

Protvino as a site  
for  
ILC detector test beams

**Alexander Kozelov**  
*IHEP ,Protvino, Russia*

# Outline

1. ILC requirements
2. IHEP accelerator parameters
3. General layout of beams
4. Proposed test beam zones
5. General questions
6. Conclusion

# ILC requirements

## 1. Calorimetric response for individual particles

( to test options and tune the simulation )

- beams: **h,e, $\mu$**
- momentum range: **(1 - 50) GeV/c**
- **different incident angles**
- statistics:  **$10^6$  per point,  $\sim 10^2$  points**

## 2. JET separation

(to test/tune energy flow reconstruction)

- different combinations of **e, h,  $\gamma$ ,  $\mu$**   
with open angles  **$\geq 6$  mrad**

# IHEP accelerator

**70 GeV accelerator  
complex for protons =**

**Linac - URAL-30, 30MeV**

**+**

**Booster – 1.5 GeV**

**+**

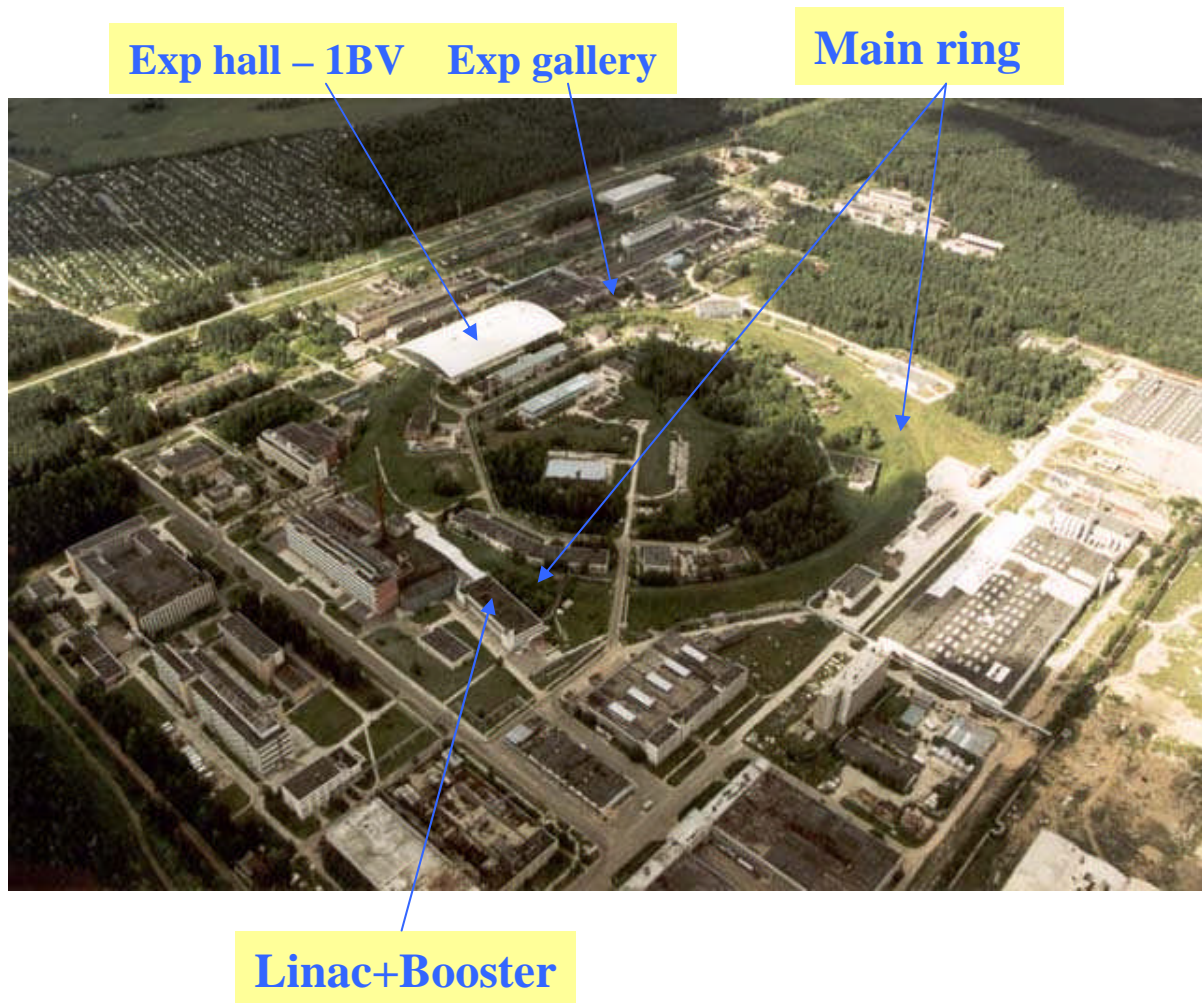
**Main ring – 70 GeV  
proton synchrotron**

**Works two times per year**

**March-April**

**Nov-Dec**

**For each run 1 month for  
physics**



# IHEP accelerator parameters

- cycle time - **10 s**
- spill time - **1.8 s**
- intensity  $\sim 1 \cdot 10^{13}$  p/cycle
- number of bunches - **30**
- RF structure: bunch length – **40 ns**,  
bunch spacing – **160 ns**
- beams are from extracted protons and internal targets

# Beams

In the 1BV exp hall are from internal targets with limited intensity ( $<10^{**7}$  part/spill):

- negative hadrons up to 55 GeV
- positive hadrons up to 20 GeV
- photons, electrons up to 30 GeV
- 70 GeV protons from crystals

In the exp gallery are from extracted protons, have high intensity :

- protons
- intensive secondary hadrons
- neutrino

# Beams in the 1BV hall

**These beams are suitable for tests**

Negative beams (outside ring):

- Beam line N 2
- Beam line N 4

Both lines have a few branches

Positive beams (inside ring):

- beam line N 18
- beam line N 6

**1BV exp hall  
Downstream view for  
beam line N 4**



# Proposed test beam zones

## In main 1BV hall:

- Beam line N 2B
- Beam line N 4V
- Soft hadron beam

## For extracted proton beams :

- beam line N 22



# Beam line N 2B

Tests with **e** and **h** beams can be done in one zone of beam line N 2B.

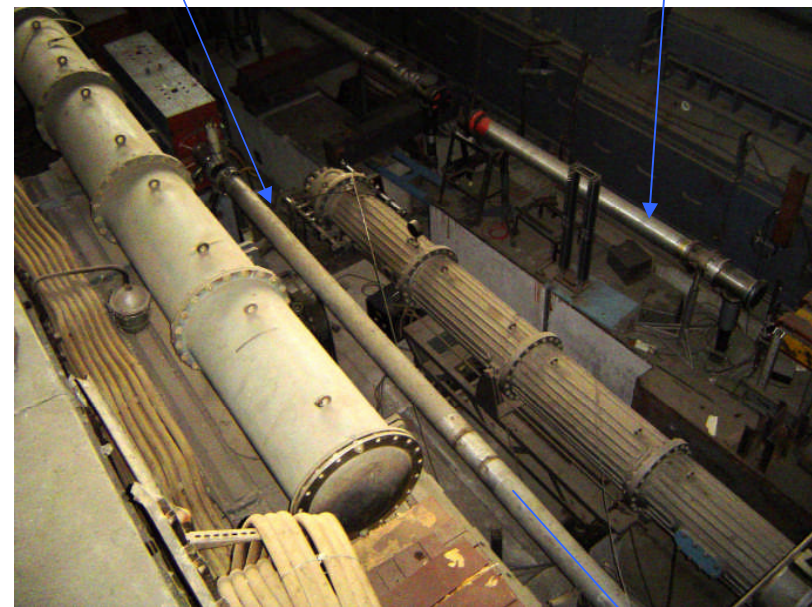
Particle type	Electron beam range, GeV/c	Hadron beam range, GeV/c
$e^-$	1- 45	-
$h^-$	1- 45	33 - 55
$\mu^-$	1- 45	33 - 55

Muon halo over 1 m<sup>2</sup> with intensity ~ 10\*\*6 can be used for monitoring purposes

Heads of beams

N 4

N 2



beam

# Beam line N 2B

## Electron beam

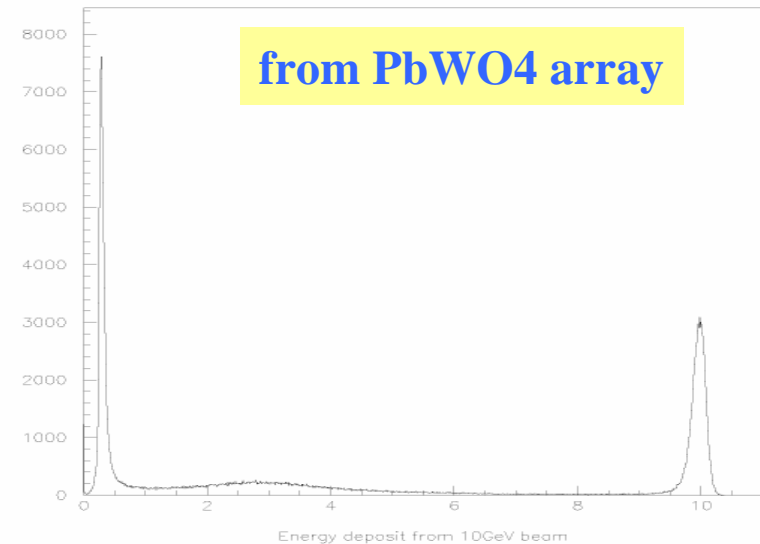
Energy, GeV	Beam resol., %	ECAL resol., %	BTS resol., %
1	4.3	11.0	2.05
2	5.5	7.8	1.03
5	5.6	4.9	0.43
10	3.8	3.5	0.24
27	1.2	2.1	0.15
45	1.0	1.6	0.13

- Beam tagging system allows to keep beam resolution  
~10 times better than expected ECAL resolution
- Beam spot,  $\varnothing \sim 3$  cm

# Beam line N 2B

## Electron beam

Energy, GeV	Intensity in spill on $10^{12}$ pot	Content		
		e, %	$\mu$ , %	h, %
1	$4 \cdot 10^2$	82	10	5
2	$1 \cdot 10^3$	77	15	8
5	$2 \cdot 10^3$	50	32	18
10	$5 \cdot 10^3$	34	35	30
27	$4 \cdot 10^4$	77	9	13
45	$2 \cdot 10^4$	91	4	5



Admixtures of  $h^-$  and  $\mu^-$  allow to measure calorimetric response simultaneously for  $e^-$ ,  $h^-$  and  $\mu^-$  using Cherenkov counter

# Beam line N 2B

## Hadron beam

- Momentum range  
(33-55) GeV/c
- Beam composition
  - $\pi^-$  96.4 %
  - $\mu^-$  1.0 %
  - $k^-$  2.3 %
  - $p^-$  0.3 %

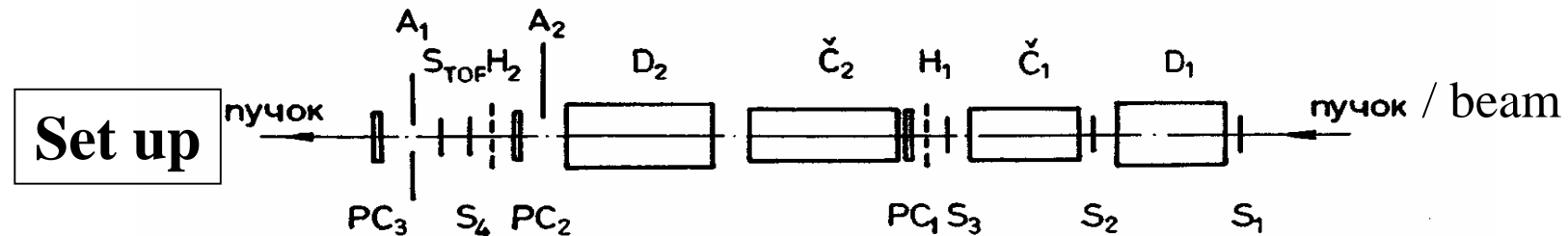
Intensity for  $\Delta p/p = \pm 1\%$

Energy, GeV	Intensity in spill on $10^{12}$ pot
33	$1 \cdot 10^6$
40	$3 \cdot 10^6$
55	$2 \cdot 10^5$

70 GeV proton beam is also available

# Beam line N 2B

## Beam monitoring system



$S_1 \div S_4, A_1, A_2$  - scintillation counters

$PC_1, PC_2$  - proportional chambers

$H_1, H_2$  - scintillation hodoscopes

$C_1, C_2$  - threshold cherenkov counters

$D_1, D_2$  - differential cherenkov counters

$S_{TOF}$  - time-of-flight scintillation counter

**Own DAQ system**

**Trigger signals are available**

**Beam experts are available**

# Beam line N 2B

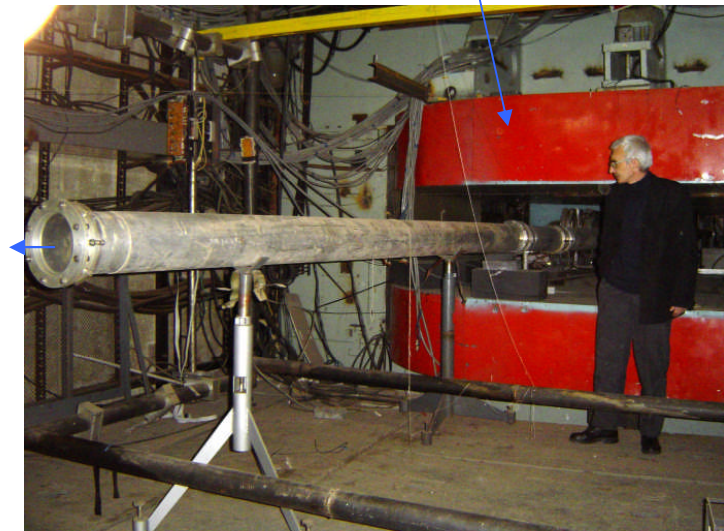
## Zone sizes:

- Beam height above flow      2.15 m
- 5/40 ton crane hook height      8 m
- Horizontal space      +/-3 m
- Longitudinal space      10 m

Two counting rooms (32 m<sup>2</sup> each)  
above zone are available with local net  
and internet connections

Part of test zone  
Beam axis is indicated by tube

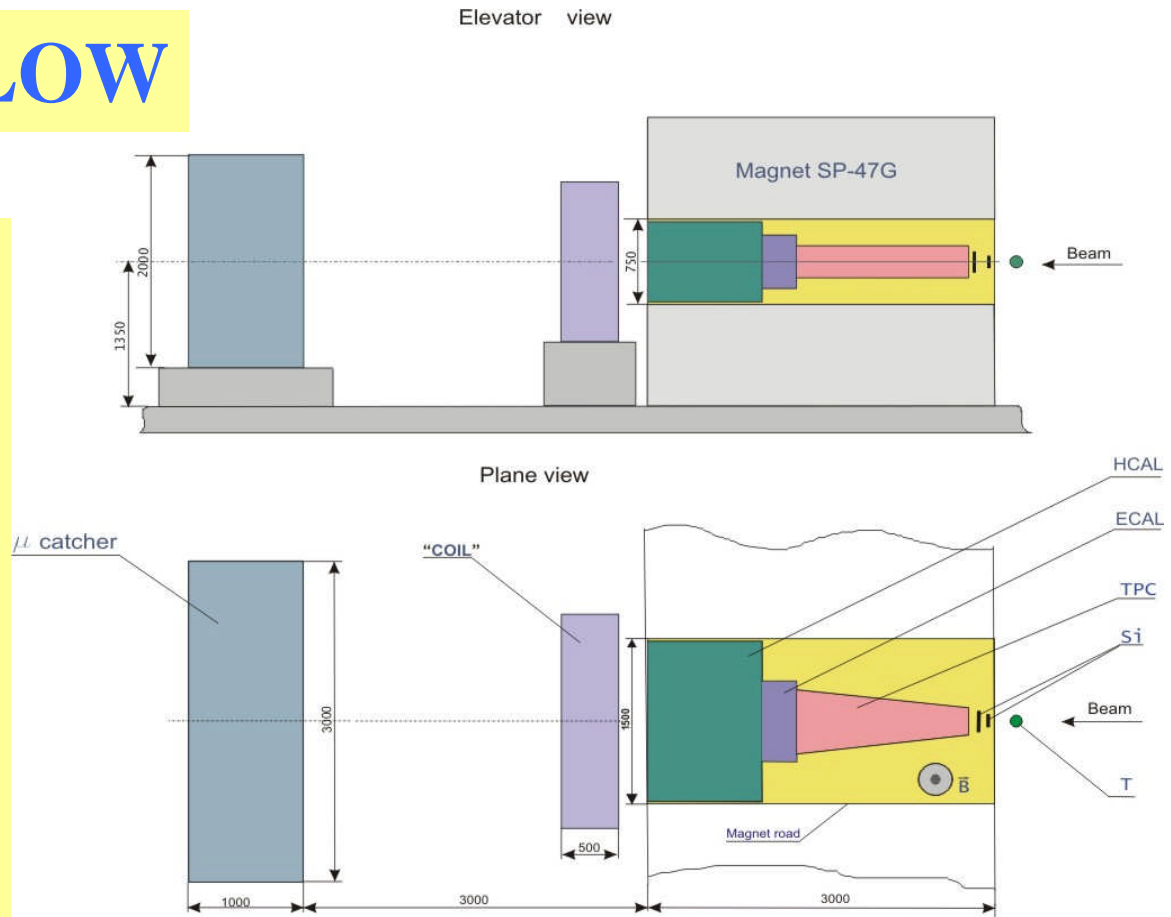
Antipov's SIGMA magnet



# Beam line N 2B for energy flow analysis

## Set up for EFLOW

- full TESLA sector  
from Si to  $\mu$  catcher
- in magnetic field
- expected acceptance
  - $\Delta tg\theta_{xz} \approx \pm 0.07$
  - $\Delta tg\theta_{yz} \approx \pm 0.20$
- requires to reconsider  
ECAL, HCAL,  $\mu$  ID  
lateral dimensions



# Beam line N 2B for energy flow analysis

## Magnet parameters

Parameter	Value	Comment
Aperture, cm <sup>2</sup>	75x150	-
Effective length, cm	300	300 for ILC
Magnetic field, T·m	4	12 for ILC



# Beam line N 2B for energy flow analysis

## Possible measurements

- inelastic  $\pi^-$  N interactions at (40-55) GeV/c  
with at least 2 particles within the set up acceptance
- $\pi^- p \rightarrow \pi^0 n$ ,  $\pi^- p \rightarrow \eta n$  reactions (  $\sim(10^{-3}-10^{-4})$  of  $\sigma_{tot}$ )  
to study the ECAL  $\gamma\gamma$  separation

$$\theta_{\gamma\gamma,\min} = 2m_m/E_m$$

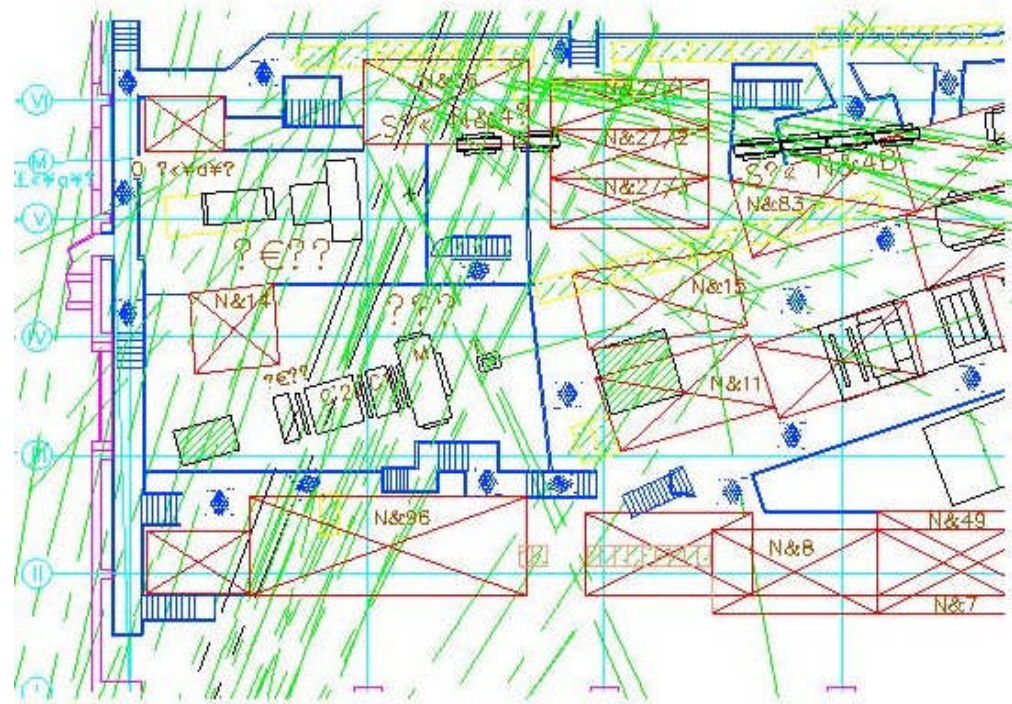
# Beam line N 4V

## Negative hadron beam

- 20 - 40 GeV/c
- intensity up to  $10^7$  pps  
(38 GeV/c at  $10^{12}$  pot)

## Electron beam

- 3 – 15 GeV/c
- intensity up to  $2 \cdot 10^4$  eps  
(10 GeV/c at  $10^{12}$  pot)
- Electron tagging system is also possible
- Beam spot,  $\varnothing \sim 3$  cm





# Universal beam line N 22

- **Proton beam:** up to 70 GeV/c ,  $I = 10^6 - 10^{10}$  pps
- **Secondary hadron beam**
  - negative: 7 - 60 GeV/c,  $I < 6 \cdot 10^8$  pps
  - positive : 7 - 60 GeV/c,  $I < 10^{10}$  pps
- **electron/positron beam:** 7 – 40 GeV/c ,  $I < 5 \cdot 10^5$  pps



# General questions

**Protvino is small town,  
~40000 people**

**Since 1963**

**~100 km south from  
Moscow**

**Connections by bus,  
~1.5-2 hours**

**IHEP was base of  
Protvino,**

**~0.5 km from town**

**Protvino**

**Protvino&IHEP**

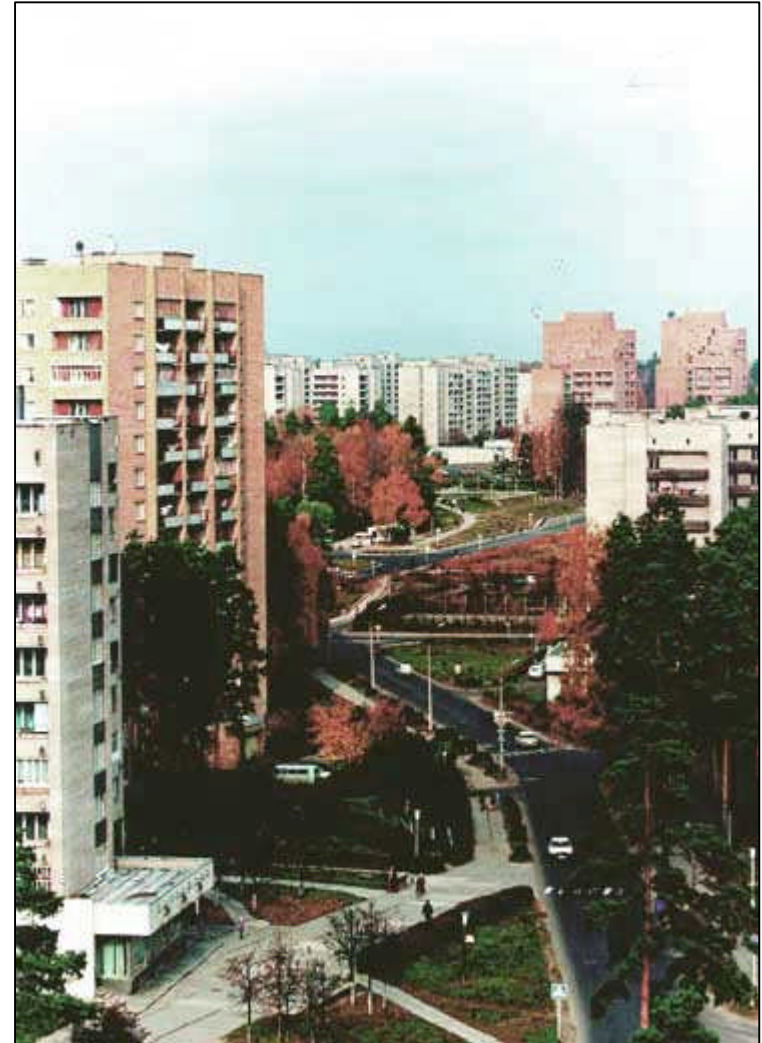


# Protvino town

## Some views



## From Protva river



Jan 17, 2007

A. Kozelov - IDTB07 Workshop at  
Fermilab

22



# General questions

**One year multi entry visas  
exist for any country**

**You are welcome !!**

**Protva hotel - 200 places**

**Costs**

**Double lux 24 Euro**

**Single lux 21 Euro**

**Single room 13 Euro**

**Double room 10 Euro**

**All with WC, Shower,TV  
and refreegirator**



# Conclusion

## Protvino is ideal site for ILC beam tests

### 1. Suitable range of particle momentum

$e^-$  : (1-45) GeV/c

$h^{+/-}$  : (1-60) GeV/c

$\mu^-$  : (1-55) GeV/c

### 2. Variety of test beam zones are available

**You are welcome !**

Beam time is available ~2 months/year (April, Nov-Dec)

Contact person: Dr. Vladimir Ammosov

e-mail: [ammosov@mail.ihep.ru](mailto:ammosov@mail.ihep.ru)