SLHC Upgrade Areas of Promise

Some areas where the lab and division might make a significant contribution to the SLHC

Many of the inner detector choices depend on reliable tests of radiation effects – RD50 is involved in this

RD50 - Development of Radiation Hard Semiconductor Devices for High Luminosity Colliders

280 Members from 55 Institutes

Main Objective

Development of ultra-radiation hard semiconductor detectors, able to withstand fast hadron fluences and doses as expected for luminosity upgrade of the LHC to 10^{35} $cm^{-2}s^{-1}$.

47 European and Asian institutes (34 west, 11 east)
Belgium (Louvain), Czech Republic (Prague (2x)), Finland (Helsinki (2x), Oulu), Germany (Berlin, Dortmund, Erfurt, Halle, Hamburg, Karlsruhe), Greece (Athens), Italy (Bari, Bologna, Florence, Milano, Modena, Padova, Perugia, Pisa, Trento, Trieste, Turin), Lithuania (Vilnius), Norway (Oslo (2x)), Poland (Warsaw), Romania (Bucharest (2x)), Russia (Moscow (2x), St.Petersburg), Slovenia (Ljubljana), Spain (Barcelona, Valencia), Sweden (Lund) Switzerland (CERN, PSI), Ukraine (Kiev), United Kingdom (Exeter, Glasgow, Lancaster, Liverpool, London, Sheffield, University of Surrey)

7 North-American institutes
Canada (Montreal), USA (Fermilab, Purdue University, Rutgers University, Syracuse University, BNL, University of New Mexico)

1 Middle East institute
Israel (Tel Aviv)

Detailed member list: http://cern.ch/rd50

Mara Bruzzi on behalf of the RD50 Collaboration – IEEE NSS MIC 2003, October 19-24, 2003

RD50 - Scientific objectives and strategies

Three R&D strategies:

- **Material engineering**
  - Defect engineering of silicon (oxygenation, dimers, …)
  - New detector materials (SiC, …)
- **Device engineering**
  - Improvement of present planar detectors (3D detectors, thin detectors, cost effective detectors,…)
- **Variation of detector operational conditions**
  - Low temperature operation
  - Forward bias operation

} RD50 Center of gravity

Further key tasks:

- Basic studies
- Defect modeling and device simulation

RD 50

Irradiation Facilities

The following list contains irradiation facilities made available to members of the RD50 collaboration:

BNL (Gamma 1.17 and 1.33 MeV)

CERN (24 GeV/c protons, 1 MeV neutrons)

NCSR "Demokritos" (Gamma, protons, neutrons)

Paul Scherrer Institut (300 MeV/c pions)

Université catholique de Louvain (Neutrons 1 to 70 MeV, Protons 10 to 75 MeV, Heavy Ions)

University of Karlsruhe (26 MeV protons)

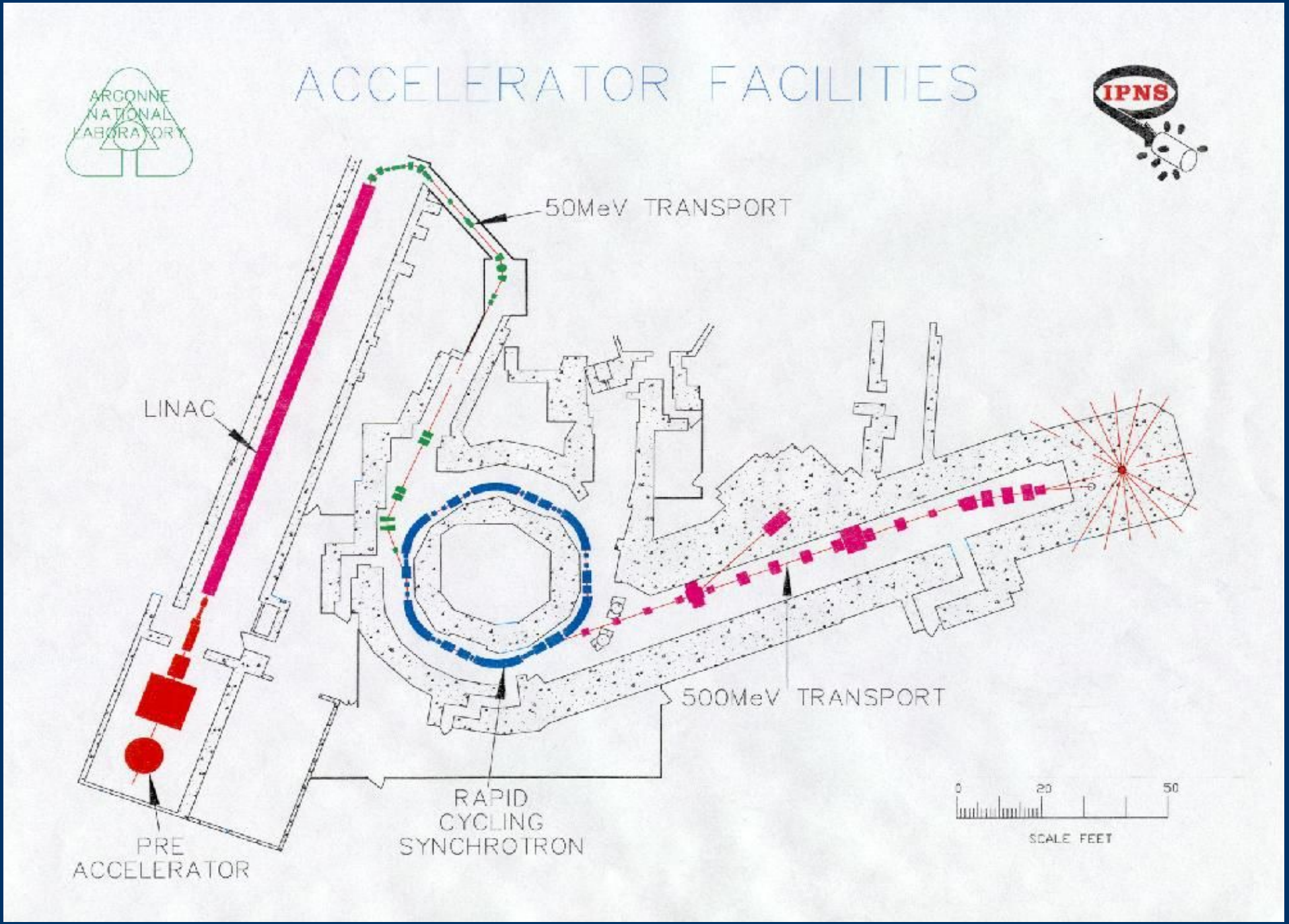
University of Ljubljana (Neutrons)

Université de Montréal (Protons up to 11 MeV, ions up to 5.5 MeV/charge)

University of Padua (27 MeV Protons, 58 MeV Lithium ions, 102 MeV Carbon ions, heavier ions)

Uniwersytet Warszawski (Heavy ions from 22 to 190 MeV)

Uppsala universitet (Protons 500 keV to 10 MeV, ions 1 to 50 MeV)


ARGONNE NATIONAL LABORATORY
ACCELERATOR FACILITIES
IPNS
50MeV TRANSPORT
LINAC
500MeV TRANSPORT
RAPID CYCLING SYNCHROTRON
PRE ACCELERATOR
0
25
50
SCALE FEET

IPNS as a resource for RD50

- Energy ~1MeV
- Measured exposure
- High intensity
- SSC era studies done in collab. with Penn. (see example to right)

ACL Job No. 90-4037

NEUTRON FLUENCES AND ACTIVITIES FOR HEP IRRADIATIONS AT IPNS-H2

Sample	Neutron Fluence n/cm^2	Activation Rate (at/at-s) (±%) $^{59}Co(n, \gamma)^{60}Co$ ($x10^{-14}$)	$^{58}Ni(n, p)^{58}Co$ ($x10^{-17}$)
35	4.21×10^{11}	13.5 (7.0)	10.5 (8.0)
36	2.43×10^{11}	7.39 (8.0)	6.49 (10.0)
37	9.23×10^{12}	69.4 (5.0)	109 (5.0)
38	6.55×10^{12}	63.0 (5.0)	62.5 (5.0)
39	6.08×10^{13}	149 (5.0)	141 (5.0)
40	8.00×10^{13}	169 (5.0)	216 (5.0)
41	1.01×10^{14}	173 (5.0)	317 (5.0)

The neutron fluences for the dosimeter wires from your IPNS-H2 irradiation on 11/7/89 are shown in the above table; these values were determined as outlined in L. Greenwood's memo of 6/2/89. The absolute uncertainties in these fluences are 15%.

The uncertainties for the activation rates are propagated from the relative difference between duplicate counts with an added 2% to account for calibration uncertainties.

New Si Det. types

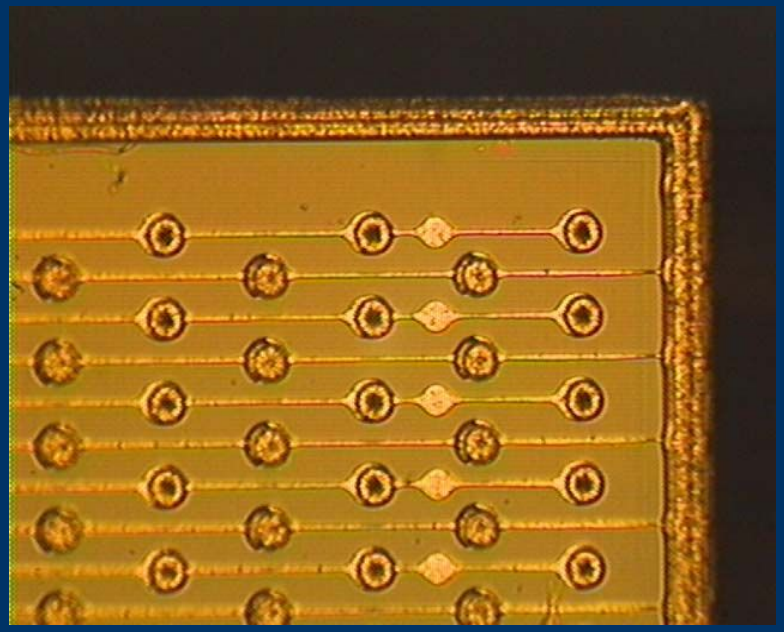
Speed -- 3D vs. planar

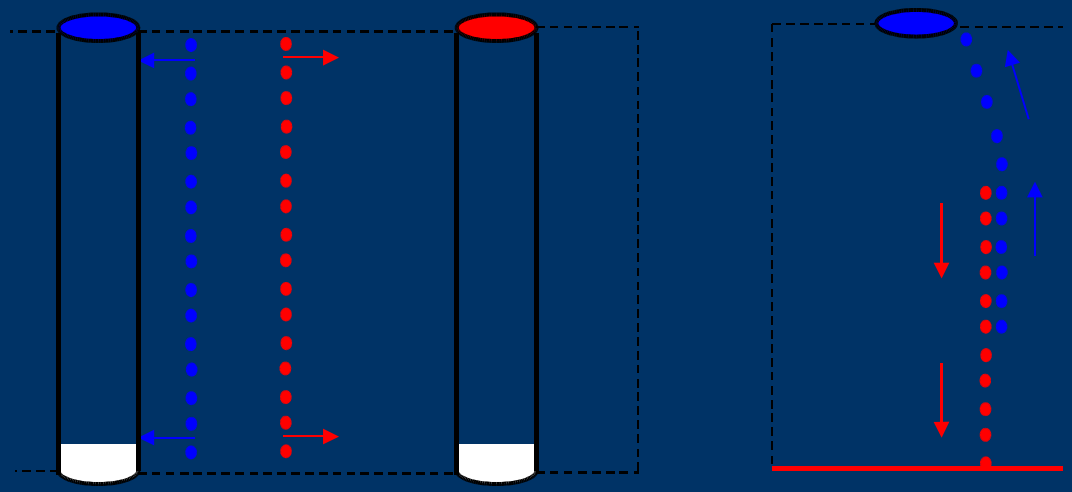
1. 3D lateral cell size can be smaller than wafer thickness, so: shorter collection distances

2. in 3D, field lines end on cylinders rather than on circles, so: higher average fields for any given maximum field
(price: larger $C_{electrode}$: we now have 0.2 pF / 121 ?m long electrode)

3. most of the signal is induced when the charge is close to the electrode, where the electrode solid angle is large, so:

planar signals are spread out in time as the charge arrives
3D signals are concentrated in time as the track arrives





4. if readout has inputs from both n^+ and p^+ electrodes,
drift time correction could be made

5. for long, narrow pixels and fast electronics, track locations within the pixel could be found

Something the *Center for Nanoscale Materials could do?*

ATLAS Front End and LVL1

- Switch to 12.5ns from 25ns. will have a big impact on frontend electronics
  - LVL1 probably needs substantial rebuilding
  - detector readouts need to be reviewed and in some cases redesigned
- ATLAS LVL1 knows nothing of tracking or Si
  - could or should this be changed
    - if there is a need this has a BIG impact on Si readout design (i.e. need to read it all out not JUST LVL1 accepts)
    - study should be done now on whether this has utility to make sure that Si design proceeds accordingly