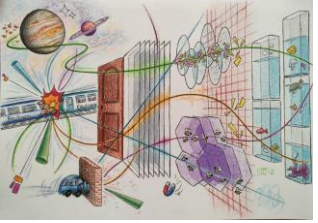


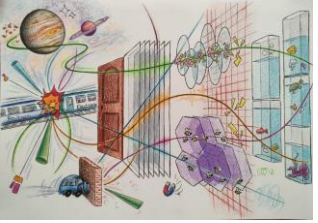
Solid-State Detectors Community Workshop

Towards the DRD3 collaboration – Proposal Writing Team

Michael Moll

CERN EP-DT, Geneva, Switzerland

on behalf of the DRD3 proposal writing team

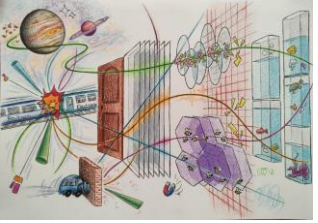


Outline

- The DRD3 proposal writing team
  - composition and mandate
- Aim and Format of this Workshop
  - Aim & splitting of activities into WPs
- DRD3 is not RD50^{++}
  - some comments from RD50 perspective

(Detailed discussion on DRD3 structure/organization tomorrow)

- Next: Survey [Nicolo]



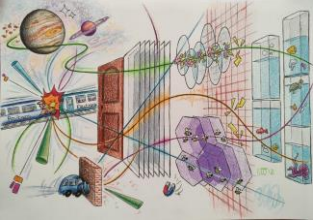
DRD3 proposal team: **members**

- DRD3 proposal core team:
  - formed in consensus between ECFA Roadmap TF3 conveners & RD50 management
  - regular meetings since October 2022
  - mandate presented on next slide

Giovanni Calderini, Nicolo Cartiglia, Gianluigi Casse, Gregor Kramberger, Michael Moll, Giulio Pellegrini, Ioana Pintilie, Ivan Vila Alvarez, Eva Vilella Figueras

- Team extended with further experts to organize individual research lines (and sessions of this workshop)
  - We are very open to integrate further volunteers into the teams!

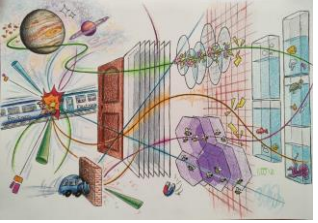
- WG1: Monolithic CMOS Sensors
  D.Bortoletto, D.Contardo, E. Vilella Figuras, H.Pernegger
- WG2: Sensors for Tracking & Calorimetry
  N.Cartiglia, C.Gemme, A.Macchiolo
- WG3: Radiation damage & ultrahigh fluences
  - M.Mikuz, M.Moll, I. Pintilie, S.Seidel
- WG4: Simulation
  - M.Bomben, G.Kramberger, A.Morozzi, F.Moscatelli, J.Schwandt, S.Spannagel
- WG5: Characterization techniques, facilities
  - D.Dannheim, M.Fernandez Garcia, M.Jakšić, I.Vila Alvarez
- WG6 Non-silicon based detectors
  - T.Bergauer, T.Koffas, A.Oh, G.Pelligrini, X.Shi
- WG7: Interconnect and device fabrication
  - G.Calderini, D.Dannheim, T.Fritzsch, F.Hügging
- WG8: Dissemination and outreach
  - N.Cartiglia et al.



DRD3 proposal team: **Mandate**

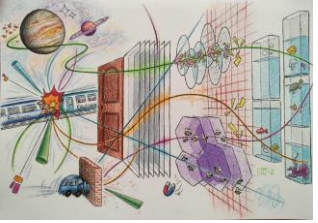
- **Our mandate** (as we see it)
  - Foster and guide a community-driven bottom-up process towards the **DRD3 proposal** and the formation of the **DRD3 collaboration**
  - **Perform a survey** of the solid-state detectors community R&D interests, plans and anticipated available/requested resources and evaluate these against the ECFA roadmap recommendations
  - Organize a **community-wide workshop** (22/23 March 2023, see next slide for details)
  - Conclude on milestones and deliverables and **write/submit the DRD3 proposal** in consensus with the community, the ECFA roadmap and within the DRDC/CERN defined boundaries
  - Prepare & organize a constitutional workshop to form the DRD3 collaboration [END of our mandate]

- What we are not and what is **not our mandate**
  - Team is neither an ECFA nor an RD50 or DRD3 body – We are serving the detector R&D community.
  - Team members are neither imposing nor volunteering for any position in the future DRD3 collaboration.
  - We are providing, based on RD50 experience, a recommendation for the structure, organization and MoU of DRD3. Clearly, all this will be entirely in the hands of the future DRD3 collaboration (i.e. you!).



AIM of this Workshop

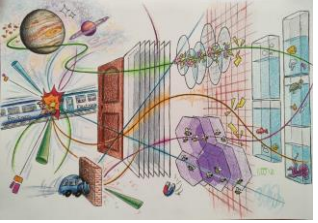
- Bring the solid-state detectors community (i.e. future DRD3 community) together
- Present the outcome of the community-wide survey (“the questionnaire”)
  - Evaluate the proposed R&D activities against the ECFA Roadmap recommendations
  - Evaluate the anticipated available resources against the needs for the proposed R&D
- Formulate the scope of the DRD3 proposal and the contents of the proposal
  - Fully covered by the ECFA Roadmap and fully covering the Roadmap recommendations?
  - Do we want/need to extend/limit the scope with respect to what will be presented by the eight working group task forces.
  - We are very open to your input for writing the proposal and need your input!
- Formulate milestones and deliverables for the proposal
  - Evaluate them against the anticipated resources (as far as possible)
- Decide on the way forward towards the proposal & the formation of DRD3
- Have a first community wide discussion on the future structure of the DRD3 collaboration



Definition of “DRD3 working groups”

- In conceiving the survey, we defined 8 fields of interest (that now are “**working groups**”):
  - WG1: Monolithic CMOS sensors
  - WG2: Sensors for tracking and calorimetry with space, time and/or energy resolution
  - WG3: Radiation damage & ultrahigh fluences
  - WG4: Simulations
  - WG5: New characterization techniques and facilities of common interest
  - WG6: Non-silicon semiconductor and other material studies
  - WG7: Interconnect and device fabrication technologies
  - WG8: Dissemination and outreach

- The structuring in 8 WGs is reflected
  - in 8 sessions in this workshop
  - in 8 WGs in the proposed organizational structure for DRD3 (open for discussion!)
  - in 8 sections in the proposal (very open for discussion!)
    - Proposal is limited to 20 pages (maybe we group some WGs for e.g. milestones, ..to be discussed)



Coverage of ECFA DRDTs (& GSRs)

DRD3

Within the ECFA roadmap
4 Detector R&D Themes (DRDTs)
have been identified for the
Solid State Detectors in particle physics.

- We are covering all ECFA DRDTs
- Additional WGs were added to cover simulations, facilities and dissemination corresponding to General Strategic Recommendations (GSRs) in the ECFA roadmap

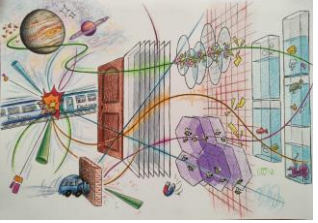
DRDT3.1. Achieve full integration of sensing and microelectronics in **monolithic CMOS** pixel sensors

DRDT3.2. Develop solid state sensors with **4D-capabilities for tracking and calorimetry**

DRDT3.3. Extend capabilities of solid state sensors to operate at **extreme fluences**

DRDT3.4. Develop full **3D-interconnection technologies** for solid state devices in particle physics.

- WG1: Monolithic CMOS Sensors
- WG2: Sensors for Tracking & Calorimetry
- WG3: Radiation damage & extreme fluences
- WG4: Simulation
- WG5: Characterization techniques, facilities
- WG6 Non-silicon based detectors
- WG7: Interconnect and device fabrication
- WG8: Dissemination and outreach



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DRD3

WG1: Monolithic CMOS Sensors

WG2: Sensors for Tracking & Calorimetry

WG3: Radiation damage & extreme fluences

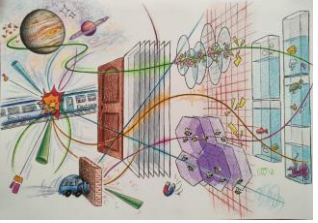
WG6: Non-silicon based detectors

WG7: Interconnect and device fabrication

WG4: Simulation

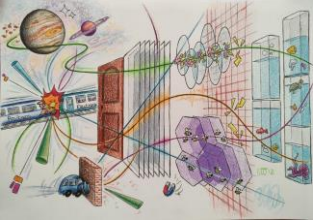
WG5: Characterization techniques, facilities

WG8: Dissemination and outreach



Concept of the DRD3 WG sessions

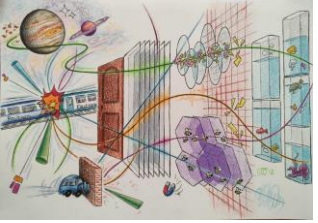
- The 8 WG sessions are between 1h and 1h 30min
  - We assume that the audience is familiar with the research topic !
    - No in-depth state-of-the art status talks will be given.
      This was e.g. discussed and documented in the ECFA roadmap meetings/documents.
  - 3 types of talks foreseen in each session (with flexibility to adjust to the subject)
    - [1] Community composition and interest
      - Analysis of the questionnaires for the particular activity
    - [2] Foreseen R&D activities, challenges and strategic R&D needs
    - [3] Outline of Milestones and Deliverables for the proposal
  - Talks are kept short (15 minutes or less), to leave ample time for discussions
- Your (future DRD3 members) active participation in the discussions is needed!
- Minutes of each session will be taken and attached to the session
- Written feedback/input much welcome as well: drd3-proposal@cern.ch



From RD50 to DRD3

- Some comments from RD50 perspective:
  - We fully support the transition into the new scheme
  - We propose to keep some well established RD50 concepts (small common fund contributions, common projects, …)
  - Detailed discussion tomorrow afternoon

- DRD3 is not RD50^{++}, but a new collaboration!



DRD3

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  - Detailed discussion tomorrow afternoon!

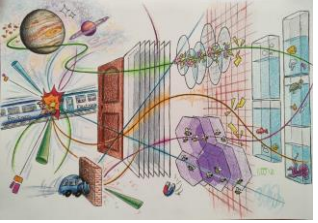
- DRD3 is not RD50^{++}, but a new collaboration!

also by very elemental means

RD50

Workshop coffee breaks & logistics support offered by RD50

[453 registered participants, 77 in-person (?)]



The RD50 Collaboration

- RD50: 65 *institutes and 438 members*

50 European institutes

Austria (HEPHY), **Belarus** (Minsk), **Czech Republic** (Prague (3x)), **Finland** (Helsinki, Lappeenranta), **France** (Marseille, Paris, Orsay), **Germany** (Bonn, Dortmund, Freiburg, Göttingen, Hamburg (Uni & DESY), Karlsruhe, Munich (MPI & MPG HLL)), **Greece** (Demokritos), **Italy** (Bari, Perugia, Pisa, Trento, Torino), **Croatia** (Zagreb), **Lithuania** (Vilnius), **Montenegro** (Montenegro), **Netherlands** (NIKHEF), **Poland** (Krakow), **Romania** (Bucharest), **Russia** (Moscow, St.Petersburg), **Slovenia** (Ljubljana), **Spain** (Barcelona(2x), Santander, Sevilla (2x), Valencia), **Switzerland** (CERN, PSI, Zurich), **United Kingdom** (Birmingham, Glasgow, Lancaster, Liverpool, Oxford, Manchester, RAL)

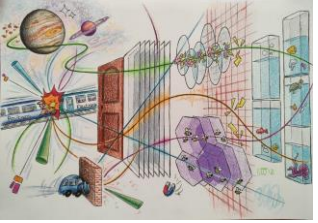
Full member list: www.cern.ch/rd50

8 North-American institutes

Canada (Ottawa), **USA** (BNL, Brown Uni, Fermilab, LBNL, New Mexico, Santa Cruz, Syracuse)

7 Asian institutes

China (Beijing-IHEP, Dalian, Hefei, Jilin, Shanghai), **India** (Delhi), **Israel** (Tel Aviv)

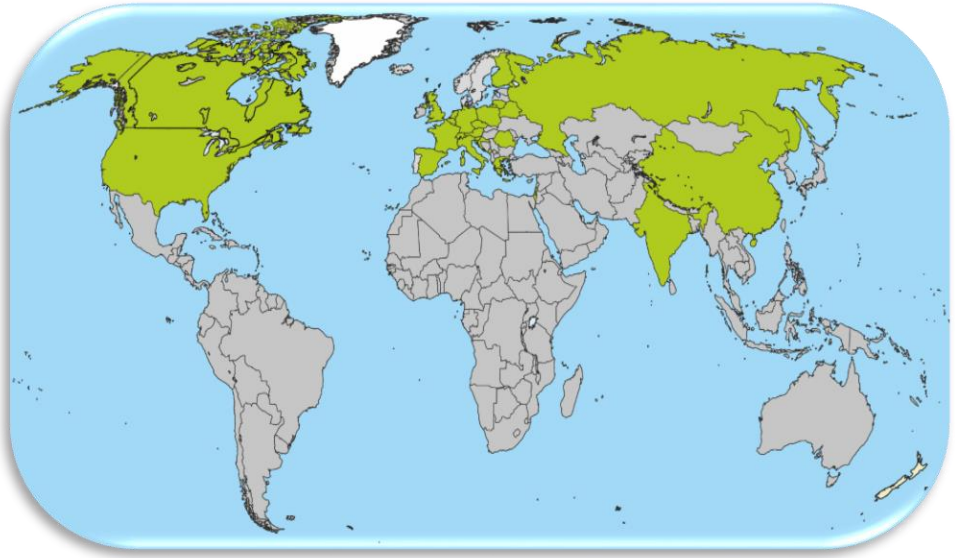


From RD50 to DRD3

Status: 17.3.2023

RD50

- 65 institutes; 438 members
  - 50 in Europe
  - 8 in North America
  - 7 in Asia



57 RD50 institutes*
(88% of RD50)

+ 35 other institutes

In DRD3 ≈ 62% will be former RD50 members

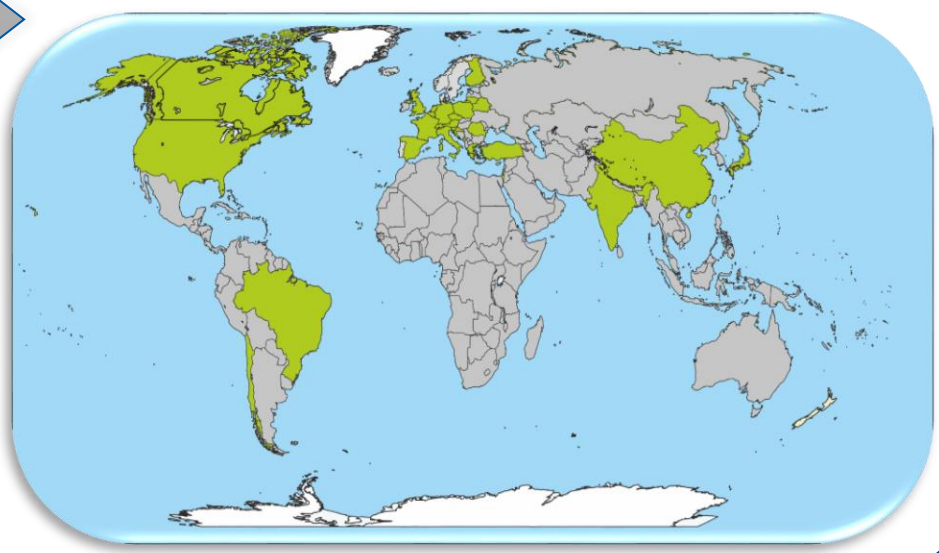
[*] 4 institutes included that did not send a questionnaire yet

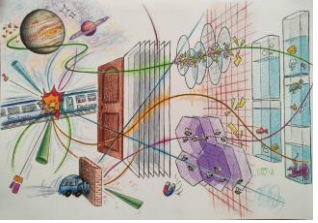
DRD3

(expression of interest)

- 92 institutes* (+27 institutes)
  - 68 in Europe (+18)
  - 12 in North America (+4)
  - 9 in Asia (+2)
  - 3 in South America (+3)

More detailed statistics in following presentation





RD50 Organizational Structure & Work Program

DRD3

Covering all fields of semiconductor detectors exposed to radiation

Co-Spokespersons

Gianluigi Casse (Liverpool University, UK) and *Michael Moll* (CERN EP-DT)

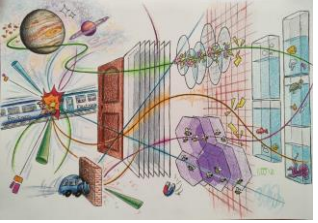
Targeting new solid-state detector technologies including high precision 4D detectors

RD50

RD50 ending on 31.12.23

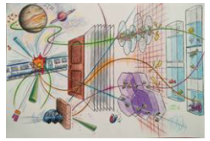
Defect / Material Characterization *Ioana Pintilie* (NIMP Bucharest)	**Detector Characterization** *Eckhart Fretwurst* (Hamburg University)	**New Structures** *Giulio Pellegrini* (CNM Barcelona)	**Full Detector Systems** *Gregor Kramberger* *(Ljubljana University)*
• Characterization of microscopic properties of standard-, defect engineered and new materials; pre- and post- irradiation • DLTS, TSC, …. • SIMS, SR, … • NIEL (calculations) • Cluster and point defects • Boron related defects • SiC/GaN based detectors	•Characterization of test structures (IV, CV, CCE, TCT,.) •Development and testing of defect engineered devices •EPI, MCZ and other materials •NIEL (experimental) •Device modeling •Operational conditions •Common irradiations •Very high radiation fluences • Wafer procurement (M.Moll) • Acceptor removal (Kramberger) • TCAD modeling (J.Schwandt)	• 3D detectors • Thin detectors • Cost effective solutions • Other new structures • Detectors with internal gain • LGAD:Low Gain Avalanche Det. • Deep Depleted Avalanche Det. • Slim Edges • HVCMOS • LGAD (S.Hidalgo) • HVCMOS (E. Vilella)	• LHC-like tests • Links to HEP (LHC P2, FCC) • Links electronics R&D • Low rho strips • Sensor readout (Caribou,Alibava) • Comparison: - pad-mini-full detectors - different producers •Radiation Damage in HEP detectors •Timing detectors •Test beams (M.Bomben & G.Casse)

Collaboration Board Chair & Deputy: G.Kramberger (Ljubljana) & D.Münstermann (Lancaster), Conferences: U.Parzefall (Freiburg), EXSO: R.Costanzi, CERN contact: M.Moll (CERN), Common projects: M.Moll (CERN), Secretary: V.Wedlake (EP-DT), Budget holder: M.Moll & M.Glaser (CERN)



DRD3 organizational structure ?

- DRD3 will have wider scope, more members (+50%), a long-term strategic reach (i.e. going beyond HL-LHC) and (hopefully soon) additional strategic R&D resources
- .. will need a larger organizational structure



Committees (IP, speakers, reporting, DRD synergies …)

Collaboration board (CB chair, deputy chair)

Administration

Spokespersons (& deputies)

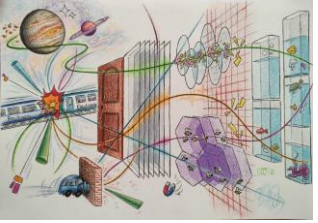
DRDC (ECFA-CERN)

DRD3 in operation on 1.1.24 (target!)

WG 1 (DRDT3.1) Monolithic CMOS sensors	WG 2 (DRDT3.2) Sensors for tracking and Calorimetry with space/time and/or energy resolution	WG 3 (DRDT3.3) Radiation damage and ultra high fluences	WG 4 (DRDT3.x) Simulations	WG 5 (DRDT3.x) New Characterization Methods, Techniques and Infrastructures	WG 6 (DRDT3.3) Non-silicon semiconductor and other material studies	WG 7 (DRDT3.4) Interconnect and device Fabrication technologies	WG 8 Dissemination and outreach
• Investigate Monolithic Active Pixel Sensors (MAPS) than may achieve very high spatial • resolution and very low mass. • Understand radiation hardness limits of MAPS. • Investigate the use of State-of-the-art commercial CMOS imaging sensor in in tracking and vertex detectors. • Explore the use of passive CMOS as a complement to standard sensors.	• Develop ultra-fast detectors, enabling 4D tracking to deal with multiple interactions occurring within a bunch crossing (pile-up). • Understand the ultimate limit of precision timing in sensors, with and without internal multiplication. • Investigate new semiconductor and technology processes with faster signal development and low noise readout properties.	• Undestrand microscopic properties of detectors at extreme fluences. • Understand the limit of WBG semicondcuntos at high fluences. • Study innovative materials	• Verify and prepare the TCAD tools for use in various DRDTs • Develop and implement new radiation hardness models and device parametrizations • Improve and develop MC tools • Design common tools for data processing (digitization, electronics)	• Explore the use of new techniques to characterize detectors at extreme fluences and for timing. • Develop new methods for radiation detectors fabricated in innovative materials • Test beam organization • Irradiation facilities, including extreme fluences.	• Understand the detailes of the damage of the WBG semicondcuntos • ….	• Advanced Integration Technologies. • Process capabilities for different wafer sizes and sensor material types. • Alternative bonding technologies for ultra-thin wafers. • Reduction of interconnection pitches	• Participation in congress • Explore other applications: ➢ Nuclear physics ➢ Astrophysics ➢ Fusion • Contact industrial partners. • Participation in EU or similar funding projects • Website

Note: This is just a proposal for a structure; DRD3 will be in charge of defining its own internal organization

…discussion tomorrow afternoon.



RD50 to DRD3: Lets take the opportunity…

- The scientific goals for solid-state detector developments for the forthcoming years have been deeply evaluated and documented in the ECFA roadmap by our community.
- The DRD3 proposal will (as we see it) fully align with those goals
- We are reshaping now the way we organize, monitor and fund our research work in going from the LHCC monitored to the DRDC monitored R&D programs and we now embrace the full HEP landscape of solid-state detector developments in a single research collaboration.
- Take the opportunity to shape the future ..
  … by actively participating in this workshop, the proposal writing ..
  …. and in the setting up and running of DRD3!