Fermilab Long Range Planning Accelerator R&D Subcommittee

"YOUNG SESSION"

1) P. Bauer, Future HEP synchrotrons - summary of proposals and R&D issues (20 mins)
2) P. Piot, Linear acceleration schemes and possible related R&D topics at FNAL (20 mins)
3) N. Barov, High power microwave generation using planar structure lasertrons (10 mins)
4) M. Huening, R&D toward polarized rf-gun electron source (10 mins)
5) G. Schvets, Concept, design, and fabrication of a laser-driven surface wave accelerator (10 mins)
6) A. Jansson, Beta-beams at Fermilab (10 mins)

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FUTURE HEP MACHINES AND RELATED R&D ISSUES

PART I - SYNCHROTRONS

P. Bauer

OUTLINE

1. Post LHC Hadron Colliders
2. Proton-Drivers
3. Neutrino Factories
4. Muon Colliders
5. Ion Colliders
6. B-factories
7. Summary

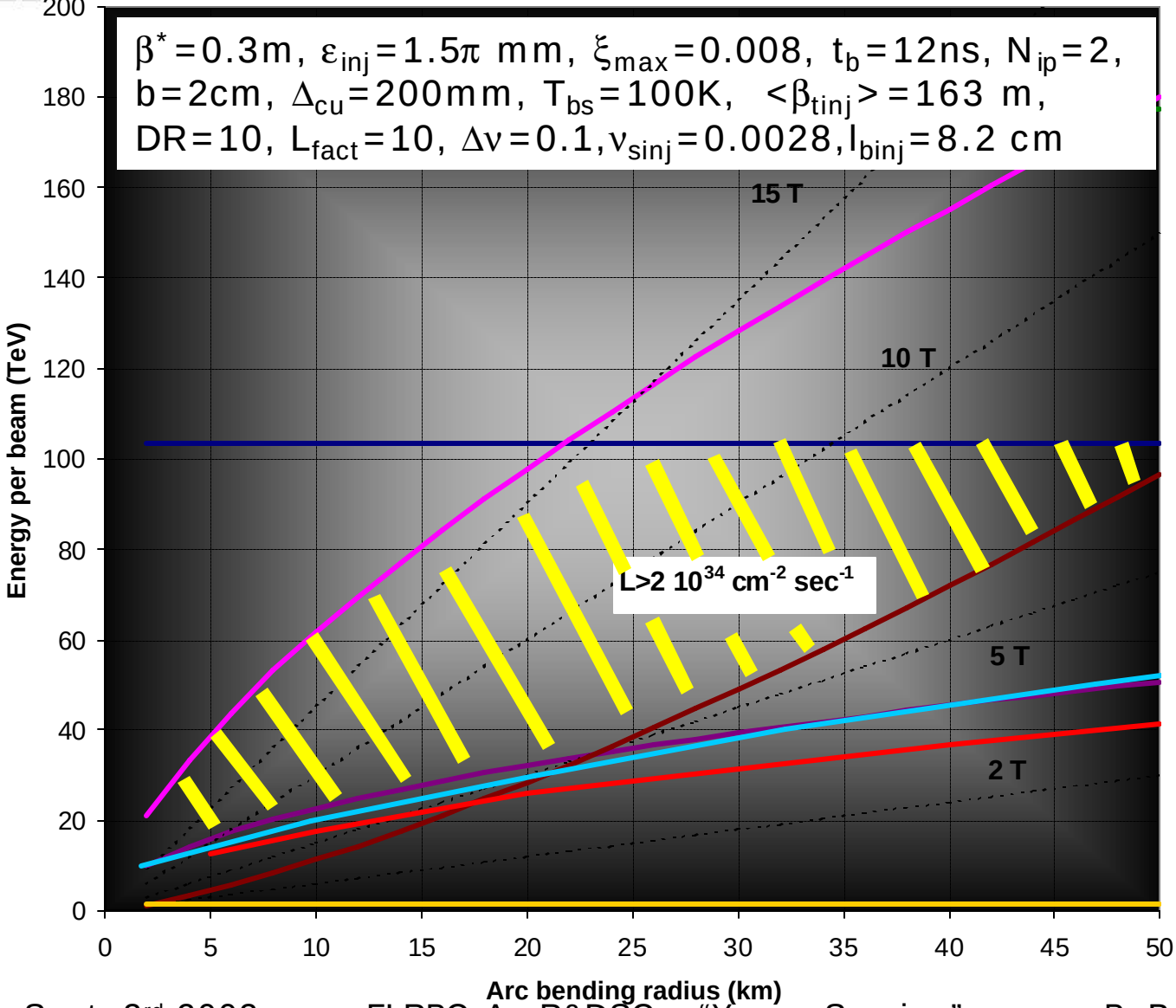
1. FUTURE HADRON COLLIDERS

Summary of major post LHC hadron collider proposals:

	RLHC-1/2/3	VLHC-1/2	LHC-II
Date of first proposal	1996	2001	2002
Collision energy (TeV per beam)	50	20 / 87.5	12.5
Injection energy (TeV per beam)	3	0.9 / 10	1
Dipole field at collision (T)	1.8/9.5/12.6	2 / 9.8	15
Machine circumference (km)	646/138/104	233	27
Total installed site power (MW)	?/?/?	35 / 250	~200
(Peak) synchrotron radiation power (W/m/beam)	0.07/1/2	0.03 / 4.7	13
Peak luminosity ($\times 10^{34} cm^{-2} sec^{-1}$)	1/ 1/1.2	1 / 2	10

Design still under discussion, medium (~6 T) field designs not studied, technical and cost optimum not necessarily the same?

PHYSICS LIMITATIONS IN FUTURE HCs



60 events/crossing

10 W/m/beam peak SR power

50 kW debris power/beam

t_{RW}**>1 turn**

d_{QL}**<0.2**

t_L/t_{rad}**=2**

N<N_{TMCI}

x**<0.008**

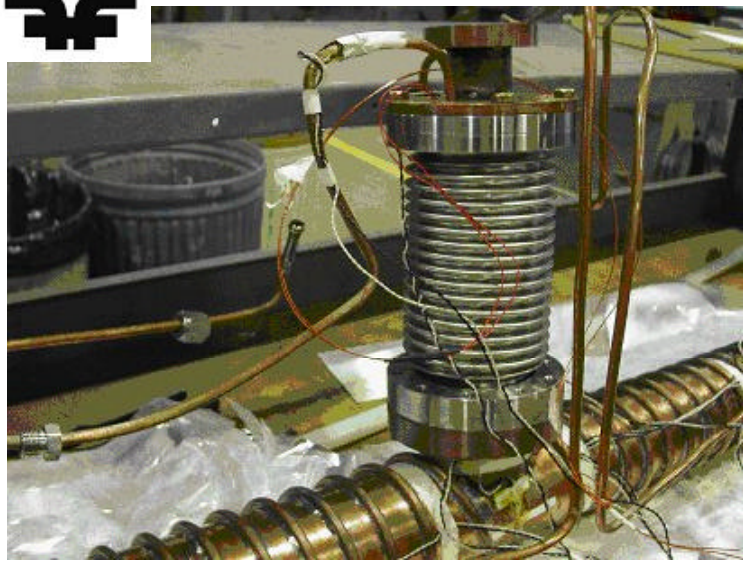
FUTURE HADRON COLLIDER R&D ISSUES:

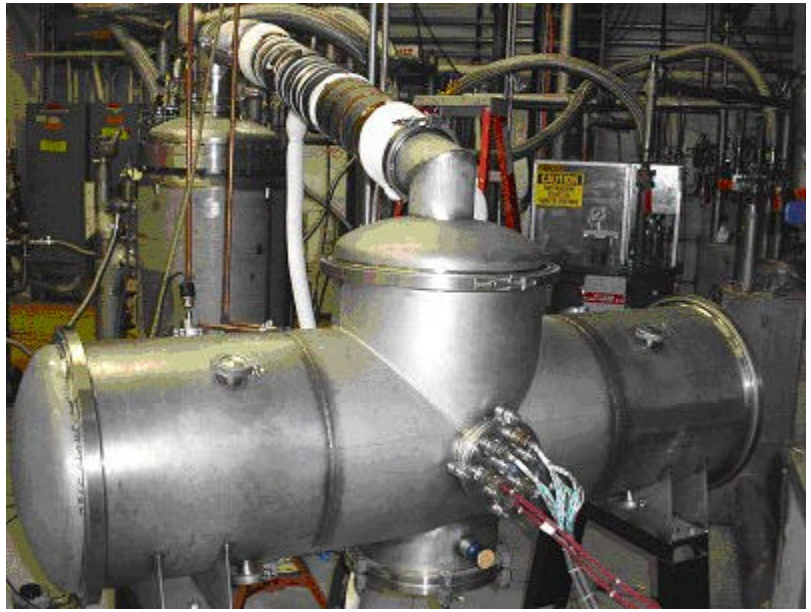
1. magnet technology and cost

2. synchrotron radiation management – g-stops
3. beam stability – feed-back systems, "super-beam-pipe"
4. IR engineering – collimation, magnets
5. Superbunches, e-cloud, e-lenses, e-cooling,..

 Tevatron R&D

Successful test of 1st photon stop prototype at FNAL





2. PROTON DRIVER SYNCHROTRONS

- **Versatility:**

  in support of existing proton programs

  neutrino experiments / neutrino factory

  muon factory

  source of ion and other "exotic" beams

- **Physics?**

2. PROTON DRIVER SYNCHROTRONS

Existing and proposed proton driver synchrotrons:

Project	Inst.	p-driver	Ep (GeV)	P (MW)	Np/fill ´ 10^{13}	Np/(~10^{7}s) ´ 10^{20}
NUMI	FNAL	MI	120	0.4	4	1.84
CNGS	CERN INFN	SPS	400	0.2	9	0.3
JPARC - JHFn	JAERI	50 GeV PS	50	1-4	33	10-41
NuFact?	FNAL	BoosterS	16	1.2	3	45
Nufact?	BNL	AGSupgr	24	1	10	25
SIS100	GSI		30	0.5	2.5	10
SNS	OR	SC Linac	1	1.4	1.5	876
SCRF Linac	CERN	LEP cavities	2.2	4	23	1150*
8GeVBL	FNAL	SC LIN	8	1-4	15	150

Other potential applications: proton radiography, medical;

ISSUES in PROTON DRIVERS

- targetry → E951/BNL
- repetition rate → FFAGs (Scaling, Non-scaling!)
- filling efficiency
- laslett tune shift –
  space charge effects
  beam stability
- losses – radiation

3. NEUTRINO FACTORY

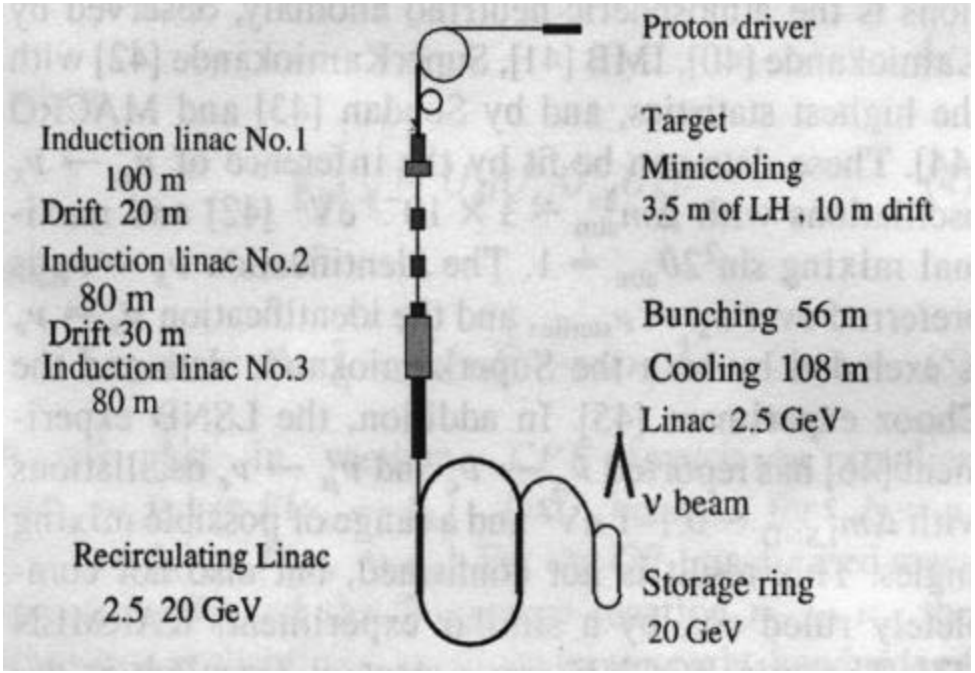
n-physics: oscillation

$n_{e,m}$ – unprecedented precision

long baseline / matter-effects

n_t oscillation

- **controlled flavor (n_e, n_m)**
- **high intensity (>10^{20}/yr)**
- **low divergence (<???)**
- **high energy (>10 GeV)**
- **50 GeV step to m-collider (?)**



BNL neutrino factory proposal

4. MUON COLLIDER

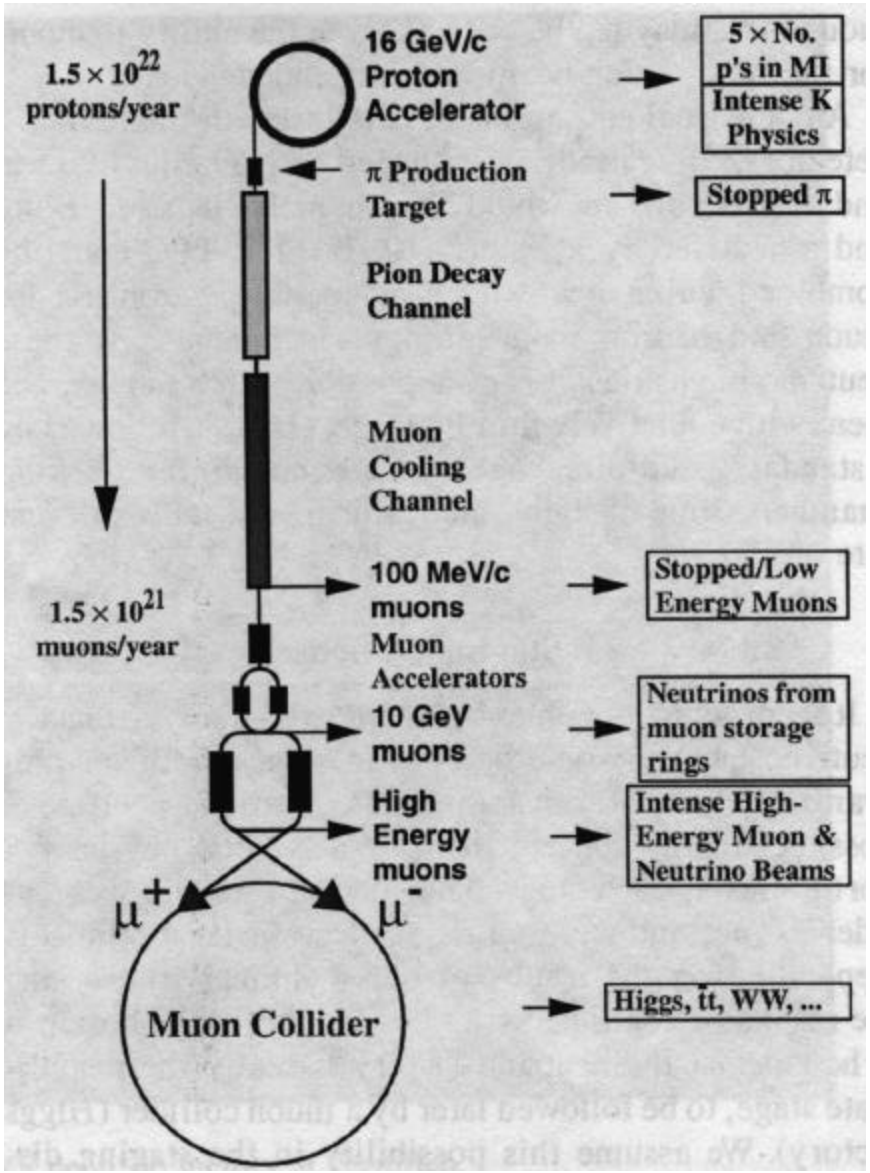
physics:

Higgs s-channel

E-frontier

m-physics

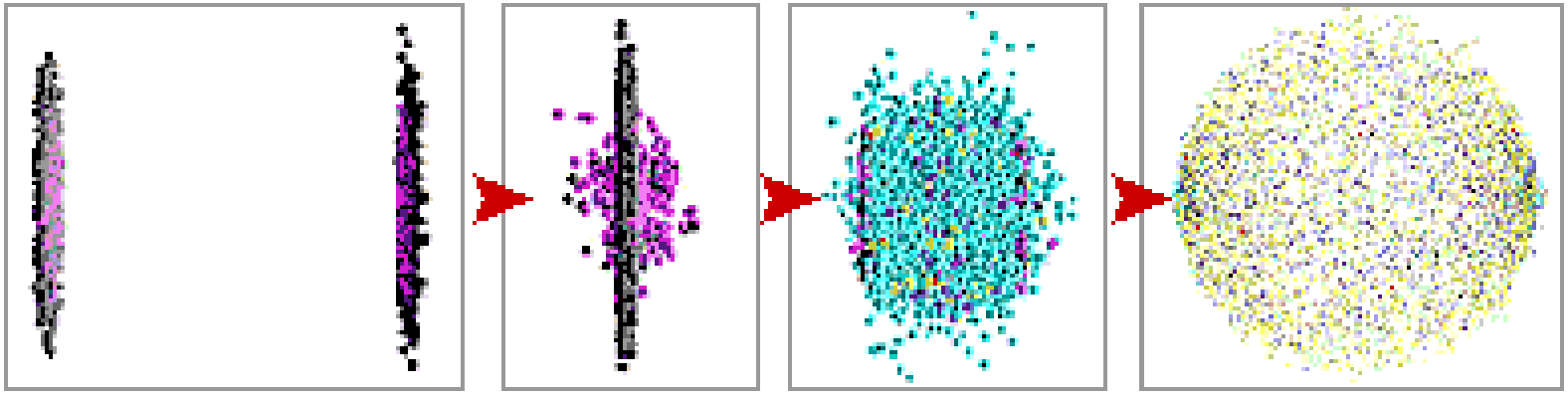
- **Higgs-factory (0.2 TeV cm)**
- **energy frontier (3-4 TeV cm)**
- **compact Tevatron-size**



3&4: n-FACTORY and m COLLIDER R&D

- **cooling:** → Mucool/FNAL; MICE/RAL; 6D ring-coolers?; no cooling – japanese design?
- **targetry** → see p-driver
- **rf:** → 200/800 Hz conventional RF FNAL/IIT/ANL; Cornell – 200 MHz SCRF
- **HFMs:** → Saclay, FNAL
- **radiation:** → radiation absorbers?

5. ION COLLIDERS



Simulation of Au-Au collision in RHIC

- accelerate heavy ion, rare isotope and pbar beams
- nuclear physics: p and n rich elements, nucleo-synthesis of heavy elements
- plasma physics: confinement fusion
- particle physics: QED in strong fields, QCD for high baryon density

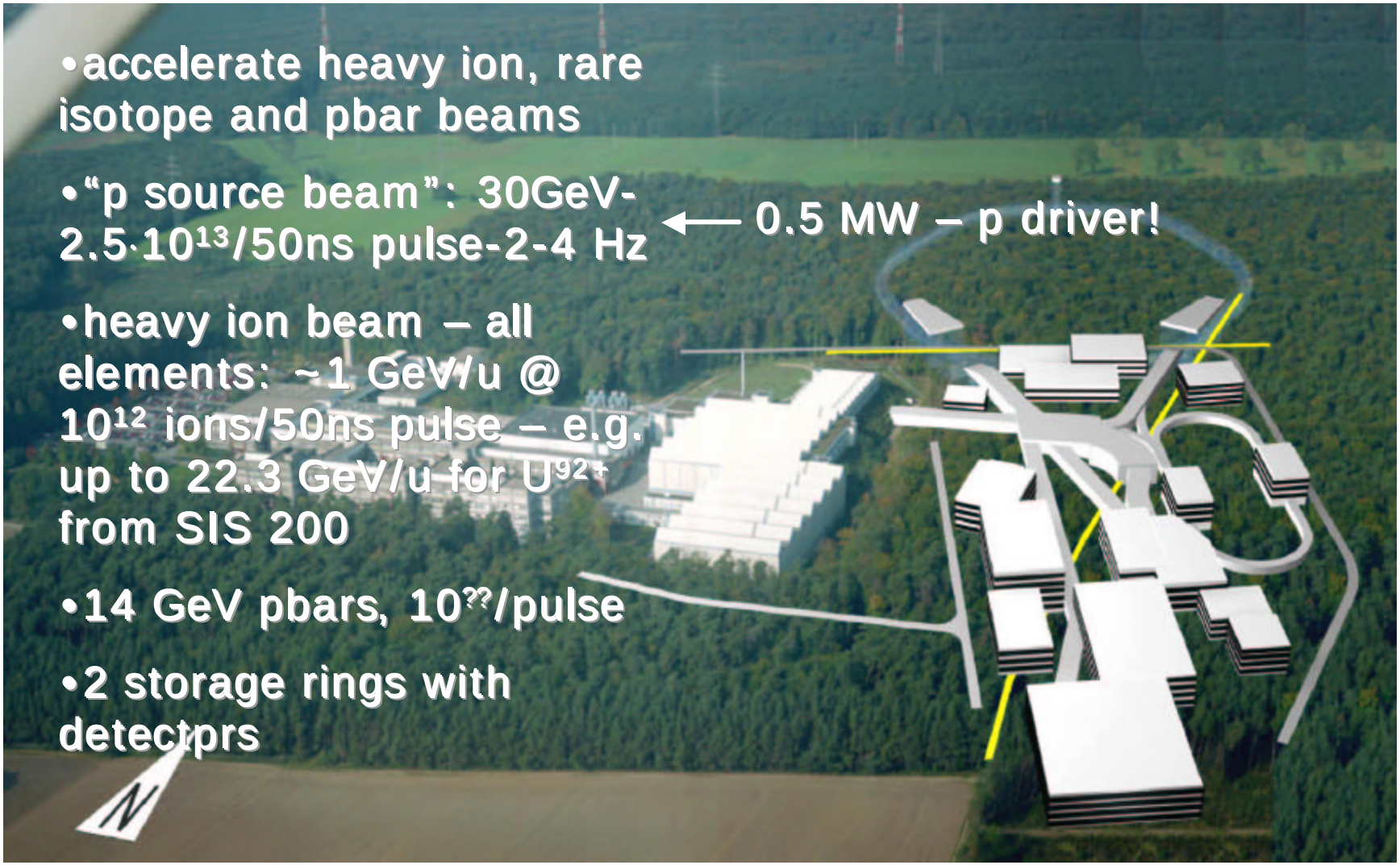
SUMMARY TABLE of MAJOR IC PROJECTS

Currently mostly parasitic (e.g. Isolde). Next generation of ICs mostly circular (e.g. SIS) to achieve higher E, but linear schemes are closing in (RIA)!

Machine	GeV/u	Beam	Stat.	Comment
ISOLDE/CERN	0.0031	Z=2-88	oper.	spall., fission, fragm.in thick target with 1-1.4 GeV p from PS booster
RHIC/BNL	100	Au^{79+}	oper.	10^{26}-$10^{27}cm^{-2}sec^{-1}$, strong IBS!!, high E (50 MeV) e-cool against IBS?
LHC/CERN	2760	Pb^{82+}	const	new injector linac, e-cool, strippers
RIBF/RIKEN	0.4	all	const	MUSES upgrade for 2009 approved
SIS100/GSI	1-30	all	plan.	SIS 200: 22.3 GeV/u for U^{92+}
RIA/NSCL-ANL	0.4-0.9	all species	plan.	SC cw linac (0.4 MW beam power) for spallation (p,He), fragmentation (HI) and fission (U), multiple state acceleration, Lithium strippers, fast gas catcher, post acceleration with RFQs for 1^+ ions of masses 1-240-u;

ICs are also of interest to HIF & Medical Accelerators;

GSI PROPOSAL: SIS 100 / SIS 200

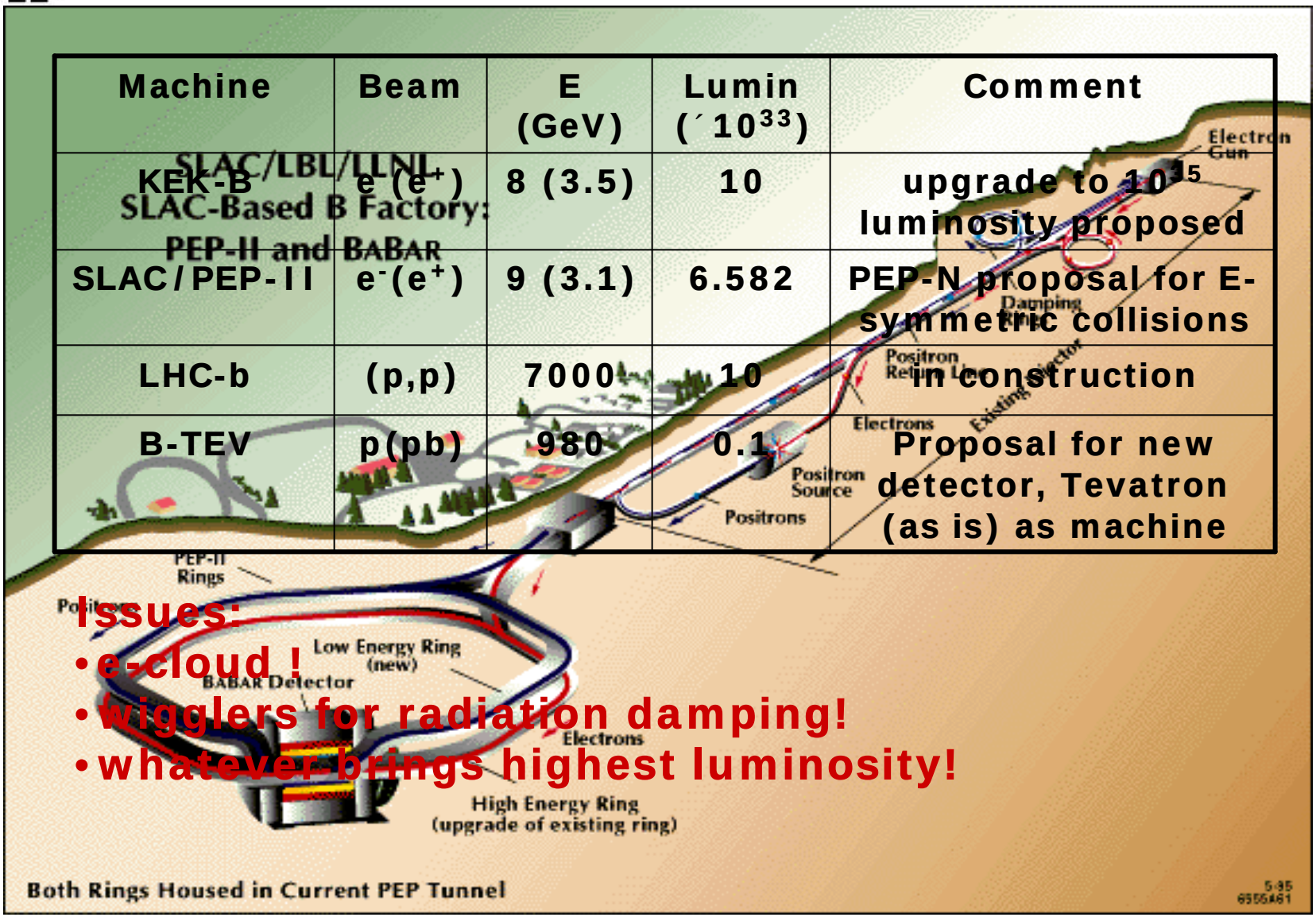


6. B FACTORIES

- heavy quark and heavy lepton sector (b, c quarks)
- Taus – 10^8/yr
- matter/antimatter – cp-violation

SUMMARY TABLE FOR MAJOR B-FACTORIES

Machine	Beam	E (GeV)	Lumin ($\acute{}10^{33}$)	Comment
KEK-B	$e^-(e^+)$	8 (3.5)	10	upgrade to 10^{35} luminosity proposed
SLAC/PEP-II	$e^-(e^+)$	9 (3.1)	6.582	PEP-N proposal for E-symmetric collisions
LHC-b	(p,p)	7000	10	in construction
B-TEV	p(pb)	980	0.1	Proposal for new detector, Tevatron (as is) as machine



Issues:

- **e-cloud !**
- **wigglers for radiation damping!**
- **whatever brings highest luminosity!**

SUMMARY

1. VLHC → Sure path to the future!

2. Proton-Drivers → "work-horse" – obviously good short term goal but not long term goal

3. Neutrino Factories
4. Muon Colliders

→ Parallel path to VLHC?

5. Ion Colliders
6. B-factories

→ BNL, SLAC, JLAB, ANL,..

END