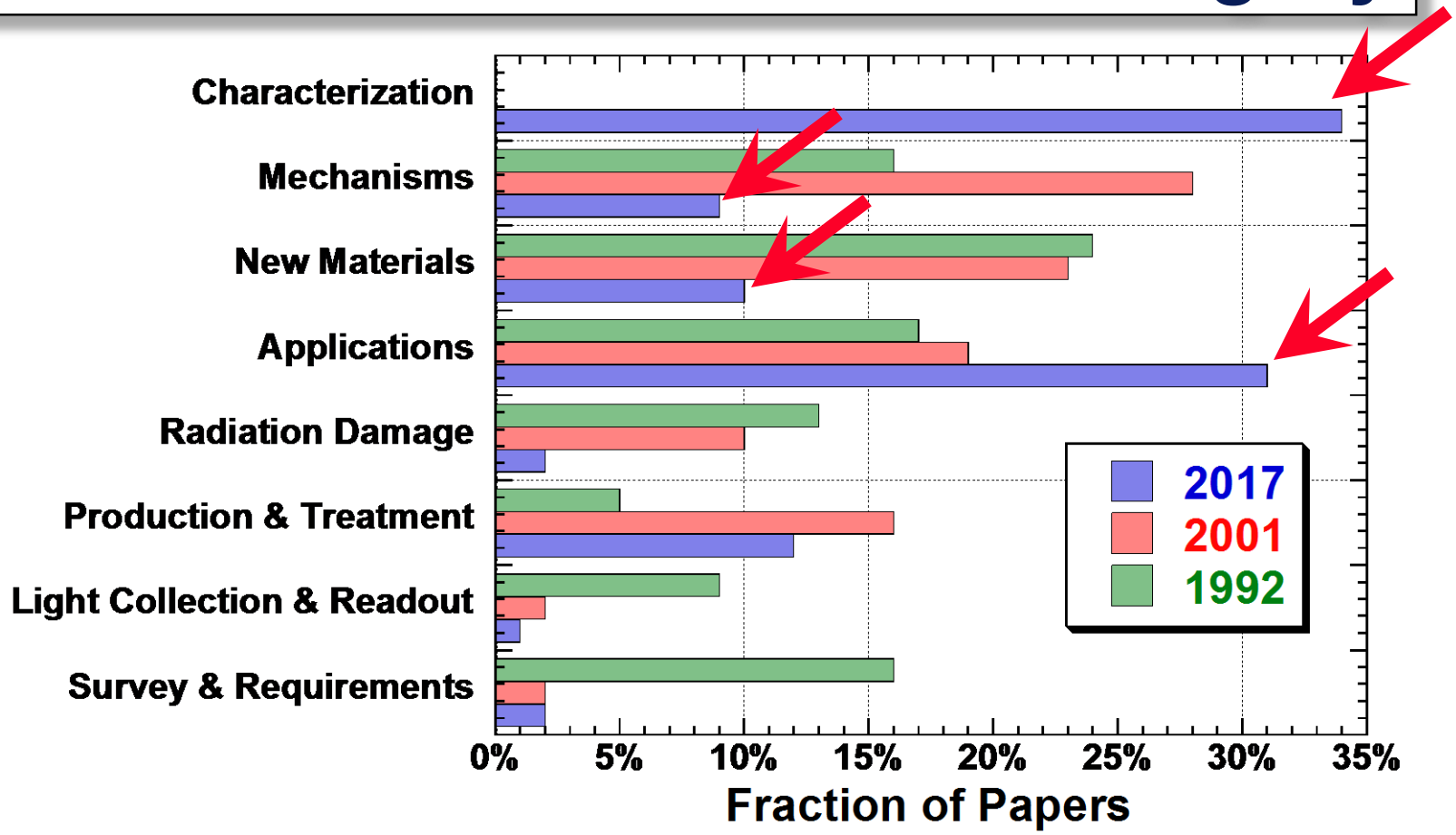
Marvin J. Weber (1933–2017)

The Scintillator World in 2017

- **Large Development Effort by Nuclear Security Community**
  - Good Energy Resolution ($LaBr_3$, SrI_2)
  - Neutron Sensitivity
- **HEP Needs Materials Beyond $PbWO_4$**
  - Radiation Hardness, Compensation
- **PET Needs Materials Beyond LSO?**
  - Time-of-Flight, Energy Resolution

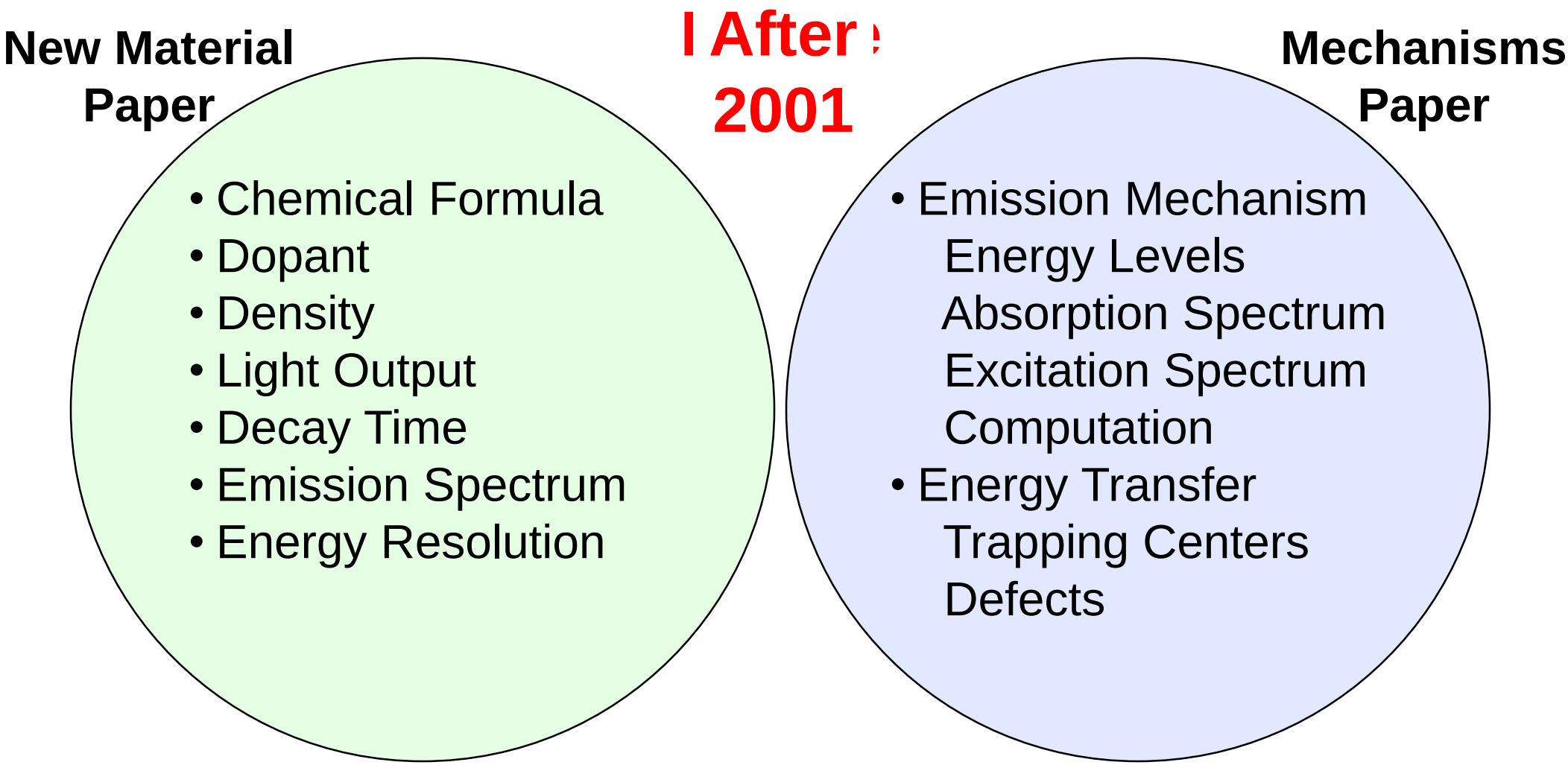
- **Re-Entering a Development Phase?**

SCINT 2017 Presentation Category



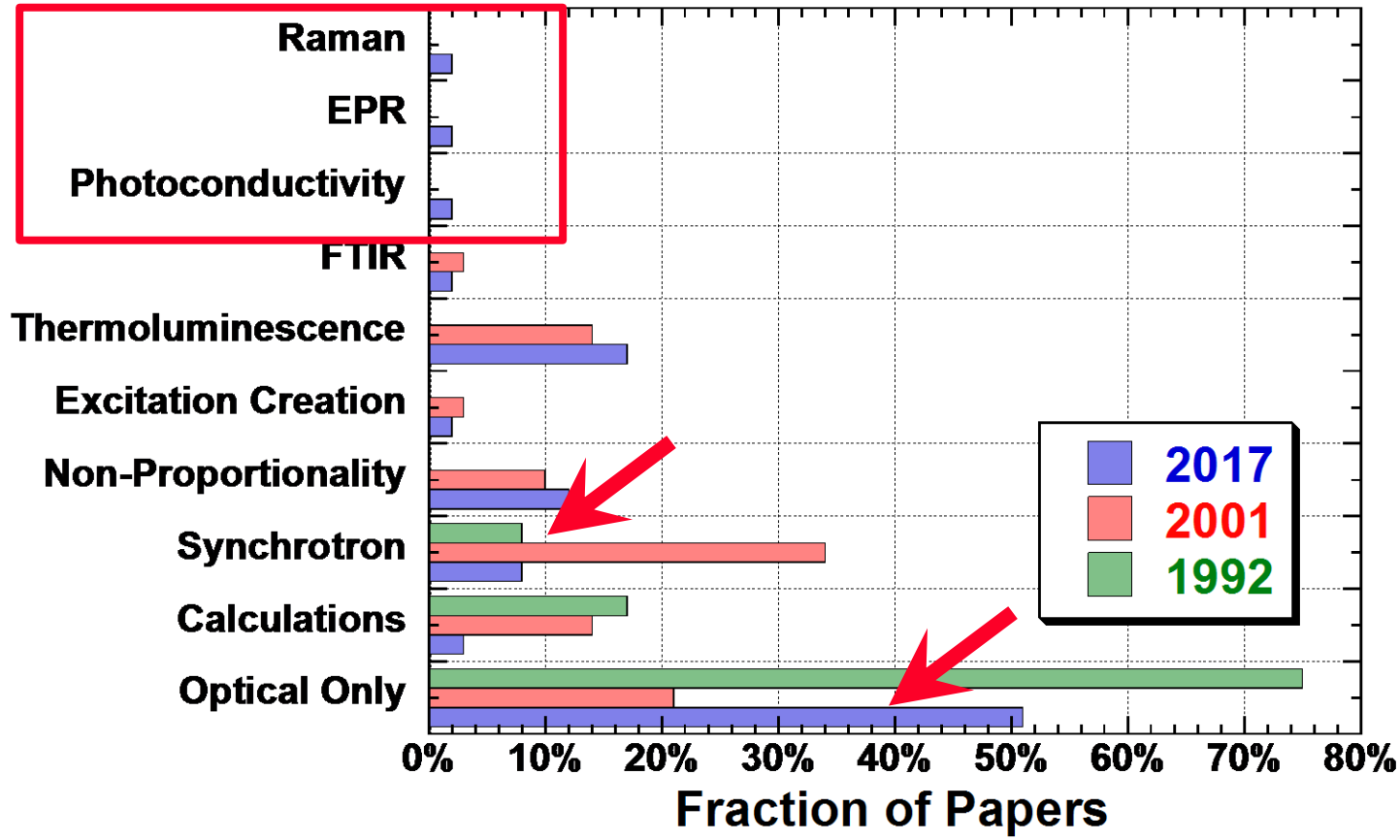
- Large Increase in “Applications”
- Large Decrease in “New Materials” & “Mechanisms”
- New Category (“Characterization”) is Largest Area

Why the Increase in "Characterization" (And Decrease in "Mechanisms" & "New Materials")?



& Characterization

SCINT 2017 "Mechanisms" Techniques



- More 'New' Measurement Techniques
  - Sharp Increase in "Optical Only"
    - Sharp Drop in "Synchrotron"

SCINT / Crystal Clear Legacy:
Scintillation Science

IEEE Nuclear Science Symposium & Medical Imaging Conference

	1989	2011	2016
Oral Presentations	3	35	34
Poster Presentations	8	~180	~300

Similar Increase Seen in Many Conferences

25 Years of SCINT Has Given Us:

- New Scintillation Materials
- Understanding of Scintillation Mechanisms
- Sophisticated Techniques
- Multi-Disciplinary Community
- Friendship
- **Scintillation Science!**